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Potential moderators of the portion size effect

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Abstract

Aim: The robust effect of portion size on intake has led to growing interest in why individuals consume more food when served larger portions. A number of explanations have been proposed, and this review aims to provide insight into potential underlying factors by summarizing recent studies testing moderators of the portion size effect.

Summary of findings: Provision of portion size information, such as through labeling or training in portion control, failed to attenuate food intake in response to increasing meal size. This indicates that a lack of knowledge about appropriate portions may not be sufficient to explain the portion size effect. In contrast, there is evidence for a role of decision making in the response to large portions, with value being one consideration of importance. The portion size effect may be more closely related to the inherent value of food than monetary value, since provision of the opportunity to take away uneaten food after a meal, which can reduce food waste, attenuated the portion size effect but variations in pricing did not. A number of studies also support an influence of orosensory processing on the portion size effect; large portions have been shown to relate to increased bite size and faster eating rate. Reduced oral processing time when consuming large portions could contribute to the effect by delaying sensory-specific satiety. Findings from a recent study supported this by demonstrating that sensory-specific satiety did not differ between larger and smaller portions despite substantial differences in intake.

Conclusions: A number of moderators of the portion size effect have been identified, including factors related to the environment, the food, and the individual. It is likely that multiple variables contribute to the response to large portions. Future research should aim to determine the relative contribution of explanatory variables across different contexts and individuals.

Keywords

Portion size; food intake; moderators; value; norms; bite size; individual differences

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1. Introduction

Large portions, particularly of energy-dense foods, are widely available in the current eating environment. This is a public health concern given that epidemiological research suggests a link between obesity and growing food portions [1,2]. Furthermore, numerous controlled experiments have demonstrated that increasing the amount of food served leads individuals to consume more food and energy [e.g. 3–6]. This "portion size effect (PSE)" has been the subject of a meta-analysis [7] as well as systematic [8] and narrative reviews [9–13]. The topic is also comprehensively summarized in the *Handbook of Eating and Drinking: Interdisciplinary Perspectives* [14]. Briefly, the effect of large portions on intake is observed across different foods, individuals, and settings, and is sustained over time. The robust nature of the PSE has led to growing interest in identifying what factors contribute to this effect. Investigation of *why* people eat more when they are served large portions is driven not just by a desire to better understand a key influence on human eating behavior, but because it could aid in the development of strategies to counter the effect. The current narrative review explores new research on factors contributing to or moderating the PSE in order to summarize what is known about explanatory variables underlying this robust influence on intake.

A number of factors thought to underlie the PSE have been proposed and data related to these explanatory variables, often referred to as "mechanisms," have been reviewed previously [10,12,15,16]. The general conclusion of these reviews has been that it remains unclear what drives the increased intake in response to large portions. However, a number of recent studies have tested novel moderators of the PSE, providing unique insight into factors underlying the effect. In the current review, we re-examine the roles of normative influences, decision making, value, and orosensory processing in the PSE in light of these new findings. Potential explanatory variables are described and results of recent research are summarized in relation to what has been shown previously. In discussing how these studies advance our understanding of individual explanatory variables, we also consider the potential for these factors to work in combination to drive the PSE, with the relative contribution depending on the context and individual. A working model (Figure 1) is presented to encapsulate what is now known about the complex interplay between factors contributing to or moderating the PSE.

2. Is the PSE driven by a lack of knowledge about how much one should eat?

Speculation on the underpinnings of the PSE can be traced back to a seminal portion size study. Rolls and colleagues [3] posited that the effect could be due to an expectation that the portion provided is an appropriate amount to eat. Prior to this, a nation-wide survey found that the amount served was used by respondents to decide how much to eat along with high levels of plate cleaning [17]. The idea that portion size is used as a cue of how much to consume was subsequently built upon by Herman and colleagues [16,18], who postulated that people have difficulty determining what is an appropriate amount to eat, causing them to rely on normative cues in an attempt to control overeating. Consequently, the portion served

could be used as a situational, or an appropriateness, norm to determine food intake; this may be especially pertinent when portions fall within a range of what the consumer considers to be typical for that food [19]. A number of studies have been designed to test this compelling proposition that increased intake from large portions is the result of a reliance on normative cues. Key findings of these studies are summarized in this section, and potential moderators related to portion size norms are included in Figure 1.

