Supertasters, winemakers, & other freaks: the taste genetics of alcoholic beverage behaviour

Gary Pickering, PhD

Professor of Biological Sciences and Psychology & Research Scientist, Cool Climate Oenology and Viticulture Institute, Brock University

gary.pickering@brocku.ca
Outline

• Taste, olfaction, flavour: concepts & definitions

• Why taste phenotypes might matter
  • General research interest and research questions

• PROP – taste & alcohol perception

• PROP – alcohol liking

• PROP and winemakers

• Conclusions & ongoing research
Acknowledgements

• Miranda Asikyan, Martha Bajec, Alex Bartolini, Amanda Bering, Amy Blake, Lauren Eckhardt, Gina Haverstock, Valerie Higenell, Mary McDermott, Alison Moyes, Gordon Robert, Katerina Simunkova

• Nancy DeCourville, David DiBattista, Valerie Duffy, Barry Green, John Hayes, Gail Higenell, Debbie Inglis, Ping Liang, Isabelle Lesschaeve, Lynda Van Zuiden

• Natural Sciences and Engineering Research Council of Canada, the Wine Council of Ontario, Wine Country Ontario, Lallemand Inc, Pangborn Sensory Science Scholarship, the American Wine Society Educational Foundation, Brock University Electronics and Machine Shops, participants
Flavour

Flavor = taste + olfaction + tactile

• 5 (ish) tastes - sweet, acid, bitter, salt, umami
• Olfaction (smell)
  • humans very sensitive sense of smell: detect > 10 000 odors
  • orthonasal vs retronasal
• Tactile (chemesthesis)
  • astringency, heat, cold, irritation/pain
Physiology of flavour
Early evidence of variation in taste
The taste phenotype: behaviour idea
The central idea (i)

- Perceived flavour of food & beverages strongly affects liking
- Liking strongly influences food & beverage consumption
- Food & beverage consumption linked to a range of diet-related nutritional outcomes & disease risk
- Therefore ….

* differences between individuals in perception of flavour associate with diet-related nutritional outcomes & disease risk

and

* psychologists, nutritionists, epidemiologists & food/beverage producers have an interest in determining the differences between individuals in perception of flavour
The central idea (ii)

- Biological and genetic-based differences in flavour perception are important sources of individual variation
- The PROP taster phenotype looks cool and worth pursuing ....
  - wine/alcoholic beverage perception ?
The PROP taster phenotype
Background – PROP taster phenotype

• 6-n-propylthiouracil (PROP)
  ➢ Different bitterness response
  ➢ PTS: pST > pMT > pNT

• Proxy for general taste responsiveness
  (Gent & Bartoshuk, ‘83; Bartoshuk et al., ‘98; Prescott et al., ‘01; Karrer et al., ‘91; Bartoshuk et al., ‘93; Prescott & Swain-Campbell, ‘00; Tepper & Nurse, ‘97; Essick et al., ‘03).

• Genetics & physiology
  - TAS2R38 (AVI/AVI, PAV/AVI, PAV/PAV)
    + other genes (Duffy et al., ‘04; Hayes et al., ’08; Bering, ‘10)
  - Fungiform papillae density
    (Reedy et al., ‘93; Bartoshuk et al., ‘94; Tepper & Nurse, ‘97; Essick et al., ’03; Hayes et al., ‘08)
Background – PROP taster phenotype

implications for...

