

# Individual Differences in Sensory Perception and Human Health

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....no two people are exactly alike in their sensory reactions....Blakeslee, 1935

[10.1126/science.81.2108.504](https://doi.org/10.1126/science.81.2108.504)

**Assertion:** People differ in their sensory experience of food and drink and these differences may account in part for food likes and dislikes and food choice and intake

Unpacking this assertion:

- Sensory differences
- Likes and dislikes
- Intake

# Sensory differences are common

2-ethyl fenchol – *mushroom*

Beta-ionone – *violets*

Capsaicin – *burning, spicy*

Citric acid – *sour*

Galaxolide – *musk*

Guaiacol – *liquid smoke*

Menthol – *cooling*

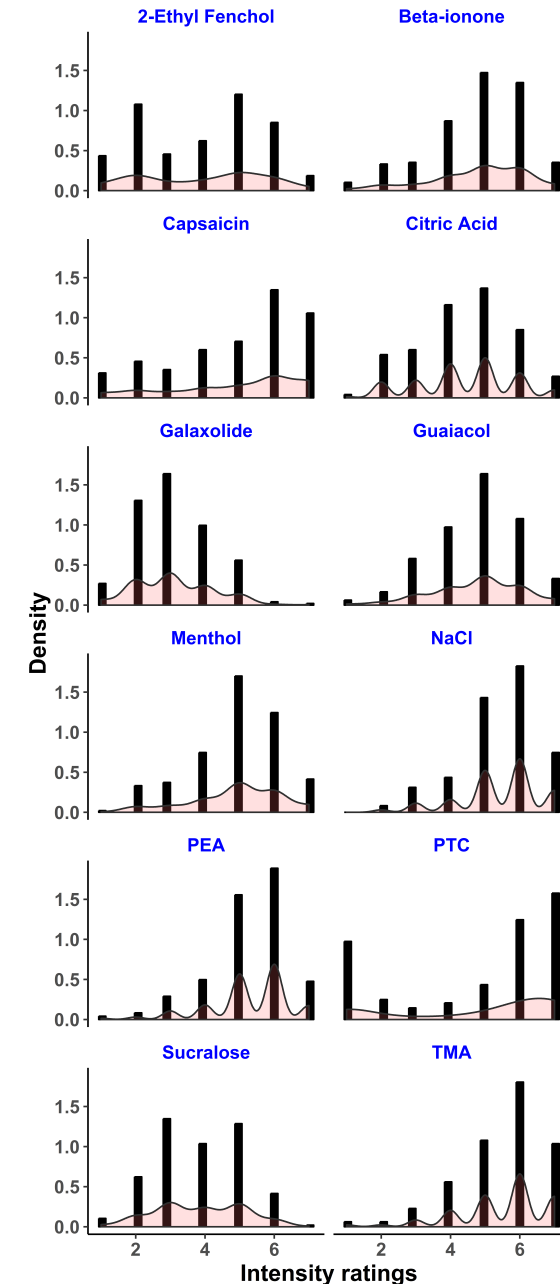
NaCl – *salty*

PEA – *phenyl ethyl alcohol - rose*

PTC – *phenylthiocarbamide – bitter*

Sucralose – *high potency sweetener*

TMA – *trimethylamine - fish*



# Scale of big data and genome wide association studies

Study	N	Reference
NHANES (taste and smell data)	3,603	<a href="https://doi.org/10.1093/chemse/bjv057">10.1093/chemse/bjv057</a>
UK Biobank	455,146	<a href="https://doi.org/10.1101/662239">10.1101/662239</a>

Ongoing  
Million Veterans Program  
All of Us

# Scale of big data and genome wide association studies

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## **UK Biobank - what data are available?**