2.1 Perceived normality and appropriateness of portions in the PSE

One way to assess the normative influence of the amount of food served on the PSE is to probe participants on their perceptions of what constitutes an appropriate or normal portion. One study found that ratings of what was an appropriate amount to eat were related to the amount served, and this perception mediated the PSE [20]. In a more recent series of studies, participants were exposed to images of smaller or larger portions of a food (spaghetti bolognese) and were later asked to rate perceived normality and ideal portion size of that food and another food (chicken curry and rice) [21]. In support of a normative influence, participant ratings of normality for the test food were consistently associated with the amount they had initially viewed. However, this effect did not extend to the other food, and visual exposure to large portions did not affect measured food intake [21]. Despite initial support, these mixed findings brought into question the impact that normative portion size cues have on intake from large portions. In response, Robinson et al. [22] enhanced their test paradigm and found that visual exposure to smaller portions not only influenced perceived normality, but also led to selection of smaller portions and reduced intake at a subsequent eating occasion. These results provide insight into the potential contribution of a reliance on normative cues in the PSE and also suggest that efforts to downsize could be effective given the possible malleability of perceptions of normality. An important caveat, however, is that reductions should be incremental such that portions still fall within the range considered to be normal by the consumer, in order to avoid compensatory overeating [19]. Future research is needed to determine whether exposure to smaller portions of some foods influences perceived normality or appropriateness as well as measured intake of other foods. Moreover, since studies of the PSE are often limited to one or two eating occasions, longer-term assessment of portion size normality in relation to the effect of portion size on consumption will be important in elucidating the role of a normative influence. Finally, replication of these findings in field settings is needed as other factors promoting greater selection and intake of larger portions (e.g. price, palatability, and other contextual factors) could overwhelm an influence of reduced portion size norms on the PSE.

2.2 Assessing the role of portion size norms through provision of portion information

If the PSE is related to reliance on cues of appropriateness or normality from the portion served, the effect could be moderated through provision of contextual cues or information about portion sizes. Our laboratory tested this by providing participants with a choice of the portion to eat for lunch and varying the size of those portion options on different occasions [23]. Despite the opportunity to assess the amounts available to aid in pre-meal decision making, participants did not select smaller relative sizes as portions got larger. Consequently, they consumed a greater amount of food as the size of the options was increased.

A more direct way to convey portion size information is through labeling, which has been proposed as a strategy to counter overeating, particularly from large portions [e.g. 24,25]. The effects of nutrition-related labels on the amount of food consumed are summarized in a systematic review [26]. Here, we will highlight studies designed to relate portion size labeling to intake in response to increasing portion sizes. The influence of labeling on the PSE was tested in a pilot study, which found that serving size labels could be used to moderate the response, but only when large portions were labeled as providing a very large number of servings [27]. Results of a follow-up study using a different test food were less positive, despite adding another level of information. Neither labeling the portion served as "small" or "large" nor labeling along with the provision of contextual information significantly influenced the response to portion size [28]. In a different approach, when the amount of food served was not varied, but the portion information on the label was, individuals consumed a consistent weight of food [29]. If the PSE is related to efforts to eat an appropriate amount, provision of contextual information, such as through labeling, would be expected to attenuate the effect. The potential influence of labeling on the PSE is acknowledged in Figure 1; however, mixed results make it difficult to determine the actual contribution of labeling, and therefore a reliance on portion norms, to the PSE.

2.3 Testing the normative influence of portions through provision of portion-control training

Providing instruction in managing food portions is another strategy to promote knowledge of what is an appropriate amount to eat. Such instruction should attenuate the PSE if a portion size norm, such as appropriateness, is an influential explanatory variable. Provision of a brief, single educational session to increase awareness of large portions failed to influence the PSE [30]. However, this was a rather minimal instruction, and so in an intensive intervention, we tested whether prolonged training in portion-control strategies influenced the PSE in women [31]. To do this, we recruited trained women who had completed the year-long Portion-Control Strategies Trial [32] and untrained control participants of differing weight status to take part in the study. During the weight loss trial, trained participants had received extended instruction in different strategies to manage food portions including structuring meals around pre-portioned foods, using energy density to determine food portions, and making healthy food choices while eating less [32]; control participants received no prior training in portion control [31]. On different occasions, we varied the portion sizes of all seven foods comprising a test lunch and compared intakes between the participant groups. Contrary to what was hypothesized, the weight of food consumed in response to increasing portion sizes was similar between the groups (Figure 2A). Despite a year of instruction in managing food portions, trained participants consumed more food when served larger portions [31]. Moreover, the PSE also did not differ between women in the control groups who had normal weight and those who had overweight. Trained participants did, however, moderate their energy intake compared to controls (Figure 2B). This was achieved not by eating less food overall, but by consuming more of the lower-energy-density foods, as is illustrated in Figure 1. These findings demonstrate the robust nature of the PSE and also suggest that a lack of knowledge about appropriate portions is not a sufficient explanation for the PSE.

The highlighted studies demonstrate the need for a better understanding of the role that normative cues play in the PSE. Findings suggest that individuals do rely on the amount of food served to determine intake; however, that they do this even in the presence of explicit information about portion size [28] or with a greater knowledge of how to manage food portions [31], indicates that the effect may extend beyond a lack of situational awareness. Indeed, it has been shown that women were aware of consuming more food than intended when served a large portion [33]. Thus, it could be that more complex decision-making, such as evaluation of the healthfulness or value of the foods available, is used to determine how much to eat in response to being served larger portions.

