Department of Food Biosciences,
University of Reading

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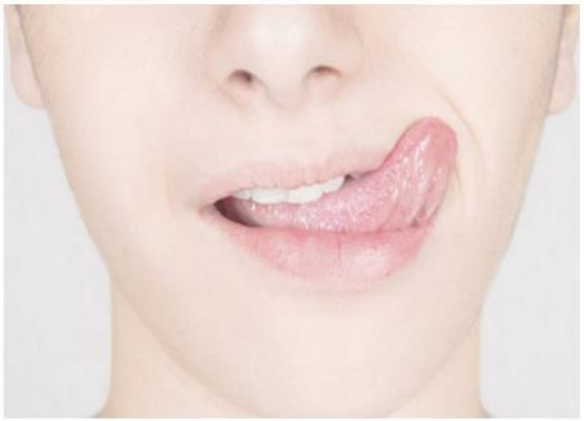
Individual difference in oral fat perception and its impact on fat consumption and preference


Dr Xirui (Sherrie) Zhou

Individual difference in fat preference and intake

1 Mela and Sacchetti, 1991
2 Mattes, 1993
3 Ledikwe et al., 2007)

Individual difference in fat preference and intake

- 87 participants (two excluded from analysis)

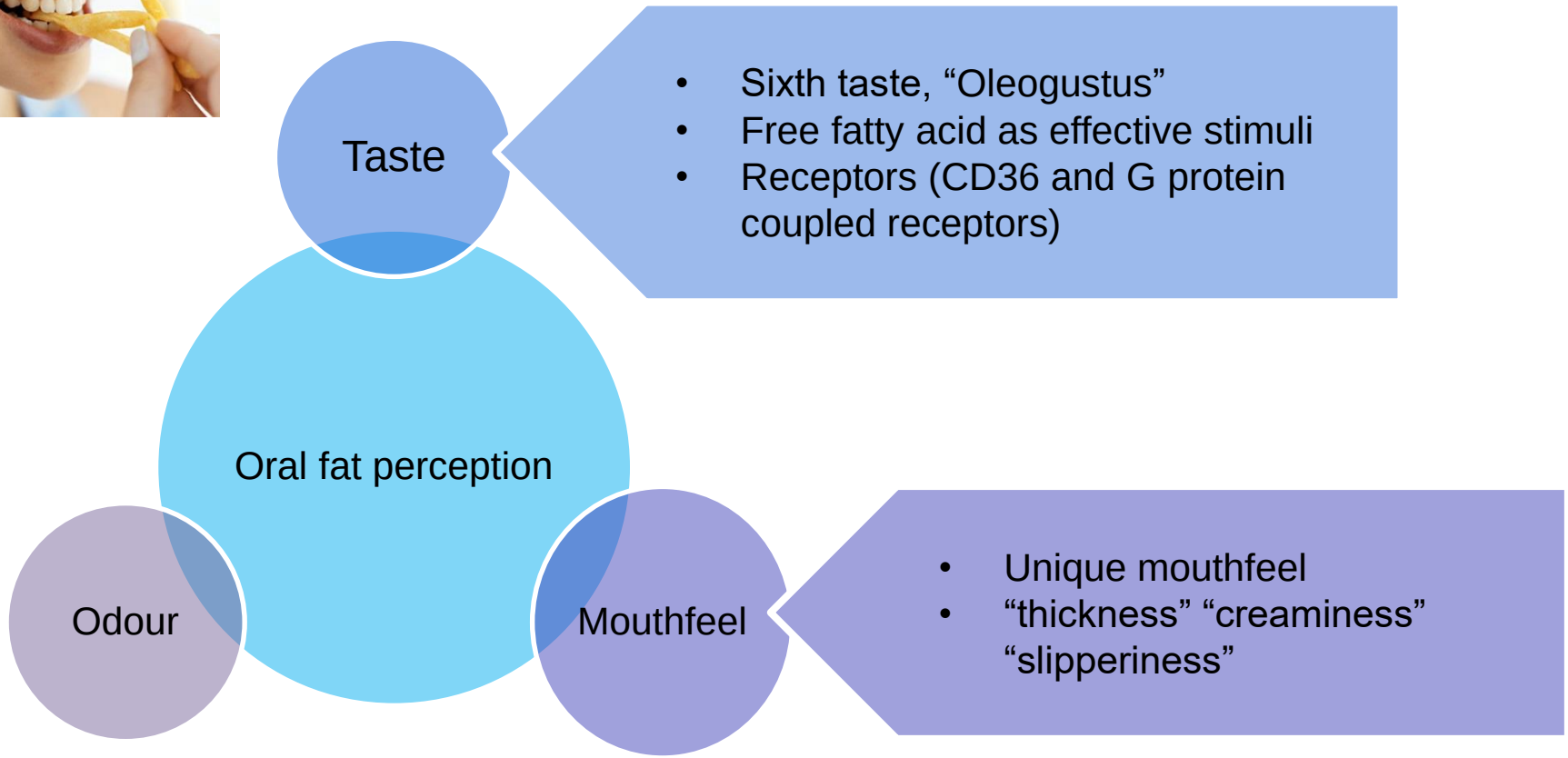
- Food preference questionnaire (FPQ modified from the PrefQuest questionnaire[1])
  - 9 point liking scale for 44 food items
- Epic-Norfolk Food frequency questionnaire[2]
- Three factor eating questionnaire (51-food items[3])

