Factors involved in the Development of Food Preferences in Young Children

Kathleen L. Keller, Ph.D.

The Pennsylvania State University
Departments of Nutritional Sciences & Food Science
• Role of individual variation in food preferences.

• Role of the food environment in food preferences.

• Opportunities for industry, scientists, parents and health professionals to work together to teach children healthier eating habits.
How do Food Preferences Develop?

- Interactions between genes x environment
- Mere exposure
- Flavor-flavor learning
- Flavor-consequence learning
- Flavor-context learning
Universal Hedonic Reaction: Tongue Protrusions to Sweet

Universal Aversion: Gapes to Bitter

Hominoids: Mid-face Aversion (bitter)  Apes & Humans Midface ‘Smile’ (sweet)

New World Monkeys: Up/Down tongue to sweet vs. bitter

(a) Eye squinch & nose wrinkle  Elevation & relaxation

Sweet (Up)  Bitter (Down)  S. oedipus infant  C. jacchus infant
Individual Differences in Food Preferences: Do Genes Matter?
Theoretical Framework Relating Taste Variations to Health

Genetic Variation in Taste

Food / Beverage Sensations

Food / Beverage Preference

Food / Beverage Intake

Risk for CVD, dyslipidemia, Obesity, Cancers
Ability to taste PROP - Phenotype

**SUPERTASTER ANATOMY**
The first inkling of a genetic basis for perceiving fat came from research on a different sensation: bitterness. One anecdotal report from the 1960s suggested that people who were more sensitive to the bitter taste of the thiourea PTC had leaner bodies than those who were less sensitive. This sensitivity correlated with other anatomical changes in the mouth that could allow for detection of fat by way of its texture.

**NONTASTER**
Having fewer, loosely arranged papillae is associated with less sensitivity to bitterness and other oral sensations like heat from chili pepper and astringency from dry red wine. Taste buds on the papillae also have fewer somatosensory nerve endings.

**SUPERTASTER**
Having a larger number of papillae that are tightly arranged is associated with more sensitivity. In addition, taste buds on the papillae have a higher proportion of somatosensory nerve endings.

**GENES THAT MAKE A SUPERTASTER**
Supertasters, or individuals who are very sensitive to the bitter taste of the thioureas PTC and PROP, have a polymorphism in TAS2R38, a gene that codes for a receptor for these bitter tasting compounds A. However, supertasters appear to be more sensitive to a wide range of oral sensations. This observation could be explained by a polymorphism in a second gene, gustin, which codes for the salivary enzyme CA6, which both promotes the growth of more taste buds, and maintains their functionality. Gustin may contribute to a greater ability to perceive textures associated with fats by inducing the development of more taste buds and because somatosensory nerve endings, which respond to touch and pressure, tend to wrap around taste buds B.
Presented in SJ Wooding “Phenylthiocarbamide: A 75-yr adventure in genetics and natural selection”
Tasters dislike...
Nontasters like...
Keller and colleagues, 2002
Keller & Tepper, *Obesity* 2004
<table>
<thead>
<tr>
<th>Children</th>
<th>A49P</th>
<th>Sucrose Preference (g/100 mL)</th>
<th>Sugar Content of Cereal (g/100 g)</th>
<th>Sodium Content of Cereal (mg/100 g)</th>
<th>Sugar Content of Beverage (g/100 mL)</th>
<th>Sodium Content of Beverage (mg/100 mL)</th>
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<tbody>
<tr>
<td>Black</td>
<td>AA</td>
<td>14.8 ± 1.9</td>
<td>36.7 ± 1.5</td>
<td>57.1 ± 2.8</td>
<td>9.8 ± 0.7</td>
<td>14.4 ± 1.9</td>
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<td></td>
<td>AP</td>
<td>21.2 ± 1.8</td>
<td>35.1 ± 1.8</td>
<td>60.5 ± 2.3</td>
<td>10.2 ± 0.5</td>
<td>14.9 ± 1.2</td>
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<td></td>
<td>PP</td>
<td>24.5 ± 2.0</td>
<td>41.6 ± 1.0</td>
<td>55.8 ± 2.6</td>
<td>11.0 ± 0.4</td>
<td>22.9 ± 3.6</td>
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<tr>
<td></td>
<td>Total</td>
<td>20.2 ± 1.2</td>
<td>37.9 ± 1.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>58.4 ± 1.5</td>
<td>10.3 ± 0.3</td>
<td>16.6 ± 1.2</td>
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<tr>
<td>White</td>
<td>AA</td>
<td>16.4 ± 2.7</td>
<td>29.5 ± 3.1</td>
<td>65.8 ± 3.7</td>
<td>8.6 ± 0.8</td>
<td>20.4 ± 2.6</td>
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<td>AP</td>
<td>22.8 ± 2.3</td>
<td>32.3 ± 2.4</td>
<td>65.3 ± 3.9</td>
<td>10.6 ± 0.7</td>
<td>21.1 ± 5.3</td>
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<td>PP</td>
<td>16.4 ± 4.1</td>
<td>37.8 ± 4.5</td>
<td>58.5 ± 5.3</td>
<td>11.0 ± 1.3</td>
<td>24.7 ± 8.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19.2 ± 1.6</td>
<td>32.2 ± 1.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.3 ± 2.4</td>
<td>10.0 ± 0.5</td>
<td>21.4 ± 3.0</td>
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<tr>
<td>All children</td>
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<td>15.5 ± 1.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35.3 ± 1.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60.8 ± 2.3</td>
<td>9.3 ± 0.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>16.9 ± 1.6</td>
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<tr>
<td></td>
<td>AP</td>
<td>21.8 ± 1.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>34.1 ± 1.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>62.3 ± 2.1</td>
<td>10.3 ± 0.4</td>
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<td>PP</td>
<td>22.0 ± 1.9&lt;sup&gt;d&lt;/sup&gt;</td>
<td>40.4 ± 1.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>56.6 ± 2.4</td>
<td>11.0 ± 0.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>23.4 ± 3.6</td>
</tr>
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</table>

