What determines real-world meal size? Evidence for pre-meal planning.

Stephanie H. Fay[a], Danielle Ferriday, Elanor C. Hinton, Nicholas G. Shakeshaft,

Peter J. Rogers and Jeffrey M. Brunstrom.

School of Experimental Psychology, University of Bristol, UK.

Running head: Meal size and meal planning

Corresponding author: [a]Stephanie Fay

School of Experimental Psychology,

University of Bristol,

12a Priory Road,

Bristol,

BS8 1TU,

England.

Email: Stephanie.Fay@bristol.ac.uk

Abstract

The customary approach to the study of meal size suggests that 'events' occurring during a meal lead to its termination. Recent research, however, suggests that a number of decisions are made before eating commences that may affect meal size. The present study sought to address three key research questions around meal size: the extent to which plate cleaning occurs; prevalence of pre-meal planning and its influence on meal size; and the effect of within-meal experiences, notably the development of satiation. To address these, a large-cohort internet-based questionnaire was developed. Results showed that plate cleaning occurred at 91% of meals, and was planned from the outset in 92% of these cases. A significant relationship between plate cleaning and meal planning was observed. Pre-meal plans were resistant to modification over the course of the meal: only 18% of participants reported consumption that deviated from expected. By contrast, 28% reported continuing eating beyond satiation, and 57% stated that they could have eaten more at the end of the meal. Logistic regression confirmed pre-meal planning as the most important predictor of consumption. Together, our findings demonstrate the importance of meal planning as a key determinant of meal size and energy intake.

Keywords: Meal-size, planning, satiation, satiety, plate cleaning, portion size, appetite

Introduction

Our energy intake is largely determined by the size of the meals that we consume. Therefore, to understand energy balance it is critical that we appreciate determinants of meal size (kcal). Typically, controlled laboratory studies explore meal size by measuring consumption *ad libitum*. In this context, participants are presented with a large amount of food and are instructed to eat until they reach a comfortable level of fullness and wish to terminate the meal. The logic behind this approach is that meal termination, and hence meal size, is determined primarily by physiological and psychological processes occurring during and towards the end of a meal that promote satiation (Blevins & Baskin, 2009; Grill, 2010; Hellstrom, et al., 2004; Zorrilla, et al., 2005).

Such studies reveal that termination of eating is affected by a number of extrinsic factors; for example, the presence of television or a recorded auditory narrative (Bellisle, Dalix, & Slama, 2004; Blass, et al., 2006), and the presence of friends (Hetherington, Anderson, Norton, & Newson, 2006). The characteristics of the meal itself are also found to be important. Palatability appears to increase meal size (Yeomans, 1996; Yeomans, Blundell, & Leshem, 2004), while within-meal attenuation of palatability ('sensory-specific satiety') may be interrupted by the introduction of alternative foods which delay meal termination (Rolls, Rolls, Rowe, & Sweeney, 1981).

By contrast, in our laboratory we have explored determinants of self-selected meal size, before eating begins. Our research indicates that people have very clear expectations about the satiety and satiation that foods are likely to confer (Brunstrom, Shakeshaft, & Scott-Samuel, 2008; Brunstrom & Shakeshaft, 2009) and that these expectations are highly correlated with decisions about portion size. Critically, participants find these decisions very undemanding, indicating that this process is highly practised and rehearsed.

Together, these observations raise important questions about the control of meal size; in particular the extent to which meal size is determined by events occurring during a meal or by decisions taken before it begins, and the extent to which these affect *everyday* dietary behaviour. To examine these meal-time behaviours in free-living individuals we identified three key research questions. The first research question was the extent to which 'plate cleaning' occurs. We hypothesised that this would be commonplace based on evidence from laboratory observations (Koh & Pliner, 2009; Pliner, 1982; Rolls, Morris, & Roe, 2002; Wansink & Cheney, 2005; Wansink & Payne, 2008; Wansink, van Ittersum, & Painter, 2006). We also examined whether plate cleaning varied according to contextual factors, such the amount of control an individual has over their meal: whether it is prepared by the consumer of the food or by another agent (*e.g.*, a chef), at home or elsewhere.

