



Human saliva, taste and food perception

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INRA: French National Institute for Agricultural Research



19 regional centres
8500 permanent positions
1900 PhD students per year

Research fields

Plant, animal and food sciences
Agro-ecology
Human nutrition
Social sciences

...

CSGA: Food and Behaviour Research Centre

To better understand physico-chemical, molecular, cellular, behavioural and psychological factors influencing food perception

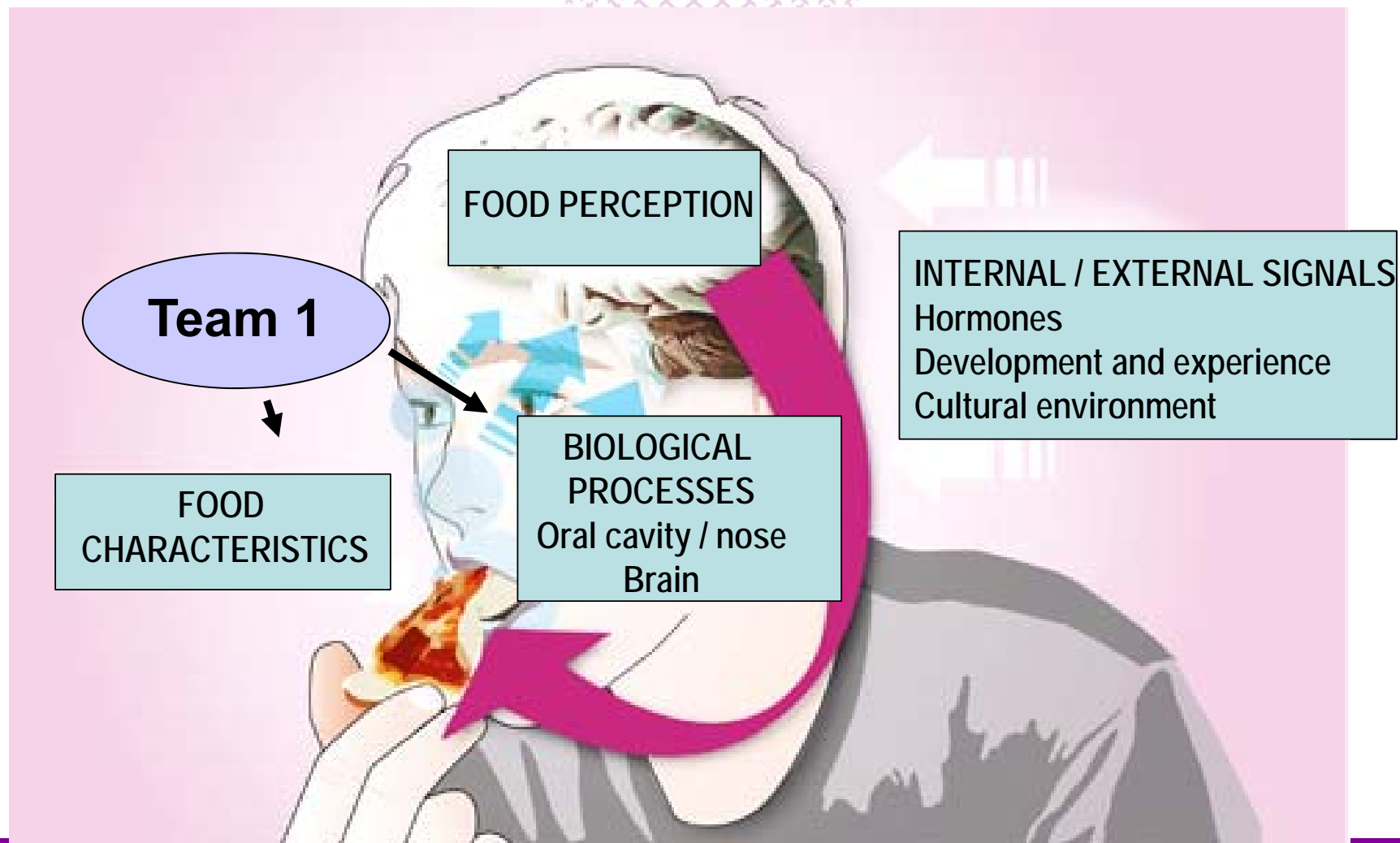
Humans

Animal models: Drosophila, Rodents

9 research teams

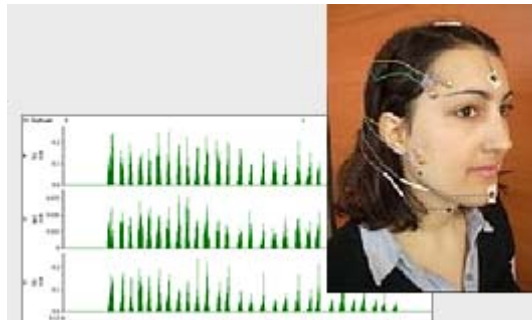
146 permanent staff – 35 PhD students

CSGA: Food and Behaviour Research Centre



Team 1: In-mouth food processing and flavour perception

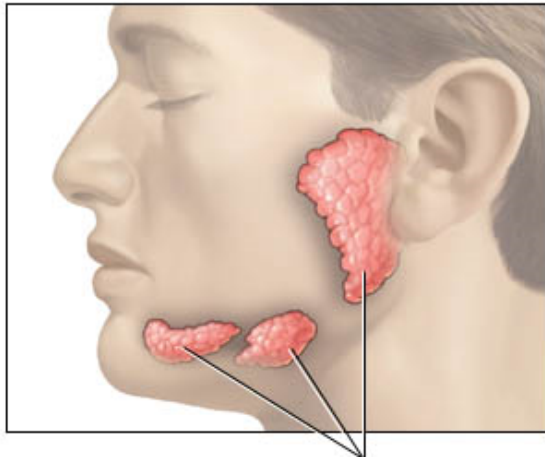
Interaction of flavour compounds with food matrix



