

Greater temperature related brain activity in thermal tasters than thermal non tasters

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Introduction: Thermal tasters (TTs) are defined as those individuals who experience a 'phantom' taste when the tongue is thermally stimulated using a temperature thermode, while thermal non-tasters (TnTs) only perceive the temperature change^[1]. The mechanism behind this phenomenon is not yet understood. TTs report perceiving most orosensory stimuli, including temperature, as more intense than TnTs^[2, 3]. Recent functional MRI (fMRI) studies have shown a heightened cortical response to trigeminal stimuli in TTs compared to TnTs^[4, 5].

Aim: To use functional MRI to perform the first study to map brain activity to the perception of temperature in thermal tasters.

Methods:

Participants: 24 subjects (6 male) were screened for thermal taste and took part in the study, 12 were classified as TTs and 12 TnTs.

Thermal Taster Status: was tested using an intra-oral thermode (Medoc PATHWAY) to deliver warming and cooling thermal stimulation to the anterior tongue tip, Fig.1.

- Subjects reported if they perceived a 'phantom' oral sensation (sweet/salty/bitter/sour/umami/other) or temperature alone^[1].
- Subjects reporting 'phantom' oral sensation were classified as TTs, and those only perceiving temperature TnTs.
- All subjects rated the intensity of the temperature (warm/cool) when it reached its maximum.

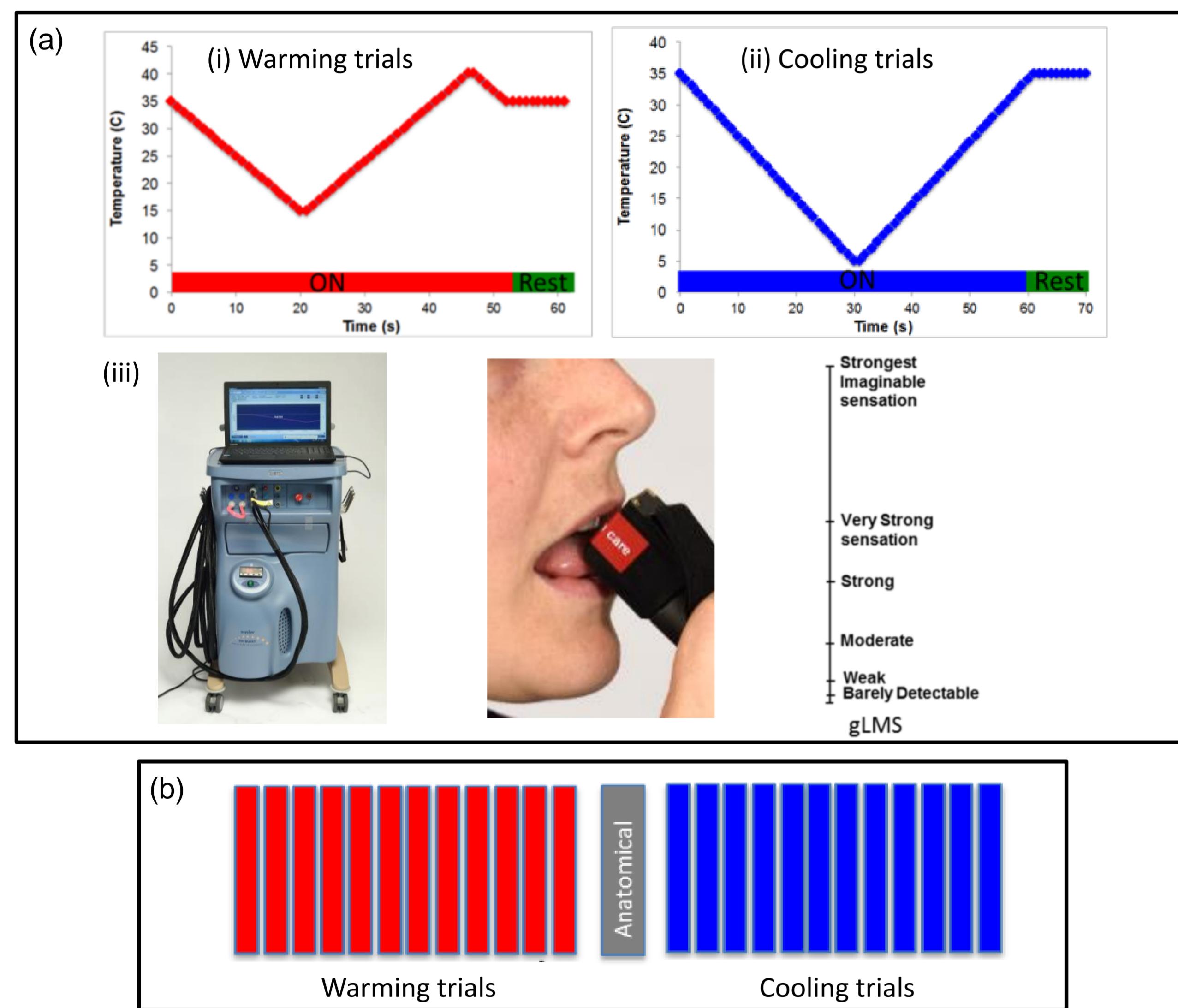


Fig.1: a) Thermal taster screening protocol, (i) warming trial, (ii) cooling trial, (iii) Thermode probe applied to the anterior tongue tip, and gLMS used to rate the temperature intensity. b) fMRI Protocol: Block paradigm of 10 repetitions of warming and cooling trials. A 5 minute break between blocks allowed the tongue to recover.

