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Short Communication

Satiety in face of variety: On sensory-specific satiety and perceived food variety

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ABSTRACT

Sensory-specific satiety (SSS) is the relative decrease in sensory pleasure derived from a specific food or drink with its consumption. Such satiation does not require ingestion, but hinges on exposure to a given flavour. As it affects meal termination, it is important in determining overall intake. Variety in a meal or dish undermines SSS and promotes consumption of the meal. In the present study, the hypothesis that the mere presentation and suggestion of food variety can undermine SSS was examined in a sample of 92 undergraduate students. All participants ate several bite-sized servings of a test food to induce SSS, but participants in the experimental group were shown another food during the consumption of the test food. Relative pleasure of the test food was determined before and directly after its repeated consumption by means of pleasure ratings and the desire to eat that particular food. Relative pleasure of the test food decreased in both groups. Therefore, there is no evidence to suggest that the mere presence of another food during intake undermines SSS for a given test food.

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1. Introduction

Sensory-specific satiety (henceforth SSS) refers to the effect of decreased pleasure derived from the sensory characteristics of a food (or drink) consumed as compared to unconsumed foods (or drinks) (Rolls, 1986; Rolls, Rolls, Rowe, & Sweeney, 1981). SSS does not require postingestive feedback, implying that it is a psychological satiation effect (see e.g., Morewedge, Huh, & Vosgerau, 2010; Rolls & Rolls, 1997; Smeets & Westerterp-Plantenga, 2006). SSS plays an important role in eating behaviour (i.e., food intake and food choice) as it inhibits meal consumption and prompts the consumption of a more varied meal (Hetherington & Rolls, 1996).

The opportunity to eat different foods in a meal appears to attenuate the development of SSS for each of the food items that make up the meal. Indeed, meal intake is typically greater when the meal is more varied (Epstein, Robinson, Roemmich, Marusewski, & Roba, 2010; Remick, Polivy, & Pliner, 2009; Rolls et al., 1981). It has been argued that this food variety effect can be explained (at least partly) as the consumption of other food items disrupting SSS (Hetherington, Foster, Newman, Anderson, & Norton, 2006). For example, Brondel and colleagues (2009) had participants eat French fries and brownies on three occasions. On two of these occasions the fries were served with condiments (i.e., ketchup and mayonnaise), and the brownies with whipped cream and va-

nilla cream. On both of these occasions, the participants ate more of the fries and brownies than when these were served without condiments/cream (i.e., just brownies and just fries) and this effect was associated with attenuated SSS for fries and brownies.

Interestingly, Redden (2008) found that merely perceived variety can slow satiation (see also Kahn & Wansink, 2004). In one of his experiments, participants were provided with different fruit-flavoured jellybeans to eat. Participants were assigned to one of two conditions. In one condition, participants received 22 fruit-flavoured jellybeans and with each jelly bean a computer screen showed the number of jelly beans eaten so far (e.g., "jellybean number 8"). In the other condition, participants received the same jelly beans, but here the computer screen showed the number of jelly beans eaten within a specific flavour category (e.g., "tangerine number 3"). Participants rated their enjoyment of the jellybeans on a line scale after the second jellybean and every fourth jellybean. Redden also asked participants to indicate perceived variety after finishing the last jellybean. He found that, as hypothesized, knowledge of the flavours increased perceived variety and disrupted the development of satiation. Participants seeing the specific flavour labels (e.g., "cherry, orange") as opposed to the more general label ("jellybean") found the product experience on the whole more enjoyable and showed greater liking for eating the jellybeans. This study is interesting as it suggests that actual consumption of varied flavours may not even be necessary to undermine SSS. It is the perception of food variety that affects satiation. Therefore, in the current study, the main aim was to test the hypothesis that the mere suggestion of food variety can disrupt SSS.

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2. Methods

2.1. Participants

A total of 92 participants were recruited among undergraduate students at Maastricht University via posted advertisements. Participants' characteristics are shown in Table 1. All participants received course credits in return for their participation. The experiment was approved by a local ethics committee.

2.2. Procedure, measurements, and design

All participants were instructed not to consume anything (excluding water, but including chewing gum) for 2 h prior to their participation in the present study. Participants were tested individually in a quiet research laboratory. On arrival (between noon and 5 pm) at the laboratory each participant received both verbal and written information concerning the procedure of the experiment and signed a consent form upon agreeing to take part.

Next, the participant rated hunger on a 100-mm line scale ranging from 0 “not at all hungry” to 100 “extremely hungry”. Then s/he received bite sized portions of four different foods to evaluate: 3 chocolate M&M's (~3 g; 492 kcal/100 g; Masterfoods), 1 chocolate chip cookie (~10 g; 526 kcal/100 g; Albert Heijn), 3 crisps (~2 g; 544 kcal/100 g; Lay's, PepsiCo), and 3 salted peanuts (~3 g; 585 kcal/100 g; Albert Heijn). Participants evaluated momentary pleasantness of the foods on separate 200-mm line scales ranging from –100 “highly disliked” to 100 “highly liked”. Similarly, participants were asked to rate their desire to eat each specific food on 200-mm line scales ranging from –100 “no desire at all” to 100 “extreme desire to eat”. These ratings served as the baseline ratings.