The second research question concerned the prevalence of pre-meal planning: the extent to which meals are planned at the outset, and whether planning corresponds with amount consumed. The third research question related to the extent to which meal size is affected by within-meal 'experiences' including hunger and satiation, and other extrinsic factors, such as a desire to eat to avoid waste or in response to social pressure. A related issue concerns the extent to which these within-meal experiences modify prior plans or whether plans are generally preserved and determine intake notwithstanding within-meal events.

In addition, we were also interested in the extent to which determinants of meal size (planning or within-meal experiences) are consistent across individuals (regardless of gender, age, BMI and dieting), and types of meal (breakfast, lunch, and dinner). To address these issues we obtained a large data set using a questionnaire focusing on respondents' most recently consumed meal.

Methods

Participants

Participants were recruited from an electronic database of staff and students at the University of Bristol, UK, who had agreed to take part in experiments in our laboratory. No payment was offered. Instead, participants were voluntarily entered into a prize draw to win a seasonal food hamper worth £100 Sterling. After data screening (detailed below), 764 participants remained. Of these, 78% (592) were female and 17% reported currently dieting to lose weight. The sample had a mean age of 25.6 years (*SD* = 9.6; range 17-64) and a mean BMI of 22.8 (*SD* = 3.5; range 15.6-41.2). This research project was approved by a local research ethics committee.

Questionnaire

To address the three research questions outlined above, an internet-based questionnaire was devised. Data presented here formed part of a larger study also assessing pre-meal cognitions. The questionnaire items presented here were followed by a set relating to experiences with particular foods in more specific contexts. The website was coded in HTML and JavaScript and responses were stored and automatically encoded in preparation for analysis. Participants were recruited via email and sent a link to the website containing the questionnaire. They were informed that the purpose of the study was to explore the psychological processes underlying food choice and dietary behaviour. Before completing the questionnaire, participants were given the following instruction: 'Think about the last meal that you ate (excluding snacks). Please select the MOST APPROPRIATE response to the following questions.'

Items addressing the three research questions were divided into four sections, shown in Table 1. The first section concerned contextual factors of the meal, such as its setting. The second section addressed research question 1: incidence of plate cleaning. The third section addressed research question 2: incidence of planning in the pre-meal period and its influence on food intake. The fourth section addressed research question 3: within-meal experiences and their impact on intake. These last items were subdivided into two categories. One of these assessed evidence for 'plan modification' (*i.e.*, eating more or less than anticipated - items 7 and 8) and the other assessed evidence for 'plan preservation' (*i.e.*, eating despite satiation - items 9 and 10). Explanations for this 'eating despite fullness' were explored using item 10a, which was made available to participants responding positively to item 10 only. These participants were instructed to select all statements which were applicable to their experience. Response options were selected based on evidence that eating may be influenced by length of the inter-meal interval (Nisbett, 1968), food cost (Bowman, 2006) and social norms (Pliner & Mann, 2004).

Items were closed-response in design with responses limited to 'yes' or 'no', except for item 10a. Their presentation was not influenced by response to previous items; that is, all participants saw an identical version of the questionnaire. In addition, measures of gender, age, height, weight, and dieting status were also taken.

Data analysis

Initially 804 responses were received. Those with missing responses to items 4, 5 or 6 (see Table 1) were removed from the sample. Data were also screened according to time taken to complete various sections of the questionnaire, and cases more than 3 standard deviation points outside the mean were removed. After screening, data from 764 participants were analysed.

Firstly, to address the extent of plate cleaning (research question 1), pre-meal planning (question 2) and the extent to which meal size is affected by within-meal factors (question 3), response frequencies were examined and chi-square analyses conducted to assess proportions of yes/no responses on the relevant items of the questionnaire. Individual differences in responses to each questionnaire item were examined with 2 x 2 chi-squares (gender, dieting status) and t-tests (BMI, age). To control for multiple testing and protect against family-wise error, a Bonferroni correction for omnibus testing was employed and a cut-off point of $p < .00098$ used for the chi-square analyses. In this way, variables significantly associated with consumption of meals in their entirety were identified.

