Sweet taste, appetite and obesity

Kees de Graaf, Am Soc Nutr Webinar 28 July 2020

The views and opinions expressed in this presentation are those of the author and do not necessarily reflect the position or policy of PepsiCo, Inc.
Declaration of interests

- Current research funding from TIFN, NL, in collaboration with 8 Industry partners (American Beverage Association, Arla Foods, Cargill, Dutch Knowledge Center for Sugar and Nutrition, Firmenich, International Sweeteners Association, SinoSweet, Unilever) on long term trial of effect sweetness exposure on sweetness liking and other outcome measures

- Member of Scientific Advisory Board of Sensus, the Netherlands, producer of plant based CHO

- Speaker, travel fees from PepsiCo, Inc., ISA, ILSI Europe, ILSI North America, Coca-Cola, Firmenich, Arla

- Member of ILSI-Europe taskforce on the effects of Sensory and physical properties of food on food and energy intake

- Associate Editor of *Food Quality and Preference*, and section editor of *Physiology and Behavior*
We love sweetness, makes you feel good

- Inborn liking
- Optimal sweetness declines until adulthood
- Sweetness levels similar across the world

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>Q1</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweetness Nether</td>
<td>22</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>Sweetness Malay</td>
<td>20</td>
<td>6</td>
<td>34</td>
</tr>
</tbody>
</table>
Sweet taste, appetite and obesity

- The narratives
- The data
- The issues remaining
The narratives

- Sweet taste signals energy in food
- Overweight people have a sweet tooth, like sweetness more
- Overweight people consume more energy from sweet tasting foods → overconsumption of energy
- Sweet taste potentiates intake
The data

- Sweetness as a signal for the energy content of foods
- Sweetness liking and overweight
- Sweetness, energy intake and overweight
- Sweetness and satiation, satiety
Taste nutrient signalling, i.e. corr (x 100), between taste intensity and nutrient concentrations across representative food supplies around the world

<table>
<thead>
<tr>
<th>N foods</th>
<th>Sweet – kcal</th>
<th>Sweet – CHO</th>
<th>Umami - PRO</th>
<th>Salt - Sodium</th>
<th>Fat sensation-Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>377</td>
<td>-08</td>
<td>41</td>
<td>27</td>
<td>64</td>
</tr>
<tr>
<td>USA</td>
<td>237</td>
<td>11</td>
<td>42</td>
<td>n.a.</td>
<td>72</td>
</tr>
<tr>
<td>Netherlands</td>
<td>489</td>
<td>11</td>
<td>54</td>
<td>54</td>
<td>69</td>
</tr>
<tr>
<td>Malaysia</td>
<td>423</td>
<td>04</td>
<td>33</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>France</td>
<td>≈350</td>
<td>-11</td>
<td>57</td>
<td>62</td>
<td>77</td>
</tr>
</tbody>
</table>

Lease, FQAP 2016; Van Langeveld FQAP 2017; Teo Appetite 2018; Martin FQAP 2019
Sweet tooth → obesity hypothesis

- Studied for about 40 years, one of the first papers

Sensory discrimination, intensity perception, and affective judgment of sucrose-sweetness in the overweight.

Abstract
Differential sensitivity, intensity perception, and pleasantness of sucrose-sweetness was determined with two groups of women, 13 overweight and 12 normal weight. Discriminability, psychophysical, psychophysical and preference functions were determined for both groups. In addition, maximally preferred sweetness intensities and the corresponding maximally preferred sucrose concentrations were calculated. The data showed that the two groups did not differ in any of these functions or measures. Individual variability in affective response behavior was larger within the overweight than within the normal weight group.

PMID: 7175511 DOI: 10.1067/2129.1982.9709931
[Indexed in MEDLINE]
Optimal sweetness and obesity

One of the last papers

Bobowski & Mennella, 2017

Selection of other papers


Consumption of sweet tasting foods and weight status, a whole diet study

- Dutch National Food consumption (DNFC) survey → select > 450 foods that encompass > 80% of energy intake

- Profile > 450 foods with Spectrum method, i.e. with the help of defined levels of sweetness, saltiness, bitterness, sourness, umami intensity, and fat sensation intensity (0 -100)

- Categorize foods into taste clusters

- Contribution of taste clusters to energy intake according to gender, age and weight status in two big cohorts in the Netherlands → DNFC and NQ+ (= Wageningen cohort on dietary assessment methods)

Van Langeveld et al, Brit J Nutr 2018
Sensory database – 481 foods, > 83 % of kcal intake

