OPPOSING THE POWER OF PORTION SIZE:
TESTING STRATEGIES TO MODERATE THE PORTION SIZE EFFECT

A Dissertation in
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by
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ABSTRACT

The current eating environment is characterized by large portions of energy-dense foods. Epidemiological research suggests that larger portion sizes served in the home and in restaurants have contributed to the rising obesity rates. There is also conclusive evidence from experimental studies that serving a greater amount of food leads to increased food and energy intake (referred to as the portion size effect) and, moreover, that these effects on intake are sustained over time. These data clearly demonstrate the need for targeted strategies to moderate energy intake from large portions. Several different interventions to address the portion size effect have been proposed. One intervention that is often recommended is the provision of portion-control training to consumers; the effect of extended training on intake from large portions, however, has not been explored. Another approach is to address the role of food value in the portion size effect. For example, previous research indicates that paying more money for a meal results in greater intake, but whether the price paid for a meal influences the response to portion size is not known. Similarly, strategies to reduce waste, such as providing an opportunity to take away uneaten food after a meal, may attenuate the effects of large portions on intake by increasing the value of a meal. Investigating the influence of factors related to portion-control training and food value will result in a more comprehensive understanding of the portion size effect as well as methods to counter the effect.

The first study followed a one-year randomized controlled trial that tested how weight loss was influenced by providing training in different targeted strategies for managing food portions. In the present study, we evaluated whether the effect of portion size on intake in a controlled setting was attenuated in trained participants compared to untrained controls. Subjects were three groups of women: 39 participants with overweight and obesity from the Portion-
Control Strategies Trial, 34 controls with overweight and obesity, and 29 controls with normal weight. In a crossover design, on four different occasions subjects were served a meal consisting of seven foods that differed in energy density (ED). Across the meals, all foods were varied in portion size (100%, 125%, 150%, or 175% of baseline). The results showed that serving larger portions increased the weight and energy of food consumed at the meal ($P<0.0001$), and this effect did not differ across groups. Increasing portions by 75% increased food intake by a mean ($\pm$SEM) of 111±10 g (27%) and increased energy intake by 126±14 kcal (25%). Across all meals, however, trained participants had lower energy intake (506±15 vs. 601±12 kcal, $P=0.006$) and lower meal ED (1.09±0.02 vs. 1.27±0.02 kcal/g; $P=0.003$) than controls, whose intake did not differ by weight status. The lower energy intake of trained participants was attributable to consuming meals with a greater proportion of lower-ED foods than controls.

The second study focused on the role of value in the portion size effect. To do this, we tested whether the amount of money paid for a meal influenced the portion size effect at a lunch served in a controlled restaurant-style setting. In a crossover design, 79 adults (55 women; 24 men) came to the lab once a week for four weeks to eat a main dish of pasta with side dishes. Across weeks, the meal was varied in two factors: portion size of the main dish (400 g or 600 g) and cost of the meal ($8 or $16). At discharge subjects completed questionnaires that assessed behaviors thought to influence the response to portion size and cost. Results showed that the portion size of the main dish had a significant effect on meal intake ($P<0.0001$). The weight of food consumed at the meal increased by 18±2% (mean±SEM 83±11 g) and energy intake increased by 20±2% (133±16 kcal) when the larger portion was served. These effects of portion size did not differ across the two levels of cost (both interactions $P>0.37$) nor did meal cost have significant effects on meal intake (both $P>0.24$). Subject scores for satiety responsiveness did,
however, influence the effect of portion size on food intake ($P=0.0007$). Serving larger portions led to increased intake in subjects with lower satiety responsiveness scores ($P<0.0001$), but did not affect intake in those with higher scores.

The final study investigated a strategy that could increase value and reduce waste. We tested how the effect of portion size on meal intake was influenced by providing the option to take away uneaten food in a “doggy bag” (to-go container). Women were randomly assigned to one of two subject groups: a To-Go Group ($n=27$) that was informed before each meal that their leftover food would be packaged to take away after the meal, and a Control Group ($n=26$) that was not given this option. In a crossover design, subjects came to the lab once a week for four weeks to eat a dinner composed of five foods. Across meals, the portion size of all foods was varied (100%, 125%, 150%, and 175% of baseline). Results showed that the portion size effect differed significantly by subject group ($P \leq 0.025$). In the Control Group, increasing the portion size of all foods led to substantial increases in intake ($P<0.0001$); for every 100 g added to the baseline portion, women in this group consumed an additional mean ($\pm$SEM) of 64$\pm$12 g of food and 90$\pm$19 kcal, until intake leveled off. In contrast, intake of women in the To-Go Group increased by only 17$\pm$12 g and 19$\pm$18 kcal for every additional 100 g served; these increases did not differ significantly from zero ($P>0.15$). Thus, the effect of portion size on intake was attenuated in the To-Go Group compared to the Control Group.

These studies provide useful insight into the portion size effect and strategies to counter it. Although extended training in portion-control did not lead women to eat less food in response to larger portions, trained participants moderated their energy intake compared to controls. This was achieved by preferential selection of the healthful, lower-energy-density foods served at the meals, providing further evidence that reducing meal ED is an effective strategy to reduce energy
intake from large portions. The effect of portion size on food and energy intake was also robust
to differences in the amount of money paid for a meal. Although this does not preclude the
possibility of cost influencing the portion size effect (particularly in restaurant settings or across
different foods), it does suggest that other facets of value are more influential in determining
intake from large portions. In contrast, higher satiety responsiveness was associated with an
attenuation of the portion size effect. We also found that providing the option to take away
uneaten food influenced the response to portion size. Thus, packaging uneaten food after a meal,
which can increase value and reduce waste, is an effective strategy to reduce overconsumption
from large portions. Considered together, these studies demonstrate that strategies to counter the
effects of large portions should include training to preferentially select large portions of lower-
ED foods (and small portions of higher-ED foods) as well as provision of opportunities to save
uneaten food for later occasions. Moreover, efforts to characterize individuals who differ in
susceptibility to overconsumption from large portions should be continued. When clear
phenotypes are established, interventions can be tailored to those at greatest risk of
overconsuming in the current obesogenic environment.
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<td>ED</td>
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<tr>
<td>kcal</td>
<td>Kilocalories</td>
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<tr>
<td>g</td>
<td>Grams</td>
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<tr>
<td>y</td>
<td>Years old</td>
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<tr>
<td>BMI</td>
<td>Body mass index; kg/m²</td>
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<td>SSS</td>
<td>Sensory-specific satiety</td>
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CHAPTER 1

INTRODUCTION
Obesity rates in the United States have reached an epidemic level; the prevalence of overweight and obesity has increased substantially in recent decades (Flegal, Carroll, Ogden & Curtin, 2010) with little evidence that these rates are slowing (NIDDK, 2017; Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016). High rates of overweight and obesity are linked to major public health and economic concerns given the associations between excess body weight, disease risk, and healthcare costs (Eckel, 1997; CDC, 2018; Finkelstein, Trogdon, Cohen & Dietz, 2009). A primary factor contributing to the obesity epidemic is the eating environment, which has changed in recent decades (Hill & Peters, 1998). Features of the current food environment, and responses of individuals to these features (Swinburn, Sacks, Hall, McPherson, Finegood, Moodie & Gortmaker, 2011), encourage overconsumption of energy (Hill, Wyatt, Reed & Peters, 2003; Papas, Alberg, Ewing, Helzlsouer, Gary & Klassen, 2007; Cohen, 2008). When sustained over time, this increased intake results in excess body weight and adiposity (Heymsfield & Wadden, 2017). Identification of specific, modifiable factors in the eating environment that contribute to overeating will be key in developing strategies to combat the obesity epidemic.

One environmental factor that has received growing attention from scientists and public health officials is the amount of food served, or portion size. The current food environment is characterized by palatable, easily accessible, energy-dense foods that are both large in portion size (Rolls, 2003) and low in cost (Drewnowski & Darmon, 2005). Epidemiological research shows that portions sizes served both within and outside of the home have increased at rates similar to obesity (Ledikwe, Ello-Martin & Rolls, 2005; Young & Nestle, 2012), and calories provided by these portions tend to exceed energy recommendations (Wu & Sturm, 2012). This has led to the suggestion that large food portion sizes play a causal role in the development of
obesity (Young & Nestle, 2012; Hill, Wyatt, Reed & Peters, 2003; Rolls, 2003). As a result, large portions, particularly of energy-dense foods, have become a target for dietary strategies to moderate energy intake (Livingstone & Pourshahidi, 2014; NIDDK, 2016). Studies investigating the direct effects of large portions on acute and long-term food and energy intake have improved our understanding of the portion size effect. From here, identifying the mechanisms driving intake in response to increasing portion size, as well as differences in susceptibility to overconsuming from large portions, will be essential in tailoring strategies to counter influences of large portion sizes on energy intake.

Do large portions encourage overconsumption?

Given the evidence that food portions have grown across most settings in recent decades (Nielsen & Popkin, 2003), an important question arose: do individuals consume more food when served larger portions? Seminal studies investigating the effects of portion size on intake in men
with normal weight and overweight yielded inconclusive results (Nisbett, 1968; Edelman, Engel, Bronstein & Hirsch, 1986). These studies provided some evidence that larger portions were associated with increased intake, but only in certain individuals (e.g. those with higher body weight; Nisbett, 1968) and under certain conditions (e.g. when portions were doubled; Edelman, et al., 1986). In response to this lack of clarity, Rolls and colleagues (2002) designed an experiment to isolate the influence of increasing portion size on food and energy intake. In this study, men and women with normal weight, overweight, and obesity were served a main dish that was varied in portion size across different occasions. Results clearly showed that individuals consumed a greater weight of food and had higher energy intake as portions were increased, and that this effect was similar across weight status (Rolls, Morris & Roe, 2002). More recent studies have extended this work by demonstrating that when a sufficient number of portions are tested, the effect of portion size on intake is curvilinear: as portions are initially increased, there is a strong linear increase in the amount of food consumed, followed by a deceleration in the rate of intake as portions are increased further (Zlatevska, Dubelaar & Holden, 2014; Roe, Kling & Rolls, 2016). Increased intake in response to being served larger portions has been labeled “the portion size effect.”

The paradigm developed by Rolls, Morris & Roe (2002), has been used in many studies in order to enhance our understanding of the portion size effect. One notable step forward was to determine whether this influence on intake is observed in more naturalistic settings. To do this, researchers have varied the portion sizes of foods served in restaurants (Diliberti, Bordi, Conklin, Roe & Rolls, 2004), dining halls (Levitsky & Youn, 2004), and the home (Raynor & Wing, 2007). These studies have even been extended to childcare settings (e.g. Kling, Roe, Keller & Rolls, 2016), although this dissertation will focus only on portion size studies in adults. Across
all of settings listed, increasing the amount of food served resulted in significant increases in intake. For example, when the weight of a popular pasta dish served at a campus dining hall was increased by 50%, customers consumed approximately 43% more food and energy (Diliberti et al., 2004). A similar effect was observed when the portions of all foods served at a dining hall were increased (Levitsky & Youn, 2002) as well as when the portion size of snacks consumed in the home was doubled (Raynor & Wing, 2007). Taken together, these results show that larger portions lead to overconsumption across a range of naturalistic settings, enhancing the ecological validity of this effect.

The pervasiveness of the portion size effect was further evidenced by a series of studies testing the influence on intake of manipulating the portion sizes of a variety of foods. Many of the original portion size studies were limited to amorphous foods (e.g. Rolls, et al., 2002; Diliberti, et al., 2004). Amorphous dishes were used to reduce the likelihood of the effect being driven by: a) a unit bias, whereby individuals are motivated to consume full units (Geier, Rozin & Doros, 2006), and b) demand characteristics resulting from noticeable differences in the amount served, which are diminished by using amorphous foods that are difficult to judge (Slawson & Eck, 1997). While use of amorphous foods was helpful in initially defining the effects of portion size on intake, it was important to determine whether these effects would be observed across a broader range of foods, since the properties of foods in the eating environment vary so widely.

Similar to findings in amorphous foods, serving larger portions of a unit food (a sandwich) led to increased food and energy intake (Rolls, Roe, Meengs & Wall, 2004a). The portion size effect was also observed in snack foods. Notably, the increased snack intake from larger portions was not fully adjusted for at a subsequent meal, resulting in significantly higher
cumulative food and energy intake (Rolls, Roe, Kral, Meengs & Wall, 2004b). Bringing these two factors together, another study found that the portion size of a snack predicts intake independent of unit size of the package (Wing & Raynor, 2007). Research on the portion size effect has also been extended to foods that are generally lower in palatability, such as vegetables (Drewnowski, 1998). Increasing the amount of vegetables served at a meal led to increased consumption of vegetables (Rolls, Roe & Meengs, 2010). Because of the low energy density (ED) of vegetables, this increase in their intake did not result in higher overall energy intake at the meal. In fact, when increases in vegetable portions were paired with corresponding decreases in meat and grain portions, subjects consumed more vegetables and less energy (overall) at the meal compared to when baseline amounts were served (Rolls, et al., 2010). Thus, the portion size effect is observed across a range of foods, and even less well-liked foods. Of further interest is that the effect of portion size on energy intake was related to the energy density of the varied foods (Rolls, et al., 2010).

Finally, the effect of portion size on intake has been extended to beverages. When looking at beverage intake alone, portion size had a significant effect on the weight of beverage consumed as well as on energy intake for caloric beverages (Flood, Roe & Rolls, 2006). In addition, serving larger portion sizes of caloric beverages led to higher combined energy intake from the food and beverage compared to when large portions of non-caloric beverages were served. However, overall energy intake did not differ between the two portion sizes of the caloric beverage (Flood, et al., 2006). Thus, while the portion size effect extends to beverages, there may be some adjustment of food intake in response to increased fluid intake.

Short-term portion size studies clearly demonstrate that the effect of portion size on acute intake is substantial and pervasive. However, these studies tell us nothing about the influence of
large portions on intake over time. The partial adjustment of food intake at the meal following increased intake of a caloric beverage (Flood, et al., 2006), for example, raises the important question of whether or not individuals adjust for perturbations in energy balance following intake from large portions. Longer-term studies assessing the prolonged effects of portion size on intake would be useful in developing a better idea of the public health relevance of large portions as well as the possible mechanisms (e.g. physiological, psychological, social, food-related) underlying this effect.

**Are the effects of portion size sustained over time?**

Self-regulation of energy intake in humans has long been a topic of debate, but what is clear is that regulatory mechanisms are disturbed by external factors (e.g. Speakman, Levitsky, Allison, Bray, de Castro, Clegg, et al., 2011; Hill, et al., 2003). Given the robust effects of large food portions on acute energy intake, determining whether these effects are sustained over time is essential to our understanding of the role of portion size in development of obesity.

Over three two-day periods, Rolls, Roe, and Meungs (2006a) served all meals, snacks, and beverages to men and women. Baseline amounts were served over one two-day period, and portions were increased by 50% and 100% in the other periods. Results showed that energy intake was greater when larger portions were served, and that this effect was sustained over the two days (Rolls, et al., 2006a). While adults did not appear to compensate for increased energy intake, it is believed that physiological regulatory mechanisms require 3-4 days to sense perturbations (Bray, Flatt, Volufova, Delany & Champagne, 2008). Therefore, in a similar paradigm, the effect of increased portion size on intake was tested over an 11-day period. In that study, increasing portion sizes of all foods and beverages (over 11 days) resulted in a cumulative
difference of over 4,000 kcal compared to baseline for both men and women (Rolls, Roe & Meengs, 2007). This finding was replicated over a four-day period in a residential setting; again, showing that serving larger portions over multiple days resulted in increased energy intake as well as increased body weight (Kelly, Wallace, Robson, Rennie, Welch, Hannon-Fletcher, et al., 2009). In two separate longer-term studies, a boxed lunch was provided to subjects over periods of one month and six months. Doubling the amount of food provided over this extended time period led to significant increases in energy intake, with no decline in the slope of intake over time (Jeffrey, Rydell, Dunn, Harnack, Levine, Pentel, et al., 2007; French, Mitchell, Wolfson, Harnack, Jeffrey, Gerlach, et al., 2014). These series of studies show that over longer time periods, men and women do not adjust energy intake in response to large portions. Sustained increases in energy intake from large portions is further evidence that portion size is likely a contributing factor to increased body weight and confirms the need to develop strategies to moderate energy intake from large portions.

Longer-term portion size studies confirm that the amount of food served is a primary determinant of intake (Hollands, Shemilt, Marteau, Jebb, Lewis, Wei, et al., 2015). Moreover, these experiments clearly demonstrate that large food portions overwhelm physiological systems related to regulating energy intake. In response to the need for development of effective strategies to counter the portion size effect, a primary aim of portion size research became the identification of factors contributing to the effects of portion size on food and energy intake.

**What is the role of energy density in determining energy intake from large portions?**

Another key determinant of energy intake is the energy density of foods (ED; Rolls, 2009). Energy density is the energy provided per unit weight of a food (kcal/g) and is determined
by the macronutrient and water content of the food (Rolls & Barnett, 2000). Consequently, overall energy content of a dish depends on both the energy density and the amount served. Given that variations in food energy density and portion size in isolation have large effects on energy intake (Rolls, 2009; Hollands, et al., 2015), there was a need to investigate their effects in combination.

In a single-meal study, both the portion size and ED of a main dish were varied on different occasions (Kral, Roe & Rolls, 2004). Energy density variations were achieved by altering the proportion of water-rich vegetables and energy-dense fats in the dish. Results showed that portion size and energy density had independent effects on energy intake. Thus, although increasing portion size led to increased intake at both levels of ED, energy intake from larger portions was lower when the ED of the meal was lower (Kral, et al., 2004). A nearly identical pattern of results was observed when ED and portion size were varied over two days; reducing both portion size and energy density led to additive reductions in energy intake that were sustained over the two-day period (Rolls, Roe & Meengs, 2006b). Of further interest, and as was previously noted, portion size can be used strategically to reduce energy intake at a meal. By increasing the proportion of vegetables served at a meal, meal ED (but not the overall amount served) is reduced, leading to reduced energy intake (Rolls, et al., 2010).

Investigation of the combined effects of energy density and portion size shows that reducing ED can be an effective strategy to moderate energy intake from large portions (Rolls, 2014). Taking nothing away from the utility of leveraging ED to counter the portion size effect, it is notable that most data show that ED and portion size do not interact to affect intake (e.g. Rolls, et al., 2006b), suggesting that factors other than ED are driving the portion size effect. Identifying those factors will allow for the development of strategies to address overconsumption
from large portions, which can be paired with methods to reduce ED in order to increase the comprehensiveness of interventions to regulate energy intake.

**What are the mechanisms driving the portion size effect?**

A number of theories attempting to explain the portion size effect have been put forth (summarized in English, Lasschuijt & Keller, 2015; Herman, Polivy, Pliner & Vartanian, 2015). The empirical evidence to support these postulations, however, is still limited. Further complexity is added by the potential for differential influences based on the types of foods or the eating context. For example, there is a relatively large and reliable body of work to support the idea that pre-meal planning is involved in decisions related to how much food to eat (Brunstrom, 2014). Research shows that expected satiety, which is shaped by experiential learning, is a strong predictor of ideal portion size (Brunstrom & Rogers, 2009; Brunstrom, 2014). Moreover, the amount of food selected is a key determinant of intake (e.g. Hinton, Brunstrom, Fay, Wilkinson, Ferriday, Rogers & deWijk, 2013). While these paradigms aid in understanding how decisions about portion selection are made, they do not address how the amount of food *served* to an individual influences intake. The latter scenario is better addressed by mechanisms related to consumption norms, which may explain why the portion size served has such a profound and persistent effect on intake.

**Consumption norms: mechanism**

One of the more commonly referenced explanations for the portion size effect is that the amount served provides a cue of what is an appropriate amount to eat (Herman & Polivy, 2005; Herman, et al., 2015). This idea was first introduced by Rolls, Morris & Roe (2002) who stated that “it is possible that people have the expectation that the amount of food served to them by
others is appropriate” (p.1211). It has since been proposed that individuals rely on this heuristic because they are unaware of the appropriate portion to consume (Herman & Polivy, 2005; Herman, et al., 2015). This suggestion is supported by research showing that exposure to different-sized portions influenced subject ratings of portion size normality and subsequent intake (Robinson, Oldham, Cuckson, Brunstrom, Rogers & Hardman, 2016; Robinson & Kersbergen, 2018). Similarly, ratings of what was an appropriate amount to consume of a snack varied with the amount served, and these ratings mediated the relationship between the portion served and the amount consumed (Kerameas, Vartanian, Herman & Polivy, 2009). Likewise, women ate more from large portions even though they demonstrated an awareness of overeating (Keenan, Childs, Rogers, Hetherington & Brunstrom, 2018), presumably due (at least in part) to using the amount served to guided intake. In another study, when subjects were served similar amounts of pasta, but the serving size on the label was varied, they still consumed a consistent amount of food (Ueland, Cardello, Merrill & Lesher, 2009). This finding provides further evidence that individuals rely on the portion served to determine intake, even in the presence of explicit information about serving size. The “appropriateness norms” theory has been expanded to suggest that the amount served is used as an initial “anchor” of what to eat, but intake is then adjusted based on other contextual factors (Marchiori, Papies & Klein, 2014).

**Consumption norms: interventions**

A number of portion size interventions have tested the theory that large portions encourage overconsumption through normative influences. One method to counter the cues provided by the amount served is to provide individuals greater control over their portions (Zuraikat, Roe, Privitera & Rolls, 2016). Variations of this strategy were tested in two studies. In the first study, subjects were provided portions of food in a serving dish and were told to serve
themselves and consume as much or as little as they would like (Rolls, et al., 2002). Results showed that increasing the amount of pasta in the serving dish still resulted in increased intake despite subjects being allowed to determine how much they served themselves from the dish. In fact, the response to portion size was similar to that of individuals who were served portions directly onto a plate (Rolls, et al., 2002). Thus, despite allowing more control, the portion served still determined intake. The next study investigated whether providing portion options, which allows subjects to compare amounts to determine which is most appropriate for them, would moderate energy intake as portions were increased (Zuraikat, et al., 2016). As the portion sizes of all options served were increased, subjects tended to select the same relative portion size rather than a smaller option (a consistent absolute size). As a result, increasing the size of portion options led to increased intake (Zuraikat, et al., 2016). These studies found that providing greater control over one’s portion size did not attenuate the effects of large portions on intake. It is notable, however, that both of these interventions were rather passive approaches to countering norms of appropriateness provided by the portions served. It may be that more explicit portion size information is needed to reduce intake from large portions.

Nutrition labels are one way to convey information about appropriate amounts to consume. Results on the effects of calorie labeling on portion selection, however, are mixed; studies have found no effect (Harnack, French, Oakes, Story, Jeffrey & Rydell, 2008), trends towards smaller choices (Vermeer, Steenhuis, Leeuwis, Bos, de Boer & Seidell, 2010), and significant shifts to greater selection of smaller portions (Freedman, 2011). While these data provide useful information on how labeling might influence portion selection, which could then affect subsequent intake, it is of greater interest to determine how explicit information about portion size (rather than calories) directly affects intake in response to increasing portion size.
This was investigated in two studies that varied the amount of food served to subjects as well as contextual information about portion size (Spanos, Kenda & Vartanian, 2015; Reily & Vartanian, 2016). The pilot study found that labeling portions attenuated the effect of portion size on intake, but only when the large portion was labeled as providing four servings, and not when labeled as providing two servings (Spanos, et al., 2015). Results of a larger follow-up study were less positive. Varying the level of contextual information provided (no label, label only: large portion/small portion, label + presence of comparator portion) across portion sizes had no significant influence on intake in response to portion size (Reily & Vartanian, 2016). The inconsistency of findings related to labeling and the portion size effect indicates that interventions might be more successful if the information is provided in a more applied manner, such as through training or education in portion control, which involve active learning.

Training in portion-control (e.g. use of measurement aids, choosing smaller portions, using energy density to determine portion size) is often recommended in public health messages for managing energy intake and body weight (e.g. CDC, 2016; NIDDK, 2016; Rolls, 2014). Short-term training in strategies like the use of portion size estimation aids has been shown to improve accuracy of estimation (Small, Lane, Vaughan, Melnyk & McBurnett, 2013; Faulkner, Livingstone, Pourshahidi, Spence, Dean, O’Brien, et al., 2016). Data on the effect of portion-control training on intake, however, is sparse. Only one study investigated the effects of portion size education on intake (Cavanagh, Vartanian, Herman & Polivy, 2014). In this study, subjects randomly assigned to the education condition attended a very brief (single-session) meeting that included information related to portion control. Results showed that this training did not reduce intake from large portions (Cavanagh, et al., 2014). Extended training in portion-control strategies (e.g. over the course of one year), on the other hand, has been shown to aid in weight
loss (summarized in Rolls, 2014; Rolls, Roe, James & Sanchez, 2017); it is not known, however, whether such training will translate to sustained behavioral changes. Based on the ability of extended training to influence body weight (Rolls, et al., 2017), it is likely the case that longer-term, more intensive training is needed to encourage behavioral changes and moderate energy intake from large portions. Investigating the influence on intake of prolonged training in portion control would clarify the effectiveness of this strategy in countering the influence of cues provided by the portion served.

**The value associated with large portions: mechanisms**

In addition to the “portion distortion” created by portion size norms, the value provided by foods has been proposed as a mechanism underlying the portion size effect (Steenhuis & Vermeer, 2009). In the current eating environment, larger portions tend to offer a greater value for money (Steenhuis & Vermeer, 2009). Common food pricing systems, such as flat-rate pricing at buffets and volume discounts for larger packages or portions, promote selection and intake of larger portions by making these a better value to the consumer (Swinburn, Caterson, Seidell & James, 2004; Siniver & Yaniv, 2012; Haws & Winterich, 2013). Given these pricing trends, the portion size effect may be even greater when dining away from home. Indeed, the magnitude of the portion size effect in a study conducted in a restaurant was large; furthermore, increasing portions led to higher ratings of value for money (Diliberti, et al., 2004). However, the increased value associated with larger portions may not be limited to purchased meals. According to unpublished data, the commonality of lower unit costs for larger portions may even influence portion selection and consumption in the home and other settings in which prices are not directly involved (cited in Steenhuis & Vermeer, 2009). Additionally, value from a meal is enhanced by reducing waste. Research finds high levels of plate-cleaning in the US population (Robinson,
Aveyard & Jebb, 2015), which suggests an aversion to wasting foods (Bolton & Alba, 2012). Thus, individuals may eat beyond satiation or energy needs in order to reduce waste and increase value from a meal.

**The value associated with large portions: interventions**

As alluded to in the previous paragraph, value is a broad construct that can be operationalized in many different ways. In terms of investigating the role of value in the portion size effect, value is typically defined in terms of pricing (Steenhuis & Vermeer, 2009). Because larger portions are often offered at lower unit prices (e.g. value pricing), many of the interventions have investigated how varying the pricing of portion options influences portion selection and intake (summarized in Steenhuis & Poelman, 2017).

Marketing research has tested whether intended intake differs between value pricing (price per weight served is lower for larger portions than for smaller) and proportional pricing (price per weight is equivalent across portions). Results showed that when proportional pricing was used, smaller portions were favored, resulting in lower intended consumption (Haws & Liu, 2016). The effects of proportional pricing on portion selection and measured intake are equivocal, however. A large study investigated the amount of food ordered and consumed from a fast-food restaurant in response to differences in pricing (value vs proportional), and found no effect of proportional pricing on portion selection nor on energy intake (Harnack, et al., 2008). This absence of an effect of pricing scheme on portion selection and intake was confirmed in a series of two studies, one conducted in a fast-food restaurant and the other conducted in a worksite cafeteria (Vermeer, Alting, Steenhuis & Seidell, 2009). These studies did find some evidence, however, that the effect of proportional pricing may differ by weight status of the consumer. For example, in individuals with overweight and obesity, use of proportional pricing
reduced selection of the largest portions of beverages and increased selection of smaller portions of chicken nuggets (Vermeer, et al., 2009). A final study extended previous research by testing whether pricing influenced portion selection and subsequent intake after the addition of a smaller portion option. While adding a smaller portion size led to 10% of consumers switching to the smaller option, this change was not affected by the way in which the options were priced (value vs proportional) (Vermeer, Steenhuis, Leeuwis, Heymans & Seidell, 2011). In combination, these studies suggest that changing the pricing structure may not be the most effective strategy to counter the portion size effect. Therefore, further studies are needed to investigate the influence of other facets of value on the response to portion size. This could be achieved by testing other interventions that are either directly related to value for money or indirectly related to value.

All of the previous studies testing the relationship between pricing and portion size have assessed intake as a consequence of portion selection rather than intake from a portion served (the typical paradigm). Furthermore, these studies have exclusively compared value pricing to proportional pricing (summarized in Steenhuis & Poelman, 2017). Another way in which food prices are believed to affect intake is through a sunk cost effect (Siniver & Yaniv, 2012). In terms of eating behaviors, as the amount of money spent on a food item increases, individuals become more motivated to overeat (derived from Arkes & Blumer, 1985). Indeed, a study investigating the influence of sunk cost on intake found that large increases to the price paid for a buffet meal led customers to select and consume more food (Sinver & Yaniv, 2012). This result shows that the cost of a meal can influence intake and suggests that increasing meal cost could exacerbate the effect of large portions on intake. Determining whether the cost of a meal influences the response to portion size would elucidate the role of value in the portion size effect;
specifically, whether high food prices encourage overconsumption from large portions. Thus, the influence of varying the price of a meal on the response to portion size needs to be tested.

Overeating in response to being served large portions may also be driven by an attempt to increase value and reduce waste. While both are related to increasing value, aversion to wasting utility (such as food) is distinct from aversion to wasting money (Bolton & Alba, 2012). Indeed, individuals have an aversion to wasting goods, and particularly food (Bolton & Alba, 2012). This aversion to food waste is supported by high prevalence of plate-cleaning (Robinson, Aveyard & Jebb, 2015; Robinson & Hardman, 2016), which could lead to overconsumption from large portions. Therefore, strategies that increase value and reduce waste may be effective in moderating intake from large portions. While pilot research demonstrated that meal intake was reduced by providing a container to take away uneaten food (Bates & Shanks, 2015), the influence of this intervention on intake in response to large portions needs to be tested. Should this approach be effective in attenuating the portion size effect, it provides a strategy that may be more acceptable than alternatives, such as changing the pricing of portions (Steenhuis & Vermeer, 2009) or reducing the sizes of portions (Marteau, Hollands, Shemilt & Jebb, 2015).

**Are there individual differences in responsiveness to increasing portions?**

A recent thought-provoking review of mechanisms underlying the portion size effect highlighted the possibility of individual differences in susceptibility to overeating from large portions (English, et al., 2015). Identifying biological or behavioral factors that are associated with differential responsiveness would provide invaluable information about drivers of the portion size effect. This insight could then be used to tailor interventions to target subject characteristics associated with higher risk of overeating from large portions.
The vast majority of portion size studies conducted in adults show that the response is uninfluenced by subject characteristics including body mass index, dietary restraint, disinhibition, tendency towards hunger, and plate-cleaning tendencies (summarized in final column of tables 1.1-1.4; Zlatevska, et al., 2014). There have been exceptions to the robust nature of this effect across individuals, though. Women had an attenuated response to increasing portion sizes of a packaged snack (Rolls, et al., 2004b) and sandwich (Rolls, et al., 2004a) compared to men. Similarly, the magnitude of the portion size effect was smaller in women when the amounts of all foods and beverages were varied over either two or eleven days (Rolls, et al., 2006a; Rolls, et al., 2007). There are two points of note about this sex difference. First, both men and women responded to increasing portion size by consuming significantly more food and energy, but the magnitude of the effect was larger in men. Second, in the shorter-term studies in which a sex difference was observed, four or more portions of the test foods were served (Rolls, et al., 2004a; Rolls, et al., 2004b). A recent study (Roe, et al., 2016) and a meta-analysis (Zlatevska, et al., 2014) both found that the portion size effect was curvilinear; as a result, responses will be better characterized when four or more portions (of multiple foods) are served (Roe, et al., 2016). This paradigm is also more sensitive to detecting individual differences, evidenced by the finding that both disinhibition and estimated energy needs were found to influence intake when four portions were tested (Roe, et al., 2016). Given advances in our understanding of the portion size effect, it is apparent that differences in individual responsiveness will likely to be identified as study designs are improved to better detect these influences. This demonstrates the need for studies that are designed systematically to assess possible influences of subject characteristics on the response to portion size, which could include recruiting a sample based on a specific set of characteristics.
One limitation of previous portion size studies in adults is that assessment of subject characteristics, particularly eating behaviors, has been restricted to only a few measures. In children, behaviors such as satiety responsiveness and food responsiveness, which are subscales of the Child Eating Behaviour Questionnaire (Wardle, Guthrie, Sanderson & Rapoport, 2001), have been found to influence the portion size effect (Smethers, Keller, Meehan, Roe, Sanchez & Rolls, 2017). Whether these characteristics influence the portion size effect in adults, however, is not known, since this questionnaire was not designed for use in adults. The finding that eating behaviors related to food and satiety responsiveness play a role in determining children’s intake from large portions, along with evidence that these characteristics change slightly with age to promote increased responsiveness to external cues (Ashcroft, Semmler, Carnell, van Jaarsveld & Wardle, 2008), demonstrates the need for measures of these behaviors in adults. Similarly, assessment of more general consumer behaviors, such as those related to food purchasing habits, could inform our understanding of differences in responsiveness to portion size.

Another characteristic that requires further exploration in adults is weight status, given the proposed association between large portions and higher body weight (Young & Nestle, 2012). Recent research in children found that the response to increasing portion sizes over five days was influenced by measures of body size (e.g. BMI z-score; Smethers, et al., 2017). Since weight status in childhood predicts later body weight (Field, Cook & Gillman, 2005), it would be expected that weight status would also be associated with responsiveness to portion size in adulthood. Although BMI typically is not found to influence the relationship between portion size and intake (summarized in Tables 1.1-1.3), no study in adults has been designed to test differences in the portion size effect by weight status.
While few individual differences in the response to portion size have been identified at present, most previous studies had not been designed to assess such influences. In addition, recent research in children suggests that investigation of eating behaviors not previously assessed in adults may help to identify phenotypes associated with differential responsiveness to large portions. Thus, systematic assessment of a broad range of characteristics using studies designed to detect such influences is needed in order to develop a comprehensive characterization of susceptibility to overeating from large portions.

### Summary

Experimental studies clearly and consistently demonstrate the robust nature of the portion size effect on intake; as the amount of food served is increased, individuals consume greater amounts of food and energy (Rolls, 2014; Hollands, et al., 2015). This effect on intake is observed across a range of settings, individuals, and food types (Zlatevska, et al., 2014). Furthermore, the effects are sustained over multiple meals, days, and even months, indicating that individuals do not adjust for the increased energy intake from larger portions (summarized in Rolls, 2014; Livingstone & Pourshahidi, 2014). Given the substantial nature of this influence on energy intake, a primary goal of public health organizations has been to develop effective strategies to moderate this substantial influence on energy intake (NIDDK, 2016).

Despite the growing body of literature on the portion size effect, little is known about factors that influence the response to increasing meal size (English, et al., 2015; Herman, et al., 2015). At present, a number of potential mechanisms have been suggested, but there is little data on whether or not interventions related to these factors influence the response to portion size (Steenhuis & Poelman, 2017). Therefore, the current series of studies was designed to test
proposed mechanisms underlying the portion size effect in order to determine whether strategies related to portion-control training and food value led to an attenuation of the effect. Identifying factors that influence the response to portion size will allow for the development of interventions that can be combined with modifications to ED to comprehensively counter the effects of large portions on intake.

**Study 1: Comparing the portion size effect in women with and without extended training in portion control: A follow-up to the Portion-Control Strategies Trial**

It is suggested that the portion size effect is the result of a lack of knowledge about appropriate portions, which leads individuals to use the amount of food served as a normative cue to determine intake (Herman & Polivy, 2005; Herman, et al., 2015). One method that is recommended to moderate energy intake from large portions is training in portion control; for example, through use of portion-control tools or instruction on appropriate food portions (Rolls, 2014; CDC, 2016). Although educational interventions can increase the accuracy of portion size estimation (Small, et al., 2013), such short-term training has not been shown to influence intake at a meal (Cavanagh, et al., 2014). The effect of prolonged portion-control training on intake from large portions, however, has not been systematically evaluated. In addition, epidemiological evidence of a relationship between portion size and obesity indicates that there may be differences in responsiveness to large portions based on weight status (Young & Nestle, 2012), but the nature of this relationship is not yet clear.

