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The reliability and validity of the Macronutrient and Taste Preference Ranking Task: A new method to measure food preferences

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ABSTRACT

Food preferences are for a large part determined by the macronutrient content and taste of foods, but may change depending on internal and external factors. Here, we discuss a newly developed food preference task, the Macronutrient and Taste Preference Ranking Task (MTPRT), in which participants rank groups of four food products according to how much they desire to eat the products. The MTPRT includes pictures of sweet and savory food products from four categories: high-carbohydrate, high-fat, high-protein and low-energy. A within-subjects study on sensory-specific satiety was conducted to assess the task's reliability and validity. Sixty-nine healthy participants performed two test sessions that were at least one week apart. Participants ate either a sweet or a savory meal, which were similar in macronutrient content. Before and after eating the meal participants rated appetite and completed the MTPRT. In hungry state, preference scores for all food categories were significantly correlated between the two test sessions (all $r > 0.68$, all $p < 0.001$). Preference for sweet decreased after the sweet meal and increased after the savory meal. In addition, preference for protein decreased more after consuming the savory meal than it did after consuming the sweet meal. Preference for carbohydrate and fat decreased after meal consumption, regardless of taste. Preference for low-energy increased after meal consumption. These results show the MTPRT is a reliable and valid task for measuring food preferences. The MTPRT can be used for both hypothesis-driven and exploratory studies to examine the influence of different factors on changes in food preferences.

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1. Introduction

Sensory properties of foods play an important role in the preferences for and intake of food (McCrickerd & Forde, 2015). The basic tastes seem to have specific signaling functions for the body, in that sweet taste signals carbohydrates, and salty and savory taste signals protein and electrolytes (Scott, 2008). Indeed, various studies have demonstrated relations between sugar content and sweetness, and between protein content and salty and umami taste (Lease, Hendrie, Poelman, Delahunty, & Cox, 2016; Martin, Visalli, Lange, Schlich, & Issanchou, 2014; Viskaal Van Dongen, Van Den Berg, Vink, Kok, & De Graaf, 2012). The body uses these signaling cues to maintain macronutrient balance. Studies have shown that a protein-depleted state elicits a higher preference and reward for and intake of savory foods in order to restore protein status (Griffioen-Roose et al., 2012, 2014). Energy and macronutrient balance may be challenged in certain people, which may be related to

changed preferences for foods. For instance after gastric bypass surgery preference for sweet and high-fat foods decreases (Miras et al., 2012; Pepino et al., 2014), while other studies report an increased preference for high-protein foods (see e.g., Ullrich, Ernst, Wilms, Thurnheer, & Schultes, 2013). In cancer patients undergoing chemotherapy, a reduced taste and smell function is frequently reported, which has consequences for food preferences and food intake (Boltong et al., 2014; Boltong, Keast, & Aranda, 2012; de Vries et al., 2016). However, it is important to note that also in the general population food preferences are influenced by many factors including the time of the day, the appropriateness of foods within a meal context and the meal eaten previously (Birch, Billman, & Richards, 1984; De Graaf, Jas, Van der Kooy, & Leenen, 1993; Griffioen-Roose, Finlayson, Mars, Blundell, & de Graaf, 2010) This multitude of factors that influence food preferences makes measuring food preferences a challenge. To better understand how food preferences can shift in different situations, it is essential to include macronutrient and taste composition when measuring food preferences. However, few methods are available that capture both macronutrient and taste composition and that are able to assess shifts in food preferences by these factors.

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A questionnaire that takes both macronutrient and taste composition into account is the macronutrient preference checklist (MPC). The MPC is a list of foods divided over four macronutrient categories, including both sweet and savory products. Participants are instructed to check off all foods in the MPC that one would like to eat right at that moment (Brisbois-Clarkson, McIsaac, Goonewardene, & Wismer, 2009; Hill, 1986; Hill, Leathwood, & Blundell, 1987). This method results in frequencies of selected products from specific macronutrient or taste categories. Another method that includes different macronutrient and taste categories is the Leeds Food Preference Questionnaire (LFPQ) (Finlayson, King, & Blundell, 2007). The questionnaire uses food pictures rather than words, which is of importance as visual cues are important factors in food selection and give input on the edibility, palatability and satiating properties of a food (McCrickerd & Forde, 2015). The LFPQ is a computer-based food preference task in which participants make forced choices between two food products from four different food categories. Thereby, products are not just rated on their own. Instead, products from different product categories are directly compared and relative preferences for food categories are measured. These relative preferences provide insight in motivation for the chosen food category over the non-chosen category (Finlayson, King, & Blundell, 2008). However, the LFPQ includes only two macronutrient-based categories divided over sweet and savory taste. In the original LFPQ, Finlayson and colleagues (2007, 2008) used high- and low-fat foods. Later studies adapted this to include high- and low-protein (Griffioen-Roose, Mars, Finlayson, Blundell, & de Graaf, 2011) and to high- and low-energy (Zoon, He, de Wijk, de Graaf, & Boesveldt, 2014). As it is essential to be able to assess preferences for a full range of macronutrients, we developed the Macronutrient and Taste Preference Ranking Task (MTPRT), which includes both macronutrient and taste categories. The task was developed based on the following criteria (1) foods included should be from multiple macronutrient categories and tastes, (2) the foods should be presented as pictures rather than words, and (3) should consist of a ranking paradigm in order to assess relative food preferences.