Genotypes, 13,791,467 markers

Food intake, up to four 24-hour diet recalls

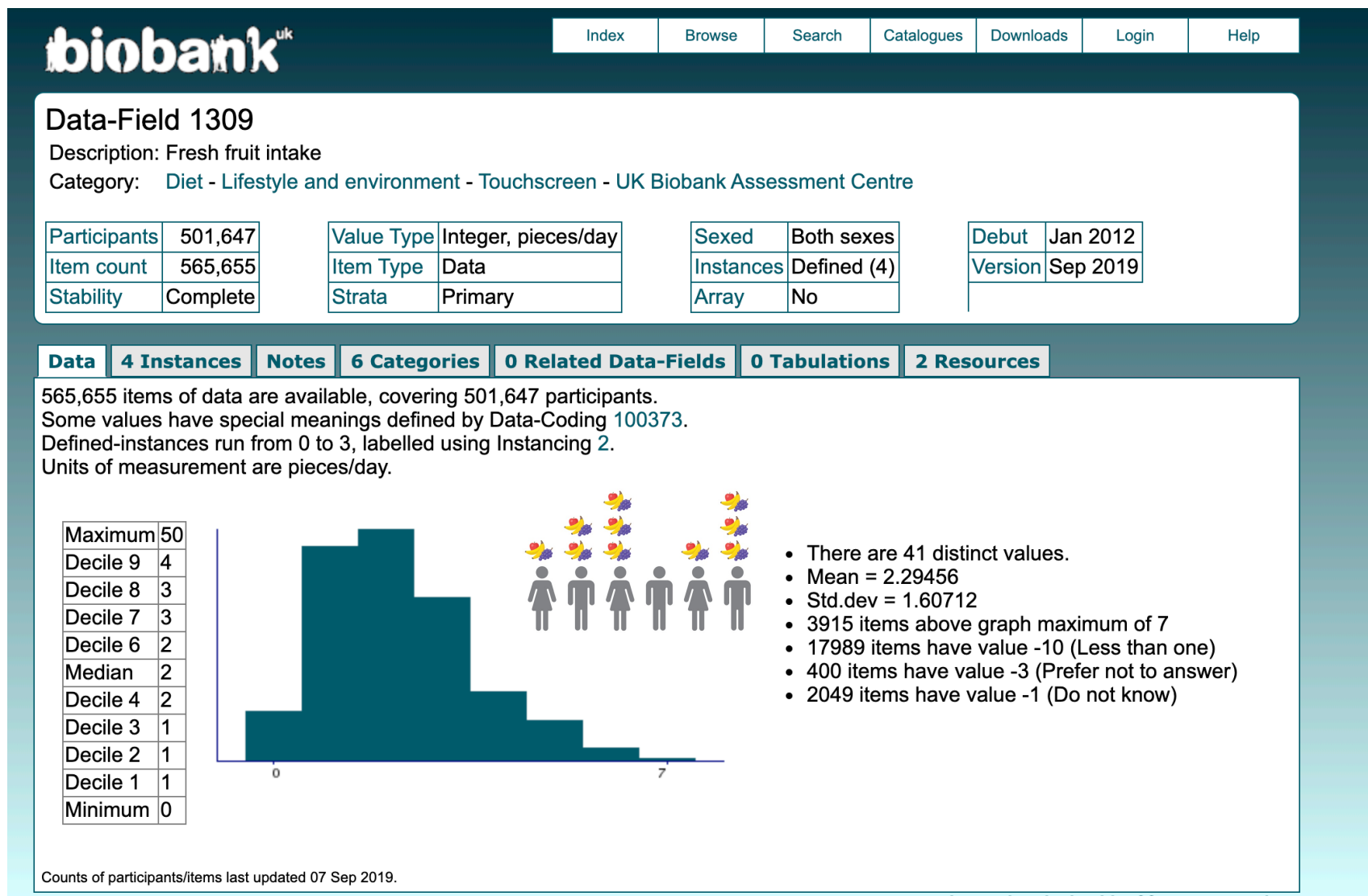
No taste or smell data except ICD-10 codes

**About how many pieces of FRESH fruit would you eat per DAY?**  
(Count one apple, one banana, 10 grapes etc as one piece; put '0' if you do not eat any)"



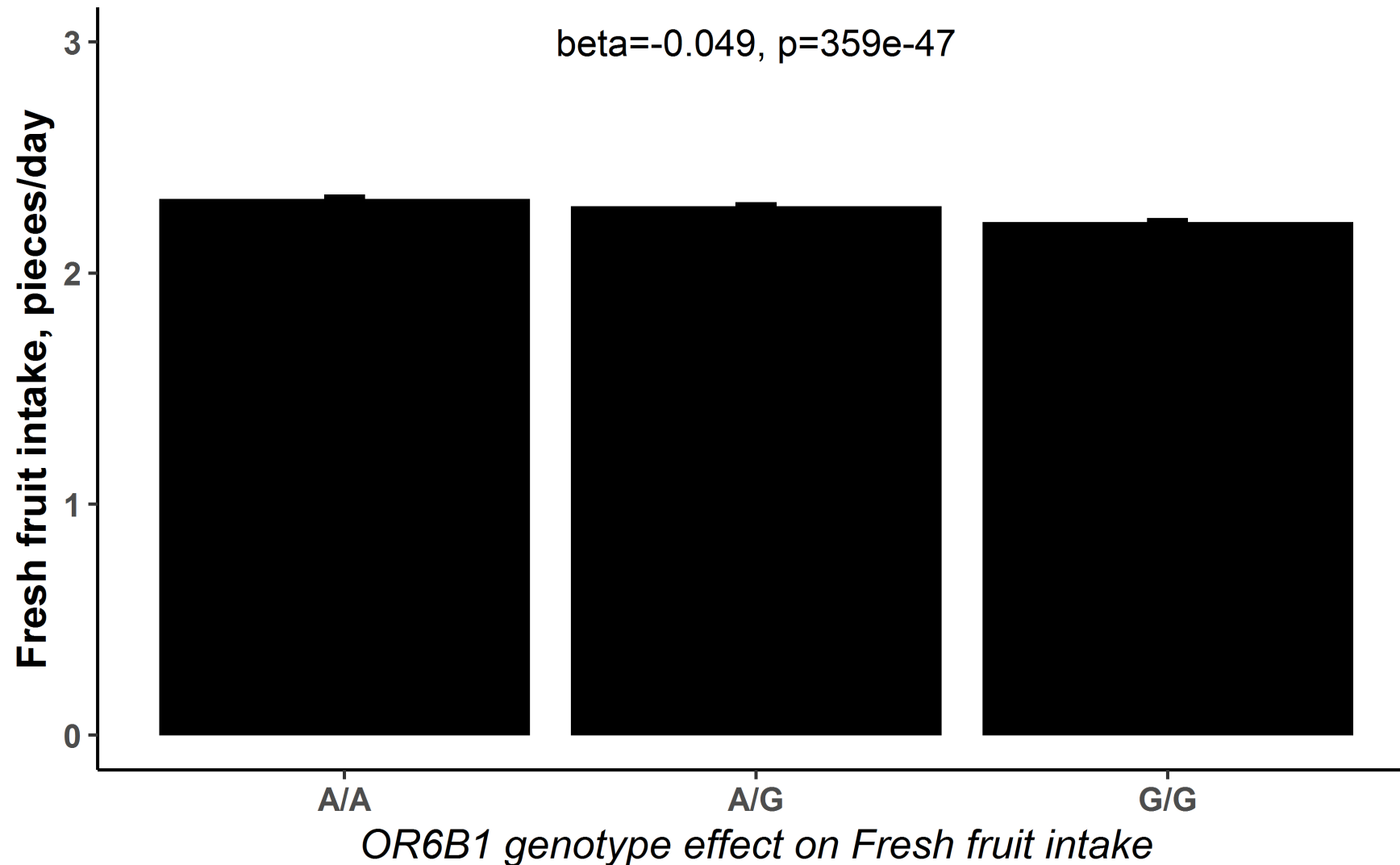
***Please provide an average considering your intake over the last year***