3. Evaluating the potential role of pre-meal decisions in intake from large portions

A hypothesis that is divergent from a normative influence of portion size is that individuals make conscious decisions that contribute to overeating from large portions [34,35]. Much of the evidence in support of the potential role of pre-meal planning has been summarized in previous reviews [12,15,16,35]. Although much of this work has focused on determinants of the amount selected to eat and not measured intake, the findings can provide insight into potential moderators of the PSE. Therefore, rather than comprehensively summarizing studies on pre-meal decisions and portion selection, we will review this literature in the context of how pre-meal decision making may relate to the PSE.

Investigation of pre-meal decisions in relation to food portions has consistently demonstrated that the amount of food chosen for consumption is influenced by factors related to the food, such as how filling it is expected to be [36]. Expected satiety, which is shaped by familiarity and experiential learning, varies across foods and is found to be inversely related to the size of the portion selected [35,36]. Another influential factor in portion decisions is perceived healthfulness [37]. This was tested by showing individuals different types of pizza and asking them to indicate their ideal portion size as well as how filling, healthy, and tasty they expected the pizzas to be. Results showed that both perceived healthfulness and tastiness were significant predictors of portion selection overall. These factors also interacted with expected satiety when examining sub-groups; for example, larger portions of pizza were selected when it was expected to be healthier and less filling [37]. While that study did not measure food intake, the role of healthfulness in decisions about how much to eat when served large portions was also apparent in a study comparing the PSE in women with and without portion-control training [31]. When served large portions of food at a meal, to reduce intake, women could decide to consume smaller portions or to make differential adjustments based on their perceived healthfulness of the foods. Indeed, we found that women trained in portion control did the latter; they moderated energy intake by consuming a greater proportion of healthier, lower-energy-density foods at meals varying in portion size [31]. Thus, there is evidence that pre-meal consideration of food properties, such as healthfulness of a food or how filling it will be, can be influential in both portion selection as well as intake in response to being served large portions (shown in Figure 1). It is possible, then, that these perceptions could be leveraged through interventions, such as training, to counter the PSE.

In summary, decision-making appears to be important in determining how much food individuals select and consume. Despite studies typically measuring ratings of the amount individuals would prospectively eat and not actual intake, there is evidence that, within a range of portions, intended intake correlates well with actual intake [38]. This, in combination with the results described previously, suggests that there can be overlap in the factors that impact portion selection and the response to portion size. It is likely, though, that context will influence the extent to which these pre-meal decisions are involved in the PSE. Evaluation of food-related factors prior to eating could be especially pertinent when eating away from home, particularly when eating at restaurants. There may also be a greater reliance on pre-meal planning when multiple foods are served in large portions. In such situations, there is evidence that certain food characteristics, such as the relative palatability or perceived value of the available foods, predict the response to portion size [6,31]. A priority of future research should be to identify factors that have the greatest impact on decisions related to increased intake from large portions and how these vary across individuals and settings.

4. Does the value associated with large portions contribute to overeating?

Steenhuis & Vermeer [10] proposed that another factor related to pre-meal decisions, the value associated with a meal, and particularly large portions, could be influential in determining how much to eat. In the current eating environment, larger portions provide better value for money than smaller portions [10]. Common food pricing systems, such as flat-rate pricing at buffets and volume discounts for large packages or portions, promote selection and intake of large portions by adding value to these options for consumers [39–41]. Notably, cost has been shown to affect food choice outside of restaurants [42], and unpublished data suggest that the increased value associated with large portions may influence the amount of food selected and consumed in the home and other settings where price is not directly involved [cited in 10]. These findings further encourage consideration of value as a potential driver of the PSE.

Initial study of the role of value in overconsumption from large portions used pricing systems to define value, and portion selection was the primary outcome assessed [summarzed in 43,44]. In the first of these studies, the amount of food ordered and consumed from a fast-food restaurant was compared between conditions of value pricing (lower price per weight for larger portions) and proportional pricing (equivalent price per weight across portions) [45]. Results showed no effect of pricing on portion selection or on intake. A subsequent series of studies varying pricing structure for chicken nuggets, beverages, or a complete meal also found no consistent evidence of an impact of pricing on portion selection [46,47]. Despite some evidence of individual differences in responsiveness to pricing structure [46], these studies showed that, overall, selection of larger portions was unaffected by whether they were a better value for money.

Although some data suggest a negligible role of pricing structure in overeating, the potential influence of value on the PSE needs further consideration. The aforementioned studies focused on portion selection, which could be difficult to influence given that individuals tend to select a consistent relative size [23]. Furthermore, these studies exclusively compared

value pricing to proportional pricing [summarized in 44]. Another way in which food prices could impact intake is through a sunk cost effect [40]. In terms of eating behaviors, as the amount of money spent on a food item increases, individuals become more motivated to overeat [derived from 48]. We tested this proposed role of monetary value in the response to portion size. In a controlled laboratory setting designed to resemble a casual restaurant, we varied the price and portion size of a popular pasta dish in a crossover design [49]. We hypothesized that the effect of portion size on intake would be enhanced when participants paid more for their meal. However, the results showed that doubling the price paid did not have a significant effect on the response to portion size. Despite substantially different ratings of value between the meals, the increase in intake in response to 50% larger portions was similar regardless of whether the meal cost was $8 or $16. Although no effects on intake were observed, post-meal fullness was highest following intake of the high cost, large portion meal. We speculate that this could suggest that participants perceived having eaten more even though actual intake did not differ significantly [49]. Could it be that high-cost meals were expected to be high in energy content or more filling leading to a disconnect between perceived and actual intake? If so, it would indicate that value influences expectations or perceptions related to large portions, which could be leveraged to reduce intake.

