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# Understanding wine quality: linking wine composition, sensory properties and consumer quality perceptions

by Markus Herderich  
The Australian Wine Research Institute  
@ Lien de la Vigne - Assemblée Générale  
11 March 2011

## Acknowledgements

- Saldie Pretorius
- Leigh Francis, Patricia Ościadacz & AWRI sensory team
- Simone Mueller & Larry Lockshin, UniSA
- Jean-Pierre Megnin & Lien de la Vigne



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  - Jean-Pierre Megnin & Lien de la Ligne
-

- WHAT is quality?
- WHO are we talking to?

- tools & case studies



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11 March 2018



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- Public Researcher
- Leigh Francis, Product Manager at A&P&S company store
- Chris Givens, Team Coordinator, Public Affairs, The Wine
- Steven Hinderlich & Larry Lockhart, UCL
- Jean-Marc Hinderlich & Lieu de la Vigne

learning

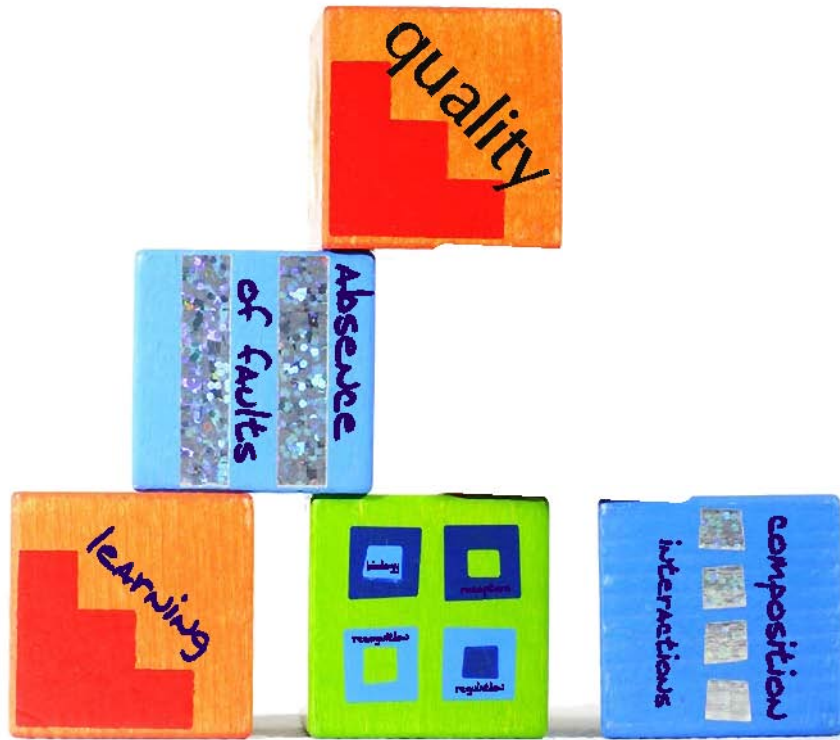
genomics

sensory vs. marketing

wine & society

- WHAT is quality?









CONSUMERS

& preferences





biology

receptors

recognition

regulation





WHO are we talking to?



# research tools

How can we relate consumer response to compositional measures?



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## Commercial wines Correlative study

- Most realistic
- Large number of variables involved
- Correlation or causation?



## Base wine with added components

- Dependent on base wine used
- Additions can unbalance the wine
- Multiple sensory properties can still be affected



## Experimentally produced wines: treatments imposed

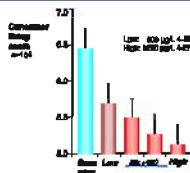
- Can be relatively small sensory differences
- Highly standardised winemaking: less pleasant wines



# faults, off flavors & taints brett & 4EP

# closures & reduced aromas

Consumer liking: Cabernet wine with added "brett" compounds



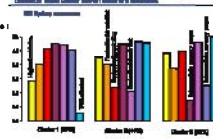
Australian domestic wine

Do sensory cues respond to closure-related

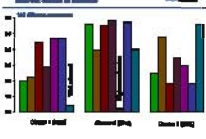
- ① Unpaired flow (bottle) response to light
- ② 14 different closures
- ③ Tasted preliminary profile for each wine



Three groups of consumer liking scores for the



Forecasting for static



- ✓ consumer expectations
- ✓ results are reproducible
- ✓ for OTR closure OK for 60%
- ✓ still target for improvement

ine

# composition and sensory

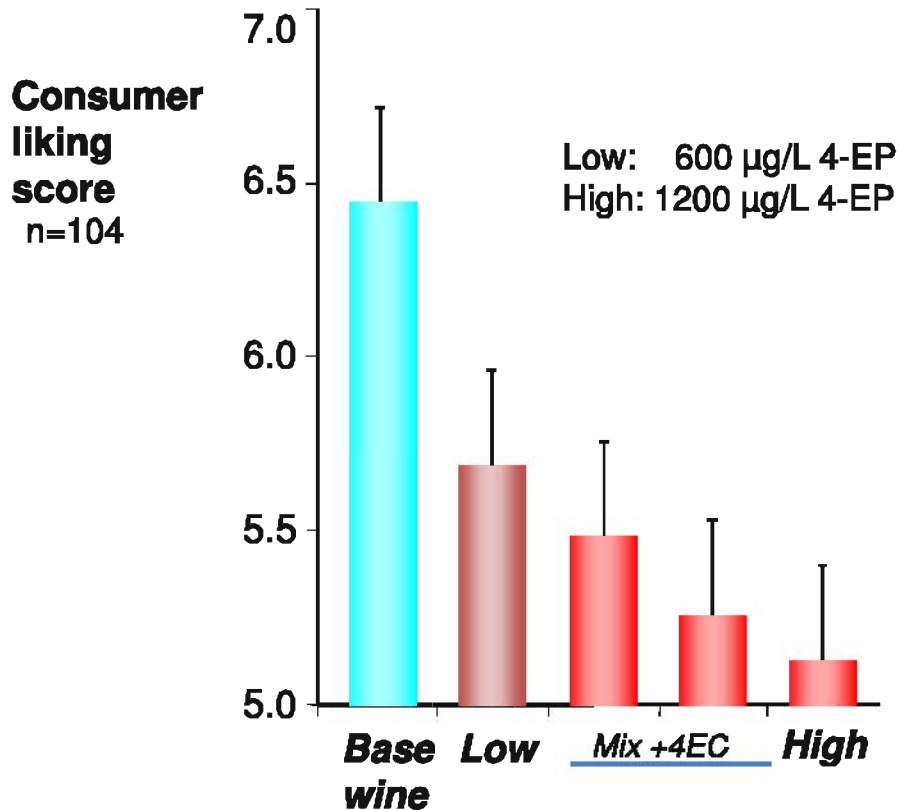
What chemical analyses relate to these key sensory properties?