To determine significant predictors of plate cleaning behaviour, a logistic regression was performed with amount eaten (entire meal or less than entire meal) as the outcome variable and pre-meal, within-meal and individual measures as predictors (those significantly associated with plate cleaning in the chi-square analyses). Pre-meal variables were pre-meal planning (whether consumption was planned or unplanned – item 6) and contextual factors (items 1, 2, 4): meal preparation setting (home or restaurant/café); portion size selection (self or other); and meal type (breakfast, lunch or dinner), to determine whether patterns were consistent across meals. Dummy variables were computed for the latter in order to transform it into a binary variable. Within-meal variables (items 7, 9, 10) were: further helpings taken during the meal (helpings taken or not); stated ability to have eaten more at the end of the meal (could have eaten more or not); and stated having eaten less than was anticipated due to satiation (ate less than anticipated or not). Responses to questionnaire item 10a were not entered. This was because a positive response (yes) was necessarily dependent on plate cleaning. Gender (male or female) was also

entered in order to examine whether it was predictive of plate cleaning. All data were analysed using SPSS version 16 (SPSS Inc., Chicago, IL, USA).

Results

Question 1: Are meals eaten in their entirety?

In most cases (91%) the last reported meal was eaten in its entirety (χ^2 (1) = 407.5, p <.001). This tendency was evident in all meal contexts; Table 2 shows frequencies and associated statistics for meals taken at different times of day (breakfast, lunch, dinner), for meals prepared at home and in restaurants, and for meals and portions selected by the respondent or by somebody else.

In a second set of tests we explored whether plate cleaning occurred equally in particular meal contexts or in combination with particular within-meal factors. Separate 2 x 2 and 2 x 3 chi-square analyses are presented in Table 3. Plate cleaning occurred more frequently at breakfast, when the meal was planned in advance, when the portion was self selected, when the food was prepared at home, when participants did not eat less than anticipated due to satiation, when they were able to eat more, when they ate all despite having reached satiation, and when they were male.

Question 2: Does pre-meal planning affect meal size?

Planned meal size was significantly associated with ingested meal size (χ^2 (1) = 204.5, p <.001). As shown in Figure 1, most participants (86%) reported that they planned to consume the entire

meal from the outset, and then proceeded to clean their plate. Of the meals that were consumed in their entirety (total = 91%), consumption was planned from the outset in 92% of cases.

Question 3: Do within-meal experiences influence meal size?

Our analysis revealed that plan modification took place in only 18% of meals (expressed by a positive response to item 7 *or* 8). By contrast, plan preservation was relatively common. Fifty seven percent of our participants reported that they could have eaten more food had it been available and 28% reported plate cleaning despite reaching satiation earlier in the meal. In 77% of these latter cases the explanation given was to 'avoid wasting food'. Frequencies and associated chi-square statistics are provided in Table 4.

Evaluating predictors of plate-cleaning behaviour

The variables identified by chi-square analysis as significant moderators of plate-cleaning behaviour (see Table 3) were entered into a logistic regression model in order to examine their relative predictive importance. These candidate variables were meal type, setting, selection of portion of food, eating less than anticipated due to satiation, being able to eat more, eating all despite reaching satiation and gender of participant. All variables were entered in one block. As meal type had three levels (breakfast, lunch and dinner), three dummy variables were created and entered into the model. One of these (dinner) was deemed to be redundant; its degrees of freedom were automatically reduced to zero and it was excluded from the model. Eleven participants (1%) had missing cases and their data were automatically excluded. The initial model (constant before independent variables were added) correctly classified 91% of participants, based on the default prediction that all participants would consume the entire meal.

A summary of the constant and final models is reported in Table 5. Examination of the Wald statistic and the odds ratio (Exp(B)) showed that the following variables: the presence of a pre-meal plan, the meal being breakfast, the meal being lunch, the portion being self-selected and eating less than anticipated due to satiation, all significantly increased the likelihood that the meal would be consumed in its entirety. The variable regarding the meal being prepared at home narrowly missed significance and is reported in Table 5. For example, participants were 6.7 times more likely to eat their entire meal if they planned to do so from the outset. Statistically, the strongest predictor of meal completion was the variable 'eating less than anticipated due to satiation'. Specifically, a strong correspondence was observed between plate cleaning and not eating less than anticipated; that is, the majority of people did not deviate from their pre-meal plan.

