Appetite 98 (2016) 95–100

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

Increasing the size of portion options affects intake but not portion selection at a meal☆

Faris M. Zuraikat [a], Liane S. Roe [a], Gregory J. Privitera [b], Barbara J. Rolls [a, *]

[a] Department of Nutritional Sciences, The Pennsylvania State University, USA
[b] Department of Psychology, Saint Bonaventure University, USA

ARTICLE INFO

Article history:
Received 20 November 2015
Received in revised form
17 December 2015
Accepted 19 December 2015
Available online 23 December 2015

Keywords:
Portion size
Portion selection
Energy intake
Eating environment

ABSTRACT

In an environment with large portion sizes, allowing consumers more control over their portion selection could moderate the effects on energy intake. We tested whether having subjects choose a portion from several options influenced the amount selected or consumed when all portion sizes were systematically increased. In a crossover design, 24 women and 26 men ate lunch in the lab once a week for 3 weeks. At each meal, subjects chose a portion of macaroni and cheese from a set of 3 portion options and consumed it *ad libitum*. Across 3 conditions, portion sizes in the set were increased; the order of the conditions was counterbalanced across subjects. For women the portion sets by weight (g) were 300/375/450, 375/450/525, and 450/525/600; for men the portions were 33% larger. The results showed that increasing the size of available portions did not significantly affect the relative size selected; across all portion sets, subjects chose the smallest available portion at 59% of meals, the medium at 27%, and the largest at 15%. The size of portions offered did, however, influence meal intake ($P < 0.0001$). Mean intake (±SEM) was 16% greater when the largest set was offered (661 ± 34 kcal) than when the medium and smallest sets were offered (both 568 ± 18 kcal). These results suggest that portions are selected in relation to the other available options, and confirm the robust effect of portion size on intake. Although presenting a choice of portions can allow selection of smaller amounts, the sizes offered are a critical determinant of energy intake. Thus, the availability of choices could help to moderate intake if the portions offered are within an appropriate range for energy needs.

1. Introduction

The portion size of food is an environmental factor with one of the strongest and most consistent influences on intake. Numerous studies show that serving larger portions leads to increased consumption of a variety of foods and in many settings (Benton, 2014; English, Lasschuijt, & Keller, 2015; Rolls, 2014). In an environment where large portions are prevalent (Young & Nestle, 2012), it is important to identify effective strategies to counter their influence on consumption. One potential strategy is to allow consumers more control by offering a range of portion sizes from which to choose (Vermeer, Steenhuis, & Seidell, 2010). The current study tested how both selection and intake from a range of portion sizes were affected when the size of all available portions was increased.

A previous study investigated whether allowing subjects greater control over the amount of food on their plates attenuated the effect of portion size on intake (Rolls, Morris, & Roe, 2002). As the amount of the pasta dish was increased across meals, some subjects were served a pre-plated portion and other subjects served their own portion from a serving dish onto the plate. The food used in that study was macaroni and cheese, which is amorphous in shape; such foods are commonly used in portion size studies rather than foods served in discrete pieces, which may encourage consumption of whole units (Geier, Rozin, & Doros, 2006). It was found that the influence of portion size on intake was not affected by whether the amount of food on the plate was determined by the subject or the researcher; for both groups, increases in the amount of available food led to increased intake. It is possible that allowing subjects to choose the size of their meal from several pre-plated options, presented at the same time, would moderate intake when portion sizes are increased (Vermeer, Steenhuis, & Seidell, 2009; Vermeer,

☆ Funded by the National Institute of Diabetes and Digestive and Kidney Diseases (R01-DK059853).

* Corresponding author. Department of Nutritional Sciences, The Pennsylvania State University, 226 Henderson Building, University Park, PA 16802, USA.
E-mail address: bjr4@psu.edu (B.J. Rolls).

http://dx.doi.org/10.1016/j.appet.2015.12.023
0195-6663/

Steenhuis & Seidell, 2010). In most previous studies, only one portion size of each food was offered at a meal. This may have led subjects to determine intake based on the amount of food available, either due to habit (Rolls et al., 2002) or a perception that the amount offered was appropriate (Herman, Polivy, Pliner, & Vartanian, 2015). Offering subjects a range of portions could modify the portion size effect by providing visual cues that help consumers assess the amount of food most appropriate to meet their particular needs (Vermeer, Steenhuis & Seidell, 2010) or to match their personal norms (Lewis, Forwood et al., 2015).

The effect of offering a choice of portion sizes on the amount of food selected has been tested in a few studies, but only in conjunction with other factors such as cost (Vermeer, Alting, Steenhuis, & Seidell, 2009; Vermeer, Steenhuis, Leeuwis, Heymans, & Seidell, 2011) and portion size labeling (Vermeer, Steenhuis, Leeuwis et al., 2010). Moreover, the effect of portion selection on intake was not measured. Given the current eating environment (Young & Nestle, 2012), it is important to evaluate the effectiveness of offering portion options in moderating intake when the size of all available portions is increasing. Thus, we tested how offering a choice of portions of macaroni and cheese, with those options varying in size on different occasions, would affect portion selection and intake at a meal. We hypothesized that subjects would choose their portion in relation to the sizes of the other available portions, rather than by the absolute magnitude. Consequently, when the sizes of all available portions were increased, subjects would select and consume greater amounts of food. Alternatively, as the size of the portion options increased, subjects might notice this difference and choose relatively smaller portions. In an environment of increasing amounts of food, assessing the response to portion options will help evaluate a potential strategy to counter the effect of large portions on energy intake.