**Aim 1:** To determine whether individuals with extended training in portion-control strategies were less responsive to the portion size effect than those without training
Hypothesis 1: The effect of portion size on food and energy intake will be attenuated in participants trained in portion control compared to untrained controls

Aim 2: To assess whether the portion size effect differed by subject weight status

Hypothesis 2: Weight status will influence the response to portion size; the effect would be largest in untrained individuals with overweight and obesity.

Study 2: Does the cost of a meal influence the portion size effect?

Food portions have grown over the years (Young & Nestle, 2012) and often exceed recommended serving sizes, particularly in restaurants (Sturm & Wu, 2012). Given these trends, it is important to identify factors that influence the response to large portions in order to develop tailored strategies to moderate this effect. One factor that may affect intake from large portions is the cost associated with a meal (English, et al., 2015; Siniver and Yaniv, 2012); however, there have been no systematic investigations of the role of cost in determining intake as portions are increased. Furthermore, at present, few studies in adults have found the portion size effect to be influenced by subject characteristics (summarized in Zlatevska, et al., 2014; Hollands, et al., 2015). Identifying individual differences in responsiveness to obesogenic external factors can aid in the development of strategies to moderate their effects on intake.

Aim 1: To determine whether varying the cost of a meal influences the effect of portion size on intake in a controlled, restaurant-style setting

Hypothesis 1: The effect of portion size on intake will be exacerbated when the cost of a meal is higher compared to lower

Aim 2: To identify any individual differences in intake in response to variations in portion size and cost
**Hypothesis 2** (exploratory): Subject characteristics related to eating behaviors (e.g. disinhibition; satiety responsiveness) and consumerism (e.g. price consciousness) will influence the effects of portion size and meal cost on intake.

**Study 3:** “Doggy bags and downsizing”: Packaging uneaten food to go after a meal attenuates the portion size effect in women

Larger portions typically offer better value for money, which encourages overconsumption (Steenhuis & Vermeer, 2009). This effect is likely augmented by aversion to wasting food which encourages plate-cleaning (Robinson & Hardman, 2016) and related “self-defeating behaviors” (Bolton & Alba, 2012) such as eating beyond fullness or energy needs. Therefore, methods to reduce waste at a meal may influence intake and can also increase value. Indeed, a previous study found that providing subjects with a “to-go” container reduced meal intake (Bates & Shanks, 2015). However, these findings need to be extended to assess how packaging food to take home after a meal influences intake from increasing portion sizes.

**Aim 1:** To determine whether packaging uneaten food to take home following a meal influences intake from large portions.

**Hypothesis 1:** The effect of portion size on the weight and energy of food consumed will be attenuated when individuals are provided with their uneaten food to take away after the meal.

**Aim 2:** To identify any subject characteristics or food properties associated with differential responses to portion size

**Hypothesis 2:** The effect of portion size will be attenuated in: a) individuals with eating behaviors related to lower responsiveness to external cues, and b) foods perceived to be lower in value.
Table 1.1: Short-term studies testing the effect of portion size on intake (adults only) in order of appearance in this chapter

<table>
<thead>
<tr>
<th>Paper and subjects</th>
<th>Test meal</th>
<th>Setting</th>
<th>Portion size manipulation</th>
<th>Effects on food and energy intake</th>
<th>Influence of subject characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolls, et al., 2002</td>
<td>Lunch: pasta entrée varied; sides unmanipulated</td>
<td>Laboratory</td>
<td>4 portion sizes: 100%, 125%, 150%, and 200% of baseline (500 g)</td>
<td>Food &amp; energy intake: increased as portions increased (no diff between 150% and 200% portions)</td>
<td>No influence of any (sex, BMI, TFEQ, EAT, Zung, Eating-then and now)</td>
</tr>
<tr>
<td>N=51 men &amp; women</td>
<td>n=27 plate group; n=24 self-serve</td>
<td></td>
<td>Mixed design: PS crossover; Serving method between-subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diliberti, et al., 2004</td>
<td>Lunch: pasta entrée varied; sides unmanipulated</td>
<td>Restaurant</td>
<td>2 portion sizes: 100% and 150% of baseline (248 g)</td>
<td>Food &amp; energy intake: increased as portions increased; intake of sides also increased</td>
<td>No influence of any (age, sex, weight status)</td>
</tr>
<tr>
<td>N=180 men &amp; women</td>
<td>n=89 small portion; n=91 larger portion</td>
<td></td>
<td>Between-subjects design</td>
<td></td>
<td>*Larger portions better value for money</td>
</tr>
<tr>
<td>Rolls, et al., 2004a</td>
<td>Snack: chips; unmanipulated dinner</td>
<td>Laboratory</td>
<td>5 portion sizes: 1.5 oz increases from baseline (1 oz)</td>
<td>Food &amp; energy intake from snack: increased as portions increased</td>
<td>Sex influenced PSE on snack intake (smaller slope for women)</td>
</tr>
<tr>
<td>N=63 men &amp; women</td>
<td></td>
<td></td>
<td>Crossover design</td>
<td>Cumulative food and energy intake: increased as portions increased</td>
<td>No influence of other characteristics</td>
</tr>
<tr>
<td>Rolls, et al., 2004b</td>
<td>Lunch: sandwich; unmanipulated sides</td>
<td>Laboratory</td>
<td>4 portion sizes: 6, 8, 10, &amp; 12 inch</td>
<td>Food &amp; energy intake: increased as portions increased</td>
<td>Sex influenced PSE</td>
</tr>
<tr>
<td>N=75 men &amp; women</td>
<td></td>
<td></td>
<td>Crossover design</td>
<td></td>
<td>No influence of other characteristics</td>
</tr>
<tr>
<td>Paper and subjects</td>
<td>Test meal</td>
<td>Setting</td>
<td>Portion size manipulation</td>
<td>Effects on food and energy intake</td>
<td>Influence of subject characteristics</td>
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<tr>
<td>Levitsky &amp; Youn, 2004 &lt;br&gt;N=13 male &amp; female students</td>
<td>Lunch: Buffet of soup, pasta, bread, ice cream</td>
<td>College cafeteria</td>
<td>3 portion size: 100%, 125% &amp; 150% of baseline (pilot cons.)</td>
<td>Overall food &amp; energy intake: increased as portions increased</td>
<td>Not reported</td>
</tr>
<tr>
<td>Flood, et al., 2006 &lt;br&gt;N=33 men &amp; women</td>
<td>Beverage: water, cola, and diet; unmanipulated lunch</td>
<td>Laboratory</td>
<td>2 portion sizes: 100% and 150% of baseline (360 g)</td>
<td>Beverage wt consumed: increased as portions increased  &lt;br&gt;Total energy intake: higher for cola than water/diet. No effect of PS  &lt;br&gt;Non-caloric: drank more but didn’t affect lunch intake</td>
<td>No influence (age, body size, TFEQ, Zung, EAT)</td>
</tr>
<tr>
<td>Rolls, et al., 2010 &lt;br&gt;N=49 veg addition &lt;br&gt;N=48 veg substit.</td>
<td>Lunch: vegetable manipulated in both studies; vegetable, meat &amp; grain manipulated in substitution</td>
<td>Laboratory</td>
<td>3 portion sizes of vegetables: 100%, 150% and 200% of baseline  &lt;br&gt;(ED of vegetables varied – not described here)</td>
<td>Veg wt consumed: Increased with increasing PS  &lt;br&gt;Total wt consumed: Add: Increased with increasing veg PS  &lt;br&gt;Sub: Did not differ across PS  &lt;br&gt;Total EI: Add: no diff  &lt;br&gt;Sub: decreased with larger veg PS</td>
<td>No influence (sex, demographics, BMI, TFEQ, Zung, EAT)</td>
</tr>
<tr>
<td>Paper and subjects</td>
<td>Test meal</td>
<td>Setting</td>
<td>Portion size manipulation</td>
<td>Effects on food and energy intake</td>
<td>Influence of subject characteristics</td>
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</tr>
<tr>
<td>Raynor &amp; Wing, 2012</td>
<td>Snack: snacks provided for 3 consecutive days</td>
<td>At home (self-report intake)</td>
<td>2 portion sizes: 100% and 200% of baseline (4320 kcal) 2 package sizes Between-subjects</td>
<td>Energy intake: increased with increasing portion size No influence of package size</td>
<td>Food amount only predictor of intake</td>
</tr>
<tr>
<td>N=28 men and women (7/group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brochado &amp; Freedman, 2012</td>
<td>French fries: daily French fry intake (population level)</td>
<td>University cafeteria</td>
<td>4 portion sizes: 88g, 73g, 58g, 44g (allowed to select more than one)</td>
<td>Fry wt and energy intake: significantly lower when smallest amount served</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=703 (mean across conditions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roe, et al., 2016</td>
<td>Lunch: 6 foods across a range of ED; all foods varied in PS</td>
<td>Laboratory</td>
<td>4 portion sizes: 100%, 125%, 150% &amp; 175% of baseline amounts of all foods served</td>
<td>Food and energy intake: increased with increasing portion size (full meal and ind foods) Food taste ranking influenced PSE Effect of portion size on food intake was curvilinear Higher BMI consumed higher meal ED</td>
<td>Disinhibition (TFEQ) positively associated w/ meal and ind food PSE EER positively associated w/ PSE</td>
</tr>
</tbody>
</table>
## Table 1.2: Longer-term studies investigating the effect of portion size on intake and body weight (adults only)

<table>
<thead>
<tr>
<th>Paper and subjects</th>
<th>Test meal</th>
<th>Setting</th>
<th>Portion size manipulation</th>
<th>Effects on food and energy intake</th>
<th>Influence of subject characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolls, et al., 2006a N=32 men and women</td>
<td>All meals, snacks, &amp; beverages over 2 days</td>
<td>Laboratory</td>
<td>3 portion sizes: 100%, 150% &amp; 200% of baseline Crossover</td>
<td>Food intake: not reported Energy intake: increased as portions were increased No adjustment over 2 days</td>
<td>Magnitude of PSE differed between men and women No influence of age, BMI, TFEQ, Zung, EAT</td>
</tr>
<tr>
<td>Rolls, et al., 2007 N=23 men &amp; women</td>
<td>All meals, snacks, and beverages over 11 days</td>
<td>Laboratory</td>
<td>2 portion sizes: 100% and 150% of baseline amounts Crossover</td>
<td>Food intake: not reported Energy intake: increasing portion size increased daily energy intake – sustained over 11-days (slope 0) PSE positively related to ED</td>
<td>No influence of age, body size, TFEQ Rate of increase differed by sex Zung depression score positively related to PSE</td>
</tr>
<tr>
<td>Jeffrey, et al., 2007 N=19 women</td>
<td>Lunch: boxed lunches every day over 1 mo.</td>
<td>Worksite cafeteria</td>
<td>2 portion sizes: 100% and 200% of baseline (750 kcal) Crossover (estimated intake)</td>
<td>Energy intake: increased with larger portions – no adjustment Trend for increased body weight</td>
<td>Not reported</td>
</tr>
<tr>
<td>Paper and subjects</td>
<td>Test meal</td>
<td>Setting</td>
<td>Portion size manipulation</td>
<td>Effects on food and energy intake</td>
<td>Influence of subject characteristics</td>
</tr>
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<td>--------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Kelly, et al., 2009</td>
<td>All meals, snacks, and beverages over 4 days</td>
<td>Residential</td>
<td>2 portion sizes: based on commercially available units (small and large)</td>
<td>Food and EI: increased with larger portions – no adjustment</td>
<td>External eating predicted EI</td>
</tr>
<tr>
<td>N=43 men &amp; women</td>
<td></td>
<td></td>
<td>Crossover</td>
<td>No effect on ED consumed</td>
<td>*Larger portions led to increased body weight over 4 days</td>
</tr>
<tr>
<td>French, et al., 2014</td>
<td>Lunch: boxed lunch provided every weekday for 6 mo.</td>
<td>Free-living</td>
<td>1 control group; 3 portion sizes: 400, 800 &amp; 1600 kcal</td>
<td>Higher energy intake at 1600 kcal – increased over time</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=233 men &amp; women</td>
<td></td>
<td></td>
<td>RCT</td>
<td>Increased body wt in 1600 kcal group</td>
<td></td>
</tr>
<tr>
<td>(control: n=61, 400: n=57, 800: n=59, 1600: n=56)</td>
<td></td>
<td></td>
<td>*dietary recalls used</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1.3: Combined effects of portion size and ED and ED as a strategy to moderate intake from large portions (adults only)

<table>
<thead>
<tr>
<th>Paper and subjects</th>
<th>Test meal</th>
<th>Intervention</th>
<th>Portion size manipulation</th>
<th>Effects on food and energy intake</th>
<th>Influence of subject characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kral, et al., 2004 N=39 women</td>
<td>Lunch: pasta entrée varied; sides unmanipulated Breakfast &amp; Dinner served as well</td>
<td>ED of entrée varied 100% and 140% of baseline (5.23 kj/g)</td>
<td>3 portion sizes: 100%, 140%, and 180% of baseline (500 g) 2x3 factorial: all within-subjects</td>
<td>Increasing PS increased food and energy intake Increasing ED decreased food intake, increased energy intake (PSxED interaction P=0.09 on food int.)</td>
<td>No influence of any (age, body size, TFEQ, depression, EAT) *potential inf. of ED on PSE btwn. med and lg PS</td>
</tr>
<tr>
<td>Rolls, et al., 2006b N=24 women</td>
<td>All foods served over 2 days</td>
<td>Reducing ED of all foods served over 2 days (100% and 75% of baseline)</td>
<td>2 portion sizes: 100% and 75% of baseline amounts Crossover</td>
<td>Dec. PS = dec. food &amp; energy intake; Dec. ED = dec. EI, no effect on wt con; Ind &amp; add effects, sustained over 2 d</td>
<td>Very little prop of var explained by subj. char. (looks like potential PSxED interaction with more power)</td>
</tr>
<tr>
<td>Rolls, et al., 2010 N=49 veg addition N=48 veg subst.</td>
<td>Lunch: vegetable manipulated in both studies; vegetable, meat &amp; grain manipulated in substitution</td>
<td>Increasing PS of veg/increasing veg proportion (ED of vegetables varied – not described here)</td>
<td>3 portion sizes of vegetables: 100%, 150% and 200% of baseline Crossover/study</td>
<td>Veg wt consumed: Increased with increasing PS Total wt consumed: Add: Increased with increasing veg PS Sub: Did not differ across PS Total EI: Add: no diff Sub: decreased with larger veg PS</td>
<td>No influence (sex, demographics, BMI, TFEQ, Zung, EAT)</td>
</tr>
</tbody>
</table>
Table 1.4: Studies testing relevant interventions to moderate energy intake from large portions (adults only)

<table>
<thead>
<tr>
<th>Paper and subjects</th>
<th>Test meal</th>
<th>Intervention</th>
<th>Portion size manipulation</th>
<th>Effects on food and energy intake</th>
<th>Influence of subject characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interventions related to normative cues provided by PS</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rolls, et al., 2002</td>
<td>Lunch: pasta entrée varied; sides unmanipulated</td>
<td>Serving method: self-serve vs pre-served (allowing more control)</td>
<td>4 portion sizes: 100%, 125%, 150%, and 200% of baseline (500 g)</td>
<td>Food &amp; energy intake: increased as portions increased (no diff between 150% and 200% portions)</td>
<td>No influence of any (sex, BMI, TFEQ, EAT, Zung, Eating-then and now)</td>
</tr>
<tr>
<td>N=51 men &amp; women</td>
<td></td>
<td></td>
<td>Mixed design: PS crossover; Serving method between-subjects</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n=27 plate group; n=24 self-serve</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Zuraikat, et al., 2016</td>
<td>Lunch: pasta dish</td>
<td>Portion options – contextual information; more control</td>
<td>3 sets of portion options; 3 PS/set Women’s sets: 300/375/450, 375/450/525, and 450/525/600 Men’s: 33% more</td>
<td>Selection: Relative size selected not influenced by increasing set PS Food and energy intake: increased with largest PS set</td>
<td>No influence on portion selection EAT scores influenced intake as PS sets increased</td>
</tr>
<tr>
<td>N=50 men &amp; women</td>
<td></td>
<td></td>
<td>Crossover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ueland, et al., 2009</td>
<td>Pre-load: Pasta preload – serving size varied, but not amount</td>
<td>Information about portion size</td>
<td>Only 1 size served; 3 different portion size labels (0.5, 1, 1.5 servings)</td>
<td>Food and energy intake: no effect of portion size info on a) preload intake b) subsequent meal intake</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=33 men &amp; women</td>
<td></td>
<td></td>
<td>Crossover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper and subjects</td>
<td>Test meal</td>
<td>Intervention</td>
<td>Portion size manipulation</td>
<td>Effects on food and energy intake</td>
<td>Influence of subject characteristics</td>
</tr>
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</tr>
<tr>
<td>Reily &amp; Vartanian, 2016</td>
<td>Lunch: Pasta dish</td>
<td>3 levels contextual information about PS: control, size, size + comparison</td>
<td>2 portion sizes: 100% and 200% of baseline (300g)</td>
<td>Food and energy intake: increased with larger PS</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=154 women</td>
<td></td>
<td></td>
<td>Fully between-subj.</td>
<td>No interactions or main effect of contextual info (*for both pre- and self-served)</td>
<td></td>
</tr>
<tr>
<td>Spanos, et al., 2015</td>
<td>Lunch: pizza (cut into bite size pieces)</td>
<td>Serving size information for large portion only (unlabeled, 2 serv., 4 serv.)</td>
<td>2 portion sizes: 100% and 200% of baseline (12 pieces)</td>
<td>Food and energy intake: increased when served L/U and L2s; no effect at L4s</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=100 women</td>
<td></td>
<td></td>
<td>S/U, L/U, L2s, L4s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cavanagh, et al., 2014</td>
<td>Lunch: pasta dish</td>
<td>Education (including PS info), mindfulness, and control</td>
<td>2 portion sizes: 350g and 600g</td>
<td>Food and energy intake: increased with increasing PS</td>
<td>Not reported</td>
</tr>
<tr>
<td>N=96 women</td>
<td></td>
<td></td>
<td>Between-subj.</td>
<td>No interaction with education or mindfulness; no main effects</td>
<td></td>
</tr>
</tbody>
</table>

**PS interventions related to value (for money)**

<p>| Harnack, et al., 2008              | Dinner: variety of options from McD’s menu | 2x2 Pricing (linear vs value) and cal labels: cal/val, cal/lin, no cal/val, no cal/lin. | 3 portion sizes (small, medium, large) – selection | Energy intake: no effect of condition | Higher nutrition importance: EI lowest at cal label+lin price condition |
| N=594                              |                               |                                                                              | Between-subj.                                    | PS selection: no effect of condition |                                        |</p>
<table>
<thead>
<tr>
<th>Paper and subjects</th>
<th>Test meal</th>
<th>Intervention</th>
<th>Portion size manipulation</th>
<th>Effects on food and energy intake</th>
<th>Influence of subject characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vermeer, et al., 2009</td>
<td>Study 1: soft drink and chicken nuggets</td>
<td>Pricing: value vs linear</td>
<td>Study 1: 3 portion sizes (sm, md, lg)</td>
<td>PS selection: No effects of pricing (study 1)</td>
<td>Study 1: In OW/OB linear pricing reduced selection of largest drink portion; increased selection of reference nuggets</td>
</tr>
<tr>
<td>Study 1: N=150</td>
<td>Study 2: hot meal</td>
<td>Study 2: 2 portion sizes (sm, md)</td>
<td>No effects of pricing (study 2)</td>
<td>Study 2: In HW linear pricing led to increased selection of reference size</td>
<td></td>
</tr>
<tr>
<td>Study 2: N=141</td>
<td></td>
<td>Selection</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Between-subj.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermeer et al., 2011</td>
<td>Lunch: hot meals</td>
<td>Addition of small portion</td>
<td>Small portion added + val pricing; Small portion added + lin pricing; No portion added</td>
<td>PS selection: 10% of subjects switched from larger to smaller portion</td>
<td>Higher in restraint = more likely to switch to smaller portion</td>
</tr>
<tr>
<td>N=308; 25 cafeterias</td>
<td>Pricing: value vs linear</td>
<td>Data on compensatory eating is mixed</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


References


Centers for Disease Control (CDC). (2016). How to avoid portion size pitfalls to manage your weight. 6 July 2016. Internet:


doi:10.1016/j.physbeh.2015.03.025


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


CHAPTER 2

Study 1:

COMPARING THE PORTION SIZE EFFECT IN WOMEN WITH AND WITHOUT EXTENDED TRAINING IN PORTION CONTROL: A FOLLOW-UP TO THE PORTION-CONTROL STRATEGIES TRIAL

Reprinted from Appetite, 123, Zuraikat, F.M., Roe, L.S., Sanchez, C.E. & Rolls, B.J., Comparing the portion size effect in women with and without extended training in portion control: A follow-up to the Portion-Control Strategies Trial, 334-342, 2018, with permission from Elsevier for non-commercial use.
INTRODUCTION

Serving larger portions leads individuals to consume more food, and this response results in substantial increases in energy intake across different types of people, foods, and settings (1-4). Given the prevalence of large portions of energy-dense foods (5-7), which contribute to overconsumption of energy (8), strategies are needed to moderate the effect of portion size on intake. One method that is recommended is training in portion control, for example through use of portion-control tools or instruction on appropriate food portions (9-14). Although educational interventions can increase the accuracy of portion size estimation (15), such training in the short-term has not been shown to influence intake (16). Furthermore, the effect of prolonged portion-control training on intake from large portions has not been systematically evaluated. To address this, we compared the response to portion size in trained individuals (who had been taught to manage food portions as part of a weight loss trial) to the response in individuals without such training. The portion size effect was assessed by measuring food intake from a meal in which all foods were systematically varied in portion size. Thus, the purpose of this study was to determine whether individuals with extended training in portion-control strategies were less responsive to the portion size effect than those without training.

The Portion-Control Strategies Trial provided a unique population in which to test the influence of training on the portion size effect. In this 1-year randomized controlled trial, women with overweight and obesity received instruction in one of three different targeted strategies for managing food portions. Although the various interventions differed in the content and intensity of instruction in portion control, the total duration of training was equivalent and all strategies were successful in promoting weight loss (17). After the trial, we aimed to determine whether the response to portion size under controlled conditions differed between trained subjects and
untrained controls of differing weight status. We were also interested in the strategies that trained individuals might adopt in order to moderate energy intake when offered large portions, in comparison to control subjects. At a meal comprised of multiple foods, individuals trained in portion control might limit the amounts of all foods consumed, or instead, make differential adjustments in intake of individual foods according to their perceived healthfulness or energy density (ED) (1).

The current study used a crossover design to test differences between subject groups in the amounts and types of food consumed in response to increasing portions, with the goal of assessing whether energy intake differed by training or weight status. Previous research showed that the effect of portion size on intake can be comprehensively evaluated by serving a meal of multiple foods that are simultaneously varied across four or more portion sizes. This paradigm allows choices among foods that differ in ED and facilitates assessment of the influence of subject characteristics (e.g. body size, eating behaviors) and food properties (e.g. healthfulness, palatability) on the response to portion size (18). We hypothesized that the effect of portion size on the weight and energy content of food consumed would be attenuated in participants who were trained in portion control, compared to untrained controls. Additionally, portion size has been implicated as contributing to the obesity epidemic (5, 7), but there is limited experimental evidence demonstrating a relationship between the portion size effect and weight status. Thus, we also tested the hypothesis that the effect of portion size on intake differed between the untrained controls with overweight and obesity and the controls with normal weight.
SUBJECTS AND METHODS

Study design

In a crossover design, women from different subject groups came to the laboratory to eat lunch once a week for 4 weeks. Across the 4 meals the same menu was served, but the portions of all foods were simultaneously varied (100%, 125%, 150%, or 175% of baseline amounts). At all meals, weighed intake of each food was determined. The order of presenting the portion size conditions was counterbalanced across subjects using Latin squares, and subjects were randomly assigned a sequence. The study was conducted at the Laboratory for the Study of Human Ingestive Behavior at the University Park campus of The Pennsylvania State University, and all procedures were approved by the Office for Research Protections. Subjects were told that the purpose of the study was to investigate eating behavior. Subjects provided signed informed consent and were financially compensated for their participation.

Subjects

One group of subjects was recruited from among women who had completed the Portion-Control Strategies Trial. In that 1-year trial, 186 women with overweight and obesity were randomly assigned to receive training in three different strategies to promote weight loss: using pre-portioned foods to structure meals, using measuring tools to select food portions based on ED, or following standard advice to eat less while selecting nutritious foods. Participants in all interventions had frequent individual contact with trained interventionists, received instruction on meal planning and healthful choices within food groups, and were advised to increase physical activity (17). For enrollment in the trial, women were required to be aged 20-65 y with a body mass index (BMI) of 28-45 kg/m² and were excluded if they showed evidence of
disordered eating (scored >19 on the Eating Attitudes Test (19)) or depression (scored >25 on the Beck Depression Inventory (20)). Recruitment for the current study took place after the trial was completed; it was presented as a separate study unrelated to the trial and was conducted in a different location with different staff. A subset of trial completers from all three intervention groups who were willing to participate in this study were enrolled. The trial participants, hereafter referred to as trained participants, who enrolled in the current study had lost a mean of 5.3±0.9% of their body weight during the trial, comparable to the 6% weight loss in all trial participants (17), but all of them still had overweight or obesity (Table 2.1).
Table 2.1: Subject characteristics of 102 women

<table>
<thead>
<tr>
<th>Variable</th>
<th>Trained participants (n=39)</th>
<th>Controls with overweight and obesity (n=34)</th>
<th>Controls with normal weight (n=29)</th>
<th>Difference between groups (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>86.4 ± 15.2 a</td>
<td>78.7 ± 13.3 b</td>
<td>60.3 ± 5.8 c</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>32.3 ± 4.8 a</td>
<td>29.5 ± 4.0 b</td>
<td>22.3 ± 1.6 c</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number with obesity (%)²</td>
<td>25 (64%)</td>
<td>14 (41%)</td>
<td>0 (0%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number with overweight (%)²</td>
<td>14 (36%)</td>
<td>20 (59%)</td>
<td>0 (0%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number with normal weight (%)²</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>29 (100%)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.3 ± 11.6 a</td>
<td>42.9 ± 14.5 b</td>
<td>35.5 ± 14.6 b</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Energy requirement (kcal/d)³</td>
<td>2354 ± 264 a</td>
<td>2318 ± 208 a</td>
<td>2079 ± 118 b</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Dietary restraint score ⁴</td>
<td>14.4 ± 3.3 a</td>
<td>7.5 ± 4.0 b</td>
<td>8.0 ± 4.4 b</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Disinhibition score ⁴</td>
<td>8.9 ± 3.9 a</td>
<td>7.3 ± 4.1 ab</td>
<td>5.4 ± 3.5 b</td>
<td>0.002</td>
</tr>
<tr>
<td>Hunger tendency score ⁴</td>
<td>5.6 ± 3.35</td>
<td>5.5 ± 2.9</td>
<td>5.1 ± 3.3</td>
<td>0.81</td>
</tr>
</tbody>
</table>

¹ Values are mean ± SD unless otherwise indicated.
² Obesity is defined as body mass index ≥ 30 kg/m²; overweight as body mass index 25-29.9 kg/m²; and normal weight as < 25 kg/m²
³ Energy requirements were estimated from sex, age, height, weight, and activity level (21).
⁴ Scores from the Eating Inventory (22).

Means with different superscript letters are significantly different according to a fixed effects model (P<0.05).

The control population for the current study consisted of women who had not participated in the weight-loss trial and were recruited through advertisements posted on campus, in the local community, and online. Controls were eligible for the study if they were aged 20-65 y, had a BMI of 19-45 kg/m², and did not show evidence of disordered eating (scored >19 on the Eating Attitudes Test (19)) or depression (scored >40 on the Self-rating Depression Scale (23)). We
included control subjects with normal weight as well as those with overweight and obesity in order to assess the effect of weight status on intake in response to increasing food portions. Potential participants were excluded if they had food allergies, restrictions, or dislike for the study foods; did not regularly eat 3 meals per day; were dieting to gain or lose weight; or were smokers, athletes in training, pregnant, or breastfeeding.

The sample size for the experiment was based on data from a related study conducted in the laboratory (18). A power analysis was conducted to determine the sample size needed to detect a 40% reduction in the slope of the portion size trajectory in trained participants compared to controls with >80% power at a significance level of 0.05. The analysis showed that it would require 40 trained participants and 60 controls (with normal weight and with overweight and obesity) to detect this difference. A total of 105 subjects were enrolled in the study, but 3 subjects failed to attend all scheduled meals. Thus, 102 subjects completed the study: 39 trained participants and 63 controls. Among the trained participants, 12 were from the pre-portioned foods intervention, 16 from the portion selection intervention, and 11 from the standard advice intervention. Among the controls, 34 had overweight or obesity and 29 had normal weight.

Prior to the first meal, subjects completed the Eating Inventory (22), which consists of 51 items about eating behavior that assess dietary restraint, disinhibition, and tendency towards hunger. Subject energy requirements were estimated from age, sex, height, weight, and activity level (21).

Test meal

The test meal consisted of 7 commercially available foods that were chosen to represent typical meal components and that differed in ED (Table 2.2). In the baseline (100%) condition,
the portion sizes were based on intake of women in previous studies in the laboratory (18, 24); in the other conditions, the portions of all foods were simultaneously increased to 125%, 150%, or 175% of baseline amounts (Table 2.2). Four portion sizes were used in order to characterize the trajectory of the weight of food consumed across the range of weight served (18). One liter of water was served as a beverage at all meals. To determine the amount of food consumed, all items were weighed to within 0.1 g before and after meals. Energy intake was calculated using information from food manufacturers and a standard food composition database (25).

Photo 2.1: Portion sizes of the test meals served at the lunches.
Table 2.2: Composition of test meals served to 102 women

<table>
<thead>
<tr>
<th>Food served</th>
<th>Energy density (kcal/g)</th>
<th>100% portion sizes</th>
<th>125% portion sizes</th>
<th>150% portion sizes</th>
<th>175% portion sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight (g)</td>
<td>Energy (kcal)</td>
<td>Weight (g)</td>
<td>Energy (kcal)</td>
<td>Weight (g)</td>
</tr>
<tr>
<td>Chicken, breaded pieces&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.86</td>
<td>80</td>
<td>149</td>
<td>100</td>
<td>186</td>
</tr>
<tr>
<td>Pasta&lt;sup&gt;b&lt;/sup&gt; with tomato sauce&lt;sup&gt;c&lt;/sup&gt; and cheese&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.38</td>
<td>160</td>
<td>221</td>
<td>200</td>
<td>277</td>
</tr>
<tr>
<td>Broccoli</td>
<td>0.45</td>
<td>80</td>
<td>36</td>
<td>100</td>
<td>45</td>
</tr>
<tr>
<td>Salad with light dressing</td>
<td>0.40</td>
<td>120</td>
<td>48</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>Garlic bread&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.60</td>
<td>48</td>
<td>173</td>
<td>60</td>
<td>216</td>
</tr>
<tr>
<td>Grapes</td>
<td>0.69</td>
<td>80</td>
<td>55</td>
<td>100</td>
<td>69</td>
</tr>
<tr>
<td>Chocolate chip cookies&lt;sup&gt;f&lt;/sup&gt;</td>
<td>4.84</td>
<td>26</td>
<td>126</td>
<td>33</td>
<td>157</td>
</tr>
<tr>
<td>Entire meal</td>
<td>1.36</td>
<td>594</td>
<td>808</td>
<td>743</td>
<td>1010</td>
</tr>
</tbody>
</table>

<sup>a</sup> Bell & Evans, Fredericksburg, PA, USA.
<sup>b</sup> Barilla USA, Northbrook, IL, USA.
<sup>c</sup> Campbell’s, Camden, NJ, USA.
<sup>d</sup> The Kraft Heinz Co., Glenview, IL, USA.
<sup>e</sup> Pepperidge Farm Inc, Norwalk, CT, USA.
<sup>f</sup> Nabisco, East Hanover, NJ, USA.
Study procedures and assessments

Subjects came to the laboratory to eat a test meal once a week for 4 weeks on a scheduled day and time. They were told that the purpose of the study was to assess eating behavior in a laboratory. Since the study was conducted on a different site and with different personnel than the weight loss trial, the environment was novel both to subjects who had participated in the weight-loss trial and to untrained controls. Subjects were instructed to maintain a consistent level of exercise and refrain from drinking alcoholic beverages on the day before their test meal and to refrain from eating after 10 pm the previous evening. They were told to eat a consistent breakfast the day of the test meal and not to consume any food or energy-containing beverages between breakfast and lunch.

Upon arrival for their meal, subjects were seated in private cubicles and rated their hunger, fullness, thirst, prospective consumption, and nausea using 100-mm visual analog scales (VAS; 26). Subjects were then served the meal and told that they could eat and drink as much or as little as they liked. After consuming the meal, subjects again rated their hunger, fullness, and prospective consumption, as well as how pleasant the meal tasted overall, how healthy the meal they consumed was, and how many calories they thought they consumed from the meal.

At a discharge session in the fifth week, subjects were given small samples of the 7 test foods, which they tasted and rated for liking and healthfulness on 100-mm visual analog scales. Thus, subjects rated healthfulness and liking of each of the four full meals they had consumed as well as liking and healthfulness of each of the individual foods that made up the meals. Additionally, after the first cohort, a subset of 88 subjects (86%) ranked the test foods for pleasantness of taste from 1 (highest) to 7 (lowest).
**Statistical analysis**

The main outcome of the effect of portion size on meal intake was defined as the trajectory of the weight of food consumed across the weight of food served. Previous research demonstrated a curvilinear trajectory of mean intake as portions were increased (18). The portion size response was characterized by a polynomial equation and analyzed by random coefficients models (27). The fixed factors in the model were meal portion size (g), subject group (trained participants, controls with overweight and obesity, and controls with normal weight), and study week. Subjects were treated as random factors; thus the intake trajectory of each individual was modeled separately. The trajectories were centered at the smallest condition of portion size, so that the linear coefficient (slope) represented the increase in intake as portions were increased above baseline amounts, and the quadratic coefficient described the deceleration of intake as portions were further increased. In addition to meal weight, the trajectories of meal ED and energy were analyzed as main outcomes using random coefficients models. Subject characteristics and questionnaire scores were tested as covariates in the models to determine whether any of these factors influenced the trajectory of intake in response to increased portion size.

Intake of the individual foods in the meal was analyzed as a secondary outcome. All the foods were included in a univariate manner in a single random coefficients model, so that intake trajectories were adjusted for the other foods in the meal. Subject characteristics and questionnaire scores were tested as covariates as in the main models. In addition, subject ratings and rankings of food-specific factors (such as liking) were also tested for their influence on food intake trajectories.
Other secondary outcomes were subject ratings of hunger, satiety, and characteristics of the meal and foods. Differences in these outcomes were analyzed by a mixed linear model with repeated measures; the fixed effects in the model were portion size condition (100%, 125%, 150%, and 175%), subject group, and study week. Post-meal ratings of hunger and satiety were adjusted by including the pre-meal rating as a covariate in the model. For all mixed linear models, the $F$-statistic and its denominator degrees of freedom were adjusted using the Kenward-Roger approximation, and adjustment for multiple comparisons between means was made using the Tukey-Kramer method (27). Differences in the distribution of food taste rankings across groups were tested using ordinal repeated-measures logistic regression. The repeated-measures correlation between subject ratings of healthfulness of the meal consumed and the overall ED of the foods consumed at the meal was determined from the covariance parameters of a mixed linear model in which the two variables were treated as repeated measures (28). The correlation between mean ratings of healthfulness of the individual foods and the ED of the food were calculated using the Pearson correlation coefficient according to the method of Bland and Altman (29). Standardized effect sizes were calculated using Cohen’s $d$ statistic, ignoring the correlations between outcomes. Differences in subject characteristics across groups were tested by fixed effects models for continuous variables and by Fisher’s exact test for categorical variables. All analyses were performed using SAS software (version 9.4, SAS Institute, Cary, NC). Outcomes are reported as mean ± SEM and results were considered significant at $P<0.05$. 
RESULTS

Subject characteristics

Subject characteristics are shown in Table 1. Trained participants were older and had higher BMI than participants in both control groups. Estimated daily energy expenditure, however, did not differ significantly between trained participants and controls with overweight and obesity. Energy requirements of the controls with normal weight were significantly lower than those of the other two groups. The study population was 97% white, 2% black, and 1% Asian; 4% were Hispanic or Latino. There was no significant difference across participant groups in the distribution of race (table probability=0.051; \( P=0.33 \)) or ethnicity (table probability=0.029; \( P=0.07 \)).

