Wine Tasting Without a Tongue: Wine Taste Perception in a Person with Isolated Congenital Aglossia, Average Naïve Taster, and Sommelier

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BACKGROUND

Gustation
- Gustation (taste) is a complex sense, with flavor perception influenced by sensory inputs (smell, sight, texture, temperature, and sound) (Small et al., 2004)
- Receptors on taste buds allow for detection of basic tastes (sweet, sour, salty, bitter, and umami), as well as fatty acids and calcium (Wata et al., 2014).
- Cranial nerves VII, IX, and X transduce taste stimuli to the primary gustatory cortex in the anterior insula and frontal operculum (de Araujo & Simon, 2009). 

Olfaction
- Olfaction (smell) involved in perceiving taste and flavor
- Odorant stimuli transduced from receptors in nasal chambers via cranial nerve I, olfactory bulb, and olfactory tract to the primary olfactory cortex
- Olfactory cortex is comprised of the anterior olfactory nucleus, prepiriform cortex, lateral entorhinal cortex, periamygdaloid cortex, and cortical nucleus of the amygdala (Doty, 2001).

Isolated Congenital Aglossia (ICA)
- ICA is a rare condition with complete absence of tongue at birth, without presence of other syndromes or symptoms (McMicken et al., 2014).
- ICA contains only 12 cases in the literature, the first reported in 1781 (de Jussieu).
- Studies confirmed taste perception in ICA with single taste solutions of sour, salty, sweet, bitter, and umami.
- No studies investigated taste perception in ICA using a whole food and/or beverage approach.

Wine Tasting
- Lack of data collection tools assessing taste or smell perception in wine tasting
- Research suggests naïve wine tasters and sommeliers use different neural pathways when tasting wine.
- Naïve tasters show activation in the dorsolateral frontal operculum (de Araujo & Simon, 2009)
- Sommeliers show activation in the dorsolateral frontal cortex associated with high-level cognitive processes (Castrionta Scanderbeg et al., 2005).

HYPOTHESES

There is no significant difference in the perception of the nose and palate components of wine tasting (fruit type, fruit character, non-fruit, organic earth, and inorganic earth) between the subjects as detailed below.

Table 1. Detailed Hypotheses

<table>
<thead>
<tr>
<th>Nose</th>
<th>Palate</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>H4</td>
<td>Person with ICA and Naïve Taster</td>
</tr>
<tr>
<td>H2</td>
<td>H5</td>
<td>Person with ICA and Naïve Taster with Tongue</td>
</tr>
<tr>
<td>H3</td>
<td>H6</td>
<td>Sommelier and Naïve Taster with Tongue</td>
</tr>
</tbody>
</table>

MATERIALS & METHODS

Figure 2. Wine Tasting Set Up

- Sample
  - One naïve taster with tongue and one sommelier age- and sex-matched to 46 year old female with ICA.

Procedures
- Five medium-bodied, red wines sampled in triplicate
- Overall order of samples was randomized
- Subjects tasted samples in same order to account for taste variations due to the ordering of the wine.

Measures
- Wine taste perception measured by 73 variables
- Sommelier validated Nose and Palate Survey developed by the researchers from the Court of Master Sommeliers Deductive Tasting Format used for data collection.
- Most variables measured using a Likert-type scale of 0 = none detected, 1 = very weak, 2 = weak, 3 = clear but not intense, 4 = intense, 5 = very intense.

Data Analysis
- Data analyzed with one-way independent ANOVA and Welch’s post hoc p-value.

RESULTS

Table 2. Rating of Nose and Palate Components in Wine Tasting by Study Participant

<table>
<thead>
<tr>
<th>ICA</th>
<th>Naïve w/ Tongue</th>
<th>Sommelier</th>
<th>ICA vs. Naïve w/ Tongue</th>
<th>ICA vs. Sommelier</th>
<th>ANOVA/ Welch’s p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Post hoc p-value</td>
<td>ICA vs. Naïve w/ Tongue</td>
<td>Post hoc p-value</td>
</tr>
<tr>
<td>Nose</td>
<td>1.441 (.056)</td>
<td>1.282 (.050)</td>
<td>0.683 (.043)</td>
<td>63.461</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fruit Type</td>
<td>2.689 (.161)</td>
<td>2.022 (.119)</td>
<td>1.944 (.107)</td>
<td>9.718</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fruit Character</td>
<td>2.140 (.087)</td>
<td>1.704 (.078)</td>
<td>0.786 (.086)</td>
<td>68.355</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Non-Fruit</td>
<td>1.133 (.140)</td>
<td>1.367 (.088)</td>
<td>0.313 (.069)</td>
<td>47.027*</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Organic Earth</td>
<td>1.120 (.153)</td>
<td>0.973 (.070)</td>
<td>0.316 (.092)</td>
<td>18.628*</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Inorganic Earth</td>
<td>0.122 (.055)</td>
<td>0.344 (.063)</td>
<td>0.060 (.034)</td>
<td>8.091</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Palate</td>
<td>1.510 (.058)</td>
<td>1.36 (.060)</td>
<td>0.750 (.055)</td>
<td>48.651</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fruit Type</td>
<td>2.711 (.121)</td>
<td>2.000 (.107)</td>
<td>1.967 (.115)</td>
<td>15.615</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Fruit Character</td>
<td>2.319 (.073)</td>
<td>1.895 (.086)</td>
<td>0.932 (.101)</td>
<td>65.461</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Non-Fruit</td>
<td>1.078 (.117)</td>
<td>1.567 (.109)</td>
<td>0.362 (.046)</td>
<td>37.041</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Organic Earth</td>
<td>1.053 (.164)</td>
<td>1.053 (.135)</td>
<td>0.273 (.094)</td>
<td>15.131*</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Inorganic Earth</td>
<td>0.267 (.078)</td>
<td>0.211 (.057)</td>
<td>0.044 (.020)</td>
<td>6.841*</td>
<td>&lt;.005</td>
</tr>
</tbody>
</table>

SUMMARY & CONCLUSIONS

- There were no significant differences between the person with ICA and average naïve taster for either nose or palate overall variable rankings (Table 2).
- Naïve tasters, both with and without tongue, had greater similarity of nose and palate variables than either compared to the sommelier.
- The person with ICA had similar wine taste perception to the average naïve taster, while wine taste perception varies greatly between trained wine experts and naïve wine tasters with or without tongue.
- Differences in neural processing between naïve and expert wine tasters may account for some differences demonstrated.

RESEARCH SIGNIFICANCE

- Rehabilitation in Taste/Tongue Loss
  - Knowledge gained by studying ICA could aid in rehabilitating loss of tongue/taste.
  - Head-and-neck cancers
  - Alzheimer’s disease
  - Aging population
- Head and neck cancer patients have high incidence of taste dysfunction due to cancer anatomy and treatment therapies.
- Incidence of malnutrition in head and neck cancer patients is 88% (Ma, Poulin, Feldstain, et al., 2013).
- Taste stimuli may be used in oral rehabilitation.
- Umami and sour tastes have been shown to aid in taste and swallowing dysfunction (Sasano, et al., 2015; Lee et al., 2012; Loret, 2015).

Future Research
- Overcome the limitations of the number of participants and taste samples.
- Expand on how a person with ICA tastes similarly to a person with no oral cavity abnormalities.
- Determine where taste receptors are located in the oral cavity of a person with ICA.
- Use fMRI to examine neural activation in ICA while performing tastings.

Figure 1. Areas of neural activation in wine tasting

Figure 2. Wine Tasting Set Up

Figure 3. Wine Tasting Samples