2. Methods

2.1. Subject recruitment and characteristics

Participants were recruited through advertisements placed in local and university newspapers and fliers posted on campus. Potential subjects were interviewed by telephone to determine whether they met preliminary inclusion criteria: 18–45 years old, regularly ate three meals per day, did not smoke, were not athletes in training, did not report any food allergies or restrictions, did not take any medications affecting appetite, and were willing to eat the food served at test meals. Individuals who met these criteria came to the laboratory to have their height and weight measured and to complete three questionnaires: the Zung Self-Rating Scale to assess symptoms of depression (Zung, 1986), the Eating Attitudes Test to assess disordered attitudes toward eating or food (Garner, Olmsted, Bohr, & Garfinkel, 1982), and the Eating Inventory to assess dietary restraint, disinhibition, and tendency toward hunger (Stunkard & Messick, 1985). Potential subjects were only enrolled in the study if their body mass index was 18–35 kg/m^2 and they scored <40 on the Zung Scale and <19 on the Eating Attitudes Test.

A power analysis estimated that 42 subjects would be needed to detect a 50 g difference in intake between sets of portion options at 80% power and a significance level of 0.05. Fifty subjects were enrolled and all of them completed the study; subject characteristics are shown in Table 1. Twenty-three subjects (46%) were overweight and two (4%) were obese. Subjects completed signed consent and were financially compensated for their participation in the study. All procedures were approved by the Office for Research Protections of The Pennsylvania State University.

2.2. Experimental design

This study used a crossover design with repeated measures; subjects came to the laboratory to eat lunch once a week for three weeks. At each meal, subjects were shown a set of three portion sizes of food, selected one for their lunch, and consumed it *ad libitum*. In this experiment, a "set" is defined as three plates of the test food, with each plate containing a different weight of food. Across the three meals, the portion sizes offered in the sets were varied, from Set 1 with the smallest options to Set 3 with the largest options (Table 2). The order of presenting the sets of portion sizes across occasions was counterbalanced across subjects. The three portions within each set are identified by their relative portion size (smallest, medium, or largest); this description indicates the size of the portion *relative* to the other portions in the set, rather than the absolute weight of the portion. In all sets, the portion sizes offered to women were 75% of the portion sizes offered to men.

2.3. Experimental meals

The test food served at all meals was macaroni and cheese (Kraft Foods Group Inc., Northfield, IL, USA) with an energy density of 6.6 kJ/g [1.6 kcal/g], which was presented on standard dinner plates (diameter 26 cm [10.25 in]). After selecting a portion from the three sizes offered in the set, subjects were seated in a cubicle with the food and 1 L of tap water and were instructed to eat and drink as much as they wanted.

Across the three test meals, subjects were offered each of the three sets of portion sizes shown in Table 2. A total of five different portion sizes were served across the three sets. The smallest portion offered in Set 1 was similar to the mean intake of the same food (300 g for women, 400 g for men) in previous laboratory studies (Rolls et al., 2002; Rolls, Roe, Halverson, & Meengs, 2007). The smallest portion in Set 2 represented a 25% increase in portion size compared to the smallest portion in Set 1, and the smallest portion in Set 3 represented a 50% increase in portion size compared to Set 1. The three portion sizes offered in Set 3 were 150–200% of the mean intake of the same food by each sex in previous laboratory studies. The energy content of the five portions ranged from 1980 to 3960 kJ [480 to 960 kcal] for women and 2640 to 5280 kJ [640 to 1280 kcal] for men. This range was similar to that of main dishes of pasta in cheese sauce (1250–8410 kJ [300–2010 kcal]) served in 13 restaurants, many of which were listed in the most popular U.S. restaurant chains (Nation's Restaurant News, 2012).

The order of presenting the three sets of portions across test days was counterbalanced within blocks of six subjects, and subjects were randomly assigned one of these orders. In addition, for a given subject, the smallest, medium and largest portions within the set were displayed in different positions (on the left, right, or center) across the three meals, as designated by a Latin square.

At each meal, the test food and water were weighed before being served and the remaining amounts were weighed after the meal to determine the amount consumed to the nearest 0.1 g. Energy intake was calculated from the weight consumed using information from the food manufacturer.

2.4. Daily procedures and assessments

Subjects were instructed to keep their food intake and activity level consistent and to refrain from consuming alcohol during the 24 h before each test meal; they kept a brief record of their food intake and activity to encourage compliance. On tests days, subjects were served a standard breakfast which was consumed *ad libitum*. Following breakfast, they were instructed to refrain from