# Fruit intake data from the UK Biobank



# GWAS: Breaking it down

# Statistical significance is striking but effect size is small





**Post GWAS studies:**  
**Related phenotypes and PheWAS#**  
**mRNA and protein expression**  
**Function**

#PheWAS == one variant, many or all phenotypes (traits)

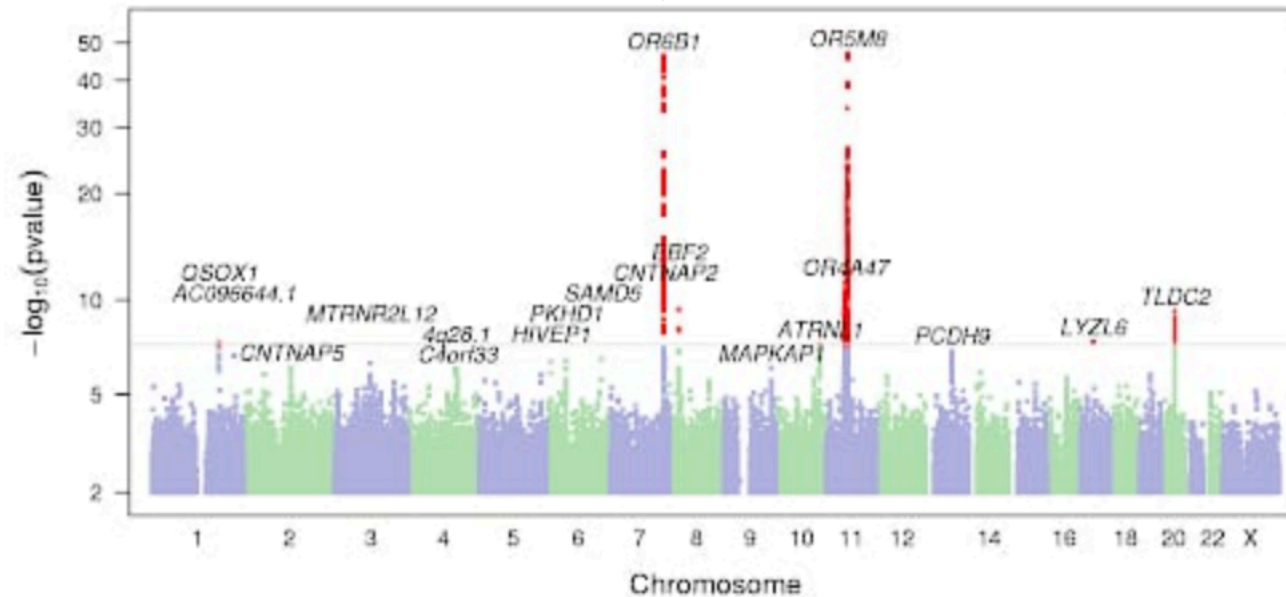
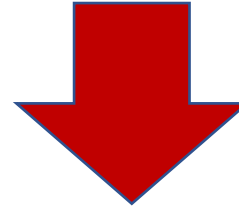
Which of the following ice cream flavors do you like best?

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- ☒ Vanilla
- ☐ Chocolate
- ☐ Strawberry
- ☐ None of the above

# OR6B1 variants are associated with strawberry ice cream preference

OR6B1



<https://blog.23andme.com/23andme-research/you-scream-i-scream-our-genes-scream-for-ice-cream/>

