Impact of Thermal Taster Status on Cortical Response to Flavour and Temperature Stimuli

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Introduction: Thermal stimulation to the tongue has been shown to elicit a phantom taste in some individuals, termed thermal tasters (TTs) [1]. Behavioural studies have found TTs to be more sensitive to taste compounds, warming temperature and vanillin compared to thermal non-tasters (TnTs). Here, we compare the cortical response of TTs and TnTs to taste stimuli at both cold and ambient temperatures, and to aroma and flavour (taste/aroma) stimuli at ambient temperature.

Methods:

• ***Participants:*** 24 subjects (11 male) took part in the study, 12 TTs and 12 TnTs, all of whom were PROP tasters.

• ***Thermal Taster Status:*** Assessed using an intra-oral thermode (Medoc PATHWAY) applied to the anterior tongue tip. Warming and cooling trials were carried out in duplicate [1,2] (see Poster #1623).

- ***Samples and Protocol:*** In an fMRI cycle (Fig. 1), 3 ml of 4 samples were delivered in a random order over a 3 s period. **Sample A:** taste stimulus cold (5° C); **Sample B:** as **A** but at ambient temperature; **Sample C:** aroma sample at ambient temperature; **Sample D:** flavour sample at ambient temperature.

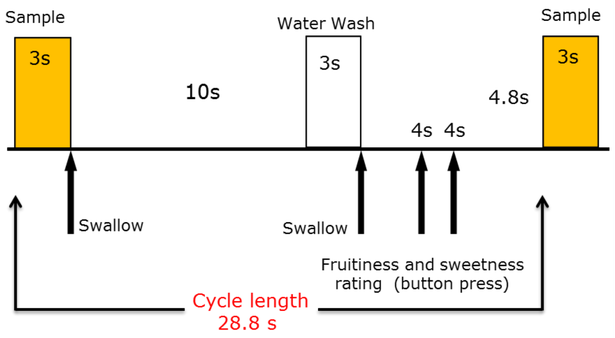


Fig.1: fMRI Protocol

• ***Data Acquisition and Analysis:***

• fMRI data was acquired on a Philips 3T Achieva scanner using 36 transverse dual-echo GE-EPI images (TE 20/45ms, SENSE 2, 3x3x3 mm^3, TR 2.5 s).

• fMRI data were slice timing corrected and realigned (SPM5). A weighted summation of the dual-echo fMRI data was performed and then normalised to MNI space, spatially and temporally filtered.

• GLM formed for each subject to identify cortical activation to each stimulus. Group analysis (RFX) and ROI analysis of parameter estimate (β-values) based on *a priori* areas of taste, aroma and flavour were performed for each sample.

• A two-sample t-test was carried out between the TTs and TnTs groups for each sample to determine any significant difference in BOLD response. Paired t-tests were carried out within groups to determine which samples significantly differed in their activation.

Results: TTs rated sweetness and fruitiness of the samples significantly higher than TnTs (Fig 2).

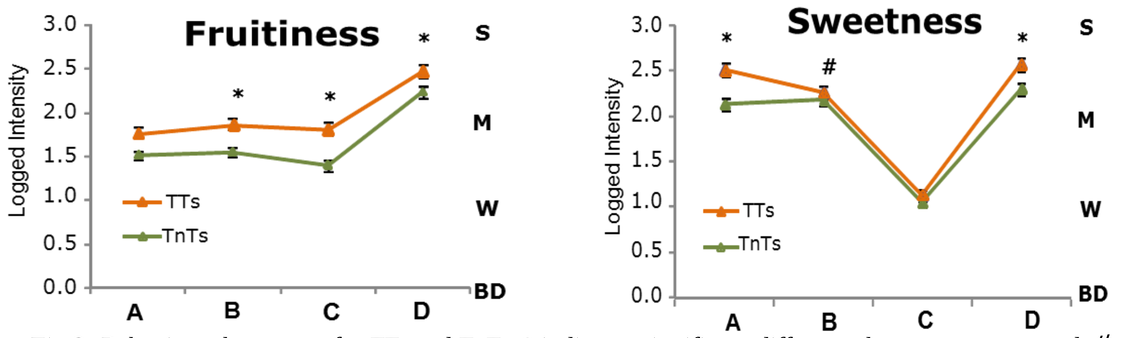


*Fig.2: Behavioural response for TTs and TnTs. * indicates significant difference between groups and # indicates significant difference between sample A and B, p<0.05.*