The MTPRT consists of pictures of products from four macronutrient categories, i.e., high-carbohydrate, high-fat, high-protein and low-energy, including both sweet and savory products. Participants are asked to make rankings of four products based on how much they desire to eat the different products at that moment. These rankings are used to assess relative preferences for the four macronutrient categories and the two tastes sweet and savory. In the current study we aim to show that the MTPRT is a reliable and valid task to measure food preferences: to demonstrate reliability of the task, we assessed test-retest reliability. To demonstrate validity of the task, we assessed the discriminative ability of the task by assessing sensory-specific satiety; after eating a food to satiety, the pleasantness of sensory properties of that food is decreased more than of foods that have not been eaten (Rolls, Rolls, Rowe, & Sweeney, 1981). Based on previous studies we expect preference for sweet products to decrease after a sweet test meal and to increase after a savory test meal. Furthermore we expect decreased preferences for high-carbohydrate and high-fat products after eating a meal in general, a decreased preference for high-protein products after a savory test meal and an increased preference for low-energy products after eating a meal in general.

2. Materials and methods

2.1. Products and categories of the MTPRT

A total of 32 food products from four macronutrient categories, i.e., high-carbohydrate, high-fat, high-protein and low-energy, was used in the MTPRT. Each category contained eight products, of which four products were sweet and four were savory. The high-protein category formed an exception and consisted of eight savory products, as no products met all requirements to be included as high-protein sweet. A product had to meet the following requirements to be included in the MTPRT:

- Commercially available.
- High-fat, high-protein and high-carbohydrate foods contained at least 50% of total energy from their respective macronutrient category classification.
- Low-energy products contained less than 60 kcal/100 g.

Hill's European MPC (Hill, 1986; Hill et al., 1987) and Brisbois-Clarkson's North American MPC (Brisbois-Clarkson et al., 2009) were used as starting point to select the food products. Products were replaced based on commercial availability in the Netherlands when needed. The Dutch Food Composition table was used to ensure appropriate macronutrient composition (RIVM., 2011). The final list of products including their respective nutritional values can be found in Supplementary Table 1.

For the products that were included in the MTPRT, standardized pictures were provided by the Image Sciences Institute, UMC Utrecht, and created as part of the Full4Health project (www.full4health.eu), funded by the European Union Seventh Framework Program (FP7/2007-2013) under grant agreement nr. 266408, and the I.Family project (http://www.ifamilystudy.eu), grant agreement nr. 266044 (Charbonnier, van Meer, van der Laan, Viergever, & Smeets, 2015). Pictures of foods were standardized by means of the plate on which products are presented, background color, contrast, camera distance and angle (see Fig. 1 for examples).

2.2. Task procedure

The MTPRT consisted of three parts: practicing, liking and ranking.

The practicing part was designed to familiarize participants with the ranking task. Participants were presented with four combinations of four pictures and asked to rank these pictures according to "what they most desire to eat at this moment". The pictures used in the practicing part were not used in the main task and did not necessarily fit within one of the macronutrient categories.

The liking part was designed to introduce participants to each product by name and picture. Liking was assessed by presenting pictures of all 32 products with the question: 'How much do you like [product name]?' which was rated on a 100 point visual analogue scale (VAS) anchored by 'do not like at all' and 'like extremely'.

The ranking part consisted of two sections, one focused on macronutrients and the other on taste, i.e., sweet and savory. In both sections, participants were presented with four different pictures, which they had to rank according to "what they most desire to eat at this moment" (Fig. 1). Participants first clicked on the product they most desired to eat at the moment of completing the task, then they clicked on the second most desired product, followed by the third and the product they least desired to eat at the moment of completing the task. In the macronutrient section, each of the four pictures represented one of the macronutrient categories. In total sixteen combinations of pictures were presented, in which each picture was shown twice. In the taste section, the four pictures that were presented came from two macronutrient categories. Within each category, one picture represented a sweet food item, and the other a savory one. For example, one sweet product and one savory product were high in carbohydrate and one sweet product and one savory product were high in fat. In the taste