Based on liking results from FPQ, some participants (n=34)

- **Higher liking scores in most food items (42 out of 46)**:
  - 25 food items significantly higher ($p<0.05$, 19 food items containing above 40% fat (as %energy))
- **Higher fat intake:**
  - Higher total fat (%) ($p=0.004$)
  - Higher monounsaturated fatty acid (%) ($p=0.007$)
  - Higher saturated fatty acid (%) ($p=0.025$)

Higher disinhibition of control ($p=0.027$)

Oral fat perception



Oral fat perception

Sensitivity to fatty acid

- Detection threshold measured by 3AFC staircase method
  - Nose-clip required
- Oleic acid
  - up to 20-30% of total fatty acid in dairy products
- Vary between individuals

		Mean	Range
Chale-Rush et al 2007	Oleic acid	0.77mM	0.01 -175mM
Stewart et al 2012		2.2mM	0.02-6.4mM

Perceived intensity from dietary fat

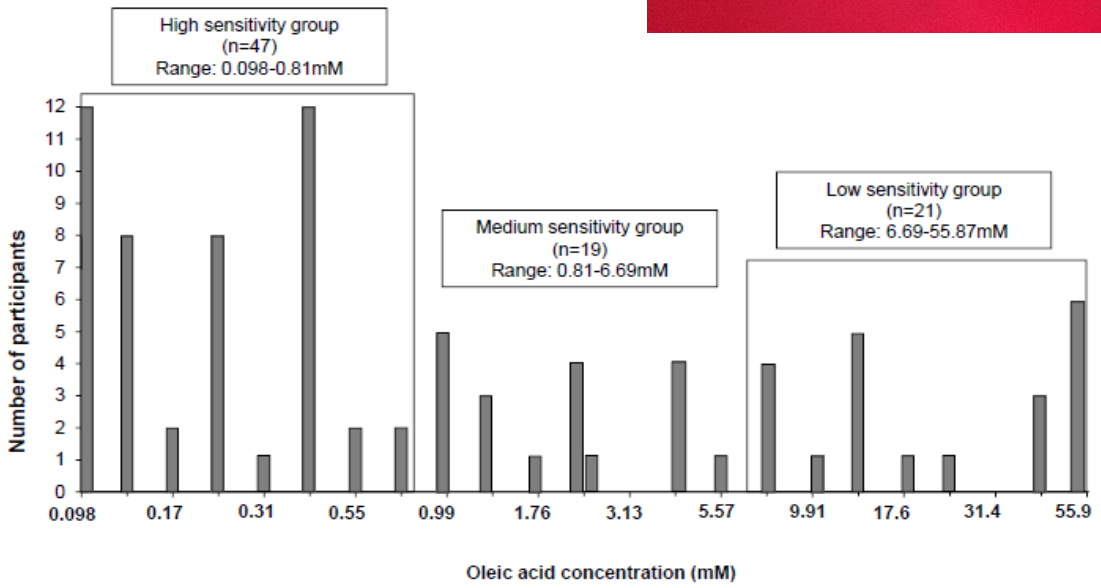
- Perception above threshold level by using intensity ratings or ranking
- Dietary fat

	Food model	Fat level
Keller et al 2012	Salad dressing	5%, 35% and 55%
Stewart et al 2012	Custard	0, 2, 6 and 10%

Individual difference in fatty acid sensitivity

- 87 participants
- Detection threshold to oleic acid ranged from 0.098mM to 55.9mM

- Based on their detection threshold, the participants are grouped into:
  - Low sensitivity group
  - Medium sensitivity group
  - High sensitivity group