Meal intake by weight

Serving larger portions of all foods significantly increased the weight of food consumed at the meal (Figure 2.1A; \( F(1,101)=138.61, P<0.0001 \)). The trajectory of meal intake (weight of food consumed across weight served) was linear and did not differ significantly across participant groups (\( F(2,99)=0.45, P=0.64 \)) nor across the type of portion-control intervention in trained participants (\( F(2,36)=2.29, P=0.12 \)). Thus, the hypothesis that trained individuals would show an attenuated response to large portions was not supported, since trained participants, controls with overweight and obesity, and controls with normal weight all responded similarly to increases in meal portion size by consuming a greater weight of food. The slope of the relationship showed an increase of 26±2 g consumed per additional 100 g served, indicating that participants consumed a mean of 26% of the food added to the baseline meal in each of the three
larger portion conditions. Increasing all portions by 75% increased food intake by 111±10 g (27%; \( d=1.02 \)).

**Meal energy density (ED)**

The effect of increasing portion size on the ED consumed at the meal differed across participant groups (Figure 2.1B; linear coefficient interaction \( F(2,243)=3.43, P=0.034 \); quadratic coefficient interaction \( F(2,202)=3.66, P=0.028 \)). For trained participants, there was a curvilinear trajectory of meal ED across portion sizes: an initial decrease (negative linear coefficient; \( t(243)=-3.44, P=0.0007 \)) as portions were increased from baseline, followed by an increase (positive quadratic coefficient; \( t(201)=3.28, P=0.001 \)) as portions were increased further. In contrast, meal ED for control participants with overweight or normal weight did not change significantly as portions were increased (linear coefficients \( t(243)=0.28, P=0.78 \) and \( t(243)=-0.77, P=0.44 \), respectively; quadratic coefficients \( t(203)=-0.63, P=0.53 \) and \( t(201)=0.93, P=0.35 \), respectively). Across all the portions served, the overall ED of the meal also differed by participant group (\( F(2,111)=4.85; P=0.010 \)). The meals eaten by trained participants were lower in ED (1.09±0.02 kcal/g) than those eaten by controls with overweight and obesity (1.22±0.02 kcal/g; \( d=0.53 \)) or controls with normal weight (1.31±0.02 kcal/g; \( d=0.82 \)), which did not differ significantly. In trained participants, the effects on meal ED in response to increased portion size did not differ significantly across the different portion-control interventions (linear coefficient interaction \( F(2,94.4)=0.32, P=0.72 \); quadratic coefficient interaction \( F(2,75)=0.47, P=0.63 \)).
Meal energy intake

For both trained participants and controls, serving larger portions significantly increased energy intake at the meal (F(1,101)=2.36, P<0.0001; Figure 2.1C). Across all groups, the trajectory of energy intake was linear and the slope of the relationship showed an increase of 29±3 kcal per additional 100 g served. Increasing all portions by 75% increased energy intake by 25% (126±14 kcal; d=0.68). Independent of the effect of portion size, the magnitude of meal energy intake differed significantly across participant groups (F(2,99)=3.78, P=0.026). Across all meals, trained participants consumed less energy (506±15 kcal) than controls with overweight and obesity (592±16 kcal; d=0.45) or controls with normal weight (611±17 kcal; d=0.55), whose intakes did not differ significantly. Thus, although food intake by weight increased similarly across portion sizes for all groups, the differences in meal energy density across groups led to significant differences in meal energy intake. Among trained participants, the effect on energy intake did not differ according to the type of portion-control intervention (F(2,36)=0.97, P=0.39).
**Figure 2.1.** Mean (±SEM) intakes of meals that were varied across 4 portion sizes, for trained participants (n=39), controls with overweight and obesity (n=34), and controls with normal weight: (n=29), as assessed by random coefficients models. Figure 2.1A: The weight of food consumed significantly increased as portions were increased (P<0.0001), and this effect did not differ across groups. Figure 2.1B: In trained participants, meal energy density (ED) initially decreased as portions were increased (P=0.0006), followed by an increase (P=0.001); in controls, meal ED was not affected by portion size (both P>0.35). Additionally, across all 4 portions, meal ED was significantly lower for trained participants than controls (P<0.015). Figure 2.1C: Meal energy intake increased as portions were increased (P<0.0001), and this effect did not differ across groups. However, across all 4 portions, trained participants had a lower energy intake than both control groups (P=0.023), whose intake did not differ.

**Intake of individual foods**

Analyzing intake of the 7 foods in a single model showed that the effects of portion size on the weight of individual foods consumed were linear and the slopes did not differ across participant groups (F(2,119) = 0.61; P=0.54), similar to the findings for the entire meal. The portion size effects, however, did differ across food items (Table 2.3; F(6,2621)=3.55, P=0.0017). Additionally, although the participant groups had similar slopes for the portion size effects, the groups had significant differences in overall consumption of 3 foods: garlic bread (F(2,1025)=5.50, P=0.004), pasta (F(2,1169)=14.03, P<0.0001), and salad (F(2,1220)=12.05, P<0.0001). Across all meals, trained participants consumed significantly less garlic bread than did controls with overweight and obesity; they also consumed less garlic bread and pasta, but more salad, than did controls with normal weight. Thus, the lower energy density of the meals consumed by trained participants compared to controls was attributable to eating less of the higher-ED garlic bread and pasta, and more of the very-low-ED salad.
Table 2.3: Weight (g) of individual foods consumed at test meals by 102 women

<table>
<thead>
<tr>
<th>Food item</th>
<th>Trained participants (n = 39)</th>
<th>Controls with overweight and obesity (n=34)</th>
<th>Controls with normal weight (n=29)</th>
<th>Portion size effect² (P-value)</th>
<th>Group effect³ (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Portion size served</td>
<td>Portion size served</td>
<td>Portion size served</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>125%</td>
<td>150%</td>
<td>175%</td>
<td>100%</td>
</tr>
<tr>
<td>Chicken, breaded pieces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>63.9 ±3.6</td>
</tr>
<tr>
<td>Pasta with tomato sauce</td>
<td>82.1 ±8.5</td>
<td>76.4 ±10.4</td>
<td>77.4 ±11.6</td>
<td>95.4 ±11.7</td>
<td>94.8 ±9.3</td>
</tr>
<tr>
<td>and cheese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>±6.3</td>
</tr>
<tr>
<td>Broccoli</td>
<td>73.0 ±2.7</td>
<td>83.7 ±4.0</td>
<td>98.2 ±6.3</td>
<td>99.8 ±6.3</td>
<td>69.2 ±3.8</td>
</tr>
<tr>
<td>Salad with light dressing</td>
<td>91.7 ±5.3</td>
<td>114.8 ±5.6</td>
<td>122.7 ±9.3</td>
<td>134.9 ±9.9</td>
<td>92.5 ±4.4</td>
</tr>
<tr>
<td>Garlic bread</td>
<td>20.3 ±2.6</td>
<td>21.3 ±3.2</td>
<td>24.2 ±3.5</td>
<td>31.4 ±4.1</td>
<td>32.8 ±2.7</td>
</tr>
<tr>
<td>Grapes</td>
<td>61.1 ±4.2</td>
<td>67.4 ±5.5</td>
<td>74.5 ±7.0</td>
<td>67.5 ±7.0</td>
<td>55.8 ±4.7</td>
</tr>
<tr>
<td>Chocolate chip cookies</td>
<td>8.9 ±1.6</td>
<td>7.8 ±1.7</td>
<td>8.4 ±1.9</td>
<td>9.5 ±2.3</td>
<td>9.1 ±1.7</td>
</tr>
</tbody>
</table>

¹ Values are mean ± SEM
² Portion size effect: non-zero slope of food intake across the portions served, as assessed by a random coefficients model
³ Group effect: difference in food intake across subject groups, as assessed by a random coefficients model
⁴ For pasta, intake of trained participants < intake of controls with normal weight
⁵ For salad, intake of trained participants and controls with overweight and obesity > intake of controls with normal weight
⁶ For bread, intake of trained participants < both groups of controls
Influence of subject characteristics

The effect of portion size on the trajectory of meal intake by weight was not influenced by the subject characteristics of age (F(1, 102)=0.22, P=0.64), estimated energy expenditure (F(1, 102)=0.05, P=0.83), or scores for restraint (F(1, 101)=0.01, P=0.94), disinhibition (F(1, 102)=0.41, P=0.52), or tendency towards hunger (F(1, 102)=0.35, P=0.56). Similarly, these subject characteristics did not influence the effect of portion size on overall meal energy density or energy intake (data not shown).

Ratings of hunger and satiety, and meal characteristics

As food portions were increased and meal intake correspondingly increased in all groups, participant ratings of post-meal fullness on 100-mm visual analog scales increased from 80.0±1.7 mm in the 100% portion size condition to 84.7±1.4 mm in the 175% condition (F(3, 199)=3.44, P=0.018; d=2.82). Likewise, ratings of hunger decreased from 6.6±1.1 mm in the 100% condition to 4.0±0.5 mm in the 175% condition (F(3, 195)=2.69, P=0.048; d=-1.85). Participant post-meal estimates of energy intake also increased as portions were increased (F(3, 216)=4.33, P=0.005); this outcome did not differ across subject groups (F(2, 100)=0.16, P=0.85). Estimated energy intake in the baseline portion size condition (598±22 kcal) was significantly less than in the three larger conditions (mean 640±14 kcal), which did not differ from each other. Thus, although measured energy intake increased 25% between the meals with the smallest and largest portions, participant estimates of their energy intake only increased by 7%.

Post-meal ratings of pleasantness of taste (mean 76±1.0 mm) and healthfulness (mean 64±1.0 mm) of the meals consumed did not differ across experimental conditions (F(3, 219)=1.16, P=0.33 and F(3, 216)=0.34, P=0.79, respectively). This was expected since the types and
proportions of foods were not varied as portions were increased. There were differences, however, across participant groups in ratings of healthfulness of the meals consumed (F(2,100)=4.45, P=0.014); trained participants rated the meals they ate as more healthful (mean 68.4±1.2 mm) than did controls with normal-weight (58.0±1.7 mm; d=-0.64). Post-meal ratings of meal healthfulness were inversely related to the ED of the meal that subjects had consumed (repeated measures correlation=-0.30; P<0.0001).

Subject ratings of liking and healthfulness of the individual foods (completed at discharge) showed significant differences across items (Table 2.4; F(6,697)=19.03, P<0.0001 and F(6,698)=372.02, P<0.0001, respectively); there were no differences, however, between trained participants and controls for these ratings (F(12,685)=1.36, P=0.18 and F(12,686)=1.02, P=0.43, respectively). Mean subject ratings of healthfulness of the individual foods were strongly and negatively correlated with the ED of the item (r=-0.94; P=0.0018). In the subgroup of subjects who completed rankings of food taste at discharge, the distribution of the rankings did not differ across subject groups (F(2,602)= 0.02, P=0.98).
Table 2.4: Mean (± SEM) ratings of food characteristics at discharge by 102 women$^1$

<table>
<thead>
<tr>
<th>Food item</th>
<th>Liking rating</th>
<th>Healthfulness rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken, breaded pieces</td>
<td>76.2 ± 2.4$^b$</td>
<td>52.8 ± 1.8$^c$</td>
</tr>
<tr>
<td>Pasta with tomato sauce and cheese</td>
<td>64.2 ± 2.4$^c$</td>
<td>47.3 ± 1.8$^c$</td>
</tr>
<tr>
<td>Broccoli</td>
<td>80.5 ± 2.4$^{ab}$</td>
<td>89.5 ± 1.1$^a$</td>
</tr>
<tr>
<td>Salad with light dressing</td>
<td>83.1 ± 1.8$^{ab}$</td>
<td>81.2 ± 1.7$^b$</td>
</tr>
<tr>
<td>Garlic bread</td>
<td>77.8 ± 2.3$^b$</td>
<td>27.4 ± 2.1$^d$</td>
</tr>
<tr>
<td>Grapes</td>
<td>85.9 ± 1.7$^a$</td>
<td>92.1 ± 0.9$^a$</td>
</tr>
<tr>
<td>Chocolate chip cookies</td>
<td>58.2 ± 3.1$^c$</td>
<td>14.3 ± 1.5$^e$</td>
</tr>
</tbody>
</table>

$^1$Ratings were assessed by visual analog scales and ranged from 0 to 100 mm. Both ratings differed significantly across food items according to a mixed model with repeated measures (P<0.0001). Means for the same rating with different superscripts were significantly different (P<0.05, adjusted for multiple comparisons by Tukey-Kramer method). There were no significant differences between trained participants and controls for these ratings.

The analysis of the portion size effect on individual foods (the trajectories of the weight of food consumed in response to increasing weight served) showed a positive effect of food liking on the slopes, and that this effect differed by subject group (F(2,2327)=12.48, P<0.0001). Across all items, the positive effect of food liking on the slopes of the intake trajectories was smaller for trained participants than for controls. Thus, although there were similar ratings of liking across subject groups, the effects of liking on the portion size response differed across groups. The ranking of the relative taste of the individual foods also influenced the portion size effect in the subset of subjects who completed this task (Figure 2.2; F(6,2238)=15.96, P<0.0001). Across all subject groups, items ranked higher in taste had a greater increase in intake (more positive slope) as portions were increased.
DISCUSSION

Serving larger portions of all foods at a meal led to an increase in the weight of food consumed by both individuals with extended training in different portion-control strategies and those without such training. Thus, the results did not support the hypothesis that the portion size effect would be attenuated in trained participants compared to controls. Furthermore, the response to portion size did not differ between the two control groups that varied by weight.
status. Compared to the control groups, however, trained participants moderated their energy intake at all meals. This was achieved not by limiting the overall amount eaten at the meals, but by consuming a greater proportion of lower-ED foods. Thus, contrary to expectation, individuals trained in portion control did not resist the portion size effect; they did, however, reduce their energy intake compared to untrained controls through their food choices at meals.

Our findings emphasize the strength of the portion size effect; despite their training, participants from the Portion-Control Strategies Trial consumed more food and more energy when they were served larger portions. This is consistent with previous unsuccessful efforts to attenuate the response to large portions, including offering portion options (30), providing short-term training in portion size awareness (16), and presenting explicit information about the portion size served (31, 32). We also found that across meals, trained participants ate a similar weight of food to untrained controls, despite differences in training and weight status. Unlike previous studies (13), post-meal ratings of hunger and fullness for all groups were affected by portion size; subjects ate to a greater level of fullness as portions were increased. The contrast between this study and others could be due to the increased power associated with large number of observations in this study. These findings provide further evidence that the portion served is a primary determinant of the amount consumed (18, 33-35), and indicate that even prolonged training in standard portion-control strategies, such as using scales and measuring tools, using pre-portioned foods, or instruction to eat less, may not be powerful enough to counteract the influence of cues from the amount of food available (36, 37). More innovative strategies are needed that provide immediate awareness of the energy content of the portions of food served, along with ways to sustain the salience of this knowledge.
Although participants with portion-control training did not resist the effect of portion size on the amount eaten, they did consume less energy at meals than controls. This difference was attributable to the lower ED of the meals that trained participants chose to consume; compared to controls, they ate more of the very-low-ED foods and less of the higher-ED foods, particularly the items they rated lowest in healthfulness. This finding shows the substantial effect of ED on energy intake and supports previous work demonstrating that decreasing meal ED reduces energy intake independent of changes in portion size (34). Trained participants also rated the meals they consumed as more healthful than did controls, and these ratings were related to the lower ED of the meals they consumed. Additionally, despite similar ratings of liking and healthfulness of the foods across groups, trained participants’ response to portion size for individual foods was less influenced by ratings of liking than it was for controls. The combination of these findings suggests that trained participants placed greater importance on healthfulness in determining food choice than did controls. Indeed, although the emphasis of the training was on targeted portion-control strategies, another component for all intervention groups was on making healthful food choices. The intake patterns of the trained subjects in this study reflected the self-reported behaviors of all participants in the weight loss trial. By the end of the trial, use of portion-control methods was no higher than at baseline; however, use of several strategies for selecting healthy foods had increased from baseline and been maintained (17). These results correspondingly suggest that it may be easier or more sustainable to moderate energy intake by consuming healthy, low-ED foods than to try to resist eating large portions. Future interventions should encourage individuals to evaluate the types of foods available, rather than focusing only on the amount of food that is served.
Another aim of the current study was to assess whether individual characteristics, such as weight status, influence the portion size effect. Although large portions have been linked to the increased energy intake driving the rise in obesity rates (7, 38), this study and those conducted previously have not shown a differential response to portion size according to weight status in adults under controlled conditions (summarized in 3, 39). Not only did we fail to find differences according to weight status, but also the magnitude of the portion size effect did not vary across age, estimated energy expenditure, or scores for restraint, disinhibition, or tendency towards hunger. These findings support previous work, which has consistently found that the portion size effect in adults persists across a range of individual characteristics (3, 4). Nevertheless, future studies should attempt to characterize individuals who are more responsive to variations in portion size and determine whether these responses are sustained, since even small increases in intake could accumulate over time. Identifying such characteristics will assist in the development of personalized interventions to attenuate the effect of large portions on intake.

One measure that did influence responsiveness to portion size was subject taste rankings of the foods. For all groups, the magnitude of the effect of portion size on intake of individual foods was related to the rankings of taste, as was observed in a previous study (18). Moreover, we extended this finding by demonstrating that not only the relative taste but also the absolute liking of individual foods affected intake in response to increasing portion size; the portion size effect on individual foods was greater for better-liked foods. Thus, methods to increase the liking of low-ED foods, in particular fruits and vegetables, have the potential to encourage preferential intake of these foods in the presence of large portions. Such methods include increasing the palatability of low-ED options (40-42) as well as repeated exposure to these foods (43, 44). Furthermore, this study and previous work have shown that serving larger portions can be used
strategically to increase intake of healthful low-ED foods if they are well-liked (45) and relatively more palatable than the other foods available (18).

Because this study was designed to compare the portion size effect in individuals with and without extended training in portion-control strategies, there were some important differences between the subject groups. For instance, trained participants had a history of dieting and recent weight loss due to their participation in the trial. In addition, trained participants were significantly older and heavier than controls, although their estimated energy expenditure did not differ from that of controls with overweight and obesity. Only women were enrolled in this study, and although previous studies demonstrate similar portion size effects in men and women (24, 30, 33, 46), future research should evaluate the effect in men trained in portion control given the possibility of sex differences in compliance to the training or success in weight loss (47, 48).

A potential confounding factor in this study is the demand characteristic associated with eating meals in controlled conditions. The trained participants may have responded differently to being under observation, since unlike the control subjects, they had previously participated in a weight-loss trial that was administered on the same campus. However, this potential influence was lessened by using different locations and different research staff for the two studies. Furthermore, despite the possibility of such a demand characteristic, the effect of portion size on the total amount consumed at the meal was similar between trained participants and controls.

In this study, the effect of portion size on the weight of food consumed and energy intake was found even in women with extended training in portion control. One explanation could be the difficulty of using visual cues to assess food amounts and energy content in order to adjust intake (37, 49). Despite the instruction that trained participants received in the trial, their estimates of energy intake from the three meals with the largest portions did not differ. Although
differences in portion size can be difficult to detect, differences in food healthfulness and energy
density are often more obvious. We found that ratings of the healthfulness of individual food
items were closely correlated with the ED of the food, and these ratings did not differ across
groups. Trained participants, however, applied their knowledge of healthfulness to reduce meal
ED and moderate energy intake from larger portions, compared to controls. Thus, strategies to
counteract the effect of portion size on energy intake should encourage preferential selection of
healthful, lower ED foods as well as awareness of portion sizes.
REFERENCES


34. Rolls BJ, Roe LS & Meengs JS. Reductions in portion size and energy density of foods are additive and lead to sustained decreases in energy intake. Am J Clin Nutr 2006; 83: 11-17.
42. Savage JS, Peterson J, Marini M, Bordi PL, Birch LL. The addition of a plain or herb-flavored reduced-fat dip is associated with improved preschoolers’ intake of vegetables. J Acad Nutr Diet 2013; 113(8): 1090-1095.
CHAPTER 3

Study 2:

DOES THE COST OF A MEAL INFLUENCE THE PORTION SIZE EFFECT?

Introduction

Food portion size has a robust effect on intake. Serving larger portions leads individuals to consume a greater weight of food, typically resulting in increased energy intake (Hollands, Shemilt, Marteau, Jebb, Lewis, Higgins, et al., 2015; Rolls, 2014). This portion size effect has been demonstrated in controlled laboratory settings (Rolls, Morris & Roe, 2002; Roe, Kling & Rolls, 2016; Rolls, 2014) as well as naturalistic, restaurant-style settings (i.e. Diliberti, Bordi, Conklin, Roe & Rolls, 2004; French, Mitchell, Wolfson, Harnack, Jeffrey, Gerlach, et al., 2014) and is observed across many different foods and types of individuals (Rolls, 2014; Zlatevska, Dubelaar & Holden, 2014). Moreover, food portions have grown over the years (Young & Nestle, 2012) and often exceed recommended serving sizes, particularly in restaurants (Wu & Sturm, 2012). Given these trends, it is important to identify factors that influence the response to large portions in order to develop tailored strategies to moderate this effect. One factor that may affect intake from large portions is the cost associated with a meal (English, Laaschuijt & Keller, 2015; Steenhuis & Vermeer, 2009; Siniver & Yaniv, 2012); however, there have been no systematic investigations of the role of cost in determining intake as portions are increased. Thus, the current study examined whether varying the amount of money paid for a meal influences the effect of portion size on intake in a controlled, restaurant-style setting; a secondary aim was to identify individual differences in responsiveness to changes in portion size and cost.

Experimental studies show that varying the price of foods influences the types of food selected (Epstein, Jankowiak, Nederkoorn, Raynor, French & Finkelstein, 2012); however, the relationship between the amount of money paid and the amount of food consumed is less clear. A recent meta-analysis concluded that changes to food costs (primarily through taxes and subsidies) influence energy intake (Afshin, Peñalvo, Del Gobbo, Silva, Michaelson, O’Flaherty,
et al., 2017), but the studies were predominantly population-based and lacked the control needed to investigate the direct effect of cost on food intake. In a field study, researchers reported that increasing the price of an all-you-can-eat buffet led to increased intake at the meal (Siniver & Yaniv, 2102). This effect could be attributed to a sunk-cost bias, which is the tendency for consumers to continue a behavior, even if it is disadvantageous, because of their investment of money, time, or effort (Arkes & Blumer, 1985). In the case of food consumption, this bias could encourage individuals to eat beyond satiation when meal prices are higher, in order to get their money’s worth. Furthermore, this effect might be augmented if individuals also perceive higher-cost meals to be of higher quality. Taken together, these results suggest that cost may influence meal intake and, consequently, an increase in the price paid could exacerbate the response to portion size. However, a controlled experiment is needed to directly assess this effect on measured intake when portion sizes are varied. Thus, using a factorial design, we examined the influence of portion size and meal cost on intake. We hypothesized that these factors would interact to affect intake; specifically, that the influence of increased portion size would be greater when the cost of the meal was higher, compared to when it was lower.

The effects of cost and portion size on intake may vary between individuals, and understanding these differences could aid the development of strategies to moderate energy intake. At present, few studies in adults have found the response to portion size to be influenced by subject characteristics (summarized in Zlatevska et al., 2014; Hollands et al., 2015), and none have examined these differences in relation to meal cost. Thus, a secondary aim of the study was to identify individual differences in response to changes in these factors. For example, individuals who are more price-conscious, frugal, or waste-averse often act to maximize the value of money spent (Shoham & Brencic, 2002; Haws, Naylor, Coulter & Bearden, 2012), and
consequently may be more prone to overeat when large meals are more expensive. Conversely, the influence of cost and portion size may be diminished in those with eating behaviors thought to be associated with lower responsiveness to environmental cues, such as individuals with high dietary restraint (Johnson, Pratt & Wardle, 2012) or those who are more responsive to satiety signals (Hunot, Fildes, Croker, Llewellyn, Wardle & Beeken, 2016). Therefore, the current study assessed consumer attitudes and eating behaviors in order to develop a more comprehensive understanding of the effects of portion size and meal cost on intake.

Methods

Experimental design

In a crossover design with repeated measures, subjects came to the laboratory one day a week for four weeks to eat lunch. Across the four occasions, the meals were varied in two factors: portion size of the main dish (400 g or 600 g) and cost of the meal (US$8 or $16). Meal cost was defined as the price assigned to the meal, which subjects were required to pay, with the intent of promoting a sunk-cost bias (Arkes & Blumer, 1985; Siniver & Yaniv, 2012). The order in which the four meals were served was counterbalanced across subjects using Latin squares and the sequences were randomly assigned to subjects. All procedures were approved by the Office for Research Protections of The Pennsylvania State University. Subjects provided signed informed consent and were financially compensated for their time.

Subject recruitment and characteristics

Men and women were recruited through advertisements on campus, in local newspapers, and on the university research website. Eligibility criteria were based on previous studies with
similar designs (Roe et al., 2016; Zuraikat, Roe, Sanchez & Rolls, 2018) and to increase the likelihood that the sample was representative of the general population. Subjects were eligible if they were 20-65 years old, regularly ate three meals per day, and were willing to refrain from eating between 10 pm the evening before the test session and breakfast on the day of the test session and to refrain from consuming alcohol the day before the test session. Potential subjects were excluded if they disliked or were unable to eat the test foods (because of allergies, intolerance, or dietary restrictions), were smokers, were taking medications that affect appetite, were diagnosed with a health condition that affects appetite, were dieting to gain or lose weight, were an athlete in training, or were pregnant or breastfeeding.

Eighty-two subjects were enrolled in the study; however, three subjects withdrew prior to completing the study due to scheduling conflicts. Thus, 79 subjects were included in analyses; their characteristics are provided in Table 3.1. Thirty-three (42%) of the subjects had overweight or obesity, and 61% had an annual household income > $50,000. The racial composition of subjects was 79% White, 9% Asian, 6% Black or African American, and 5% of mixed or unreported race; 6% of subjects were of Hispanic or Latino ethnicity.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>33.9 ± 12.7</td>
<td>19.5 – 64.3</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.71 ± 0.10</td>
<td>1.52 – 1.95</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>75.3 ± 18.5</td>
<td>47.7 – 131.8</td>
</tr>
<tr>
<td>Body mass index (kg/m$^2$)</td>
<td>25.6 ± 5.0</td>
<td>19.2 – 39.9</td>
</tr>
<tr>
<td>Energy requirement (kcal/d)$^a$</td>
<td>2205 ± 392</td>
<td>1561 – 3270</td>
</tr>
<tr>
<td>Price consciousness score$^b$</td>
<td>4.9 ± 1.1</td>
<td>2.4 – 7.0</td>
</tr>
<tr>
<td>Frugality score$^c$</td>
<td>5.8 ± 0.8</td>
<td>3.9 – 7.0</td>
</tr>
<tr>
<td>Product retention tendency score$^d$</td>
<td>3.9 ± 1.6</td>
<td>1.0 – 7.0</td>
</tr>
<tr>
<td>Dietary restraint score$^e$</td>
<td>9.2 ± 4.6</td>
<td>1.0 – 20.0</td>
</tr>
<tr>
<td>Disinhibition score$^e$</td>
<td>6.2 ± 3.2</td>
<td>1.0 – 15.0</td>
</tr>
<tr>
<td>Tendency to hunger score$^e$</td>
<td>5.0 ± 3.3</td>
<td>0.0 – 14.0</td>
</tr>
<tr>
<td>Satiety responsiveness score$^f$</td>
<td>2.8 ± 0.6</td>
<td>1.4 – 4.4</td>
</tr>
<tr>
<td>Food responsiveness score$^f$</td>
<td>2.4 ± 0.8</td>
<td>1.0 – 4.2</td>
</tr>
<tr>
<td>Slowness in eating score$^f$</td>
<td>2.7 ± 0.8</td>
<td>1.3 – 4.8</td>
</tr>
</tbody>
</table>

$^a$ Energy requirements were estimated from sex, age, height, weight, and activity level (Institute of Medicine, Food and Nutrition (IOM), 2002).

$^b$ Price Consciousness Scale (Lichtenstein et al., 1993). Range of possible scores is 1.0-7.0.

$^c$ Frugality Scale (Lastovicka et al., 1999). Range of possible scores is 1.0-7.0.

$^d$ Product Retention Tendency Questionnaire (Haws et al., 2012). Range of possible scores is 1.0-7.0.


$^f$ Eating Behavior Questionnaire (modified from Wardle et al., 2001). Range of possible scores is 1.0-5.0 for all subscales.
Experimental meals

The experimental lunch consisted of a main dish of pasta, side dishes of salad with Italian dressing and a bread roll, and 1 L of water as a beverage (Table 3.2). The main dish of pasta baked in a creamy cheese and tomato sauce with fresh basil was similar to a popular recipe served in a campus restaurant. The portion size of the main dish was varied between two amounts: 400 g in the smaller portion condition and 600 g in the larger condition. The amount of pasta served in the smaller portion condition was based on average intakes of a similar dish served in a previous study (Diliberti et al., 2004); the amount served in the larger portion condition was increased by 50%. This increase in portion size has been shown to affect intake in previous studies (Diliberti et al., 2004; Rolls, Roe, & Meengs, 2007). Side dishes were not varied in portion size. The main dish accounted for the majority of the weight of food and energy served at the meal (Table 3.2).

Table 3.2: Composition of experimental meals

<table>
<thead>
<tr>
<th>Test meal food</th>
<th>Energy density (kcal/g)</th>
<th>Smaller portion condition</th>
<th>Larger portion condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Weight (g)</td>
<td>Energy (kcal)</td>
</tr>
<tr>
<td>Baked pasta&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.59</td>
<td>400</td>
<td>636</td>
</tr>
<tr>
<td>Salad with dressing&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.86</td>
<td>120</td>
<td>103</td>
</tr>
<tr>
<td>Bread roll&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.22</td>
<td>40</td>
<td>88</td>
</tr>
<tr>
<td>Total meal served</td>
<td>1.36</td>
<td>560</td>
<td>828</td>
</tr>
</tbody>
</table>

<sup>a</sup> Ingredients: Penne pasta (Barilla USA, Northbrook, IL, USA), crushed tomatoes, tomato sauce (Del Monte, San Francisco, CA, USA), ricotta cheese, romano cheese, mozzarella cheese, heavy cream, dried oregano, pepper, and fresh basil.

<sup>b</sup> Mixed green salad with Italian dressing (Newman’s Own, Westport, CT, USA).

<sup>c</sup> Bread roll (Reinhart Food Service, Rosemont, IL, USA).
The price of the meal was varied between two amounts: US$8 and $16. The higher-cost meal was set at double the price of the lower-cost meal so that the cost difference would be salient; previous research found that increasing the price of a restaurant meal by a large amount (e.g. doubling) significantly influenced consumer behavior (Siniver & Yaniv, 2012). This manipulation was used to compare how differences in the amount of money paid for a meal (the sunk cost) might influence intake from large portions. Subjects were required to pay for the meal in order for them to experience the sunk cost manipulation. Information was collected from community restaurants to verify that the main dish served in the study was within local ranges for weight, energy content, and price of similar pasta dishes.

Intake of the experimental meals was determined by weighing all foods before and after meals to within 0.1 g. Energy consumed from the meal was calculated from weight using nutrient data from food manufacturers and a standard food composition database (USDA, 2015).
Subjects were instructed to consume a normal breakfast on the day of their test sessions and to refrain from eating in the 3 hours prior to their scheduled test meal. At the first test session, subjects were told a cover story in order to divert attention from the true study purpose and limit participant reaction bias. Subjects were told that the purpose of the study was to test consumer satisfaction with aspects of a meal that was being developed. Subjects were informed that at each meal they would be given $20 as compensation for their time and that a portion of this stipend would be used to pay for the meal, which would vary in price from week to week. This method of payment from the stipend has been used in previous studies and found to influence purchasing behavior (Giesen, Payne, Havermans & Jansen, 2011). The $20 stipend was given to the subjects as three $5 bills and five $1 bills, so that they could pay the exact cost of their meal (either $8 or $16).

At each test session, subjects were given the stipend, informed of the price of the meal, and reminded that they would pay for the meal when it was served. Subjects were then seated for the meal. Although subjects ate alone in booths to control for social influences on intake, the table was arranged to resemble a casual restaurant setting and neutral instrumental music was

Photo 3.2: The different menus placed in booths to remind subjects of the cost of the meal.
played quietly in the room. A menu describing the meal and its price was displayed on the table, so that subjects were reminded of how much they would pay for the meal. After being seated, subjects rated their pre-meal hunger, thirst, fullness, prospective consumption, and nausea using 100-mm visual analog scales (VAS; Flint, Raben, Blundell, & Astrup, 2000). For example, to assess prospective consumption, subjects responded to the question “How much food do you think you could eat right now?” by marking a single vertical line on the scale between the anchors of “Nothing at all” and “A large amount.” All VAS ratings were evaluated as the distance (in mm) of the marked line from the lower anchor of the 100-mm scale. The food was then served and subjects paid for the meal from their stipend. Subjects then rated the appearance and pleasantness of taste of each of the three foods on 100-mm VAS. Upon completion of those ratings, subjects were instructed to eat and drink as much or as little as they desired.

When subjects were finished eating, they completed post-meal VAS ratings of hunger, thirst, fullness, and prospective consumption; these questions were identical to those asked prior to the meal. Subjects also used VAS to rate their overall satisfaction with the meal, satisfaction with the cost of the meal, perceived value of the meal, appropriateness of the amount of food served, and likelihood of purchase. Examples of these questions are: “How satisfied are you with the cost of this meal?” (anchored by “Not at all satisfied” and “Very satisfied”) and “How do you perceive the appropriateness of the amount of food provided by the pasta?” (anchored by “Not enough food” and “Too much food”).

One week after the last test session, subjects returned to the laboratory for a discharge session to have their height and weight measured and to complete questionnaires about demographic characteristics, consumer attitudes, and eating behaviors (described below). Upon
completion of the questionnaires, subjects were informed of the true purpose of the study and were compensated for attending the final session.

**Questionnaires**

At the discharge session, subjects completed a demographic questionnaire that assessed age, race, ethnicity, and household income (using six categories). Additional questionnaires included the Price Consciousness Scale (Lichtenstein, Ridgway, & Netemeyer, 1993), a 5-item measure of value-seeking behavior; the Frugality Scale, an 8-item measure of economic behavior and decision-making (Lastovicka, Bettencourt, Hughner & Kuntze, 1999); and the Product Retention Tendency questionnaire (Haws et al., 2012), a 4-item scale evaluating aversion to wasting goods. Subjects also completed the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985), which is a 51-item scale assessing dietary restraint, disinhibition, and tendency towards hunger.

We also developed a questionnaire for adults based on a subset of the parentally-evaluated questions from the validated Children’s Eating Behaviour Questionnaire (Wardle, Guthrie, Sanderson, & Rapoport, 2001; Carnell & Wardle, 2008); this questionnaire is hereafter referred to as the Eating Behavior Questionnaire and is included in Appendix T. The questionnaire assessed three subscales of eating behavior: satiety responsiveness (5 items; $\alpha=0.75$), food responsiveness (5 items; $\alpha=0.88$), and slowness of eating (4 items; $\alpha=0.76$). Satiety responsiveness assesses sensitivity to internal cues of fullness, whereas food responsiveness assesses the degree to which an individual is influenced by external food cues. Shortly after this study was completed, a longer version of this questionnaire with some
differences to the one we developed was validated to assess the relationship between eating behaviors and body weight in adults (Hunot et al., 2016).

Data analyses

The main outcomes of the study were the weight of food consumed at the entire meal (g) and energy intake at the meal (kcal), which were analyzed using a linear mixed model with repeated measures (SAS 9.4; SAS Institute, Inc., Cary, NC, USA). Fixed effects in the model were main dish portion size (400 g or 600 g), meal cost (US$8 or $16), study week, and subject sex. Interactions between these factors were tested before examining main effects. For the main outcomes, standardized effect sizes are also reported using Cohen’s $d$ statistic. Similar mixed models were used to analyze secondary outcomes including the amount consumed of the individual meal components as well as subject ratings of hunger, satiety, food characteristics, and meal satisfaction. The post-meal ratings of hunger and satiety were adjusted for pre-meal ratings. The $F$-statistic and its denominator degrees of freedom were adjusted using the Kenward-Roger approximation, and for outcomes with significant effects, the Tukey-Kramer method was used to adjust for multiple comparisons between means (Littell, Milliken, Stroup, Wolfinger & Schabenberger, 2006). Prior to analyses, we determined that individuals would be categorized as “plate-cleaners” if they left $\leq 20$ g of the main dish uneaten at $> 2$ of any of the 4 meals. Analyses were conducted with and without plate-cleaners in order to determine whether these subjects influenced the main outcomes.

