Neurodynamics of expression coding in the core face network

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Does neural activity in fusiform code for facial expression information?

- Contradictory evidence and theories can be found in the literature about the coding in fusiform face area (FFA).

	Classical model (Haxby et al., 2000)	**Recent proposed model (Duchaine & Yovel, 2015)**
FFA coding	invariant aspect of faces	general structural and shape information of faces
FFA contributes to expression recognition	No	Yes
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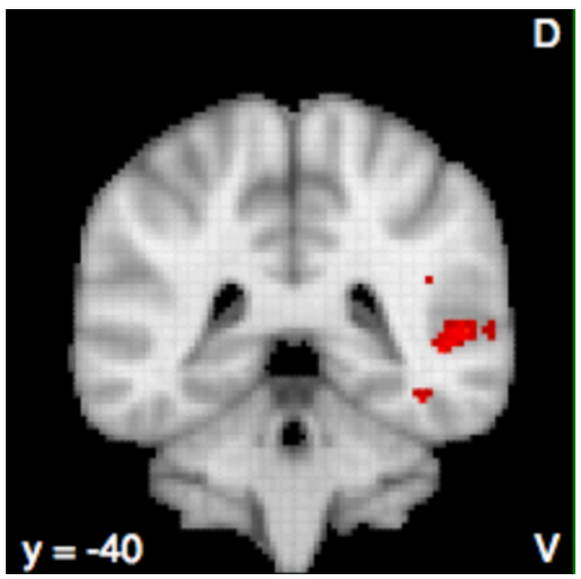

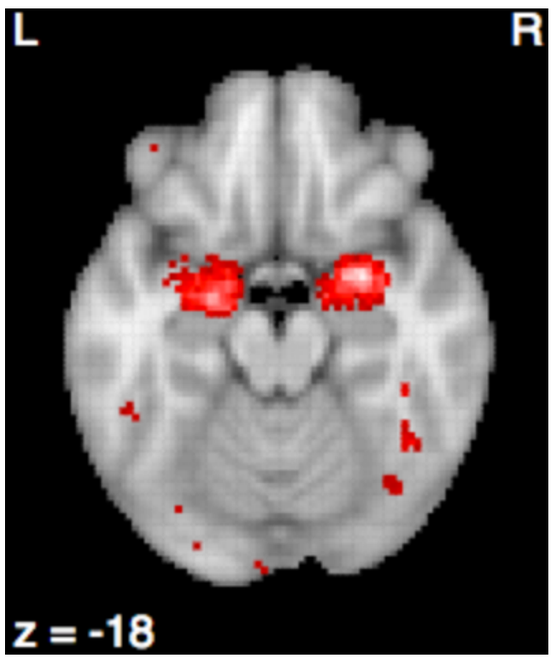

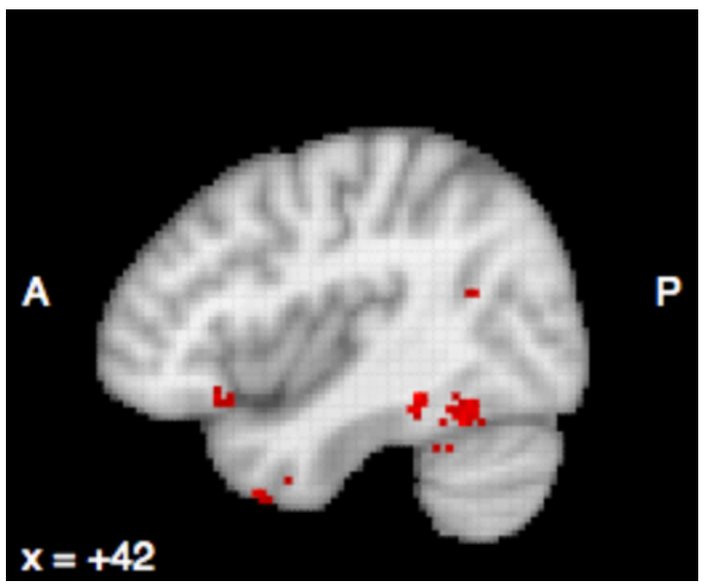

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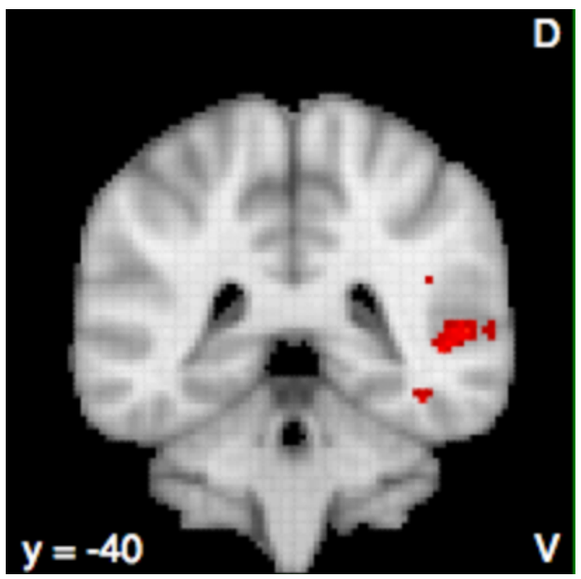

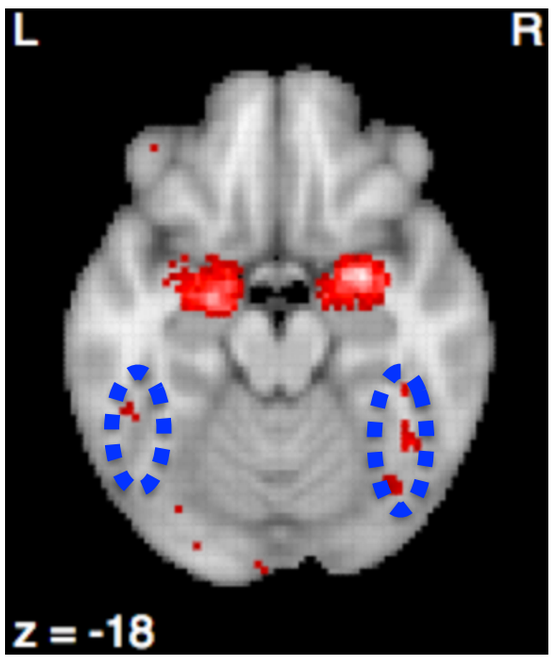

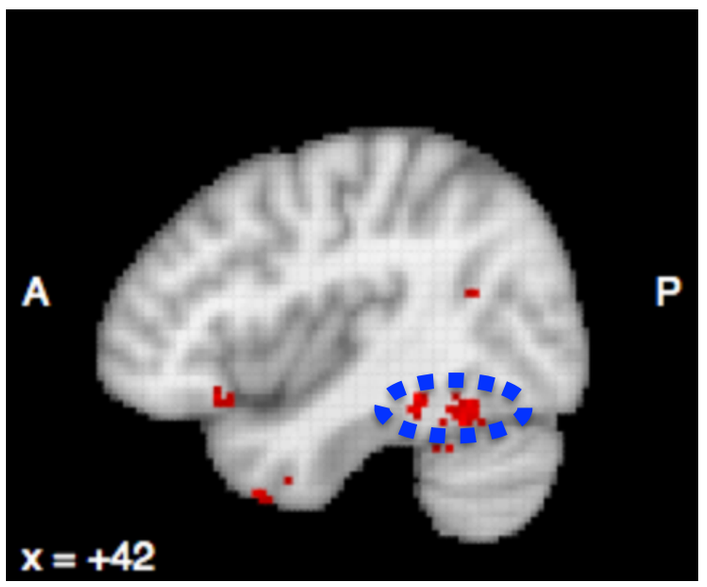

Research questions

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intracranial EEG:

- 19 subjects, 29 electrodes directly recording from the human fusiform
- Sensitive multivariate classification approach

Methods: intracranial EEG

- 19 human epileptic patients
- 29 fusiform electrodes selected
  - anatomical: electrode located in fusiform area
  - functional: face sensitivity over other categories in event-related potential (ERP) and broadband activity (BB)

