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Influence of BMI and dietary restraint on self-selected portions of prepared meals in US women

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ABSTRACT

The rise of obesity prevalence has been attributed in part to an increase in food and beverage portion sizes selected and consumed among overweight and obese consumers. Nevertheless, evidence from observations of adults is mixed and contradictory findings might reflect the use of small or unrepresentative samples. The objective of this study was i) to determine the extent to which BMI and dietary restraint predict self-selected portion sizes for a range of commercially available prepared savoury meals and ii) to consider the importance of these variables relative to two previously established predictors of portion selection, expected satiation and expected liking. A representative sample of female consumers ($N = 300$, range 18–55 years) evaluated 15 frozen savoury prepared meals. For each meal, participants rated their expected satiation and expected liking, and selected their ideal portion using a previously validated computer-based task. Dietary restraint was quantified using the Dutch Eating Behaviour Questionnaire (DEBQ-R). Hierarchical multiple regression was performed on self-selected portions with age, hunger level, and meal familiarity entered as control variables in the first step of the model, expected satiation and expected liking as predictor variables in the second step, and DEBQ-R and BMI as exploratory predictor variables in the third step. The second and third steps significantly explained variance in portion size selection (18% and 4%, respectively). Larger portion selections were significantly associated with lower dietary restraint and with lower expected satiation. There was a positive relationship between BMI and portion size selection ($p = 0.06$) and between expected liking and portion size selection ($p = 0.06$). Our discussion considers future research directions, the limited variance explained by our model, and the potential for portion size underreporting by overweight participants.

1. Introduction

Results from National Health and Nutrition Examination Survey (NHANES) indicate that the prevalence of obesity among US adults rose from 23% to 35% between 1988 and 2012 (Ogden, Carroll, Kit, & Flegal, 2014). Portion size is widely regarded as an important driver of overconsumption, in part, because people tend to consume all of the food portion they select; *i.e.*, they 'plate clean' (Wansink & Johnson, 2015). This view is supported by an association between trends in obesity and corresponding changes in food portion sizes in the US (Duffey & Popkin, 2011). Nevertheless, it remains unclear whether (and to what extent) BMI and/or adiposity is associated with the selection of larger portions.

Previously, a positive relationship between BMI and self-selected portion sizes has been identified in a secondary analysis of national dietary surveys, both in an adult Swedish population (Berg et al., 2009) and in children in the US (Herman, Polivy, Pliner, & Vartanian, 2015; Huang, Howarth, Lin, Roberts, & McCrory, 2004; McConahy, Smiciklas-Wright, Birch, Mitchell, & Picciano, 2002), and in two acute studies performed among US children (Fisher, Liu, Birch, & Rolls, 2007; Mooreville et al., 2015). In another study students with a higher BMI were found to select larger portions (Burger, Kern, & Coleman, 2007), however other studies in adults

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report a weak or no association (Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Ferriday & Brunstrom, 2011; Rolls, Roe, Meengs, & Wall, 2004; Rolls, Morris, & Roe, 2002; Rolls, Roe, Kral, Meengs, & Wall, 2004). These inconsistencies may reflect the use of small sample sizes (range: 51–104, Mean = 74.6, *SD* = 24.7 across the studies cited) or otherwise a tendency to recruit participants with a relatively narrow range of BMIs or from particular populations (e.g., university students). To address these concerns we sought to determine the relationship between BMI and portion selection in a larger sample, recruited to provide a broader representation of adult females in the US and with a typical wide range of variation in BMI. In addition to body weight, dietary restraint may also influence selected portion sizes. However, again, the evidence for this association has been mixed, some studies suggest that dietary restraint promotes the selection of smaller portions (Brunstrom et al., 2008; Gorman & Allison, 1995) and others do not (Rolls, Roe, & Meengs, 2006; Rolls et al., 2004; Wilkinson et al., 2012).

Although the impact of individual characteristics (BMI and dietary restraint) on self-selected portion size remains unclear, evidence supporting a role for expectations generated by foods has been more consistent. Indeed, expected liking appears to play a role (Brogden & Almiron-Roig, 2010; Brunstrom & Shakeshaft, 2009; Labbe, Rytz, Godinot, Ferrage, & Martin, 2017; Spence et al., 2016) and, in particular, expected satiation (anticipated fullness from a food) has also been identified as an important determinant of portion selection. The relationship between expected satiation and self-selected portion size has been demonstrated in several studies combining diverse meals, snacks (Brunstrom & Rogers, 2009; Brunstrom & Shakeshaft, 2009) and calorie-containing beverages (Brogden & Almiron-Roig, 2011). Indeed, repeated exposure modifies the satiation that is expected from a food (Irvine, Brunstrom, Gee, & Rogers, 2013; Wilkinson & Brunstrom, 2009) which in turn impacts future portion size selection (McCrickerd & Forde, 2016).

