

# Sensory-modality independent activation of the brain network for language

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## Introduction

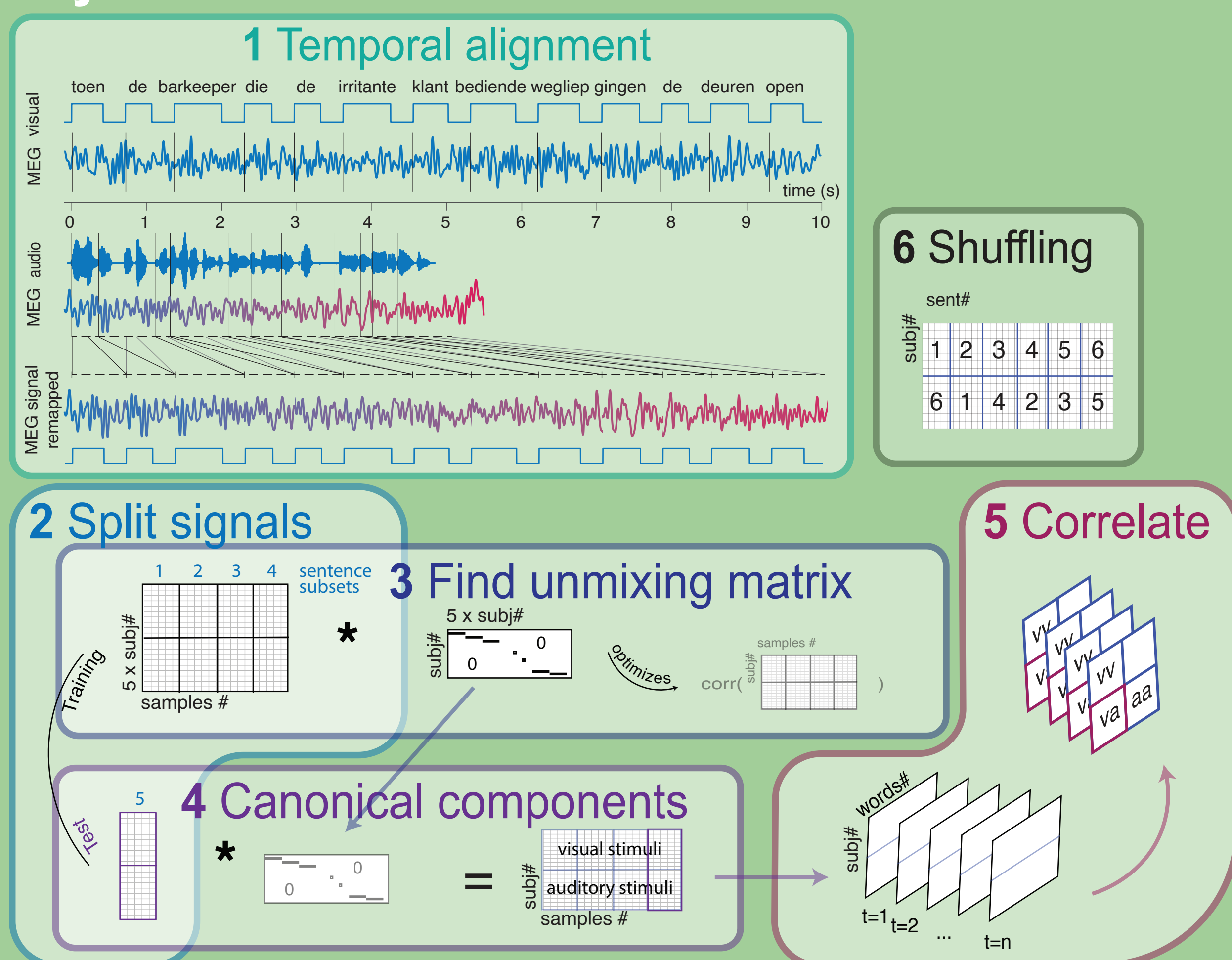
The sensory modality of language stimuli determines the dominant spatiotemporal patterns of the neural response.