Individual differences

Chi-square analyses revealed a significant relationship between gender and plate cleaning, questionnaire item 9 (could have eaten more), and item 10 (ate less than anticipated due to reaching satiation). While males made up only 22% of the sample, as mentioned above (see Research Question 1) they reported a higher incidence of plate cleaning than females (97% of meals were eaten in their entirety compared with 89% for females; χ^2 (1) = 10.13, p <.001). A greater proportion of males than females reported being able to eat more at the end of the meal (70% compared with 53%; χ^2 (1) = 15.80, p <.001). However, more females than males ate less than planned due to reaching satiation (8% females compared with 1% males; χ^2 (1) = 10.29, p <.001). No individual differences were found regarding BMI, dieting status or age.

Discussion

Our results show that, in free-living participants, consumption at most meals is planned in advance and that meal planning tends to coincide with plate cleaning (*i.e.*, 'we eat what we place on our plate' (Brunstrom, Scott-Samuel, & Shakeshaft, 2008)). Indeed, in line with our first two research questions, plate cleaning occurred in 91% of meals, of which 92% were planned in advance. To date, only a relatively small number of studies have focused on self-reports relating to meal size and meal termination. For example, Mook and Votaw (1992) and Zylan (1996) found that fullness was the most common explanation for stopping eating. By contrast, Hetherington (1996) and Tuomisto *et al.* (1998) found that satiation was acknowledged by only a small proportion of respondents, whereas the majority tended to cite hedonic factors such as tiring of the food. Importantly, these studies did not include questions on planning and plate cleaning.

The most important predictors of plate cleaning were those relating to pre-meal planning. Moreover, in answer to our third research question, plans formed before a meal began were found to be resistant to modification over its course, as shown by the finding from the analysis of frequencies that 28% of participants reported plate cleaning despite having reached satiation. Further, in many cases satiation was poorly associated with intake; for example, only 7% reported eating less than expected due to satiation, and 57% reported being able to consume more food at the end of the meal. Indeed, logistic regression confirmed that within-meal consumption factors were poor predictors of plate cleaning.

Based on the above, we conclude that meal size is typically planned in advance and that satiation often plays a secondary role in determining the amount of food that is consumed. This contrasts the prevailing view which emphasises satiation (fullness) as the primary control of meal termination (Blundell, et al., 2010; Blundell, Rogers, & Hill, 1987). Typically meal size is studied using an *ad-libitum* eating paradigm in which participants are encouraged to eat until they feel comfortably full. Our findings suggest that this type of behaviour is rarely observed outside the laboratory, raising questions about the explanatory value of this approach.

Notwithstanding the above point, these findings do not negate a role for satiation in the control of meal size. Research has shown that expected satiation plays an important role in determining meal-size decisions (Brunstrom & Rogers, 2009). These expectations may be governed by the satiation that is experienced after a food has been consumed. Specifically, an association may form between the sensory characteristics of the meal (taste, volume etc.) and the visceral sensations that are experienced upon meal completion (Brunstrom, 2005, 2007). These associations are especially likely to form or change when a mismatch exists between expected and actual satiation (Wilkinson & Brunstrom, 2009). These learned expectations enable anticipatory control of meal size in the pre-meal planning stage, and thus inform subsequent meal size decisions (Brunstrom, 2007, 2008; Higgs, 2005). The high observed incidence of plate cleaning at meals prepared by the individual (when in full control of their meal), and for those that tend to have low variability (i.e. breakfast), may suggest that the amount chosen is refined through such learning processes.

The context in which the meal was prepared and consumed was found to moderate the tendency to engage in plate cleaning. While plate cleaning was prevalent (at least 77% consumed their entire meal in all contexts), participants were especially likely to eat their entire

meal on occasions when the respondent had control over their portion and to a lesser extent when the meal was prepared at home. This may suggest that individuals have learned the appropriate amount of food for a meal, and plan and consume those meals accordingly. Lastly, while the majority of findings were consistent across individuals (across BMI, age and dieting status), three gender differences were observed. Males were more likely than females to consume their whole meal and to report being able to eat more, whereas females were more likely to decrease their consumption from planned in response to feelings of satiation. The lower incidence of plate cleaning in females, and fewer reports of being able to eat more, are consistent with gender stereotypes; individuals eating smaller meals are rated as more feminine and less masculine (Bock & Kanarek, 1995; Chaiken & Pliner, 1987; Pliner & Chaiken, 1990). Moreover, females tend to be more motivated to control their weight and restrain their eating behaviour (Westenhoefer, 2005). The responses from the present study may, therefore, be indicative of a more restrained eating style in females. However, as trait eating behaviours were not assessed here, more data would be necessary in order to establish restraint as an influence on meal size and plate cleaning in females.