Activation maps for TTs and TnTs to all samples revealed a large network of brain areas in response. TT group showed significantly greater cortical activation in oral somatosensory areas of SI, SII and mid-insula (Fig. 3).

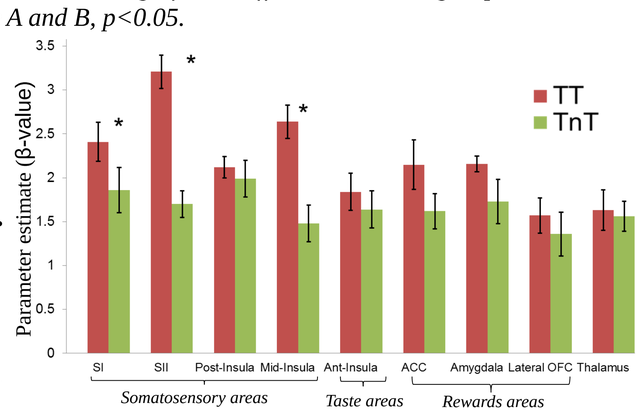
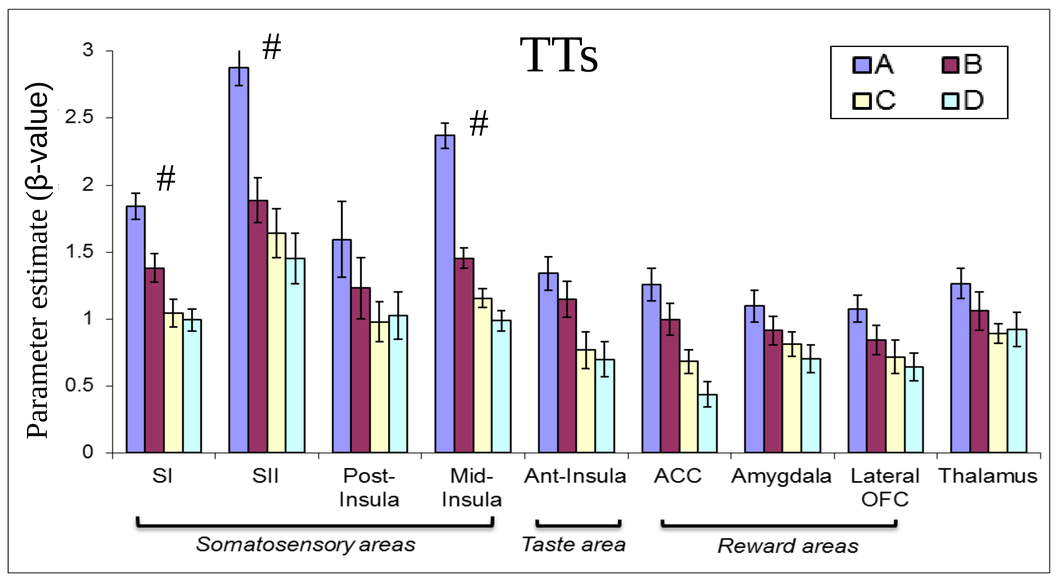


*Fig.3: ROI analysis for TT and TnT group to all samples A-D, * indicates significant difference.*

- For both groups there is a trend for an increase in BOLD response to the cold taste **Sample (A)** compared to the ambient temperature **Sample (B)** in all areas. In addition to a heightened response for **Sample B** compared to **Sample C** with the lowest response to the ambient flavour sample **(Sample D)**, Fig 4 a.

