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Validation of prospective portion size and latency to eat as measures of reactivity to snack foods

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ABSTRACT

In experimental studies that investigate reactivity to the sight and smell of highly palatable snack foods, *ad libitum* food intake is commonly used as a behavioural outcome measure. However, this measure has several drawbacks. The current study investigated two intake-related measures not yet validated for food cue exposure research involving common snack foods: prospective portion size and latency to eat. We aimed to validate these measures by assessing prospective portion size and eating latencies in female undergraduate students who either underwent snack food exposure or a control exposure. Furthermore, we correlated prospective portion size and latency to eat with commonly used measures of food cue reactivity, i.e., self-reported desire to eat, salivation, and *ad libitum* food intake. Results showed increases in prospective portion size after food cue exposure but not after control exposure. Latency to eat did not differ between the two conditions. Prospective portion size correlated positively with desire to eat and food intake, and negatively with latency to eat. Latency to eat was also negatively correlated with desire to eat and food intake. It is concluded that the current study provides initial evidence for the prospective portion size task as a valid measure of reactivity to snack foods in a Dutch female and mostly healthy weight student population.

1. Introduction

Exposure to the sensory properties of palatable foods (e.g., their sight and smell) stimulates appetitive responses, including a heightened desire to eat as well as 'cephalic phase' responses that serve to prepare an organism for the digestion and metabolism of food (Nederkoorn, Smulders, & Jansen, 2000; Power & Schulkin, 2008). Collectively, responses to food cues are termed food cue reactivity, and it is thought that this reactivity stimulates food intake (Boswell & Kober, 2016; Jansen, 1998; Jansen, Havermans, & Nederkoorn, 2011). This behavioural consequence of food cue exposure is important given that overeating is a main contributor to obesity.

To measure food intake after food cue exposure, experimental studies commonly use an *ad libitum* food intake test (often presented as a 'taste test'), in which participants are presented with generously filled bowls containing snack foods of which participants can eat as much as they like. However, assessing behavioural reactivity to snack food exposure this way has some limitations. First, it has been argued that the presence of the sight, smell, and taste of food during an *ad libitum* food intake test is a strong form of cue exposure in itself, which may diminish the differences between the cued (i.e., exposure to food cues) and control (i.e., exposure to neutral objects) conditions (Tetley, Brunstrom, & Griffiths, 2009, 2010). This could explain why several studies failed to find increased intake after food cue exposure compared to a control condition (Larsen, Hermans, & Engels, 2012; Nederkoorn & Jansen, 2002; Zoon, He, de Wijk, de Graaf, & Boesveldt, 2014). Second, while *ad libitum* food intake induces satiation, it can arguably only be assessed once during an experimental session and after the other outcome measures have been administered. As a result, no baseline or repeated measures can be obtained, reducing power

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and limiting its applicability. Third, it can be questioned whether the "unlimited" amount of food in a typical *ad libitum* intake test accurately reflects most instances of food intake in the natural environment (Ferriday & Brunstrom, 2008). Finally, laboratory eating behaviour may be particularly susceptible to participant's awareness of being monitored. In a recent meta-analysis (Robinson, Hardman, Halford, & Jones, 2015), it was shown that in healthy-weight females (a commonly used sample in eating research) both belief and knowledge of observation of their eating behaviour reduced food intake in the laboratory.

It has been proposed that an important determinant of food intake within one eating occasion is the amount of food one plans to eat (Brunstrom, 2011; 2014), for example by influencing the amount of food that one prepares and serves. This pre-meal planning of portion sizes has previously been assessed in experiments using a computerized task (the prospective portion size task or PPST; e.g., Ferriday & Brunstrom, 2008; Holliday, Batey, Eves, & Blannin, 2014; Wilkinson et al., 2012), in which participants can adjust the amount of food they wish to eat on a virtual plate. Unlike an *ad libitum* food intake test, the PPST does not induce satiation (allowing for its repeated administration), and its assessment may not elicit as much cue reactivity (potentially increasing its sensitivity). In support of its validity in food cue reactivity paradigms, several prior studies have demonstrated increases in prospective portion sizes of a cued food after exposure to its sight and smell (Ferriday & Brunstrom, 2008, 2011; Tetley, Brunstrom, & Griffiths, 2010). However, the cued food in these studies was restricted to pizza. To our knowledge, it has never been studied whether prospective portion size of common snack foods increases after snack food exposure, even though food cue reactivity studies very often involve exposure to high-calorie snack foods, as this is the type of food obese individuals and dieters usually struggle to refrain from eating. Therefore, validating the PPST involving snack foods in food cue reactivity paradigms is of importance.