Individual difference in perceived fat intensity

- 87 participants

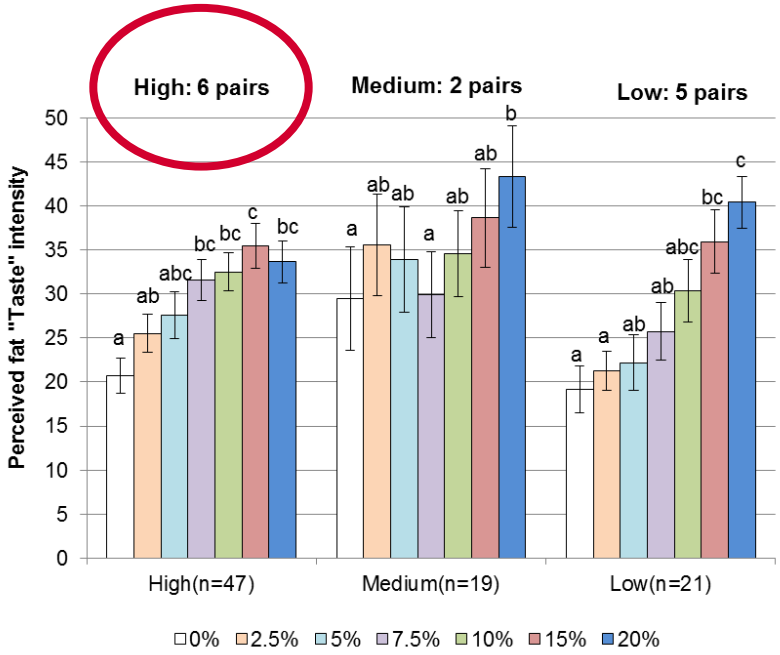
- Emulsion: varied amount of single cream and double cream added into milk
- Fat level : 0%, 2.5%, 5%, 7.5%, 10%, 15%, 20%

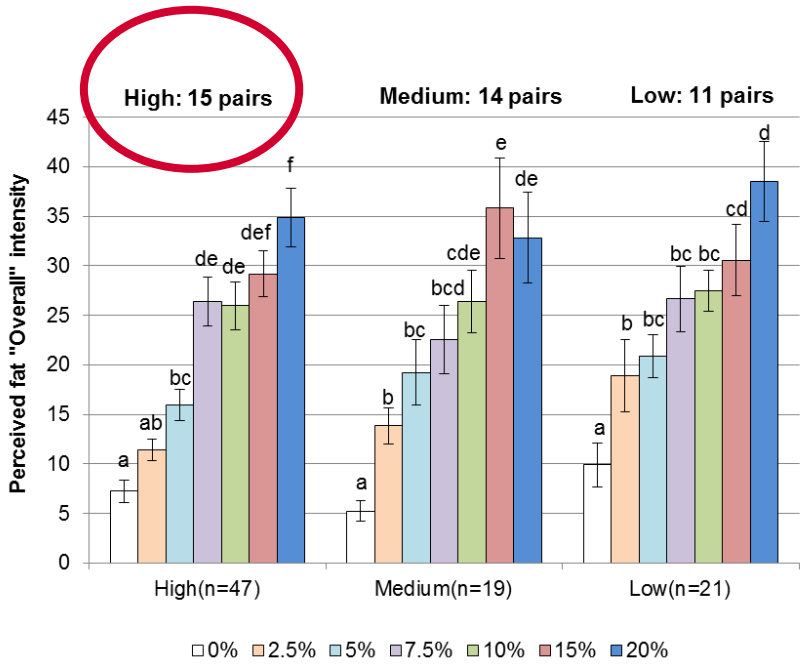
- Rating for perceived fat intensity

Fat intensity ratings under **“taste” condition**	Fat intensity ratings under **“overall” condition**
☐ Thickener and liquid paraffin	☐ Red light
☐ Nose-clip	
☐ Red light	

How fatty acid sensitivity and oral fat perceived intensity link together?

- Subjects with high sensitivity to fatty acid could distinguish more pairs of fat levels in the milk/cream model

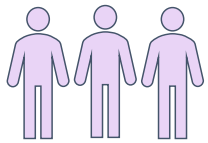




Perceived fat intensity under “Taste” modality (left) and under “Overall” modality (right) for three sensitivity groups. Bars not sharing a common letter differ significantly ($p<0.05$) between fat levels within one sensitivity group

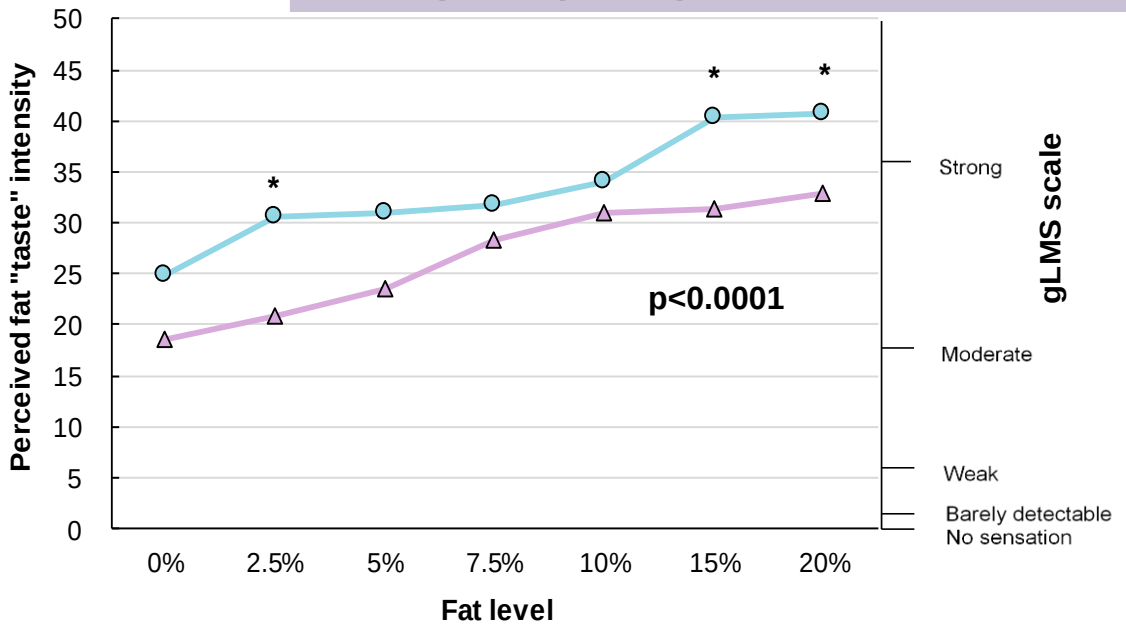
How the oral fat perception and fat preference link together?