The studies reviewed consistently demonstrate that the PSE is robust to variations in price as a measure of value. This, along with the fact that the PSE is observed in populations and settings in which money is typically irrelevant (children and the laboratory, respectively), has led to questioning the contribution of food value to the PSE [16]. Aspects of the previous study designs may explain why this is premature. Most notably, all of the studies tested foods that were low in market value such as chicken nuggets [46] and pasta [49]. Value might have influenced the PSE if test foods such as fish or steak had been served. It is also probable that an inherent value is associated with food given its ability to provide satisfaction or energy, which could contribute to overeating from large portions, either in combination with or independent of price.

Value is a broad construct that extends beyond direct monetary transactions. Another way value from a meal can be enhanced is through reducing food waste, aversion to which is distinct from wasting money [50]. A desire to reduce food waste likely contributes to high rates of plate-cleaning [51], which is associated with greater intake from large portions [52]. Thus, individuals may eat beyond satiation or energy needs in order to reduce waste and increase value from large portions. We tested this idea through use of an intervention that could reduce food waste [53]. Participants were randomly assigned to 1 of 2 groups: a To-Go Group that had their uneaten food packaged to take away (in a “doggy bag”) after a meal, and a Control Group that was not given the option to take away uneaten food. Results showed that the PSE was attenuated in the “doggy bag” group (Figure 3A & B). Notably, this influence on the PSE was observed even though the packaging was not provided until participants had indicated that they were finished; simply informing them of the option at the start of the meal was sufficient to reduce the linear rate of intake in response to increasing portion size by over 25% [53]. As shown in Figure 1, findings suggest that value may indeed contribute to the PSE, but indirectly, through efforts to not waste food. This could be the long-term result of caregiver practices; children are often encouraged to or praised for

finishing all of their food [54], a pattern that continues into adolescence [55]. Indeed, Siegel postulated in 1957 that individuals have a “completion compulsion” [56]; however, the underpinnings of this influence on the PSE remain to be determined.

Despite initially mixed findings, recent studies have moved the field forward on the role of value in the PSE. Broadening the scope of the components of value assessed, we determined that a desire to reduce food waste could be a more salient moderator of the PSE than the price assigned to a meal. Thus, an inherent value associated with foods could underlie the effect, which is supported by exploratory data showing that the response to portion size for individual foods tends to relate to the perceived value of the food [53]. Replication of these studies beyond the laboratory would improve understanding of the contribution of value to the PSE, since different components of value could vary in their level of influence depending on the setting.

5. Do changes in orosensory processing contribute to the PSE?

Results from the previous section indicate that increased intake from large portions is at least partially explained by an effort to maximize value from a meal [53]. It is therefore plausible that individuals may make efforts to enhance intake when served large portions. One way this could be achieved is by taking larger bites, which can increase eating rate and reduce oral processing time, factors that are known to affect intake [57,58]. Indeed, the role of both bite size and eating rate in response to large portions has been studied previously [59–61] and will be revisited here.

The contribution of bite size to the PSE was first noted in 3–5-y-old children; when served larger portions of macaroni and cheese, they ate more food and consumed more grams of food per bite in doing so [62]. This relationship was confirmed in a later study in 8–9-y-old children [63]. Findings from research investigating this association in adults were similar to the first study in children; increasing portions led to increased food intake but did not affect the *number* of bites taken [59]. Thus, bite sizes were significantly larger when served larger portions, a relationship shown in Figure 1. The positive association between portion size and bite size was replicated in another study that found that tripling the amount of food served at a meal led to a 12% increase in bite size [60]. It is notable, however, that only women with overweight and obesity were included in this study and that they were required to eat the full portion; both factors may have inflated the influence of bite size on the PSE. Replication of this study in a more diverse sample is needed. In addition, future studies would benefit from use of new methods developed to improve accuracy of continuous measurement of food intake [64,65]. Despite these limitations, there is evidence for a role of increasing bite sizes in the PSE that is consistent across a range of ages.

