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Research report

Measuring affective (liking) and non-affective (expected satiety) determinants of portion size and food reward

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ABSTRACT

Previously, we have used a 'method of constant stimuli' to quantify the satiety that different foods are expected to deliver. Our data indicate that foods differ considerably (some are expected to deliver 5–6 times more satiety than others [per kcal]). In the present study we explored the relative importance of 'expected satiety' in decisions about portion size. For eight different snack foods, we measured 'ideal' portion size and compared these values with corresponding measures of liking, expected satiety, and intention to restrict intake. Across participants ($N = 60$), ideal portion size was predicted by both liking and expected satiety. Individuals differed in the relative importance of expected satiety and liking. In particular, expected satiety was a more important predictor in restrained eaters and in individuals with a higher BMI. In this study we also included a measure of food reward. For each food, reward was inferred from a measure based on cash spend per kcal. Again, food liking and expected satiety were both significant predictors. Together, our findings confirm the importance of expected satiety and they demonstrate the quantification of separate affective and non-affective determinants of food reward and portion size.

Introduction

Researchers who study meal size tend to focus on factors that influence the termination of a meal. They reason that meal size is controlled by cognitive and physiological events that take place during and towards the end of an eating episode. However, in a recent paper we questioned this research bias (Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Our suggestion is that meals are often planned (self-served) before a meal begins. Since self-selected meals tend to be consumed in their entirety (Wansink & Cheney, 2005) it follows that a critical determinant of energy intake may be a brief period of cognitive activity, during which a decision about portion size is made.

Despite the logical importance of portion-size decisions, virtually nothing is known about the basis on which they are made. In this paper we introduce and test a novel methodology that addresses this problem. In our study we focus on the role of three factors that might influence decision-making: 'expected satiety,' hedonic quality (liking), and intention to restrict dietary intake. These are considered in turn.

When deciding on a particular portion size our strategy may be guided by a concern to ensure that a portion of food will deliver adequate satiety. Or, put differently, we may wonder whether a particular food portion is large enough to stave off hunger until our next meal. Previously, we have referred to this concept as 'expected satiety' (Brunstrom et al., 2008). Our findings suggest that humans are well able to express expectations of this kind. Moreover, foods appear to differ considerably in this regard. For example, in one experiment 18 different foods were compared. We found that some foods were expected to confer 5–6 times greater satiety than others (calorie for calorie). Thus, a nominal 200 kcal portion of one food was expected to deliver approximately the same satiety as a 1000–1200 kcal portion of other foods. We noted that differences in expected satiety might be a very important determinant of selected portion size (and hence energy intake). In the present study we reasoned that when asked to select an appropriate portion size, participants will choose a smaller portion (in kcals) of those foods that are expected to deliver relatively greater satiety. In this 'proof of concept' study, we explored this idea using a small number of test foods. Based on previous data from our laboratory, we selected eight test foods that share a common characteristic (all are typically described as a snack food), yet are likely to differ in their respective expected satiety (Brunstrom et al., 2008). For each food, we asked the participants to indicate their hypothetical ideal portion size (around lunchtime), and then compared these portions with a measure of their expected satiety.

Expected satiety reflects aspects of the 'utility' value of a food, *i.e.*, the expected benefits to the individual after it has been

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consumed. This contrasts food 'liking,' which is the second factor that we incorporated into our model of portion size. The role of palatability in appetite regulation has been debated over a number of years (*e.g.*, Berridge, 1996; Cabanac, 1971; Yeomans, Blundell, & Leshem, 2004). However, evidence that liking impacts on planned portion size has not been explored previously and the role of pleasantness relative to expected satiety remains unknown. Therefore, in addition to measuring expected satiety, we also asked participants to rate their 'liking' for each of the test foods.

The third and final factor that we focused on in this study was 'dietary restraint.' This term normally refers to a general tendency to attempt to limit food intake in order to either lose weight or to maintain existing weight. Typically, this behaviour is measured using a restraint questionnaire. However, questions about restriction of individual foods are rarely asked. In this study, participants were asked to rate the extent to which they would normally restrict their intake of the test foods. Again, by exploring the relationship between a participant's ideal snack-size portions and ratings of 'food specific restraint,' we sought to determine the extent to which concerns about food restriction influence decisions about portion size, relative to liking and expected satiety.