Our conclusions are based on data from a large cohort. Nevertheless, we are aware of limitations in our methodology that might be addressed in future work. Notably, the simplicity of the questionnaire items used to investigate plate cleaning, planning and within-meal experiences means that a degree of interpretation is required. In this way, the underlying reasons for the meal-time behaviours observed may be somewhat obscured. For example, the role of planning in behaviours such as taking further helpings is unknown, as is the basis on which participants reported being able to eat more. Further, it is possible that responses given to questionnaire item 10a in particular may have been affected by questionnaire design. While a

positive response to one or more of the items suggested was not obligatory, the addition of a free-response option might widen the scope of reasons for overconsumption. Future refinements may clarify these issues, and we suggest that these findings be validated by direct observation.

The advantages and disadvantages associated with retrospective self-report experimental designs are discussed elsewhere (Brunstrom, Mitchell, & Baguley, 2005). One potential concern is that participants may deliberately give false information due to concerns over creating a negative impression (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). However, this is perhaps less likely in the present study given the anonymity of an online questionnaire. A second concern relates to the reliability and accuracy of memory. However, as the present study concerned the last meal eaten, time between the meal and questionnaire completion was minimal. Taking these methodological considerations into account, we may conclude from the present evidence that meal size is determined primarily by planning occurring in the period before the meal begins. We would suggest that the role of meal planning has, to date, been overlooked in the study of meal size, and that the relative importance of satiation at the time of eating has been overstated.

As pre-meal plans would seem to be a key determinant of meal size, it follows that for successful weight control the planned amount to be eaten should be an accurate reflection of the individual's energetic needs. It is well documented that commercially available portions are increasing in size, both in restaurants and home cooking (Nielsen & Popkin, 2003; Young & Nestle, 2002), and that larger than necessary meals promote passive overconsumption (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Rolls, Roe, Kral, Meengs, & Wall, 2004; Rolls, Roe, Meengs, & Wall, 2004). Our evidence suggests that, rather than being a passive process, eating behaviour is cognitive in nature, dynamically changing through repeated experience.

Notwithstanding, we do see some evidence of passive overconsumption in some cases. For example, 35% of participants were aware that their meal was larger than necessary to achieve satiation, as they reported having reached satiation with some food remaining (total positive responses to questionnaire items 7 and 10; see Table 4). Faced with this surplus, 28% of the whole sample continued eating in order to finish the portion, whereas only 7% reduced their intake from planned. Therefore, adherence to meal-size plans with little or no adjustment for satiation may result in miscalculated intake, and potentially a considerable surplus which could impact on weight control.

In summary, our results suggest that meal planning and plate cleaning are both commonplace behaviours. At the majority of meals, individuals appear to form a plan in advance to finish the entire portion, which is then executed. By contrast, we find that fullness plays a relatively modest role in determining meal size. Together, these findings challenge the extent to which measures of *ad libitum* eating capture key processes that govern the control of meal size in humans. Our evidence suggests the potential for significant theoretical advance by understanding the cognitive processes prior to consumption, such as meal planning and expected satiety (Brunstrom, 2005).

Acknowledgment

This research was supported by a BBSRC-DRINC grant (ref: BB/G005443/1).

References

Bellisle, F., Dalix, A. M., & Slama, G. (2004). Non food-related environmental stimuli induce increased meal intake in healthy women: comparison of television viewing versus listening to a recorded story in laboratory settings. *Appetite, 43*(2), 175-180.

Blass, E. M., Anderson, D. R., Kirkorian, H. L., Pempek, T. A., Price, I., & Koleini, M. F. (2006). On the road to obesity: Television viewing increases intake of high-density foods. *Physiology & Behavior, 88*(4-5), 597-604.

Blevins, J. E., & Baskin, D. G. (2009). Hypothalamic-Brainstem Circuits Controlling Eating *Frontiers in Eating and Weight Regulation* (Vol. 63, pp. 133-140). Basel: Karger.