# Consumer liking: Cabernet wine with added 'Brett' compounds



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CATEGORY	SCREWCAPS	CORKS
Under \$20 Whites	98.6%	1.4%
Under \$20 Reds	96.7%	2.3%
Over \$20 Whites	98.5%	1.5%
Over \$20 Reds	83.2%	16.8%

Australian domestic win





# Do consumers respond to closure related sensory differences?

- ❖ Unoaked Clare Semillon two years in bottle
- ❖ 14 different closures
- ❖ Trained panel sensory profile for each wine



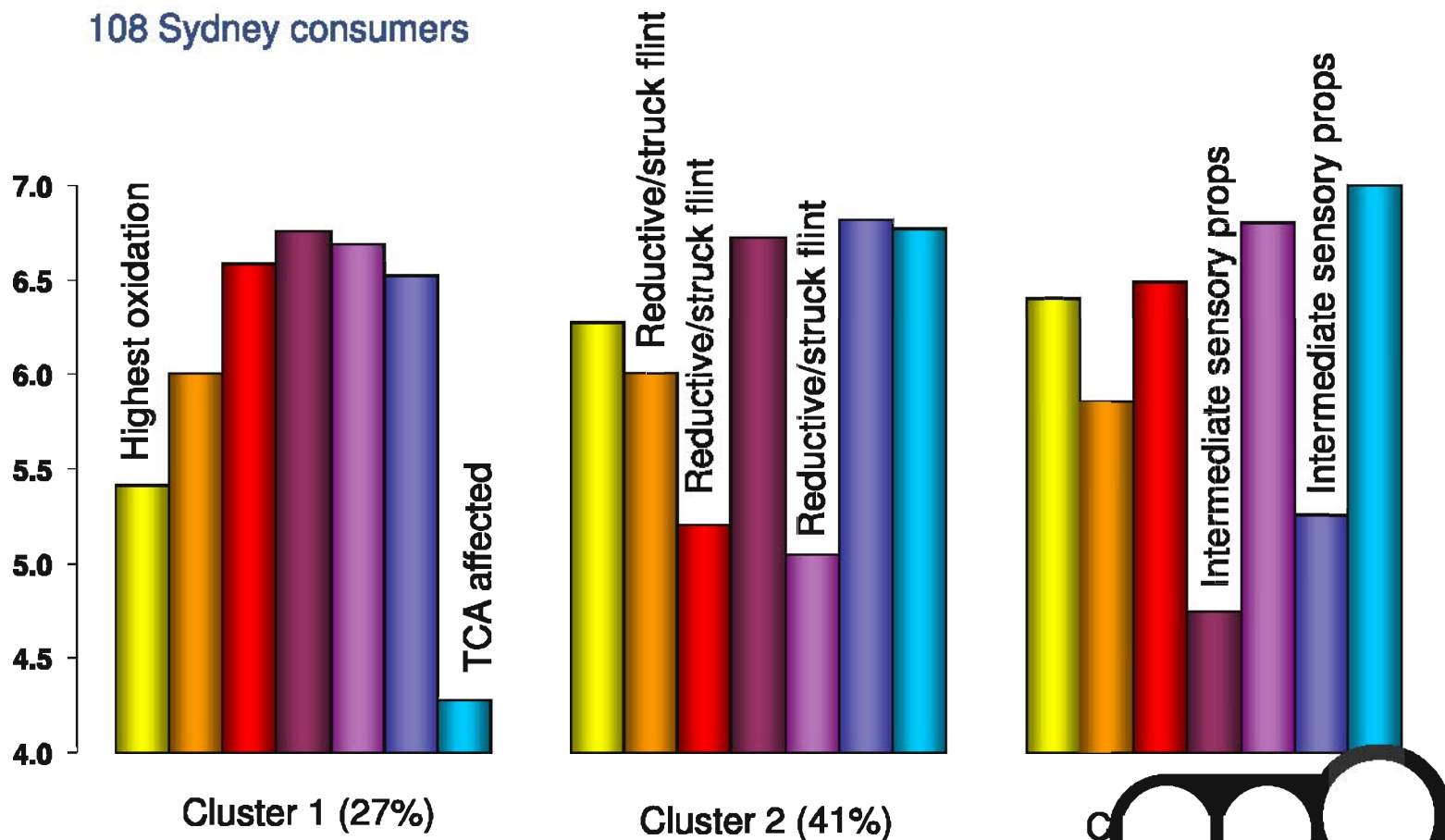


# Three groups of consumers: liking scores for the Semillon wine under seven different closures



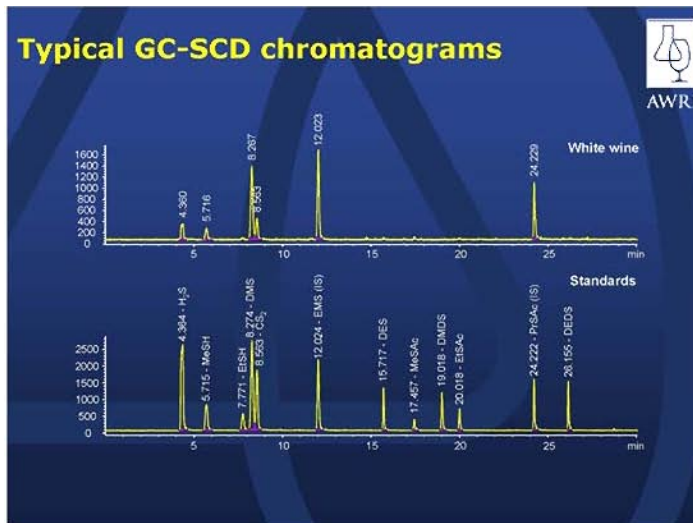
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108 Sydney consumers



reductive struck flint character:  
methyl mercaptane

(large volume headspace - COC - GC-SCD)