A key question is *how* large bites influence the PSE. Almiron-Roig and colleagues [60] found portion size and eating rate were positively correlated, indicating that oral processing time per amount eaten is reduced. Indeed, a large body of work, recently summarized in a meta-analysis, shows that reduced oral processing time leads to greater intake [58]. Furthermore, a recent investigation of individual differences in the PSE indicates an influence of eating rate as well, as is shown in Figure 1. We found that participant scores for

slowness of eating on the Eating Behaviors Questionnaire [49], which were highly correlated with meal duration, influenced the response to portion size: faster eating was associated with a larger magnitude of the PSE [53]. An experiment intervening on eating rate provided further insight into its role in the PSE [61]. Although food texture did not influence the slope of intake in response to increasing portions, increasing food thickness (which increased oral processing time) moderated intake from large portions [61]. These studies show that eating rate is associated with susceptibility to overconsuming from large portions and that targeting oral processing time, particularly in fast eaters, could be an effective strategy to moderate the PSE.

In attempting to explain better the roles of bite size and eating rate in the PSE, Herman and colleagues [16] revisited an idea proposed in one of the first portion size studies; namely, that sensory-specific satiety (SSS) could play a role in the PSE [3]. Sensory-specific satiety is the decline in hedonic value of a food as it is eaten, particularly in comparison to foods that are uneaten [66]. Indeed, Rolls et al. [3] showed that greater intake from large portions did not influence the change in pre- to post-meal ratings of pleasantness, although comparison of these changes to those in uneaten foods was not available. Extending this result, preliminary data from our lab demonstrated that SSS, quantified as the difference in the decline in ratings of prospective consumption (a proxy for SSS: [67]) for eaten compared to uneaten foods, was similar as portions of a meal were increased, despite participants eating more food (Figure 4) [53]. We speculate that similar SSS across different levels of intake may relate to differences in bite size and eating rate as portions are increased, since SSS has been shown to occur in closer relation to orosensory exposure than consumption [68]. Therefore, SSS could play a role in the PSE (Figure 1), although controlled studies designed specifically to test this relationship are needed.

There is evidence to suggest that both eating rate and bite size help to explain why large portions are associated with increased intake. Given the potential interplay between these factors and others, such as value or pre-meal decision making, it is of interest to determine whether increased bite size is an inherent response to being served more food or driven by a motivation to eat more. Studies demonstrating pre-meal intentions to eat more [69] as well as post-meal awareness of eating more [33] when served large portions could mean that changes in bite size and eating rate are the result of an effort to increase intake, although this remains to be tested. Further investigation of the decision making involved in determining intake from large portions will be a crucial step in understanding the PSE.

6. Conclusions

That people eat more food when served a larger compared to smaller portion is a simplistic and intuitive observation. However, studies assessing potential explanatory variables have identified numerous influences on the PSE, demonstrating the complexity of this effect. We propose that there is synergy between the driving factors, but also that the level to which each component contributes to the effect will vary depending on the individual and the context. The complex interactions between moderator, individual, and the PSE explored in this review are summarized in Figure 1.

Pairing novel findings with previous work on explanatory variables has highlighted the interplay between different factors underlying the PSE. Patterns emerged, allowing us to create categories of overarching influences. These include environmental, food, and individual-level moderators of the PSE. Pre-meal decisions can also play a role in the response to large portions, as food properties are often evaluated in selecting an amount to eat. Importantly, there is overlap across all of these categories of influences. For example, provision of a to-go container can attenuate the PSE, but the value preserved by saving food likely underlies this influence. Similarly, training in portion control may lead to increased pre-meal consideration of food-related properties, such as healthfulness, resulting in reduced meal energy density and energy intake. The model presented in Figure 1 helps to establish the interrelationships between factors influencing the PSE.

In assessing the roles of different factors in the PSE, we have emphasized the importance of considering how the setting or individual might influence the relative contribution of different moderators of the effect. As shown in Figure 1, recent studies have identified characteristics related to the PSE, which can help to elucidate how explanatory variables vary across individuals. For example, we observed a larger PSE in women who were higher in their rated price consciousness [53]; for those individuals, the value associated with a meal may be the primary moderator of the effect. Faster eaters were also found to be more responsive to large portions [53], meaning that the primary contributor to the effect in this case could be increased bite size. Finally, those rated lower in satiety responsiveness were more susceptible to overconsuming from large portions [49], and this could be because they rely on the portion served, rather than their internal cues of hunger and fullness, to determine what is an appropriate amount to eat. Variability in responsiveness to large portions across individuals demonstrates the potential for multiple factors to contribute to the PSE. Therefore, the efficacy of targeted interventions will rely on the explanatory variable, or combination of variables, most salient to the individual.

Indeed, there is evidence that a number of environmental, food-related, and individual factors contribute to the PSE. Future research should prioritize the development of a better understanding of the relative contribution of moderators across different contexts. One method of assessing the role of context is to test moderators of the PSE in field settings such as restaurants. In situations in which a meal has been purchased, a desire to maximize value could be the primary contributor to the effect. This could also lead to behaviors associated with delaying satiation, such as taking larger bites, demonstrating a contribution of multiple explanatory variables. Additionally, in settings outside the laboratory, such as when eating with others, reliance on an appropriateness norm could correspond with or outweigh a desire to reduce waste. As our understanding of these explanatory variables and their relative roles in the PSE improves, this knowledge can be applied to the development of effective strategies to counter the effects of large portions on intake.