Blundell, J. E., de Graaf, C., Hulshof, T., Jebb, S., Livingstone, B., Lluch, A., et al. (2010). Appetite control: methodological aspects of the evaluation of foods. *Obesity Reviews, 11*(3), 251-270.

Blundell, J. E., Rogers, P. J., & Hill, A. J. (1987). Evaluating the satiating power of foods: implications for acceptance and consumption. . In J. Solms, D. A. Booth, R. M. Pangbourne & O. Raunhardt (Eds.), *Food Acceptance and Nutrition* (pp. 205-219). London: Academic Press.

Bock, B. C., & Kanarek, R. B. (1995). Women and men are what they eat: The effects of gender and reported meal size on perceived characteristics. *Sex Roles, 33*(1), 109-119.

Bowman, S. A. (2006). A comparison of the socioeconomic characteristics, dietary practices, and health status of women food shoppers with different food price attitudes. *Nutrition Research, 26*(7), 318-324.

Brunstrom, J. M. (2005). Dietary learning in humans: Directions for future research. *Physiology & Behavior, 85*(1), 57-65.

Brunstrom, J. M. (2007). Associative learning and the control of human dietary behavior. *Appetite, 49*(1), 268-271.

Brunstrom, J. M. (2008). The role of learning in expected satiety and decisions about portion size. *Appetite, 51*(2), 356-356.

Brunstrom, J. M., Mitchell, G. L., & Baguley, T. S. (2005). Potential early-life predictors of dietary behaviour in adulthood: a retrospective study. *International Journal of Obesity, 29*(5), 463-474.

Brunstrom, J. M., & Rogers, P. J. (2009). How many calories are on our plate? Expected fullness, not liking, determines meal-size selection. *Obesity, 17*, 1884-1890.

Brunstrom, J. M., Scott-Samuel, N. E., & Shakeshaft, N. G. (2008). Exploring expectations about the satiating quality of foods. *Appetite, 50*(2-3), 556-556.

Chaiken, S., & Pliner, P. (1987). Women, but not Men, Are What They Eat. *Personality and Social Psychology Bulletin, 13*(2), 166-176.

Diliberti, N., Bordi, P. L., Conklin, M. T., Roe, L. S., & Rolls, B. J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obesity research, 12*(3), 562-568.

Grill, H. J. (2010). Leptin and the systems neuroscience of meal size control. *Frontiers in Neuroendocrinology, 31*(1, Sp. Iss. SI), 61-78.

Hebert, J. R., Clemow, L., Pbert, L., Ockene, I. S., & Ockene, J. K. (1995). Social Desirability Bias in Dietary Self-Report May Compromise the Validity of Dietary-Intake Measures. *International Journal of Epidemiology, 24*(2), 389-398.

Hellstrom, P. M., Geliebter, A., Naslund, E., Schmidt, P. T., Yahav, E. K., Hashim, S. A., et al. (2004). Peripheral and central signals in the control of eating in normal, obese and binge-eating human subjects. *British Journal of Nutrition, 92*, S47-S57.

Hetherington, M. M. (1996). Sensory-specific satiety and its importance in meal termination. *Neuroscience and Biobehavioral Reviews, 20*(1), 113-117.

Hetherington, M. M., Anderson, A. S., Norton, G. N. M., & Newson, L. (2006). Situational effects on meal intake: A comparison of eating alone and eating with others. *Physiology & Behavior, 88*(4-5), 498-505.

Higgs, S. (2005). Memory and its role in appetite regulation. *Physiology & Behavior, 85*(1), 67-72.

Koh, J., & Pliner, P. (2009). The effects of degree of acquaintance, plate size, and sharing on food intake. *Appetite, 52*(3), 595-602.

Mook, D. G., & Votaw, M. C. (1992). How important is hedonism? Reasons given by college students for ending a meal. *Appetite, 18*(1), 69-75.

Nielsen, S. J., & Popkin, B. M. (2003). Patterns and trends in food portion sizes, 1977-1998. *Journal of the American Medical Association, 289*, 450-453.

Nisbett, R. E. (1968). Taste, deprivation, and weight determinants of eating behavior. *Journal of Personality and Social Psychology, 10*(2), 107-116.