- 87 participants
- Fat intensity ratings under “taste” condition
  - Fat level : 0%, 2.5%, 5%, 7.5%, 10%, 15%, 20%



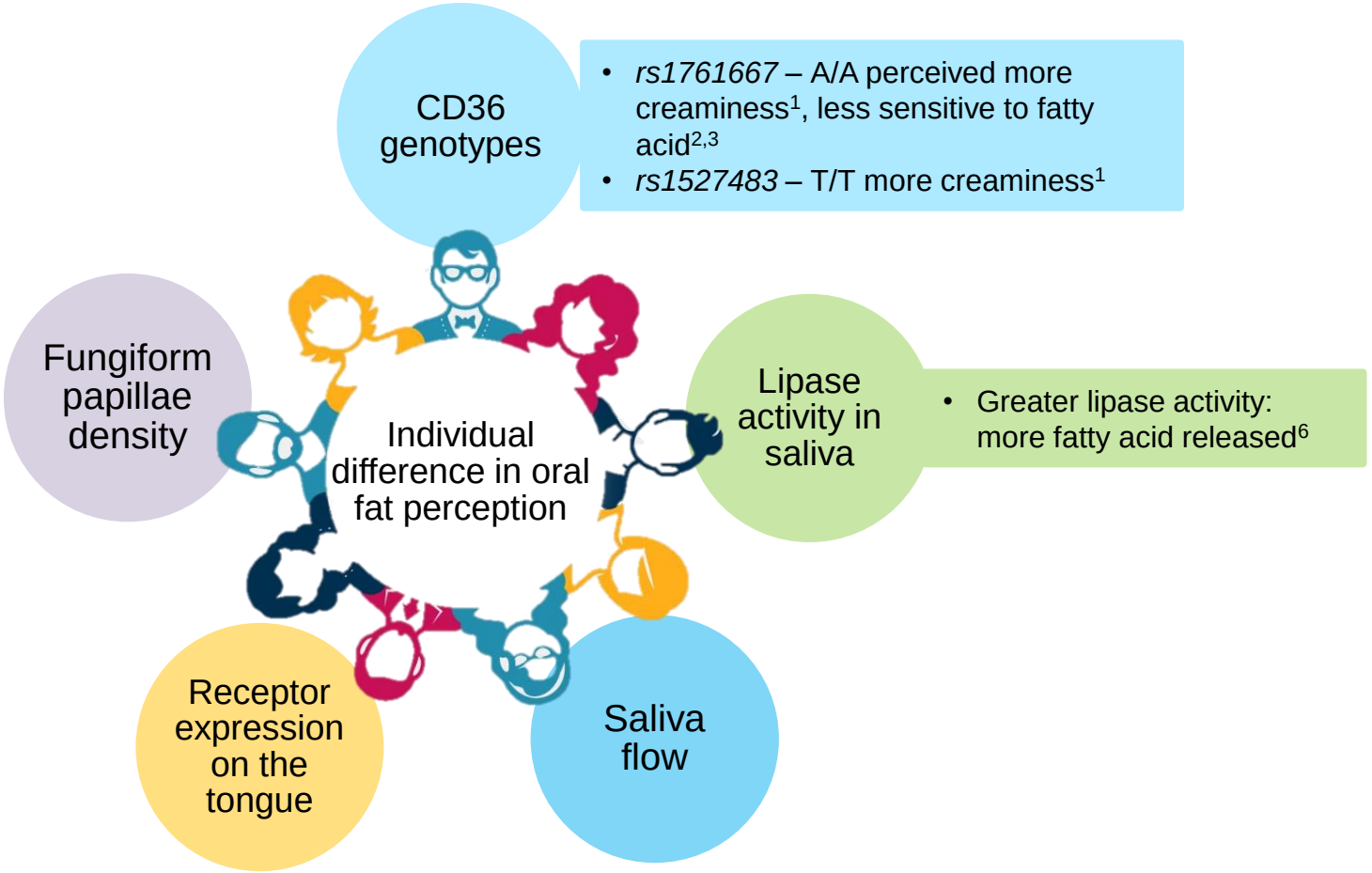
Participants with high liking scores for the foods rich in fat (n=34)

