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Relation between sweet food consumption and liking for sweet taste in French children



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ABSTRACT

Given the growing evidence that sugar intake could promote a positive energy balance and lead to weight gain and obesity, the World Health Organization published new recommendations in terms of sugar consumption in children and adults. However, the influence of sweet food and drink consumption on sweetness liking has not been fully characterized. Therefore, the present study aimed at exploring whether sweet food consumption is positively associated with sweetness liking in 101 children aged between 7 and 12 years. Sweetness 'preference' and liking optima for sweetness (calculated for 100% and 60% of the children, respectively) were measured by asking the children to taste and rate on a 9-point hedonic scale three ranges of food products that varied in sucrose content. Each range of products (sugar water, strawberry syrup with water, and cornflakes in milk) contained 5 levels of sweetness. Sweet food consumption from sweet drinks, candies and snacks, cereal/dairy/fruit products or added sugar were calculated using data from a food frequency questionnaire which focused on the children's consumption of sweet products, taking into account the sweetness intensity of each food. Structural Equation Modelling fitted for the 101 children showed a weak but significant positive association between candy and snack consumption and sweetness liking (path coefficient = 0.28; $p = 0.04$). However, sweetness liking was not associated with sweet drink consumption, cereal/dairy/fruit product consumption or added sugar consumption. The absence of a clear relationship between sweet food consumption and sweetness liking in this sample calls for further clarifications on the potential effect of sweet food consumption on preferred sweetness level in liquid and solid foods.

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1. Introduction

Concomitant with the increase of overweight and obesity rates, a rise in free sugar consumption was observed in France as well as in other industrialized countries (AFSSA, 2004; PNNS, 2007). Given the growing evidence that sugar intake could promote a positive energy balance and lead to weight gain and obesity (Drewnowski & Bellisle, 2007; Forshee, Anderson, & Storey, 2008; Gibson, 2008; James & Kerr, 2005; Jensen, Nichols, et al., 2013; Jensen, Nielsen, et al., 2013; Lim et al., 2009; Te Morenga, Mallard, & Mann, 2013) the World Health Organization (WHO) recently published new recommendations in terms of sugar consumption in children and adults (WHO, 2015). These guidelines strongly suggest reducing free-sugar intake to less than 10% of total energy intake in children. However, because liking is an important driver of consumption, in particular in children, it is important to

evaluate whether high sugar intake could drive high liking for sweet foods, which could in turn reinforce sugar intake.

Liking for sweet taste is present since birth (Steiner, 1979). Over the course of the first year of life, infants' acceptance for sweet taste over water is high (Schwartz, Issanchou, & Nicklaus, 2009); moreover, the preference for high levels of sweetness has been demonstrated later in childhood (Beauchamp & Cowart, 1987; de Graaf & Zandstra, 1999; Desor & Beauchamp, 1987; Desor, Greene, & Maller, 1975). However, individual variations in liking for sweet taste do exist and several studies have shown that early experiences and age contribute to these differences. For instance, it has been shown that intake of sugar water during infancy could lead to a greater preference for sweet taste at 2 years of age (Beauchamp & Moran, 1984) and between 6 and 10 years of age (Pepino & Mennella, 2005). However, the influence of current sweet food consumption on sweetness preference remains unclear. In adults, Pangborn and Giovanni (1984) showed a small but significant association between the subjects' frequency of consumption of sweet foods and their most liked sugar concentration in lemonade. In a study using an expanded number of sensory measures and

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different testing conditions, [Mattes and Mela \(1986\)](#) failed to show a consistent association between sugar intake and hedonic ratings of different concentrations of sucrose in coffee, oatmeal and water. For children, the results are somewhat inconsistent. Using a preference ranking test, [Olson and Gemmill \(1981\)](#) showed that the frequency of sweet food consumption in 4–5 year-old children, as reported by parents, was not related to sweetness preference. In accordance with these results, an extensive study involving almost 1700 children aged 6–9 years from eight European countries, showed no association between sweet food consumption frequency and preference for sweetened over non-sweetened apple juice ([Lanfer et al., 2012](#)). In contrast with these results, [Liem and Mennella \(2002\)](#) showed that children aged 4–7 years whose mothers routinely added sugar to their foods preferred higher levels of sugar in apple juice, which suggests that dietary experiences may influence sweetness preference. However, in a recent study, [Mennella and colleagues](#) found no correlation between daily added sugar intake and the most preferred sucrose concentration in water in children (aged 5–10) and their mothers ([Mennella, Finkbeiner, Lipchock, Hwang, & Reed, 2014](#)). These discrepancies could be due to the different foods used to assess preferred levels of sweetness or to the use of different methodologies for assessing sweet food consumption. In previous studies, the authors considered the overall consumption of sweet foods and drinks, the addition of sugar to foods, or the consumption of a specific sweetened food but none of them took into account the sweetness intensity of the consumed foods and compared, over different categories of sweet food products, the association between sweet food consumption from sweet foods and sweetness liking.