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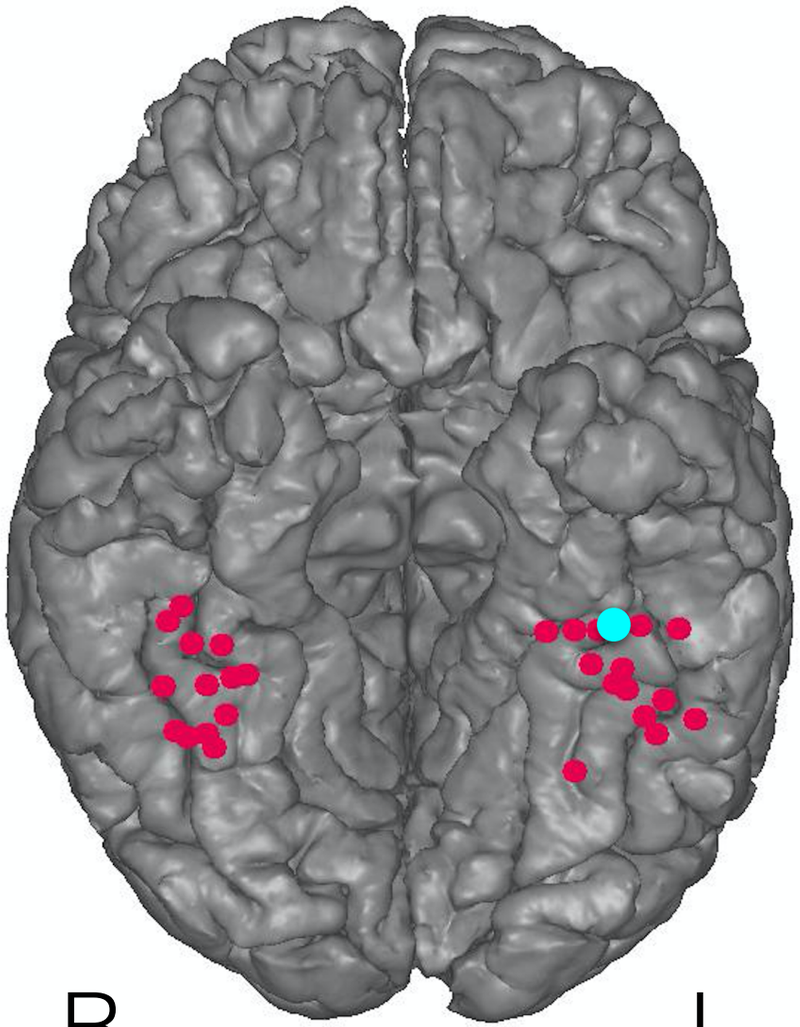
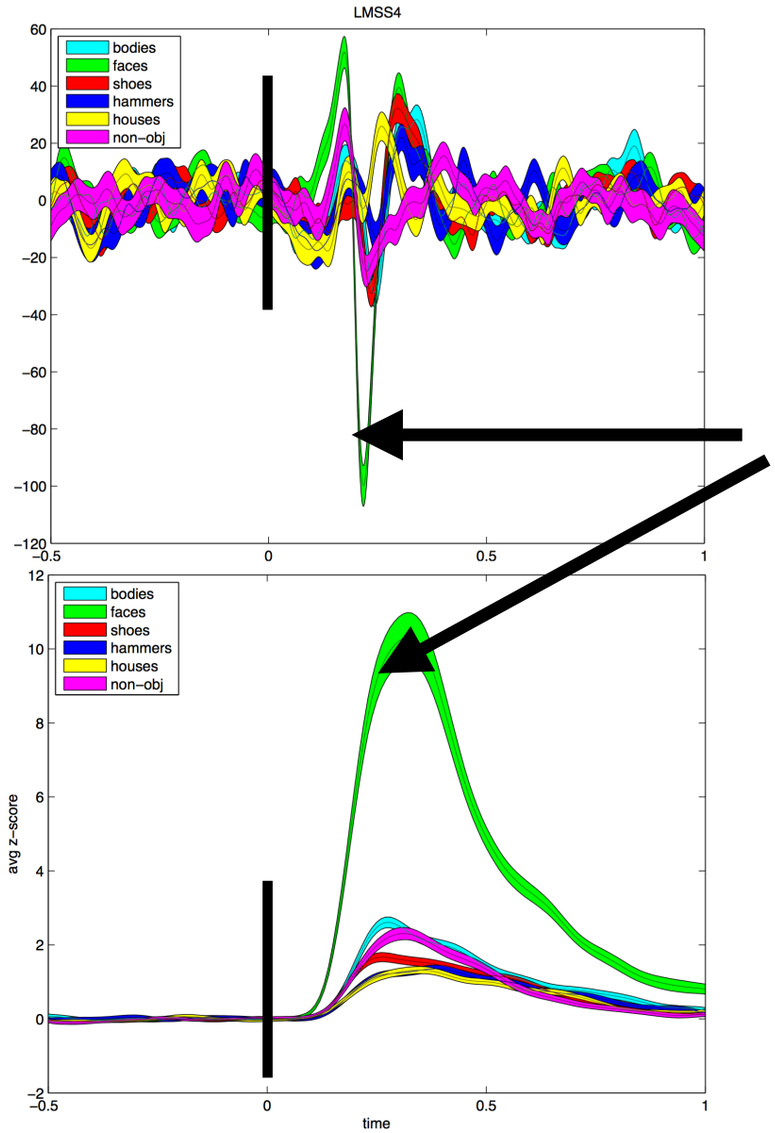


ERP

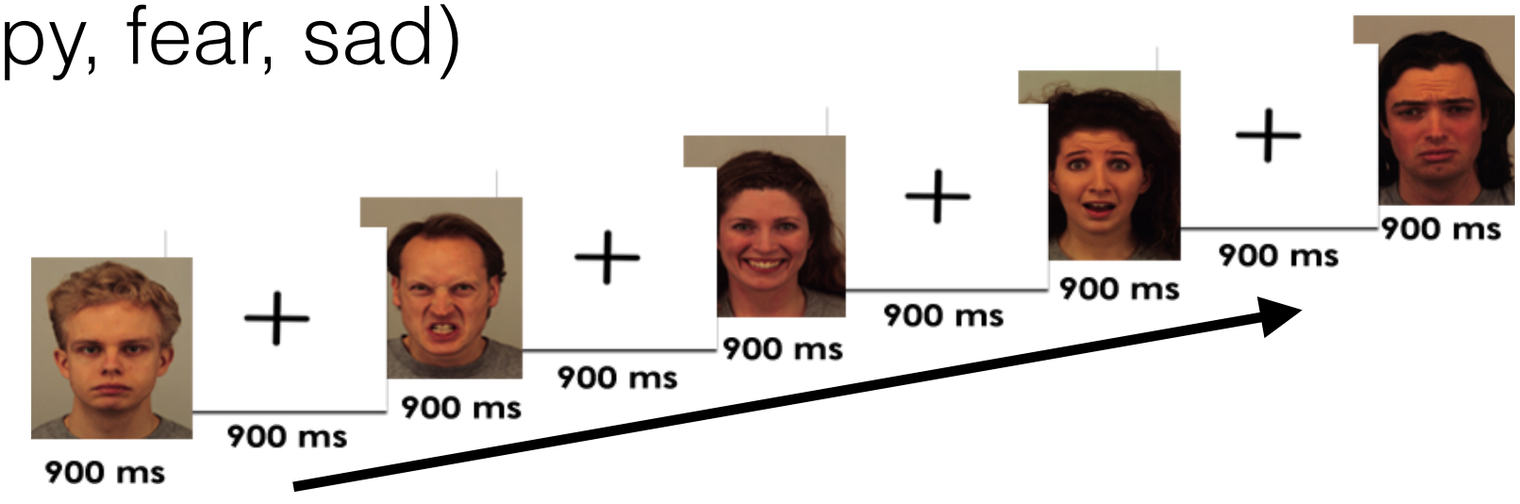
BB



~200 ms after stim onset

Methods:

- Cognitive task: gender discriminant
  - 40 individuals (20 male), 5 expressions (neutral, angry, happy, fear, sad)



