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## Affective responses to sweet products and sweet solution in British and Finnish adults

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## ABSTRACT

Responses to sweetness are reported in two populations, one segmented by gender and age, and the other one by gender only. The strength of the association between liking for specific sweet foods and liking for an aqueous sucrose solution (20% w/v) is also tested, and health attitudes examined. British adults (n = 1855, age 17–82, mean 55 years, 90% women) and Finnish young adults (n = 1292, age 20–25, mean 22 years, 54% women) rated their liking of ten sweet foods and beverages based on product names, and completed questionnaires on Craving for Sweet Foods (CSF) and General Health Interest (GHI). One-half of Brits and a third of Finns rated liking and intensity of sucrose solution. In factor analysis, identical categories of liking for sweet products were formed in each population, one consisting of five *processed sweets* (“Goodies”), and the other of *naturally sweet fruits and berries* (“Fruits”). *Sugared and sugar-free soft drinks and fruit juice* loaded on the third factor. After age 50, British men scored higher than British women in CSF and liking for several sweet products; Finnish women scored higher than Finnish men in CSF and liking for most sweet products. GHI was positively associated with liking for Fruits and negatively with liking for sugared soft drinks. Sucrose solution was better liked by British men than women, with no gender difference in Finns. Liking for sucrose solution was only weakly associated with liking for sweet products based on product names. In two demographically different European populations, attraction to sweet gathered in similar product categories, but manifested differently at different ages and each gender.

## 1. Introduction

Abundant sugar intake is a health concern worldwide (WHO, 2015). High consumption of mono- and disaccharides added to foods is associated with higher body weight, and high consumption of sugar-sweetened beverages is associated with overweight and obesity in children (Cox, Hendrie, & Carty, 2016; Te Morenga, Mallard, & Mann, 2013). High sugar intake is also associated with increased incidence of dental caries (Moynihan & Kelly, 2014).

The flip side of the concern is the deeply rooted position of sweetness in our biology and culture (Rozin, 1982). Inclination to enjoy sweetness is inherent and evolutionarily well founded due to energy and nutrients associated with it (Drewnowski, Mennella, Johnson, & Bellisle, 2012). Technologies to refine sugar from canes and beets, to produce a great variety of fine-tuned commercial sweet products, have been generated to satisfy the indulgence for sweetness. Further technological development

has introduced intense sweeteners to the market to satisfy the need without calorie load and caries risk (Spillane, 2006).

Data from Finnish families (Keskitalo et al., 2007a) and British and Finnish twins (Keskitalo et al., 2007b; Keskitalo et al., 2008) suggest that part of the predilection for sweetness (“sweet tooth”) is inherited and thus, it runs in families. Evidence for some genetic influence was also found in 3-year-old twins whose parents rated their preference for snacks that were primarily sweet (Fildes et al., 2014). Studying genetic variations in the perception of sweetness in children and adults, Mennella, Pepino, and Reed (2005) concluded that in adults, cultural forces override genetic effects. Thus, genetic architecture defines the basis on which the cultural supply of products builds individual profiles of sweet preferences and inclinations.

The data of the present study were originally collected for the purpose of research on genetics of sweetness preferences. We measured sweetness perception using a sweet aqueous solution of sucrose – a

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**Table 1**  
Profiles of British and Finnish respondents. M + F refers to the number of males + females.

| Background        |            | Brits                                    |   | Finns                         |  |
|-------------------|------------|--|---|-------------------------------|--|
| Characteristic    | Categories | Questionnaire<br>n = 1855 (M + F)<br>(%) | Subgroup tasting sweet solution<br>n = 987 (M + F)<br>(%) | Questionnaire n = 1292<br>(%) | Subgroup tasting sweet solution n = 468<br>(%) |
| Sex               | Male       | 188<br>(10.1%)                           | 102<br>(10.3%)  | 594<br>(46.0%)                | 186<br>(39.7%)                                 |
|                   | Female     | 1667<br>(89.9%)                          | 885<br>(89.7%)  | 698<br>(54.0%)                | 282<br>(60.3%)                                 |
| Age group (years) | 17–39      | 242 (33 + 209)<br>(13.0%)                | 122 (13 + 109)<br>(12.4%)                                 | 1292<br>(100%)                | 468<br>(100%)                                  |
|                   | 40–49      | 306 (29 + 277)<br>(16.5%)                | 149 (12 + 137)<br>(15.1%)                                 |                               |  |
|                   | 50–59      | 623 (49 + 574)<br>(33.6%)                | 332 (28 + 304)<br>(33.6%)                                 |                               |  |
|                   | 60–69      | 501 (45 + 456)<br>(38.6%)                | 279 (33 + 246)<br>(28.3%)                                 |                               |  |
|                   | 70–82      | 183 (32 + 151)<br>(9.9%)                 | 105 (16 + 89)<br>(10.6%)                                  |                               |  |