These participants perceived fat “taste” less



Fatty acid sensitivity, fat perceived intensity, fat preference

Potential mechanisms for individual difference in oral fat perception



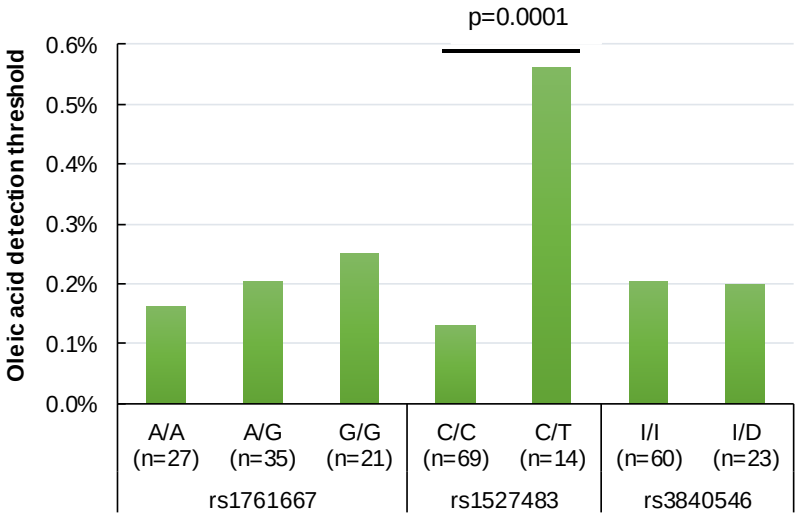
1 Keller et al, 2012
2 Melis et al, 2015
3 Mizake et al, 2015
4 Mennella et al, 2014
5 Kulkarni et al, 2014
6 Voigt et al, 2014

Influence of CD36 on oral fat perception

- **CD36 genotyping –** *rs1761667*, *rs1527483*, *rs3840546*

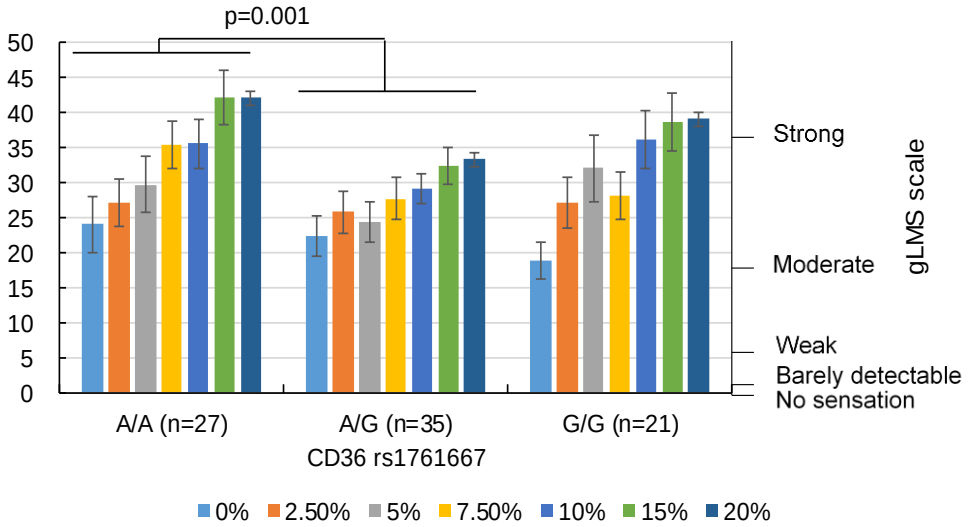
rs1527483 C/T carriers:

- higher detection threshold (less sensitive)



rs1761667 A/A carriers:

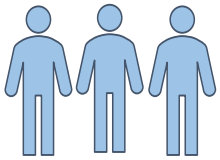
- higher perceived fat “taste” intensity



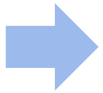
Influence of lipase activity on oral fat perception