A further possibility is that people differ in the relative weight that they place on these different factors when making decisions about portion size. A comparison of this kind could be extremely informative because it may help to explain why certain individuals appear especially predisposed to make unhealthy food choices. To address this possibility we also included a measure of BMI and the Dutch Eating Behaviour Questionnaire (van Strien, Frijters, Vanstaveren, Defares, & Deurenberg, 1986). The subscales of this questionnaire assess three aspects of dietary behaviour, dietary restraint, external eating, and emotional eating.

In this study a second objective was to assess whether it is possible to identify specific determinants of food reward. In particular we chose to explore how expected satiety, liking, and food restriction combine in the mind of a participant when he or she evaluates the value of food. This is theoretically important, because it tells us something about factors that determine our motivation to choose particular foods, including those that are regarded as healthy or unhealthy. With this in mind, and as with our measure of ideal portion size, we were also interested in individual differences in the relative importance of expected satiety, liking, and restraint influence reward. Food reward can be measured in a number of ways (Epstein, Leddy, Temple, & Faith, 2007). Our approach relies on a simple proxy measure of food reinforcement. For each test food, participants were required to indicate the amount of money that they would spend on particular portion sizes. Using this technique it is possible to arrive at a convenient estimate of reward based on amount of cash per kcal.

The choice of stimuli was an important methodological issue. People often eat particular foods at a specific mealtime (*e.g.*, breakfast). On these occasions we may rely on previous experience and select a typical or habitual portion rather than engaging in a more complex decision-making process. From a research perspective this poses a potential problem: when asked to make decisions about an ideal portion, participants may select a typical or habitual norm rather than a portion that reflects their immediate need. To reduce this possibility, we elected to use snack foods in this initial study. These were chosen because they tend to be familiar (so that participants are able to rate their liking for these foods), yet they tend not to be consumed to satiety in a specific meal, making it less likely that judgements will be biased by habitual norms. In our study the participants were asked to imagine eating each snack food in place of a mid-day meal, and to choose their ideal portion sizes accordingly. We reasoned that if portion-size decisions are adequately modelled in this context then this will form the basis for further studies exploring the role of our three predictors in other foods, including those that are more appropriate for specific meals.

In summary, our general objective was to introduce and test a methodology that can be used to explore two kinds of decision-making: (i) how much food to consume and (ii) the extent to which a food is regarded as rewarding. In each case, we explored the relative contribution of three factors, expected satiety, food liking, and food-specific restraint.

Methods

Participant characteristics

Participants ($N = 60$) were undergraduate psychology students, 11 were male and 49 were female. Vegetarians and vegans were excluded from the study. The mean age of the sample was 20.3 years ($SD = 3.1$) and their mean BMI was 21.61 ($SD = 2.63$). Four of the participants were overweight (BMI = >25 and <30) and one was obese (BMI > 30). Participants either completed the study as part of an undergraduate course requirement or they were offered £10 Sterling in remuneration for their assistance.

Procedure

Participants were tested between 9 a.m. and 5 p.m. on weekdays. On arrival at our laboratory the participants were given general instructions on how to complete a visual-analogue rating scale. They then rated their hunger and fullness ("How [hungry/full as appropriate] do you feel right now?" with anchor points 'not at all' and 'extremely'). Participants then completed the following measures in order—prospective portion size, expected satiety, food reward, food liking, food-specific restraint, and prospective portion size (to increase the accuracy of this assessment prospective portion-size was measured twice). The participants then completed the three sections (restraint, emotional eating, and external eating) of the Dutch Eating Behaviour Questionnaire (van Strien et al., 1986). Finally, a measure of height and weight was taken and the participants were debriefed and thanked for their assistance with the experiment. Participants took approximately 90 min to complete this procedure.

Food images

Measures of reward, expected satiety, prospective portion size, and food-specific restraint involved showing participants pictures of eight different snack foods. For each food, a set of photographs was taken using a high-resolution digital camera. Each food was photographed on the same white plate (255 mm diameter). Particular care was taken to maintain a constant lighting condition and viewing angle in each photograph. For each food, picture number one showed a 20 kcal food portion, picture two showed a 40 kcal portion, picture three showed a 60-kcal portion, and so on. In total, each food was photographed either 60 (maximum portion 1200 kcal) or 70 times (max portion 1400 kcal), depending on the total amount of food that could be positioned on the plate. Table 1 provides information about the eight test foods, including their macronutrient composition (obtained from product packaging), and the number of pictures taken.

Measures

Prospective portion size

Prospective portion size was measured over a series of trials. In each trial a picture (210 mm $\times$ 285 mm) of one of the test foods