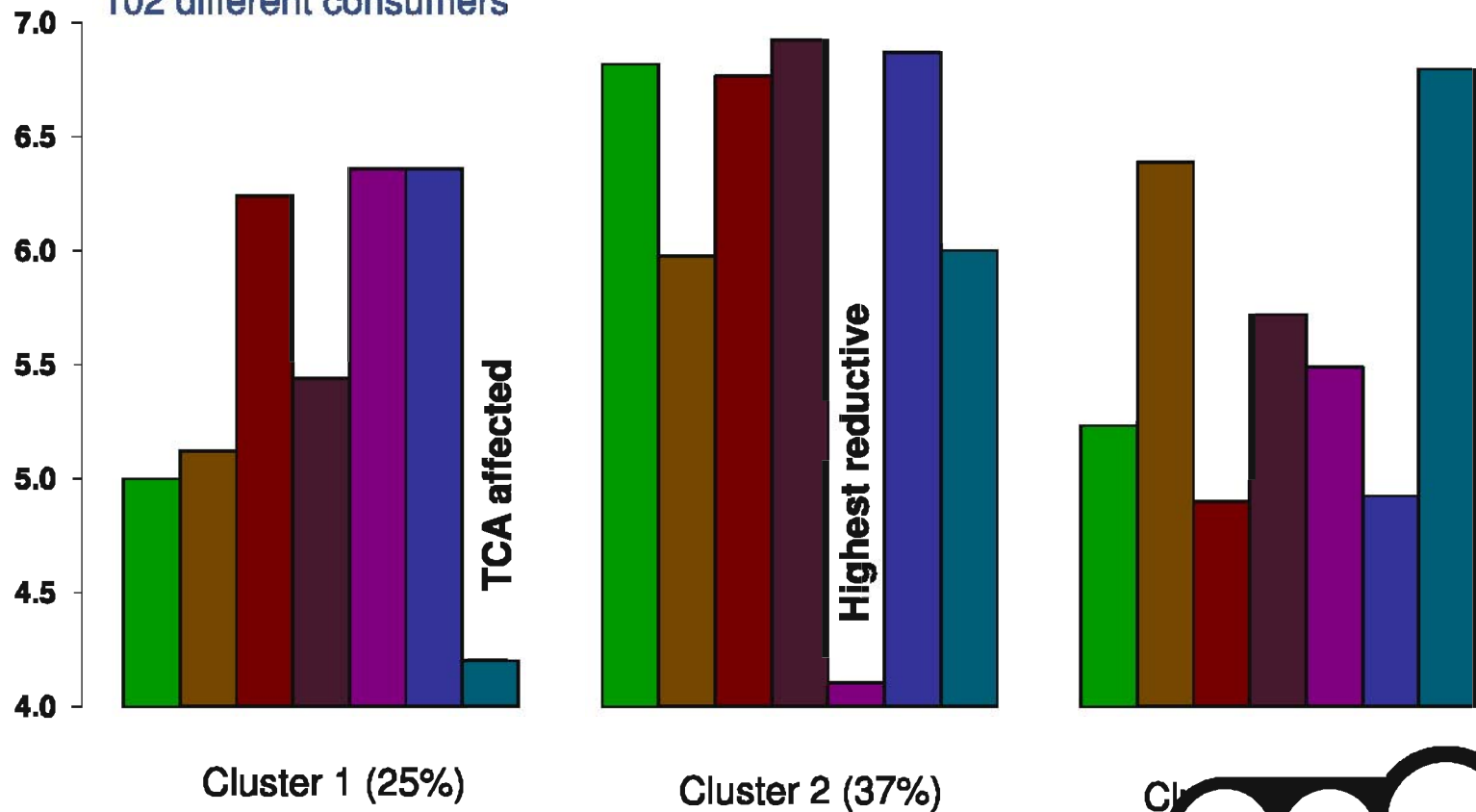


# Repeating the study: different subset of closures



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102 different consumers



Cluster 1 (25%)

Cluster 2 (37%)

Cluster 3 (38%)

- ✓ consumer segmentation
- ✓ results are reproducible
- ✓ low OTR closures OK for 60%
- ✓ MeSH target for improvements

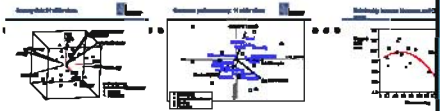


# commercial white wine: sensory & composition

Relating consumer acceptance of white wines to  
phenolic related sensory and chemical attributes



- ◆ 24 commercial white wines: Chardonnay, Riesling, Pinot Gris
- ◆ High sales examples, lower and higher levels of phenolics
- ◆ Residual sugar less than 4 g/L