• **food preference** e.g. - \(^{\uparrow}\)PROP = \(^{\uparrow}\)cruciferous vegetables, citrus fruit, fat (Tepper, ‘08; Duffy, ’07)

• **alcohol intake & alcoholism**?
  Literature equivocal – more later

• **other health consequences**
  PROP = some cancers, body mass index (BMI), cardiovascular disease, smoking (Enoch et al., ‘01; DiCarlo & Schade, ‘98; Miluncova et al., ’69; Duffy et al., ’04; Tepper & Nurse, ‘98; Tepper & Ulrich, ‘02)
The PROP taster phenotype

Does PROP Taster Status (PTS) associate with perception of simple oral stimuli important in wine/alcohol?
• 126 participants
• Stimuli: chemical tastants, metallic flavour, astringent (all aqueous slns), temperature
• Scale: gLMS (intensity ratings)
• PTS determined (duplicate) with 0.32 mM PROP
  • bitterness cut-offs (Porubcan & Vickers, ‘05)
• Data treatment & analysis:
  - standardization against a non-oral standard (brightness of the sun)
  - log10 transformation
  - Pearson’s r
  - ANOVA
PTS and intensity of oral sensations

Bajec & Pickering, 2008
Thermal taste, PROP responsiveness, and perception of oral sensations

Martha R. Bajec a, Gary J. Pickering a,b,c,*

a Department of Biological Sciences, Brock University, St. Catharines, Ontario, Canada L2S 3A1
b Cool Climate Oenology and Viticulture Institute, Brock University, St. Catharines, Ontario, Canada L2S 3A1
c Department of Psychology, Brock University, St. Catharines, Ontario, Canada L2S 3A1
The PROP taster phenotype

Does PTS associate with perception of wine-relevant odorants presented retronasally?

Expectation: *in the presence of concurrent taste or tactile stimuli, intensity ratings for retronasally presented odorants will vary with PTS*
Experimental

15 NT, 15 MT, 15 ST assessed intensity of 3 odorants (diacetyl, linalool, acetaldehyde) in aqueous solution at 3 concs in duplicate using LMS under 3 conditions:

- **Condition 1**: Orthonasally
- **Condition 2**: Retronasally
- **Condition 3**: Retronasally + an astringent (0.25g/L alum sulfate)
- **Condition 4**: Retronasally + a bitterant (0.4g/L epicatechin)
Orthonasal Aroma Evaluation

Using the protocol for assessing ortho-nasal aroma intensity, evaluate the intensity of the aroma. For example, 'Strongest Imaginable' refers to the strongest imaginable aroma.

Sample 111

AROMA INTENSITY

- Strongest Imaginable
- Very Strong
- Strong
- Moderate
- Weak
- Barely Detectable
- No Sensation

Display Instructions

Done
Retronasal aroma intensity vs PROP-taster status group with alum sulphate
(averaged across odorants, odorant levels & replicates)

(Bonferroni_{0.05})
Retronasal aroma intensity vs PROP-taster status group with epicatechin
(averaged across odorants, odorant levels & replicates)

(F=2.36, df=2,43, p=0.107)

NT + T vs ST is significant (estimate = 7.34, p=0.036)
Retronasal aroma intensity vs PROP-taster status group
(averaged across odorants, odorant levels & replicates)

Taster status group

Non-tasters  Tasters  Super-tasters

Perceived retronasal aroma intensity (LMS, mm)
Food & Health

Evidence that sensitivity to 6-n-propylthiouracil (PROP) affects perception of retro-nasal aroma intensity

Gary J. Pickering 1, 2, 3*, Gina Haverstock 1 and David DiBattista 3

1Department of Biological Sciences, 2 Cool Climate Oenology and Viticulture Institute, 3 Department of Psychology; Brock University, St. Catharines, L2S 3A1, Canada. *e-mail: gary.pickering@brocku.ca
The PROP taster phenotype

Does PTS associate with oral sensations elicited by alcoholic beverages?
Experimental

- Use wine, because:
  - Many wines are bitter
  - Wines elicit tactile sensations
  - Keep Debbie happy

- 3 red commercial wines

- Dominant sensations rated in triplicate on LMS

- PTS determined per Tepper et al. (’01)
Fig. 1. Mean intensity ratings for bitterness, astringency and acidity elicited by red wines across the three taster groups; PROP non-tasters NT (n=10), tasters T (n=7) and super-tasters ST (n=8). Values shown are means±SE averaged across sessions (3), and wine types (3). For each attribute, means sharing the same letter do not differ significantly (LSD_{0.05}).
PROP status & astringency intensity elicited by red wine

From Pickering et al. (2004)
What about some of the more complex sensations?