Participants were then told that they would now receive one of the four foods (selected randomly for each participant) and would consume several bite-sized portions of. Every 60 s the experimenter would instruct the participants to take one of an initial total of 10 portions from a tray and to eat it. This signalled exposure procedure produces strong SSS (Havermans, Geschwind, Filla, Nederkoorn, & Jansen, 2009; Havermans, Siep, & Jansen, 2010) and, contrary to ad libitum eating, allows tight experimental control of the rate, total duration, and amount of orosensory exposure to the test food. For this phase of the experiment, participants were randomly assigned to one of two possible conditions: Experimental or Control. The participants in the Experimental group were shown a food other than the test food (perceived variety). A tray containing 10 portions of another food item (a random selection from the remaining control food items) was placed in clear view next to the tray containing the test food. Half way through the signalled exposure (after finishing the 5th serving of the test food), the participants from the experimental group were asked to draw a ticket from a box. It was explained that whatever food was written on the ticket would be the food item they would have to eat the next 5 times. Unbeknownst to the participant all of the tickets in the box referred to the original test food. This interruption took no

longer than 1 min and was intended to remind participants of the presence of the other food. Participants in the Control group also received the 10 portions of the test food to consume, but no other food was placed in sight. Note that all participants consumed the same volume of food, but depending on the test food one had to eat, the participant consumed approximately 30 g of M&M's, or 100 g of chocolate chip cookies, or 20 g of crisps, or 30 g of salted peanuts.

Directly after the signalled exposure procedure, all of the participants received all four food items again to consume and evaluate in the same way as they had done at baseline. Finally, the participant was thanked and received his/her course credit.

2.3. Statistics

To determine SSS, difference scores were calculated for the pleasantness ratings and for the ratings of the desire to eat the test food and the unconsumed control foods. The difference scores for the three unconsumed foods were averaged into a single mean score. The difference scores correct for individual differences in the evaluation of the foods at baseline and represent the change in rated pleasantness and desire to eat from before the signalled exposure to the test food until directly after this exposure. These change scores served as the dependent variables in a 2×2 split plot MANOVA with Food (2: control food versus test food) and

Fig. 1. Change in mean ratings ($\pm$ SEM) of the test food and the unconsumed foods from pre-test (i.e., before the signalled exposure to the test food) to post-test (after the signalled exposure to the test food) for each group (Experimental versus Control). The upper panel represents the desire to eat ratings. The lower panel refers to the pleasantness evaluations.

Table 1

Participants' characteristics: mean age, mean hunger, and gender distribution for each group (Experimental versus Control). Values in parentheses represent SD.

	Group		
	Experimental	Control	
N	45	47	
Age	22.1 (3.3)	21.2 (1.4)	$t(90) = 1.79, p = .08$
Hunger	62.4 (21.2)	63.4 (20.0)	$t(90) = 0.23, p = .82$
Gender	30 women 15 men	36 women 11 men	$\chi^2 = 1.12, p = .29$

Group (2: Experimental versus Control) as the between-subjects variable.

3. Results and discussion

Mean pre-prandial hunger did not differ between the two groups (Experimental versus Control), $t(90) = .23$, $p = .82$ (see also Table 1). Fig. 1 displays the change in ratings from pre-test to post-test for groups Experimental and Control for the separate evaluation of food pleasantness and desire to eat.

The MANOVA only revealed a significant main effect for Food, $F(2,89) = 3.38$, $p = .038$, $\eta^2_{\text{partial}} = .07$. As can be inferred from Fig. 1, this finding indicates SSS. The hypothesized Food $\times$ Group interaction was absent, $F(2,89) = 0.21$, $p = .81$, $\eta^2_{\text{partial}} = .01$. Furthermore, no Group effect was found, $F(2,89) = 0.33$, $p = .72$, $\eta^2_{\text{partial}} = .01$. Although the overall pattern of results suggests SSS in both groups, further univariate analyses showed this effect to be statistically significant for the desire to eat ratings ($F(1,90) = 6.72$, $p = .01$, $\eta^2_{\text{partial}} = .07$), but not for the pleasantness ratings ($F(1,90) = 1.55$, $p = .22$, $\eta^2_{\text{partial}} = .02$).

In the present study, it was hypothesized that the presence of another food during intake would disrupt the development of SSS for the test food. The results, however, show that this is not the case; indeed, with the present paradigm, SSS was found, but it was unaffected by the presence of another food.

One may wonder why no effect was found. One possibility is that the presentation of just a single other food item is too weak to induce perceived variety. Perhaps the offering of various different food items would be more effective at establishing perceived variety and hence disrupt SSS. Although this is certainly a possibility, it should be noted that prior research suggests that the consumption of a single different flavoured food is able to disrupt SSS. In one of their experiments, Hetherington and colleagues (2006) allocated participants to one of two groups. In one group (food focus; FF) participants ate chocolate. Chocolate consumption was repeatedly interrupted to rate chocolate enjoyment. In the other group (food distraction; FD), the participants also ate chocolate, but were repeatedly asked to rate both chocolate and cheese crackers. Chocolate pleasantness ratings decreased more rapidly in the FF group than in the FD group. Hetherington et al. concluded that the variety effect partly comprises the delaying of SSS. Clearly this delay does not require exposure to a wide variety of foods.

Another explanation of why no effect of perceived variety was found in the present study is that the hypothesized disruption of SSS requires at the very least the expectation of food variety; that is, if one does not expect to be able to consume or taste the alternative food presented, the expectation of food variety is effectively nullified. In the current study, it might thus have been the case that strong SSS did not develop in the experimental condition until after the first five portions of the test food. Indeed, despite the presence of another food, the participants from that point on knew they would not have the opportunity to consume that food. It is con-

ceivable that this contributed to the development of strong SSS for the test food with consumption of the last five portions and hence obscured differences in the development of SSS between the two groups at post-test. Unfortunately, we did not assess SSS after the first five portions and hence whether or not the mere expectation of food variety affects SSS remains to be investigated. Furthermore, we did not assess whether the participants in the experimental condition perceived the added tray of food as substantial food variety (see Redden, 2008). Nonetheless, the presents finding shows that merely presenting a single different food alongside the consumption of a test food is insufficient to attenuate the development of SSS for that test food.

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