Trained AWRI panel  
sensory profiles



203 Sydney consumers:  
regular white wine drinkers



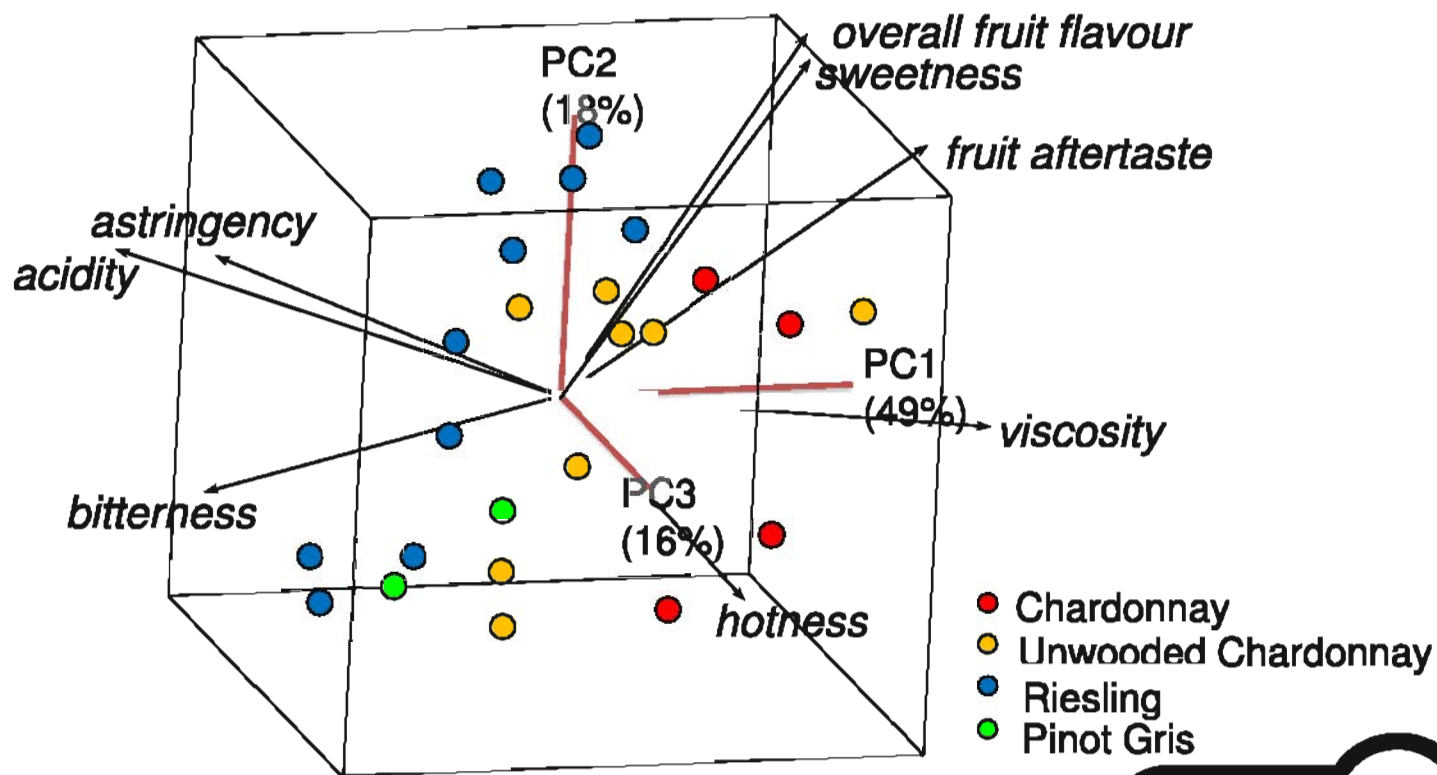
Compositional data



# Sensory data 24 white wines



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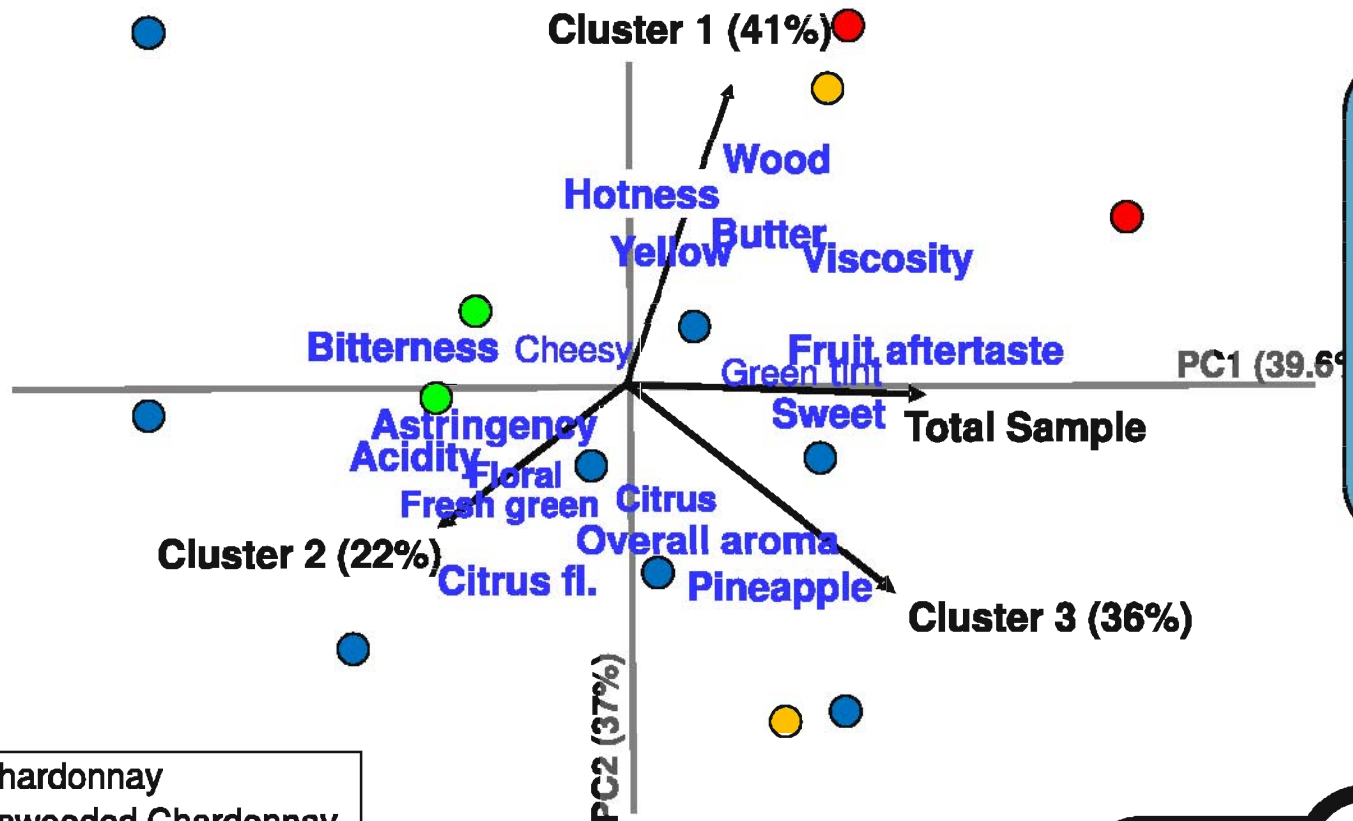




# Consumer preference map: 14 white wines



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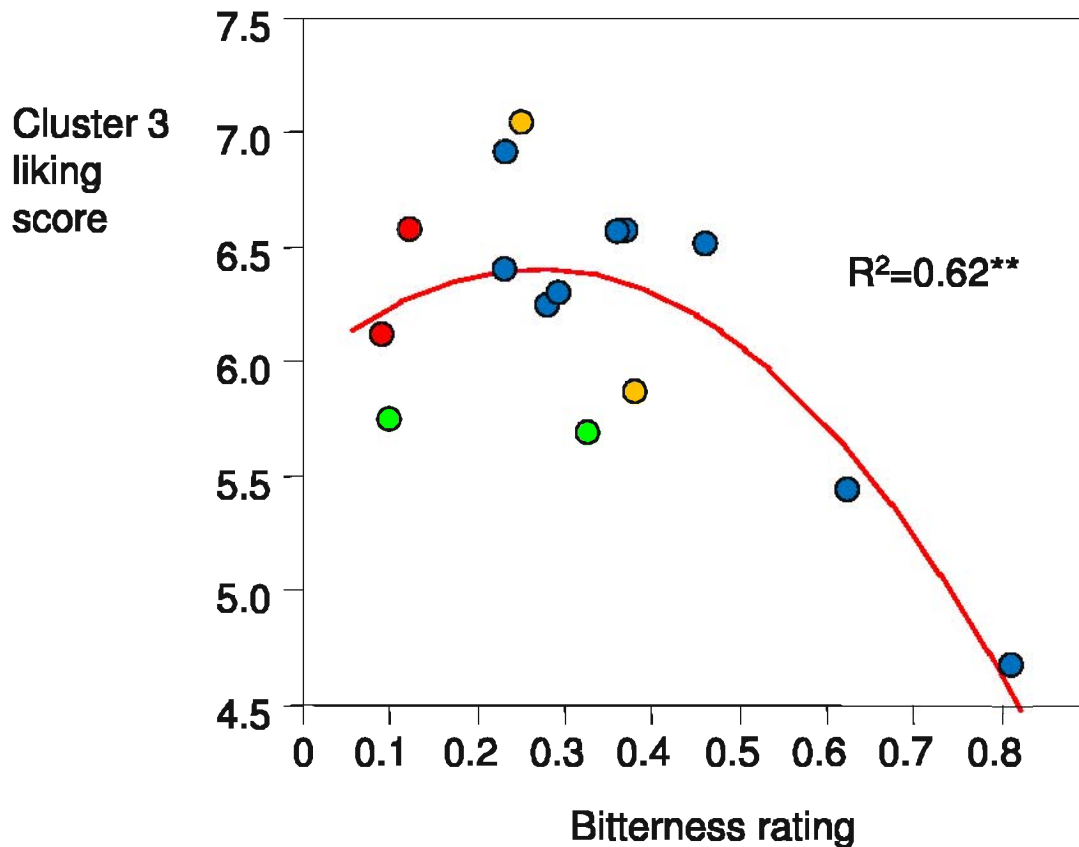