simple and universal stimulus which is easy to present to large populations (Keskitalo et al., 2007b; Keskitalo et al., 2008). For getting a wider perspective to sweetness perceptions we developed a questionnaire in which liking responses to sweet products and craving for sweet foods were recorded from British and Finnish twins (Keskitalo et al., 2007b; Keskitalo et al., 2008; Knaapila et al. 2011). These data were used in the search of genetic roots in sweetness preferences using a twin paradigm (Keskitalo et al., 2007b; Keskitalo et al., 2008; Knaapila et al., 2011), and of specific trait locus of genetic linkage analysis (Keskitalo et al., 2007a). Because of the long term data collection expanding over years, and the focus of the reports, only a part of the outcome data have been incorporated into the published papers to date.

The data contain unique and as yet unused information of the attraction to sweetness in two large, separate populations at three levels: 1) hedonic and intensity ratings of a simple aqueous solution of sucrose, 2) reported liking and use frequency of a range of everyday sweet foods and beverages, and 3) craving for sweet foods, measured by a six-item validated instrument (CSF) (Roininen, Lähteenmäki, & Tuorila, 1999). Analyzing the data fills a gap in knowledge of demographic variations in sweetness preferences, as the published literature tends to focus on specific sensory stimuli in specific experimental conditions (an exception is the large web-based study with French consumers, Urbano et al., 2016). The British respondents covered a wide age range, thus enabling the analysis of responses to sweetness across age groups. Both the British and Finnish data contained responses from both genders, thus gender differences could be analyzed. By reporting on two data sets that share the methodology in the same paper, we seek to identify characteristics of sweetness responses that are not bound to a specific age group, gender or cultural setting. The members of twin pairs are here treated as individuals, but their data are not statistically independent observations, which is taken into account in statistical analyses (see Section 2.3 Statistical analysis).

The data also allow to examine the prediction of liking for sweet products from responses to an aqueous sucrose solution, a stimulus that is widely and universally used in the measurement of sweetness attraction (e.g., Desor & Beauchamp, 1987; Esses & Herman, 1984; Keskitalo et al., 2007a; Keskitalo et al., 2007b; Keskitalo et al., 2008; Mennella, Finkbeiner, Lipchock, Hwang, & Reed, 2014; Mennella, Finkbeiner, & Reed, 2012; Mennella et al., 2005; Pepino & Mennella, 2012; Thai et al., 2011). The present analysis adds to research comparing liking for aqueous solutions with ratings of liking for sweet products based on their names (Kim, Prescott, & Kim, 2014).

The General Health Interest (GHI) (Roininen et al., 1999) was used to examine the potentially controlling role of health attitudes in responses to sweetness. If powerful in this context, GHI should be negatively correlated with liking for sweet items that are perceived as unhealthful.

Thus, the objective of the present study was to describe demographic variations in affective responses to a range of sweet foods and beverages in two populations of which one (British) allowed the examination of variation by gender and age, and the other (Finnish) by gender only. Besides ratings of liking of sweet products based on product names, also craving for sweet foods (CSF) was measured. The secondary aim was to describe the demographic variations in responses to an aqueous sweet solution in the same populations and to examine the extent to which liking for the very sweet solution could predict the rated liking of sweet products based on product names. Finally, the capability of health attitude (GHI) to control the responses to sweetness was tested by correlational analysis.

## 2. Respondents and methods

### 2.1. Respondents

The present data were collected in British (UK) and Finnish twin research units in years 2005–2007, British data in English and Finnish data in Finnish language. Table 1 presents the distribution of participants by gender and age group, as used in the subsequent analyses. For brevity, we refer to British respondents as Brits and the Finnish respondents as Finns.

The British respondents (n = 1855 individuals) were twins in the UK Adult Twin Registry (Spector & Williams, 2006). A minority (n = 188, 10.1%) were men. The age range of the respondents was 17–82 y (mean ± SD: 54.9 ± 12.7; for men 54.9 ± 14.1, for women 54.9 ± 12.6). The present study was approved by the Guy's and St Thomas's Hospital Ethics Committee.

The Finnish data (n = 1292 individuals) were collected during the fourth wave assessment of the FinnTwin12 study (Kaprio, Pulkkinen, & Rose, 2002), which is based on five consecutive and complete year cohorts of Finnish twins born in 1983–87. Close to half (n = 594, 46.0%) were men, and the age range was 20–25 y (mean ± SD: 22.4 ± 0.7, for men and women identical). The present study was approved by the Coordinating Ethics Committee of Helsinki University Hospital and the IRB of Indiana University, Bloomington, IN.

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