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- We review recent studies designed to provide insight into factors underlying the PSE
- Environmental, food, and consumer-related moderators of the PSE have been identified
- It is likely that multiple factors work in combination to drive the PSE
- The relative contribution of these factors differs across contexts and individuals
- We use a model to illustrate the complex interplay between factors underlying the PSE

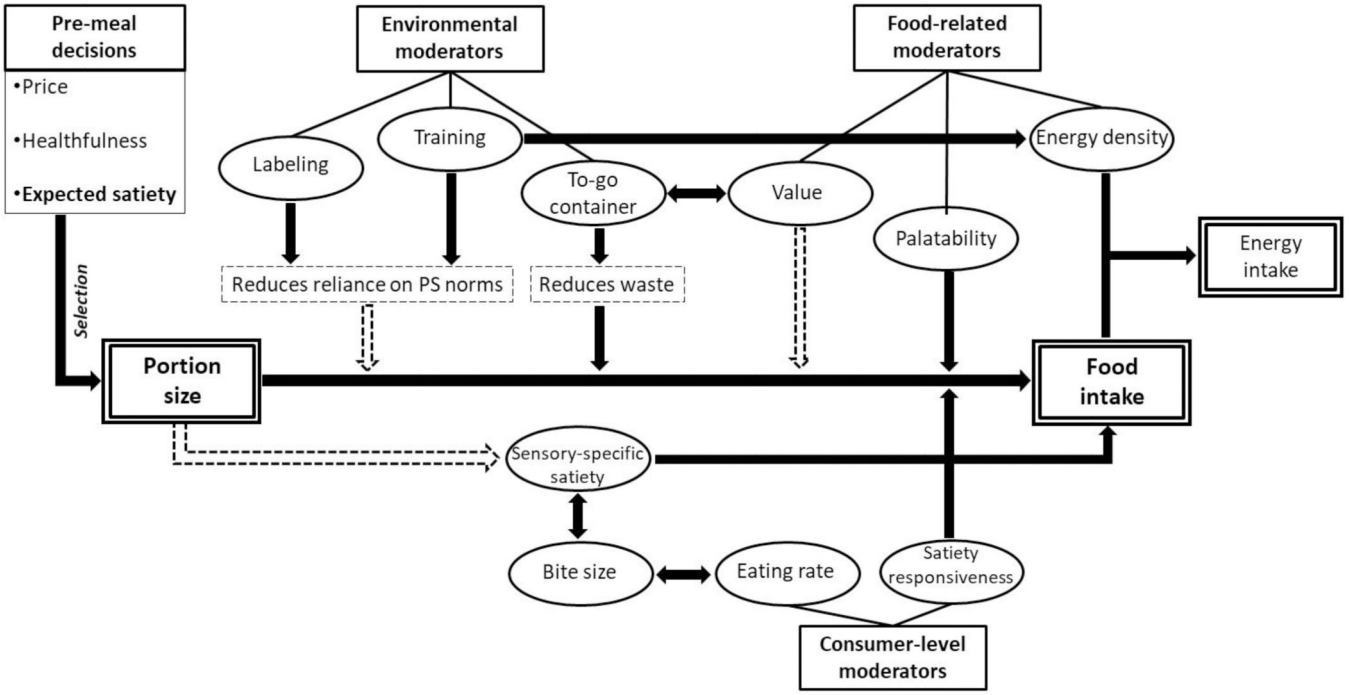

Figure 1:

A number of variables to explain the portion size effect (PSE) have been identified and are shown here. These include environmental and food-related factors as well as consumer characteristics. In addition, pre-meal decision making can impact portion selection, which would influence subsequent intake. Boxes with single solid lines represent overarching influences (explanatory variables), while the circles are the moderators related to these variables. Dashed lines appear around a variable that may underlie a moderator's role in the PSE, but is not proven. Arrows with solid lines indicate strong evidence of an influence on the PSE, while dashed lines represent some evidence of an influence. Bi-directional arrows are used to highlight moderators that likely fall under a related explanatory variable, such as value or orosensory processing.