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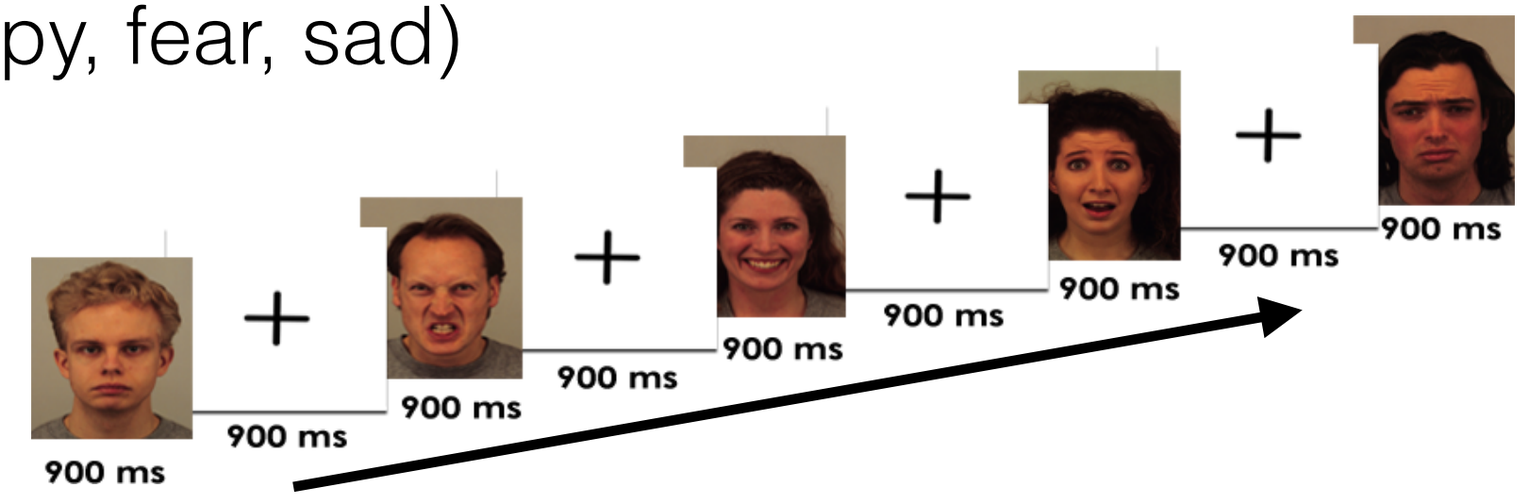
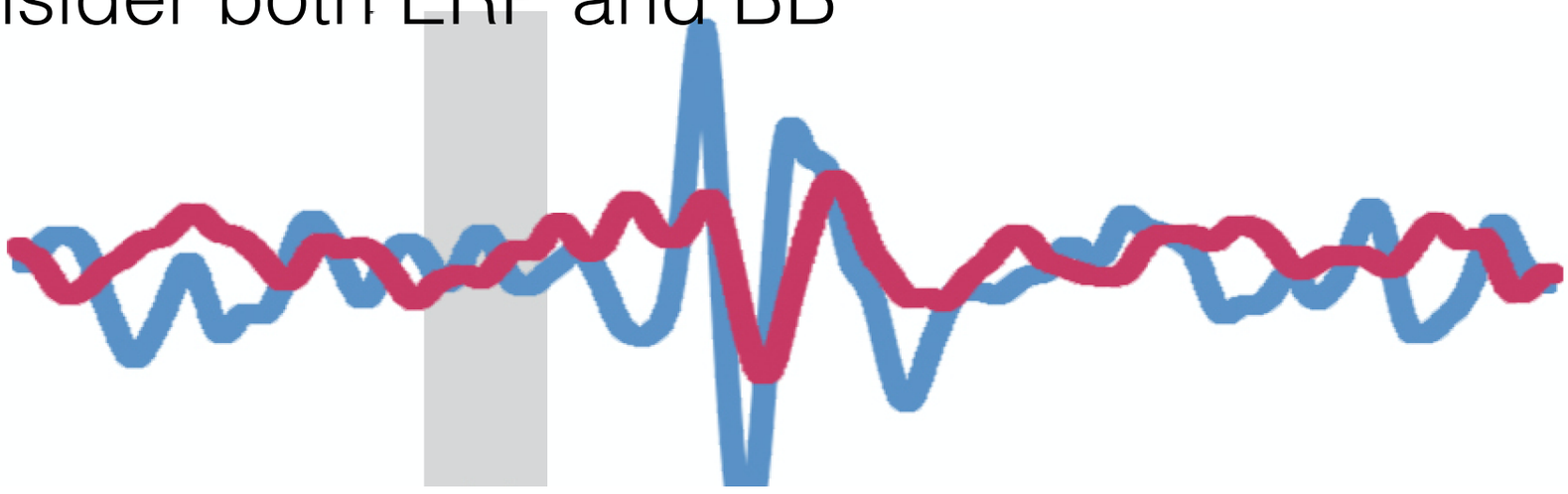
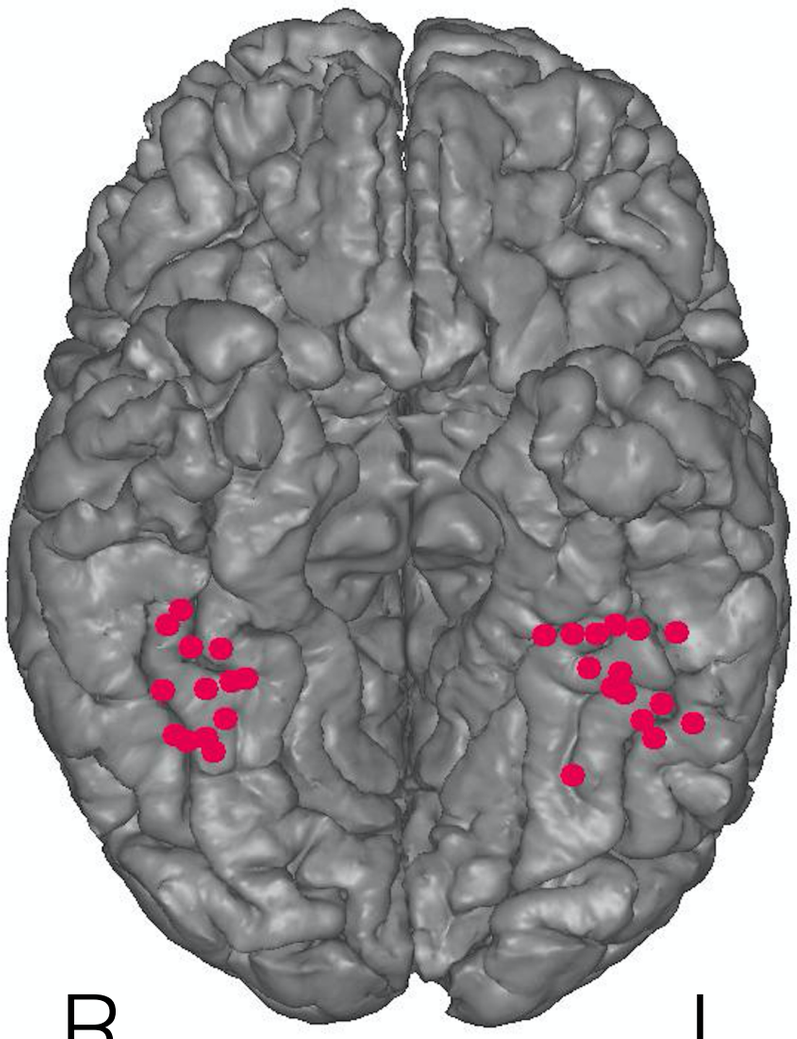