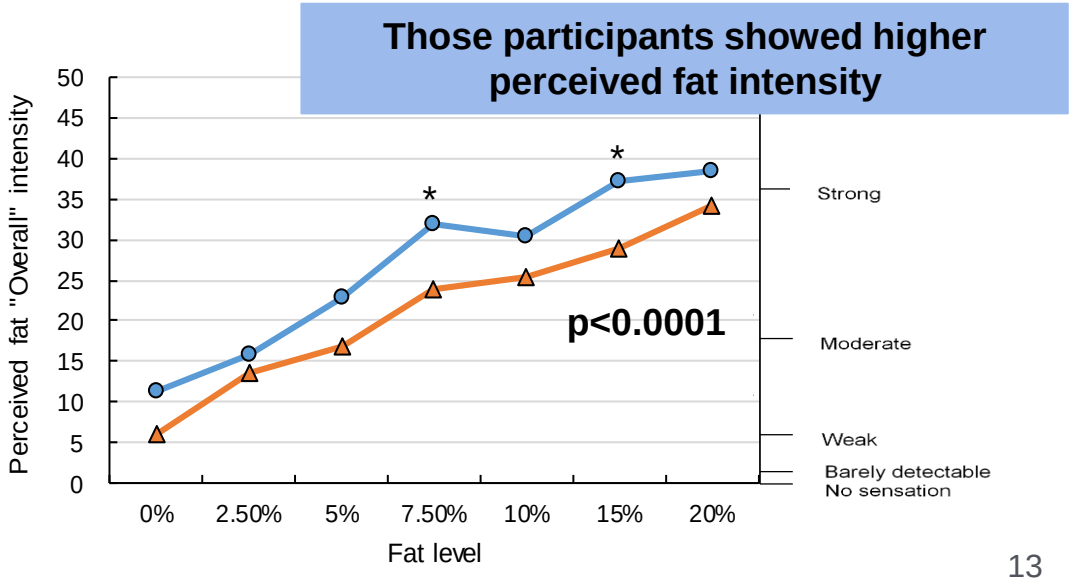
- **Salivary lipase activity** – Free oleic acid analysis from expectorated almond
  - Chewed almond (one almond per person, 1 bite/s for 15 seconds)

- **Free oleic acid (as % of total fat) in expectorated almond samples varied between individuals : 0.024% to 3.75%w/w,** compared with the free fatty acid (as % of total fat) in whole almond (0.027% to 0.26%)

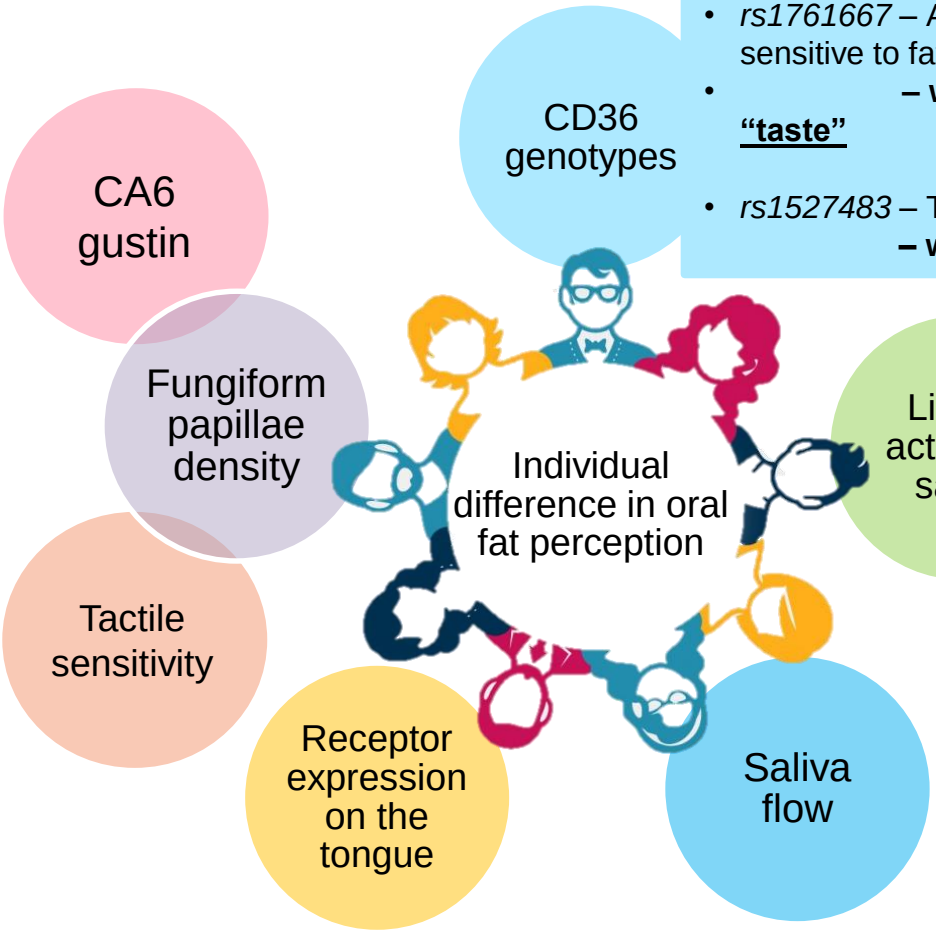


A group of participants can produce more free oleic acid in their mouth (n=20)