Ripe, rich and round with over-tones of spicey, earth-scented black cherry and berry flavours, hinting deliciously at chocolate on the smooth finish.
PROP status & astringency sub-quality ratings elicited by red wine \( (p(t)<0.001) \)

(Pickering & Robert, 2006)
Intensity of taste and astringency sensations elicited by red wines is associated with sensitivity to PROP (6-n-propylthiouracil)

Gary J. Pickering\textsuperscript{a,b,c,*}, Katerina Simunkova\textsuperscript{a}, David DiBattista\textsuperscript{c}

\textsuperscript{a}Department of Biological Sciences, Brock University, St. Catharines, Canada L2S 3A1
\textsuperscript{b}Cool Climate Oenology and Viticulture Institute, Brock University, St. Catharines, Canada L2S 3A1
\textsuperscript{c}Department of Psychology, Brock University, St. Catharines, Canada L2S 3A1

Received 10 January 2003; received in revised form 10 March 2003; accepted 28 March 2003

© 2006, The Author(s)
Journal compilation © 2006, Blackwell Publishing

PERCEPTION OF MOUTHFEEL SENSATIONS ELICITED BY RED WINE ARE ASSOCIATED WITH SENSITIVITY TO 6-N-PROPYLTHIOURACIL

GARY J. PICKERING\textsuperscript{1,2,3,4,5}, and GORDON ROBERT\textsuperscript{1}

\textsuperscript{1}Department of Biological Sciences
\textsuperscript{2}Cool Climate Oenology and Viticulture Institute
\textsuperscript{3}Department of Psychology
\textsuperscript{4}Centre for Biotechnology
Brock University
St. Catharines, Ontario L2S 3A1, Canada
The PROP taster phenotype

Does PTS associate with liking of alcoholic beverages?
Why interest in liking?

1. Liking scores can indicate preference
   - If PTS groups differ in wine/alcohol preferences, may create product formulation, branding, & marketing opportunities

2. Potential measure of alcohol consumption
   - In nutrition field, liking advocated as superior measure of actual dietary intake
   - IF principle applies with alcohol, MAY be useful in predicting alcoholism and other alcohol-related disease risk
Pontifications

• Why expect that alcohol preference or consumption varies with PROP sensitivity?

- We see it with some foods
- Some prior data, but results conflicted
- Mechanism? Alcohol is bitter (& sweet) and hot ..... 
  - STs would show an aversion to bitterness &/or heat & drink less, or ..... 
  - STs would consume the same, but compensate for higher bitterness/heat intensity in beverage preference
    - avoid spirits
    - greater use of mixers/diluting/sweeteners
Experimental

• 123 alcohol drinking participants from Brock University student & staff populations
  • 81 females, 42 males; mean age 31.1 yrs

• PTS classification, etc, per Bajec & Pickering (2008)

• Liking scores for 43 alcoholic beverages collected on 7-point hedonic scale
Hedonic scale

Beverage

<table>
<thead>
<tr>
<th>Ale</th>
<th>Pale ale</th>
<th>Lager</th>
</tr>
</thead>
</table>