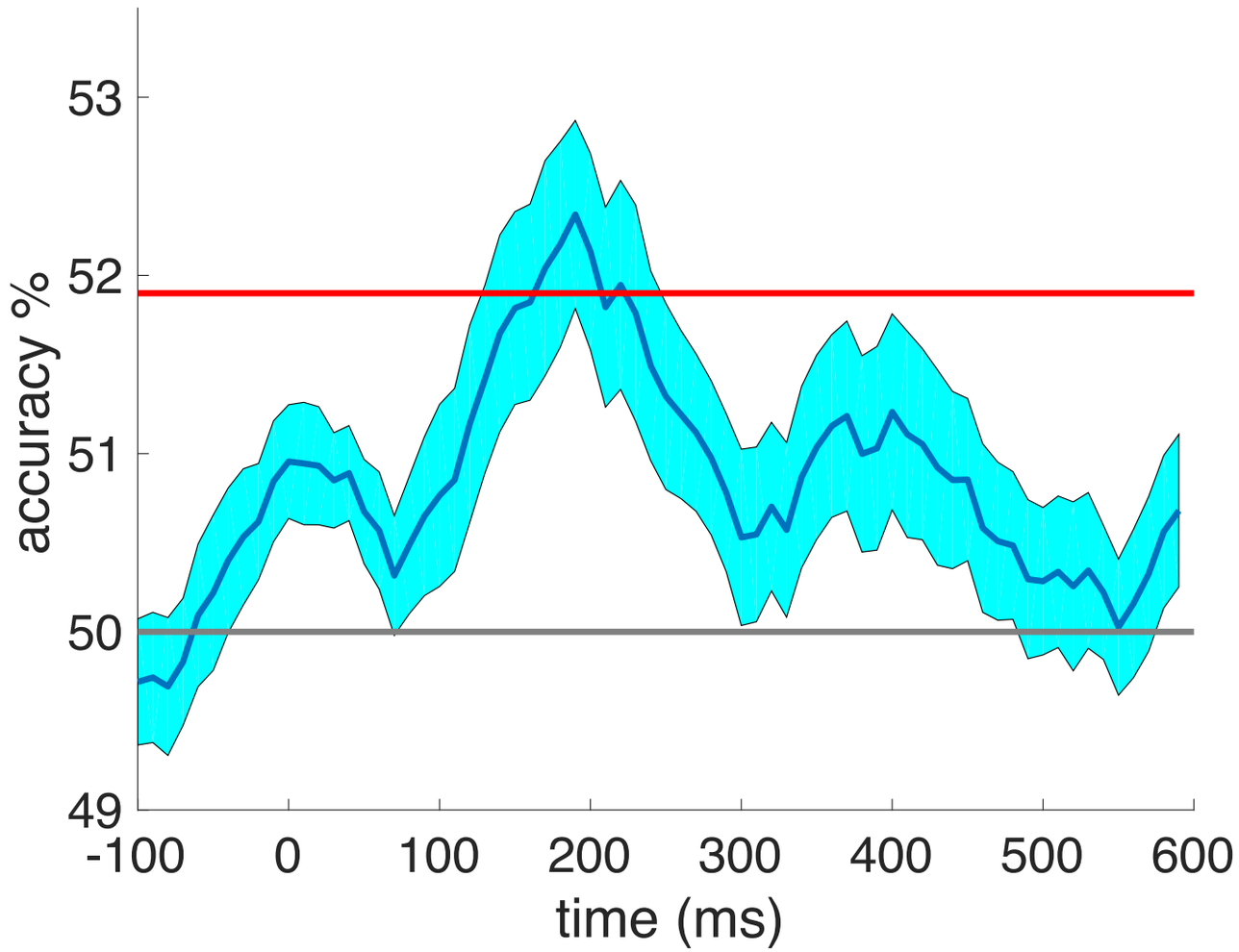
- Data analysis
  - sliding time window
  - multivariate pattern classification
  - consider both ERP and BB



Results: expression decoding

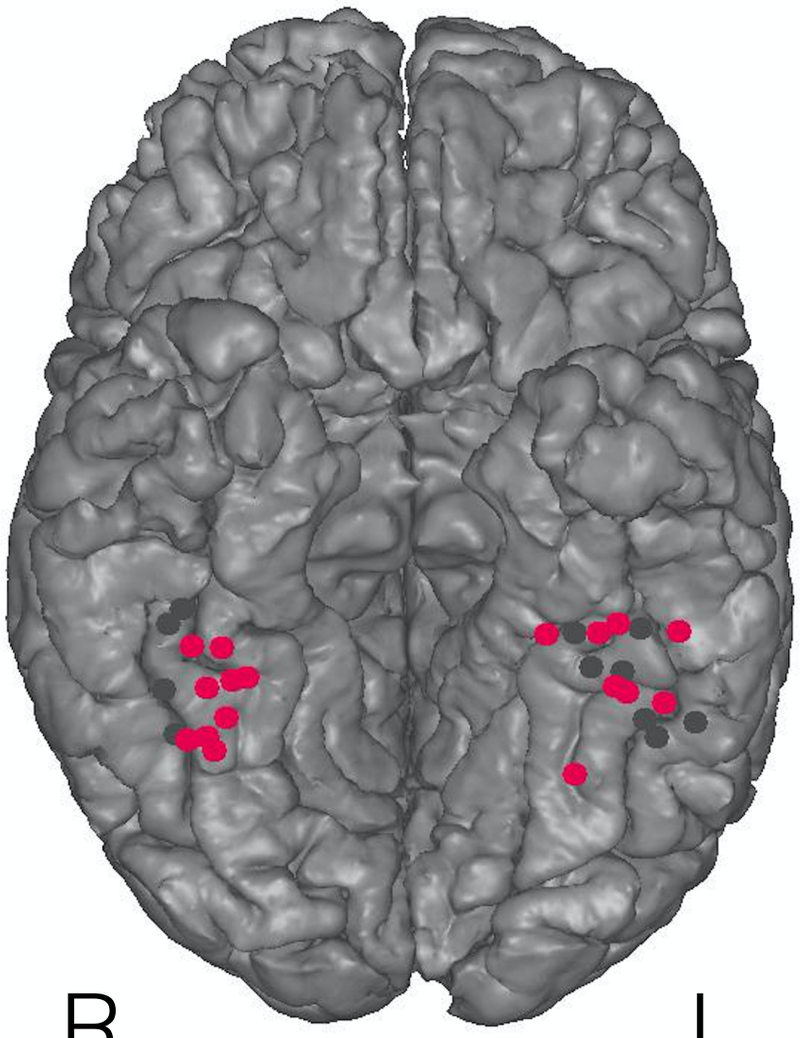
- mean binary expression classification across all fusiform electrodes
  - peak accuracy 52.34% at 190 ms after stim onset ($p < 0.05$, Bonferroni corrected)