(a)



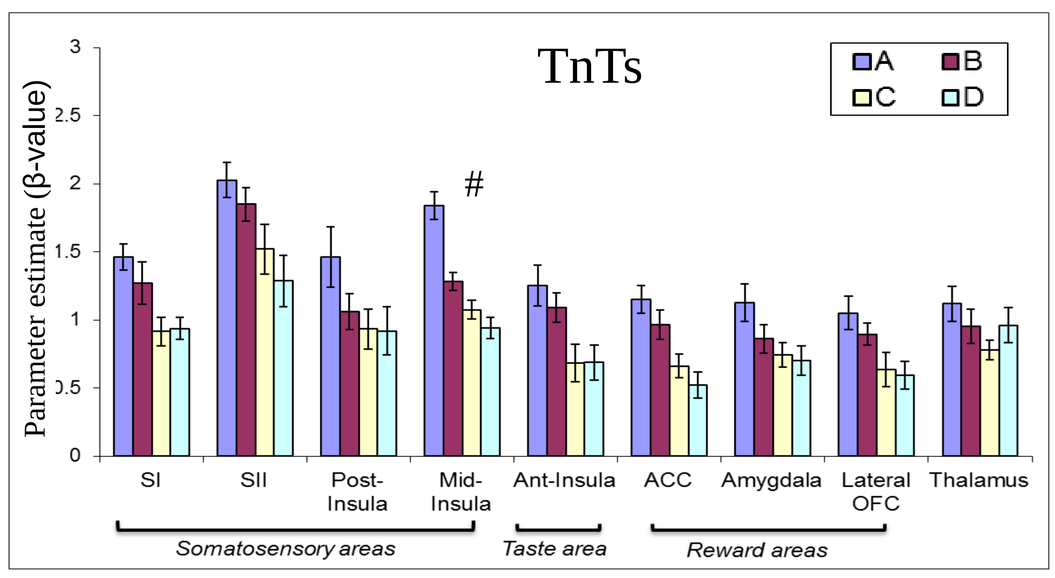


Fig. 4 a: Beta values for samples (A, B, C and D) for the TTs and TnTs group. # indicates significant difference between sample A and B, p<0.05.

- Comparison of the cortical response to **Sample A>Sample B** revealed that both the TT and TnT group showed an increasing BOLD response to the cold sample (Fig.4a), with this increase being heightened in oral somatosensory areas for the TT group, Fig. 4.

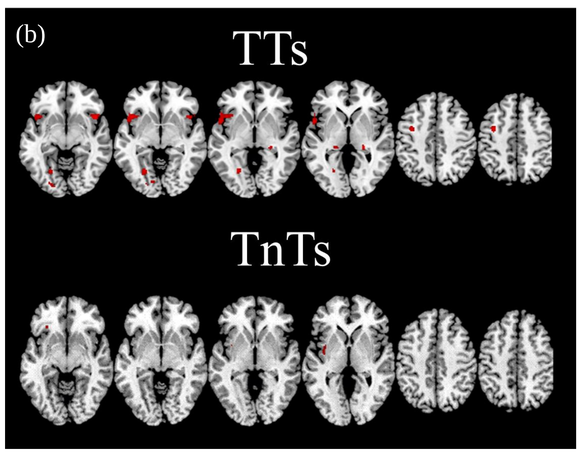


Fig. 4 b: RFX differential maps for the TTs and TnTs group in response to sample A > B (P<0.005 uncorrected).

Discussion:

- The TT group rated the sweetness of cold taste sample higher than for the TnT group, and this probably due to crossmodal interaction.
- The increase in cortical response to the cold compared to ambient sample may be due the increase in sensory response to the cold stimulus.
- The heightened response to the cold sample and perceived sweetness in the TT compared to TnT group can be hypothesized to result from an interaction between taste and trigeminal response in thermal tasters.

References

[1] Cruz, A. and Green, B. G. Nature, 403 (6772): 889-892, 2000.

[2] Bajec, M. R. and Pickering, G. J. Physiology & Behavior, 95 (4), 581:590, 2008.

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