Mastication and flavour release or perception

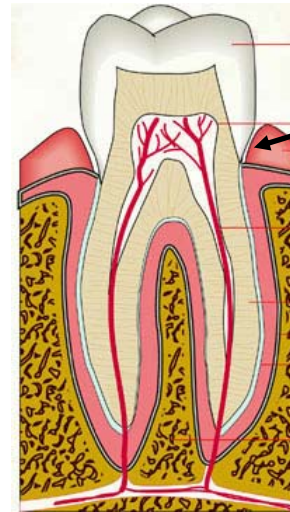
Saliva and taste (3 researchers)

Whole saliva: a complex fluid



major salivary glands

+ minor salivary glands



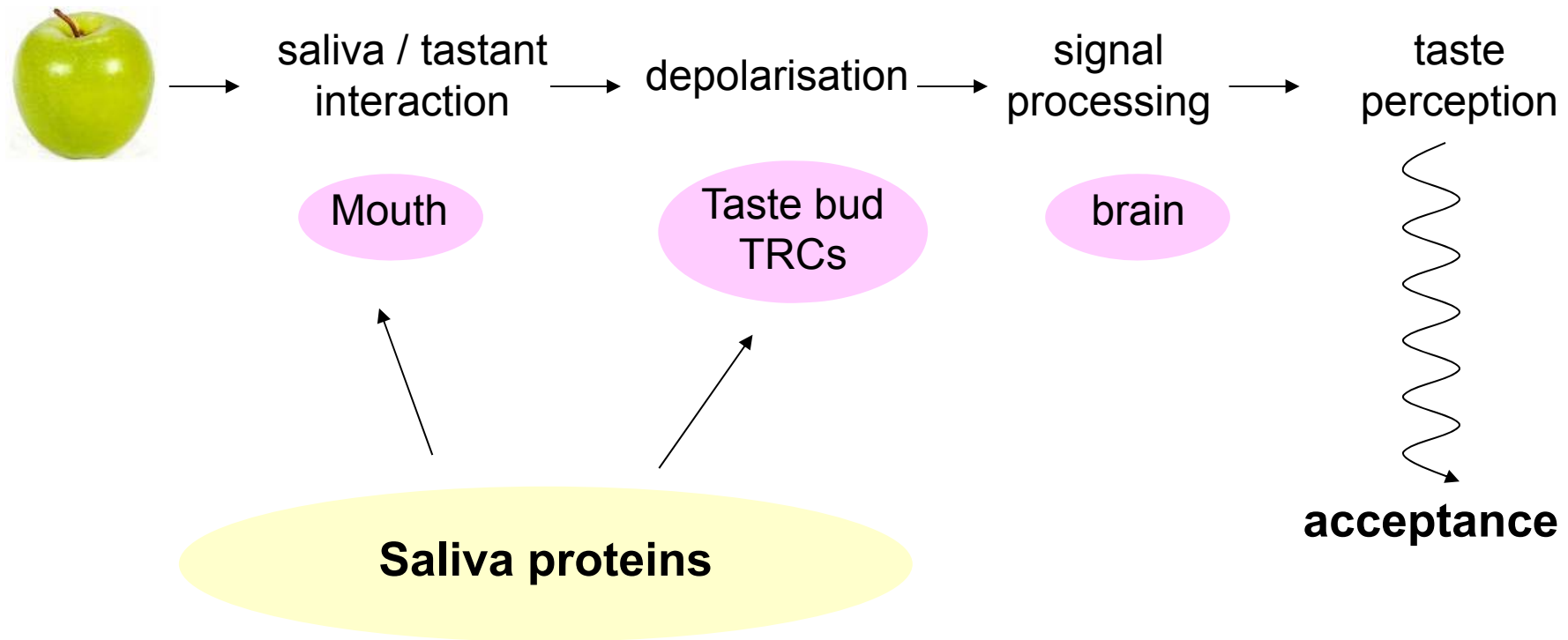
+ crevicular fluid

+ epithelia, oral
flora ...

Composition: water, ions, nucleic acids, lipids...

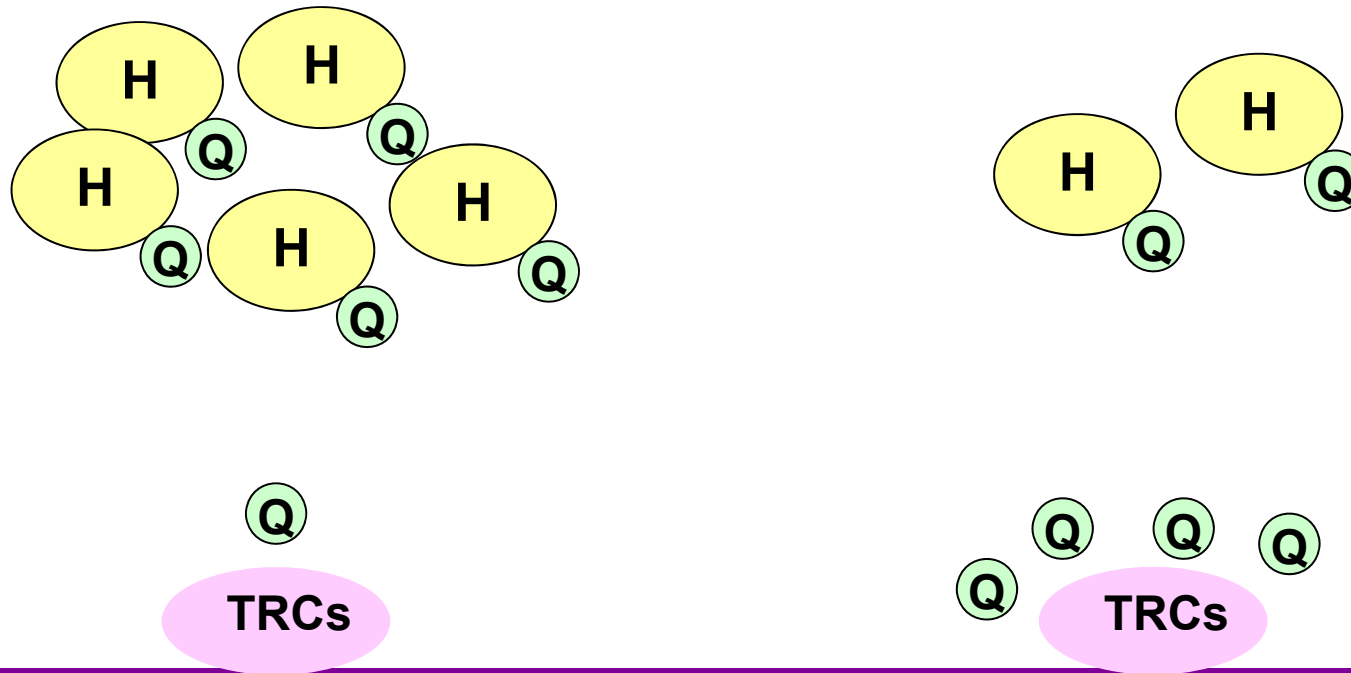
proteins / peptides (over 1000 described)