The objective of the current study was to determine whether dietary restraint and/or BMI of a large cohort of adult females is associated with self-selected portions across a wide range of commercially available single-serve frozen lunchtime meals. The current trial focused on female participants, as they were the most regular users of the frozen pre-prepared meal category. They were recruited to ensure that the sample represented a wide variation in age (18–55 years) and comprised participants who were highly familiar with frozen prepared meal category. We hypothesized that beyond the predictive role of expected satiation and expected liking, both BMI and dietary restraint would further explain variance in portion selection. Specifically, we reasoned that relatively large portions would be selected by participants with a higher BMI and by participants with low dietary restraint.

Expected satiation and measures of 'ideal portion size' were obtained using screen-based psychophysical tools. These tools, which have been validated previously in a study showing that estimated portion size for pasta sauce predicted actual self-selected portion and food intake (Wilkinson et al., 2012), enable participants to assess a large number of foods in a single test session, without the need for meal preparation. For reviews of this approach see Forde, Almiron-Roig, and Brunstrom (2015, 2014).

2. Materials and methods

2.1. Participants

A sample of 300 females from the Chicago metropolitan area were recruited to complete a series of computer tasks at a central location. Participants were excluded if they had an eating disorder or if they were not a regular frozen prepared meal consumer (frequency consumption below once a week). Participants were not pregnant, did not report any specific intolerances, aversions or dietary restrictions (i.e. vegetarians, pork aversion), were not currently dieting, and had been weight stable for the previous 12 months (<5 kg change in body weight). Participants were recruited to have an equal distribution across a wide range or ages with four groups of (n = 75) between 18 and 25, 26–35, 36–45 and 46–55 years (age *M* = 36.8 y, *SD* = 11.2). Each participant consented before participating in the study and received an incentive for their time after completing the study. The study was assessed and approved internally as having met the ethical criteria considered appropriate for consumer and sensory studies of this nature.

2.2. Test meal images

Fifteen commercially available single-serving frozen test meals were selected for the study including: lasagne with meat sauce, macaroni and cheese, parmesan crusted fish, four cheese pizza, pepperoni pizza, spaghetti and meat sauce, Salisbury steak with macaroni and cheese, Santa Fe Mexican rice and beans, shrimp Alfredo, steak tips portabella, salmon and basil pasta, baked chicken, butternut squash ravioli, chicken enchilada suiza and sesame chicken. Meals were selected to represent a diverse set of different meal component combinations, cultural styles, familiarity and energy densities (Range: 75.2–211.6 Kcal/100 g, Mean = 114.4 Kcal/100 g, *SD* = 40.3 Kcal/100 g).

Test meals were photographed in line with the protocol for stimuli preparation outlined in Brunstrom, Rogers, et al. (2008) and Brunstrom, Shakeshaft, et al. (2008). Each meal was presented on a standard 255-mm white plate and images were taken in 51 different portion sizes. In each case, picture 25 corresponded to the commercially available pre-packaged portion size and pictures 1 and 51 represented 33% and 300% of the calorie content of picture 25. Across this range the portion size increased in equally-spaced logarithmic steps. Logarithmic spacing enabled a broad range of portion sizes to be taken with a roughly equal discriminable distance between adjacent images.

To assess expected satiation (methods outlined below) images of the 15 test meals were compared against images of four highly familiar 'comparison' meals; chicken fried rice, steak fries, meat loaf and potatoes and spaghetti bolognaise. In all images, the name of the meal was included. To maintain consistency, all images were taken with the same lighting, viewing angle, and camera settings.

2.3. Test measures

At the beginning of the test session, participants rated their hunger. They then completed the expected satiation task and provided measures of expected liking, self-selected portion sizes, familiarity. Within each measure, the presentation order of the test meals was randomized, both within and across participants. At the end of the test session participants completed the DEBQ-R and the test supervisors recorded the height and weight of each participant.

2.4. Hunger

Since estimates of portion size were likely to co-vary according to the level of hunger (Brogden & Almiron-Roig, 2010), each participant rated their hunger using a 100-mm visual-analogue scale, anchored from "not all hungry" to "extremely hungry".

2.5. Expected satiation

Expected satiation was quantified using a 'Matched Fullness'