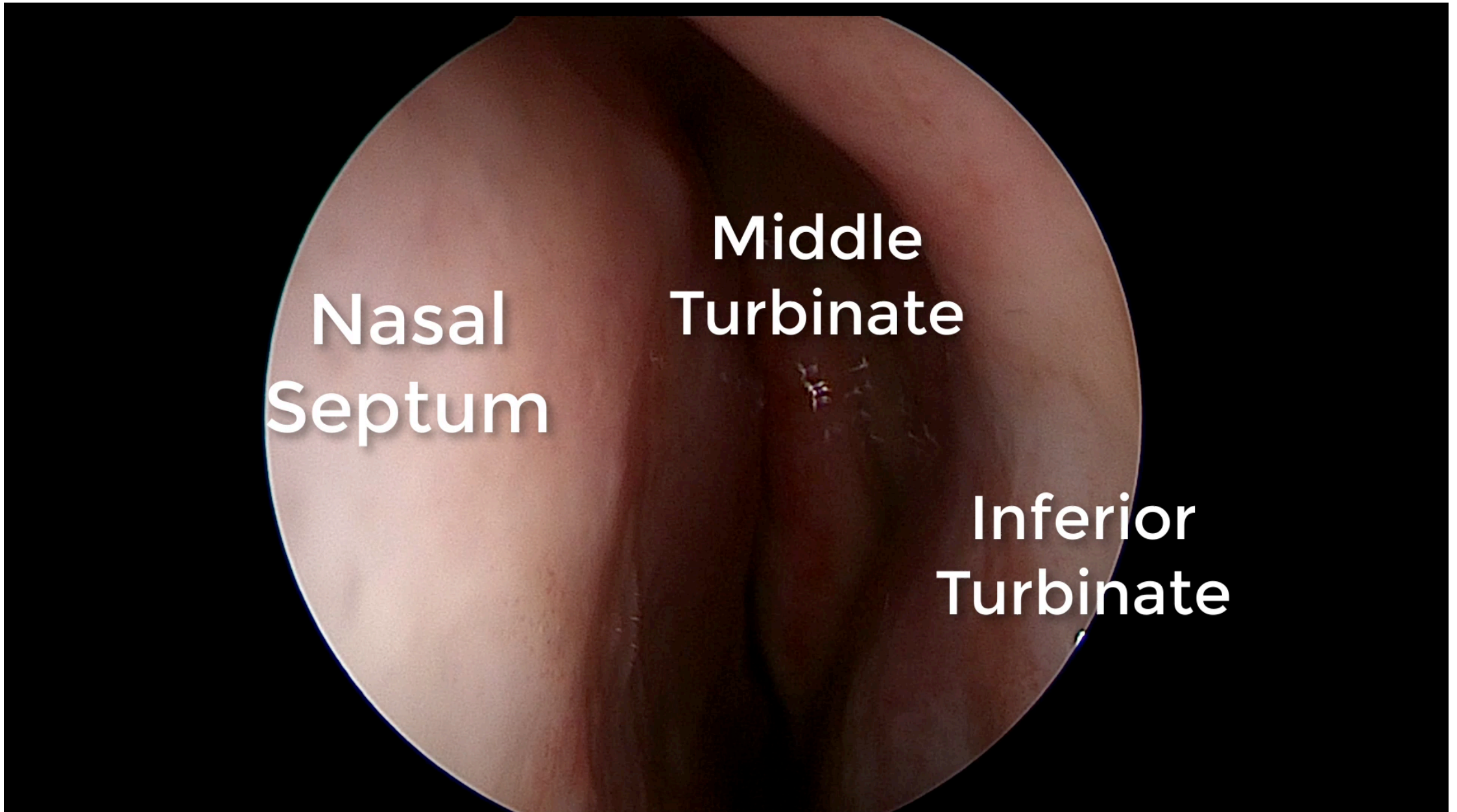
Figure 4. Genome-wide association study Manhattan plot for ice cream flavor preferences.

Possible responses were "vanilla" (n= 123,599) or "strawberry" (n=45,423). This model treated the responses as binary variables, and adjusted for age, sex, genotyping platform, and the top-5 principal components of genetic ancestry.

## **Post GWAS studies:**

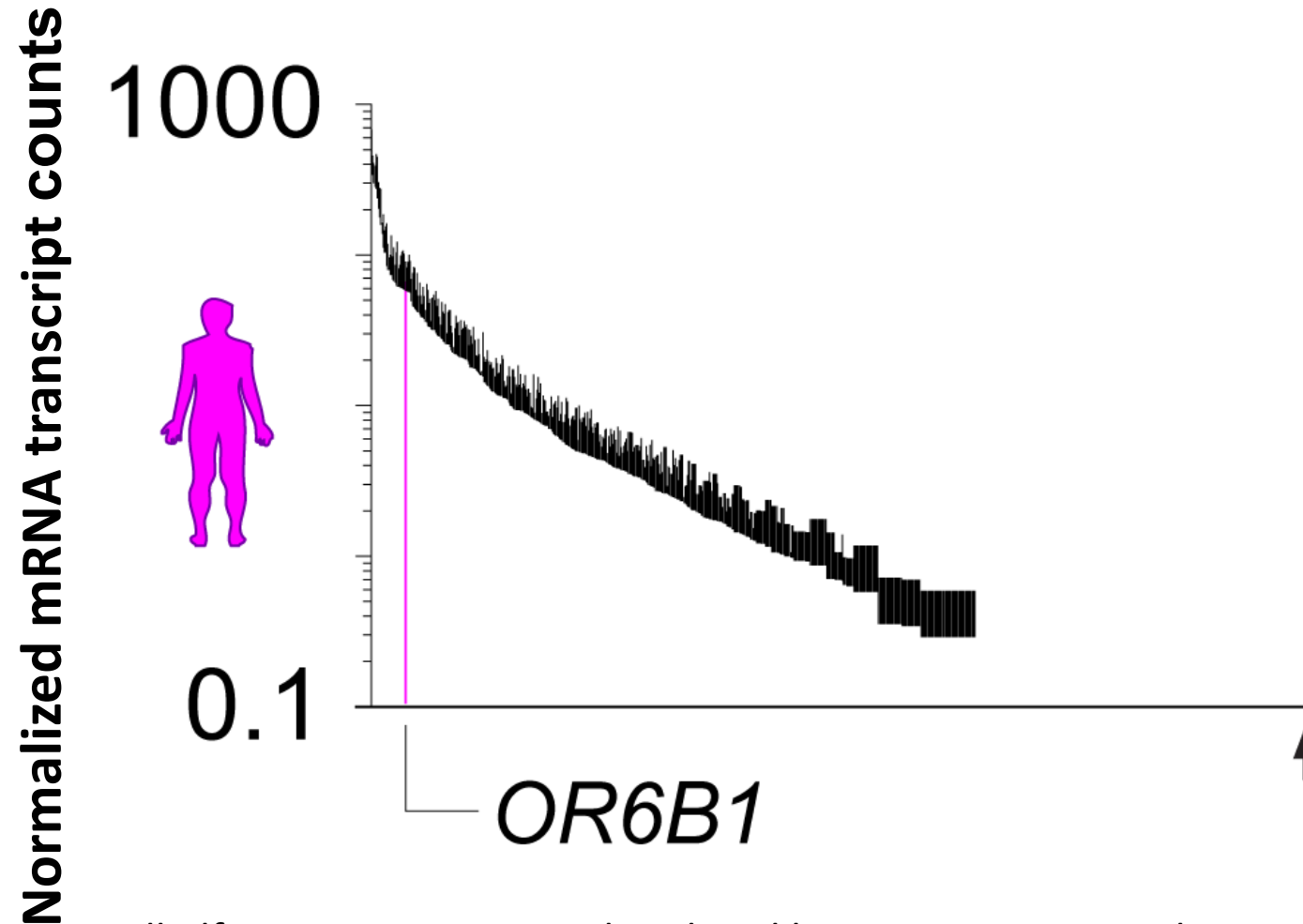
**Related phenotypes and PheWAS**  
**mRNA and protein expression**  
**Function**