- Chardonnay
- Unwooded Chardonnay
- Riesling
- Pinot Gris





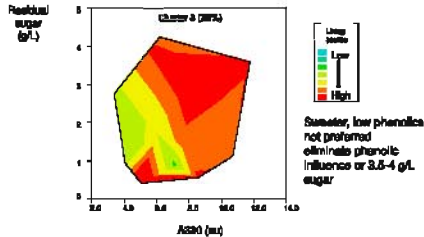
# Relationship between bitterness and liking score



# practical tools

practical tools  
for the winery

Chemical measures and cluster 3 preference



practical tools  
for the consumer



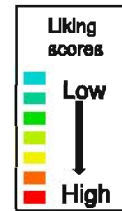
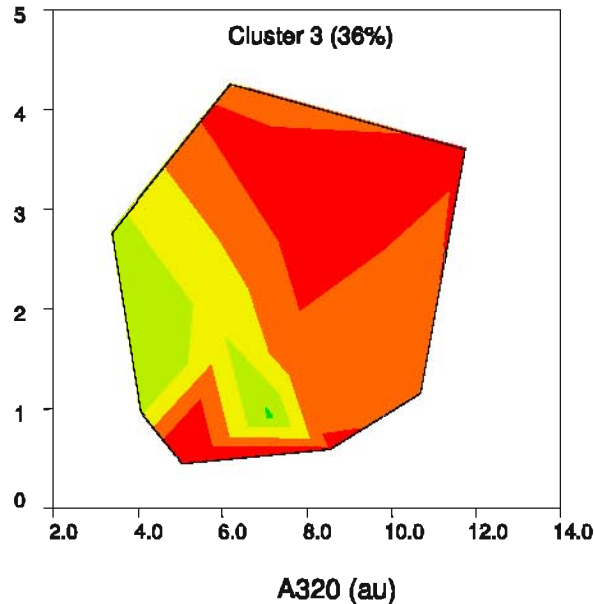
# practical tools for the winery

## Chemical measures and cluster 3 preference



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Residual  
sugar  
(g/L)



Sweeter, low phenolics  
not preferred  
eliminate phenolic  
influence or 3.5-4 g/L  
sugar

# practical tools for the consumer








Pinot  
grigio

PinotG Style Spectrum™

HOME | THE SPECTRUM OF STYLES | ABOUT US | HISTORY | THE SCIENCE | PEOPLE | AWRI | CONTACT US

CRISP LUSCIOUS

What sort of  
**PinotG**  
are you?

 CRISP, LEAN AND RACY	 DRY, TANGY AND VIBRANT	 LIVELY, FRESH AND ZESTY	 FRUITY, ELEGANT AND REFRESHING	 STYLISH, SOFT AND SUPPLE	 FULL, ROUND AND SILKY	 VELVETY AND RICH TEXTURE
---	---	--	---	---	---	---

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Pinot  
gris



# Pinot grigio



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VELVETY, GENEROUS  
AND RICHLY  
TEXTURED



POWERFUL, RICH  
AND WARM



LUSCIOUS, OPULENT  
AND LUXURIOUS



# practical tools for the consumer

## PinotG Style Spectrum™

| HOME | THE SPECTRUM OF STYLES | ABOUT US | HISTORY | THE SCIENCE | PEOPLE | AWRI | CONTACT US |

CRISP

LUSCIOUS

What sort of  
**PinotG**  
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CRISP, LEAN AND  
RACY

DRY, TANGY AND  
VIBRANT

LIVELY, FRESH AND  
ZESTY

FRUITY, ELEGANT  
AND REFRESHING

STYLISH, SOFT AND  
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FULL, ROUND AND  
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VELVETY  
AND RICH  
TEXTURE

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Pinot  
gris

Pinot  
grigio

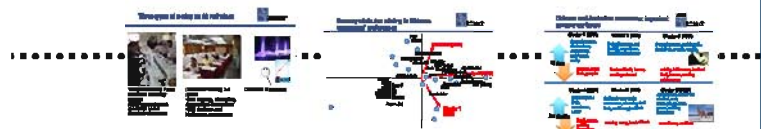


# commercial red wine

Comparing Chinese and Australian consumers' red wine preferences



- ◆ 22 widely varying commercial red wines: Cabernet and blends, Shiraz and blends, Merlot, Malbec, Sangiovese
- ◆ Australia, France, California, China, Argentina, Italy
- ◆ 2007- 2004 vintage
- ◆ \$A8-20





# Three types of testing on 22 red wines



**Trained Sensory Panel**  
attribute intensity  
ratings  
**AWRI external panel:**  
consumer based  
descriptive language



**Consumer testing 14**  
**wines**  
•310 Beijing, Shanghai,  
Guangzhou consumers  
•210 Sydney and  
Melbourne consumers