Saliva proteins and taste



Interaction proteins / tastants

- **Histatin / quinine.** Histatin 5 concentration significantly lower in subjects hypersensitive to quinine. *Wada et al., 2010.*



Saliva proteins and taste acuity – CA6

Henkin et al., 1975, 1999. A zinc-binding protein isolated from saliva (**gustin, carbonic anhydrase 6**). Decreased CA6 secretion + abnormal taste bud anatomy in patients with taste complaints.

Padiglia et al., 2010. PROP taster status associated with CA6 **polymorphism** at the active zinc binding site.

Two main research objectives

Are the salivary profiles stable / variable?

with developmental stage in infants

with time (day, year)

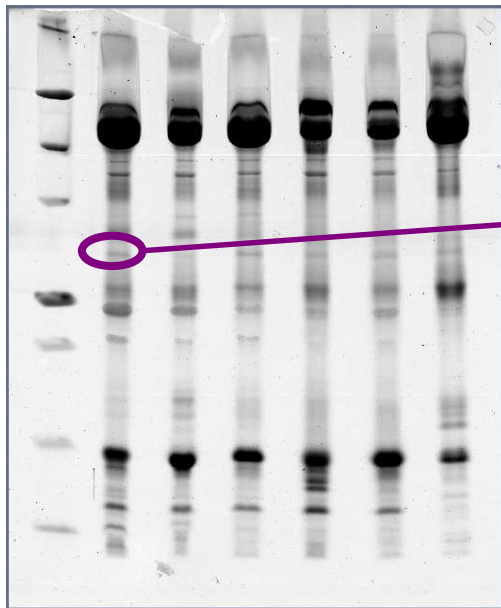
in response to taste stimulation or diet

May the saliva composition predict taste sensitivity or taste acceptance?

Variation of protein profiles with age during infancy

A longitudinal study on 3 and 6 month-old infants (n=73).

Saliva proteins separated by 1-D electrophoresis



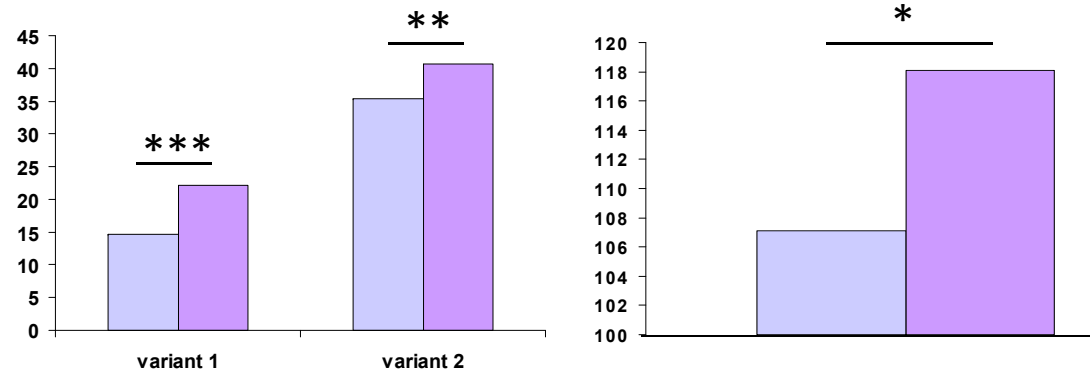
Quantification in arbitrary units

Morzel, Palicki, Chabanet, Lucchi, Ducoroy, Chambon, Nicklaus. 2011. *Archives of Oral Biology*, 56: 634-642 .

Variation of protein profiles with age during infancy

Profiles are modified substantially: 13 out of 21 bands vary in abundance between 3 and 6 months of age.

Increase of amylase abundance and activity



abundance of amylase bands (n=73) amylase activity (n=42)

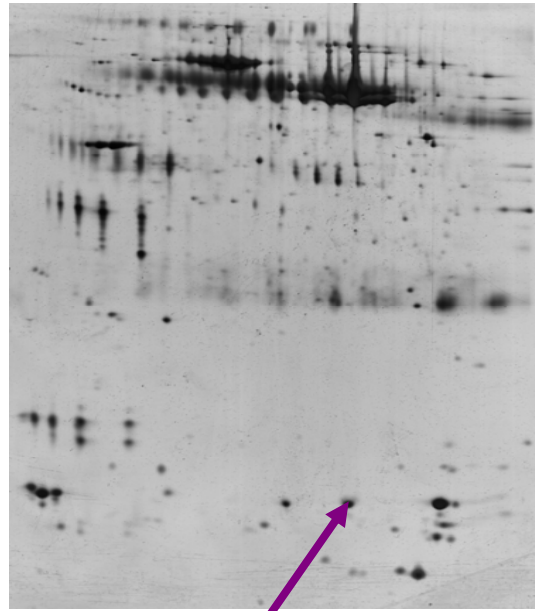
 **3 month-old infants**
 **6 month-old infants**

Morzel, Palicki, Chabanet, Lucchi, Ducoroy, Chambon, Nicklaus. 2011. *Archives of Oral Biology*, 56: 634-642 .

Circadian variations in salivary profiles

12 subjects, at-rest saliva sampled AM / PM of the same day.