## Olfactory epithelium tissue for mRNA transcript profiling by endoscope



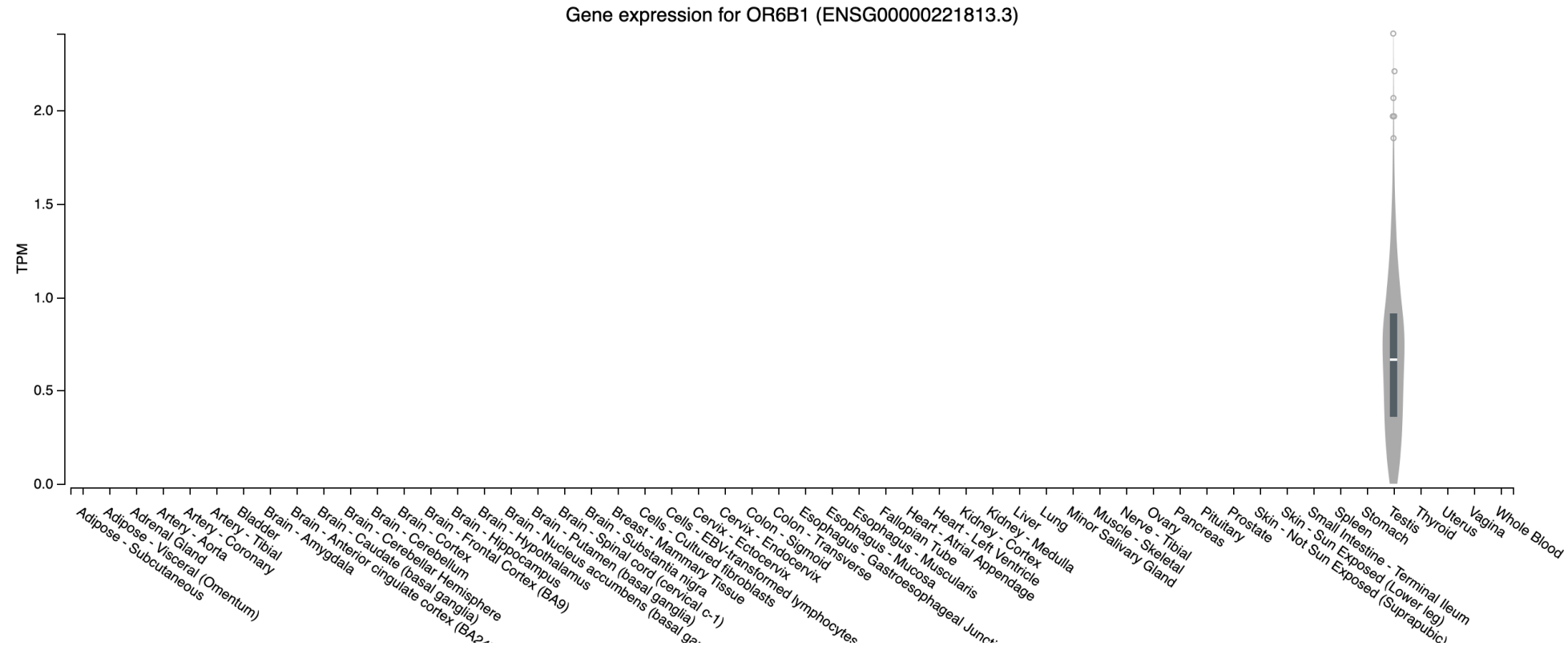
# OR6B1 mRNA is highly expressed in human olfactory receptor neurons

[10.1126/sciadv.aax0396](https://doi.org/10.1126/sciadv.aax0396)