Analyses of covariance with linear mixed models were used to test whether the relationship between the experimental factors and the main outcomes was influenced by both continuous subject characteristics such as body mass index (BMI) or score for satiety
responsiveness as well as categorical characteristics such as income level. Differences in subject characteristics between women and men were tested by independent-samples t-tests. Pearson correlation coefficients were calculated to determine associations between the subscales of the Eating Behavior Questionnaire and other subject characteristics. Data for continuous outcomes are reported as mean ± standard error and criteria for significance was set at P < 0.05.

**Results**

*Food and energy intake*

**Combined effects of cost and portion size:** The cost of the meal and the portion size of the main dish did not interact to affect the weight consumed of the entire meal (F(1,202)=0.81, P=0.37 for interaction), nor energy intake at the meal (Figure 3.1; F(1,201)=0.70, P=0.40). Thus, the data did not support the primary hypothesis that the cost of the meal would influence the effect of portion size on intake. The increase in the weight of food consumed at the meal in response to a 50% larger portion was similar whether the cost of the meal was $8 (76±13 g increase) or $16 (91±13 g increase). The interaction of cost and portion size was non-significant for both women and men and also remained non-significant when plate-cleaners were excluded from the analysis (6 women and 14 men); in addition, it was not influenced by the order of presentation. Meal cost and portion size also did not interact to affect intake of any of the individual meal components: pasta (F(1,196)=0.37, P=0.54), bread roll (F(1,224)=0.80, P=0.37), or salad (F(1,222)=1.93, P=0.17).

**Effect of portion size on intake:** Regardless of the cost of the meal, increasing the portion size of the main dish had a significant effect on the weight consumed of the total meal (F(1,138)=86.75, P<0.0001, d=0.65) as well as on energy intake at the meal (F(1,137), P<0.0001, d=0.68). When
the larger portion was served, food intake from the meal increased by 18±2% (83±11 g) and meal energy intake increased by 20±2% (133±16 kcal). The effect of portion size on meal intake was significant for both women and men and also remained significant when plate-cleaners were excluded from the analyses. When the larger portion of pasta was served, pasta intake increased by 87.9±9.4 g (F(1,137)=122.89, P<0.0001); intake of the bread roll decreased slightly (5%; 1.9±0.9 g) but significantly (F(1,198)=5.62, P=0.019); and salad intake did not differ significantly between conditions (F(1,228)=2.60, P=0.11). The percent consumed of the main dish was also affected by increasing portion size (F(1,222)=71.74, P<0.0001). Subjects ate a smaller proportion of the 600-g main dishes (68±2%) than the 400-g main dishes (79±2%), but still consumed a greater total weight of food from the meals with the larger portion.

**Effect of meal cost on intake:** The cost of the meal did not affect meal intake (F(1,212)=1.04, P=0.31, d=0.08); subjects consumed a similar weight of food from the meal whether it cost $8 or was doubled to $16 (Figure 3.1A). Likewise, there was no effect of cost on meal energy intake (F(1,210)=1.39, P=0.24, d=0.09), as illustrated in Figure 3.1B. The effect of cost on meal intake was non-significant for both women and men and also remained non-significant when plate-cleaners were excluded from the analyses. Increasing the cost of the meal also did not affect intake of the individual meal components: pasta (F(1,209)=1.83, P=0.18), bread roll (F(1,226)=0.63, P=.43), or salad (F(1,230)=0.20, P=0.65).
Figure 3.1. Intake of meal components and the entire meal (mean and SEM) by weight (A) and energy (B) across the four experimental conditions. In a crossover design, subjects were served meals with combinations of two portion sizes of the main dish (400 g and 600 g) and two costs of the meal (US$8 and $16) in a counterbalanced order across four weeks. According to linear mixed models with repeated measures, there was no significant interaction between portion size and cost on meal intake by weight (P=0.37) or energy (P=0.40). There was a main effect of increased portion size on meal intake by weight (83±11 g; P<0.0001) and energy (133±16 kcal; P<0.0001), but no main effect of increased cost (P>0.24). Different lower case letters (a, b) are used to indicate means that differed significantly (P<0.05).
Ratings of hunger, satiety, food characteristics, and satisfaction

As shown in Table 3.3, serving larger portions led to small, but significant, decreases in post-meal ratings of hunger (F(1,197)=3.90, P=0.049) and prospective consumption (F(1,215)=4.99, P=0.027), and an increase in ratings of appropriateness of the amount served (F(1,228)=62.93, P<0.0001) in comparison to when smaller portions were served. In addition, the effect of portion size on post-meal ratings of fullness was influenced by cost (F(1,175)=6.68, P=0.011 for interaction). When the cost of the meal was $8, the fullness ratings did not differ following the smaller (82.0±1.4) and larger (82.6±1.8) meals (t(122)=-0.33, P=0.99). In comparison, when the cost of the meal was $16, the fullness ratings were greater following the larger meal (86.5±1.2) than the smaller meal (77.4±2.5) (t(91.2)=-3.61, P=0.002). Thus, serving larger meals only resulted in increased fullness ratings when the cost of the meal was higher.

The cost of the meal had no effect on pre-meal ratings of the appearance or taste of any of the foods served. However, meal cost did influence the various measures of meal satisfaction that were assessed after each lunch. Ratings of overall satisfaction (F(1,217)=17.28, P<0.0001), satisfaction with the cost of the meal (F(1,197)=597.58, P<0.0001), perceived value of the meal (F(1,198)=477.57, P<0.0001), and likelihood of purchase (F(1,191)=173.70, P<0.0001) were all significantly higher when the meal cost $8 rather than $16 (Table 3). At the discharge session, among the 77 subjects who answered the question about meal costs, 72 (94%) recalled the prices correctly. Subject ratings of satisfaction, cost, and value, as well as their accurate recollection of the meal costs, indicate that the cost manipulation was noticed by the subjects and influenced their evaluation of the meals.
Table 3.3: Ratings (mm) of hunger, satiety, and satisfaction following the meals

<table>
<thead>
<tr>
<th>Portion size:</th>
<th>Experimental condition</th>
<th>Significance of portion size effect&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Significance of cost effect&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smaller</td>
<td>Smaller</td>
<td>Larger</td>
</tr>
<tr>
<td></td>
<td>$8</td>
<td>$16</td>
<td>$8</td>
</tr>
<tr>
<td>Post-meal rating&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunger</td>
<td>7.8 (1.2)</td>
<td>8.8 (1.7)</td>
<td>6.6 (1.0)</td>
</tr>
<tr>
<td>Fullness</td>
<td>82.9 (1.4)</td>
<td>79.4 (2.4)</td>
<td>84.3 (1.9)</td>
</tr>
<tr>
<td>Prospective consumption</td>
<td>11.5 (1.2)</td>
<td>12.0 (1.4)</td>
<td>9.6 (1.1)</td>
</tr>
<tr>
<td>Thirst</td>
<td>16.4 (1.9)</td>
<td>16.6 (2.0)</td>
<td>16.0 (1.8)</td>
</tr>
<tr>
<td>Appropriateness of amount</td>
<td>60.5 (1.8)</td>
<td>57.6 (2.0)</td>
<td>70.2 (1.7)</td>
</tr>
<tr>
<td>Overall satisfaction</td>
<td>81.2 (1.6)</td>
<td>75.4 (2.0)</td>
<td>80.6 (1.8)</td>
</tr>
<tr>
<td>Cost satisfaction</td>
<td>79.6 (2.2)</td>
<td>34.0 (2.9)</td>
<td>82.4 (2.0)</td>
</tr>
<tr>
<td>Perceived value</td>
<td>79.6 (2.2)</td>
<td>41.1 (2.8)</td>
<td>83.3 (1.9)</td>
</tr>
<tr>
<td>Likelihood of purchase</td>
<td>69.8 (2.6)</td>
<td>41.0 (3.6)</td>
<td>70.5 (2.6)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Significance of main effects (or interaction) in a linear mixed model with repeated measures.

<sup>b</sup> Subject post-meal ratings were measured using 100-mm visual analog scales and are reported as mean (SEM); post-meal ratings of hunger and satiety were adjusted for the pre-meal rating of the same measure.

<sup>c</sup> Ratings of hunger and prospective consumption were lower for the meals with larger portion sizes than for the meals with smaller portion sizes; ratings of appropriateness of amount were higher for meals with larger portions.

<sup>d</sup> There was a significant effect of portion size on post-meal fullness ratings when the meal cost $16, but not when it cost $8.

<sup>e</sup> Ratings were higher for the meals with lower cost than for the meals with higher cost.
Influence of subject characteristics

Analysis of covariance showed that the effect of meal cost on intake (both in terms of the weight of food consumed and energy intake) was not significantly influenced by measures of subject consumer attitudes, including price consciousness (F(8,159)=1.35, P=0.22), frugality (F(8,59)=1.61, P=0.13), and product retention tendency (F(8,159)=0.27, P=0.97). Neither was the influence of cost on intake affected by subject characteristics including age, BMI, energy requirements, and scores for dietary restraint, disinhibition, or tendency towards hunger.

Similarly, the effect of portion size on intake was not significantly influenced by subject characteristics including consumer attitudes, age, BMI, energy requirements, restraint, disinhibition, and tendency towards hunger, nor by the eating behaviors of food responsiveness and slowness of eating. As shown in Figure 3.2, however, the relationship between portion size and intake was influenced by one measure of eating behavior: the score for satiety responsiveness on the Eating Behavior Questionnaire (F(1,140)=12.16, P=0.0007). The effect of portion size on meal intake was attenuated for subjects who scored higher on this measure compared to those who scored lower. For example, individuals with a relatively high satiety responsiveness score of 4.0 had no overall difference in intake between the smaller and larger meals (t(141)=−0.92, P=0.36). In comparison, those with a relatively low score of 2.0 had a mean increase in intake of 127±15 g (26%) or 203±24 kcal (27%) when they were served the larger meals (t(141)=−8.22, P<0.0001). Thus, the magnitude of the portion size effect differed according to an individual’s self-reported sensitivity to internal cues of fullness.
Figure 3.2. The influence of subject scores for satiety responsiveness on the relationship between portion size of the main dish and the weight of food consumed at the meal. The 5-item satiety responsiveness scale of the Eating Behavior Questionnaire assesses sensitivity to internal cues of fullness; the score ranges from 1 to 5. Analysis of covariance using linear mixed models showed that the difference in intake between the larger and smaller meals decreased with increasing satiety responsiveness score (P=0.0007). Thus, the effect of portion size on meal intake was attenuated in subjects with higher levels of satiety responsiveness.

Investigation of the relationship of satiety responsiveness to other subject characteristics found that it was significantly inversely correlated with subject body weight (r=-0.35, P=0.001) and estimated energy requirements (r=-0.53, P<0.0001), and had a trend towards a significant association with BMI (r=-0.19, P=0.087). A comparison of satiety responsiveness scores to the subscales of the TFEQ found significant positive correlations with dietary restraint (r=0.33; P=0.004) and negative correlations with disinhibition (r=-0.35; P=0.002) and tendency towards hunger (r=-0.53; P<0.0001). However, when the subscales of the TFEQ were analyzed as covariates along with satiety responsiveness, the relationship between portion size and meal intake was only influenced by satiety responsiveness (F(1,131)=9.03, P=0.0032), not by restraint
(F(1,131)=1.30, P=0.26), disinhibition (F(1,131)=0.17, P=0.68) or tendency toward hunger (F(1,131)=0.40, P=0.53). Thus, satiety responsiveness continued to influence the portion size effect after adjusting for TFEQ subscales such as restraint.

Discussion

In this controlled study in a restaurant-style setting, changes to the cost of a meal did not affect the response to increasing portion size of the main dish. In line with previous research (Rolls, 2014; Hollands et al., 2015), we found that serving larger portions led subjects to consume more food, and we extended these findings by demonstrating that this effect was not exacerbated by doubling the price paid for the meal from $8 to $16. Although meal cost did not affect the response to large portions as was hypothesized, the magnitude of the portion size effect was found to be attenuated in individuals who were higher in satiety responsiveness.

It has been proposed that one driver of the portion size effect is value for money; individuals may consume more food from large portions in order to maximize economic value (Steenhuis and Vermeer, 2009). The results of the present study, however, do not support this theory, since the cost of the meal had no significant influence on the response to portion size nor any independent effect on intake. Previous findings have also been cited as evidence against monetary value as an explanation for the portion size effect (Herman, Polivy, Pliner & Vartanian, 2015). In particular, this effect has been observed in children as young as 3 years old (Kling, Roe, Keller & Rolls, 2016), an age at which an association between food and economic value is unlikely. Data from this study and those in children, suggest that monetary value is not the primary contributor to the portion size effect; however, the potential influence of cost on intake from large portions should not be discounted entirely. In the present study, the effect of
cost on intake may have been limited because of the type of main dish that was served at the meal. It is possible that foods with higher market values than pasta, such as meat or seafood dishes, would elicit a more robust portion size effect from a higher-priced meal. Indeed, data show that meats are wasted in lower proportions than most other foods (Lipinski, Hanson, Lomax, Kitinoja, Waite & Searchinger, 2013). Furthermore, the market value of food as well as competitor’s pricing are important determinants of the amount that chefs serve, which is then likely to influence the amount consumed (Condrasky, Ledikwe, Flood & Rolls, 2007). These responses to more valuable foods, in combination with high prices, could promote overconsumption from large portions. A more comprehensive characterization of the influence of value on the response to portion size can be achieved by serving a meal of multiple foods that differ in market value, and varying those foods across four or more portions (Roe et al., 2016). Thus, future studies should examine the effect of cost on intake across a broader range of foods and portion sizes in order to determine whether pricing influences the portion size effect in such meals.

In the current study, we found that post-meal ratings of hunger and prospective consumption differed between conditions of portion size. Although the observed differences were small, these results were inconsistent with most previous portion size studies, which found no changes in post-meal assessments of hunger and satiety despite differences in intake across portion sizes (e.g. Rolls, Morris & Roe, 2002; Rolls, Roe, Meengs & Wall, 2004; Zuraikat, Roe, Privitera & Rolls, 2016). Differences in post-meal ratings of fullness between portion size conditions were rather large, and the cost associated with the meals may be the explanation for this effect; an increase in fullness ratings with increased portion size was only found when the meal was higher in price. This provides evidence that subjects perceived that they ate more from
the larger meal when it had a higher cost, despite similar intake across costs. It is possible that upon being served the meal, individuals intended to consume more when the cost was higher, but failed to do so because they could not accurately assess their intake of the amorphous food served, for which estimates are generally inaccurate (Slawson & Eck, 1997; Ovaskainen, Paturi, Reinivuo, Hannila, Sinkko, Lehtisalo, et al., 2008). Alternatively, that cost and portion size interacted to affect fullness ratings could be a result of subjects cognitively justifying their higher investment in the meal; they may be demonstrating a sunk-cost bias by believing they ate more when larger portions were served at a higher cost (Arkes & Blumer, 1985), or rather, by perceiving the meal to be more filling based on an association between quality and cost. The unique finding of differences in post-meal satiety ratings between portion sizes may be explained by increased attention to the meal in response to the restaurant setting and association of a cost with the meal. Therefore, pricing may affect perceptions of how much was eaten, but the influence on actual intake may vary based on the type of food served or the setting.

Similar to the findings of previous studies, the portion size effect was robust across most individual characteristics (Rolls, 2014; Zlatevska et al., 2014). The current study extended previous findings by examining consumer traits such as price consciousness (Lichtenstein et al., 1993), frugality (Lastovicka et al., 1999), and waste aversion (Haws et al., 2012), none of which influenced the response to variations in cost or portion size. However, since these validated measures of consumer attitudes were developed in order to assess purchasing behavior, they likely are more informative about influences on buying food rather than consuming it. Given the interest in leveraging food pricing to reduce overconsumption of energy and obesity (Powell & Chaloupka, 2009), there is a need for the development of more comprehensive measures tailored to assess the role of consumer traits on food choice and intake.
We did identify one characteristic that was associated with an attenuation of the effect of large portions on intake: satiety responsiveness. We modified the parentally evaluated questions of a children’s questionnaire for use in adults; using this method, we showed for the first time that satiety responsiveness influenced the portion size effect in adults. Although there is some indication that satiety responsiveness is related to intake from large portions in children (Mooreville, Davey, Orloski, Hannah, Mathias, Birch, et al., 2015), this is one of the only factors found to be associated with reduced susceptibility to the portion size effect in adults (Steenhuis & Poelman, 2017; Zlatevska et al., 2014). Higher scores for satiety responsiveness indicate greater sensitivity to internal cues of fullness (Wardle et al., 2001), and have been found to be negatively associated with weight status in both children (e.g. Carnell & Wardle, 2008) and adults (Hunot et al., 2016). Similarly, our data showed an inverse relationship between satiety responsiveness and both body weight and energy requirements (which are based on age, BMI, and activity level). Given these associations as well as the lack of an independent influence of body size on the portion size effect observed in this study, we propose that satiety responsiveness could play a role in mediating the proposed relationship between portion size and obesity. Furthermore, the finding that restraint, disinhibition, and tendency toward hunger were related to satiety responsiveness but not the portion size effect suggests that satiety responsiveness may provide more information about susceptibility to overconsumption from large portions than these more commonly measured scores. Thus, garnering a better understanding of satiety responsiveness could be beneficial in developing strategies to moderate energy intake from large portions.

An advantage of the design of this study is that it allowed us to isolate the influence of cost on the portion size effect. When a high level of experimental control was applied in a
restaurant-style setting, we found that the effect of portion size was similar in magnitude across changes in meal cost. While efforts were made to enhance ecological validity, and subject ratings suggest a salient cost manipulation, future studies should examine the influence of portion size and cost on intake in a field setting. Meal cost may have a larger effect on intake when paying for the meal in more naturalistic setting. In this study, subjects paid from their compensation, resembling a sunk cost, but they still left with some amount of money. The sunk cost effect may be greater when subjects choose to pay for their meal, and even more so when there is no money remaining following payment. Replicating this study in a restaurant would allow for assessment of the role of cost on food choice prior to intake and would provide an opportunity to examine the effect of cost on the portion size effect of a broader range of foods. Price is known to be a salient driver of food choice (Epstein et al., 2012; French, 2003), but once a meal is selected, factors such as portion size, palatability, or perceived value likely determine the amount consumed. Furthermore, certain subject characteristics may be associated with differential responses across different environments. In this controlled setting, satiety responsiveness was found to be a primary determinant of intake in response to portion size. Future studies should further explore the relationships between satiety responsiveness, portion size, and body weight as well as whether satiety responsiveness can be used in the development of interventions to counter the effect of large portions on energy intake.
References


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CHAPTER 4

Study 3:

“DOGGY BAGS” AND DOWNSIZING: PACKAGING UNEATEN FOOD TO GO AFTER A MEAL ATTENUATES THE PORTION SIZE EFFECT IN WOMEN

Reprinted from Appetite, in press, Zuraikat, F.M., Roe, L.S., Smethers, A.D. & Rolls, B.J.

Doggy bags and downsizing: Packaging uneaten food to go after a meal attenuates the portion size effect in women, 2018, with permission from Elsevier for non-commercial use.
Introduction

When larger portions are served, most individuals consume more food (Rolls, 2014; Hollands, Shemilt, Marteau, Jebb, Lewis, Wei, et al., 2015). This portion size effect leads to sustained increases in energy intake that have not been found to be adjusted for at later meals (Rolls, Roe, Kral, Meengs & Wall, 2004) or over multiple days (Rolls, Roe & Meengs, 2007; Kelly, Wallace, Robson, Rennie, Welch, Hannon-Fletcher, et al., 2009). Given the prevalence of large portions of energy-dense foods, paired with their role in the overconsumption of energy and their potential to promote weight gain (Rolls, 2003), strategies to counter the effects of large portions are needed (Livingstone & Pourshahidi, 2014). One suggestion is to “downsize” portions, particularly in restaurant settings (Marteau, Hollands, Shemilt & Jebb, 2015). While this approach may be useful in some cases (Freedman & Brochado, 2010), it has limitations; most notably, the likelihood of consumer resistance (Vermeer, Steenhuis, & Seidell, 2010; Riis, 2014). Larger portions often provide greater value for money (Steenhuis & Vermeer, 2009), and exposure to them inflates portion-size norms (Robinson, Oldham, Cuckson, Brunstrom, Rogers & Hardman, 2016); both of these factors could increase demand for large portions (Ledikwe, Ello-Martin, & Rolls, 2005). Furthermore, according to the majority of restaurant chefs polled in a survey, it is likely that consumers would recognize reductions in portion size (Condrasky, Ledikwe, Flood & Rolls, 2007). Therefore, a decrease in portion sizes in restaurants could negatively influence consumer perceptions of value and result in decreased satisfaction and sales (Vermeer, et al., 2010). An alternative to reducing portions is to provide the option to package leftover food to eat at a later occasion (e.g., in a “doggy bag”, hereafter referred to as a to-go container). The influence of this strategy on the portion size effect, however, has not been tested. Thus, the purpose of this study was to determine whether packaging uneaten food for
participants to take with them for future consumption would moderate intake in response to increasing portion size. A secondary aim was to assess whether other factors such as subject characteristics (English, Lasschuijt & Keller, 2015) or the development of sensory-specific satiety (Herman, Polivy, Pliner & Vartanian, 2015) influenced the response to large portions.

One way in which packaging food to take away could reduce meal intake is by increasing the value of the food to the consumer by providing part of another meal and by reducing waste. It has been proposed that the portion size effect is driven in part by consumers’ desire to get more value for money, motivating them to eat a greater amount when larger portions are available (Steenhuis & Vermeer, 2009). In addition, many consumers have an aversion to waste, particularly for food waste (Bolton & Alba, 2012). A concern for wasting food has been associated with a high prevalence of plate-cleaning (Robinson, Aveyard & Jebb, 2015; Robinson & Hardman, 2016), which also contributes to overeating from large portions (Sheen, Hardman, and Robinson, 2018). Therefore, providing individuals the option of taking uneaten food with them after a meal may be an effective strategy to discourage overeating from large portions, both by retaining food value and by reducing waste. This idea is supported by a study in which a to-go container was provided to half of the subjects at a test meal (Bates & Shanks, 2015); it was found that food and energy intake were significantly reduced in those who could take uneaten food away, compared to those who could not. While the provision of a to-go container can decrease intake at a single meal, it is not known whether this will reduce overconsumption as portions are increased. Furthermore, in the previous study, the container was provided at the start of the meal, which served as an overt behavioral nudge or portion-control motivation (Bates & Shanks, 2015). In the current study, we informed subjects at the beginning of the meal of the option to take uneaten food away, while supplying the packaged food at the end of the meal. Although this
method does not eliminate the behavioral nudge, it more closely resembles the common practice in restaurants.

In order to determine whether the response to portion size was influenced by packaging uneaten food to take away, on different occasions we varied the amounts of all foods served at a meal and assessed intake in two subject groups (with and without the to-go option). Because providing food in a to-go container after a meal may maintain value to the consumer and offers an alternative to wasting food, we hypothesized that this strategy would attenuate the effect of portion size on meal intake. Furthermore, the foods served at the meal were selected to vary in properties such as energy density (ED) and market cost in order to determine whether these characteristics influenced the relationships between the experimental variables and intake. We also assessed eating behaviors, perceptions of food characteristics, and consumer attitudes as well as sensory-specific satiety to determine whether the response to packaging leftovers or to portion size was affected by these factors. Developing a better understanding of how the response to portion size is affected by packaging leftovers to take away, as well as whether this response differs across individuals or foods, should aid in the development of strategies to moderate intake from large portions.

Methods

Study Design

In a crossover design with repeated measures, women were served dinner in the laboratory once a week for four weeks. Across weeks, the portion sizes of all foods served at the meal were varied (100, 125, 150, and 175% of baseline) in a counterbalanced order. Subjects were randomly assigned to one of two groups: participants in the To-Go Group were provided
with their uneaten food in a container at the end of each meal (and informed of this prior to the
meal); in contrast, those in the Control Group were not provided the option to take food away.

All study procedures were approved by the Office of Research Protections at The Pennsylvania
State University. Upon completion of the study, subjects were provided with financial
compensation for their time as well as information on the purpose of the study.

Subjects

Women between the ages of 18 and 60 were recruited through advertisements for a
“dinner feeding study” placed on the university’s research website, in local newspapers, and
around campus and in local businesses. Potential subjects were told nothing about the purpose of
the study, only that they would be eating dinner in the laboratory on four occasions. Those who
met initial eligibility criteria based on a phone screening came to the lab and completed the
Eating Attitudes Test (Garner, Olmstead, Bohr, & Garfinkel, 1982), indicated for a variety of
foods whether they disliked or would be unwilling to eat any of the foods, filled out a schedule
of their availability, had their height and weight measured, and rated the taste of the foods to be
served. Women were eligible for the study if they had a body mass index (BMI) between 18.5
and 36.0 kg/m², regularly ate three meals per day, liked and were willing to eat the foods served
at the meal, and were willing to refrain from drinking alcohol the day before their scheduled
experimental sessions. Potential subjects were excluded if they smoked, were athletes in training,
were dieting to gain or lose weight, were taking medications known to affect appetite, were
pregnant or breastfeeding, had allergies or intolerances to the foods served, reported having a
medical condition known to affect eating, or showed signs of disordered eating as indicated by a
score ≥ 19 on the Eating Attitudes Test (Garner, et al., 1982).
Fifty-eight women were eligible for participation and were enrolled. Due to lack of data on an effect size, we aimed to recruit a number of women similar to the only other study reporting an influence of packaging on intake (N=50; Bates & Shanks, 2015). We included only women in order to reduce variability in intake and increase statistical power to detect the influence of this novel strategy to address the portion size effect. After enrollment, subjects were assigned to one of two subject groups (To-Go Group or Control Group) using block randomization on the factors of age (18-24.9 or 25-60 years) and body weight status (BMI of 18.5-24.9 or 25.0-36.0 kg/m²). Within each block, subjects were assigned to a group using a random number generator. In both groups, the order in which portion sizes were served across weeks was counterbalanced using Latin squares, and subjects were randomly assigned a sequence. Of the 58 enrolled subjects, four withdrew from the study prior to completion and one was excluded from analysis for failing to comply with the study protocol. Thus, a total of 53 women (27 To-Go and 26 Control) were included in the analysis.

**Test meals**

At each of the four experimental sessions, subjects were served a test meal composed of five foods made from commercially available ingredients (Table 4.1). The same foods were served at each meal; only the amounts were varied. Foods were selected to represent typical meal components. In addition, they ranged in energy density (ED; Rolls & Barnett, 2000) and market cost (range calculated from our recipes: ~$0.40/100 g (orzo) to ~$1.30/100 g (chicken)). The two primary meal components were chicken with sauce (0.99 kcal/g, classified as a low-ED food) and orzo pasta with butter (1.75 kcal/g, classified as a medium-ED food). The test foods were either amorphous or cut into small pieces in order to reduce the risk of a unit bias affecting intake.
(Geier, Rozin & Doros, 2006), in addition to making it difficult to judge the amounts of food served from week to week.

The amount of food served in the baseline (100%) condition was determined from the average intake of a similar baseline meal consumed by women in a previous study (Zuraikat, Roe, Sanchez, & Rolls, 2018a); this amount was increased in order to provide more food than most women would fully consume, reducing the risk of a false-positive portion size effect. In the other experimental conditions, the portion size of each food was increased to 125%, 150%, and 175% of the baseline amount. The order in which portion size conditions were served was counterbalanced, and there was a one-week washout period between meals. Subjects were also served 1 L of water with each meal. Food and water intake was determined by weighing all items before and after the meal to within 0.1 g (Mettler-Toledo PR5001 and XS4001S; Mettler-Toledo, Columbus, OH). Energy intake was calculated using information from a standard food composition database (USDA, 2015) and from food manufacturers.

Photo 4.1: Portion sizes of the test meals served at the lunches.
Table 4.1: Composition of test meals served to 53 women

<table>
<thead>
<tr>
<th>Meal component</th>
<th>Energy density (kcal/g)</th>
<th>100% portion sizes</th>
<th>125% portion sizes</th>
<th>150% portion sizes</th>
<th>175% portion sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Weight (g)</td>
<td>Energy (kcal)</td>
<td>Weight (g)</td>
<td>Energy (kcal)</td>
</tr>
<tr>
<td>Chicken breast, baked with creamy parmesan sauce&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.99</td>
<td>150</td>
<td>149</td>
<td>188</td>
<td>186</td>
</tr>
<tr>
<td>Orzo pasta&lt;sup&gt;b&lt;/sup&gt; with butter and garlic</td>
<td>1.75</td>
<td>130</td>
<td>228</td>
<td>162</td>
<td>284</td>
</tr>
<tr>
<td>Broccoli with butter</td>
<td>0.71</td>
<td>120</td>
<td>85</td>
<td>150</td>
<td>107</td>
</tr>
<tr>
<td>Garlic bread&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.89</td>
<td>80</td>
<td>311</td>
<td>100</td>
<td>389</td>
</tr>
<tr>
<td>Grapes</td>
<td>0.69</td>
<td>80</td>
<td>55</td>
<td>100</td>
<td>69</td>
</tr>
<tr>
<td>Entire meal</td>
<td>1.48</td>
<td>560</td>
<td>828</td>
<td>700</td>
<td>1035</td>
</tr>
</tbody>
</table>

<sup>a</sup> Campbell Soup Company, Camden, NJ, USA; modified by adding ½ cup water per 311 g packet.

<sup>b</sup> Barilla USA, Northbrook, IL, USA.

<sup>c</sup> Pepperidge Farm Inc, Norwalk, CT, USA.
Procedures

Each subject came to the lab once a week for four weeks to eat dinner on the same weekday and at the same time between 5:00 and 6:30 p.m. In order to minimize the risk of subjects learning the study purpose, the factor of packaging uneaten food was varied between subjects, and meals for subjects in the two groups were scheduled on different days. All subjects were asked to consume a normal breakfast and lunch on the day of the test session and to refrain from eating within three hours prior to their scheduled dinner time. Subjects were also asked to refrain from drinking alcoholic beverages the day before their test meal. Subjects completed a brief food diary at the beginning of each test meal to check compliance with these instructions.

Subjects were seated alone in private cubicles (to control for social influences on food intake) and completed pre-meal ratings of hunger, thirst, fullness, and general prospective consumption using 100-mm visual analog scales (VAS; Flint, Raben, Blundell, & Astrup, 2000). For example, to rate general prospective consumption, subjects answered the question “How much food do you think you could eat right now?” using the anchors of “Nothing at all” and “A large amount”. Subjects were then given 12 small food samples (<3 g each) comprising the five foods to be served at the meal plus seven foods that were not served at the meal and were selected to vary in sensory properties, such as flavor and texture. Subjects were instructed to taste each sample and use VAS to rate the pleasantness of taste as well as how much of that food they would like to eat (prospective consumption); subjects also completed this same procedure directly after consuming the meal. This task was developed as a variation of the sensory-specific satiety (SSS) paradigm, which is used to assess the change in hedonic value of food that is eaten at a meal in comparison to food that is not eaten. Changes in both pleasantness of taste and prospective consumption of individual foods are used to characterize specificity of satiety (Rolls,
Rolls, Rowe & Sweeney, 1981). This component of the experiment was included to determine whether SSS influenced patterns of intake, but also diverted attention from the true purpose of the study.

After completing the pre-meal ratings, subjects were served the test meal. All subjects were instructed to eat and drink as much or as little as they liked, and to indicate that they had finished eating by pushing a button in the cubicle. In addition, subjects from the To-Go Group were informed that any food that they did not eat at the meal would be packaged for them to take away and were shown an example of the restaurant-grade container. Subjects in the Control Group were not given explicit information about what was done with uneaten food, but they were aware that they could not take it away. Each cubicle had a menu describing the meal; for the To-Go Group, the menu included a reminder that uneaten food would be provided in a to-go container. When subjects indicated that they had finished eating, leftovers were collected, weighed, and either packaged or discarded, depending on the group.

Photo 4.2: The restaurant grade container in which uneaten food was packaged to take away and reminder.

Following the meal, subjects rated post-meal hunger, fullness, thirst, prospective consumption, and overall satisfaction with the meal using VAS. In addition, for descriptive
purposes subjects were asked to indicate how much money they would expect to pay for the meal in a restaurant as well as how much they would be willing to pay. Subjects then used VAS to rate the taste and prospective consumption for the same 12 food samples that were rated prior to the meal, completing the SSS paradigm. At the end of final meal, subjects completed a series of computerized tasks described in the next section.

Measures

Eating behaviors and consumer attitudes were assessed by the following questionnaires: the Three-Factor Eating Questionnaire, which measures dietary restraint, disinhibition, and tendency towards hunger (Stunkard & Messick, 1985); the Eating Behavior Questionnaire, which measures behaviors such as satiety responsiveness, food responsiveness, and slowness of eating (Zuraikat, Roe, Smethers, Reihart & Rolls, 2018b); a Price Consciousness Scale, which assesses value-seeking behaviors (Lichtenstein, Ridgway & Netemeyer, 1993); a Frugality Scale, which assess economic behavior and decision-making (Lastovicka, Bettencourt, Hughner & Kuntze, 1999); and a Food Waste Aversion Scale that was developed for this study. An example of a question from this scale is “When food goes to waste, it upsets me” rated on a 7-point scale ranging from “strongly disagree” to “strongly agree.” These measures of eating behaviors and consumer attitudes were included to assess individual differences in the response to packaging uneaten food or to portion size.

In addition, subjects were shown pictures of the 125% portion of the meal and asked to (a) rate (using VAS) the cost and value of each individual food in the pictured meal, and (b) rank (from 1 to 5) the relative taste, healthfulness, calorie content, cost, and value of the individual foods. These questions were included to determine whether the effect of portion size on intake of individual foods was influenced by perceptions of the food properties. Subjects also responded to
questions about their perceptions of restaurant portion sizes, influences on the amount of food they typically consume in restaurant settings, how often they eat all of the food at a restaurant meal, and how the availability of a to-go container might influence the amount of food they would eat and the likelihood of taking food away. These data were collected in order to assess subject perceptions of the feasibility, usefulness, and effectiveness of providing to-go containers at restaurants as a strategy to reduce intake. Finally, subjects completed a discharge questionnaire that included questions about demographic characteristics as well as their perception of the purpose of the study. Upon completion of these tasks, subjects were informed of the purpose of the study and were provided with financial compensation for their participation.

Data analysis

The main outcome of this study was the trajectory of the weight of food consumed at the meal in response to increases in the weight of food served (the portion size effect). It was hypothesized that the trajectory of the portion size effect would differ by subject group, specifically, that individuals in the To-Go Group would demonstrate an attenuated response to portion size compared to the Control Group. To test this hypothesis, the response to portion size was characterized by a polynomial equation and analyzed using random coefficients models; previous research has shown that the trajectory of the portion size effect is curvilinear (Roe, et al., 2016). The meal portion size served (total weight of food served at the meal) was treated as a continuous covariate in the model; subject group and study week were included as fixed factors. Subjects were treated as random factors in the model, so that each subject’s intake trajectory in response to increasing portion size was modeled separately. Trajectories of intake were centered at the weight of food served in the 100% (baseline) portion condition. Thus, the linear coefficient
of the trajectory represents the change in intake (slope) as portions were initially increased from baseline amounts, and the quadratic coefficient characterizes the change in the trajectory of intake (acceleration or deceleration) as portions were increased further. Subject characteristics (e.g. BMI and scores for slowness of eating and price consciousness) were analyzed as covariates in the random coefficients models to determine whether any of these measures affected intake in response to increasing portion size. Other primary outcomes included the trajectories of meal energy intake and meal energy density, which were analyzed using similar statistical models.

The trajectories of intake for the individual foods served at the meal were analyzed as a secondary outcome. Using random coefficients models, we tested whether the trajectory of intake for each individual food was influenced by portion size as well as whether the effect differed by subject group. Ratings and rankings of food properties (e.g. food value and pleasantness of taste) were analyzed as covariates in a single random coefficients model that included all foods in a univariate manner, in order to determine whether the trajectory of intake for an individual food was influenced by any of these measures.

Subject ratings of hunger, fullness, thirst, prospective consumption, and satisfaction after each meal were secondary outcomes, as were post-meal measures of how much subjects expected and were willing to pay for the meals. The effects of portion size and subject group on these ratings were analyzed using linear mixed models with repeated measures. Portion size condition, subject group, and study week were included as fixed effects in the model. Post-meal hunger, thirst, prospective consumption, and fullness ratings were adjusted by including the equivalent pre-meal rating in the model. Sensory-specific satiety was also analyzed using linear mixed models; outcomes were the differences in pre- to post-meal ratings of taste and prospective consumption of the individual foods. The fixed effects in these models were portion
size condition, subject group, study week, and whether or not the foods were served at the meal, as well as the interactions between factors.

