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Research report

'Expected satiety' changes hunger and fullness in the inter-meal interval☆

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ABSTRACT

Previously, we have shown that foods differ markedly in the satiety that they are expected to confer (compared calorie-for-calorie). In the present study we tested the hypothesis that 'expected satiety' plays a causal role in the satiety that is experienced after a food has been consumed. Before lunch, participants ($N = 32$) were shown the ingredients of a fruit smoothie. Half were shown a small portion of fruit and half were shown a large portion. Participants then assessed the expected satiety of the smoothie and provided appetite ratings, before, and for three hours after its consumption. As anticipated, expected satiety was significantly higher in the 'large portion' condition. Moreover, and consistent with our hypothesis, participants reported significantly less hunger and significantly greater fullness in the large-portion condition. Importantly, this effect endured throughout the test period (for three hours). Together, these findings confirm previous reports indicating that beliefs and expectations can have marked effects on satiety and they show that this effect can persist well into the inter-meal interval. Potential explanations are discussed, including the prospect that satiety is moderated by memories of expected satiety that are encoded around the time that a meal is consumed.

Introduction

In several recent studies, we have explored 'expected satiety' – the extent to which foods are expected to confer satiety when they are compared on a calorie-for-calorie basis. Our findings reveal the following. First, foods differ markedly in this regard; for example, calorie-for-calorie, boiled potatoes are expected to deliver around five times more satiety than cashew nuts (Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Second, expectations are learned (Brunstrom, Collingwood, & Rogers, 2010a, 2010b; Wilkinson & Brunstrom, 2009). In particular, expected satiety tends to increase as foods become familiar (Brunstrom et al., 2008) and after they have been eaten to fullness (Irvine, Brunstrom, & Rogers, 2008). Third, expectations of this kind are highly correlated with the calorie content of self-selected meals (Brunstrom & Rogers, 2009; Brunstrom & Shakeshaft, 2009). Together, these studies suggest that meal size is under learned control, and that this learning might be expressed in the form of expectations that affect meal-size selection, before a meal begins (Brunstrom, 2007).

Over time, energy intake is also influenced by the inter-meal interval: the period during which satiety is experienced. Satiety tends to be attributed to the proximal effects of a food on neural and endocrine signalling. However, cognition might also play a role during this period. In an early study, Wooley showed that labelling a food as 'high calorie' reduced subsequent intake and increased feelings of fullness 20 min after consuming a test meal (Wooley, 1972). By contrast, the actual number of calories consumed had little effect. In a related study, obese and lean individuals were unable to accurately identify otherwise identical-tasting high and low energy-dense meals (Wooley, Wooley, & Dunham, 1972b). Nevertheless, reported post-meal hunger was differentially influenced by the participants' own predictions about the energy content of the food that they had been offered.

Together, these findings suggest that beliefs about a recently consumed food can influence the satiety that it confers. Similar effects of providing explicit information about the food to be consumed have been reported elsewhere (Caputo & Mattes, 1993; Shide & Rolls, 1995). However, in other studies the effects of labelling have been less reliable (Ogden & Wardle, 1990; Wardle, 1987; Yeomans, Lartamo, Procter, Lee, & Gray, 2001). In part, this might reflect a failure to 'believe' in a label or the use of specific labels that are believed but which have little effect on expected satiety.

In the present study we sought to extend research relating to these expectation effects. Previously, beliefs have been manipulated using explicit labels such as 'high calorie' or 'high fat'. This approach is easy to implement. However, explicit labelling can be problematic. In particular, it introduces the issue of differentiating between actual satiety effects and more mundane 'demand characteristics' that might take the form, 'I've just been told that this is a high-calorie version so I guess I'm being expected to report that it is highly satisfying'. To address this concern we attempted to manipulate beliefs about a food incidentally, by presenting either a

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large or small portion of fruit as the contents of a fruit smoothie, without exposing participants to explicit satiety-related information. To directly evaluate the effects of our manipulation we measured the expected satiety associated with a test food immediately prior to consumption. In so doing, our objective was to demonstrate that expected satiety can be manipulated incidentally and that the effects of this manipulation can be observed in measures of actual satiety, during the inter-meal interval.

Previously, it has been suggested that the effects of food labelling are relatively short lived (Yeomans et al., 2001). Perhaps for this reason researchers have tended to explore expectancy effects over a short post-meal period (around 30 min), and often in the context of a preload-test meal paradigm. To address this limitation we explored the effects of expected satiety on hunger and fullness over a longer three-hour post-meal period.