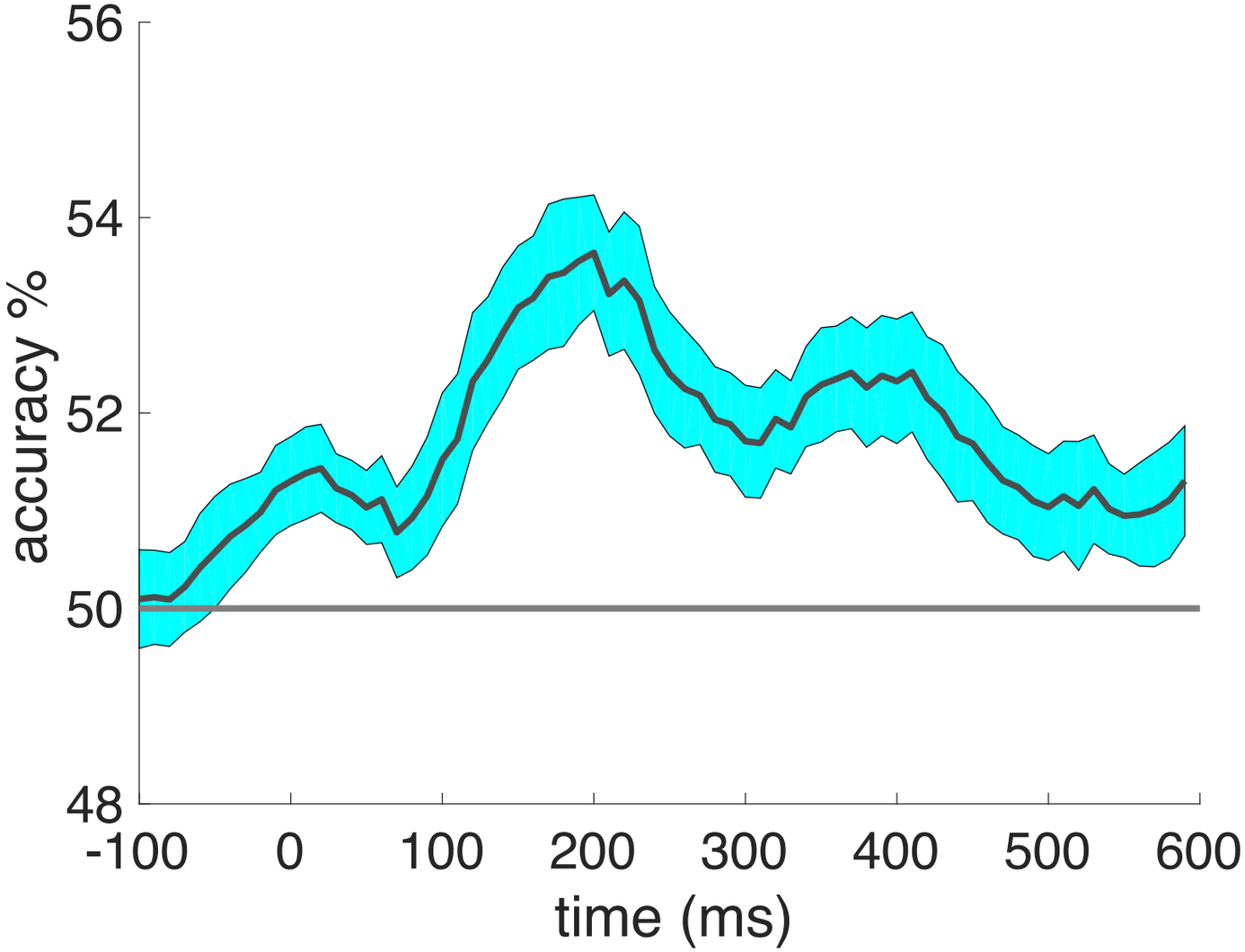


Results: spatiotemporal dynamics

- pick the electrodes with significant facial expression decoding (permutation test)



17/29 electrodes have significant expression decoding



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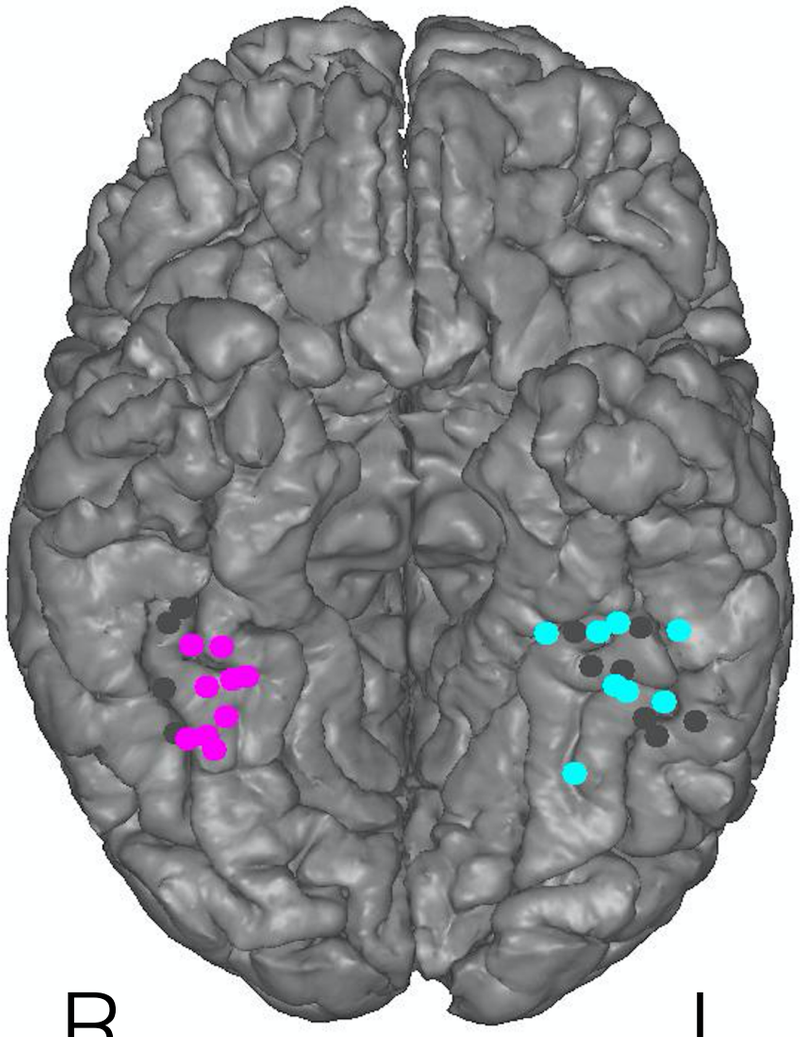
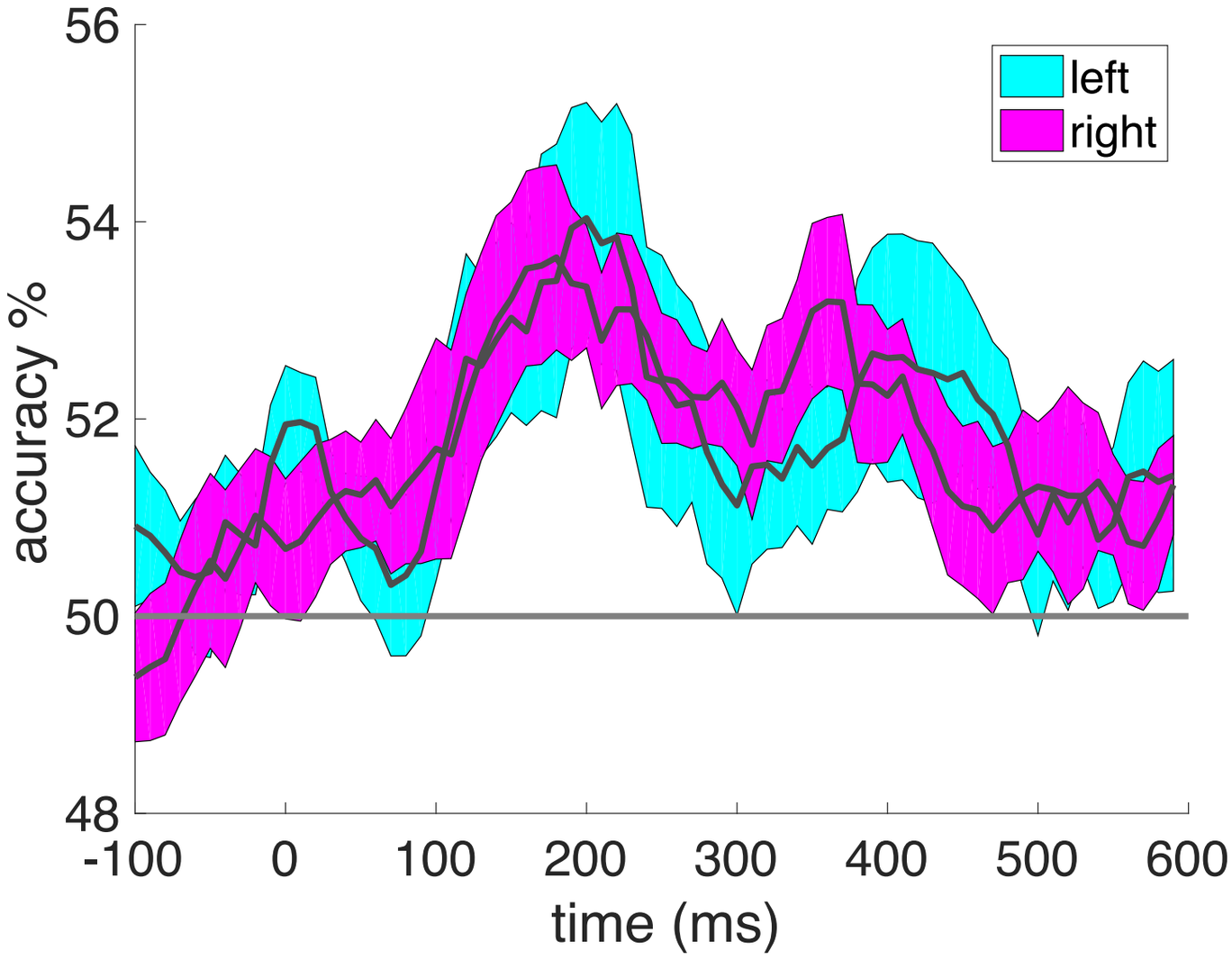
Results: spatiotemporal dynamics