Potential mechanisms for individual difference in oral fat perception

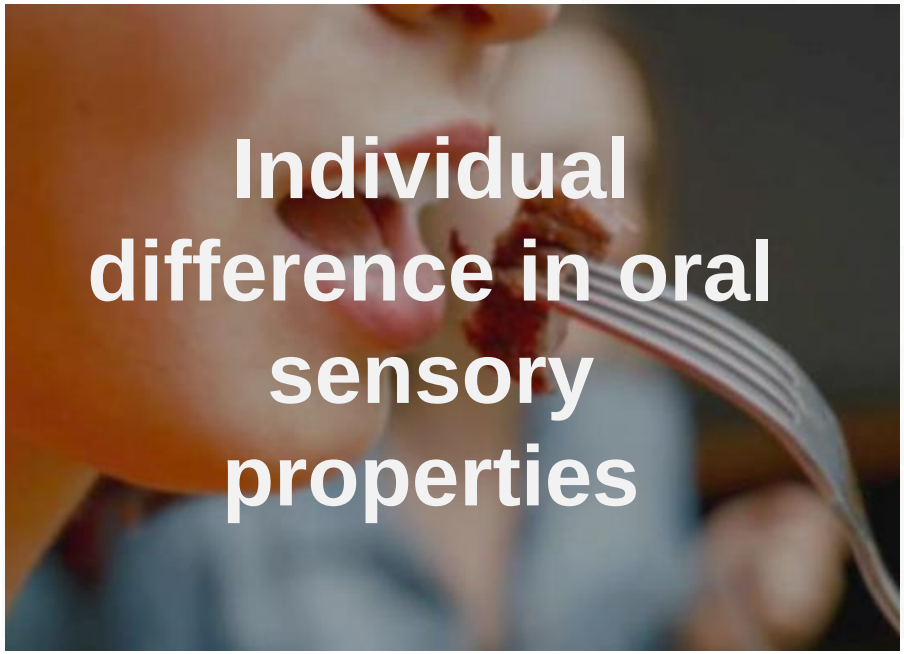


- *rs1761667* – A/A perceived more creaminess[1], less sensitive to fatty acid[2,3]
- **– we found <u>A/A perceived stronger fat "taste"</u>**
- *rs1527483* – T/T more creaminess[1]
  – we found <u>C/T less sensitive to oleic acid</u>

- Greater lipase activity:
  - More fatty acid released[4]
  - **We found <u>perceive stronger oral fat perception</u>**

1 Keller et al, 2012
2 Melis et al, 2015
3 Mizake et al, 2015
4 Mennella et al, 2014

The project that I am currently working on…

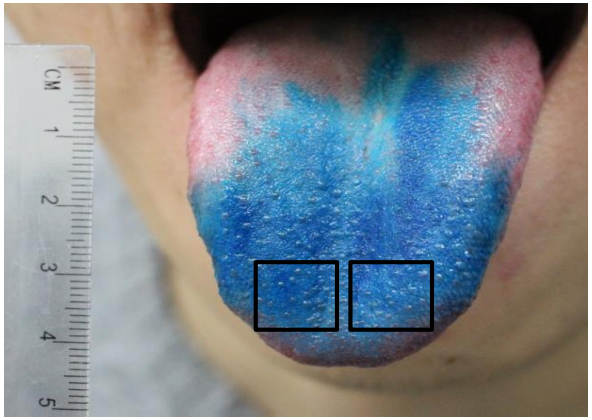


Individual difference in oral sensory properties

Fungiform papillae density

- Blue dyed tongue and natural tongue

Blue dyed tongue:
manual counting



Natural tongue: automatic counting
by ImageJ software and Matlab[1]

- A ruler is paralleled to the tongue, in order to obtain a reference of 1cm^2

[1] Eldeghaidy et al (2018) Physiol Behav. 184: 226–234.

Tactile sensitivity

- Von Frey filament
  - 0.02g force and 0.008g force
- Each filament: ten times
  - Five times with filament touch
  - Five times without any touch
- Participant with blindfold

- R-index: probability of discriminating samples
  - R-index value of 1.0: easily distinguishable
  - R-index value of 0.5: extremely difficult to discriminate.

	Y-sure	Y-unsure	N-sure	N-unsure	Total	R-index
True	a	b	c	d	5	
False	e	f	g	h	5	

$$\text{R index} = \left[a\times(f+g+h)+b\times(g+h)+c\times h+\frac{1}{2}\times(a\times e+b\times f+c\times g+d\times h)\right]/(5\times 5)$$

Individual differs in tactile sensitivity

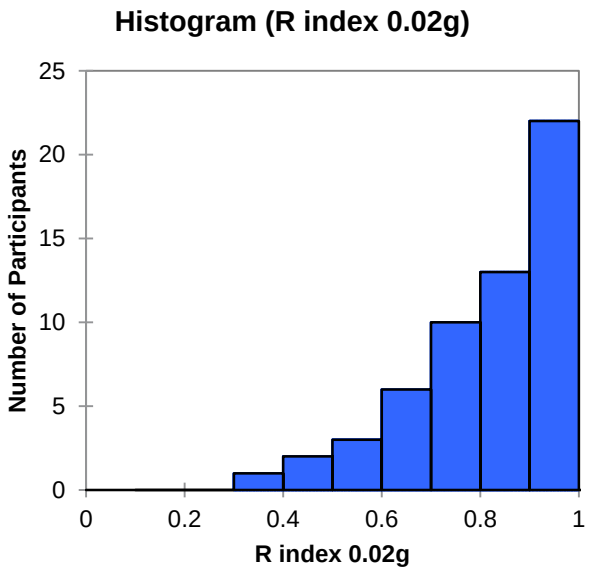
- Participants shows various scores of R-index:
  - Individual differs in tactile sensitivity