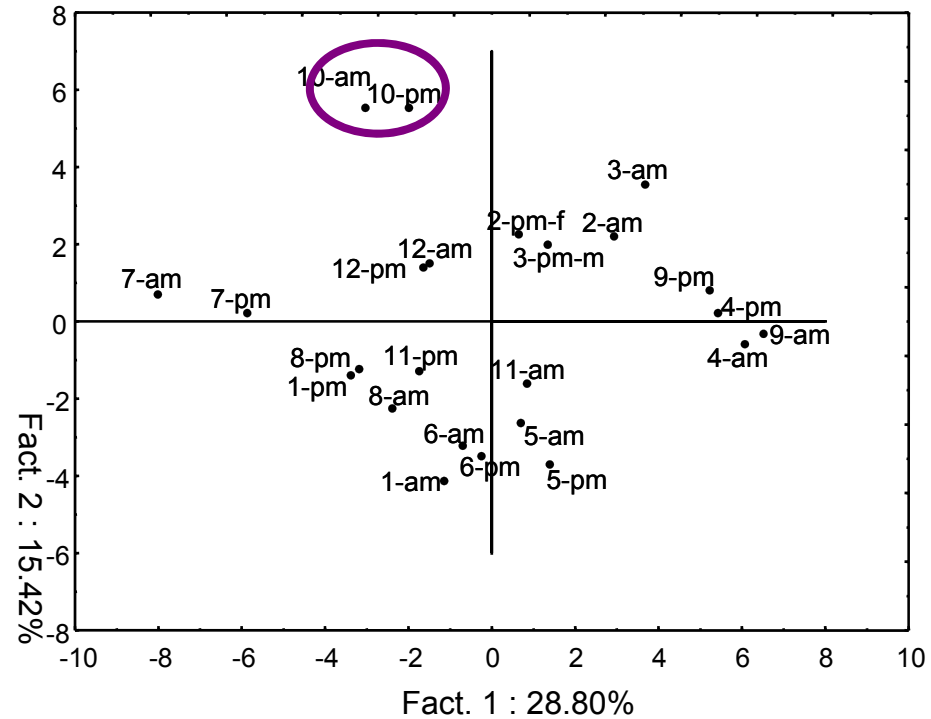
Saliva proteins separated by 2-D electrophoresis



one spot ~ one protein: quantification in ppm

Circadian variations in salivary profiles

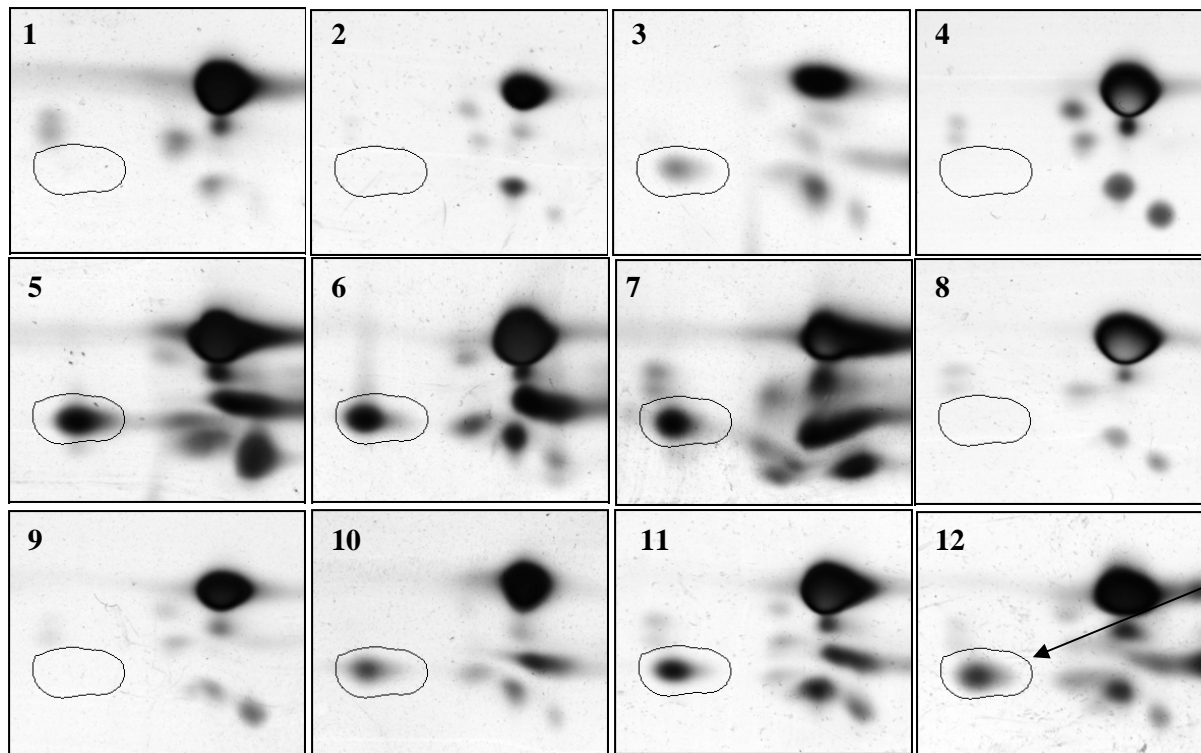
Overall, **limited circadian effect**



Quintana, Palicki, Lucchi, Ducoroy, Chambon, Salles & Morzel. 2009. *Journal of Proteomics* 72: 822-830.

A very high between-subject variability

Out of 509 spots detected, 47 differ significantly between subjects.