Exposure to food cues likely increases food intake not only through increasing the size of eaten meals and snacks but also by promoting their initiation (e.g., Ferriday & Brunstrom, 2011). Although this might seem common sense, very few human studies have examined this possibility. Several conditioning studies in rats and one study in humans have found that exposure to food-associated stimuli prompts a shorter latency to initiate eating when presented with the opportunity to consume the cued foods (Birch, McPhee, Sullivan, & Johnson, 1989; Weingarten, 1983). However, to the authors' knowledge, this has not yet been examined in a food cue reactivity paradigm. Eating latency may also reflect a relatively unobtrusive measure of food cue reactivity, as participants may be more likely to be unaware of their eating initiation to be monitored than their actual food intake.

In sum, the PPST and eating initiation might both reflect ecologically valid intake-related measures in food cue reactivity paradigms that can provide insight into important aspects of cue-elicited eating and that may overcome some of the limitations of the *ad libitum* food intake tests. In the current study we aimed to validate the cue-elicited prospective portion size of snack foods and eating initiation by (1) assessing prospective portion size and latency to eat in response to food cue-exposure vs. control exposure, and by (2) correlating PPST and latency scores with commonly used measures in food cue reactivity paradigms (desire to eat, salivation, and *ad libitum* food intake). We hypothesized that prospective portion size in the cue-exposure condition is increased and that food cue exposed participants start eating more quickly, relative to participants in the control condition. In addition, positive correlations between prospective portion size and desire to eat, salivation and actual food intake were expected, and negative correlations between these measures and eating latency.

2. Methods

2.1. Participants

Fifty-three female undergraduate students between 18 and 26 years old ($M = 20.38$, $SD = 2.07$) participated in the study in return for course credit or a € 5 gift voucher. Participants were recruited through flyers put up in the university building. The flyers advertised the cover story of the study, which was the influence of sensory processes on perception. After signing up, participants answered some questions to check for eligibility for the study (i.e., female undergraduate students between the age of 18 and 30 with no food allergies). In addition, they were instructed to eat something small (e.g., an apple or a sandwich) 2 h before participating, but to refrain from eating thereafter. The study was approved by the Ethics Committee of the Faculty of Psychology and Neuroscience of Maastricht University.

2.2. Measures

2.2.1. Food selection

After signing up for the study, participants received an email in which they were given a list of 8 well-known and generally liked snack foods. They were asked to select their top three of these foods and rank these according to their preference. For each participant, their personal most-preferred food was used throughout the study i.e., if a participant rated milk chocolate as her most favourite food, the PPST, cue exposure, and the taste test were all conducted with milk chocolate. All foods and the frequency with which they were selected in each condition are displayed in Table 1. Participants were instructed not to consume this food in the 24 h before participating.

2.2.2. Cue exposure manipulation

Participants were randomly assigned to either the experimental ($n = 27$) or the control ($n = 26$) condition. In the experimental condition, participants were instructed to smell their personally preferred food for 2 min. They were told they could look at it, smell it, and touch it, but were not allowed to eat it. Seeing and smelling palatable food has been shown to be an effective way to induce cue reactivity (Boswell & Kober, 2016). In the control condition, participants smelled small scented soaps for the same amount of time.

2.2.3. Prospective Portion Size Task (PPST)

A new PPST was designed as a measure of intended snack food intake. Our PPST is based on the original PPST of Ferriday and Brunstrom (2008) but includes a diverse range of snack foods (see Table 1). In the current study, participants performed the PPST with their highest ranked snack food. Participants are presented with an empty bowl in the middle of a computer screen and they are instructed to fill the bowl with the amount of food they would like to eat at that moment. Pieces of food can be added one-by-one using a slider, and the task is programmed in such a way that it looks 'animated'. To help participants make accurate judgments about the size of the bowl, a real bowl that is identical to the one used in the PPST is placed next to the participant. In addition, the food package of the cued food is presented on the screen next to the bowl. This is done to clarify to the participant which exact food was selected in the task, as participants may vary in their liking of different brands of a snack. Before the actual task takes place, participants complete a practice task in which they fill a bowl with purple and green cubes. Responses are recorded in pieces of food (e.g., number of M&Ms that are placed in the bowl) which are later converted to kcal. The task was designed in Unity and screenshots are presented in Fig. 1.