All olfactory receptors, rank ordered by average counts in humans

***OR6B1* is not expressed in other tissues tested except testes**



## **Post GWAS studies:**

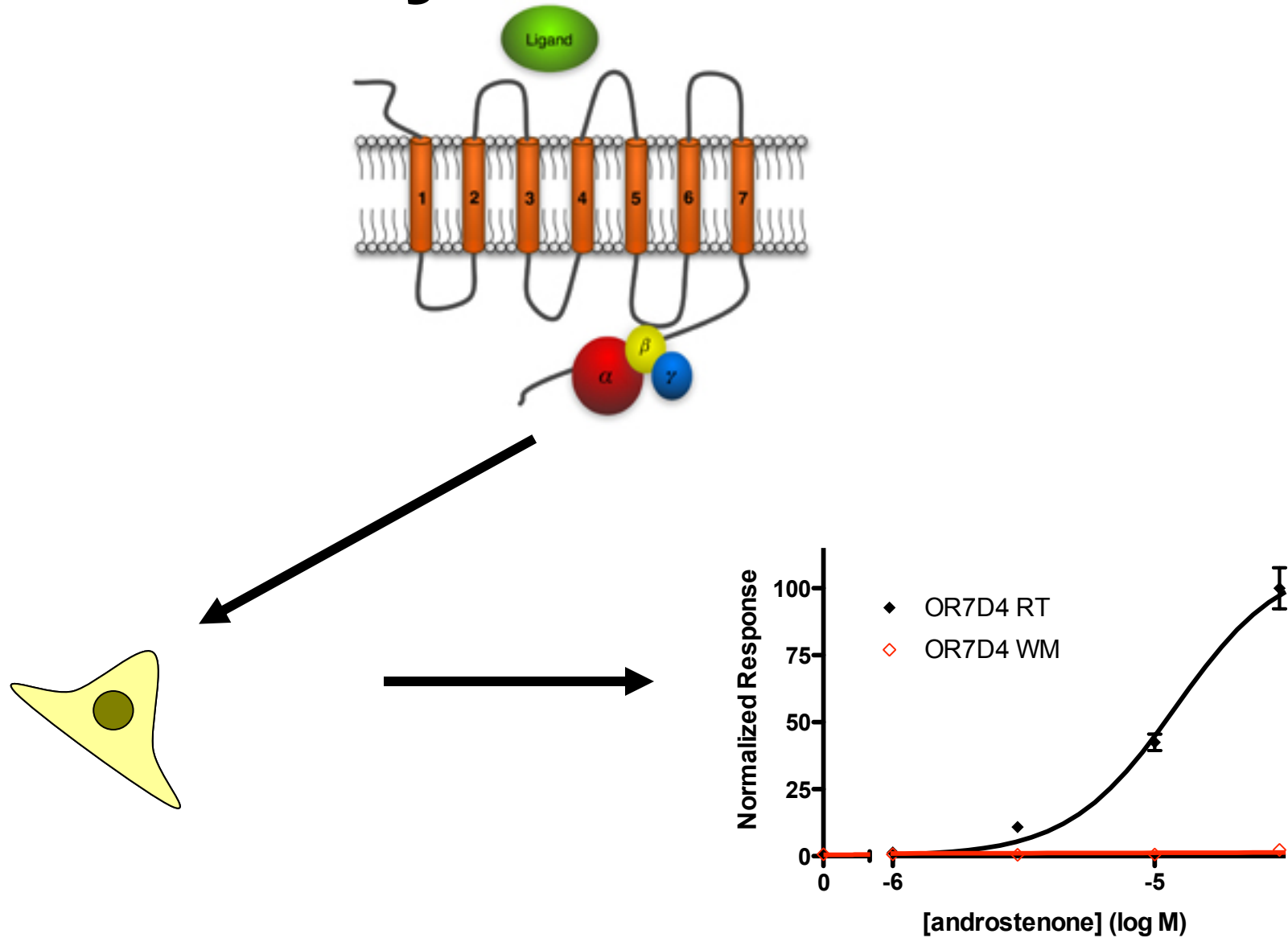
**Related phenotypes and PheWAS  
mRNA and protein expression  
Function**



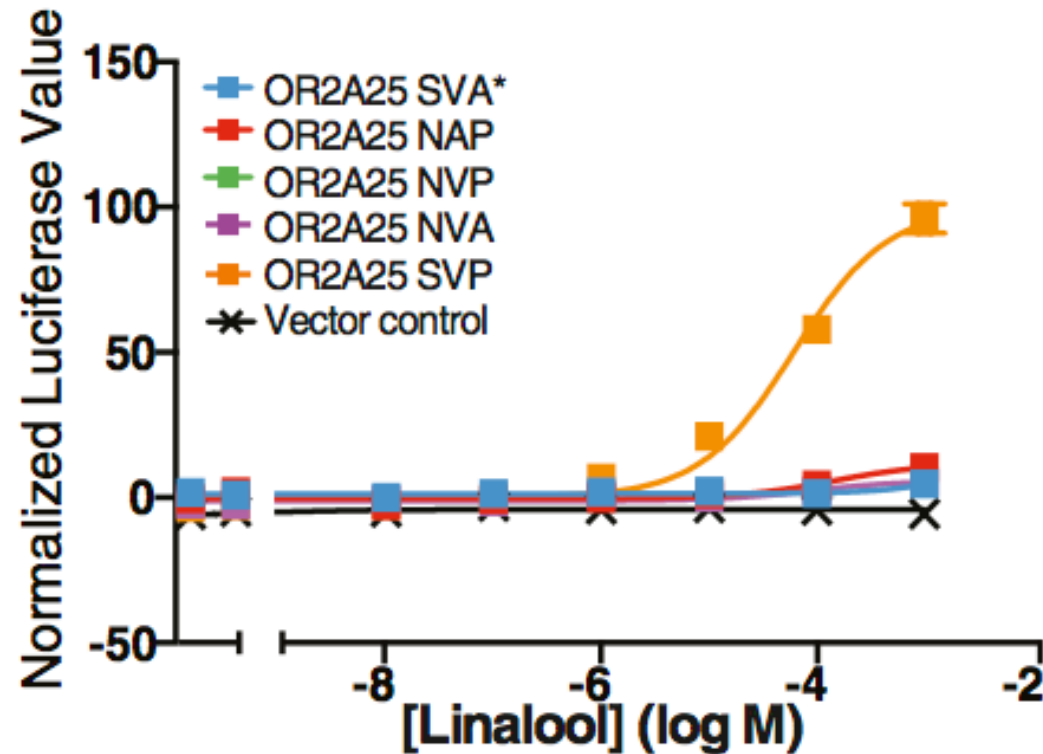
# Olfactory receptor functional assay

1. Olfactory receptors are GPCRs; activated, they produce cAMP
2. We transfect cells with (a) the receptor (genotypes) and (b) a reporter
3. When an odor is delivered, the cells glow yellow
4. Light production increases as odor amount increases for a dose-response curve