- like extremely
- neither like nor dislike
- dislike extremely
- allergic
- never tried
- don't know what it is
<table>
<thead>
<tr>
<th>TYPE</th>
<th>BEVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEER</td>
<td></td>
</tr>
<tr>
<td>Ale</td>
<td>Mild/Brown</td>
</tr>
<tr>
<td>Pale Ale</td>
<td>Pilsner</td>
</tr>
<tr>
<td>Lager</td>
<td>Strong</td>
</tr>
<tr>
<td>Lambic</td>
<td>Stout/Porter</td>
</tr>
<tr>
<td>Light</td>
<td>Wheat</td>
</tr>
<tr>
<td>SPIRITS</td>
<td>UNMIXED</td>
</tr>
<tr>
<td>Bitters</td>
<td>Rye</td>
</tr>
<tr>
<td>Bourbon</td>
<td>Scotch</td>
</tr>
<tr>
<td>Brandy</td>
<td>Bitter/Sour/Spicy Shots</td>
</tr>
<tr>
<td>Gin</td>
<td>Sweet Shots</td>
</tr>
<tr>
<td>Rum</td>
<td>Tequila</td>
</tr>
<tr>
<td>Vodka</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
</tr>
<tr>
<td>Mixed Bourbon</td>
<td>Mixed Rye</td>
</tr>
<tr>
<td>Mixed Gin</td>
<td>Mixed Tequila</td>
</tr>
<tr>
<td>Mixed Rum</td>
<td>Mixed Vodka</td>
</tr>
<tr>
<td>WINE</td>
<td>DRY</td>
</tr>
<tr>
<td>Dry Sparkling</td>
<td>Dry Red</td>
</tr>
<tr>
<td>Dry White</td>
<td></td>
</tr>
<tr>
<td>SWEET</td>
<td></td>
</tr>
<tr>
<td>Sweet Sparkling</td>
<td>Rose/Blush Wine</td>
</tr>
<tr>
<td>Sweet Red</td>
<td>Fruit Wine</td>
</tr>
<tr>
<td>Sweet White</td>
<td>Desert/Ice Wine</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
</tr>
<tr>
<td>Wine Cooler</td>
<td>Cider</td>
</tr>
<tr>
<td>Rum Cooler</td>
<td>Sherry</td>
</tr>
<tr>
<td>Cream Liqueurs</td>
<td>Port</td>
</tr>
<tr>
<td>Clear Liqueurs</td>
<td></td>
</tr>
</tbody>
</table>
Alcoholic beverage liking - PTS

Bajec & Pickering, 2011 (in preparation)
The PROP taster phenotype

Does the distribution of PTS groups differ between wine makers/experts and consumers?
Experimental

- A convenience sample of Ontario wine drinkers (n=330) recruited and phenotyped for PROP bitterness via filter paper disk.

- Also filled out a short questionnaire regarding willingness to try new foods & alcoholic beverages, as well as level of wine involvement
  - level of wine involvement used to classify them as a wine expert (n=110) or wine consumer (n=220).
Differences in PROP distribution across wine experts and non-experts (Pickering & Hayes, 2011 in preparation)
Results + thoughts

- Mean PROP bitterness higher among wine experts than wine consumers
- The conditional distribution functions differed between experts and consumers
- Data suggest individuals may self-select for specific professions based on sensory ability (i.e., an active gene-environment correlation)
- Think about:
  - implications for wine experts as authority figures in guiding consumer purchase decisions
  - “winemakers making wine for winemakers”
Summary

• PROP ‘Supertasters’ more responsive than others to wide range of taste & tactile stimuli relevant to wine/alcohol
• PROP STs more responsive than others to retronasal aroma
• PROP STs and medium tasters more responsive to dominant wine sensations than non-tasters
• PROP STs more responsive to subtle mouthfeel sensations in wine than non-tasters
• PROP medium tasters tend to like alc. beverages more than STs or NTs
• Wine experts more likely to be STs or MTs

Conclusion: Supertasters and winemakers are freaks!
Further research

• Predictive models of wine/alcohol liking & preferences based on PTS, expertise, gender, beverage neophobia and other taste phenotypes (PSU)

• Does greater liking in MTs translate into higher alcohol consumption/alcohol-related disease risk? (SUNY-UB + Rutgers)

• What sensory features of wine are responsible for different wine preferences between the PTS groups?

• Wine development, formulation and marketing opportunities from market segmentation by ‘taste’ types

• Other taste phenotypes (thermal tasters)