Gustotopic Mapping in the Human Brain

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Introduction

Goal: To characterise the behavioural and cortical response to tastants using functional MRI (fMRI).

•There are 5 purported tastants - salty, sweet, sour, bitter and umami - as well as 'fatty acid' [1] and 'metallic' [2].

•Animal data has recently shown a gustotopic map tuned to bitter, sweet, umami and salty tastes [3].

•Behavioural studies show some individuals experience a phantom taste when the tongue is thermally stimulated [4], called thermal tasters.

•We aim to form a gustotopic map in the human brain using high spatial resolution fMRI at 7 Tesla, and investigate the cortical response to phantom taste across individuals.

Objectives

- To identify a **gustotopic map** in the human brain for prototypical and purported tastes.
- To investigate the effect of **PROP** and **thermal taste** phenotype, and **gustin** genotype on the cortical response to tastants.
- To study how **phantom taste** modulates the primary gustatory cortex and whether this maps to the gustotopic map.
- To determine the cortical response to **increasing concentration** of tastants.
- To identify how **intramodal** combinations of tastants modulate cortical activity.

Behavioural Measures

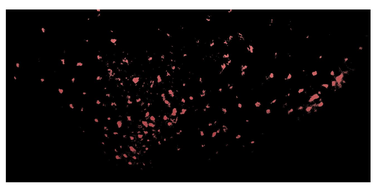
- **PROP and Gustin**

  1 buccal swab to be collected per subject:
  - PROP, polymorphism of the TAS2R38 receptor
  - Gustin, polymorphism in gustin gene at rs2884333

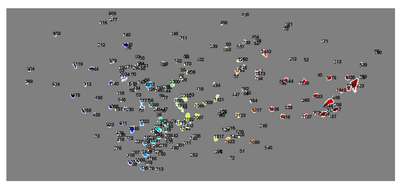
- **Papillae Count**

  High resolution tongue images collected for each subject:
  - Images segmented into regions of interest using Matlab.
  - Number and area of each fungiform papillae calculated.

High resolution image



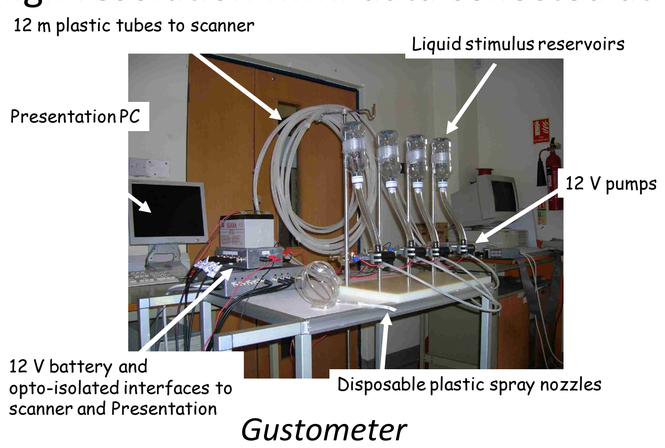
Papillae segmented



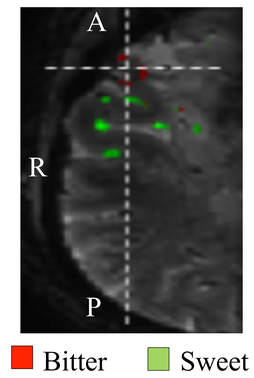
Area of each papillae

Gustotopic Mapping

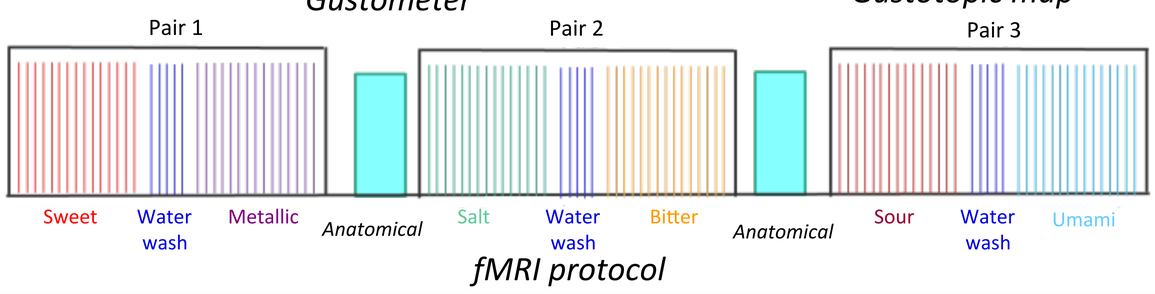
- Tastants delivered using an automated delivery system
- High resolution fMRI data collected at 7T