# Luciferase Assay



# Cell-based assays to find flavor ligands for olfactory receptors OR2A25 (near OR6B1) but no ligands yet for OR6B1



Different genotypes  
SVA  
NAP  
NVP  
NVA  
SVP

10.1073/pnas.1804106115

**Linalool – found in essential oils and many plants**

## Wrapping up

- Sensory differences are common
- Fruit intake GWAS points to olfactory receptors (OR)
- Functional OR studies are underway

## Future

- Volatile cheminformatics common to many fruits

# Looking ahead

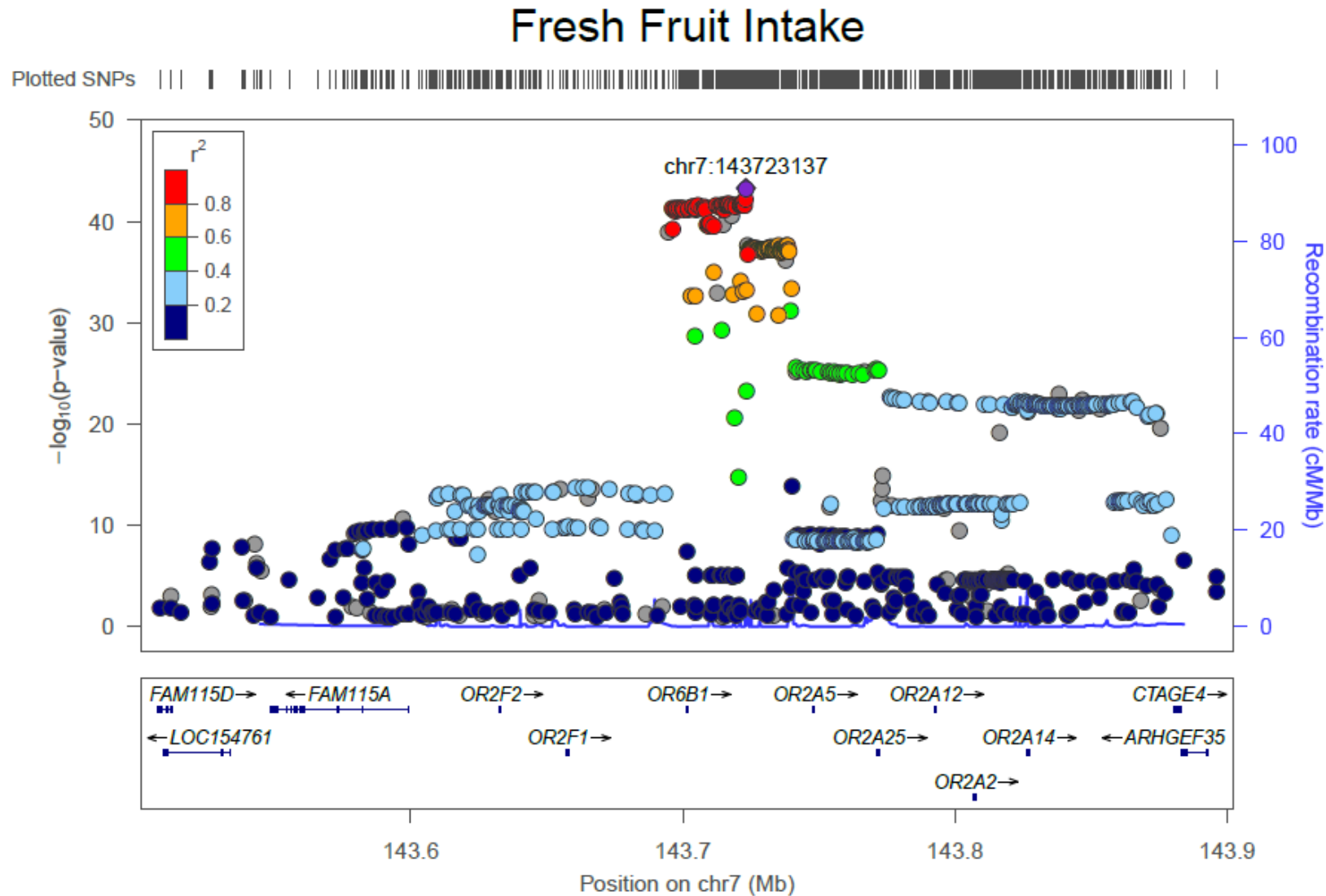
## Scale and big data

- Data scientists trained in chemosensory biology and nutrition
- Phenotyping, chemosensory measures and food intake data