For all linear mixed models, the $F$-statistic and its denominator degrees of freedom were adjusted using the Kenward-Roger approximation, and multiple comparisons between means were adjusted using the Tukey-Kramer method (Littell, Milliken, Stroup, Wolfinger & Schabenberger, 2006). Independent sample $t$-tests and chi-squared test of proportions were used to examine whether subject characteristics differed between subject groups. All analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC, USA). For outcomes of the random coefficients and linear mixed models, means are reported with SEM; all results are considered significant at $P<0.05$.

**Results**

*Subject characteristics*

Subject groups did not differ significantly in any of the measured characteristics, including body weight, body mass index (BMI), age, estimated energy needs, and scores for price consciousness and waste aversion (*Table 4.2*). Overall in both groups, average age was $29\pm12$ y and average BMI was $25\pm4$ kg/m$^2$. The proportion of women with overweight or obesity was 36%, and 54% had an annual household income $>\$50,000$. The racial composition of the 50 subjects (94%) who reported this information was 82% White, 14% Asian, and 4% Black; 8% of participants were Hispanic or Latino. The distribution of weight status, income, race, and ethnicity did not differ between subject groups. On average, the taste of all of the foods was rated highly (VAS ratings collected at screening (mm) - chicken: $78.4\pm2.1$; orzo: $53.5\pm3.2$; broccoli: $66.6\pm2.7$; garlic bread: $73.6\pm2.6$; grape: $81.5\pm2.5$). In addition, mean taste ratings did not differ between subject groups (all $P>0.18$).
Table 4.2: Subject characteristics of 53 women

<table>
<thead>
<tr>
<th>Variable</th>
<th>To-Go Group (n=27)</th>
<th>Control Group (n=26)</th>
<th>Significance of group difference (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>67.1 ± 13.8</td>
<td>66.6 ± 9.6</td>
<td>0.87</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.5 ± 4.7</td>
<td>24.7 ± 3.8</td>
<td>0.85</td>
</tr>
<tr>
<td>Age (years)</td>
<td>27.1 ± 10.1</td>
<td>30.9 ± 13.5</td>
<td>0.24</td>
</tr>
<tr>
<td>Energy requirement (kcal/d)³</td>
<td>2015 ± 179</td>
<td>1973 ± 125</td>
<td>0.33</td>
</tr>
<tr>
<td>Dietary restraint score⁴ (range 0-21)</td>
<td>8.1 ± 4.4</td>
<td>5.9 ± 3.9</td>
<td>0.07</td>
</tr>
<tr>
<td>Disinhibition score⁴ (range 0-16)</td>
<td>7.4 ± 4.0</td>
<td>5.9 ± 3.3</td>
<td>0.16</td>
</tr>
<tr>
<td>Hunger tendency score⁴ (range 0-14)</td>
<td>5.7 ± 3.5</td>
<td>5.2 ± 3.0</td>
<td>0.56</td>
</tr>
<tr>
<td>Satiety responsiveness score⁵ (range 1-5)</td>
<td>2.9 ± 0.6</td>
<td>2.9 ± 0.6</td>
<td>0.98</td>
</tr>
<tr>
<td>Food responsiveness score⁵ (range 1-5)</td>
<td>2.7 ± 1.1</td>
<td>2.3 ± 0.9</td>
<td>0.19</td>
</tr>
<tr>
<td>Slowness in eating score⁵ (range 1-5)</td>
<td>2.8 ± 0.9</td>
<td>2.5 ± 0.8</td>
<td>0.25</td>
</tr>
<tr>
<td>Price consciousness score⁶ (range 1-7)</td>
<td>4.8 ± 0.9</td>
<td>4.7 ± 1.1</td>
<td>0.57</td>
</tr>
<tr>
<td>Frugality score⁷ (range 1-7)</td>
<td>5.7 ± 0.7</td>
<td>5.9 ± 0.7</td>
<td>0.33</td>
</tr>
<tr>
<td>Food Waste Aversion score⁸ (range 0-7)</td>
<td>4.4 ± 1.2</td>
<td>4.7 ± 1.3</td>
<td>0.42</td>
</tr>
</tbody>
</table>

¹Values are mean ± SD unless otherwise indicated.
²Analyzed using independent samples t-tests.
³Energy requirements estimated from sex, age, height, weight, and activity level (Institute of Medicine, 2002).
⁴Scores from the Eating Inventory (Stunkard & Messick, 1985).
⁵Scores from the Eating Behavior Questionnaire (Zuraikat, et al., 2018b).
⁶Score from the Price Consciousness Scale (Lichtenstein, et al., 1993).
⁷Score from the Frugality Scale (Lastovicka, et al., 1999).
⁸Score from the Food Waste Aversion Scale (developed for this study).
**Meal intake by weight**

The portion size effect, defined as the change in weight of food consumed in response to increasing portion size, differed significantly between the two subject groups (Figure 4.1A). Specifically, there were differences between groups in both the linear coefficient (interaction $F(1,139)=7.57, P=0.0067$) and the quadratic coefficient (interaction $F(1,105)=5.91, P=0.017$) of the intake trajectories. In the Control Group, the trajectory of food intake in response to increasing portion size was curvilinear. As portions were initially increased from baseline amounts, there was a significant linear increase in the weight of food consumed (mean slope $0.64±0.12; t(139)=5.31, P<0.0001$). Thus, for every 100 g added to the baseline meal, control subjects consumed an additional 64 g of food. This linear increase was modified by a significant deceleration in intake as portions were increased further, indicated by a negative quadratic coefficient of $-0.00086±0.0003 (t(105)=−3.29, P=0.014)$. In contrast, the trajectory of food intake in the To-Go Group was linear. The slope was $0.17±0.12$, meaning for every additional 100 g added to the baseline meal, food intake increased by 17 g, which was not significantly different from zero ($t(139)=1.47, P=0.14$). The quadratic coefficient also did not differ significantly from zero ($0.000032±0.0003, t(105)=0.12, P=0.90$). Thus, the effect of portion size on the weight of food consumed at the meal was attenuated in the To-Go Group compared to the Control Group. This result was not affected by the order in which portions were presented.

The mean weight of food packaged to take away in the To-Go Group was $165±18$ g in the 100% condition, $280±19$ g in the 125% condition, $391±17$ g in the 150% condition, and $507±20$ g in the 175% condition, representing 29%, 40%, 47%, and 52% of the amount served at the meal, respectively. None of the subjects in the To-Go Group declined to take away their uneaten food from any meal.
Meal energy intake

Similar to the outcome of intake by weight, the pattern of meal energy intake in response to increasing portion size differed significantly between the two subject groups (Figure 4.1B). In particular, the trajectories of meal energy intake differed between groups in both the linear coefficient (interaction F(1,144)=7.39, P=0.007) and the quadratic coefficient (interaction F(1,105)=5.20, P=0.025). In the Control Group, energy intake showed a curvilinear response to portion size. The linear coefficient as portions were initially increased was 0.90±0.19 (t(144)=4.85, P<0.0001) indicating a 90 kcal increase for every 100 g added to the baseline meal. The linear increase was modified by a deceleration in intake as portions were increased further, characterized by a quadratic coefficient of -0.0012±0.0004 (t(105)=-2.97, P=0.0036). Thus, in control subjects, increasing portion size led to an initial increase in energy intake followed by a lessening in the rate of increase as portions were further increased. In contrast, the To-Go Group showed a linear response to portion size. The linear coefficient for the To-Go Group was 0.19±0.18 (t(144)=1.05, P=0.30), and the quadratic coefficient was 0.00009±0.0004 (t(105)=0.23, P=0.82). These coefficients demonstrate that for every 100 g increase in the portion served, energy intake for the To-Go Group increased by 19 kcal, which did not differ significantly from zero. Thus, for subjects in the To-Go Group, energy intake in response to increasing portions was moderated compared to controls. The trajectories of the two groups showed the greatest difference in energy intake (mean 105±47 kcal) at the meal with 150% portions (Control Group: 776±37 kcal versus To-Go Group: 671±29 kcal; t(51)=2.25, P=0.029). The difference in intake between the two groups was non-significant (mean 73±59 kcal) at the meal with the largest portions (Control Group: 759±48 kcal versus To-Go Group: 686±34 kcal; t(51)=1.25, P=0.22).
Meal energy density consumed

The energy density consumed at the meal was not affected by the portion sizes served (F(1,125)=0.24, P=0.62) nor by the subject group (F(1,125)=0.09, P=0.77). For both groups, as portions were increased, the trajectory of meal ED consumed was linear and the slope did not differ significantly from zero. Across portions, the average meal ED consumed by both groups was 1.46±0.01 kcal/g. Thus, the proportions of lower- and higher-ED foods consumed at the meals were similar across portion size conditions and between subject groups.
**Figure 4.1:** The effect of increasing the portion size of all foods at the meal on the modeled trajectory of meal intake (the portion size effect) differed by subject group for both (A) the weight of food consumed ($P \leq 0.017$) and (B) energy intake ($P \leq 0.025$). Means and trajectories from the random coefficients model are shown. For subjects in the Control Group, increasing meal size led to an initial linear increase in the weight and energy consumed at the meal (both $P<0.0001$) that was modified by a deceleration in intake characterized by a negative quadratic coefficient (both $P<0.02$). In the To-Go Group, increases in portion size led to linear increases in food and energy intake that were not significantly different from zero ($P>0.14$).

*Ratings of hunger, satiety, and meal properties*

Despite different patterns of intake between subject groups, none of the ratings assessed after the meal differed significantly between groups (all $P>0.08$), indicating that packaging uneaten food to go did not affect assessments of hunger, fullness, and meal properties (perceived meal cost; willingness to pay). Additionally, despite increasing intake, serving larger portions of all foods at the meal did not affect ratings of hunger, fullness, thirst, or satisfaction following the meal. Portion size did, however, have a small but significant effect on post-meal ratings of general prospective consumption ($F(3,66)=4.75$, $P=0.005$); for example, increasing portions by 75% led to a decrease in subject ratings of the amount of food they could consume following the meal (from $10.3\pm2.0$ mm to $5.6\pm1.0$ mm) in both groups. Increasing portion size of the meal also influenced the amount of money subjects expected that the meal would cost in a restaurant ($F(3,72.6)=9.20$, $P<0.0001$) as well as how much they would be willing to pay for the meal in a restaurant ($F(3,74.9)=8.46$, $P<0.0001$). For both groups, subjects expected the meals with larger portions to cost more (e.g. $2.47\pm0.50$ more for the largest compared to the smallest portion), but they were also willing to pay more (e.g. $1.96\pm0.46$ more for the largest compared to the smallest portion).
Sensory-specific satiety

At this meal composed of multiple foods, subjects exhibited SSS as assessed by ratings of prospective consumption. The decline in pre- to post-meal ratings for the foods eaten at the meal was greater than for those that were not eaten (F(1,2476)=354.98, P<0.0001; Figure 4.2). For the ratings of taste, this difference (eaten: -8.2 mm vs. uneaten: -7.0 mm) did not reach significance (F(1,2478)=2.94, P=0.09). Notably, SSS did not differ between the Control Group and To-Go Group across meals (prospective consumption: F(1,2475)=0.00, P=0.95; taste: F(1,2474)=0.36, P=0.55) despite different patterns of intake. Moreover, serving larger portions of food had no significant influence on SSS (prospective consumption: F(3,2473)=0.89, P=0.45; taste: F(3,2472)=0.84, P=0.47). For example, at the baseline meal, mean intake was 406±12 g and the change in ratings of prospective consumption as a measure of SSS was 18.8±2.0 mm. At the meal with the largest portions, despite a greater intake of 497±18 g (t(48.3)=-6.06, P<0.0001), prospective consumption as a measure of SSS was similar to that at the baseline meal (17.9±2.0 mm; t(150)=-0.47, P=0.96). Thus, when served larger portions, subjects consumed a greater amount of food for a similar change in ratings of prospective consumption.
Figure 4.2: The decline in ratings of prospective consumption from before to after meals for samples of foods that were either eaten or uneaten at the meal. Sensory-specific satiety (defined as the difference in decline between the eaten and uneaten foods) was not influenced by subject group (P=0.17) or portion size condition (P=0.48), thus the combined results are presented. For both the eaten and uneaten foods, mean ratings of prospective consumption declined after the meal compared to before. However, the decline in ratings of prospective consumption, one marker of the specificity of satiety, was greater for the five foods eaten at the meal than for the seven foods that were rated but not eaten at the meal (P<0.0001). Means with different letters were significantly different.

Influence of subject characteristics

Most of the measured subject characteristics did not have a significant influence on the trajectory of intake as portion sizes were increased. For both groups, the portion size effect did not differ across age, BMI, body weight, height, estimated energy requirements, restraint, disinhibition, hunger, or scores for satiety responsiveness, food responsiveness, frugality, or waste aversion. In addition, when the three subjects who correctly identified the purpose of the study were excluded from the analysis, the influence of packaging uneaten food on the portion size effect remained significant. There were, however, two characteristics that significantly influenced the portion size effect: slowness of eating (a subscale of the Eating Behavior Questionnaire; Zuraikat, et al., 2018b) and price consciousness (Lichtenstein, et al., 1993).
effect of slowness of eating on the trajectory of intake differed by subject group (F(1,49.8)=5.16, P=0.028). In the To-Go Group, slowness of eating scores had no influence on the portion size effect (t(49.9)=0.54, P=0.59), which was already attenuated by packaging uneaten food to take away. In the Control Group, however, slowness of eating scores were inversely related to the slope of the portion size effect (t(49.8)=2.54, P=0.014). Thus, women in the Control Group who reported being slower eaters had a moderated intake of larger portions compared to those who were faster eaters. For the characteristic of price consciousness, scores were positively related to the slope of the portion size effect in both groups, despite different patterns of intake (F(1,51.3)=4.80, P=0.033). Subjects with higher levels of price consciousness had a greater increase in intake in response to larger portions than those with lower price consciousness.

*Intake of individual foods*

The effect of portion size on intake of the individual foods differed between the subject groups for the two primary components of the meal: chicken with sauce (F(1,105)=4.33, P=0.04) and pasta with butter (F(1,105)=5.16, P=0.03), as shown in Table 4.3. In response to larger portions, subjects in the Control Group consumed a greater weight of both the low-ED chicken (t(131)=2.72, P=0.007) and the medium-ED pasta (t(136)=2.75, P=0.007), whereas subjects in the To-Go Group had no difference in intake of either food (chicken: t(131)=0.20, P=0.84; pasta: t(136)=1.33, P=0.19). For the other three foods served at the meal (broccoli, garlic bread, and grapes), there was a significant effect of portion size on intake (all P < 0.005 for linear coefficient), and this effect did not differ between groups. Thus, differences in the pattern of intake for the two primary meal components contributed to group differences in overall meal intake.
Rankings of food cost (P=0.43), value (P=0.34), healthfulness (P=0.08), and calorie content (P=0.17) of the individual foods had no significant influence on the trajectories of intake of the foods as portions were increased. Similarly, ratings of food cost did not affect the response to portion size of the individual foods served at the meal. However, two food characteristics approached (but did not reach) statistical significance for influence on the slope of the portion size effect: the relative taste ranking (P=0.062) and the relative market value of the food (P=0.066). The effect of portion size showed a trend to be greater for foods ranked highest in taste and those rated as having higher value, such as chicken, which 78% of women reported to have the highest value of the foods served at the meal.
## Table 4.3: Individual and total food intake (g) and meal energy intake (kcal) at test meals by 53 women according to subject group

<table>
<thead>
<tr>
<th>Food item</th>
<th>Control Group (n = 26)</th>
<th>To-Go Group (n=27)</th>
<th>Portion size effect (^2) (P-value)</th>
<th>Group influence on portion size effect (^3) (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Portion size served</td>
<td>Portion size served</td>
<td>Linear coefficient</td>
<td>Quadratic coefficient</td>
</tr>
<tr>
<td></td>
<td>100% 125% 150% 175%</td>
<td>100% 125% 150% 175%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken with sauce</td>
<td>107.4 ±6.7  115.1 ±8.5  131.2 ±9.2  122.4 ±10.6</td>
<td>101.6 ±6.4  99.8 ±7.2  109.2 ±6.3  115.2 ±6.6</td>
<td>0.07 0.50</td>
<td>&lt;0.04(^4)</td>
</tr>
<tr>
<td>Orzo pasta with butter</td>
<td>91.4 ±7.2  109.4 ±8.5  117.4 ±9.5  121.4 ±11.2</td>
<td>97.5 ±6.2  93.2 ±6.0  92.5 ±7.5  103.3 ±8.0</td>
<td>0.31 0.94</td>
<td>&lt;0.03(^4)</td>
</tr>
<tr>
<td>Broccoli</td>
<td>93.7 ±5.4  109.2 ±6.6  126.0 ±6.8  113.4 ±9.6</td>
<td>83.2 ±6.4  98.3 ±7.9  105.6 ±9.0  105.9 ±9.1</td>
<td>&lt;0.0001 0.001</td>
<td>&gt;0.22</td>
</tr>
<tr>
<td>Garlic bread</td>
<td>57.6 ±4.0  62.7 ±5.2  75.3 ±5.8  72.2 ±6.2</td>
<td>59.7 ±4.2  58.2 ±4.8  71.3 ±5.9  66.7 ±6.4</td>
<td>0.0005 0.02</td>
<td>&gt;0.38</td>
</tr>
<tr>
<td>Grapes</td>
<td>67.1 ±3.7  75.5 ±5.5  85.3 ±6.5  93.3 ±8.2</td>
<td>53.2 ±6.2  70.3 ±6.9  70.8 ±9.1  81.8 ±10.1</td>
<td>0.005 0.34</td>
<td>&gt;0.91</td>
</tr>
<tr>
<td>Total meal food intake</td>
<td>417.0 ±16.1  471.9 ±19.0  535.1 ±21.7  522.7 ±29.3</td>
<td>395.3 ±17.7  419.8 ±18.9  449.3 ±17.1  473.0 ±20.5</td>
<td>&lt;0.0001 0.90</td>
<td>&lt;0.017(^4)</td>
</tr>
<tr>
<td>Total meal energy intake (kcal)</td>
<td>602.8 ±26.6  679.0 ±31.9  776.4 ±37.1  759.4 ±48.3</td>
<td>599.4 ±26.5  606.7 ±26.8  671.0 ±28.9  686.0 ±34.2</td>
<td>&lt;0.0001 0.82</td>
<td>&lt;0.025(^4)</td>
</tr>
</tbody>
</table>

\(^1\) Values are (raw) mean ± SEM.

\(^2\) Significance of the linear and quadratic coefficients of intake trajectory as portions were increased, as assessed by a random coefficients model.

\(^3\) Group difference in the linear and quadratic coefficients of the intake trajectory as portions were increased, as assessed by a random coefficients model.

\(^4\) Significant group difference in both the linear and quadratic coefficients of the portion size effect: linear increase followed by deceleration in intake for the Control Group compared to non-significant change in intake for the To-Go Group.
Perceptions of restaurant portion sizes and the influence of taking food to go

Although 80% of the women reported that they felt restaurant portions were excessively large, 84% reported that when dining out they finished all of the food served at least some of the time (sometimes, most of the time, or always), with half of these individuals reporting that they did so most of the time or always. When asked how their intake at a restaurant is influenced by the availability of a to-go container, 47% reported that they eat less food compared to when there is no option to take leftovers to go. Moreover, 63% of participants stated that their likelihood of taking food to go increases when it is obvious that there is more food served than can be eaten.

Discussion

The option to take away uneaten food for later consumption influenced food and energy intake when participants were served larger portions at a meal. Women who were told they would be provided with their leftovers in a to-go container after the meal showed an attenuated response to the typically robust effect of portion size on intake. Moreover, although women in the To-Go Group ate less than Controls as portions were increased, their lower intake did not result in less fullness or satisfaction after the meals, reducing the likelihood that they would compensate by eating more at subsequent meals. Thus, providing an option to take away uneaten food from a meal could be an effective strategy to reduce overconsumption from large portions.

In showing that the effects of portion size on intake were attenuated by packaging uneaten food to go, we extended the previous finding that intake at a single meal was reduced by provision of a to-go container (Bates & Shanks, 2015). In addition, the effect observed in this study did not rely on providing subjects with the container before the meal as in the earlier study; simply making subjects aware of the option to take food away was sufficient to counter the cues
provided by the amount of food served. Packaging leftovers after the meal is a more typical practice than providing a box in advance and shifts the focus of the intervention from a behavioral prompt to a means of reducing waste. Therefore, while our method did not eliminate the possibility of a behavioral nudge, it is likely that the effectiveness of the strategy relates to its ability to increase the value of a meal and reduce waste. Previous research has investigated portion size interventions directly related to monetary value, such as varying the price paid for a meal (sunk cost; Zuraikat et al., 2018b) or the price per unit (value vs linear pricing; Harnack, French, Oakes, Story, Jeffrey & Rydell, 2008), which have been found to have little effect on intake. The results of the studies using a to-go container, however, show that this strategy that indirectly increases value, as well as directly reducing waste, is effective in moderating intake from large portions.

In addition to the reduction in intake and waste, a benefit of packaging uneaten food is that it is unlikely to provoke consumer resistance, since it does not limit choice, nor does it eliminate the greater value typically associated with larger portions (Steenhuis & Vermeer, 2009). However, despite these moderating effects, this strategy should not be regarded as a comprehensive solution to the problem of overconsumption from large portions. In this study, when the largest portion was served, there was a convergence of intake between the To-Go Group and Controls, such that the option to take away leftovers no longer reduced intake. When served excessively large portions, individuals could be at risk for overeating despite taking away sizeable amounts of food. Downsizing is needed in these situations to address the risk of overconsumption. Our data also suggest that modest reductions of very large portions are unlikely to reduce consumer satisfaction. Thus, while packaging uneaten food for a later
occasion can be useful to counter the portion size effect within a range of portion sizes, it will likely be most effective as a complementary strategy to downsizing.

It has been proposed that the portion size effect could be related to the development of sensory-specific satiety (SSS; Herman, Polivy, Pliner & Vartanian, 2015), which is a component of meal termination (Rolls, 1986). We found that subjects experienced SSS as evaluated by ratings of prospective consumption, but not by ratings of taste. Notably, ratings of prospective consumption have been found to be more sensitive than ratings of taste in assessing SSS (Bell, Roe & Rolls, 2003; Miller, Bell, Pelkman, Peters & Rolls, 2000; Rolls & McDermott, 1991). The finding of SSS in a meal composed of multiple foods is of interest, given that SSS is usually offset by food variety (Rolls, 1986). However, four of the five meal components were savory, and this similarity could have reduced variety effects in the meal, since larger contrasts in flavor (e.g. salty versus sweet) lead to more pronounced specificity of satiety (Rolls, et al., 1981; Rolls & McDermott, 1991). Of particular interest is that SSS was not influenced by the portion served nor by whether leftovers were packaged to go. As a result, as portions were increased subjects consumed more food for a similar decrease in ratings of prospective consumption. A congruent finding was observed in a previous study testing a single food: the change in pre- to post-meal ratings of palatability did not differ as intake increased with larger portions (Rolls, Morris & Roe, 2002). These results suggest that the portion of available food determines how much food will be consumed before its desirability declines enough to contribute to the termination of eating. Clearly, portion size is a primary determinant of intake, even overriding processes related to meal termination.

In common with many other studies, the effect of portion size in this experiment was not found to be influenced by most subject characteristics (Hollands, et al., 2015). However, we did
find that subjects who scored higher in price consciousness had a stronger response to portion size than those lower in this attribute. This finding adds to our understanding of the role of value in the portion size effect at an individual level: those who are more concerned with maximizing monetary value were more susceptible to overeating from larger portions, even when provided with a to-go container. It is likely that these individuals are more averse to wasting money, which is distinct from wasting food (Bolton & Alba, 2012). Therefore, the risk of overeating in individuals high in price consciousness may be amplified in settings in which value pricing is used, since consumers with higher responsiveness to price would be expected to select larger portion sizes (McCall & Bruneau, 2010). We also observed that in control subjects, self-identified slow eaters were less responsive to increases in portion size than fast eaters. Slower eating has been found to relate to lower energy intake in general (Robinson, Almiron-Roig, Rutters, de Graaf, Forde, Smith, et al., 2014), but had not previously been related to the portion size effect. Notably, slowness of eating has similarities to satiety responsiveness (Hunot, Fildes, Croker, Llewellyn, Wardle & Beekman, 2016), which was previously found to affect the relationship between portion size and intake (Zuraikat, et al., 2018b). We speculate that the mechanism by which slowness of eating reduces intake from large portions is related to having more time to process and respond to cognitive or internal satiety cues. Continued investigation of the relationship between eating behaviors and the portion size response can aid in the development of individualized interventions to reduce susceptibility to this effect.

A secondary aim of this study was to assess influences on intake of the individual foods served at the meal. Packaging leftovers attenuated the effect of larger portions on intake of chicken and pasta, but for the other meal components, intake did not depend on whether the uneaten food was packaged after the meal. This finding suggests that the influence of packaging
leftover foods is related to the properties or perceptions of the foods. For example, this strategy may be most effective with foods that reheat well, or foods that are highly valued, such as meats (Drewnowski & Darmon, 2005). Additionally, the relative palatability and perceived value of foods might be found to influence the portion size effect in a larger sample of participants, although these effects did not reach statistical significance in the current study. Previous research has found that foods ranked higher in taste exhibit larger portion size effects (Roe, et al., 2016; Zuraikat, et al., 2018a), and our data were trending in the same direction. Similar to taste rankings, there was a trend for larger portion size effects in foods perceived to have the greatest value, such as the chicken. The role of these food-related characteristics should be examined further by replicating this study in a larger sample of both men and women. This would clarify how the influence of packaging uneaten food on the response to portion size is affected by food properties such as taste and value, as well as helping to determine how results differ between individuals.

Development of strategies to moderate intake from large portions is a primary goal of public health agencies (Raynor & Champagne, 2016; NIDDK, 2016). This study presents one of the clearest demonstrations of an environmental intervention that attenuates the response to portion size. The portion size effect has been shown to persist despite interventions such as extended training in portion control (Zuraikat et al., 2018a), provision of portion options (Zuraikat, Roe, Privitera & Rolls, 2016), information about serving size (Reily & Vartanian, 2016), and mindfulness training (Cavanagh, Vartanian, Herman & Polivy, 2013). Providing the opportunity to take away food after a meal is practical and relatively easy to implement in settings such as restaurants, worksite cafeterias, and dining halls, and as shown here, can be an effective strategy to reduce intake from large portions. It is noteworthy that participants were
made aware prior to the meal of the option to take away uneaten food; the timing of this nudge towards healthy behavior may be an important step in maximizing efficacy of the provision of packaging and should be tested in restaurant settings. A further benefit of this strategy is its potential to reduce food waste without having to restrict portion sizes. Thus, providing the option to take away uneaten food could help to address concerns related to overconsumption of energy (Swinburn, Sacks, Hall, McPherson, Finegood, Moodie & Gortmaker, 2011) and food waste (EPA, no date; Venkat, 2011) by reducing intake from large portions at a meal.
References


CHAPTER 5

CONCLUSIONS
Summary of findings

These studies were designed to determine whether the portion size effect was influenced by extended training in portion control, the cost of a meal, or provision of the option to take away uneaten food. Another aim of these studies was to identify subject characteristics associated with higher or lower responsiveness to increases in portion size. Investigation of these factors provided information on proposed mechanisms underlying the portion size effect related to normative cues and food value. Moreover, in testing strategies to counter the portion size effect, we found that preferential selection of healthful, lower-ED foods following portion-control training and packaging uneaten food for later occasions can be used to moderate energy intake from large portions. Two subject characteristics, satiety responsiveness and slowness of eating, were also found to influence the response to portion size. Thus, interventions tested in these studies can be incorporated into the development of strategies to moderate energy intake from large portions, and these strategies can be tailored to those most susceptible to the effects of large portions.

Does portion-control training influence intake from large portions?

Previous research found that providing short-term education in managing food portions did not influence intake in response to increasing portion size (Cavanagh, Vartanian, Herman & Polivy, 2014). It was thought, however, that extended training in portion-control strategies would be needed to attenuate the effects of large portions on intake. Therefore, in Study 1, we compared the response to portion size of women who had participated in the year-long Portion-Control Strategies Trial (Rolls, Roe, James & Sanchez, 2017) and women who had no previous training. Similar to results on the influence of short-term training (Cavanagh, et al., 2014), the
effect of portion size on intake did not differ between women with and without extended training in portion control; despite prolonged instruction in managing food portions, trained participants consumed more food and energy when served larger portions. This finding further demonstrates the robust nature of the portion size effect. The cues provided by the amount of food served appear to overwhelm efforts to provide contextual information (e.g. Zuraikat, Roe, Privitera & Rolls, 2016; Ueland, Cardello, Merril & Lesher, 2016; Reily & Vartanian, 2016) and education (Cavanagh, et al., 2014) about appropriate portion sizes. As a consequence, portion size remains a primary determinant of intake.

That the amount of food served influenced trained participants’ intake is likely due to the lack of sustainability of many strategies to limit food portion sizes (Rolls, et al., 2017), which can be impractical for everyday use. For example, portion size estimation aids can improve accuracy of estimation (Byrd-Bredbenner & Schwartz, 2004), but are often limited to use in certain settings. This was exemplified by trained subjects’ relatively poor estimation of their intake in response to increases in portion size in the lab. These findings highlight the importance of developing sustainable methods to increase awareness of large portions as a component of education in portion-control strategies. Furthermore, it will be important to identify ways to translate that training and increased awareness into changes in eating behavior.

Evoking a change in responsiveness to portion size following training may also require implementation of environmental cues, such as labeling. Although prolonged training and labeling in isolation have been found to have little influence on the response to portion size (e.g. Study 1; Reily & Vartanian, 2016); in combination, they may be more effective in attenuating the response. Finally, in addition to development of methods to sustain the salience of portion size awareness, the ability of training to stimulate behavioral change may be enhanced by
provision of comprehensive instruction in multiple portion-control strategies (use of portion estimation aids, reducing energy density, etc.), rather than narrower, targeted approaches as was the case in the Portion-Control Strategies Trial (Rolls, et al., 2017). Future research should investigate how comprehensive training in portion-control strategies influences the response to portion size in comparison to training in more targeted strategies; having alternative strategies to resort to if a preferred strategy fails may aid in moderating intake from large portions.

Although extended training in portion control did not attenuate the portion size effect, trained participants did moderate their energy intake in comparison to untrained controls. This was achieved not by limiting the amount of food eaten, but by consuming meals lower in energy density (ED) than untrained controls. This finding highlights the importance of ED in determining intake from large portions. Previous studies have shown that methods to reduce meal ED are effective in moderating energy intake when large portions are served (e.g. Rolls, Roe & Meengs, 2006). One such strategy to reduce meal ED, and energy intake as a result, is to increase the proportion of low- compared to high-ED foods consumed at a meal (Rolls, Roe & Meengs, 2010). Indeed, this was the strategy used by trained participants; in comparison to untrained controls, they consumed more of the very-low-ED foods (which were rated high in healthfulness) and less of the high-ED foods (which were rated low in healthfulness). Thus, although only a fraction of the training received by women in the Portion-Control Strategies Trial was related to making healthful food choices, this was the aspect of training employed to moderate energy intake. Notably, using ED to determine food portions was the primary intervention for one of the groups in the Portion-Control Strategies Trial (Rolls, et al., 2017); however, in Study 1, we did not have enough women from the different intervention arms to determine whether one specific training was more influential on intake than the others.
The findings of Study 1 clearly indicate that strategies to moderate energy intake from large portions should emphasize preferential section of lower-ED foods. Contrary to the suggestion that advising the use of ED to determine portions will be too complex for individuals to put into practice (Mattes, 2018), previous weight loss trials have found that training individuals to use food ED (increase fruit and vegetable intake, reduce fat intake) to determine meal size is more effective in promoting weight loss than standard advice to reduce fat in the diet (Ello-Martin, Roe, Ledikwe, Beach & Rolls, 2007). Furthermore, data from the Portion-Control Strategies Trial shows that approaches related to reducing dietary ED are more sustainable than those related to limiting portion sizes (Rolls, et al., 2017). This was validated by the reliance of trained participants (Study 1) on selecting healthful, lower-ED foods when faced with increasing portion sizes. An additional benefit of consuming foods lower in ED, and one that may augment sustainability, is the promotion of satiety, enabling the consumption of more food for fewer calories (Rolls, 2014). Therefore, a primary component of portion-control strategies should be training in methods to reduce dietary ED; for example, through increased intake of lower-ED fruits and vegetables.

Although trained participants moderated their energy intake in comparison to untrained controls in Study 1, they still consumed more energy when served larger portions, which should not be overlooked. Thus, while preferential selection of lower-ED foods should be an emphasis of education in portion control, it should not displace approaches to address large portions, for example, environmental changes aimed at countering the effects of large portions.

**Do interventions related to value influence the portion size effect?**

The results from Study 1 further demonstrated the robust nature of the portion size effect. However, that instruction in managing food portions did not attenuate the response to portion
size suggests that factors other than a lack of knowledge about appropriate portions contribute to the effect. One such influence on the portion size effect may be the desire to maximize value from a meal (Steenhuis & Vermeer, 2009). Studies 2 and 3 were consequently designed to investigate this theory.

Study 2 tested whether varying the amount of money paid for a meal influenced intake in response to increasing portion size. Similar to most portion size studies (summarized in Zlatevska, Dubelaar & Holden, 2014) increasing the portion size of the main dish led to significant increases in intake. However, this effect was not exacerbated by doubling the price of the meal. In fact, the cost of the meal had no influence on intake at all. These findings contradict previous research indicating that higher meal costs motivate individuals to overeat (Sinver & Yaniv, 2012). Rather, in the context of this study, large portions motivated greater intake independent of the amount of money paid.

Although the potential for price to influence intake should not be discounted entirely, the lack of evidence that higher costs exacerbate energy intake from large portions may have important policy implications. Previous literature used the sunk cost effect on food intake as a caution against policy efforts to eliminate the greater value for money typically associated with energy-dense foods and larger portions (Just & Wansink, 2011). However, given evidence from Study 2 that price does not affect intake from a pre-determined amount of food, pricing food proportionally by weight, a strategy suggested by Steenhuis & Vermeer (2009), should not have deleterious effects on intake. Rather, proportional pricing of portion options has the potential to lead to selection of smaller portions, which can result in lower energy intake. There is a need, however, for further investigation of the influence of reducing the value of large relative to small portions, since current findings are mixed and are limited to fast-food settings and worksite
cafeterias (Harnack, French, Oakes, Story, Jeffrey & Rydell, 2008; Vermeer, Alting, Steenhuis & Seidell, 2009). Nevertheless, our data suggest that, should proportional pricing be employed, selection of large portions (at a higher price) will not exacerbate overconsumption.

Study 2 also provides interesting insights into the influence of price and portion size on consumer satisfaction. Ratings of satisfaction with cost, value for money, and likelihood of purchase were all well-above neutral (mid-point of the scale) when the meal was priced at $8, regardless of the portion size served. Similarly, these ratings were substantially lower when meals were priced at $16, and did not differ following a 50% change in the amount of food served. As a consequence, rather similar prices per gram served (e.g. small portion priced at $8 compared to large portion priced at $16) were associated with starkly different levels of satisfaction and perceived value for money. Thus, ratings of satisfaction may be more reliant on absolute price than on price per unit. Based on these findings, food providers may be able to reduce portion sizes (within a reasonable range) without reducing customer satisfaction. This may aid in efforts to downsize, which has been advocated for as a solution to overconsumption from large portions (Marteau, Hollands, Shemilt & Jebb, 2015).

Most importantly, findings from Study 2 provide information on the role of value in the portion size effect. That the magnitude of the portion size effect was similar across very different meal costs suggests that the monetary value associated with a meal is not the primary contributor to increased intake from large portions. As is noted by Herman, Polivy, Pliner, and Vartanian (2015), factors beyond a desire to maximize value for money must contribute to the portion size effect given that it is observed in laboratory settings when there is no money paid for the meal (e.g. Rolls, Morris & Roe, 2002; Roe, Kling & Rolls, 2016) as well as in children (Kling, Roe, Keller & Rolls, 2016), who have little to no concept of monetary value. Moreover, in Study 2,
we observed that subjects consumed more food from larger portions even when the two portion sizes were rated as providing equivalent value for money and satisfaction with the cost. Thus, even when the greater value for money that is often associated with larger portions is eliminated, the portion size effect persists.