The potential relationship between sweet food consumption and sweetness liking could be bidirectional: high sweet food consumption could lead to higher sweetness preference ([Liem & Mennella, 2002](#); [Pangborn & Giovanni, 1984](#)) and it could be assumed that high sweetness preference could lead to the consumption of highly sweetened food and thus lead to higher sweet food consumption. In this study, our work focused on studying whether high sweet food consumption was related to higher sweetness preference in children. To do so, we explored the relationship between sweet food consumption in children and liking for sweet taste in three different ranges of food products varying in sugar content. Given that several studies found a link between early or current sweet food consumption and sweetness preference, we expected a positive association between children's sweet food consumption and liking for sweet taste. We expected to find this association more specifically for sweet foods with high sweetness intensity, such as sweet drinks, candies and sweet snacks.

2. Materials & methods

2.1. General overview

To study the potential association between children's sweet food consumption and liking for sweet taste, we collected sweet food and drink consumption data as well as liking scores for sweet foods (varying in sweetness levels) in school-aged children. A questionnaire measured the frequency of consumption of sweet foods and drinks and was completed by the children and their parents at home. The children's liking measurement task took place in the sensory evaluation laboratory of the Centre des Sciences du Goût et de l'Alimentation (Dijon, France). The present study is part of a project aiming at measuring attraction to sweet, salty and fatty foods, in which 15 ranges of products were tasted by the children; only results for three ranges of products varying in sweetness level are presented here.

2.2. Participants

Participants were recruited during the first semester of 2013 in three private schools located in Dijon, France. Eligible participants attended elementary school and did not have any health problems, food restrictions or food allergies. A total of 126 children aged between 7 and 12 years were enrolled. This study was conducted according to the guidelines established in the Declaration of Helsinki; the local ethics committee approved the study protocol (Comité de Protection des Personnes Est 1 Bourgogne, no. 2013/12). Written and informed consent was obtained from both parents and oral assent was obtained from each child. Parents were asked to provide us with the weight (kg) and height (cm) of their child as measured by their medical doctor and as reported in the child's health notebook. The body mass index (BMI) (kg/m²) was calculated and transformed into age- and sex-standardized z-scores (zBMI) on the basis of French reference data ([Rolland-Cachera et al., 1991](#)).

2.3. Food frequency questionnaire

To assess children's frequency of consumption of sweet food products, we developed a food frequency questionnaire adapted to the French dietary habits that consisted in 74 questions. Fifty-two questions assessed the frequency of consumption of 40 sweet foods (caloric sweetened foods) and 12 sweet drinks (eight caloric and four non-caloric sweetened drinks) that are commonly consumed by French children. For each food or drink, children had to answer the question "How many times per week do you consume each of the following food/drink?", taking into account what they ate/drank the previous week, using a 6-point scale: 0, "I don't know this food/drink"; 1, "never or less than once a week"; 2, "once or twice a week"; 3, "almost every day"; 4, "two or three times a day"; and 5, "more than three times a day". The questionnaire also included questions on the frequency and quantity of sweet ingredients added to food (for instance: sugar, jam or chocolate spread added on toast, yogurt or fruits). Children were asked to complete this questionnaire with the help of their parents using a paper (n = 86) or an online version (Timesens, ChemoSens platform, Dijon, France; n = 34) according to their availability of an internet access or their willingness to use it.

2.4. Liking measurements

Three ranges of food products (sugar in water, strawberry syrup with water and cornflakes in milk) varying in sucrose content, were used to determine the children's liking for different levels of sweetness as was done in previous studies in adults ([Urbano et al., 2016](#)) or children ([Mennella et al., 2014](#)). Each range of products contained five levels of sweetness intensity, which are described in [Table 1](#). Levels were chosen in order to produce perceivable intensity differences in adults ([Urbano et al., 2016](#)). To facilitate interpretation, each sweetness level was labelled similarly for the three ranges of product, from '−2' for the lowest sugar level to '+2' for the highest sugar level, level '0' corresponding to the medium sweetness level ([Urbano et al., 2016](#)). For each range, the added sucrose (Carrefour, France) was diluted into the corresponding matrices: water (Evian[®], Evian-les-Bains, France), strawberry syrup with water (Teisseire[®], Crolles, France), and semi-skimmed milk (Lactel Bio[®], Laval, France) in which cereals were added (Cornflakes, Kellogg's[®], Noisy-le-Grand, France). The food stimuli were prepared the previous night or on the morning of the session and stored at 4 °C until 10 min before they were tasted.

Children were invited to the sensory evaluation laboratory three times for lunch to taste the three ranges of food products described above. Product evaluations started at 12:45. These

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