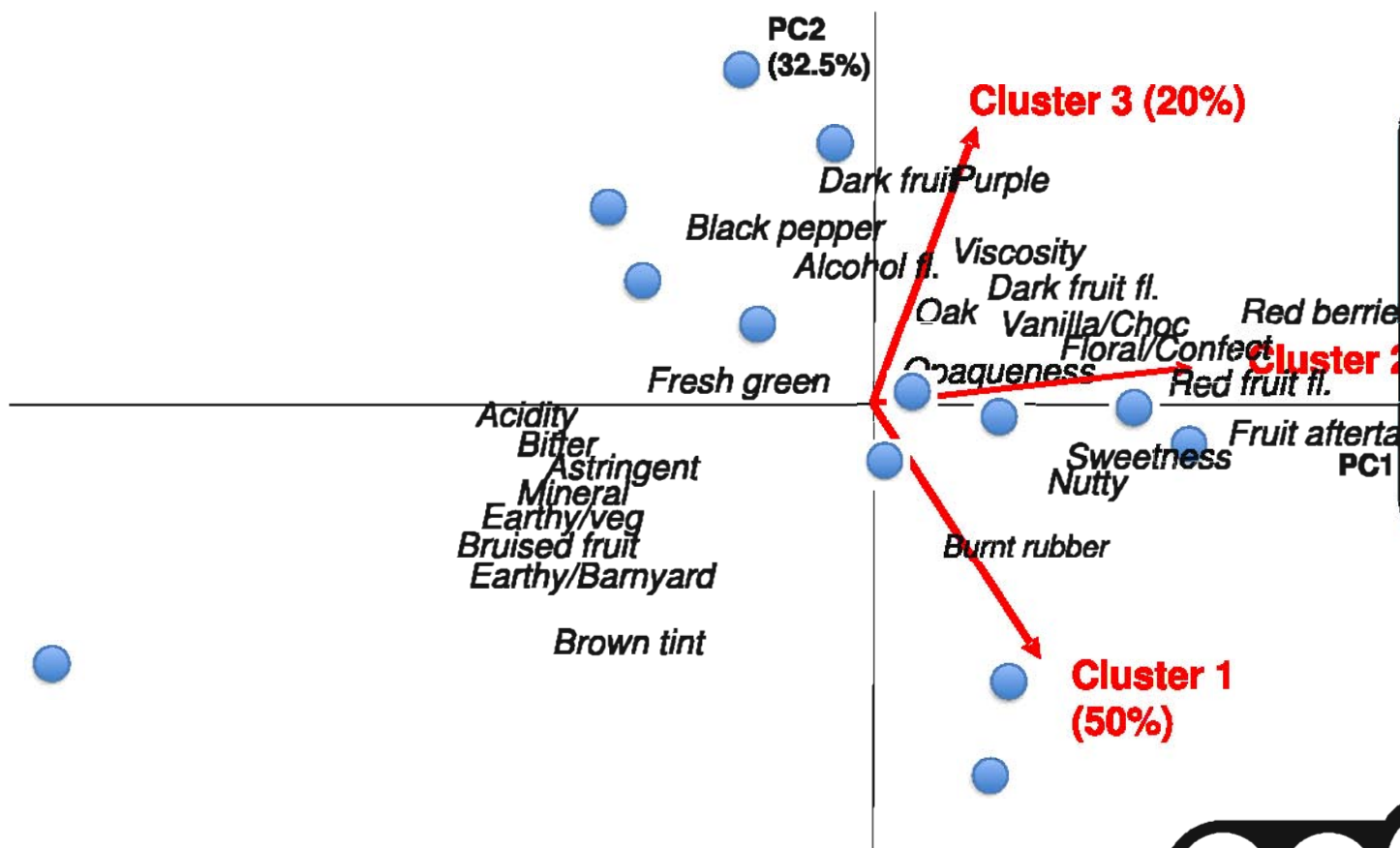


**Chemical measures**





# Sensory attributes relating to Chinese consumers' preferences





# Chinese and Australian consumers: important sensory attributes



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## Cluster 1 (50%)

fruit aftertaste,  
dark colour,  
sweetness,  
oak/wood,  
nutty

alcohol, **dark fruit, purple**

## Cluster 2 (30%)

fruit aftertaste, red fruit fl., sweetness, floral/confectionary

bruised fruit, brown, earthy, mineral

## Cluster 3 (20%)

fruit aftertaste, red fruit fl., dark fruit, purple, vanilla

acidity, bitterness, bruised fruit, brown, earthy, astringency



## Cluster A (38%)

red berry/red fruit, sweetness, nutty

fresh green, acidity, bitterness

## Cluster B (39%)

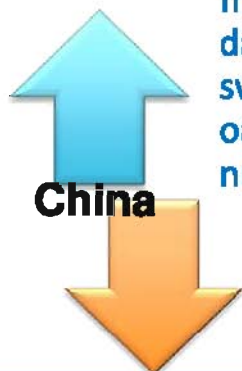
dark colour, purple, sweetness, viscosity, dark fruit, red berry/red fruit

earthy, nutty, bruised fruit

## Cluster C (23%)

dark colour, dark fruit, alcohol, oak, astringency, fresh green, acidity, bitterness

sweetness, red fruit



China



Australia





# composition AND sensory

What chemical analyses relate to these key sensory properties?



- ❖ 62 chemical measures: volatile aroma compounds (oak compounds, sulfur compounds, fermentation derived esters, alcohols, acids, methoxypyrazine, monoterpenes, norisoprenoids, rotundone, cineole, 4-EP.....), tannin, basic composition
- ❖ Additional 21 Australian Shiraz wines studied as part of the University of South Australia/AWRI collaborative project



Ehrenberg-Bass  
Institute for Marketing Science  
WINE MARKETING GROUP



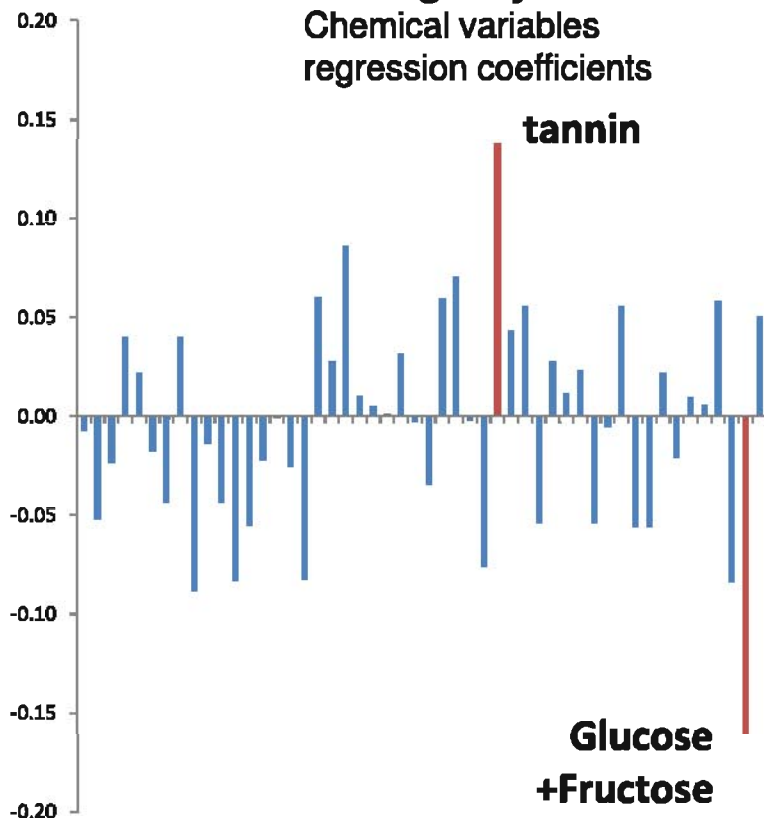
# PLS models: what are the most important predictive components for each sensory attribute?