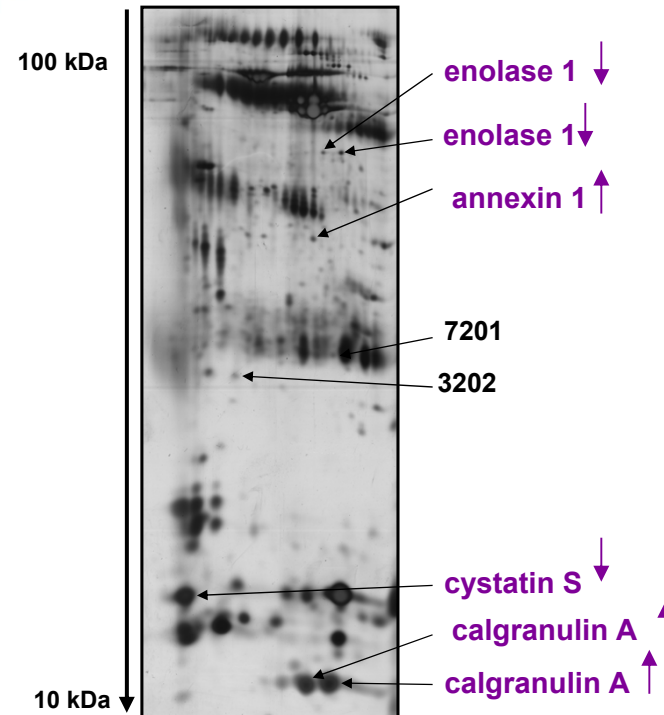
Cystatin D

Quintana, Palicki, Lucchi, Ducoroy, Chambon, Salles & Morzel. 2009. *Journal of Proteomics* 72: 822-830.

Modification of saliva proteome by taste stimulation

Comparison of saliva profiles after stimulation (15 sec) by four taste solutions

Profiles are altered differently
acid > bitter > umami > sweet



An inflammatory-like response to bitterness

Neyraud, Sayd, Morzel & Dransfield. 2006. Journal of Proteome Research 5: 2474:2480.

Modification of saliva proteome by bitter tastants

Comparison of saliva profiles 15 minutes after ingestion of two bitter tastants: urea and quinine

Profiles are altered and the response is **molecule-specific**

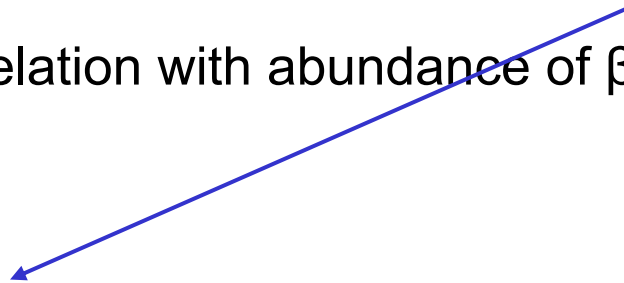
Quintana, Palicki, Lucchi, Ducoroy, Chambon, Salles & Morzel. 2009. Chemosensory Perception 3: 133-142.

Impact of diet transition on infants' saliva

duration of exposure to **solid foods**

Positive correlation with abundance of S-type cystatins

Positive correlation with abundance of β -2 Microglobulin



Inhibition of dietary cysteine proteases

Morzel, Palicki, Chabanet, Lucchi, Ducoroy, Chambon, Nicklaus. 2011. Archives of Oral Biology, 56: 634-642 .

Conclusions (1): saliva variability / stability

Infancy is a period during which salivary profiles are still evolving.
Childhood?

Once settled, **in adults**, profiles are extremely variable from one subject to the next, but relatively stable (circadian and seasonal variations) within the same subject: **biological signature**.

May the saliva composition affect taste sensitivity or taste acceptance?

Fat perception and fat liking in adults

Sensitivity to the **bitter taste of caffeine** in adults

Taste acceptance in infants

Fat perception / fat liking

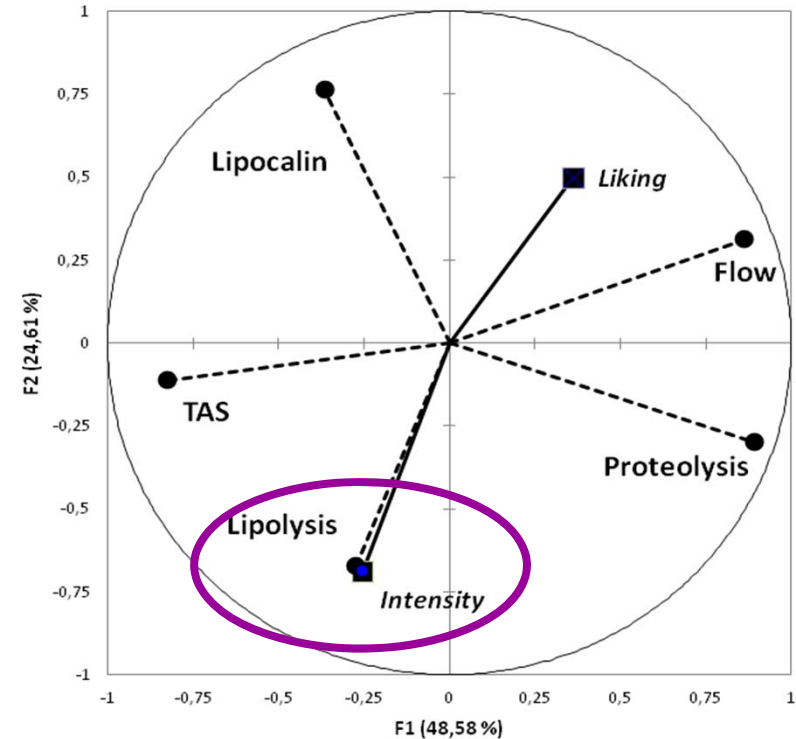
13 adults tasting an oil-in-water emulsion