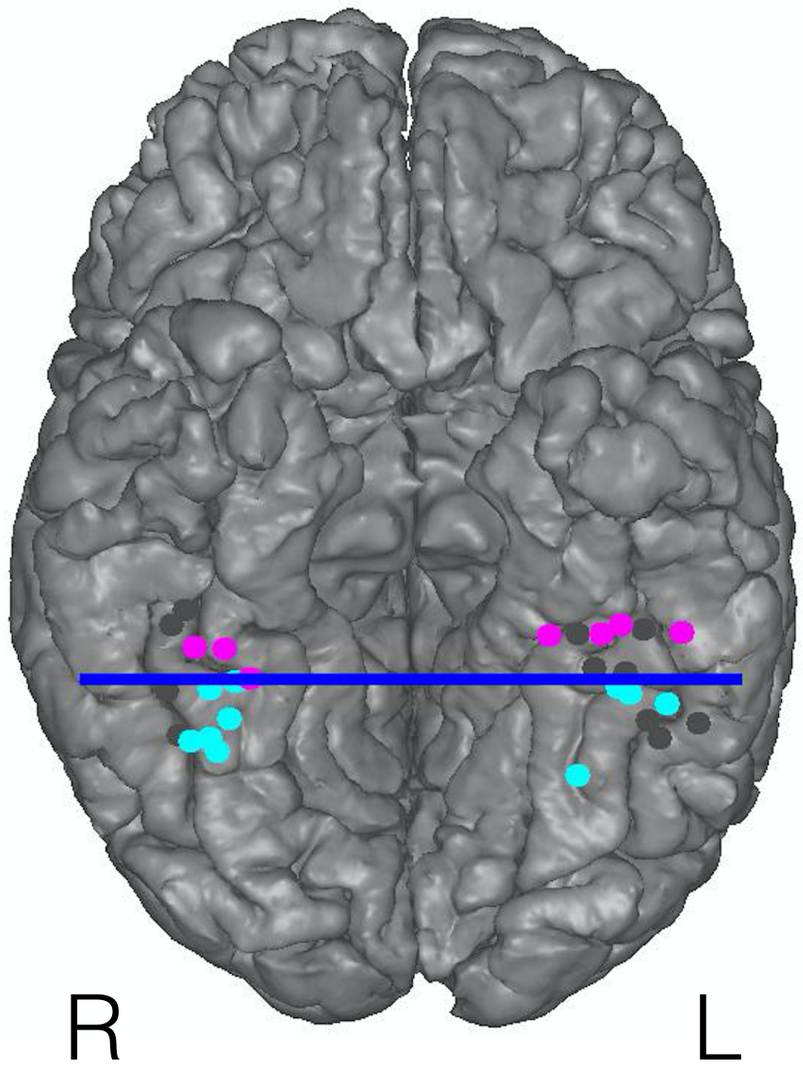
- No significant difference between the time courses of left fusiform and right fusiform

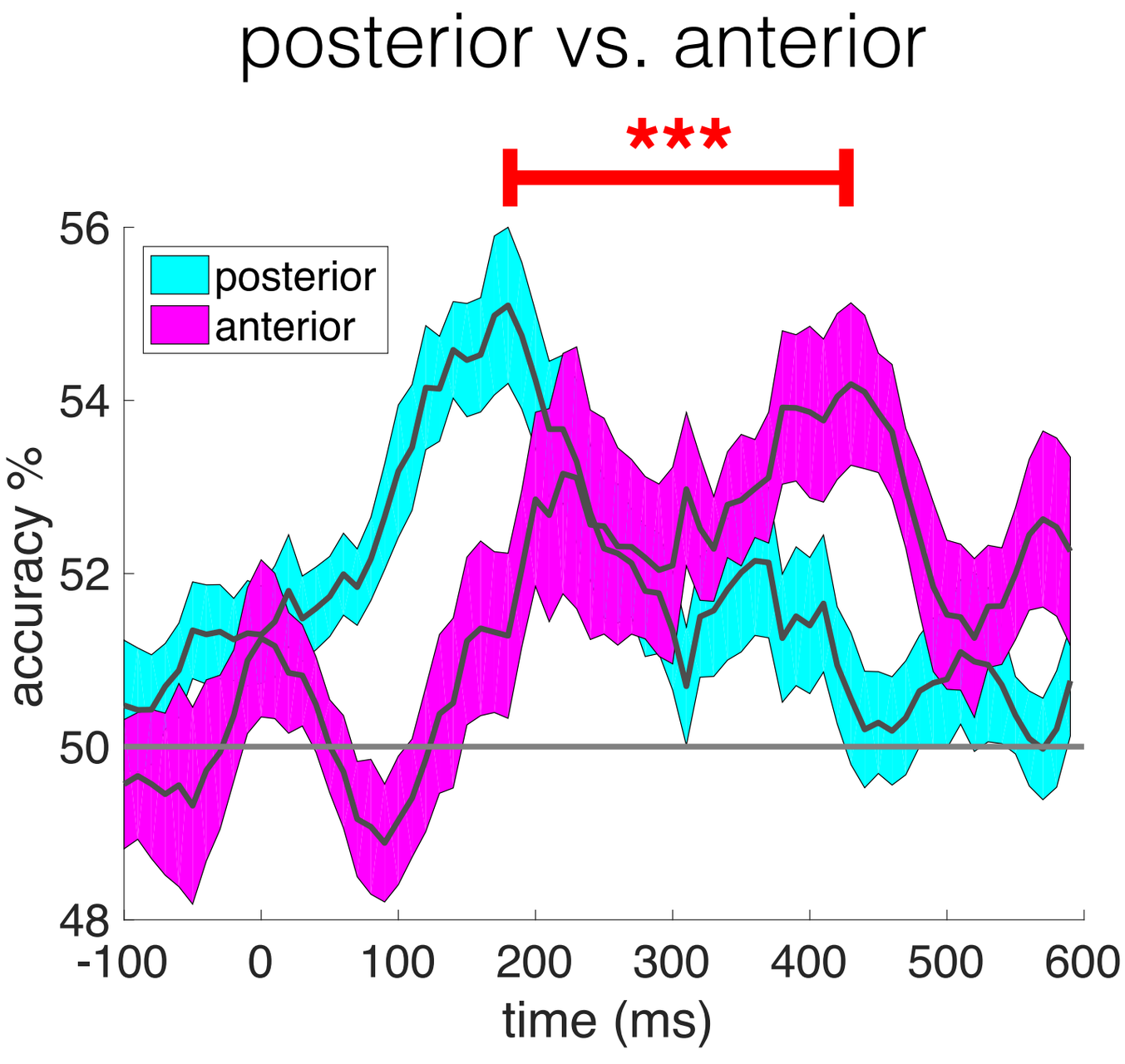




Results: spatiotemporal dynamics

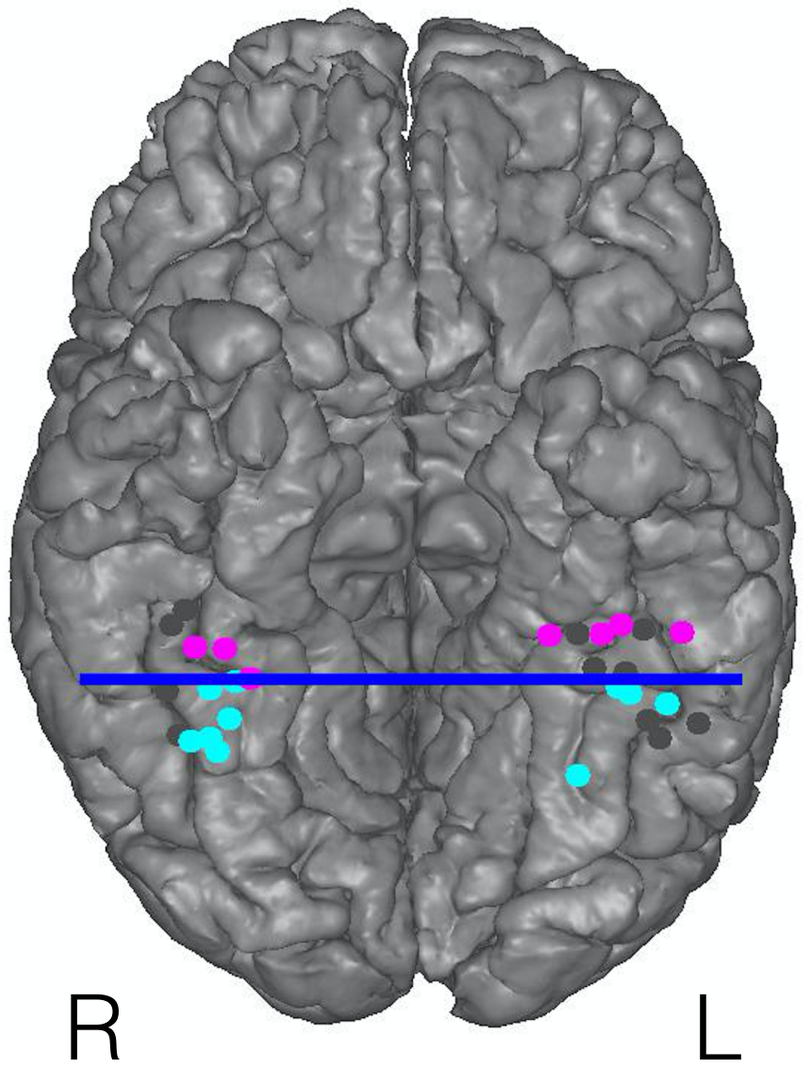
- Significant difference between the timecourses of posterior fusiform and anterior fusiform