Methods

Overview

Participants were tested at lunchtime in one of two conditions. In a 'large portion' condition they were shown a large portion of fruit, purportedly the raw ingredients of a fruit 'smoothie' (blend of fresh fruit and fruit juice). In a 'small portion' condition they were shown a small fruit portion. Participants were told that they were being shown the fruit to check for potential allergens. The fruit was then removed and replaced with a smoothie. Participants assessed its expected satiety and then provided appetite ratings before and for three hours after consuming the smoothie. At the end of the experiment the participants completed an awareness questionnaire to determine whether they believed that the smoothie had contained the ingredients that they were shown prior to consumption.

Participants

Participants were staff and students at the University of Bristol (United Kingdom). All received £10 Sterling for their assistance with the experiment. On arrival, participants were allocated alternately to the small-portion and the large-portion condition. Data from participants who did not believe that the smoothie contained the amount of fruit shown (determined using the awareness questionnaire – see below) were removed from the main analysis, and others were recruited in their place. In this way, 22 participants were tested in the small-portion condition and 28 participants were tested in the large-portion condition. Five participants in the small-portion condition and 12 in the large-portion condition did not believe the contents of the smoothie, leaving 16 participants in each condition. There were three males in the small-portion condition and two males in the large-portion condition.

Participants provided written consent before assisting with the study. Ethical approval was obtained from the local Faculty of Science Human Research Ethics Committee.

Fruit smoothie

Each 450 g fruit smoothie was served in a 568-ml glass. The smoothie was freshly prepared by blending 135 g of fresh strawberries with 150 g of banana and 165 g of orange juice, and contained approximately 250 kcal.

Expected satiety

The expected satiety of the smoothie was assessed using a 'method of adjustment'. This approach is described in detail elsewhere (Brunstrom et al., 2010a; Brunstrom & Rogers, 2009). In this version our participants completed four trials. In each trial a different test food was displayed (image size = 210 mm × 285 mm) in the middle of a 19-inch TFT-LCD monitor. The left arrow-key (on a keyboard) caused the portion size to decrease and the right arrow-key caused the converse. The pictures were loaded with sufficient speed that continuous depression of the left or right arrow key gave the appearance that the change in portion size was 'animated'. Each trial started with a different and randomly selected portion size. Participants were instructed to look at the smoothie and then match the picture on the screen so that both foods would stave off hunger to the same extent. The test foods were cheese and tomato pizza, pasta and sauce, oven fries, and chicken tikka masala. Each test food was photographed and presented in portions ranging from 50 kcal to 1250 kcal in equal logarithmic spaces. As in previous studies (Brunstrom & Rogers, 2009; Brunstrom & Shakeshaft, 2009; Brunstrom et al., 2008; O'Sullivan et al., 2010; Wilkinson & Brunstrom, 2009), our choice of comparison foods was motivated by a concern to present stimuli that are highly familiar. Here, selection was based on familiarity data obtained from a similar population (Brunstrom & Rogers, 2009). After each trial, the amount (in kcal) of test food selected was recorded. The order of these comparison foods was randomized across participants.

Awareness questionnaire

Participants completed a series of questions relating to their beliefs about the smoothie and the nature of the experiment. Embedded in these questions were three specific items. First, we asked participants to consider whether they produced hunger and fullness ratings based on their genuine experience at the time (option 1) or, in part, based on how the researcher expected them to respond (option 2). Second, we asked participants to guess the purpose of the experiment. Finally, and on a separate sheet of paper, we asked participants whether they believed that the smoothie contained the amount of fruit that they were shown at the beginning of the experiment. Here, participants were required to select either 'no' (option 1) or 'yes' (option 2). Respondents were categorised as having a genuine belief in the contents of the smoothie if they selected option 2 in questions 1 and 3, *and* they failed to mention or allude to possible expectancy effects in the open-ended assessment of demand awareness (question 2).

Procedure

Testing took place between 11.00 and 14.00. Participants were asked to refrain from eating and drinking anything other than water for three hours prior to the test session. This was confirmed on arrival at the laboratory with hunger and fullness ratings in response to the question "How HUNGRY/FULL [as appropriate] do you feel RIGHT NOW?" on a 100-mm visual analogue scale with anchor points 'not at all' and 'extremely'. An information sheet was given to participants explaining that the purpose of the study was to assess the satiating properties of a smoothie. Participants were then presented with a plate of fruit. Depending on the experimental condition, the portion of fruit was either small (small-portion condition: 134 g of unpeeled banana and 135 g of strawberries), or large (large-portion condition: 536 g of unpeeled banana and 264 g of strawberries). On the pretext of complying with regulations relating to potential allergens in foods, participants were asked to confirm that they had no special dietary requirements or allergies that would prevent them consuming the strawberry and banana smoothie.

The to-be-consumed smoothie was then presented (same across conditions). Participants were instructed to take a mouthful