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Research report

Food liking, food wanting, and sensory-specific satiety

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Sensory-specific satiety refers to a temporary decline in pleasure derived from consuming a certain food in comparison to other unconsumed foods. It has been argued that such a reduction may not be limited to food liking but extends to food wanting as well. Animal research suggests that sensory-specific satiety reflects a reduction in both food liking and food wanting and in the present study it was investigated whether this also holds true for humans. Participants had to consume a certain amount of chocolate milk and afterwards approximately half of the participants played a game to obtain more chocolate milk, whereas the other half played a game to obtain crisps. Participants showed a decline in subjective liking of taste and smell of the chocolate milk in comparison to crisps. Furthermore, they showed less motivation (i.e. wanting) to obtain more chocolate milk. It is concluded that sensory-specific satiety in humans reflects a decrease in both food liking and food wanting.

Berridge (1996, 2007) argues that when examining the role of food reward in eating behaviour one has to differentiate between food liking and food wanting, with ‘liking’ roughly referring to palatability (i.e. the pleasure derived from eating a given food) and ‘wanting’ referring to appetite (i.e. the disposition to eat). Within animal research, food wanting is typically measured as instrumental behaviour to obtain food reinforcement; whereas food liking is assessed by observing facial taste reactivity patterns (see Berridge & Robinson, 1998). According to Berridge, different neural substrates underlie the two components of food reward. Food liking appears related to opioid and GABAergic neurotransmitter systems, whereas dopaminergic neurotransmitter systems are thought to participate in food wanting. In animals, it has been shown that it is possible to dissociate food wanting and food liking. For example, dopamine depleted rats (through 6-OHDA lesions) develop aphagia, but dopamine depletion does not affect these rats’ hedonic taste reactivity (see Berridge & Robinson, 1998).

In humans too, it appears that one can dissociate food liking from food wanting. Finlayson, King, and Blundell (2007a) asked their participants to indicate on a line scale how pleasant it would be to experience a mouthful of a specific food, in order to assess food liking. Further, they adopted a forced choice methodology to assess food wanting. With this methodology participants repeatedly had to choose between two food items receiving the instruction to select the food they would most want to eat now. Finlayson and colleagues measured food liking and wanting before and after consumption of a meal and found that changes in food liking and wanting due to meal consumption did not always match. When hungry, participants wanted high-fat savoury foods over low-fat savoury foods with no difference in liking, and liked high-fat sweet foods over low-fat sweet foods with no difference in wanting. When satiated, this pattern of results was reversed. In a more recent study, Finlayson, King, and Blundell (2008), however, failed to replicate these results. Changes in liking after meal consumption could not be fully dissociated from changes in wanting. Finlayson and colleagues thus concluded that their forced choice methodology may well assess elements of both food wanting and liking.

Perhaps a more promising approach to measuring food wanting concerns tasks in which the participant has to perform a certain instrumental response to obtain food reinforcement (see also Mela, 2006). Such a task was employed by Epstein, Truesdale, Wojcik, Paluch, and Raynor (2003). Participants had to perform a game in which they could work for points that could be traded for snack food. They had to pull a joystick in order to obtain these points. Not every response was reinforced though and throughout the task the response requirement for further snack points was regularly increased. Participants could stop working for food points whenever they wished. It was found that food deprived participants worked longer (and thus much harder) to obtain snack food than satiated participants did. Food deprivation, however, did not affect subjective ratings of food liking.

Despite the fact that food liking and food wanting can be dissociated, Berridge (1996) argues that many manipulations of food reward alter food liking and wanting together. One such manipulation concerns sensory-specific satiety, a decline in

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pleasantness derived from consuming a food with prior exposure or consumption of that specific food (Rolls, 1986). Berridge (1991) found that rats show a reduction in hedonic taste reactivity to a sucrose solution or milk after having been pre-fed with either the sucrose solution or milk. Balleine and Dickinson (1998: Experiment 1) showed in rats, that sensory-specific satiety may also affect the motivation to obtain a certain food reward. Rats first learned two distinct instrumental responses, with each response rendering a specific food reward: a salt- or lemon-flavoured polycose solution. The rats received a subsequent extinction test in which both responses were no longer reinforced. Just prior to the extinction test, however, the rats were pre-fed with one of the two flavours. At test, all rats predominantly worked to obtain the food reinforcer different from the food they had consumed just prior to the test. In other words, sensory-specific satiety not only is reflected by a reduction in liking but also by a reduction in wanting as well, at least in rats. Mela (2001) has suggested that in humans too sensory-specific satiety is likely to be reflected by a reduction in both food liking and food wanting (see also Brunstrom & Mitchell, 2006). However, to our knowledge, this assumption has not been tested directly. Therefore, in the present study, we examined if sensory-specific satiety in humans is reflected by a reduction in liking of a given test food, and also by decreased wanting of that particular food.