Gustometer



Gustotopic map

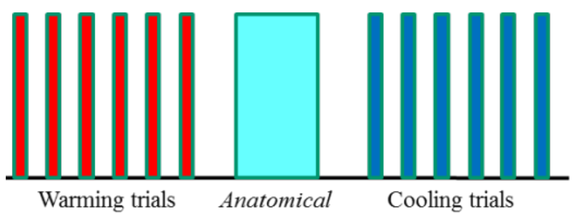


fMRI protocol

Phantom Taste

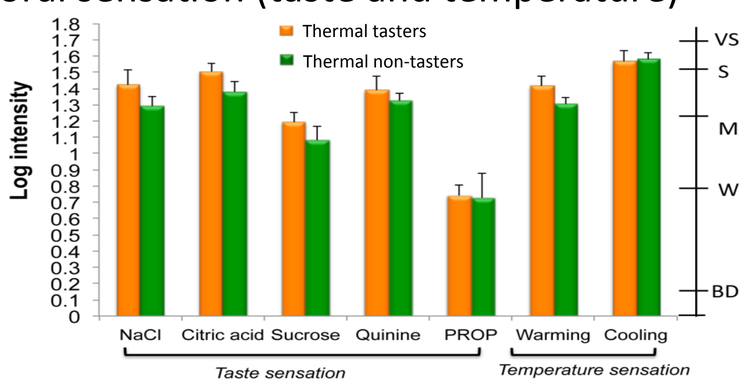
•Subjects scanned during a block paradigm in which thermode probe is placed on the tip of the tongue.

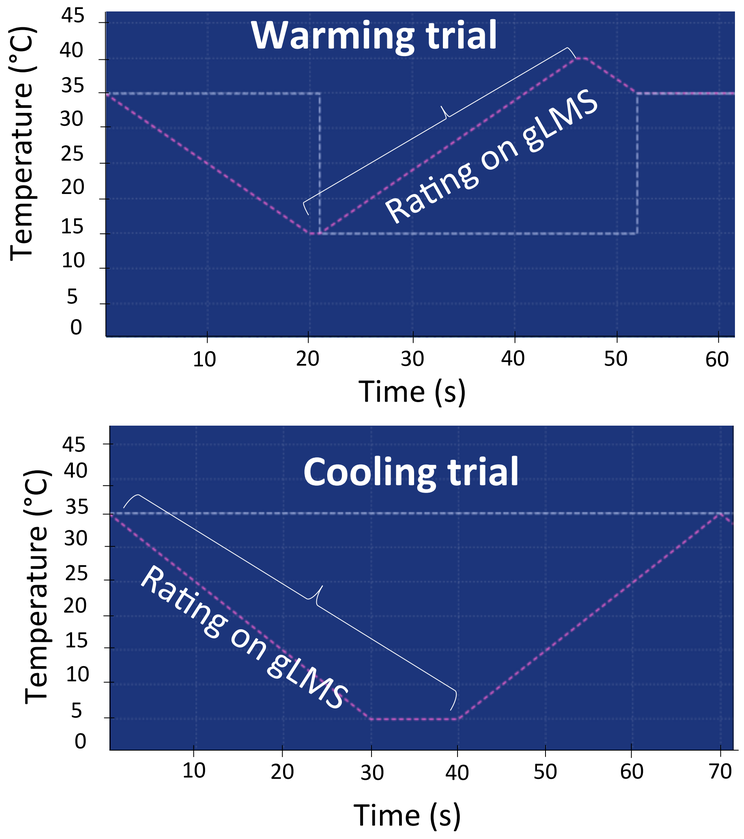
- Warming trial: from 15°C to 40°C
- Cooling trial: from 35°C to 5°C



fMRI protocol

- If a taste perceived, subjects asked to rate its intensity for each trial on a general Labelled Magnitude Scale (gLMS).
- Behaviourally thermal tasters are more sensitive to oral sensation (taste and temperature)





Warming and cooling trials

gLMS

Medoc Pathway device used for thermal taster screening, and intra-oral ATS (advanced thermal stimulator) thermode probe applied to the tongue.

Project

- BBSRC IPA 3 year project grant
- Multidisciplinary project led between SPMIC and Sensory Science.
- Project commenced in March 2014.

References

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