In addition to the lack of interaction between portion size and meal cost observed in Study 2, substantial decreases in ratings of satisfaction, signifying a salient sunk cost, did not drive individuals to consume more food. Thus, the effect of portion size does not appear to be driven by an aversion to wasting money. However, the value associated with foods is not limited to the price paid. For example, aversion to wasting food is distinct from aversion to wasting money (Bolton & Alba, 2012). Thus, while an aversion to wasting money (greater sunk cost) did not influence the portion size effect, aversion to wasting food may be a motivating factor in driving overconsumption from large portions.

Study 3 was designed to determine whether a strategy that could increase value and decrease waste influenced the response to portion size. Results from this study showed that providing women with the opportunity to take away uneaten food following a meal attenuated the portion size effect. This extended the previous finding that subjects who were provided a to-go container consumed less food and energy at a single meal than those who were not (Bates & Shanks, 2015). The combination of these experimental findings paired with population data showing high levels of plate-cleaning (Robinson & Hardman, 2016) support the notion that individuals are particularly averse to wasting food (Bolton & Alba, 2012). This aversion to waste likely leads individuals to overeat when served large portions in order to increase value from a meal and reduce waste. Thus, these results provide unique insight into the role of value in the
portion size effect; value appears to contribute to the effect indirectly, through aversion to wasting food more than money.

In addition, findings from Study 3 suggest that another proposed mechanism underlying the portion size effect, visual cues, may have little to do with increased consumption from large portions. It has been suggested that the portion size effect may occur, in part, because large portions influence visual cues used to determine meal termination (reviewed in English, Lasschuijt & Keller, 2015). For example, if individuals usually stop eating when the plate is half-empty, they will eat more when served large portions. If the portion size effect was the result of a reliance on visual cues, then packaging the food for subjects after the meal (as was done in Study 3), with no changes to the meal itself, should still result in increased intake from larger portions. In contrast, subjects in the To-Go Group consumed relatively (and statistically) similar amounts of food as portions were increased. This corroborates the finding that individuals responded to increasing portion sizes even when blindfolded (Burger, Fisher & Johnson, 2011). Visual cues may play a role in decisions around food intake, but the aforementioned findings suggest that the influence of visual cues on the response to large portions is rather negligible in comparison to other factors. Thus, the packaging of uneaten food in Study 3 provided clarity on the relative influence of factors proposed to affect the response to portion size, as well as an effective strategy to reduce intake from large portions.

Packaging food to take away can also serve as a strategy to reduce food waste, high levels of which are a growing global concern (Venkat, 2011). Provision of a to-go container may be especially effective at reducing waste when very large portions are served. One reason is that such large portions can provide enough food for two meals, which can then replace a future meal. Indeed, subjects reported that their likelihood of taking food away increases when it is
obvious that there is more food served than can be eaten. The other reason relates to the response to very large portions of individuals not provided with the opportunity to take food away. The (uninfluenced) portion size effect is curvilinear (Zlatevska, et al., 2014), meaning that intake tails off as portions become very large. This pattern was observed in the Control Group in Study 3 as well as in previous studies (e.g. Roe, et al., 2016). As portions become excessively large, it is likely that individuals recognize that they cannot consume the full amount (potentially disinhibiting the waste aversion) and thus they stop eating. As a consequence of this, in Study 3, we saw a convergence of intake between the To-Go Group and Control Group at the largest portion served. While intake was similar, women in the To-Go Group were able to take over 50% of the meal home, while that amount was discarded in the Control Group. Thus, while the convergence of intake at the largest portion has some negative implications in terms of the role of packaging on intake (discussed in Study 3), it also highlights the positive effect of packaging on reducing waste.

Data from Study 3 show that provision of packaging uneaten food to take away can have beneficial effects on food intake and waste; however, its utility may vary depending on differences in personal or cultural norms. Notably, efforts to reduce food waste have led to legislation requiring the provision of packaging in countries typically averse to the use of “doggy bags,” such as France (Mourad, 2015). While these policies were implemented in response to concerns about waste (and not intake), it is of interest to determine whether these practices will have unintended positive consequences on energy intake and obesity rates over time.

An important next step in developing a more comprehensive understanding of the influence of packaging uneaten food on intake will be to assess how this strategy affects intake at later meals. In Study 3, despite consuming less food than Controls, post-meal ratings of hunger
and satiety did not differ between the two groups. Thus, the reduced intake following provision of a to-go container is unlikely to lead to compensatory overeating at future meals. Nevertheless, future studies should assess subsequent consumption, in order to determine how the strategy affects daily energy intake. It is also of interest to determine whether individuals who have taken food away use leftover food to replace a meal, whether it is eaten in addition to other meals, or if it is eaten at all. What is done with the uneaten food can have interesting implications in terms of the value provided by packaging it. Again, the amount of food served could be important in determining what is done at the test meal and subsequent meals.

An important avenue of future research related to both Studies 2 and 3 will be to develop a better understanding of how the available foods influence any relationship between the response to portion size and sunk cost or provision of a to-go container. In Study 2, only a single food was served in order to limit differences in liking or ED that could confound results on intake. Although the pasta in Study 2 was very well liked, it could be the case that it was not valued enough for the cost associated with it to influence intake. Foods that have high energy (and market) costs, such as meats (Drewnowski & Darmon, 2005), may lead the sunk cost to be more salient. In addition, there is greater aversion to wasting foods that are more highly valued (Lipinski, Hanson, Lomax, Kitinoja, Waite & Searchinger, 2013). This was supported by data from Study 3; the most highly-valued food, chicken, was one of the only foods to be influenced by packaging it to take away. Thus, high costs paired with the increased aversion to wasting a highly-valued food could lead to exacerbated effects of large portions on intake. In contrast, the provision of packaged leftovers could counter any sunk cost effects on intake from large portions (of valuable foods), since the aversion to waste is eliminated.
Future studies conducted in restaurant settings could address some of this speculation. Furthermore, it is important to replicate Studies 2 and 3 in more naturalistic settings in order to enhance the ecological validity of the results. Restaurants offer a variety of foods across a range of prices, thus making a restaurant an ideal setting to provide clarity on whether sunk costs influence the response to portion size. This would also allow for investigation of how provision of packaging may mediate any relationship between meal cost and the portion size effect.

**What do these studies tell us about individual differences in the response to portion size?**

**Weight status and the portion size effect**

An aim of Study 1 was to investigate whether the response to portion size differed between women with normal weight and women with overweight and obesity. Many studies have examined weight status as a covariate and found no influence of BMI on the effect of portion size (summarized in Tables 1.1-1.3). Study 1, however, was one of the first studies designed specifically to examine this question. Similar to previous results, this study showed that women of differing weight status had nearly identical responses to increasing portion size of a meal. This finding is surprising given the relatively strong epidemiological link between portion size and obesity (Young & Nestle, 2012).

One possible explanation for the lack of relationship between weight status and the portion size effect in Study 1 and others is that the duration (number of meals observed) was not sufficient to detect differences. Individuals with overweight and obesity may demonstrate poorer regulation in response to prolonged variations in portion size, and it is believed that a minimum of 3-4 days are needed for regulatory mechanisms to detect perturbations (Bray, Flatt, Volufova, Delany & Champagne, 2008). Indeed, a recent study varying the portion size of all foods served
to children over a 5-day period found that the effect of portion size was greater in children with higher weight status (Smethers, Keller, Meehan, Roe, Sanchez & Rolls, 2017). However, this relationship was not observed in one longer-term portion size study in adults (Rolls, Roe & Meengs, 2007) and was only observed in women in another (Kelly, Wallace, Robson, Rennie, Welch, Hannon-Fletcher, et al., 2009). It is notable, though, that in multiple longer-term studies, serving larger portions over a prolonged period led to increases (or trends toward increases) in body weight (Kelly, et al., 2009; Jeffrey, Rydell, Dunn, Harnack, Levine, Pentel, et al., 2007; French, Mitchell, Wolfson, Harnack, Jeffrey, Gerlach, et al., 2014).

One could speculate that the relationship between large portions and body weight is not a matter of differences in susceptibility to the portion size effect but a difference in the sizes of portions selected or the frequency of eating large portions. Reily, Herman, and Vartanian (2016) tested the former of these hypotheses and found that selection of large compared to small portion sizes did not differ between individuals of differing weight status. On the other hand, population-based data suggest that eating frequency and larger portions both contribute to increases in body weight (Duffey & Popkin, 2011); however, experimental evidence of a relationship between increased frequency of eating large portions and higher body weight is lacking. Thus, although it is likely that a relationship between portion size and body weight exists, the inconsistency of results makes it hard to determine the exact nature of this relationship. Clarification of the impact of intake from large portions on the development of obesity should remain a primary focus of future research.

**Eating behaviors and the portion size effect**

As was summarized in Chapter 1, the portion size effect is typically found to be robust across participants (Zlatevska, et al., 2014; Hollands, et al., 2015). For the most part, results of
Studies 1-3 agreed with this pattern. However, we did find that scores from two subscales of the Eating Behavior Questionnaire (EBQ; Zuraikat, Roe, Smethers, Reihart & Rolls, 2018) influenced the effect of portion size on intake. The portion size effect was attenuated in subjects higher in satiety responsiveness and higher in slowness of eating. Because of the novelty of using the EBQ in an adult sample, these studies were the first to show that either of these eating behaviors influenced the portion size effect in adults. Identification of these influences on the portion size effect was also aided by recruitment of a large sample of subjects in Study 2, which increased the statistical power to detect effects. In addition, varying portions across four sizes in Study 3, which gives a more comprehensive characterization of the portion size effect that is sensitive to detecting influential factors (Roe, et al., 2016), allowed us to identify individual differences in the response.

Satiety responsiveness, which is said to measure responsiveness to internal cues of fullness (Carnell & Wardle, 2008), has been found to influence the portion size effect in children (Mooreville, Davey, Orloski, Hannah, Mathias, Birch, et al., 2015 & Smethers, et al., 2017). Similar to our findings in adults, children higher in satiety responsiveness moderated their intake from large portions both at a single meal (Mooreville, et al., 2015) and over a five-day period (Smethers, et al., 2017). Thus, across a broad range of ages, this eating behavior is associated with a reduced susceptibility to overeating from large portions. This may have important implications in terms of the development of strategies to counter the portion size effect. Furthermore, in both our sample and others, satiety responsiveness was inversely associated with measures related to body weight (e.g. Hunot, Fildes, Croker, Llewellyn, Wardle & Beeken, 2016), suggesting that this behavior may be a mediating factor in the possible relationship between portion size and obesity.
An aim of future research should be to develop a more comprehensive understanding of satiety responsiveness. For example, it will be useful to know if satiety responsiveness is just a measure of interoceptive awareness as well as if it is a trait or a learned behavior. Research shows that there is some level of heritability to satiety responsiveness (Kral & Hetherington, 2015), but also that responsiveness to internal cues declines with age (Ashcroft, Semmler, Carnell, van Jaarsveld & Wardle, 2008). Determining whether satiety responsiveness is something that can be influenced, or taught, will be essential in creating tailored interventions to reduce intake from large portions. Recent work in children shows that training them to be more cognizant of their internal cues of hunger and fullness can improve compensation for energy perturbations in some children (Reigh, O’Neill, Kramer, Rolls, Savage, Johnson, et al., 2018). This work should be extended to determine whether similar training can lead to sustained increases in satiety responsiveness. It will also be useful to know whether training individuals to be more responsive to internal cues of hunger and fullness is effective at all ages, and, if so, whether such training leads to reduced susceptibility to the portion size effect.

Study 3 found that slowness of eating also influenced the portion size effect. In the Control Group, slow eaters had an attenuated response to portion size in comparison to faster eaters. Interestingly, in validating the Adult Eating Behaviour Questionnaire, a near analog of the EBQ, it was reported that slowness of eating had similarities to satiety responsiveness (Hunot, et al., 2016). Given that both satiety responsiveness and slowness of eating influence the portion size effect, it would be of interest to investigate whether slowness of eating contributes to satiety responsiveness by allowing more time to process internal and cognitive cues for meal termination. Similarly, future research is needed to investigate the effect on intake of methods to reduce eating rate, such as instruction or food formulation. A recent systematic review and meta-
analysis shows that changing the texture of foods can slow eating rate and, consequently, reduce intake (Krop, Hetherington, Nekitsing, Miquel, Postelnicu & Sarkar, 2018). One study extended this to assess whether changes in texture (hard vs soft versions of the same food) moderated intake in response to increasing portion size. Although food texture did not interact with portion size, harder foods led to reduced eating rate and lower energy intake from large portions compared to softer foods (McCrickerd, Lim, Leong, Chia & Forde, 2017). As noted in the meta-analysis by Krop and colleagues (2018), though, there are a number of factors related to food properties that can affect oral processing time. Therefore, future research should assess how a broader range of changes to food properties affects eating rate and the response to portion size. It would also be interesting to determine whether the response to portion size differs across cultures that vary in typical eating rates (e.g. the “slow food” movement of Italy (Jones, Shears, Hillier, Comfort & Lowell, 2003) compared to the United States).

**What role does the food itself play in the portion size effect?**

Results from Study 1 clearly demonstrate that the energy density of the foods that are consumed has a large impact on energy intake from large portions. Given consistent evidence that lowering meal ED leads to reduced energy intake (Rolls, 2017), a primary strategy to moderate the effects of large portions should be reductions to meal ED (Rolls, Drewnowski & Ledikwe, 2005). Perhaps the most obvious method to reduce ED is to consume a greater proportion of lower-ED fruits and vegetables, a strategy recommended by public health agencies (USDA, 2016). Increasing the proportion of vegetables served at a meal has been found to reduce energy intake (Rolls, et al., 2010), and a similar strategy was used by trained subjects in Study 1 to moderate energy intake from large portions. Data from Study 1 showed that ratings of
food healthfulness were highly (inversely) correlated with ED, suggesting that training individuals to select healthful foods can aid in the implementation of selecting larger portions of lower-ED foods. This strategy may also be easier for individuals than trying to limit their intake in general.

There are, however, barriers to encouraging preferential selection of lower-ED foods. Fruits and vegetables tend to be lower in palatability than higher-ED alternatives (Drewnowski, 1998). This is a concern given that the relative palatability of foods influences the portion size effect; in Studies 1 & 3, as well as others, the magnitude of the portion size effect was greater for foods ranked higher in taste (Roe, et al., 2016). This limitation can be avoided by subtly varying the ED of well-liked dishes by incorporating fruits and vegetables and reducing fat content, a strategy previously found to reduce energy intake from large portions (Rolls, et al., 2006). On the other hand, methods to increase the palatability of lower-ED foods can be used strategically to leverage the influence of palatability on the portion size effect. Research has shown that a variety of approaches to varying the palatability of vegetables can be successful in increasing liking and acceptance without significantly increasing the ED of the foods; such methods include use of herbs and spices (Peters, Polsky, Stark, Zhaoxing & Hill, 2014; Fritts, Fort, Corr, Liang, Alla, Cravener, et al., 2018), dips (Savage, Peterson, Marini, Bordi & Birch, 2013) as well as addition of agents to mask bitterness, such as sweeteners and salt (Sharafi, Hayes & Duffy, 2013; Bakke, Stubbs, McDowell, Moding, Johnson & Hayes, 2018). Pairing these changes with larger portions of vegetables can lead to increased intake of lower-ED foods at a meal, in turn reducing energy intake. Finally, pairing relatively well-liked lower-ED foods with lesser-liked higher-ED meal components could be another effective strategy to increase the proportion of lower-ED foods consumed at a meal (Ishdorj, Capps, Storey & Murano, 2015).
In addition to palatability, Study 3 showed that the perceived value of food was trending towards a significant influence on the portion size effect; the increase in intake in response to larger food portions was greatest for foods rated higher in value. This finding further highlights the importance of providing packaging as a strategy to moderate intake from large portions. Providing the opportunity to take food away could reduce the likelihood of overconsumption when highly valued foods are served at a meal. The finding that food value influences the portion size effect can also have important implications for increasing the proportion of fruit and vegetables consumed. Lower-ED foods are often higher in value given the inverse relationship between ED and food costs (Drewnowski & Darmon, 2005). Thus, methods to increase accessibility and affordability of these options (e.g. increased government assistance) could be an effective strategy to promote preferential selection and intake of healthful, lower-ED foods and moderate energy intake from large portions.

The findings of Studies 1-3 demonstrate the substantial influence of food properties on intake from large portions. Future research should investigate how variations in food properties can be leveraged to increase the proportion of lower-ED options consumed as a means to moderate the effects of large portions on energy intake. Furthermore, while not directly compared, these results suggest that characteristics and perceptions of the food itself are likely more influential in determining intake than will be small environmental nudges.

**Summary of strengths and limitations**

The studies described in this dissertation have a number of strengths; most notably, that they advance our understanding of mechanisms underlying the portion size effect and strategies to counter these effects. These studies extended previous research by investigating whether the
portion size effect was influenced by extended training in portion-control, variations in meal cost, or provision of packaged leftovers after a meal. Conducting these studies in the laboratory allowed for a high level of experimental control. Thus, we were able to isolate the influence of the experimental factors of interest on food and energy intake.

Having previously run a randomized-controlled trial testing the efficacy of portion-control strategies on weight loss (Rolls, et al., 2017), we had access to a unique population of subjects to study. In recruiting these women, we were able to determine whether long-term instruction in portion-control would be sufficient to counter the cues provided by large portions. As a consequence, we gained valuable insight into the pervasiveness of the normative cues provided by the portion served. This study was also one of the first designed to examine the portion size effect across women of differing weight status, an important step in understanding the relationship between large portions and body weight.

A limitation of conducting a study following a weight-loss trial is the potential for demand characteristics to influence intake. The trained participants may have responded differently to being under observation, since unlike the control subjects, they had previously participated in a weight-loss trial that was administered on the same campus. However, this potential influence was lessened by using different locations and different research staff for the two studies. Furthermore, despite the possibility of such a demand characteristic, the effect of portion size on the total amount consumed at the meal was similar between trained participants and controls.

Studies 2 and 3 helped to clarify the relationship between value and the response to portion size. Study 2 had the advantage of investigating the influence of meal cost on intake in a setting that had likenesses to a restaurant (decoration, real costs), while still maintaining a high
level of experimental control. Similarly, the provision of a to-go container in Study 3 more closely resembled practices in restaurant settings than the intervention in the previous study (Bates & Shanks, 2015), enhancing the ecological validity of our findings. However, despite efforts to increase the ecological validity of these studies, there is a need for replication in field settings. The influence of meal cost and provision of packaging could be more salient in naturalistic settings. Moreover, restaurant settings provide a broader range of food choices, which would allow for a more complete understanding of the influence of different food properties on the relationship between cost, packaging, and the portion size effect. In addition, determining the influence of the price paid for a meal on intake from large portions will be aided by assessment of food choice prior to intake.

Another advantage of Studies 1-3 is that they were designed to increase the likelihood of detecting individual differences in the response to portion size. Indeed, this was an aim of Study 2, which boasted one of the largest sample sizes of any portion size study in adults (see Hollands, et al., 2015 for comparison). Study 2 also assessed a broad range of eating behaviors and consumer factors, many of which had not previously been tested. One novel tool for assessment of eating behaviors was the Eating Behaviors Questionnaire, which was developed for use in Study 2 and was used in Study 3 as well. Use of the EBQ led to identification of behavioral influences on the portion size effect not previously observed in adults; these findings can aid in the development of tailored interventions to counter the effects of large portions on intake. In Study 3, although the sample size was smaller, we varied the portion size over four conditions, which allowed for a better characterization of the portion size effect and greater sensitivity to detecting individual differences.
A further benefit of these studies was that they included subjects across a broad range of age and body weight, and had relatively representative distributions of both. In contrast, Studies 1 and 3 were run exclusively in women, and Study 2 had more women than men. Although the effect of portion size extends to both men and women (Zlatevska, et al., 2014), these studies need to be replicated in men in order to enhance the generalizability of findings. Another limitation of these studies is a result of the location in which the research was conducted. The relative lack of ethnic and racial diversity in Centre County (US Census Bureau, 2016) was exhibited in these studies. In addition, although a range of household income was represented, there were few individuals with low socioeconomic status (SES) or a low level of education. Given the potential for SES differences in the influence of value on the portion size effect, it will be of great interest to extend these experiments to rural and urban areas with a greater prevalence of low educational attainment and low income.

**Graphical Abstract and General Conclusions**

The model illustrated in Figure 5.1 summarizes the findings from the three studies presented in this dissertation. Food prices influence selection (Epstein, Jankowiak, Nederkoorn, Raynor, French & Finkelstein, 2012), but it is likely that once a meal is purchased, it is the portion size served that determines the amount consumed, and not the sunk cost. Large portions encourage increases in the weight of food consumed through normative influences, aversion to waste, and the delay of mechanisms that stimulate meal termination, such as sensory-specific satiety. Furthermore, interventions that reduce waste and increase value at a meal, such as packaging uneaten food to take away, can attenuate the effects of portion size on intake. Similarly, slower eating and higher satiety responsiveness are associated with reduced
susceptibility to overeating from large portions. This may be the result of these characteristics overriding the influence of large portions on satiation mechanisms. Ultimately, how the amount of food consumed impacts energy intake will be determined by the energy density of foods eaten, which will be partly determined by the relative palatability and value of those foods.

Figure 5.1: Graphical abstract of the complex relationship between portion size and intake. Portion size (A) overrides cues that signal meal termination (B) and is a key determinant of the weight of food consumed (C). The weight of food consumed (C) combines with the ED consumed (D) to ultimately determine energy intake (E). The interventions tested were training in portion control (F), varying food price (G), and provision of packaging (H). Training was found to influence energy intake from large portions through selection of lower-ED foods (F→D). Price (G) was not shown to have an influence on the relationship between portion size and intake, but may have an influence on portion selection (G→A; not tested in this study). Provision of packaging attenuated the response to portion size (H), likely through reducing food waste (mechanism related to value). Finally, satiety responsiveness and slowness of eating influenced the response to portion size (I→C). Higher satiety responsiveness and slower eating may counter the typical influence of large portions on the signaling of meal termination (B).

In summary, these studies provide insight into factors that influence the response to portion size and have important implications for reducing overconsumption from large portions. Although the amount of food served is a primary determinant of intake, energy intake from large
portions can be moderated through education to promote preferential selection of lower-energy-density foods, packaging uneaten food to reduce waste, and characteristics related to responsiveness to internal cues of hunger and fullness.
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APPENDIX A

TELEPHONE SCREENING QUESTIONNAIRE

STUDY 1
Pre-screening Questionnaire

Date: 
Age: _______ Date of Birth: _________
Height: _______ Weight: _____________
Do you smoke? No Yes

Are you currently taking any prescription or “over the counter” medications regularly? No Yes
If yes, what?____________________

Are you currently dieting to gain or lose weight? No Yes

Are you an athlete in training? No Yes

Do you have any food allergies or intolerances? No Yes

Do you have any sugar/sweetener or sodium restrictions? No Yes

Do you have any food restrictions related to religious practices? No Yes:
Are you a vegetarian? No Yes
If no, are there any meats that you exclude from your diet?___________

Do you like and are willing to eat:
(Will insert study entrees and ask if they like them)

Do you regularly eat 3 meals per day? No Yes
If no, what is your usual daily pattern of meals?

Would you be willing to refrain from eating after 10:00 pm the evening before the test session? No Yes

Would you be willing to refrain from drinking caffeinated beverages for 24 hours prior to the test session? No Yes

Would you be willing to refrain from drinking alcoholic beverages the day before the test session? No Yes

Are you pregnant or breast feeding? No Yes

Where did you hear about the study?______________________________

Have you participated in any other studies in our lab? No Yes
If yes, what study and when? ____________________________________

Are you a: _____ Undergraduate semester standing: ________ major: _______
_____ Graduate major: __________
_____Penn State Staff
_____State College Resident

If criteria are satisfied, take their name and ask them to come to the lab to fill out questionnaires and to have their weight & height recorded.

Name: _________________ Phone: ________________ Appointment:
_______________________
APPENDIX B

INFORMED CONSENT FOR SCREENING

STUDY 1
INFORMED CONSENT FORM FOR BIOMEDICAL RESEARCH
Prescreening Questionnaire

Title of Investigation: Adult Women Lunchtime Study

Investigator: Barbara Rolls, Ph.D.
Department of Nutrition
226 Henderson Bldg. Penn State University
University Park, PA 16802
EMAIL: bjr4@psu.edu
TELEPHONE: 814-863-8481

Purpose of today’s visit: To determine if you meet the criteria to be a participant in this laboratory’s human eating behavior study.

Procedure: It will take you approximately 45 minutes to complete the screening process. These questionnaires are to determine whether or not the study we are conducting is appropriate for you. You will be weighed and your height will be measured. Our studies require a considerable amount of preparation, and, in order to assure reliable results for the study, it is very important that participants fulfill all study criteria.

Because of strict subject criteria, it may be determined that we cannot have you participate in the current study. There are a variety of reasons why an individual may not be chosen for a particular study. Often the number of responses from potential participants exceeds the number of individuals needed for the study. If you are not chosen to participate at this time, your information will be kept on file and you may be called later to participate in another study. If you do not want your information to be saved, please initial below.

_________ Initial here if you do not want your information to be saved for a future study

Risks: There are no risks in participating in this research beyond those experienced in everyday life. Some of the questions are personal and might cause discomfort.

If, as a result of filling in the questionnaires, you feel that you would benefit from psychological assistance, or individual counseling, you may contact:

Psychological Clinic of the Penn State University
314 Moore Building
University Park, PA 16802
Phone: (814) 865-2191

Benefits: If you qualify to become a participant in a study at the Laboratory for the Study of Human Ingestive Behavior, you will be contributing to our understanding of human eating behavior.

Contact Person: Christine Sanchez
226 Henderson Building
University Park, PA 16802
814-863-8482
**Confidentiality:** Your responses on the questionnaires will remain confidential. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. The following may review and copy records related to this research: The Office of Human Research Protections in the U.S. Department of Health and Human Services, Penn State University’s Biomedical Review Board, and Penn State University’s Office for Research Protections. If you become a participant in this study, the first page of the questionnaire packet which contains your full name will be shredded and you will only be identified by a subject ID number. If you are not a good match, but agree for us to keep your information on file, only members of our lab would have access to these questionnaires. Consent forms will be kept in a locked closet.

**Voluntary Participation:** Your participation in the research is voluntary. You do not have to answer any questions you do not wish to answer. Your participation is voluntary and you are free to withdraw your consent and terminate your participation at any time. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

**Right to Ask Questions:** Please contact Christine Sanchez at 863-8482 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you. Questions about your rights as a research participant may be directed to Penn State University’s Office for Research Protections at (814) 865-1775.

**Injury:** In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document, you are not waiving any rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

To the best of your knowledge and belief, you have no physical condition or dietary requirements, such as food allergies or food restrictions, which would increase your risk for participation in this investigation.

You must be 20 years of age or older to take part in this research study.

If you agree to take part in this research study and the information outlined above, and to have your body measurements taken, please sign your name and indicate the date below. You will be given a copy of this signed and dated consent form for your records.

<table>
<thead>
<tr>
<th>Date</th>
<th>Date of Birth</th>
<th>Subject's Signature</th>
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</table>

<table>
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<tr>
<th>Date</th>
<th>Investigator's Signature</th>
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APPENDIX C

INFORMED CONSENT FOR STUDY

STUDY 1
Informed Consent Form for Biomedical Research
The Pennsylvania State University

Title of Project: Adult Women Lunchtime Study

Principal Investigator: Barbara Rolls, Ph.D.
Department of Nutritional Sciences
226 Henderson Building, University Park, PA 16802
EMAIL: bjr4@psu.edu; TELEPHONE: 814-863-8481

Other Investigator(s): Christine Sanchez
Department of Nutritional Sciences
226 Henderson Building, University Park, PA 16802
EMAIL: cqv5011@psu.edu; TELEPHONE: 814-863-8482

1. Purpose of the study: The purpose of this research is to investigate eating behaviors.

2. Procedures to be followed: This study will last for 5 weeks. You will be asked to come to the lab to eat lunch on one day per week for 4 weeks. On one day during the fifth week of the study, you will come to the lab to complete a series of questionnaires. At all meals you may eat as much or as little of the foods as you would like. All foods served are commercially available. On test days, we ask that you consume breakfast at home and try to keep the time you eat and the foods you eat as consistent as possible each week. We will give you a list of suggested foods to have for breakfast. You will record your food intake for breakfast and bring it with you to your lunch session. We also ask that you not consume any foods or beverages, other than water, between breakfast and lunch. If you consume water, we ask that you not drink one hour before a test meal. You will be asked to complete a Food and Activity Diary the day before each test session. You will also be asked to keep the amount of food eaten at dinner the night before each test session as consistent as possible each week and to refrain from eating or drinking (other than water) after 10:00 p.m. on the evening before your test session until you eat breakfast on the day of your test session. You will also be asked to refrain from drinking alcohol and to maintain your usual activity level the day before your test day. A questionnaire at lunch will ask if you have consumed any alcohol. If you are underage and admit to alcohol use, that information will remain confidential.

You will complete a questionnaire about your general well being during each session. You will be asked to rate the sensory properties (i.e. taste) of various foods at each meal and to record you hunger, thirst, fullness, and nausea during test days. You will complete a questionnaire after the meal on the forth test day.

If you were a participant in IRB#36405/LEAPS Trial, we will be using your questionnaire results from your time in the study to reduce the amount of paperwork you complete in this study. However, we will measure your weight at the 5th session.

Since each participant can have a great impact on the study, it is important that you carefully adhere to the guidelines of the study. If you feel that this is not possible, please do not join the study. If during any session you think that some factor may have influenced your behavior or responses, please notify the experimenter immediately. Since we have specific requirements for participants in this study, we reserve the right to reschedule or drop you from the study at any time. If that happens, you will be compensated for any time that you have already given to the study.
3. **Discomforts and risks:** There are no risks involved in eating lunch in the lab and filling out questionnaires. It may be possible that someone could have an allergic reaction to one of the food items or food item ingredients. Allergies will be screened prior to study participation.

4. **Benefits:** There are not direct benefits to you. However, you will be aiding in our understanding of human eating behavior and this can benefit society.

5. **Duration/Time Commitment:** Each test session will take approximately 30 minutes. The day before each test day it will take up to 15 minutes to record food intake and physical activity. The morning of each test day it will take no more than 5 minutes to record breakfast food intake.

6. **Statement of confidentiality:** Your participation in this research is confidential. All possible steps have been taken to assure your confidentiality. You will be identified by subject number and an assigned dot color. Any identifying information will be kept in a locked location and password protected electronic files. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. The following may review and copy records related to this research: The Office for Human Research Protections in the U.S. Department of Health and Human Services, The Pennsylvania State University’s Biomedical Institutional Review Board, and The Pennsylvania State University’s Office for Research Protections. In the event of any publication resulting from the research, no personally identifiable information will be disclosed.

7. **Right to ask questions:** Please contact Christine Sanchez at (814) 863-8482 with questions, complaints, or concerns about this research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, or problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. **Compensation:** You will be paid up to $90 broken out in the following amounts:
   - $10 for completion of each lunch in the lab for a total of $40;
   - $10 for completion of the questionnaire session; and
   - a $40 bonus for completing all study components.
   Payment will not be made until the completion of the study, unless you withdraw from the study. You will then be paid for any portion of the study completed.

9. **Voluntary participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would otherwise receive otherwise. Since we have specific requirements for participants in this study, we reserve the right to reschedule or drop you from the study at any time, particularly if you miss more than 2 sessions without rescheduling. If that happens, you will be compensated for any time that you have already given to the study.

10. **Injury Clause:** In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document,
you are not waiving any rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

You must be 20 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent form for your records.

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<th>Participant Signature</th>
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<th>Signature of Person Obtaining Consent</th>
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APPENDIX D

THREE-FACTOR EATING QUESTIONNAIRE (TFEQ/EI)

STUDIES 1-3

<table>
<thead>
<tr>
<th>Statement</th>
<th>T/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I smell a freshly baked pizza, I find it very difficult to keep from eating, even if I have just finished a meal.</td>
<td>T/F</td>
</tr>
<tr>
<td>2. I usually eat too much at social occasions, like parties and picnics.</td>
<td>T/F</td>
</tr>
<tr>
<td>3. I am usually so hungry that I eat more than three times a day.</td>
<td>T/F</td>
</tr>
<tr>
<td>4. When I have eaten my quota of calories or fat, I am usually good about not eating any more.</td>
<td>T/F</td>
</tr>
<tr>
<td>5. Dieting is so hard for me because I just get too hungry.</td>
<td>T/F</td>
</tr>
<tr>
<td>6. I deliberately take small helpings as a means of controlling my weight.</td>
<td>T/F</td>
</tr>
<tr>
<td>7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry.</td>
<td>T/F</td>
</tr>
<tr>
<td>8. Since I am often hungry, I sometimes wish that an expert would tell me that I have had enough to eat or that I can have some more.</td>
<td>T/F</td>
</tr>
<tr>
<td>9. When I feel anxious, I find myself eating.</td>
<td>T/F</td>
</tr>
<tr>
<td>10. Life is too short to worry about dieting.</td>
<td>T/F</td>
</tr>
<tr>
<td>11. Since my weight goes up and down, I have gone on reducing diets more than once.</td>
<td>T/F</td>
</tr>
<tr>
<td>12. I often feel so hungry that I just have to eat something.</td>
<td>T/F</td>
</tr>
<tr>
<td>13. When I am with someone who is overeating, I usually overeat too.</td>
<td>T/F</td>
</tr>
<tr>
<td>14. I have a pretty good idea of the number of calories or grams of fat in common foods.</td>
<td>T/F</td>
</tr>
<tr>
<td>15. Sometimes when I start eating, I just can’t seem to stop.</td>
<td>T/F</td>
</tr>
<tr>
<td>16. It is not difficult for me to leave something on my plate.</td>
<td>T/F</td>
</tr>
<tr>
<td>17. At certain times of the day, I get hungry because I have gotten used to eating then.</td>
<td>T/F</td>
</tr>
<tr>
<td>18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.</td>
<td>T/F</td>
</tr>
</tbody>
</table>

19. Being with someone who is eating often makes me hungry enough to eat also.   | T/F |
20. When I feel sad or blue, I often overeat.                                   | T/F |
21. I enjoy eating too much to spoil it by counting calories, counting grams of fat, or watching my weight. | T/F |
22. When I see a real delicacy, I often get so hungry that I have to eat it right away. | T/F |
23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. | T/F |
24. I get so hungry that my stomach often seems like a bottomless pit.          | T/F |
25. My weight has hardly changed at all in the last ten years.                  | T/F |
26. I am always hungry, so it is hard for me to stop eating before I finish the food on my plate. | T/F |
27. When I feel lonely, I console myself by eating.                             | T/F |
28. I consciously hold back at meals in order not to gain weight.               | T/F |
29. I sometimes get very hungry late in the evening or at night.               | T/F |
30. I eat anything I want, any time I want.                                    | T/F |
31. Without even thinking about it, I take a long time to eat.                 | T/F |
32. I count calories or grams of fat as a conscious means of controlling my weight. | T/F |
33. I do not eat some foods because they make me fat.                          | T/F |
34. I am always hungry enough to eat at any time.                               | T/F |
35. I pay a great deal of attention to changes in my figure.                   | T/F |
36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high-calorie foods. | T/F |

Please continue on page 2
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>37. How often are you dieting in a conscious effort to control your weight?</td>
<td>1 rarely, 2 sometimes, 3 usually, 4 always</td>
</tr>
<tr>
<td>36. Would a weight fluctuation of five pounds affect the way you live your life?</td>
<td>1 not at all, 2 slightly, 3 moderately, 4 very much</td>
</tr>
<tr>
<td>39. How often do you feel hungry?</td>
<td>1 only at meal times, 2 between meals, 3 almost, 4 always</td>
</tr>
<tr>
<td>40. Do your feelings of guilt about overeating help you to control your food intake?</td>
<td>1 never, 2 rarely, 3 often, 4 always</td>
</tr>
<tr>
<td>41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?</td>
<td>1 easy, 2 slightly difficult, 3 moderately difficult, 4 very difficult</td>
</tr>
<tr>
<td>42. How conscious are you of what you are eating?</td>
<td>1 not at all, 2 slightly, 3 moderately, 4 extremely</td>
</tr>
<tr>
<td>43. How frequently do you avoid buying a large amount of tempting foods?</td>
<td>1 almost never, 2 seldom, 3 usually, 4 almost always</td>
</tr>
<tr>
<td>44. How likely are you to shop for low-calorie or low-fat foods?</td>
<td>1 unlikely, 2 slightly likely, 3 moderately likely, 4 very likely</td>
</tr>
<tr>
<td>45. Do you eat sensibly in front of others and splurge alone?</td>
<td>1 never, 2 rarely, 3 often, 4 always</td>
</tr>
<tr>
<td>46. How likely are you to consciously eat slowly in order to cut down on how much you eat?</td>
<td>1 unlikely, 2 slightly likely, 3 moderately likely, 4 very likely</td>
</tr>
<tr>
<td>47. How frequently do you skip dessert because you are no longer hungry?</td>
<td>1 almost never, 2 seldom, 3 at least once a week, 4 almost every day</td>
</tr>
<tr>
<td>48. How likely are you to consciously eat less than you want?</td>
<td>1 unlikely, 2 slightly likely, 3 moderately likely, 4 very likely</td>
</tr>
<tr>
<td>50. To what extent does this statement describe your eating behavior?</td>
<td>1 not like me, 2 a little like me, 3 pretty good description of me, 4 describes me perfectly</td>
</tr>
<tr>
<td>51. On the following scale of 1 to 6, where 1 means no restraint in eating (eat whatever you want, whenever you want it) and 6 means total restraint (constantly limiting food intake and never “giving in”), what number would you give yourself?</td>
<td>1 Eat whatever you want, whenever you want it, 2 Usually eat whatever you want, whenever you want it, 3 Often eat whatever you want, whenever you want it, 4 Often limit food intake, but often “give in”, 5 Usually limit food intake, rarely “give in”, 6 Constantly limit food intake, never “give in”</td>
</tr>
</tbody>
</table>
APPENDIX E

EATING ATTITUDES TEST (EAT-26)

STUDIES 1 & 3

**Instructions:**
Please place an X in the column which applies best to each of the numbered statements. All of the results will be strictly confidential. Please answer each question carefully.