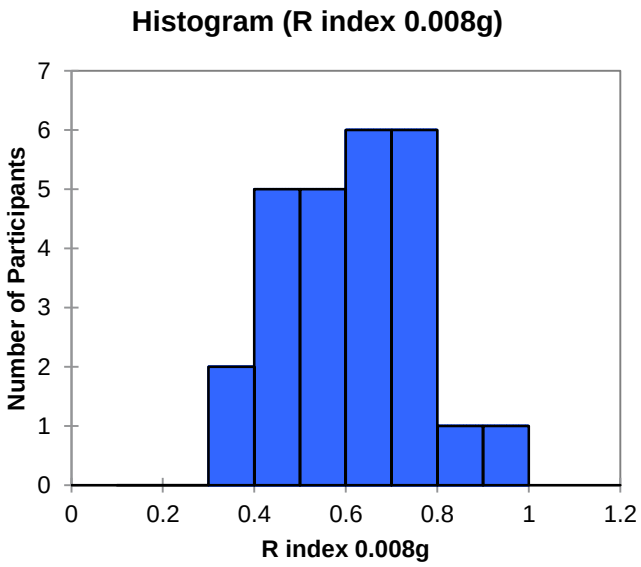
0.02g force

- 81 results
- Ranged: 0.38-1
- Mean: 0.84; Median: 0.90

0.008g force

- 27 results
- Ranged: 0.36-0.90
- Mean: 0.59; Median: 0.60





Tactile sensitivity & FPD

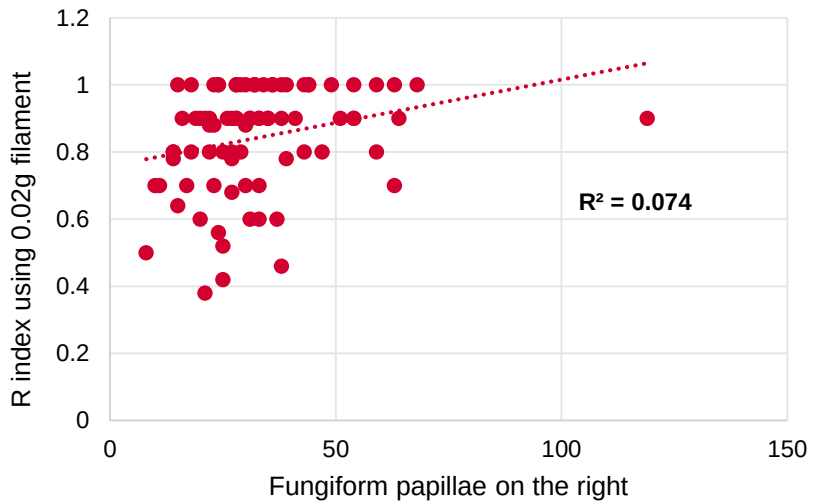
- **81 results from blue dyed tongue (manual counting)**
- Participants shows different fungiform papillae number

- High correlation between the fungiform papillae number on the left and on the right ($p<0.0001$, $r^2=0.85$)

	Average	Min	Max
FPD Left	**31**	**10**	**85**
FPD right	**32**	**8**	**119**

Tactile sensitivity & FPD

- Significant correlation between fungiform papillae number and tactile sensitivity by 0.02g
  - R index (by using 0.02g) vs FPD on right: p=0.014



- No correlation between fungiform papillae number and tactile sensitivity by 0.008g

Future work

Future work of our project:

- Genotypes
- Fatty acid sensitivity
- Biscuit ratings
- Mouth behaviours

Future work of our project:

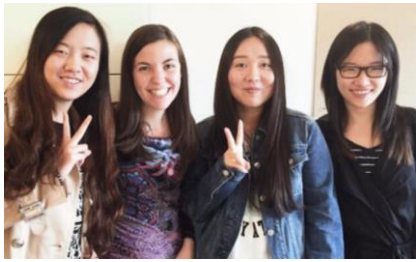
- Real snack

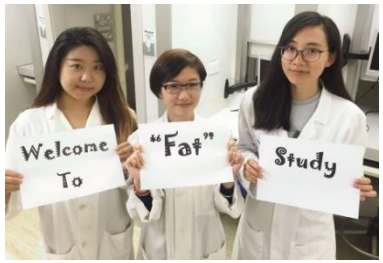
How these individual measurements benefit us for a quick check, in order to:

- Know our consumers
- Characterize our consumers

ACKNOWLEDGEMENTS

- All the participants
- My supervisors
- BBSRC and all the industrial sponsors
- All the project students who made great contributions to the studies





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Thank you for listening