This makes it hard to quantitatively compare signals across input modalities, and to relate them in terms of supramodal brain activation, i.e. purely reflecting neural computations specific for language processing.

## Design

Native Dutch speakers (n=204, 102 males) either read or listened to 120 sentences, while MEG was recorded. The data used here are part of a publicly available large scale dataset<sup>1</sup>, used in prior work<sup>2-4</sup>.

## Analysis



Parcellation-based source reconstruction (lcmv) of per sentence time courses of neural activation:

- 386 parcels based on subdivision of Conte69atlas.
- 5 dimensional signal per parcel.

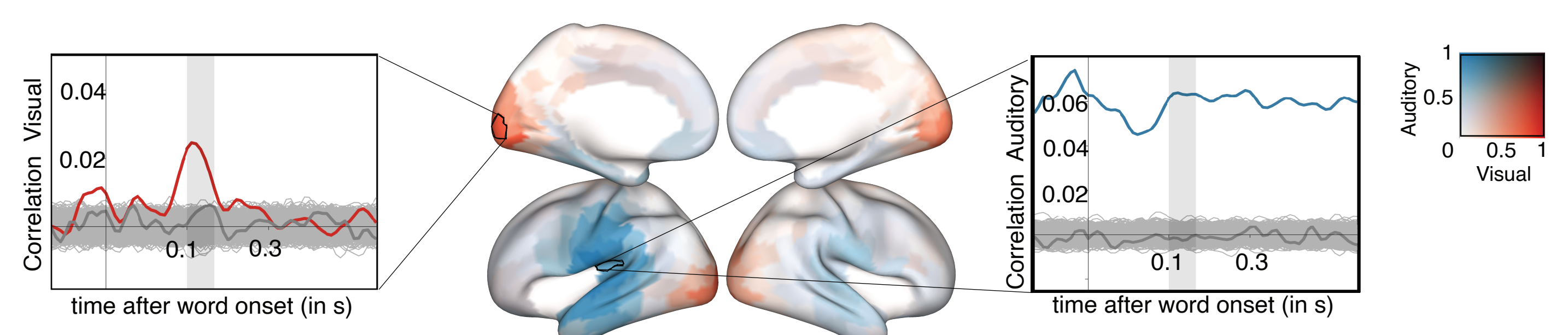
- (1) Alignment of word onsets between auditory and visual subjects
- (2-4) Parcel-wise multiset canonical correlation analysis<sup>5</sup> (MCCA) with 5-fold cross-validation to avoid overfitting.
- (5) Time-resolved correlation across words between pairs of subjects. Average across subject pairings that listened to/read the sentences quantifies supramodal activation.

## References

1. Schoffelen JM et al. Scientific data 2019, 6(1), 17.
2. Schoffelen JM et al. Proc Natl Acad Sci USA. 2017 Jul 25;114(30):8083-8088.
3. Lam NHL et al.. Neuroimage. 2016 Nov 15;142:43-54.
4. Lam NHL et al.. Language, cognition and neuroscience 2018 Jan; 33(8):943-954.
5. Kettenring JR, Biometrika 1971 Dec; 58(3):433-451