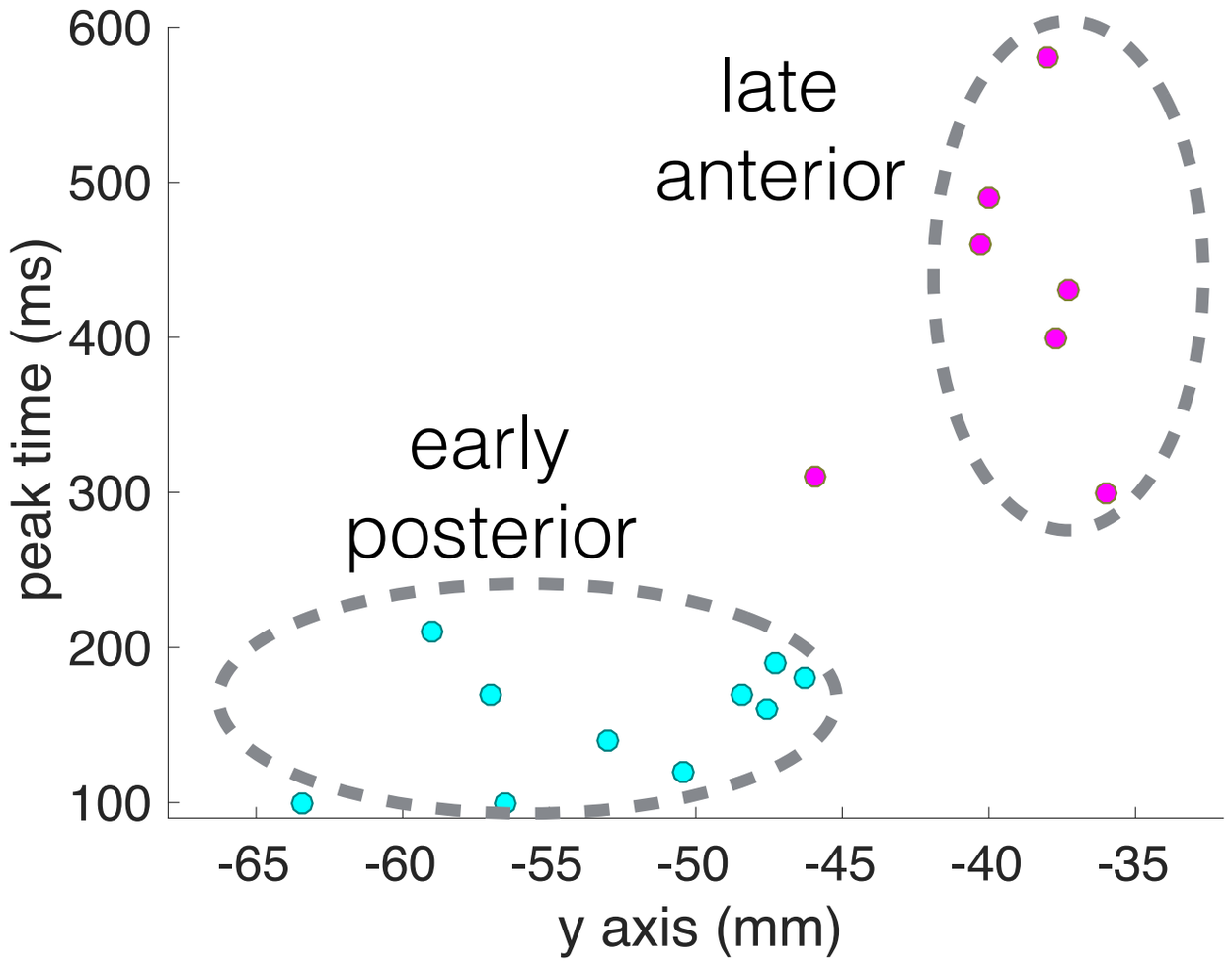


Results: spatiotemporal dynamics

- Fusiform electrodes cluster into posterior and anterior clusters



posterior vs. anterior



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  Yes, bilateral fusiform activity encodes facial expressions

- What are the spatiotemporal dynamics of such encoding in fusiform?

  Posterior fusiform encodes expressions at the **early stage**
  Anterior fusiform encodes expressions at the **late stage**