<table>
<thead>
<tr>
<th></th>
<th>ALWAYS</th>
<th>VERY OFTEN</th>
<th>OFTEN</th>
<th>SOMETIMES</th>
<th>RARELY</th>
<th>NEVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am terrified about being overweight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. I avoid eating when I am hungry.</td>
<td></td>
<td></td>
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<tr>
<td>3. I find myself preoccupied with food.</td>
<td></td>
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<tr>
<td>4. I have gone on eating binges where I feel that I may not be able to stop.</td>
<td></td>
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</tr>
<tr>
<td>5. I cut my food into small pieces.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6. I am aware of the caloric content of foods that I eat.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7. I particularly avoid foods with a high carbohydrate content (such as bread, potatoes, or rice).</td>
<td></td>
<td></td>
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<tr>
<td>8. I feel that others would prefer if I ate more.</td>
<td></td>
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<tr>
<td>9. I vomit after I have eaten.</td>
<td></td>
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<tr>
<td>10. I feel extremely guilty after eating.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11. I am preoccupied with a desire to be thinner.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12. I think about burning up calories when I exercise.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13. Other people think that I am too thin.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>14. I am preoccupied with the thought of having fat on my body.</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>15. I take longer than others to eat my meals.</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>16. I avoid foods with sugar in them.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>17. I eat diet foods.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>18. I feel that food controls my life.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>19. I display self-control around food.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>20. I feel that others pressure me to eat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. I give too much time and thought to food.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. I feel uncomfortable after eating sweets.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>23. I engage in dieting behavior.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. I like my stomach to be empty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. I enjoy trying rich new foods.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. I have the impulse to vomit after meals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX F

DEMOGRAPHICS AND HEALTH QUESTIONNAIRE

STUDY 1
Subject Profile

Name ________________________________ Date ____________________

Address

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Phone (w) ________________________________ (h): __________________________
Age: __________________________ Date of Birth: __________________________

Height: ________________ Weight: ________________

Do you smoke: ☐ Yes ☐ No If yes, how many cigarettes per day? __________

Ethnicity (please check only one):
☐ HISPANIC OR LATINO
☐ NOT HISPANIC OR LATINO

Race (please check only one):
☐ AMERICAN INDIAN/ALASKAN NATIVE ☐ WHITE
☐ ASIAN ☐ HAWAIIAN/PACIFIC ISLANDER
☐ BLACK OR AFRICAN AMERICAN

What time do you usually eat the following meals?

Breakfast: ________________ Dinner: ________________
Lunch: ________________ Snack(s): ________________

Are there foods you don’t eat because they are not good for you or disagree with you?

☐ Yes ☐ No
If yes, what foods? __________________________________________________

Are there any foods you don’t eat because of medication you are on? ☐ Yes ☐ No
If yes, what foods? __________________________________________________

Are there any foods you make it a point to eat because you feel they are good for your health?

☐ Yes ☐ No
If yes, what foods? __________________________________________________

Are you currently on any kind of special diet? ☐ Yes ☐ No
If yes, what kind (low-salt, low-fat, etc.)? __________________________________

Have you ever had an eating disorder? ☐ Yes ☐ No
If yes, please explain: _________________________________________________

Do you have, or have you had any of the following?
☐ High blood pressure ☐ Diabetes
☐ Heart trouble ☐ Other stomach/intestinal disorder
☐ Thyroid or other glandular disorders ☐ Kidney disease
☐ Liver disease ☐ Cancer
☐ Depression ☐ Other, please specify __________________________
Are you presently taking medication (over the counter and/or prescription)? □ Yes □ No

If yes, please specify: ________________________________

What is your current weight?__________________________

What is your highest past adult weight (*excluding pregnancy*)?______________________

  When did this occur?__________________________

What is your lowest past adult weight?______________

  When did this occur?__________________________

Have you *gained* weight in the last 6 months? □ Yes □ No

  If yes, please explain how much:__________________________

Have you *lost* weight in the last 6 months? □ Yes □ No

  If yes, please explain how much:__________________________
APPENDIX G

BREAKFAST DIARY

STUDIES 1 & 2
This is a list of suggested breakfast foods; you can mix and match from each column:

<table>
<thead>
<tr>
<th>Bagel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
</tr>
<tr>
<td>English muffin</td>
</tr>
<tr>
<td>Toast</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cream cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jelly</td>
</tr>
<tr>
<td>Butter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juice</td>
</tr>
<tr>
<td>Coffee</td>
</tr>
<tr>
<td>Hot tea</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt</td>
</tr>
<tr>
<td>Cottage cheese</td>
</tr>
</tbody>
</table>

ID_____________

Date__________ M T W R

Please record all foods and beverages that are consumed for breakfast on the day of your session. In completing this worksheet, please try to be as accurate as possible and include as much detail as you can (e.g. the brand names of foods, amounts, meal times, & beverages). Do not forget to include condiments such as butter, cream cheese, and jelly. If you run out of space, please use the back of this form. Also, please leave excess spaces blank.

**Breakfast** — Foods and beverages (including brand names)

Time: ___________ Place: ______________

Foods:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Beverages:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
APPENDIX H

FOOD AND ACTIVITY DIARY

STUDY 1
Food and Activity Diary

ID_____________

Date_____________ S M T W

Please record all foods and beverages that are consumed the day before your session begins. Please remember to not eat anything after 10:00pm and do not eat in a restaurant the night before your session begins. In completing this worksheet, please try to be as accurate as possible and include as much detail as you can (e.g. the brand names of foods, amounts, meal or snack times, beverages). Do not forget to include condiments such as butter, ketchup, mustard, and jelly. If you run out of spaces, please use the back of this form. Also, please leave excess spaces blank. For example, if you have not eaten an appetizer at dinner, please leave that space blank.

If you have any questions about completing this food diary, please call the Food Lab at 863-8482. Thank you for your cooperation.

Breakfast – Foods and beverages (including brand names)

Time:___________ Place:______________

Foods:____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Beverages: __________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Lunch - Foods and beverages (including brand names):

Time: _________________ Place: ____________________
Main Dish: __________________________________________________________

____________________________________________________________________

Side Dishes (ex. Vegetables, salads, etc.): ________________________________

____________________________________________________________________

Desserts/sweets: ______________________________________________________

Beverages: __________________________________________________________

____________________________________________________________________

**Dinner** - Foods and beverages (including brand names):

Time: _________________   Place: ________________________________

Main Dish: __________________________________________________________

____________________________________________________________________

Side Dishes (ex. Vegetables, salads, etc.): ________________________________

____________________________________________________________________

Bread/rolls: _________________________________________________________

Desserts/sweets: _____________________________________________________

Beverages: _________________________________________________________

____________________________________________________________________

**Snacks (all day)** -

Snack/Time Consumed: ______________________________________________

Snack/Time Consumed: ______________________________________________

Snack/Time Consumed: ______________________________________________
Physical Activity

Please record all physical activity for the day before your test session. Please remember to keep it as consistent as possible each week. Thank you.

Before breakfast:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Between breakfast and lunch:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

Between lunch and dinner:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

After dinner:
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
APPENDIX I

LUNCH MEAL REPORT

STUDY 1
Lunch Report

Subject ID:_________ Date:__________ Week:_________

1. Have you felt well since breakfast?
   _______Yes _______No
   If No, please explain:__________________________________________

2. Have you taken any medication since breakfast?
   _______Yes _______No
   If Yes, please list:__________________________________________

3. Have you consumed any foods or beverages since breakfast, other than water?
   _____Yes _____No
   If Yes, please indicate what food(s) and approximate amount(s) and when you ate it:
   ....................................................................................................
   ....................................................................................................

4. Did you get a good night’s sleep last night?
   _______Yes _______No
   If No, please explain:____________________________________________

5. Have you maintained your usual level of physical activity during the last 24 hours?
   _______Yes _______No
   If No, please explain:____________________________________________

6. Have you consumed alcohol in the past 24 hours?
   _______Yes _______No
   If Yes, what type, how much and when did you consume it:
   ....................................................................................................
   ....................................................................................................
APPENDIX J

PRE-MEAL HUNGER AND FULLNESS RATINGS

STUDY 1
How hungry do you feel right now?

Not at all ________________________________ Extremely hungry

How thirsty do you feel right now?

Not at all ________________________________ Extremely thirsty

How much food do you think you could eat right now?

Nothing ________________________________ A large amount

at all

How nauseated do you feel right now?

Not at all ________________________________ Extremely nauseated

How full do you feel right now?

Not at all ________________________________ Extremely full

full
APPENDIX K

POST-MEAL RATINGS

STUDY 1
How hungry do you feel right now?

Not at all _______________________________ Extremely hungry

How thirsty do you feel right now?

Not at all _______________________________ Extremely thirsty

How much food do you think you could eat right now?

Nothing ________________________________ A large amount

at all

How nauseated do you feel right now?

Not at all _______________________________ Extremely nauseated

How full do you feel right now?

Not at all _______________________________ Extremely full

full

How pleasant was the overall taste of the meal you ate today?

Not at all _______________________________ Extremely pleasant

t

How healthy was the meal you ate today?

Not at all _______________________________ Extremely healthy

healthy

How many calories do you think you ate at this meal?

__________________
APPENDIX L

RATINGS AND RANKINGS OF INDIVIDUAL FOODS (WEEK 5)

STUDY 1
How pleasant is the taste of this food right now?

Not at all                                         Extremely pleasant
pleasant                                         pleasant

How filling do you think this food will be?

Not at all                                         Extremely filling
Filling                                         filling

How does the size of this serving compare to your usual portion?

A lot                                         A lot
smaller                                         larger

How much fat do you think this food has?

No fat                                         Extremely high
at all                                         in fat

How healthy do you think this food is?

Not at all                                         Extremely healthy
healthy                                         healthy

How many calories do you think are in this serving of food? (please write a number)

________________________
Of the foods served to you at the lunch time meals, please rank the TASTE of the foods with 1 being the one that you think tastes best, 2 being the 2nd best tasting, etc, ending with 7 being the least best tasting of the foods.

- Pasta with red sauce
- Breaded Chicken
- Tossed salad with Italian dressing
- Garlic Bread
- Broccoli
- Red Grapes
- Chocolate Chip Cookies
APPENDIX M

INTAKE SHEETS (CONDITIONS 1-4)

STUDY 1
**Intake Sheets: LEAPS – PSS Study**

**Condition 1: 100% (Std.)**

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked Spiral Pasta (98g) (160g total for pasta w/ sauce)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft Parm Cheese (3g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prego (61g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken Tenders (80g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli (80g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/ bowl)</td>
</tr>
<tr>
<td>Garlic Bread (48g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/ plate)</td>
</tr>
<tr>
<td>Red Grapes (80g)</td>
<td>(w/o bowl)</td>
<td></td>
<td>(w/ bowl)</td>
</tr>
<tr>
<td>Salad (120g)</td>
<td>(w/o bowl)</td>
<td></td>
<td>(w/ bowl)</td>
</tr>
<tr>
<td>Romaine Lettuce (37g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced Tomato (29g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chopped Carrot (7g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced, peeled cucumber (26.7g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ken’s Northern Ital (21.6g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choc. Chap Cookies (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water (1L)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time Meal: __________

Disk 1: __________

Disk 2: __________
### Intake Sheets: LEAPS – PSS Study

**Condition 2: 125%**

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked Spiral Pasta (119g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft Parmesan Cheese (3.7g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prego (76g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken Tenders (100g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli (100g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/o bowl)</td>
</tr>
<tr>
<td>Garlic Bread (60g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/o plate)</td>
</tr>
<tr>
<td>Red Grapes (100g)</td>
<td>(w/o bowl)</td>
<td></td>
<td>(w/o bowl)</td>
</tr>
<tr>
<td>Salad (150g)</td>
<td>(w/o bowl)</td>
<td></td>
<td>(w/o bowl)</td>
</tr>
<tr>
<td>Romaine Lettuce (46g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced Tomato (36g)</td>
<td></td>
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</tr>
<tr>
<td>Chopped Carrot (9g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced, peeled cucumber (32.5g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ken’s Northern Ital (26.5g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choc. Chip Cookies (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water (1L)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Time Meal: **

**Disk 1:**

**Disk 2:**
## Intake Sheets: LEAPS – PSS Study

### Condition 3: 150%

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked Spiral Pasta (147.4g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(240g total for pasta w/ sauce)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft Parm Cheese (4.4g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prego (91g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken Tenders (120g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli (120g)</td>
<td>(w/o plate)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Garlic Bread (72g)</td>
<td>(w/o plate)</td>
<td>(w/ plate)</td>
<td></td>
</tr>
<tr>
<td>Red Grapes (120g)</td>
<td>(w/o bowl)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Salad (180g)</td>
<td>(w/o bowl)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Romaine Lettuce (55.5g)</td>
<td></td>
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<tr>
<td>Diced Tomato (43.2g)</td>
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<td>Chopped Carrot (10.5g)</td>
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</tr>
<tr>
<td>Diced, peeled cucumber (40.1g)</td>
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</tr>
<tr>
<td>Ken’s Northern Ital (32.2g)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Choc. Chip Cookies (6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water (1L)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Time Meal:** ____________

**Disk 1:** ____________  
**Disk 2:** ____________

**Check 1:** ____________  
**Subject ID:** ____________

**Check 2:** ____________  
**Date:** ____________  
**Week:** ____________
<table>
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<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
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<tr>
<td>Cooked Spiral Pasta (172g)</td>
<td>(w/o plate)</td>
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<tr>
<td>(280g total for pasta w/ sauce)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft Parmesan Cheese (5.4g)</td>
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<tr>
<td>Prego (105.2g)</td>
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</tr>
<tr>
<td>Chicken Tenders (140g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli (140g)</td>
<td>(w/o plate)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Garlic Bread (84g)</td>
<td>(w/o plate)</td>
<td>(w/ plate)</td>
<td></td>
</tr>
<tr>
<td>Red Grapes (140g)</td>
<td>(w/o bowl)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Salad (210g)</td>
<td>(w/o bowl)</td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Romaine Lettuce (64.7g)</td>
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<tr>
<td>Diced Tomato (50.3g)</td>
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<td>Chopped Carrot (12.2g)</td>
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<tr>
<td>Diced, peeled cucumber (46.7g)</td>
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<tr>
<td>Ken’s Northern Ital (38g)</td>
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<tr>
<td>Choc. Chip Cookies (7)</td>
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<td></td>
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<tr>
<td>Water (1L)</td>
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</tbody>
</table>

Time Meal: ________________

Disk 1: ________________    Disk 2: ________________
APPENDIX N

PHONE SCREENING FORM

STUDY 2
Cost and Portion Size Pre-screening Phone Questionnaire

Date: __________
Age: __________ Date of Birth: __________
Height: __________ Weight: __________
Do you smoke? No Yes
Are you currently taking any prescription or “over the counter” medications regularly? No Yes
If yes, what? ______________________________________________________
Are you diagnosed, or have you ever been diagnosed with any of the following?
□ Depression □ Eating Disorder
□ Stomach/intestinal disorder □ Diabetes
□ Cancer
Are you currently dieting to gain or lose weight? No Yes
Are you an athlete in training? No Yes
Do you have any food allergies or intolerances? No Yes
Do you have any sugar/sweetener or sodium restrictions? No Yes
Do you have any food restrictions related to religious practices? No Yes
If Yes, what?: _______________________________ ___________________
Are you a vegetarian? No Yes
Are you vegan? No Yes
Are you lactose intolerant? No Yes
If no, are there any foods that you exclude from your diet? ________________
Do you like and are willing to eat:
Baked Ziti with Cheese
Salad
Bread Roll
Do you regularly eat 3 meals per day? No Yes
If no, what is your usual daily pattern of meals?
________________________________________________________________
Would you be willing to refrain from eating after 10:00 pm the evening before the test session? 
No  Yes

Would you be willing to refrain from drinking caffeinated beverages for 24 hours prior to the test session?  No  Yes

Would you be willing to refrain from drinking alcoholic beverages the day before the test session?  No  Yes

Are you pregnant or breast feeding?  No  Yes

Where did you hear about the study? ____________________________

Have you participated in any other studies in our lab?  No  Yes
If yes, what study and when? ____________________________

Are you a:

_____ Undergraduate  semester standing: ________  major: ____________

_____ Graduate  major: ____________

_____ Penn State Staff

_____ State College Resident

If criteria are satisfied, take their name and ask them to come to the lab to fill out doodle pool to determine dates of availability

[If participants meet inclusion criteria, interviewer will schedule all five meals at this time. If participant does not meet inclusion criteria, conversation ends at this point.]

Name: __________________ Phone: __________________

Appointment: ______________________________________

Are you willing to receive email reminders the day before you are scheduled to participate (Your identity will be kept confidential and you will only be contacted with information regarding your participation in the study)?  Yes  No

If Yes, what is your email address?: __________________________

APPENDIX O

INFORMED CONSENT

STUDY 2
CONSENT FOR RESEARCH
The Pennsylvania State University

Title of Project: Adult Lunch Restaurant Study
Principal Investigator: Barbara J. Rolls, PhD
Address: 226 Henderson Building, University Park, PA 16802
Telephone Number: 814-863-8481

Subject’s Printed Name: _____________________________

We are asking you to be in a research study. This form gives you information about the research. Whether or not you take part is up to you. You can choose not to take part. You can agree to take part and later change your mind. Your decision will not be held against you.

Please ask questions about anything that is unclear to you and take your time to make your choice.

1. Why is this research study being done?
We are asking you to be in this research because you are a resident of State College, or a nearby municipality, who has likely been exposed to the commercial food environment in this area and enjoys the dish we are serving.

This study is being done because we are developing a pasta recipe and are testing the tastiness of the recipe and its price on customer satisfaction. Approximately 75 people will take part in this research study from the State College area.

2. What will happen in this research study?
This study will last for 5 weeks. You will be asked to come to the lab to eat lunch on one day per week for 4 weeks and to rate the characteristics of the meal. During the fifth week of the study, you will come to the lab to complete a series of questionnaires and height and weight will be measured. At all meals, you may eat as much or as little of the foods as you would like, and you are free to leave any questions unanswered that you are not comfortable answering. All foods can be prepared through commercially available products, and the entree recipe is developed from a dish formerly available at a campus dining venue.

Procedures leading up to test days:

▪ We ask that you consume breakfast at home and try to keep the time you eat and the foods you eat as consistent as possible each week.
▪ You will record your food intake for breakfast and bring it with you to your lunch session.
▪ We also ask that you not consume any foods or beverages, other than water, between breakfast and lunch.
  ▪ If you consume water, we ask that you do not drink one hour before a test meal
▪ You will be asked to complete a Food and Activity Diary the day before each test session.
Please keep the amount of food eaten at dinner the night before each test session as consistent as possible each week and refrain from eating or drinking (other than water) after 10:00 pm on the evening before your test session until you eat breakfast on the day of your test session.

- You will be asked to refrain from drinking alcohol and to maintain your usual activity level the day before your test day.
  - A questionnaire at lunch will ask if you have consumed any alcohol. If you are underage and admit to alcohol use, that information will remain confidential.

Test day procedures:

- You will be told the cost of your meal, and then complete a questionnaire about your general well-being during each session.
- You will also be asked to record your hunger, thirst, fullness, and nausea during test days.
- You will be asked to provide ratings on the appearance, value and sensory properties (i.e. taste) of the meal.
- You will eat the meal.
- At week 5: You will complete an online questionnaire (on the final test day) and height and weight will be measured.

Since each participant can have a great impact on the study, it is important that you carefully adhere to the guidelines of the study. If you feel that this is not possible, please do not join the study. If during any session you think that some factor may have influenced your behavior or responses, please notify the experimenter immediately. Since we have specific requirements for participants in this study, we reserve the right to reschedule or drop you from the study at any time. If that happens, you will be compensated for any time that you have already given to the study.

3. **What are the risks and possible discomforts from being in this research study?**

   There are no risks involved in eating lunch in the lab and filling out questionnaires. It may be possible that someone could overeat and feel discomfort from overeating or have an allergic reaction due to one of the food items or food item ingredients. Allergies will be screened for prior to study participation.

   There is a risk of loss of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening. The confidentiality of your electronic data created by you or by the researchers will be maintained to the degree permitted by the technology used. Absolute confidentiality cannot be guaranteed.

4. **What are the possible benefits from being in this research study?**

   There are no direct benefits to the participant. However, you will be aiding in our understanding of consumer behavior, allowing us a better understanding of how well liked a version of a popular campus dish is.

5. **What other options are available instead of being in this research study?**

   You may decide not to participate in this research. Unfortunately, there is no alternate means of participation in this study without being physically present for each of the five test days.

6. **How long will you take part in this research study?**

   If you agree to take part, it will take you about 30 minutes to complete each of the sessions. You will be asked to come to the research site a total of 5 times. The day before each test day it will take up to 15 minutes to record food intake and physical activity. The morning of each test day it will take no more
than 5 minutes to record breakfast food intake. In total, you participation in this study should take around 250 minutes (just over 4 hours).

7. **How will your privacy and confidentiality be protected if you decide to take part in this research study?**

Efforts will be made to limit the use and sharing of your personal research information to people who have a need to review this information.

Your participation in this research is confidential. All possible steps have been taken to assure your confidentiality.

- Each subject will be assigned a random three-digit number using a computer tool for random selection. Each number will have a corresponding colored sticker (randomly selected). Your first name and phone number will be associated with your three-digit number and dot color only for the purpose of communicating with you should you need to cancel or reschedule an appointment. This list (including first name, phone number and three-digit ID) will be kept in the kitchen, which is locked at any time staff are not in it. Only kitchen staff are allowed in the kitchen.
- Any identifying information beyond what is in the kitchen, e.g. your first name and three-digit number, will be kept in a locked filing cabinet in the lab and password protected electronic files only on lab computers.
- Your confidentiality will be kept to the degree permitted by the technology used.

In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

We will do our best to keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people may find out about your participation in this research study. For example, the following people/groups may check and copy records about this research.

- The Office for Human Research Protections in the U. S. Department of Health and Human Services
- The Institutional Review Board (a committee that reviews and approves research studies) and
- The Office for Research Protections.

Some of these records could contain information that personally identifies you. Reasonable efforts will be made to keep the personal information in your research record private. However, absolute confidentiality cannot be guaranteed.

8. **What happens if you are injured as a result of taking part in this research study?**

In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document, you are not waiving any rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

9. **Will you be paid or receive credit to take part in this research study?**

You will be paid up to $50 for your participation (averaging to $10/week)
Payment will be received at each respective test session with exception of the $10 for completing all questionnaires, which will be provided at the conclusion of the final test day. If you withdraw from the study, you will have already received payment for any portion of the study completed.

10. Who is paying for this research study?
   ▪ Funding disclosure: This research was funded by gift money from Jenny Craig®
   ▪ Conflict of Interest: Jenny Craig® licenses the Volumetrics book series authored by Dr. Barbara Rolls

11. What are your rights if you take part in this research study?
   Taking part in this research study is voluntary.
   ▪ You do not have to be in this research.
   ▪ If you choose to be in this research, you have the right to stop at any time.
   ▪ If you decide not to be in this research or if you decide to stop at a later date, there will be no penalty or loss of benefits to which you are entitled.

   However, if you decide to leave the research voluntarily, you forfeit your opportunity to compensation beyond the amount equivalent to the number of test days that you attended. If you decide to leave the research, contact the investigator so that the investigator can arrange for your termination of your meetings.

   If protocol is not followed, we will reschedule your appointment for a later time. Persistent inability to adhere to protocol or blatant intentional lack of compliance can result in removal from the study.

   The person in charge of the research study or the sponsor can remove you from the research study without your approval. Possible reasons for removal include ignoring protocol (i.e. eating within 4 hours of the scheduled test meal, consuming alcohol in excess on the day prior to the scheduled test meal) or development of a disease or disorder that might affect normal intake. Moreover, we reserve the right to drop you from the study at any time, particularly if you miss more than 2 sessions without rescheduling. If you are dropped for any reason, you will be compensated for any time that you have already given to the study.

   During the course of the research you will be provided with any new information that may affect your health, welfare or your decision to continue participating in this research.

12. If you have questions or concerns about this research study, whom should you call?
   Please call the study coordinator, Christine Sanchez at 814-863-8482 if you:
   ▪ Have questions, complaints or concerns about the research.
   ▪ Believe you may have been harmed by being in the research study.

   You may also contact the Office for Research Protections at (814) 865-1775, ORProtections@psu.edu if you:
   ▪ Have questions regarding your rights as a person in a research study.
   ▪ Have concerns or general questions about the research.
   ▪ You may also call this number if you cannot reach the research team or wish to offer input or to talk to someone else about any concerns related to the research.

   You must be 20 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date on the following page.
INFORMED CONSENT TO TAKE PART IN RESEARCH

Signature of Person Obtaining Informed Consent

Your signature below means that you have explained the research to the subject or subject representative and have answered any questions he/she has about the research.

______________________________
Signature of person who explained this research

_________
Date

________________
Printed Name

(Only approved investigators for this research may explain the research and obtain informed consent.)

Signature of Person Giving Informed Consent

Before making the decision about being in this research you should have:
- Discussed this research study with an investigator,
- Read the information in this form, and
- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.

Signature of Subject

By signing this consent form, you indicate that you voluntarily choose to be in this research and agree to allow your information to be used and shared as described above.

______________________________
Signature of Subject

_________
Date

________________
Printed Name

Demographic information:

Age: __________
Date of Birth: __________
Height: __________
Weight: __________

Ethnicity (check only one):
☐ HISPANIC OR LATINO
☐ NOT HISPANIC OR LATINO

Race (check only one):
☐ AMERICAN INDIAN/ALASKAN NATIVE
☐ WHITE
☐ ASIAN
☐ HAWAIIAN/PACIFIC ISLANDER
☐ BLACK OR AFRICAN AMERICAN
APPENDIX P

SCRIPT FOR STUDY PURPOSE

STUDY 2
**Script Week 1:**

“Thank you for your interest in this study. As you read in the informed consent document, we are developing a pasta recipe and are testing the tastiness of the recipe and its price on customer satisfaction. You will be asked to return for four additional sessions on top of the session today, and will receive a cash payment at the beginning of each session in exchange for your time. A portion of this cash payment will be used to pay for your meal each week, and this price will vary from week to week. Whatever remains of your cash payment after paying for your food is yours to keep….

*Hand subject $20 to subject broken into 3-$5 bills and 5-$1 bills*

“Your meal is a baked pasta dish—priced at $ ___. I will take the payment when your meal is served. If you have any questions, feel free to ask—otherwise, follow me to the lab session.”

**Script Weeks 2-4:**

“Here is your $20, remember that you will be asked to pay for your meal when it is served, and that cost will vary from week to week.

*Hand subject $20 to subject broken into 3-$5 bills and 5-$1 bills*

This week your meal will cost $ ___”
APPENDIX Q

PRE-MEAL HUNGER AND FULLNESS RATINGS

STUDY 2
How hungry do you feel right now?

Not at all hungry  ___________________________  Extremely hungry

How thirsty do you feel right now?

Not at all thirsty  ___________________________  Extremely thirsty

How much food do you think you could eat right now?

Nothing at all  ___________________________  A large amount

How nauseated do you feel right now?

Not at all nauseated  ___________________________  Extremely nauseated

How full do you feel right now?

Not at all full  ___________________________  Extremely full
APPENDIX R

PRE-MEAL TASTE AND APPEARANCE RATINGS

STUDY 2
Pre-meal ratings – subjects will take a bite of each food when meal is delivered

How pleasant is the appearance of the pasta?

Not at all pleasant _______________________________ Extremely pleasant

How pleasant is the taste of the pasta?

Not at all pleasant _______________________________ Extremely pleasant

How pleasant is the appearance of the salad?

Not at all pleasant _______________________________ Extremely pleasant

How pleasant is the taste of the salad?

Not at all pleasant _______________________________ Extremely pleasant

How pleasant is the appearance of the bread?

Not at all pleasant _______________________________ Extremely pleasant

How pleasant is the taste of the bread?

Not at all pleasant _______________________________ Extremely pleasant
APPENDIX S

POST-MEAL RATINGS

STUDY 2
How hungry do you feel right now?

Not at all hungry  ___________________________  Extremely hungry

How thirsty do you feel right now?

Not at all thirsty  ___________________________  Extremely thirsty

How much food do you think you could eat right now?

Nothing at all ___________________________  A large amount

How full do you feel right now?

Not at all full  ___________________________  Extremely full

How satisfied were you with this meal overall?

Not at all satisfied  ___________________________  Very satisfied

If this meal were offered at an on-campus dining location, what is the likelihood that you would purchase it?

Very unlikely  ___________________________  Very likely
How satisfied are you with the cost of this meal?

Not at all satisfied  ________________________________  Very satisfied

How you perceive today’s meal as giving you value for your money?

Poor value  ________________________________  Good value

How do you perceive the appropriateness of the amount of food provided by the pasta?

Not enough food  ________________________________  Too much food
APPENDIX T

INTAKE SHEETS (CONDITIONS 1-4)

STUDY 2
### Intake Sheets: Cost and PS Study

**Condition 1: 100% PS/Low cost ($8)**

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked Pasta w/ Sauce (400g)</td>
<td>w/ dish</td>
<td>w/ dish</td>
<td></td>
</tr>
<tr>
<td>Bread Roll (1 roll)</td>
<td>w/o plate</td>
<td>w plate</td>
<td></td>
</tr>
<tr>
<td>Salad (120g)</td>
<td>w/o bowl</td>
<td>w bowl</td>
<td></td>
</tr>
<tr>
<td>Romaine lettuce (37g)</td>
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<tr>
<td>Diced tomato (29g)</td>
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<tr>
<td>Chopped carrot (7g)</td>
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<tr>
<td>Diced, peeled cucumber (26.7g)</td>
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<tr>
<td>Newman's classic Italian (21.6g)</td>
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<tr>
<td>Water (1L)</td>
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</tbody>
</table>

**Time Meal:** ____________

**Money returned:** ____________

**Disk 1:** ____________

**Disk 2:** ____________

Subject ID: ____________
Condition: ____________
Date: ____________
Week: ____________
### Intake Sheets: Cost and PS Study

**Condition 2: 150% PS/Low cost ($8)**

Check 1: __________ Subject ID: __________

Check 2: __________ Condition: __________

Date: ________________ Week: __________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cooked Pasta w/ Sauce (600g)</td>
<td>(w/o dish)</td>
<td>(w/dish)</td>
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</tr>
<tr>
<td>Salad (120g)</td>
<td>(w/o bowl)</td>
<td>(w/o bowl)</td>
<td></td>
</tr>
<tr>
<td>Romaine lettuce (37g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced tomato (29g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chopped carrot (7g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diced, peeled cucumber (26.7g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newman’s classic Italian (21.6g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water (1L)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time Meal: ___________
Money returned: ________

Disk 1: ________________ Disk 2: ________________
APPENDIX U

LINK TO FULL WEEK 5 SURVEY

STUDY 2
The full survey administered to subjects can be found by typing this link into your browser:

http://smeal.qualtrics.com/jfe/form/SV_54G05jICQioYreB

When you have arrived at the login screen, enter the id:

1234
APPENDIX V

SELECTED QUESTIONNAIRES FROM SURVEY:
EATING BEHAVIOR QUESTIONNAIRE
STUDIES 2 & 3

**Eating Behavior Questionnaire**: This questionnaire was developed from the Child Eating Behaviour Questionnaire (CEBQ; Wardle et al, 2001). All of the questions from three subscales of the CEBQ (satiety responsiveness, slowness of eating, and food responsiveness) were modified for self-assessment in adults. These questions were presented in a randomized order. Scores for individuals were calculated by averaging the values of the responses (Never =1 to Always = 5; for reverse scored items Never = 5 to Always =1) within a subscale.

**Instructions**: Please read the following statements and select the option that best describes your eating behavior.

<table>
<thead>
<tr>
<th>Satiety responsiveness subscale</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I fill up easily</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have a big appetite*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I leave food on my plate at the end of a meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get full before my meal is finished</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I cannot eat a meal if I have had a snack just before</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slowness of eating subscale</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I eat slowly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I take more than 30 minutes to finish a meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I finish my meal very quickly*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I eat more and more slowly during the course of a meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Food responsiveness subscale</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am always looking to consume food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If given the chance, I would always have food in my mouth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Given the choice, I would eat most of the time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I allow myself, I would eat too much</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Even if I am full, I find room for my favorite food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Reverse scored
APPENDIX W

SELECTED QUESTIONNAIRES FROM SURVEY:

PRICE CONSCIOUSNESS SCALE

STUDIES 2 & 3

**Instructions:** Please select the response that best applies to you.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am not willing to go to extra effort to find lower prices*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I will stop at more than one restaurant to take advantage of low prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The money saved by finding low prices is usually not worth the time and effort*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would never shop at more than one store to find low prices*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The time it takes to find low prices is usually not worth the effort*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Reverse scored
APPENDIX X

SELECTED QUESTIONNAIRES FROM SURVEY:

PRODUCT RETENTION TENDENCY

STUDY 2

**Instructions:** Please select the response that best applies to you.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting rid of stuff is difficult for me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I tend to hold onto my possessions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unless I have a really good reason to throw something away, I keep it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not like to dispose of possessions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX Y

SELECTED QUESTIONNAIRES FROM SURVEY:

FRUGALITY SCALE

STUDIES 2 & 3

**Instructions:** Please select the response that best applies to you.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you take good care of your possessions, you will definitely save money in the long run</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are many things that are normally thrown away that are still quite useful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Making better use of my resources makes me feel good</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If you can re-use an item you already have, there's no sense in buying something new</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I believe in being careful in how I spend my money</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I discipline myself to get the most from my money</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am willing to wait on a purchase I want so that I can save money</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are things I resist buying today so I can save for tomorrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX Z

SELECTED QUESTIONNAIRES FROM SURVEY:

DEMOGRAPHICS & DISCHARGE QUESTIONNAIRE

STUDY 2
Demographic/Background Information

What is your date of birth? ________________________________

Who in your household has the primary role in food preparation? ________________________________

What is your marital status:
___Married ___Single ___Widowed ___Divorced
___Separated ___Remarried ___Living together (not married)

What is your total or combined family income, before taxes?
___Less than $20,000 ___$21,000 - $35,000 ___$36,000 - $50,000 ___$51,000-$75,000 ___$76,000-$100,000 ___$100,000+

What is your highest level of formal education:
___High school (12 yrs) ___Associates (14 yrs) ___Technical/Vocational School (14 yrs) ___Bachelors (16 yrs) ___Masters (18 yrs) ___PhD (20 yrs) ___MD (20 yrs) ___JD (20 yrs) ___Other, describe____________

Are you currently employed?
___No ___Retired ___Yes
___Hrs per week at work (not traveling to & from)
How often do you eat food prepared outside of the home (restaurants, to-go, delivery, etc)?