Values are means ± SEM. To convert values for sucrose to moles per liter, multiply by 0.0292. Within each measure, <sup>a</sup> is significantly different from <sup>b</sup>; <sup>c</sup> is significantly different from <sup>d</sup>.

Mennella & colleagues *Pediatrics*, 2005
PROP Status x Food Environment

Figure 3.

Burd & Keller, 2012 (in press)
PROP Status x Food Environment

Burd & Keller, 2012 (in press)
Figure 4. Changes in raw broccoli liking with 7 weeks of repeated exposure at an afternoon snack. (A) Percentage of children rating raw broccoli as “yummy,” “just okay,” and “yucky” at pre- and post-exposure. $\chi^2$ analysis revealed an increase in the percentage of children rating raw broccoli as “yummy” (52% vs 70%; $\chi^2 = 20.3$, df = 4, $P < 0.0001$) following 7 weeks of exposure at an afternoon snack. (B) Proportion of children showing increases, no change, or decreases in raw broccoli liking following repeated exposure, by dip condition and bitter sensitivity. Changes in liking by condition and bitter sensitivity were not significant.
Adults with the AA genotype of CD36 have higher liking of added fats and oils (p=0.02).

...and children with this genotype give lower liking ratings to low-fat milk compared to high-fat milk (p=0.01).
The Food Environment
Sucrose infusions result in increased suckling, increased heart-rate.
Advertising Overrides Taste Preferences

Children (3-5 years) were significantly more likely to prefer the taste of a food if they thought it came from McDonald’s.

Robinson et al., Arch Pediatr Med. 2007
Results: OW Children Increased Intake in Branded Conditions

![Graph showing increased intake in branded conditions for different weight statuses.]

- Lean
- Overwt.

Weight Status
Neural responses to Food Branding

Healthy weight children show greater activation in areas of the brain commonly associated with cognitive control and disinhibition in response to food ads.

Figure 2. fMRI statistical maps (coronal perspectives) showing results from between groups food versus blurred baseline contrasts, coregistered with average structural magnetic resonance imaging data from participants. Significance thresholds are set at $P < .01$, corrected. Highlighted areas indicate greater activation in the left postcentral gyrus (left) and midbrain (right) in the obese group compared with the healthy weight group.

Bruce AS et al., 2012
Opportunities to Change Food Preferences and Prevent Obesity?
It's Broccoli Time!

Pooh's Pineapples!

Blue’s Blueberries!

Clifford’s Tomatoes!

Hola Amigos!
Do you want some of my carrots?

Bob’s Gem Stacks!

Ponyville Raspberry
Overall Findings

Keller et al., Physiology & Behavior, 2012
What about Body Weight?

[Graph showing BMI z-score difference between Control and Treatment groups]
Opportunities

• Flavor-flavor learning: Spices and cooking preparations to enhance the appeal of vegetables.

• Mere exposure – increasing opportunities to have children help in food preparation

• Flavor-context: Presenting vegetables and fruits and parties, in fast food meals, etc.
Acknowledgements

- NIH – K01DK068008
- St. Luke’s Roosevelt Hospital Pilot Grant