Pliner, P. (1982). The Effects of Mere Exposure on Liking for Edible Substances. *Appetite, 3*(3), 283-290.

Pliner, P., & Chaiken, S. (1990). Eating, social motives, and self-presentation in women and men. *Journal of Experimental Social Psychology, 26*(3), 240-254.

Pliner, P., & Mann, N. (2004). Influence of social norms and palatability on amount consumed and food choice. *Appetite, 42*(2), 227-237.

Rolls, B. J., Morris, E. L., & Roe, L. S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *American Journal of Clinical Nutrition, 76*(6), 1207-1213.

Rolls, B. J., Roe, L. S., Kral, T. V. E., Meengs, J. S., & Wall, D. E. (2004). Increasing the portion size of a packaged snack increases energy intake in men and women. *Appetite, 42*(1), 63-69.

Rolls, B. J., Roe, L. S., Meengs, J. S., & Wall, D. E. (2004). Increasing the portion size of a sandwich increases energy intake. *Journal of the American Dietetic Association, 104*(3), 367-372.

Rolls, B. J., Rolls, E. T., Rowe, E. A., & Sweeney, K. (1981). Sensory specific satiety in man. *Physiology & Behavior, 27*(1), 137-142.

Tuomisto, T., Tuomisto, M. T., Hetherington, M. M., & Lappalainen, R. (1998). Reasons for initiation and cessation of eating in obese men and women and the affective consequences of eating in everyday situations. *Appetite, 30*(2), 211-222.

Wansink, B., & Cheney, M. M. (2005). Super bowls: Serving bowl size and food consumption. *Journal of the American Medical Association, 293*(14), 1727-1728.

Wansink, B., & Payne, C. R. (2008). Eating behavior and obesity at Chinese buffets. *Obesity, 16*(8), 1957-1960.

Wansink, B., van Ittersum, K., & Painter, J. E. (2006). Ice cream illusions - Bowls, spoons, and self-served portion sizes. *American Journal of Preventive Medicine, 31*(3), 240-243.

Westenhoefer, J. (2005). Age and gender dependent profile of food choice. . *Forum of Nutrition, 57*, 44-51.

Yeomans, M. R. (1996). Palatability and the micro-structure of feeding in humans: The appetizer effect. *Appetite, 27*(2), 119-133.

Yeomans, M. R., Blundell, J. E., & Leshem, M. (2004). Palatability: response to nutritional need or need-free stimulation of appetite? *British Journal of Nutrition, 92*, S3-S14.

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health, 92*(2), 246-249.

Zorrilla, E. P., Inoue, K., Fekete, E. M., Tabarin, A., Valdez, G. R., & Koob, G. F. (2005). Measuring meals: structure of prandial food and water intake of rats. *American Journal of Physiology: Regulatory, Integrative and Comparative Physiology, 288*(6), R1450-1467.

Zylan, K. D. (1996). Gender Differences in the Reasons Given for Meal Termination. *Appetite, 26*(1), 37-44.

Table 1: Questionnaire items with response options, in order of presentation

	Questionnaire item	Response options
Contextual factors		
	1. What was the meal?	Breakfast Lunch Dinner
	2. Was the meal prepared at home or served from a restaurant or café?	Home Restaurant/café
	3. Did you select the type of food or did somebody else?	Selected myself Somebody else
	4. Did you select the portion size or did somebody else?	Selected myself Somebody else
Research question		
1. Plate cleaning	5. Did you eat all the food on your plate?	Yes No
2. Pre-meal planning	6. Did you know you were going to eat all of the food/leave some food at the beginning of the meal? [deleted as appropriate]	Yes No
3. Within-meal experiences	7. Did you end up eating less of the meal than you anticipated (at the beginning) because you felt too full?	Yes No
	8. In your last meal did you start eating and then help yourself to even more food part-way through the meal?	Yes No
	9. At the end of your last meal could you have eaten even more?	Yes No
	10. In your last meal did you eat all of the food on your plate even though you felt full and could have stopped before that point?	Yes No
	10a. If yes, which of the following applies? Feel free to select more than one option.	
	i. I ate more because I didn't want to waste food	Yes
	ii. I ate more because the food cost a lot of money	Yes
	iii. I ate more because I knew I wasn't going to eat again for some time	Yes
	iv. I ate more because I didn't want to hurt somebody's feelings (e.g., because they cooked the food for me)	Yes