fMRI Paradigm:

All subjects tongues were thermally stimulated during blocks of 10 repetitions of both warming and cooling trials designed for fMRI compatibility, Fig.1.

fMRI 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 mm³, TR 2.5 s).
- The dual-echo fMRI data was combined using a weighted summation, slice timing corrected, realigned, normalised to MNI space, spatially smoothed, and temporally filtered (SPM12).
- A GLM was formed to identify cortical activation to both warming and cooling stimulation using a random effects group analysis.
- Warming and cooling maps were compared between TTs and TnTs.

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Perceptual Results:

TTs reported perceiving temperature more intensely than TnTs, although this did not reach significance ($p > 0.05$), Fig. 2. The intensity of cooling was perceived to be more intense than warming.

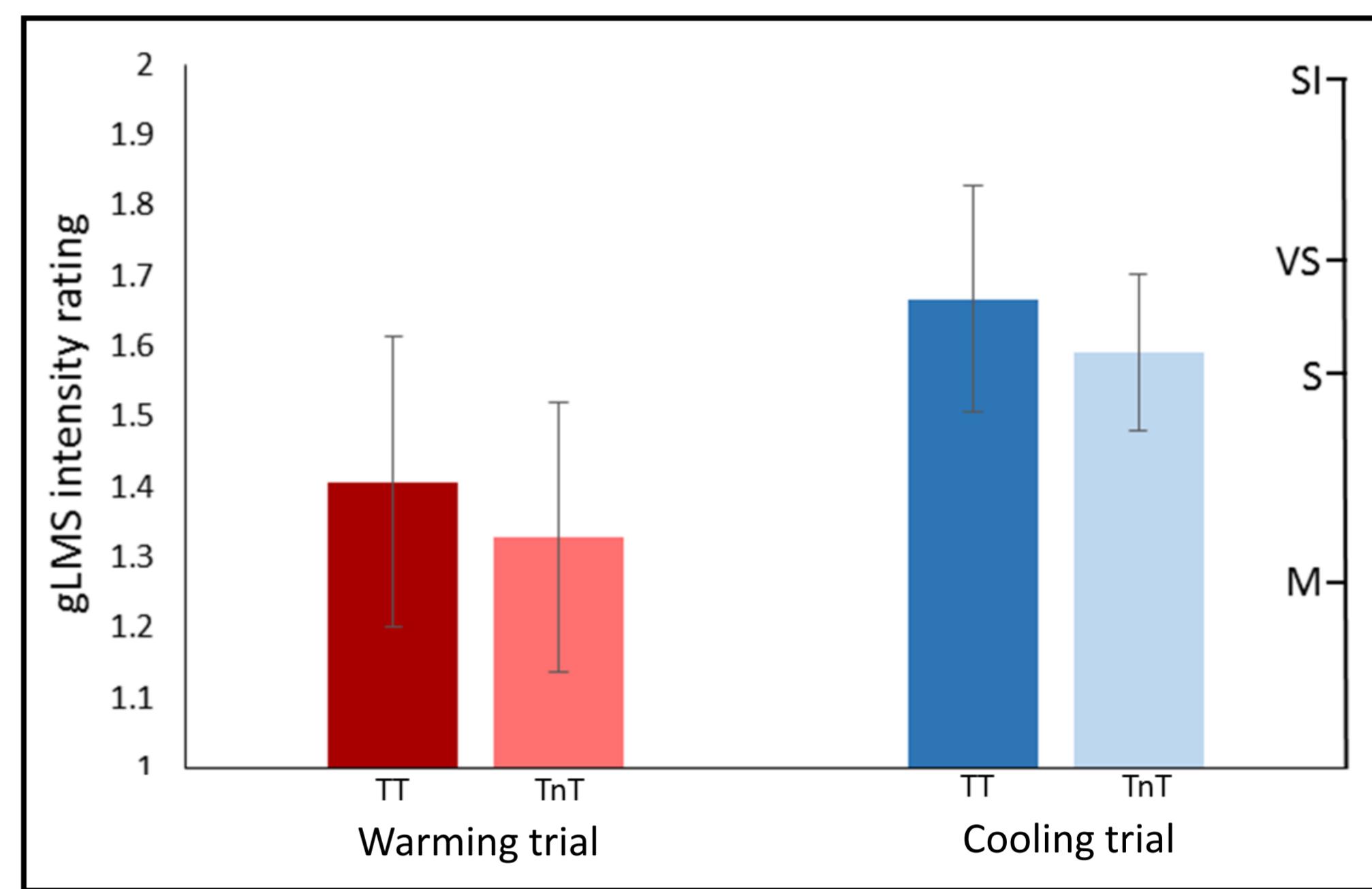


Fig. 2: Temperature perception in TTs and TnTs. Bars represent log mean intensity +/- 1 SD as rated on gLMS (M – moderate, S – strong, VS – very strong, SI – strongest imaginable sensation).

fMRI Results:

Functional MRI maps showed greater temperature related brain activation in TTs compared to TnTs, for example in somatosensory areas. A greater difference between TTs and TnT was found for cooling trials. Fig. 3.