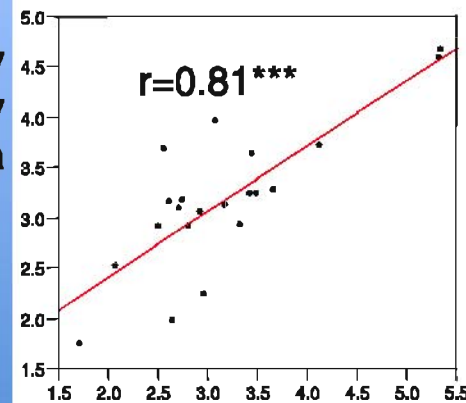
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## Astringency

Chemical variables  
regression coefficients



Astringency  
predicted by  
chemical data



Astringency  
measured by  
sensory panel

$r=0.67^{**}$  21 Shiraz wines





# Relationships between sensory properties and aroma compounds

## Red berry

### positive, enhancing

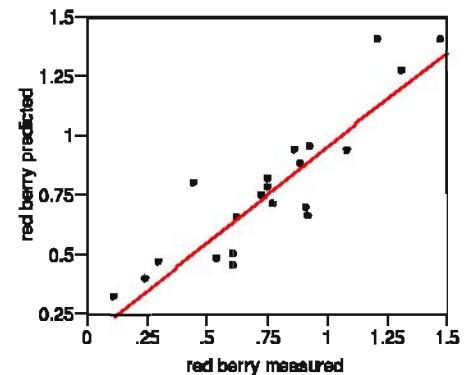
- 2, 3- Methyl butyl acetate
- *Hexyl acetate*
- 2-phenylethyl acetate
- *Damascenone*
- *Vanillin*
- *4-Methyl guaiacol*



### negative, masking

- *Acetic acid, Ethyl acetate*
- *Eugenol, cis- and trans-oak lactone*
- 4-EP, 4-EG
- *DMS*
- *IBMP*
- *Ethyl 2+3 methyl butanoate*

$r=0.90^{***}$  China study  
 $r=0.78^{***}$  21 Shiraz wines



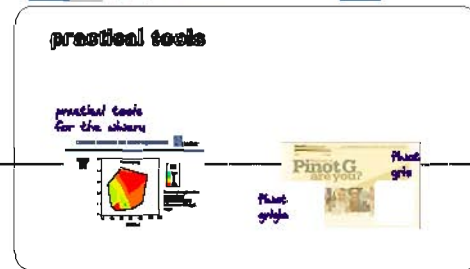


# 'Fresh green' green beans/capsicum

- ❖ **Positive**, enhancing
- ❖ IBMP
- ❖ **Negative**, masking
- ❖ **Beta-ionone**
- ❖ **vanillin**

China study  $r = 0.55$





# case studies

winemaking AND packaging affect composition AND preferences  
 consumer segmentation is real AND stable  
 wine drinking experience key factor  
 understanding composition is key for targeted improvements



# Effect of repeated wine exposure on consumer preferences

Leigh Francis & Patricia Osidacz, AWRI; Mark Stevens SensoMetrics



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- where to next?

learning



matter





# • where to next?

## genomics

micro arrays

human taste & olfactory receptors

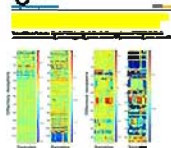
next gen sequencing

\$1000 genome

personalised medicine

biology vs learning

- genes, SNPs, CNVs;
- regulation;
- signal processing



characterise  
panel members

Genome-Wide Association Study Reveals Genetic Variants Associated with Human Taste Receptor Genes

Researchers have identified genetic variants that are associated with human taste receptor genes. The study, published in the journal Nature Genetics, shows that these variants are located in the same regions of the genome as the genes themselves. This suggests that the variants may be affecting the function of the genes, leading to differences in taste perception. The study also found that these variants are associated with specific taste preferences, such as a preference for sweet or bitter foods. This information could be useful for understanding individual differences in taste and for developing personalized nutrition plans.



understand  
& better target  
consumers





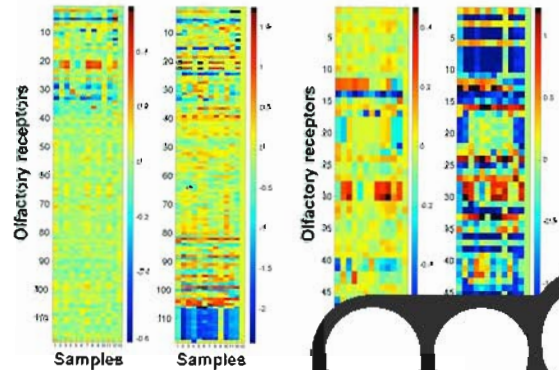
# biology vs learning

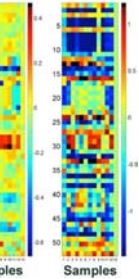
- genes, SNPs, CNVs;
- regulation;
- signal processing

OPEN ACCESS Recently available online

PLoS

Yehudit Hada<sup>1\*</sup>, Tsviya Oshada<sup>1\*</sup>, Miriam Khan<sup>1</sup>, Claudie Geronzi-Jarregui<sup>1,2</sup>, Philip M. Kim<sup>3</sup>, Alexander Eckhart Urban<sup>1</sup>, Michael Snyder<sup>1,4</sup>, Mark B. Gerstein<sup>1,4</sup>, Doron Lancet<sup>1</sup>, Jan O. Korbel





# characterise panel members

Common Worldwide Variation Discovered In Human Taste Receptor Genes

## Common Worldwide Variation Discovered In Human Taste Receptor Genes

Common Worldwide Variation Discovered In Human Taste Receptor Genes

**Background:** Differences in our sense of taste may have a profound impact on which foods we choose to eat, so it is important to understand the basis of these differences. Recent advances in chemosensory science have led to the identification of taste receptors, located on the surface of taste cells that reside on the taste buds on the tongue. These receptors bind to tastants released from food and initiate signals to the brain, where the specific taste is recognized. It has been known that the *T2R* gene family is involved in detecting bitter taste in humans. This gene family contains 25 different genes, encoding different receptors that allow humans to taste a wide variety of different bitter substances.



**Advance:** In studying the individual difference in bitter taste sensation, NIDCD intramural scientists discovered that all 25 human bitter taste receptor genes exist in a variety of different forms in the population. These genes encode for different receptor proteins. Evolutionary genetic analyses suggest the different forms of these genes have occurred in high frequencies in the population under the influence of natural selection. This implies that the different forms of each receptor functions to sense different bitter substances.