fat intensity

fat liking

at-rest saliva characteristics

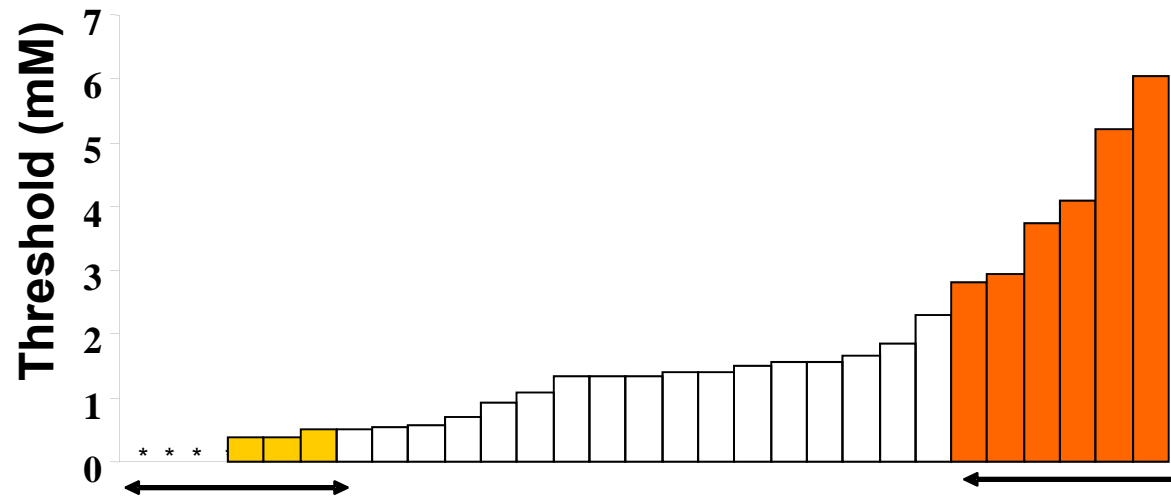
Correlation of data by PCA



Neyraud, Palicki, Scwhartz, Nicklaus, Feron. 2011. Archives of Oral Biology, in press.

Sensitivity to bitterness: sensory aspects

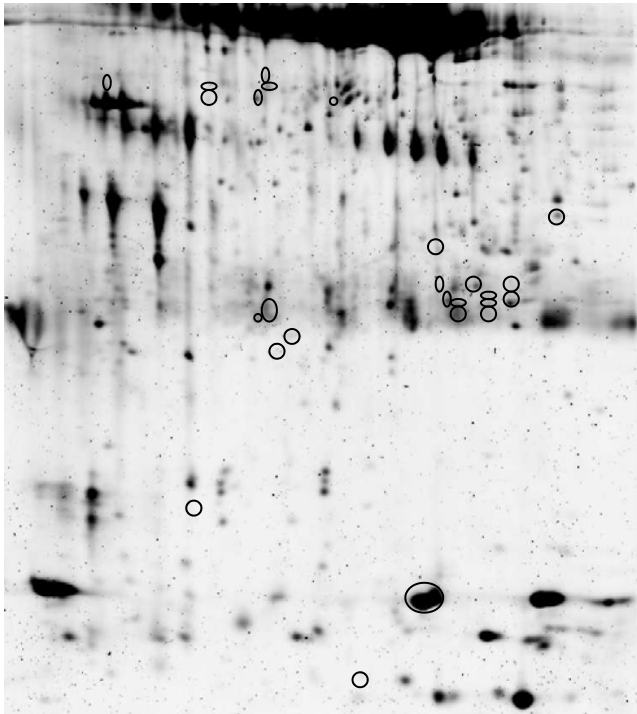
29 male healthy subjects. Detection threshold for the bitter taste of caffeine.



Dsamou, Palicki, Septier, Chabanet, Lucchi, Ducoroy, Chagnon, Morzel. 2011. Chemical Senses, in press.

Sensitivity to bitterness: 2D profiles

Differences of **protein 2D profiles** between subjects hyposensitive / hypersensitive to caffeine.



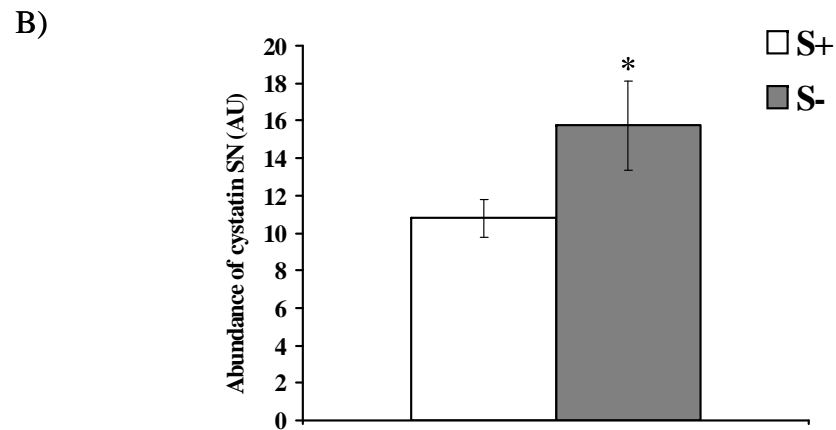
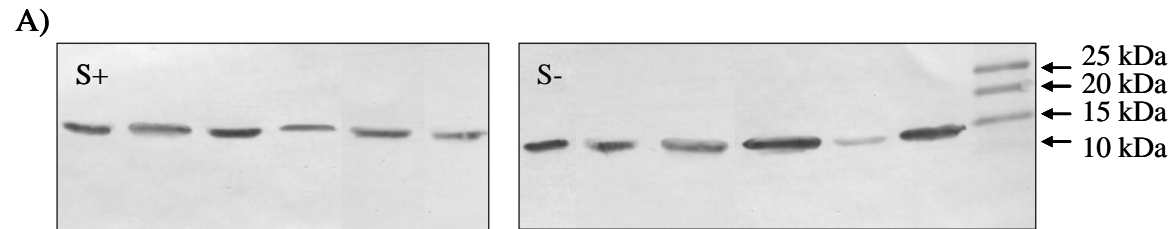
Hypersensitive subjects:

+ fragments (amylase, serum albumin)

– cystatin SN

Dsamou, Palicki, Septier, Chabanet, Lucchi, Ducoroy, Chagnon, Morzel. 2011. Chemical Senses, in press.

Sensitivity to bitterness: cystatin expression



Dsamou, Palicki, Septier, Chabanet, Lucchi, Ducoroy, Chagnon, Morzel. 2011. *Chemical Senses*, in press.