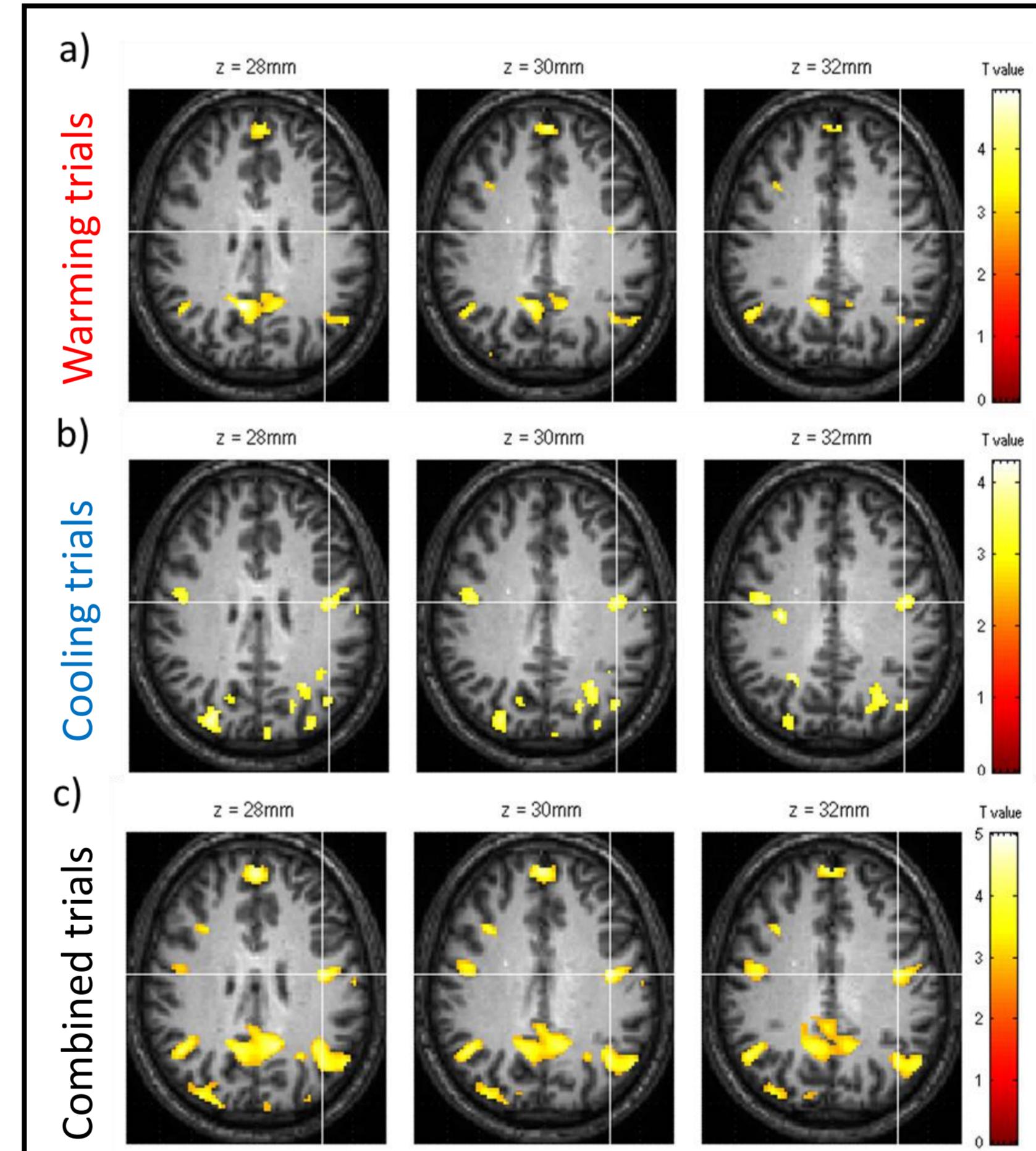


Fig. 3: Differential TTs>TnTs group activation maps for a) warming, b) cooling, c) combined warming and cooling trials. Maps overlaid on T₁ images and threshold at FDR corrected P < 0.05.

Discussion:

- We demonstrate greater temperature related brain activation is observed in TTs compared to TnTs when the anterior tip of the tongue is thermally stimulated with warming and cooling trials.
- TTs consistently report perceiving most orosensory stimuli, including temperature, as more intense than TnTs^[2, 3].
- Recent fMRI studies have shown a heightened cortical response to trigeminal stimuli in TTs when compared with TnTs^[4, 5]. This work supports these findings which suggest TTs have an increased sensitivity to orosensory stimuli such as temperature.

References:

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