□ ≤ once per year
□ Once or twice a year
□ Every two to three months
□ Once a month
□ 2-3 times per month
□ 1-3 times per week
□ ≥ once day

What is your ethnicity (please check only one)?
Hispanic or Latino □
Not Hispanic or Latino □

What is your race (please check only one)?
American Indian/Alaskan Native □
Asian □
Black or African American □
White □
Hawaiian/Pacific Islander □

1. What do you think the purpose of this study was?

2. Did you find any aspect of the experiment to be particularly odd? Yes □ No □
If yes, please explain:
3. Did the price assigned to the meal lead you to feel as though you were investing something into the meal? Please indicate the price of the meal each week. If you do not recall, simply write, “Do not recall.”

4. How much did the cost assigned to the meal influence your intake? Were there any additional factors that affected how much food you ate? Yes  No
   If yes, please explain:

5. Did you notice any differences between any of the sessions?

6. Do you have any specific comments about this study?
APPENDIX AA

DEBRIEFING FORM

STUDY 2
DEBRIEFING FORM

IRB Protocol No.: _____________________

Principal Investigator: Barbara J. Rolls

Laboratory for the Study of Ingestive Behavior
226 Henderson Building
814-863-8482

You are being given this form because deception was used in this study.

In this context, deception can be defined as the giving false information or withholding of information regarding the reason for conducting the research study. In the current study, you were told that the purpose of the study was to get input on the taste and cost of a dish that we were developing. While this information is true, those are only secondary outcomes. The true interest of this study was to determine how changes in cost would influence intake in regards to changes in portion size (weight of food served).

The deception used in this study was seen as necessary because we wanted subjects to behave as they normally would in an eating situation. We wanted the manipulations to seem as naturalistic as possible, so that the results of our study could be more generalizable. We felt that if subjects knew the specific aims of our study, it may lead them to change their eating behaviors based on their knowledge of our outcomes of interest. If this were to occur, it brings into question the validity and reliability of our results.

Again, the true purpose of this study is to examine how intake is influenced by changes to food characteristics including portion size and cost. Secondary outcomes of interest are personality traits that may influence the aforementioned relationships and if perceptions (i.e. of taste) are influenced by changes to perceived price of the meal.

If you feel a need to speak to a professional concerning any uncomfortable feelings from your participation in this research, you may contact Christine Sanchez at 814-863-8482 any time you have questions about the research. She will be able to put you in touch Counseling and Psychological Services (CAPS) with whom an appointment can be scheduled at your convenience.

Please sign this form to allow for documentation that we have debriefed you on the true purpose of this study.

_________________________  ______________  _______________________
Signature             Date             Printed name
APPENDIX BB

PHONE SCREENING QUESTIONNAIRE

STUDY 3
Date:

Age: __________ Date of Birth: __________

Height: __________ Weight: __________ BMI: ________

Gender: ___: M
___: F
___: Not specified/other

Do you smoke?     No        Yes

Are you currently taking any prescription or “over the counter” medications regularly?   No  Yes

If yes, what? ________________________________________________

Are you diagnosed, or have you ever been diagnosed with any of the following?

□ Depression       □ Eating Disorder
□ Stomach/intestinal disorder □ Diabetes
□ Cancer

Are you currently dieting to gain or lose weight?     No      Yes

Are you an athlete in training?     No      Yes

Do you have any food allergies or intolerances?     No      Yes

Do you have any sugar/sweetener or sodium restrictions?   No      Yes

Do you have any food restrictions related to religious practices?   No      Yes

If Yes, what?: ________________________________________________

Are you a vegetarian?     No      Yes

Are you vegan?     No      Yes

Are you lactose intolerant?     No      Yes

If no, are there any foods that you exclude from your diet? ________________

Do you like and are willing to eat:

Chicken in a creamy parmesan sauce
Orzo with butter and garlic
Broccoli
Garlic bread
Grapes
Meatball with marinara sauce
Cheddar Cheese
Almond Yogurt Banana Pretzel Chocolate chip cookie

Do you regularly eat 3 meals per day?  No  Yes
If no, what is your usual daily pattern of meals?

How often do you eat food prepared outside of the home?

  Never  Rarely  Sometimes  Often  Very often

How often do you order take out?

  Never  Rarely  Sometimes  Often  Very often

How often do you take leftover food at restaurants to-go?

  Never  Rarely  Sometimes  Often  Very often

Would you be willing to refrain from eating after 10:00 pm the evening before the test session?  No  Yes
Would you be willing to refrain from drinking alcoholic beverages the day before the test session?  No  Yes

Are you pregnant or breast feeding?  No  Yes

Where did you hear about the study?  ______________________________________

Have you participated in any other studies in our lab?  No  Yes
If yes, what study and when?  ______________________________________

Are you an undergraduate or graduate student?

If yes: Major:  __________________________

Are you a faculty or staff member?

If yes: Dept:  __________________________

[If participants meet inclusion criteria, interviewer will schedule screening visit at this time. If participant does not meet inclusion criteria, conversation ends at this point.]

Name:  __________________________  Phone:  __________________________

Appointment:  __________________________
Are you willing to receive email reminders the day before you are scheduled to participate (Your identity will be kept confidential and you will only be contacted with information regarding your participation in the study)? Yes  No

If Yes, what is your email address?: _____________________
CONSENT FOR RESEARCH
The Pennsylvania State University

Title of Project: Dinner Feeding Study for Women
Principal Investigator: Barbara J. Rolls, PhD

Address: 226 Henderson Building, University Park, PA 16802
Telephone Number: 814-863-8482

Subject’s Printed Name: _____________________________

We are asking you to be in a research study. This form gives you information about the research. Whether or not you take part is up to you. You can choose not to take part. You can agree to take part and later change your mind. Your decision will not be held against you.

Please ask questions about anything that is unclear to you and take your time to make your choice.

1. Why is this research study being done?
We are asking you to be in this research because you are a resident of State College, or a nearby municipality, who has likely been exposed to the commercial food environment in this area and enjoys the meal we are serving.

This study is being done because we are investigating adult eating behavior in response to the food environment. Approximately 75 people will take part in this research study from the State College area.

2. What will happen in this research study?
Visit 1 – Screening Visit:
• You will come to the lab and be provided with an informed consent form and given the opportunity to ask the research team questions.
• At this visit, you will taste and rate the food characteristics of small samples of test foods. Your height and weight will be recorded and you will complete a behavior questionnaire. You will also complete taste testing and ranking of foods at this visit. This visit will take approximately 20 minutes.
• If you are eligible for study enrollment, your next 3 visits will be scheduled at this time. Please note: it is possible that you will not be eligible to continue with this study after completion of this first visit.

Visits 2, 3, and 4 – Meal visits:
• The day of this visit, you will be asked to complete a food and activity diary, this will take you approximately 5 minutes each day. We also require that you not consume any food or energy containing beverages within 3 hours of your scheduled dinner visit.
• You will come to the lab at your scheduled dinner time (between 5 pm and 6:30 pm) to eat dinner. You will be permitted to eat as much or as little as you like at this meal. These sessions will take approximately 35 minutes total.
• At each dinner, you will complete hunger and taste VAS questionnaires before and after eating. You will also taste and rate, using a VAS questionnaire, a series of food samples at the beginning and end of each dinner.
• Ingredients and foods served at all meals are commercially available
• At the end of your 5th visit, you will complete the discharge questionnaire (including demographics and study related questions), along with 5 other behavior questionnaires. You will also rate and rank the taste of each test food. There will not be a meal served at this visit. This visit will take approximately 55 minutes.

3. What are the risks and possible discomforts from being in this research study?
There are no risks involved in eating dinner in the lab and filling out questionnaires. It may be possible that someone could overeat and feel discomfort from overeating or have an allergic reaction due to one of the food items or food item ingredients. Allergies will be screened for prior to study participation.

There is a risk of loss of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening. The confidentiality of your electronic data created by you or by the researchers will be maintained to the degree permitted by the technology used. Absolute confidentiality cannot be guaranteed.

If participating in this research caused you to feel concerns beyond normal daily living, you may contact Counseling and Psychological Services (CAPS) at 814-863-0395 with whom an appointment can be scheduled at your convenience.

4. What are the possible benefits from being in this research study?
4a. What are the possible benefits to you?
There are no direct benefits to the participant.

4b. What are the possible benefits to others?
You will be aiding in our understanding of adult eating behavior.

5. What other options are available instead of being in this research study?
You may decide not to participate in this research. Unfortunately, there is no alternate means of participation in this study without being physically present for each of the five test days.

6. How long will you take part in this research study?
If you agree to take part, it will take you about 20 minutes to complete the screening visit, each dinner (visits 2 – 4) will take approximately 40 minutes and your 5th visit will take approximately 55 minutes – this is a total of approximately 3 hours and 15 minutes.

7. How will your privacy and confidentiality be protected if you decide to take part in this research study?
Efforts will be made to limit the use and sharing of your personal research information to people who have a need to review this information.

Your participation in this research is confidential. All possible steps have been taken to assure your confidentiality.
• Each subject will be assigned a random three-digit number using a computer tool for random selection. Each number will have a corresponding colored sticker (randomly selected). Your first name and phone number will be associated with your three-digit number and dot color only for the purpose of communicating with you should you need to cancel or reschedule an appointment. This list (including first name, phone number and three-digit ID) will be kept in
the kitchen, which is locked at any time staff are not in it. Only kitchen staff are allowed in the kitchen.

- Any identifying information beyond what is in the kitchen, e.g. your first name and three-digit number, will be kept in a locked filing cabinet in the lab and password protected electronic files only on lab computers.
- Your confidentiality will be kept to the degree permitted by the technology used.

In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

We will do our best to keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people may find out about your participation in this research study. For example, the following people/groups may check and copy records about this research.

- The Office for Human Research Protections in the U. S. Department of Health and Human Services
- The Institutional Review Board (a committee that reviews and approves research studies) and
- The Office for Research Protections.

Some of these records could contain information that personally identifies you. Reasonable efforts will be made to keep the personal information in your research record private. However, absolute confidentiality cannot be guaranteed.

8. What happens if you are injured as a result of taking part in this research study?
In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document, you are not waiving any rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

10. Will you be paid or receive credit to take part in this research study?
You will be paid up to $25 for your participation, equating to $5 for each dinner visit and $5 for filling out final questionnaires. Payment will be received at your final visit. If you withdraw from the study, your payment will be prorated for the number of visits completed.

10. Who is paying for this research study?
This research was funded by gift money from Jenny Craig®.

11. What are your rights if you take part in this research study?
Taking part in this research study is voluntary.

- You do not have to be in this research.
- If you choose to be in this research, you have the right to stop at any time.
- If you decide not to be in this research or if you decide to stop at a later date, there will be no penalty or loss of benefits to which you are entitled.

However, if you decide to leave the research voluntarily, you forfeit your opportunity to compensation beyond the amount equivalent to the number of test days that you attended. If you decide to leave the research, contact the investigator so that the investigator can arrange for your termination of your meetings.
If protocol is not followed, we will reschedule your appointment for a later time. Persistent inability to adhere to protocol or blatant intentional lack of compliance can result in removal from the study.

The person in charge of the research study or the sponsor can remove you from the research study without your approval. Possible reasons for removal include ignoring protocol (i.e. eating within 3 hours of the scheduled test meal, consuming alcohol in excess on the day prior to the scheduled test meal) or development of a disease or disorder that might affect normal intake. Moreover, we reserve the right to drop you from the study at any time, particularly if you miss more than 2 sessions without rescheduling. If you are dropped for any reason, you will be compensated for any time that you have already given to the study.

During the course of the research you will be provided with any new information that may affect your health, welfare or your decision to continue participating in this research.

12. If you have questions or concerns about this research study, whom should you call?

Please call the study coordinator, Christine Sanchez at 814-863-8482 if you:

- Have questions, complaints or concerns about the research.
- Believe you may have been harmed by being in the research study.

You may also contact the Office for Research Protections at (814) 865-1775, ORProtections@psu.edu if you:

- Have questions regarding your rights as a person in a research study.
- Have concerns or general questions about the research.
- You may also call this number if you cannot reach the research team or wish to offer input or to talk to someone else about any concerns related to the research.

You must be 18 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date on the following page.

INFORMED CONSENT TO TAKE PART IN RESEARCH

Signature of Person Obtaining Informed Consent

Your signature below means that you have explained the research to the subject or subject representative and have answered any questions he/she has about the research.

______________________________
Signature of person who explained this research

Date

______________________________
Printed Name

(Only approved investigators for this research may explain the research and obtain informed consent.)

Signature of Person Giving Informed Consent

Before making the decision about being in this research you should have:

- Discussed this research study with an investigator,
- Read the information in this form, and
- Had the opportunity to ask any questions you may have.

Your signature below means that you have received this information, have asked the questions you currently have about the research and those questions have been answered. You will receive a copy of the signed and dated form to keep for future reference.
Signature of Subject

By signing this consent form, you indicate that you voluntarily choose to be in this research and agree to allow your information to be used and shared as described above.

_________________________________________  __________  ____________________________
Signature of Subject                              Date                        Printed Name
APPENDIX DD

SCREENING MATERIALS

STUDY 3
**Subject Profile**

Name: _________________________________________ Date: _________________

Email: _________________________________________

Phone (w): _______________ (h): _________________

Age: _____________ D.O.B.: _________________
**Instructions:**

Please place an X in the column which applies best to each of the numbered statements. All of the results will be strictly confidential. Please answer each question carefully.

<table>
<thead>
<tr>
<th></th>
<th>Always</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am terrified about being overweight.</td>
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<td>2. I avoid eating when I am hungry.</td>
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<td>3. I find myself preoccupied with food.</td>
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<td>4. I have eating binges where I feel that I may not be able to stop.</td>
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<td>5. I cut my food into small pieces.</td>
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<td>6. I am aware of the caloric content of foods that I eat.</td>
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<td>7. I particularly avoid foods with a high carbohydrate content (such as bread, potatoes, or rice).</td>
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<td>8. I feel that others would prefer if I ate more.</td>
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<td>9. I vomit after I have eaten.</td>
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<td>10. I feel extremely guilty after eating.</td>
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<td>11. I am preoccupied with a desire to be thinner.</td>
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<td>12. I think about burning up calories when I exercise.</td>
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<td>13. Other people think that I am too thin.</td>
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<td>14. I am preoccupied with the thought of having fat on my body.</td>
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<td>15. I take longer than others to eat my meals.</td>
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<td>16. I avoid foods with sugar in them.</td>
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<td>17. I eat diet foods.</td>
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<td>18. I feel that food controls my life.</td>
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<td>19. I display self-control around food.</td>
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<td>20. I feel that others pressure me to eat.</td>
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<td>21. I give too much time and thought to food.</td>
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<td>22. I feel uncomfortable after eating sweets.</td>
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<td>23. I engage in dieting behavior.</td>
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<td>24. I like my stomach to be empty.</td>
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<td>25. I enjoy trying rich new foods.</td>
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<td>26. I have the impulse to vomit after meals.</td>
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</tbody>
</table>
Please cross off any foods that you are unwilling to eat:

Baked chicken in a creamy parmesan sauce
Meatballs in marinara sauce
Garlic Bread
Pretzels
Banana
Red Grapes
Yogurt
Almonds
Pasta with a butter garlic sauce
Cheddar cheese cube
Broccoli
Chocolate chip cookie
Availability Sheet

Thank you for taking the time to fill out the attached forms. We will contact you by telephone if we find that you meet our eligibility requirements for this study.

If chosen for this study, what days of the week are you available to come into the laboratory for dinner? All meals will take approximately 30 minutes. Please pick all the days and times that fit into your schedule.

Please circle all meal times that fit into your schedule.

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>5:00</td>
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<td></td>
<td>5:30</td>
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<tr>
<td>MONDAY</td>
<td>6:00</td>
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<td></td>
<td>6:30</td>
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<tr>
<td>TUESDAY</td>
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<td>6:30</td>
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<td>WEDNESDAY</td>
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<td>THURSDAY</td>
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<tr>
<td>FRIDAY</td>
<td>5:00</td>
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<td>6:00</td>
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<td></td>
<td>6:30</td>
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</tbody>
</table>
********** To be completed by Research Assistant **********

Screening Visit Ht/Wt.

Height 1: __________(in)  Height 2: __________(in)

Weight 1: __________(lb)  Weight 2: __________(lb)

BMI: __________
How pleasant is the taste of the pretzel?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the chicken?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the cheese?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the orzo?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the cookie?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the broccoli?

Not at all pleasant

Extremely pleasant
How pleasant is the taste of the garlic bread?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the grapes?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the almond?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the banana?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the yogurt?

Not at all pleasant

Extremely pleasant

How pleasant is the taste of the meatball?

Not at all pleasant

Extremely pleasant
APPENDIX EE

PRE-MEAL HUNGER AND FULLNESS RATINGS

STUDY 3
How hungry do you feel right now?

Not at all hungry ____________________________ Extremely hungry

How thirsty do you feel right now?

Not at all thirsty ____________________________ Extremely thirsty

How much food do you think you could eat right now?

Nothing at all ____________________________ A large amount

How nauseated do you feel right now?

Not at all nauseated ____________________________ Extremely nauseated

How full do you feel right now?

Not at all full ____________________________ Extremely full
APPENDIX FF

PRE/POST-MEAL SSS RATINGS

STUDY 3
How pleasant is the taste of the chicken?

Not at all pleasant  ________________________________ Extremely pleasant

How much of the chicken do you want to eat right now?

None at all ________________________________ A very large Amount

*The same two questions (identical format and anchors) were asked for the 11 remaining foods: orzo, broccoli, garlic bread, grapes, pretzel, cheddar cheese, meatball, banana, almond, yogurt, chocolate chip cookie.

**This series of 24 ratings were assessed again after the dinner.
APPENDIX GG

POST-MEAL RATINGS

STUDY 3
How hungry do you feel right now?
Not at all hungy ___________________________ Extremely hungry

How thirsty do you feel right now?
Not at all thirsty ___________________________ Extremely thirsty

How much food do you think you could eat right now?
Nothing at all ___________________________ A large amount

How full do you feel right now?
Not at all full ___________________________ Extremely full

How satisfied were you with this meal overall?
Not at all satisfied ___________________________ Very satisfied

How much (in USD) would you expect to pay for this meal at a restaurant?
$ _____

How much (in USD) would you be willing to pay for this meal at a restaurant?
$ _____
APPENDIX HH

INTAKE SHEETS (CONDITIONS 1-4 FOR BOTH SUBJECT GROUPS)

STUDY 3
Intake Sheets: PSxTo-Go Study

Group 1: NO To-Go Container/ Condition 1: 100% PS

Check 1: ____________  
Check 2: ____________  
Subject ID: ____________  
Group: 1 – NO To-Go Cont.  
Condition: 1  
Portion Size: 100%  
To-Go Container: NO  
Date: ______________  
Week: ______________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
</table>
| Chicken slices tossed in sauce (~140g)  
(150g total with added sauce) | (w/o plate) |             |                 |
| Added Sauce (~10g)                |            |             |                 |
| Broccoli (120g)                   | (w/o plate) |             |                 |
| Seasoned Orzo (130g)              | (w/o plate) |             |                 |
| Grapes (80g)                      | (w/o plate) | (w/ bowl)   |                 |
| Garlic Bread (80g)                | (w/o plate) | (w/ plate)  |                 |
| Water (1L)                        |            |             |                 |

Time Meal: ______________

Disk 1: ______________  
Disk 2: ______________
**Intake Sheets: PSxTo-Go Study**

**Group 1: NO To-Go Container / Condition 2: 125% PS**

Check 1: __________ Subject ID: __________
Check 2: __________

Group: 1 - NO To-Go Cont.
Condition: 2
Portion Size: 125%
To-Go Container: NO
Date: ________________
Week: ________________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (~175g)</td>
<td>(on plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(187.5g total with added sauce)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Added Sauce (~12.5g)</td>
<td>(on plate)</td>
<td></td>
<td></td>
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<tr>
<td>Broccoli (150g)</td>
<td>(on plate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasoned Orzo (162.5g)</td>
<td>(on plate)</td>
<td></td>
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<tr>
<td>Grapes (100g)</td>
<td>(on plate)</td>
<td>(w/ bowl)</td>
<td></td>
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<tr>
<td>Garlic Bread (100g)</td>
<td>(on plate)</td>
<td>(w/ plate)</td>
<td></td>
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<tr>
<td>Water (1L)</td>
<td>(on plate)</td>
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<td></td>
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</tbody>
</table>

Time Meal: ________________

Disk 1: ________________ Disk 2: ________________
**Intake Sheets: PSxTo-Go Study**

**Group 1: NO To-Go Container / Condition 3: 150% PS**

- Check 1: __________
- Check 2: __________
- Subject ID: __________
- Group: 1 – NO To-Go cont.
- Condition: 3
- Portion Size: 150%
- To-Go Container: NO
- Date: __________
- Week: __________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (~210g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
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<tr>
<td>(~225g total with added sauce)</td>
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<tr>
<td>Added Sauce (~15g)</td>
<td></td>
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<tr>
<td>Broccoli (180g)</td>
<td>(w/o plate)</td>
<td></td>
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<tr>
<td>Seasoned Orzo (195g)</td>
<td>(w/o plate)</td>
<td>(w/ bowl)</td>
<td></td>
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<tr>
<td>Grapes (120g)</td>
<td>(w/o plate)</td>
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<td>(w/ plate)</td>
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<tr>
<td>Garlic Bread (120g)</td>
<td>(w/o plate)</td>
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<tr>
<td>Water (1L)</td>
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</table>

**Time Meal: __________**

**Disk 1: __________**

**Disk 2: __________**
Intake Sheets: PSxTo-Go Study

Group 1: NO To-Go Container / Condition 4: 175% PS

Check 1: ____________  Subject ID: ____________
Check 2: ____________

Group: 1 – NO To-go cont.
Condition: 4
Portion Size: 175%
To-Go Container: NO
Date: ________________
Week: ________________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
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</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (245g)</td>
<td>(w/o plate)</td>
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<tr>
<td>(262.5g total with added sauce)</td>
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<tr>
<td>Added Sauce (~17.5g)</td>
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<tr>
<td>Broccoli (192.5g)</td>
<td>(w/o plate)</td>
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<tr>
<td>Seasoned Orzo (227.5g)</td>
<td>(w/o plate)</td>
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<tr>
<td>Grapes (140g)</td>
<td>(w/o plate)</td>
<td>(w/ bowl)</td>
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<tr>
<td>Garlic Bread (140g)</td>
<td>(w/o plate)</td>
<td>(w/ plate)</td>
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<tr>
<td>Water (1L)</td>
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</table>

Tune Meal: ________________

Disk 1: ________________  Disk 2: ________________
**Intake Sheets: PSxTo-Go Study**

**Group 2: To-Go Container / Condition 1: 100% PS**

Check 1: __________  
Check 2: __________  
Subject ID: __________  
Group: 2 – YES To-go cont.  
Condition: 1  
Portion Size: 100%  
To-Go Container: YES  
Date: ________________  
Week: ________________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
<th>To-go (Y/N)</th>
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</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (~140g)</td>
<td>(w/o plate)</td>
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<tr>
<td>(150g total with added sauce)</td>
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<tr>
<td>Added Sauce (~10.0g)</td>
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<tr>
<td>Broccoli (120g)</td>
<td>(w/o plate)</td>
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<tr>
<td>Seasoned Orzo (130g)</td>
<td>(w/o plate)</td>
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<tr>
<td>Grapes (80g)</td>
<td>(w/o plate)</td>
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<td>(w/ bowl)</td>
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<tr>
<td>Garlic Bread (80g)</td>
<td>(w/o plate)</td>
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<tr>
<td>(w/ plate)</td>
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<tr>
<td>Water (1L)</td>
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Took to-go container with them (Y/N): ______
Time meal: ________________
Disk 1: ________________  
Disk 2: ________________


Intake Sheets: PSxTo-Go Study

Group 2: To-Go Container / Condition 2: 125% PS

Check 1: __________  Subject ID: __________
Check 2: __________

Group: 2 – YES To-Go cont.
Condition: 2
Portion Size: 125%
To-Go Container: YES
Date: ______________
Week: ______________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (~175g)</td>
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<td>(w/o bowl)</td>
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<td>(w/o plate)</td>
<td>(w/o plate)</td>
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<tr>
<td>Water (~1L)</td>
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Took to-go container with them (Y/N): _____
Time meal: ______________
Disk 1: ______________
Disk 2: ______________
Intake Sheets: PSU To-Go Study

Group 2: To-Go Container / Condition 3: 150% PS

Check 1: ___________  Subject ID: _______________
Check 2: ___________

Group: 2 ~ YES To-Go cont.
Condition: 3
Portion Size: 150%
To-Go Container: YES
Date: _______________
Week: _______________

<table>
<thead>
<tr>
<th>Lunch Food</th>
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<tr>
<td>Water (1L)</td>
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<td>Y</td>
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</tbody>
</table>

Took to-go container with them (Y/N): ______
Time meal: _______________
Disk 1: _______________  Disk 2: _______________
**Intake Sheets: PSxTo-Go Study**

**Group 2: To-Go Container / Condition 4: 175% PS**

Check 1: ____________  
Check 2: ____________  
Subject ID: ____________  
Group: YES To-Go cont.  
Condition: 4  
Portion Size: 175%  
To-Go Container: YES  
Date: ________________  
Week: ________________

<table>
<thead>
<tr>
<th>Lunch Food</th>
<th>Pre-weight</th>
<th>Post-weight</th>
<th>Amount Consumed</th>
<th>To-go (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken slices tossed in sauce (~245g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(262.5g total with added sauce)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Added Sauce (~17.5g)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli (192.5g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasoned Orzo (227.5g)</td>
<td>(w/o plate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapes (140g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/ bowl)</td>
<td></td>
</tr>
<tr>
<td>Garlic Bread (140g)</td>
<td>(w/o plate)</td>
<td></td>
<td>(w/ plate)</td>
<td></td>
</tr>
<tr>
<td>Water (1L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Took to-go container with them (Y/N): ______

Time meal: ________________

Disk 1: ________________  
Disk 2: ________________
APPENDIX II

LINK TO FULL WEEK 5 SURVEY

STUDY 3
The full survey administered to subjects can be found by typing this link into your browser:

https://hhdevpsu.az1.qualtrics.com/jfe/form/SV_3aYwlvlik6zLz49

When you have arrived at the login screen, enter the id:

1234
APPENDIX JJ

SELECTED QUESTIONNAIRES FROM SURVEY:

FOOD WASTE AVERSIÓN SCALE

STUDY 3
<table>
<thead>
<tr>
<th>I try to avoid wasting food</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Disagree Somewhat</th>
<th>Neither agree nor disagree</th>
<th>Agree somewhat</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I dislike wasting food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am very concerned about food waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Getting rid of wasted food is difficult for me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unless I have a really good reason to throw food away, I consume it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I do not like to dispose of food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasting food makes me feel uncomfortable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I see wasted food, I feel distress</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When food goes to waste, it upsets me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasting food is sinful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasting food is against my principles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is immoral to waste food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food waste is environmentally irresponsible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food waste is bad for the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food that goes unused harms others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food waste is socially irresponsible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wasting food is uneconomic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I see discarded food, I think of the wasted money</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I regularly keep leftovers in my fridge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I don’t mind expending extra effort to make sure food does not go to waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I try to find new ways to use food to avoid having it go unused</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX KK

SELECTED QUESTIONNAIRES FROM SURVEY:
RATINGS AND RANKINGS OF INDIVIDUAL FOODS
STUDY 3
The following items will ask you about the market value of each of the food items served at the meal.

How costly do you think the chicken is?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>costly</td>
<td>costly</td>
</tr>
</tbody>
</table>

How costly do you think the orzo is?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>costly</td>
<td>costly</td>
</tr>
</tbody>
</table>

How costly do you think the broccoli is?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>costly</td>
<td>costly</td>
</tr>
</tbody>
</table>

How costly do you think the garlic bread is?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>costly</td>
<td>costly</td>
</tr>
</tbody>
</table>

How costly do you think the grapes are?

<table>
<thead>
<tr>
<th>Not at all</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>costly</td>
<td>costly</td>
</tr>
</tbody>
</table>
The following items will ask you about the how you value each food component in general.

How valuable is the chicken to you?

Not at all _______________________________ Extremely valuable
valuable _______________________________ valuable

How valuable is the orzo to you?

Not at all _______________________________ Extremely valuable
valuable _______________________________ valuable

How valuable is the broccoli to you?

Not at all _______________________________ Extremely valuable
valuable _______________________________ valuable

How valuable is the garlic bread to you?

Not at all _______________________________ Extremely valuable
valuable _______________________________ valuable

How valuable are the grapes to you?

Not at all _______________________________ Extremely valuable
valuable _______________________________ valuable
Of the foods served to you at the meal, please rank the TASTE of the foods from 1 (most pleasant) to 5 (least pleasant):

_____ : Chicken
_____ : Orzo
_____ : Broccoli
_____ : Garlic bread
_____ : Grapes

Of the foods served to you at the meal, please rank the HEATHFULNESS of the foods from 1 (most healthy) to 5 (least healthy):

_____ : Chicken
_____ : Orzo
_____ : Broccoli
_____ : Garlic bread
_____ : Grapes

Of the foods served to you at the meal, please rank the CALORIE CONTENT of the foods from 1 (most caloric) to 5 (least caloric):

_____ : Chicken
_____ : Orzo
_____ : Broccoli
_____ : Garlic bread
_____ : Grapes

Of the foods served to you at the meal, please rank the COST of the foods from 1 (highest cost) to 5 (lowest cost):

_____ : Chicken
_____ : Orzo
_____ : Broccoli
_____ : Garlic bread
_____ : Grapes
Of the foods served to you at the meal, please rank the VALUE of the foods from 1 (highest value) to 5 (lowest value):

_____: Chicken
_____: Orzo
_____: Broccoli
_____: Garlic bread
_____: Grapes
APPENDIX LL

SELECTED QUESTIONNAIRES FROM SURVEY:
DEMOGRAPHIC AND DISCHARGE QUESTIONNAIRE
STUDY 3
Demographic/Background Information

What is your sex?
☐ Male
☐ Female
☐ Other

What is your age? ________________

What is your date of birth? ________________

What is your ethnicity (please select only one)?
___ Hispanic or Latino
___ Not Hispanic or Latino

What is your race? (select as many as apply)
___ American Indian or Alaskan Native
___ Asian
___ Black or African American
___ White
___ Native Hawaiian or Other Pacific Islander
___ Other specify: _________________________

What is your total or combined family income, before taxes?
___ Less than $20,000
___ $21,000 - $35,000
___ $36,000 - $50,000
___ $51,000 - $75,000
___ $76,000 - $100,000
___ $100,000+

What is the highest level of education that you have completed?
___ Some high school
___ High school graduate
___ Some college
___ 2-year college degree (Associate, Vocational)
___ 4-year college degree (Bachelors)
___ Masters, professional, PhD degree
What is your current employment status?
___ Working full time
___ Working part time
___ Homemaker
___ Student
___ Unemployed
___ Retired
___ Other, specify_____________

Are you primarily responsible for preparing meals in your household?
☐ Yes
☐ No

This section asks about your usual practices when eating out.

On average, how frequently do you eat meals at any type of restaurant (e.g., fast food, cafes, casual, fine dining)?
___ Once a month or less       ___ Twice a month       ___ Once a week       ___ 2-5 times a week
___ Daily       ___ More than once a day

Which of the following reasons are the most important in determining the amount you eat at a restaurant meal? Rank the top 5 influences in determining how much you eat (1 – most important to 5 – least important).
___ How hungry you are
___ The taste of the meal
___ The calorie content of the meal
___ The amount you are used to eating
___ The amount you are served
___ How filling the meal is
___ The cost of the meal
___ The quality of the meal
___ Who you are eating with
___ How safe the leftover food is to transport
___ How good the food is as a leftover
___ The time of day
___ The time until your next meal?
___ How much you dislike wasting food

Please list below any other influences on the amount that you eat at a restaurant.
__________________________________

In general, how do you feel about the portions of food served at a restaurant meal (Please select one response)?
___ The amount of food is not enough to fill me up
___ The amount of food is just right
___ The amount of food is excessive
When eating out at a restaurant, how often do you eat all of your meal? (Please select one response)

___ All of the time
___ Most of the time
___ Some of the time
___ Rarely or Never

How often do you take leftovers to go when you are eating out? (Please select only one response)

☐ Every time possible
☐ Most of the time
☐ About half of the time
☐ Rarely
☐ Never

Which of the following reasons are the most important in determining whether or not to take away leftover food from a restaurant meal? Rank the top 5 influences in determining how much you eat (1 – most important to 5 – least important).

___ How hungry you are:
___ The taste of the food:
___ How healthy the food is:
___ How much you are used to eating:
___ The amount of food served:
___ How filling the meal is:
___ The amount of money paid for the food:
___ The quality of the food:
___ Others’ opinions of me if I am seen taking home leftovers:
___ How safe the food is to store/transport:
___ How well the food reheats/how good the food is as a leftover:
___ When your next meal is:
___ My feelings on waste:

When you are able to package leftovers compared to not, the availability of a “to-go” container at a meal will most often lead me to… (Please select only one response)

___ Eat a lot more at the meal
___ Eat slightly more at the meal
___ Eat about the same at the meal
___ Eat slightly less at the meal
___ Eat far less at the meal

How does the likelihood of taking food to go change when it is obvious that there is more food than you can eat? (Please select only one response)

___ Increases
___ Decreases
___ Stay the same
Would you be motivated to have your uneaten food packaged to go even if you did not pay for the meal?

___ Yes
___ No
If you answered “No”, why not?

7. What do you think was the purpose of this study?

8. At what time do you normally eat dinner (outside of the study sessions)?

9. a. Did you eat the remaining food that was packaged to go? If no, why not?*

   b. Did you share the leftover food with anyone else?*

   c. If you did not eat the remaining food packaged to go from the meal, did that affect how much you decided to eat at the next session [Ignore if you answered “yes” to previous question]?*

10. Were there any factors that affected how much food you ate? Yes  No

    If yes, please explain:

11. Did you notice any differences between any of the sessions?

12. Do you have any specific comments about this study?

*These questions will only be asked to the intervention group (group who is given the option to take leftovers home).
APPENDIX MM

DEBRIEFING FORM

STUDY 3
DEBRIEFING FORM

IRB Protocol No.: ______________________

Principal Investigator: Barbara J. Rolls

Laboratory for the Study of Ingestive Behavior
226 Henderson Building
814-863-8482

You are being given this form because deception was used in this study.

In this context, deception can be defined as the giving false information or withholding of information regarding the reason for conducting the research study. It was not stated that the true interest of this study was to determine how the availability of a to-go container influences intake in regards to changes in portion size (weight of food served). Some participants in this study were offered a to-go container at each of their meals.

The deception used in this study was seen as necessary because we wanted subjects to behave as they normally would in an eating situation. We wanted the manipulations to seem as naturalistic as possible, so that the results of our study could be more generalizable. We felt that if subjects knew the specific aims of our study, it may lead them to change their eating behaviors based on their knowledge of our outcomes of interest. If this were to occur, it brings into question the validity and reliability of our results.

Again, the true purpose of this study is to examine how intake is influenced by changes to food environment including portion size and ability to take food to-go. Secondary outcomes of interest are personality traits that may influence the aforementioned relationships and if perceptions (i.e. of taste) are influenced by changes in the eating environment.

If you feel a need to speak to a professional concerning any uncomfortable feelings from your participation in this research, you may contact Christine Sanchez at 814-863-8482 any time you have questions about the research. She will be able to put you in touch Counseling and Psychological Services (CAPS) with whom an appointment can be scheduled at your convenience.

Please sign this form to allow for documentation that we have debriefed you on the true purpose of this study.

_________________________  ___________  ______________________
Signature                   Date                    Printed name
Faris M. Zuraikat
Curriculum Vitae

Education & Training
2018 Ph.D. in Nutritional Sciences, The Pennsylvania State University, University Park, PA
2014 B.A. in Psychology, St. Bonaventure University, St. Bonaventure, NY

Research Experience
2014-2018 Graduate Research Assistant, The Pennsylvania State University, University Park, PA
Sum. 2013 Visiting Research Assistant, The Pennsylvania State University, University Park, PA
2011-2014 Undergraduate Research Assistant, St. Bonaventure University, St. Bonaventure, NY

Fellowships, Awards & Honors
AHA Research Leaders Academy Invitee August 2018
Ruth L. Pike Graduate Fellowship Award Recipient, Penn State 2018
First Place, Health and Life Sciences, Penn State Graduate Exhibition 2017
Fellow, USDA Childhood Obesity Prevention Training Program 2016-2018
Graham Fellow, Penn State 2014-2015

Publications


Selected Conference Presentations