<table>
<thead>
<tr>
<th>Cluster</th>
<th>N</th>
<th>Sweet</th>
<th>Sour</th>
<th>Bitter</th>
<th>Umami</th>
<th>Salt</th>
<th>Fat</th>
<th>Example foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>481</td>
<td>22±20</td>
<td>11±14</td>
<td>4±9</td>
<td>8±11</td>
<td>17±17</td>
<td>31±24</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>37</td>
<td>7±6</td>
<td>13±16</td>
<td>2±3</td>
<td>6±6</td>
<td>20±14</td>
<td>80±11</td>
<td>Mayonnaise</td>
</tr>
<tr>
<td>Neutral</td>
<td>130</td>
<td>10±8</td>
<td>4±3</td>
<td>3±4</td>
<td>4±5</td>
<td>10±9</td>
<td>13±9</td>
<td>Bread brown wheat</td>
</tr>
<tr>
<td>Sweet/sour</td>
<td>66</td>
<td>31±15</td>
<td>36±15</td>
<td>3±5</td>
<td>1±4</td>
<td>5±7</td>
<td>11±12</td>
<td>Apple with skin average</td>
</tr>
<tr>
<td>Salt/umami/fat</td>
<td>119</td>
<td>8±6</td>
<td>9±7</td>
<td>1±2</td>
<td>23±9</td>
<td>42±9</td>
<td>46±14</td>
<td>Cheese Gouda 48+ average</td>
</tr>
<tr>
<td>Sweet/fat</td>
<td>113</td>
<td>51±11</td>
<td>5±7</td>
<td>3±5</td>
<td>1±1</td>
<td>8±5</td>
<td>37±16</td>
<td>Chocolate bar milk nuts</td>
</tr>
<tr>
<td>Bitter</td>
<td>16</td>
<td>12±8</td>
<td>12±11</td>
<td>47±11</td>
<td>1±1</td>
<td>2±1</td>
<td>5±4</td>
<td>Coffee prepared</td>
</tr>
</tbody>
</table>

Van Langeveld et al, Brit J Nutr 2018
Contribution of sweet tasting foods to energy intake, by gender

Van Langerveld et al, Brit J Nutr 2018
Contribution sweet tasting foods to energy intake by weight status in men

Van Langeveld et al, Brit J Nutr 2018
Contribution of sweet-tasting food to energy intake by weight status in women

Van Langeveld et al, Brit J Nutr 2018
On sweetness and satiation (=meal termination), i.e. does sweetness lead to an higher ad libitum intake, controlling for energy density, macronutrient content, and palatability?

- Sweet and savoury rice meals, equal in texture, palatability, macronutrient composition, fibre, energy density; but distinct sensory profiles

- 3 x 2; test 1: just ad-libitum, test 2: appetite ratings during meal, test 3: Leeds Food Preference Questionnaire during meal

- Within subjects with n = 64

Ad libitum intakes of sweet and savoury meals

Very, very similar

On sweetness and satiety, i.e. does consuming a fixed sweet only, savoury only, or a mixed diet for 24 hr lead to an higher energy intake in a test-meal?

- Diet composed of sweet food only, savoury foods only, or mixed, personalized diets equal in texture, energy density, macronutrient composition etc..
- Within subjects designs, n = 39, start with fixed lunch
- Ad libitum intake in lunch 24 hr after start
- Lunch comprised high protein savoury (HPSA), low protein savoury (LPSA), high protein sweet (HPSW), low protein sweet foods (LPSW)

Griffioen-Roose et al, Appetite 2012; 59: 1-8
Lunch intake after 24 hr sweet, savoury, or mixed diet; Kcal intake was equal, strong sensory specific satiety effect

Griffioen-Roose et al, Appetite 2012; 59: 1-8
Liking for sweetness is inborn and universal

Sweetness does not signal the energy content in current day food supplies

No difference in sweetness perception, liking as function of weight status

Overweight, obese → Slightly less sweet, more savoury fatty tasting foods

Sweetness, savouriness → similar effects on energy intake but strong sensory specific satiety effects

Energy intake is much more determined by energy density and eating rate (=texture)

Forde et al, Curr Dev Nutr 2020
Can we change generalized preferences for sweetness; can we get used to, learn to like diets that are high and low in sweetness?

We know that high consumption of sugar sweetened beverages leads to overweight; what is the long term effect of diets low and high in (solid) sweetness exposure on energy intake/balance?

There are distinct differences between subjects in sweetness preferences; what are causes and consequences?
Thank you for your attention

Questions?