**Implications:** These findings reveal how inherited factors affect taste perception and food preferences in different individuals. These preferences can have major implications for dietary choices each person makes. Obesity and Type 2 diabetes are known to be caused by a combination of genetic and environmental factors. The variations found in taste receptor genes may represent a portion of the underlying causes of these disorders, and additional research is warranted. In addition, the discovery that different forms of a particular gene exist at high frequency in different populations may provide information about ethnic differences in food preferences and dietary choices, and may allow reveal more about health disparities between different groups of individuals.

**Citation:** Kim U, Wooding S, Ricot D, Jorde LB, Drayna D. Worldwide haplotype diversity, and coding sequence variation at human bitter taste receptor loci. *Human Mutation* 26: 199-204, 2005.

# next gen sequencing

\$1000 genome

personalised medicine

characterise  
panel members

understand  
& better target  
consumers

Common Worldwide Variation Discovered in Human Taste Receptor Genes

## Common Worldwide Variation Discovered in Human Taste Receptor Genes

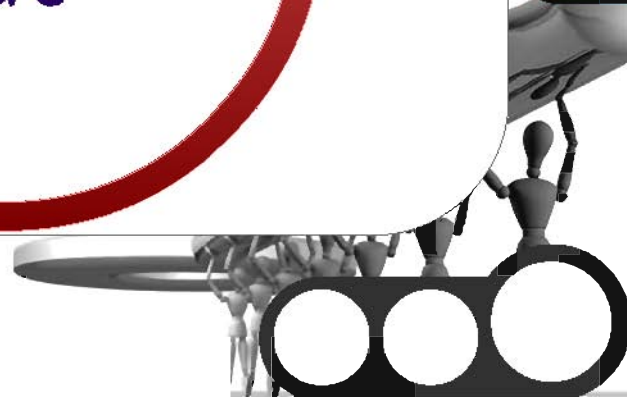
**Common Worldwide Variation Discovered in Human Taste Receptor Genes**  
Researchers have discovered that the same genetic variation in a taste receptor gene is found in people from all over the world. This finding suggests that the variation is very old and may have been present in our ancestors. The variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances. The variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances. The variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances.



**Abstract** In studying the individual differences in bitter taste sensitivity, TAS2R38 became the candidate gene for all 14 human bitter taste receptor genes. This gene encodes for different forms in the population. These gene variants for different receptor proteins. Population genetic analysis suggests the different forms of these genes have occurred in high frequency in the population under the influence of natural selection. This is the first time that the different forms of taste receptor genes have been identified in human populations.

**Background** Taste plays a crucial role in human health and taste perception is not uniform in all human individuals. These perceptions can have a great influence on the choice of food and the health of the individual. The variation in the TAS2R38 gene is the most common variation in the human genome. This variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances. The variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances.

**Conclusion** The TAS2R38 gene is the most common variation in the human genome. This variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances. The variation is found in the TAS2R38 gene, which codes for a protein that helps us taste bitter substances.



# sensory vs marketing

preferences,  
choices &  
repeat purchase

intrinsic sensory properties,  
product acceptance &  
pleasantness during consumption

extrinsic product  
attributes & purchase  
of the product



Contents lists available at ScienceDirect

Food Quality and Preference

Journal homepage: [www.elsevier.com/locate/foodqual](http://www.elsevier.com/locate/foodqual)



Combining discrete choice and informed sensory testing in a two-stage process:  
Can it predict                     

Simone Mueller<sup>a,\*</sup>, Patricia Osidacz<sup>b</sup>, I. Leigh Francis<sup>b</sup>, Larry Lockshin<sup>a</sup>

<sup>a</sup>Flindersberg-Wine Institute for Marketing Science, University of South Australia, P.O. Box 2476, Adelaide SA 5033, Australia

<sup>b</sup>The Australian Wine Research Institute, P.O. Box 197, Glen Osmond SA 5084, Australia



- where to next?  
*wine & society*

sustainability

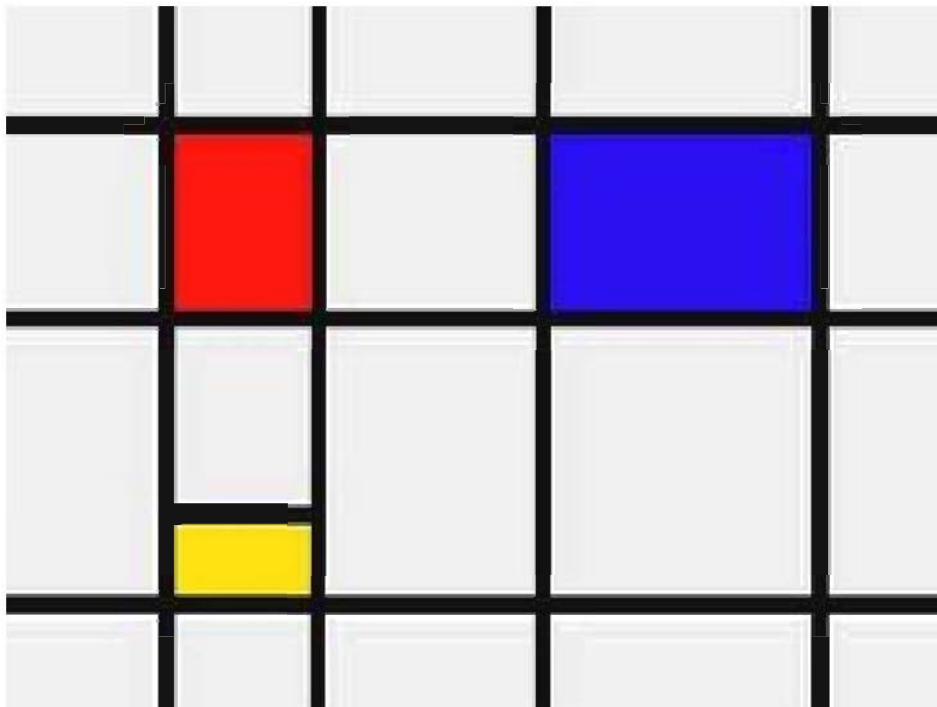


public health



next gen consumers





Piet Mondrian:

a painting is no longer  
describing things we see,  
self-expression of the artist

BUT:

a way of organising space  
design, furniture, architecture, town planning

Sensory:

is no longer only describing the wine we produce & sell and drink,  
self-expression of the winemaker or marketing team.

BUT:

A way of connecting with  
consumers,  
future consumers,  
and society