Method

Participants

A total of 55 participants (48 female, 7 male) were recruited among the undergraduate student population of Maastricht University. Participants' characteristics are shown in Table 1. A local ethics committee reviewed and approved the present study. All participants were informed beforehand of the experimental procedure (orally and in writing) and signed a consent form. Participants were aware that participation involved the repeated tasting of chocolate milk and crisps, but they were not informed of the precise research hypothesis until after their participation.

Procedure and design

Participants were tested individually in a quiet research laboratory. All participants were instructed not to eat or drink anything (except water) 2 h prior to their participation. Experimental sessions were conducted during weekdays between noon and 4 p.m. On arrival, the participant was seated and first received a small cup containing 20 ml chocolate milk (Chocomel, Friesland Foods, Veenendaal, the Netherlands) and a single paprika flavoured crisp (Lay's, Smiths Food Group, Maarssen, the Netherlands) to taste and evaluate. The participant had to indicate momentary perceived pleasantness of taste and smell of each food item on a continuous 100-mm line scale ranging from 0 (not at all pleasant) to 100 (very pleasant). The participant was allowed to taste and evaluate the chocolate milk and crisp in whatever order s/he preferred, but s/he did receive the explicit instruction to first smell each item by holding it right under the nose and that with the subsequent evaluation of taste s/he would have to fully consume each item.

Next, each participant received 250 ml of chocolate milk to consume. After the consumption of the chocolate milk, the participants received a second tasting of the chocolate milk and crisps. Again, they had to evaluate the taste and smell of each food item. We used chocolate milk and crisps so that the two items would be generally well liked, but have a different taste, odour, and texture to minimize potential generalization of sensory-specific satiety from the chocolate milk to the crisps (Guinard & Brun, 1998).

Next, the participants were randomly assigned to one of two groups: chocolate milk (CHOC; $n = 28$) or crisps (CRISP; $n = 27$). Both groups then indicated their momentary degree of hunger and thirst on separate 100-mm line scales ranging from 0 (no hunger/thirst at all) to 100 (very hungry/thirsty). Hunger and thirst were measured as these have been found to affect food wanting. For example, the motivation to obtain snack foods (i.e. wanting) can be stronger when feeling hungry (Epstein et al., 2003).

Participants had to play a computer game comprising a series of choices between working for either chocolate milk (group CHOC) or crisps (group CRISP) and the option to stop playing. After randomly determining whether the participant would have to play for chocolate milk or crisps, the participant received the following instruction (translated from Dutch) on screen:

> "In this game, you may collect points by pressing the [left/right] mouse key. When pressing this key, you may earn one point for [crisps/chocolate milk]. When pressing the other mouse key, the game will stop and you will receive 10 grams of [crisps/chocolate milk] for each point. Pay attention! Not every [left/right] key press will render a point. Throughout the task it will become harder to obtain further points."

Participants in group CHOC could trade their points for chocolate milk. With each choice (play or stop), a picture of a glass of chocolate milk and a picture of a sign reading STOP were displayed at the left and right centre of a computer screen. By clicking on the corresponding left or right mouse key, participants indicated to play for either chocolate milk or to stop playing. The position of the two pictures (left or right) was determined randomly for each separate participant. Upon selecting chocolate milk the participant received immediate feedback whether s/he had earned an additional point or not. For each of the five points, each participant had to choose chocolate milk four times to earn a single point, a fixed ratio reinforcement schedule of 4 (FR-4). For every next 5 points, the response requirement (i.e. the reinforcement ratio) was doubled. Participants could earn a maximum total of 25 points (250 g of chocolate milk). In this case the participant would have to click the same mouse key 320 times to obtain the 5 points for the final reinforcer (FR-64). Participants could, however, decide to stop playing before obtaining the maximum 25 points. The total number of points obtained would then be displayed on screen and the experimenter would serve the participant a cup of chocolate milk corresponding to the number of points. Participants in group CRISP had to play the same game, but they earned points for crisps, not chocolate milk, with each point corresponding to 10 g of crisps.

After the consumption of either the chocolate milk or the crisps, the participant was thanked and debriefed, and received a €5 monetary voucher or course credit for compensation.

Table 1
Size, mean age, mean body mass index (BMI, kg/m^2), mean hunger and thirst ratings per group and for the total sample of participants.

	Group		Total
	CHOC	CRISP	
N	28	27	55
Age	21.6 (5.3)	21.1 (3.2)	21.4 (4.4)
BMI	22.25 (2.58)	23.75 (2.65)	22.99 (2.70)
Hunger	37.14 (25.71)	49.52 (21.57)	43.22 (24.36)
Thirst	37.39 (19.78)	35.70 (20.68)	36.56 (20.05)

Note: Values enclosed in parentheses represent S.D.