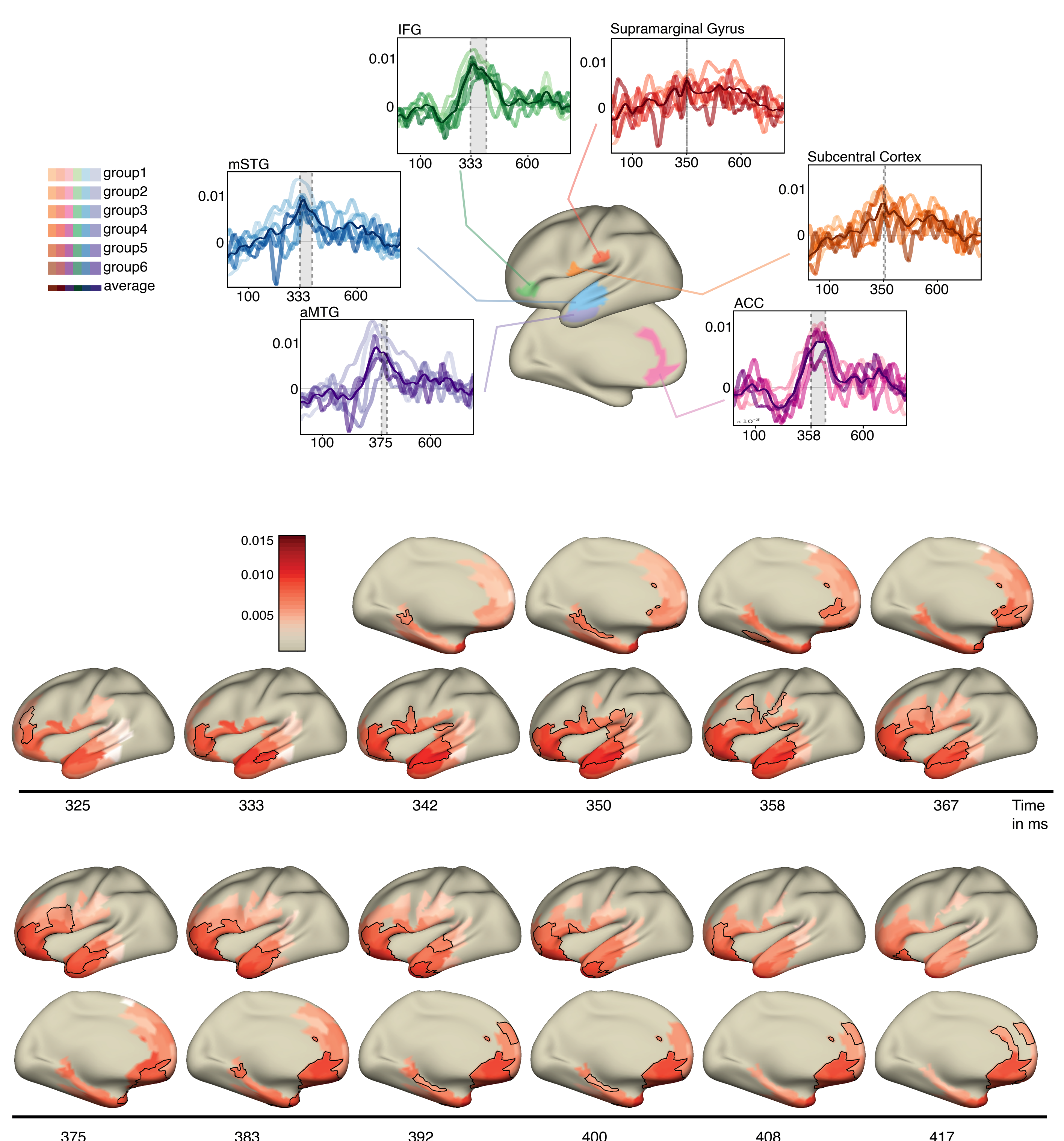
## Results I: Modality-specific activation

Early sensory cortical areas show correlated activity between those subjects receiving stimulation in the corresponding sensory modality, but only after boosting common signal aspects using MCCA.



## Results II: Supramodal correlation

Supramodal activation starts in middle temporal & dorsolateral frontal cortex and spreads towards the left anterior temporal lobe and left inferior frontal cortex.



## Conclusion

- Widespread left-lateralized brain network activated independent of modality when processing sentences.
- Includes domain general control areas and phonological mapping circuits next to traditional language areas in frontal and temporal-parietal cortex.
- MCCA makes it possible to investigate subtle word-in-context specific brain activation patterns through time-resolved inter-subject correlations.