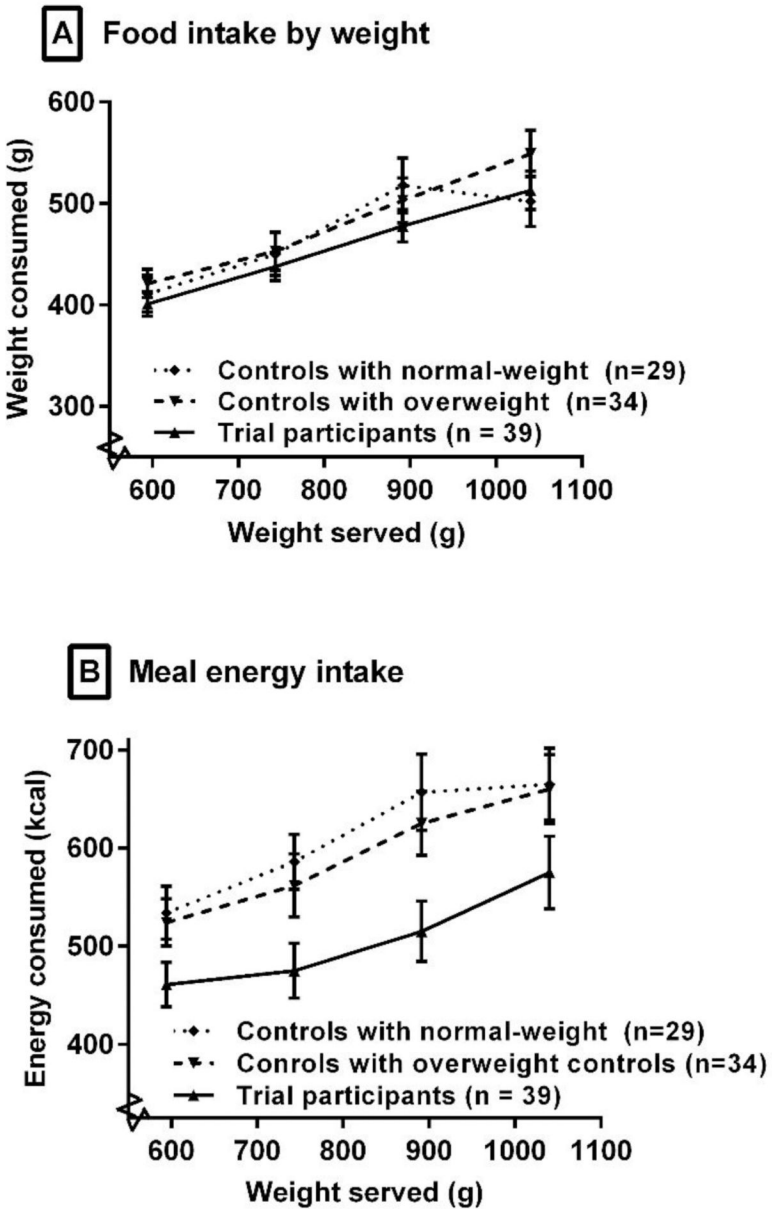

Figure 2:

Comparison of the portion size effect (PSE) across women with extended training in portion control (trial participants), controls with normal weight, and controls with overweight. Women consumed a significantly greater amount of food (2A) and energy (2B) as portions were increased, and these effects did not differ by training or weight status. Across meals, trained participants consumed fewer calories on average than did controls (506±15 vs 601±12 kcal), whose energy intake did not differ. (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).