## Public policy, medicine and food implications

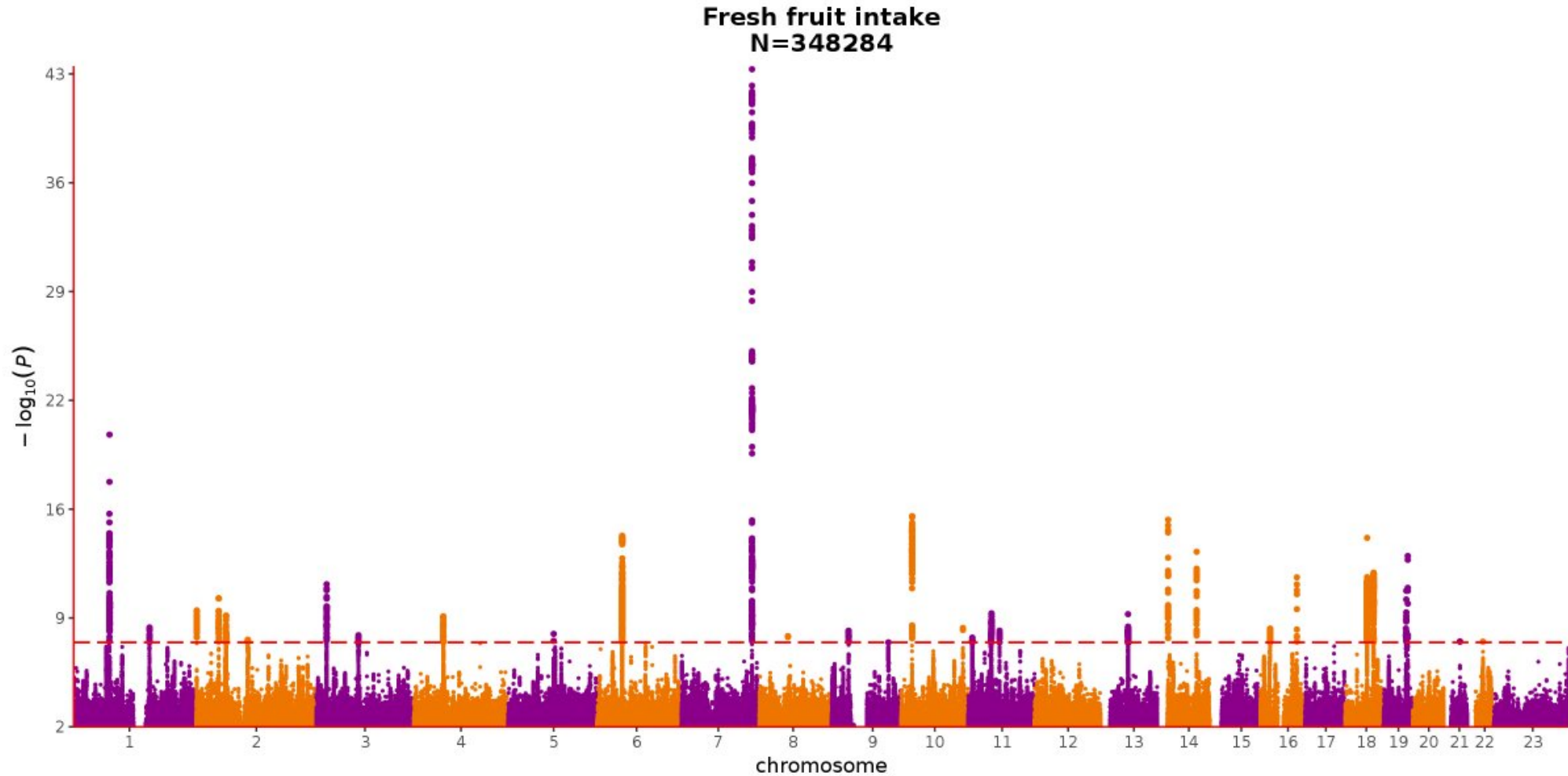
- Using genetic information for the forces of good
- Tailoring foods including plants

# Most significant associations are on top of *OR6B1*, an olfactory receptor

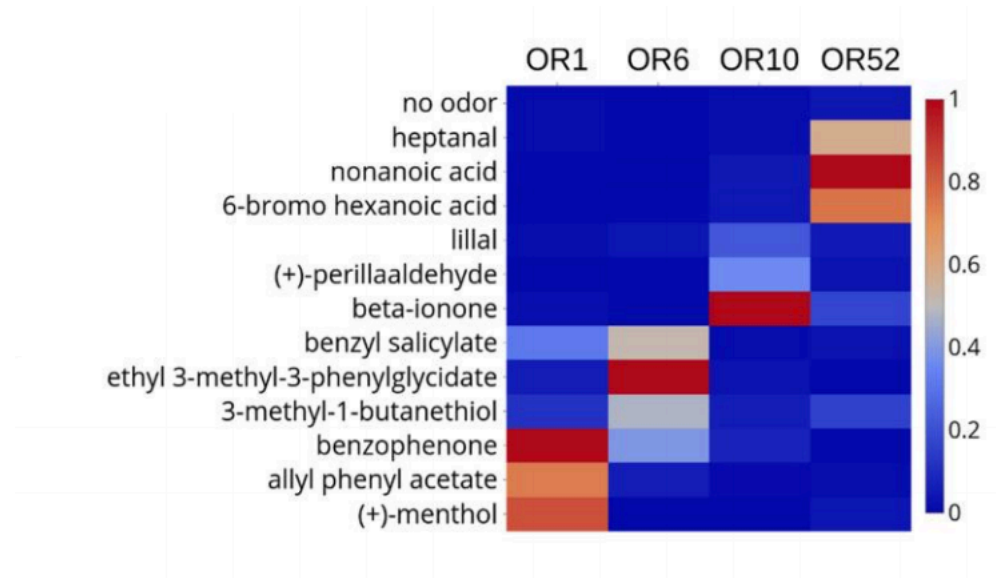




# Genetic variants on human chr 7 and fresh fruit intake



The consensus OR for subfamily hOR6 has ethyl 3-methyl-3-phenylglycidate (also known as 'strawberry glycidate') and 3-methyl-1-butanethiol as top ligands



<https://www.biorxiv.org/content/biorxiv/early/2019/04/10/605337.full.pdf>



# 81+ volatile compounds from strawberries