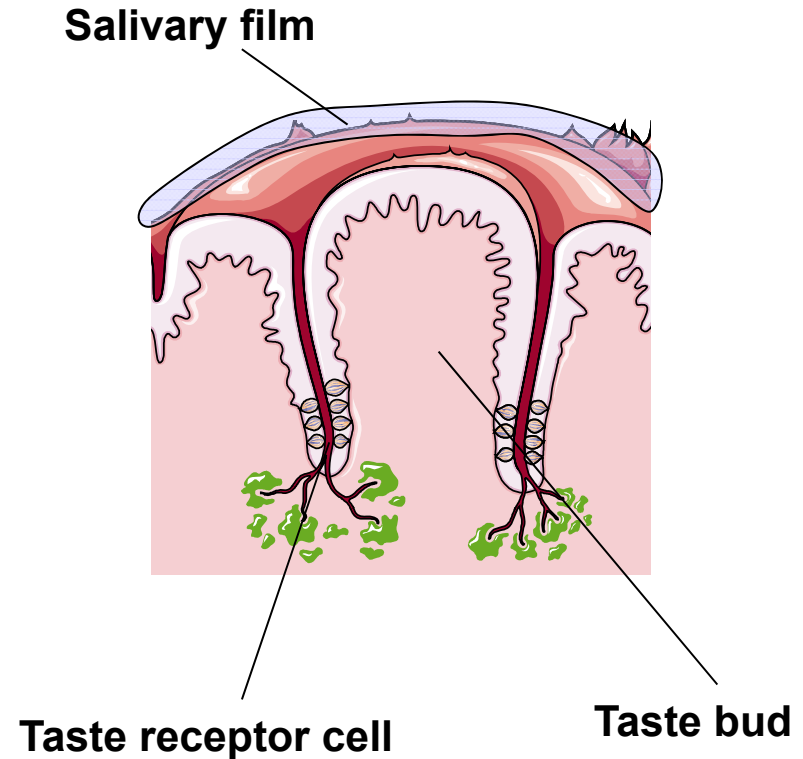
Sensitivity to bitterness: in-mouth proteolysis?

Hypersensitive subjects

Less protease inhibitors

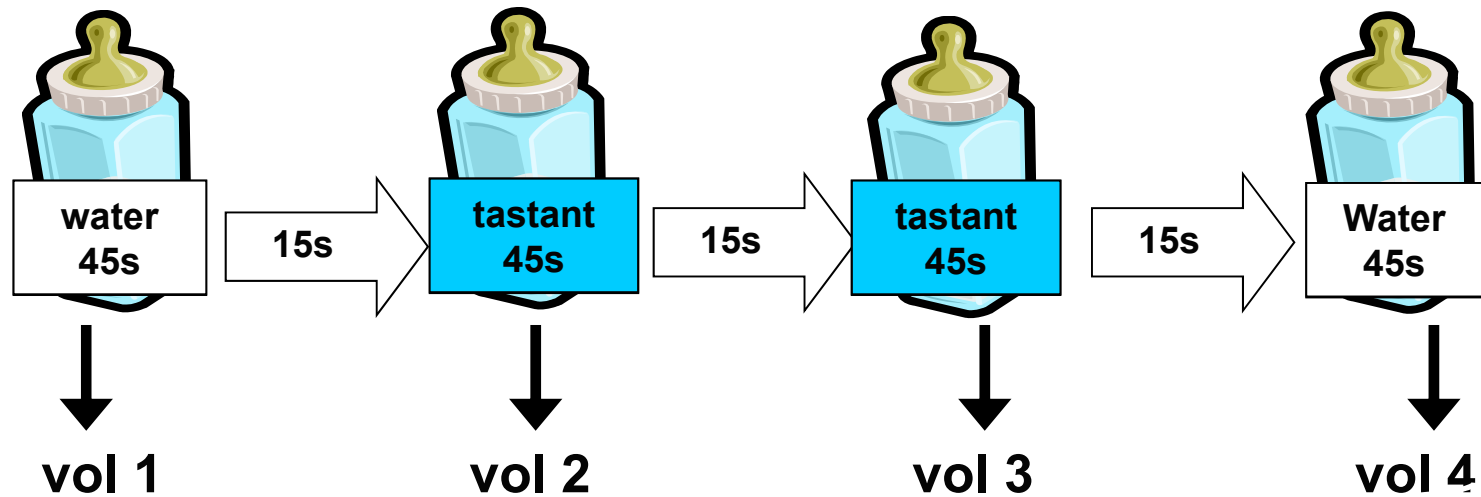
More fragments of the salivary film constituents

A thinner or looser salivary film:
facilitated interaction between caffeine molecules and TRCs



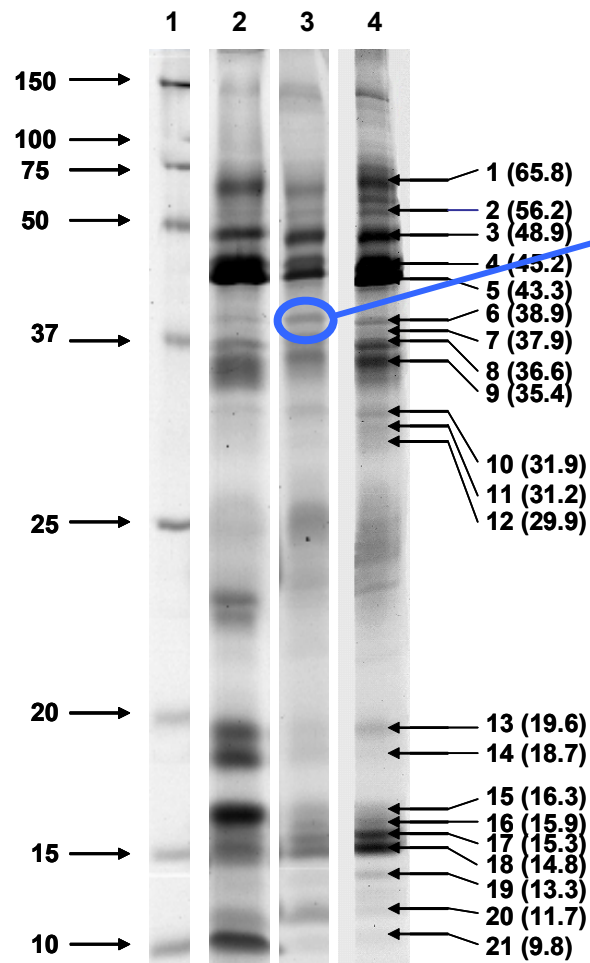
Dsamou, Palicki, Septier, Chabanet, Lucchi, Ducoroy, Chagnon, Morzel. 2011. Chemical Senses, in press.