Table 2: Frequency of plate cleaning in the presence of contextual factors (questionnaire items 1-4)

Context	% of total	Qu. item	Entire meal consumed		χ^2 (df= 1)[1]	p
			Yes (n) (relative %)	No (n) (relative %)		
Meal type		1				
Breakfast	27		204 (99%)	1 (1%)	201.0	<.001
Lunch	39		266 (89%)	33 (11%)	181.6	<.001
Dinner	34		225 (87%)	35 (13%)	138.8	<.001
Meal preparation setting		2				
Home	81		578 (94%)	38 (6%)	473.4	<.001
Restaurant/café	19		117 (79%)	31 (21%)	50.0	<.001
Meal type selection		3				
Self	86		607 (92%)	53 (8%)	465.0	<.001
Other	14		88 (85%)	16 (15%)	49.8	<.001
Meal portion selection		4				
Self	80		579 (95%)	34 (5%)	484.5	<.001
Other	20		116 (77%)	35 (23%)	43.5	<.001

[1] Chi-square analyses were conducted on raw frequency data.

Table 3: Chi-square statistics examining associations between plate cleaning and all questionnaire items

Variable (association with plate cleaning)	χ^2 ($df = 1$)[1]	p
Meal type	25.89[2]	<.001
Meal setting	31.72	<.001
Selection of type of food	5.92	.03
Selection of portion of food	45.85	<.001
Meal planning	250.90	<.001
Eating less than anticipated due to reaching satiation	330.20	<.001
Choosing more food during the meal	.92	.34
Being able to eat more	25.98	<.001
Eating all despite reaching satiation	26.43	<.001
Gender of individual	10.13	<.001
Dieting status of individual	3.55	.06
BMI of individual	$r = .03$[3]	.39
Age of individual	$r = .05$[3]	.15

[1]Chi-square analyses were conducted on raw frequency data.

[2]$df = 2$

[3] Continuous variables on which a point-biserial correlation was conducted.

Table 4: Response frequencies of questionnaire items addressing within-meal experiences.

Questionnaire construct	Item number	Response frequency: Yes (*n*) (% of total)	Response frequency: No (*n*) (% of total)	χ^2 ($df = 1$)[1]	*p*
Eating less than anticipated due to satiation	7	49 (7%)	707 (93%)	572.70	<.001
Taking further helpings	8	94 (12%)	670 (88%)	434.26	<.001
Being able to eat more	9	432 (57%)	332 (43%)	13.09	<.001
Eating entire portion despite reaching satiation	10	214 (28%)	546 (72%)	145.03	<.001
To avoid wasting food	10a[2]	166 (22%)			
To compensate for a long inter-meal gap	10a	67 (9%)			
Because the food cost a lot of money	10a	48 (6%)			
To avoid hurting someone's feelings	10a	11 (1%)			

[1] Chi-square analyses were conducted on raw frequency data.

[2]Item 10a only concerned participants who had responded positively to item 10. Participants were instructed to select all statements with which they agreed; therefore overlap in responses was possible.

Table 5: Summary of initial and final logistic regression models predicting plate cleaning with all variables entered.

Variable	B	SE	Wald	*df*	*p*	Exp(B)	95% CI	
							Lower	Upper
Constant (Step 0)	2.39	.13	330.74	1	<.001	10.95		
Eating less than anticipated due to satiation	-3.46	.56	38.41	1	<.001	.03	.01	.09
Meal planning	1.90	.45	18.22	1	<.001	6.70	2.78	16.05
Meal portion selection	1.31	.53	6.20	1	<.05	3.70	1.32	10.36
Last meal as breakfast	2.59	1.11	5.47	1	<.05	13.34	1.52	116.96
Last meal as lunch	.92	.45	4.15	1	<.05	2.50	1.04	6.03
Meal preparation setting	1.05	.54	3.81	1	.051	2.87	1.00	8.27

R^2 = .68 (Nagelkerke), .30 (Cox and Snell)

Figure 1: Correspondence between plate cleaning (entire portion or less than entire portion consumed) and a pre-meal plan to consume the entire meal (consumption planned or unplanned).

Figure 1

Click here to download high resolution image