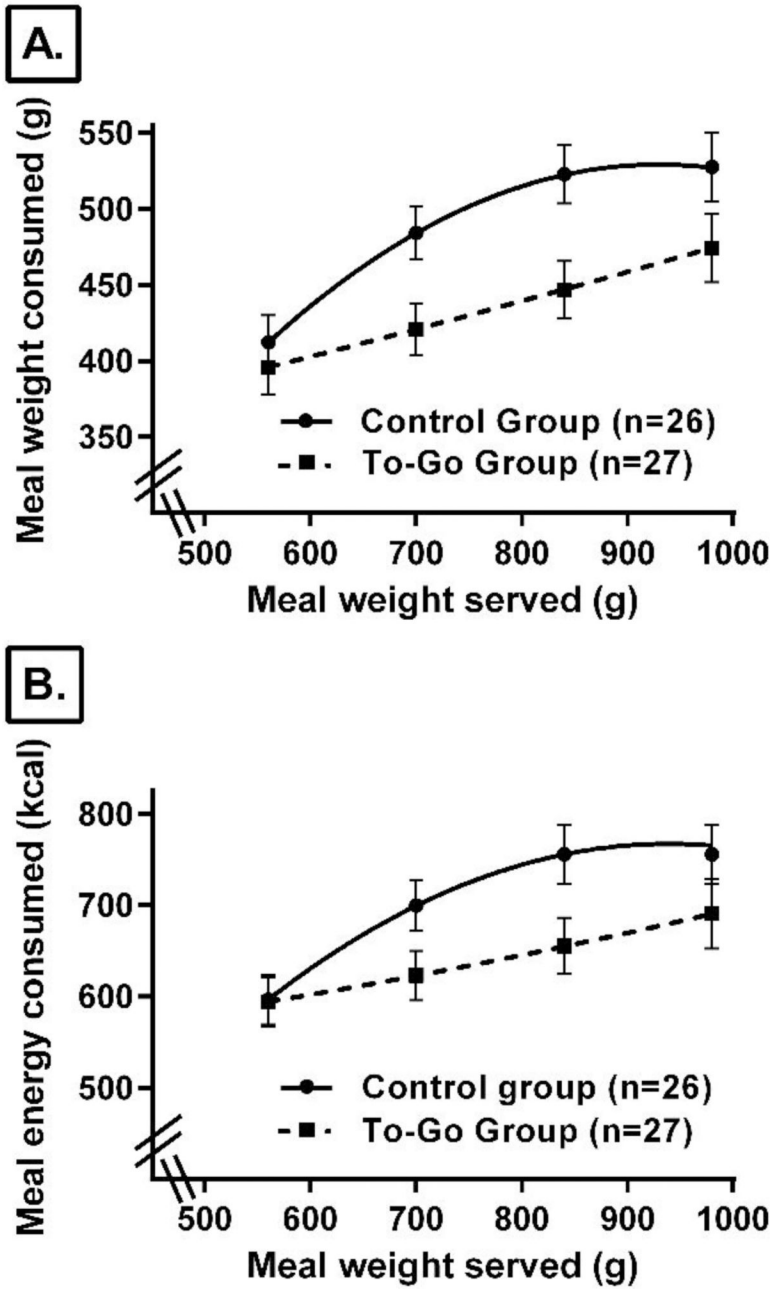

Figure 3:

Comparison of the portion size effect (PSE), defined as the trajectory of intake in response to increasing portion sizes of a meal, between women who were provided the opportunity to take away uneaten food (To-Go Group) and those who were not (Control Group). For women in the Control Group, there was a significant PSE on food (3A) and energy (3B) intake. For every 100 g increase in the weight of food served beyond baseline amounts, intake increased by 64±12 g (90±19 kcal) until levelling off. In contrast, the effects of portion size on food (3A) and energy (3B) intake were attenuated for women in the To-Go Group. For every 100 g increase in the weight of food served beyond baseline amounts, intake increased by only 17±12 g (19±18 kcal). (Reprinted from Appetite, 129, 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, 162–170, 2018, with permission from Elsevier for noncommercial use).

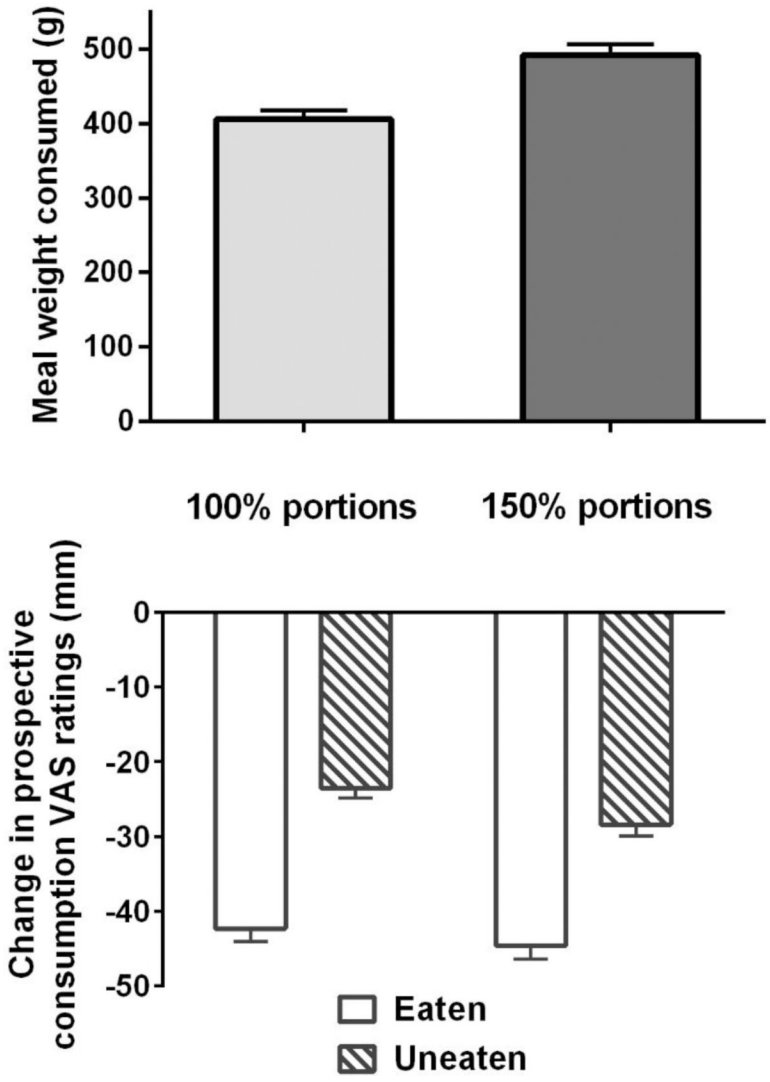

Figure 4:

Sensory-specific satiety (SSS) as it relates to the portion size effect (PSE). Increasing the amount of food served by 50% led to a significant increase in food intake (top graph). In contrast, the difference in the decline in ratings of prospective consumption for foods that were eaten compared to foods that were not eaten (SSS) was similar between portion conditions. Thus, SSS did not differ between different portion sizes, despite differences in intake.