Taste acceptance in infants (n=73)



$$\text{intake ratio} = (\text{vol2} + \text{vol3}) / (\text{vol1} + \text{vol2} + \text{vol3} + \text{vol4})$$

Salivary profiles



Semi-quantification

21 bands detected in at least half of the children

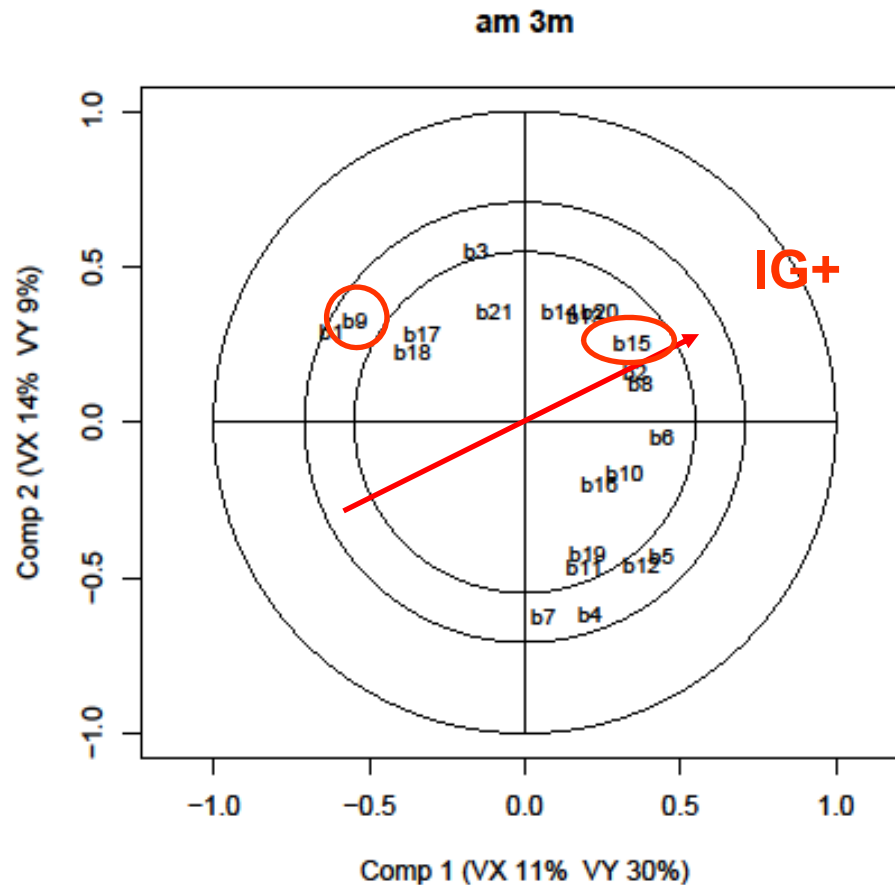
Salivary profiles / intake ratios

Multivariate statistical analysis (PLS): relative quantities of bands vs intake ratios. Crossed validation.

At 6 months, no statistical link between salivary profiles and taste acceptance.

At 3 months, **bitterness** stands out

Markers of bitterness acceptance



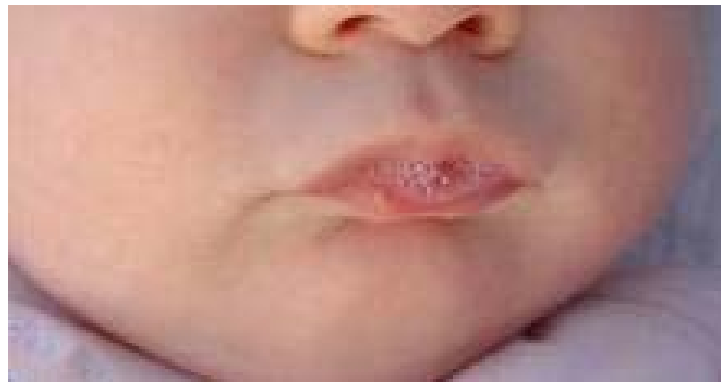
Infants who accept bitterness have higher proportions of S-type cystatins (band 15)

Infants who reject bitterness have higher proportions of band 9 (containing CA6)

Conclusions (2): saliva and taste

Taste perception does not depend only on genetic variability of taste receptors!

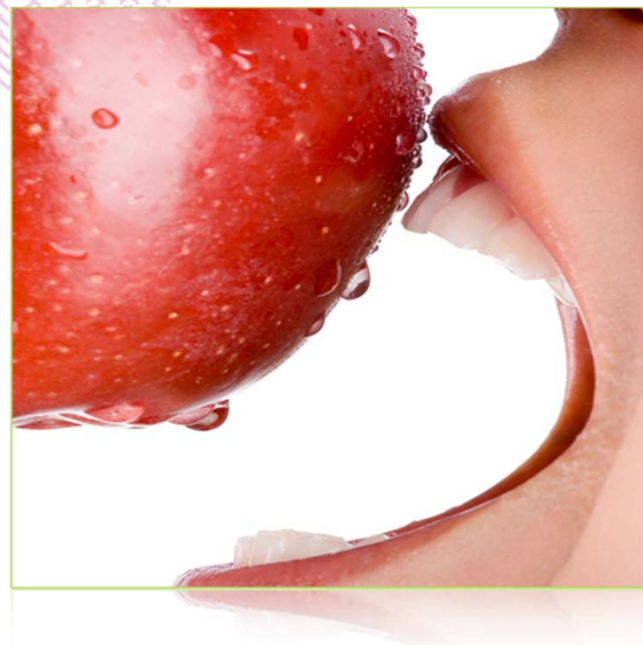
Saliva is probably an important peri-receptor factor conditioning in part the way we perceive and appreciate the taste of food.





Thank you for your kind attention

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Chemical Sciences



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Beaune 1st – 5th July 2012

<https://colloque.inra.fr/fop>

ICAAM – 03/11/11

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