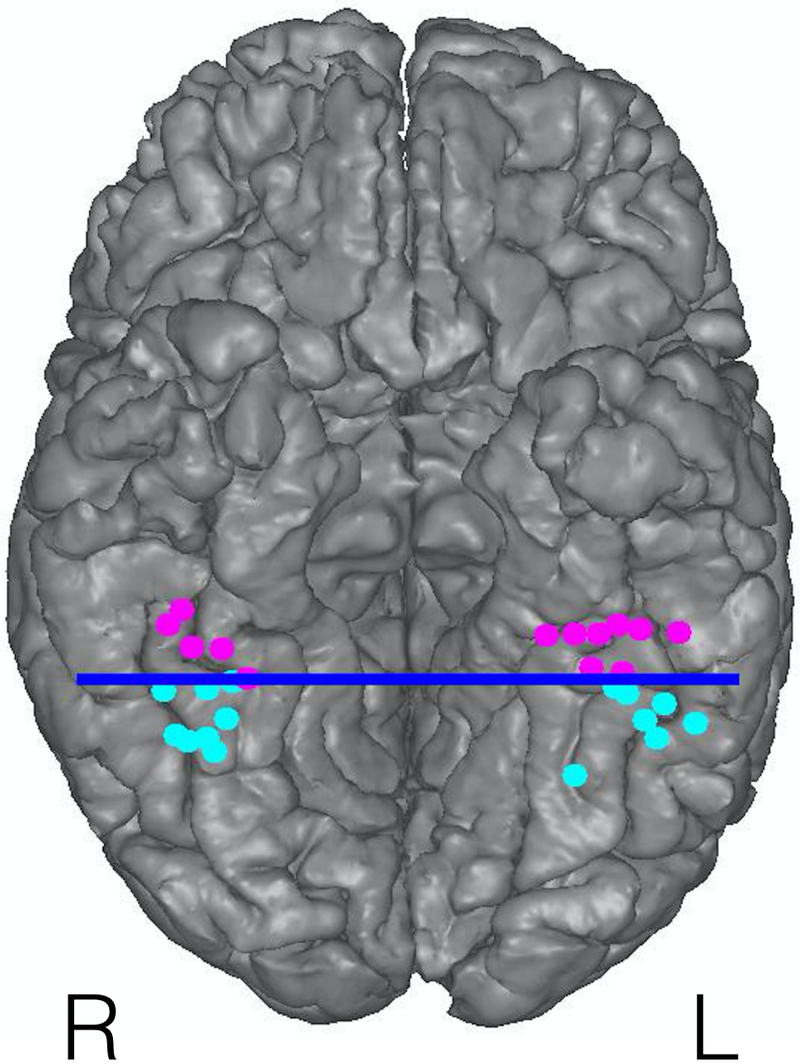
Discussion

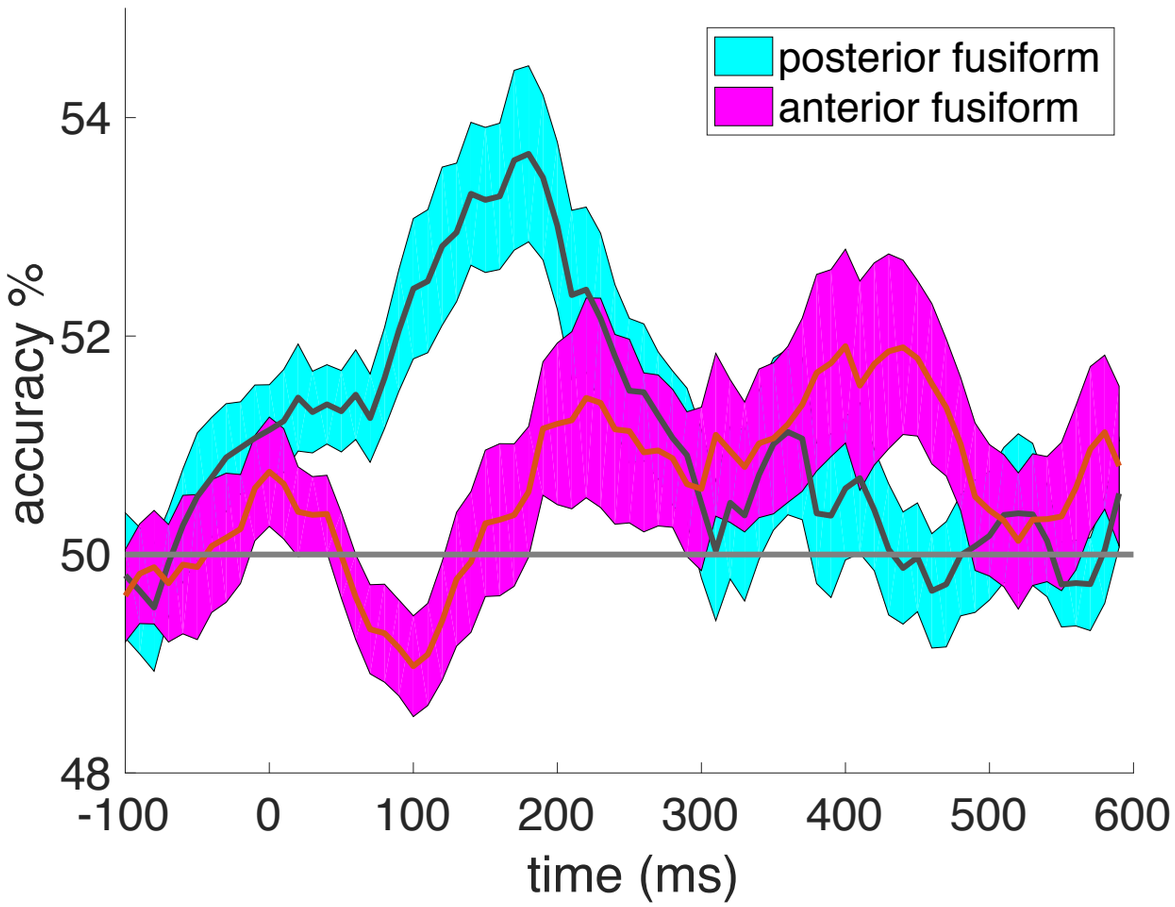
- Timing is an important factor in analyzing facial expression processing.
  - Early (100-200 ms): core processing, intrinsic coding for structural and general shape info
  - Late (300-500 ms): reciprocal, more deliberative processing (Freiwald & Tsao 2010)

Note: (Ghuman et al., 2014) FFA encodes face category in the early stage and individual faces in the late stage.

Discussion

- Spatial heterogeneity may explain the discrepancy of expression encoding in fusiform from the literature, esp. in fMRI studies.





Acknowledgments

Coauthors:

- Dr. Avniel Singh Ghuman (UPMC, CNBC)
- Dr. R. Mark Richardson (UPMC, CNBC)
- Dr. Witold Lipski (UPMC)
- Michael Ward (UPMC)

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- EMU staff (UPMC Presbyterian)
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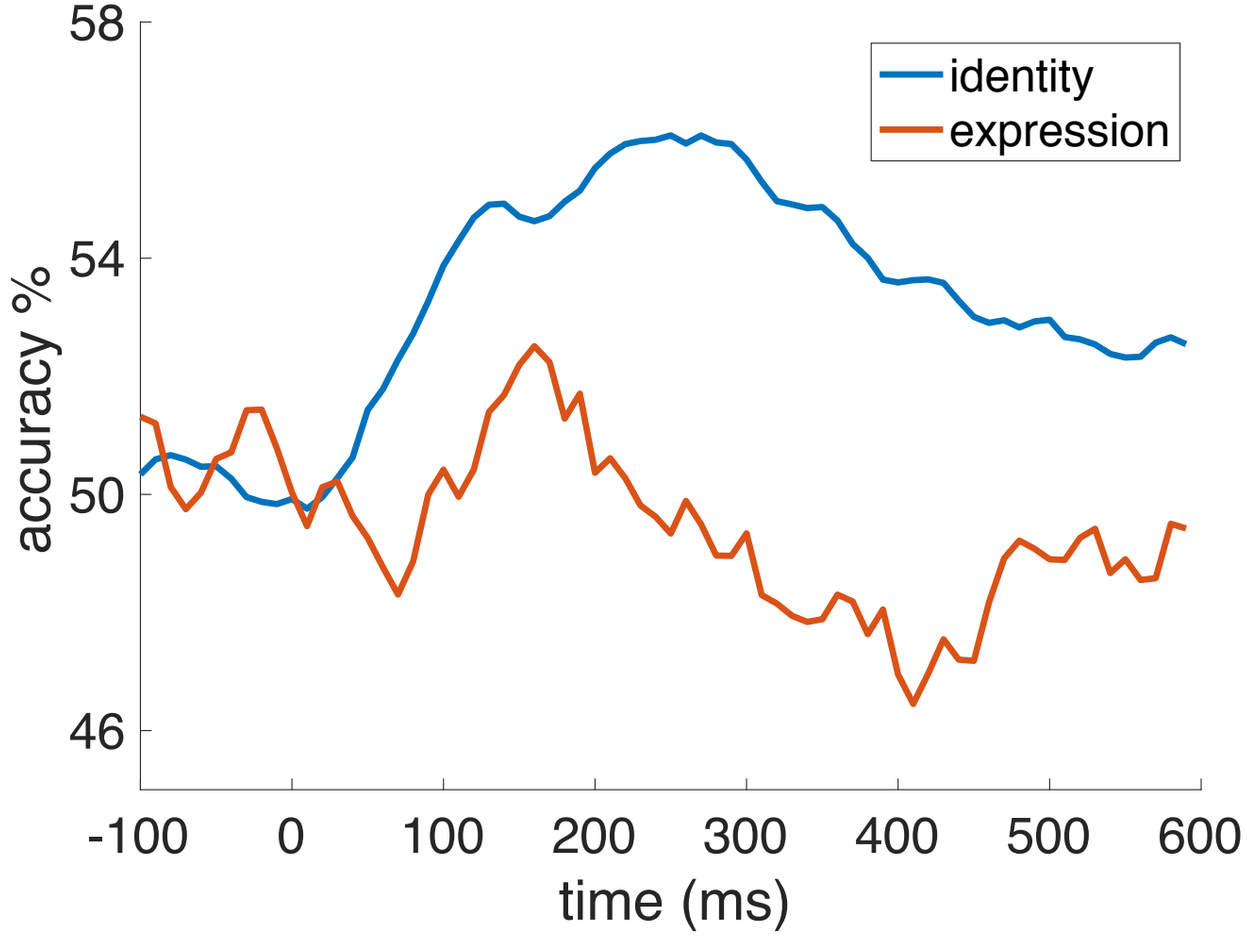
Thank you!

Future directions

- Identity X Expression
  - FFA encodes face individuation (late stage, 200-500 ms after stim. onset) (Ghuman et al., 2014)



Future directions

- What facial features underlie such spatiotemporal processing?

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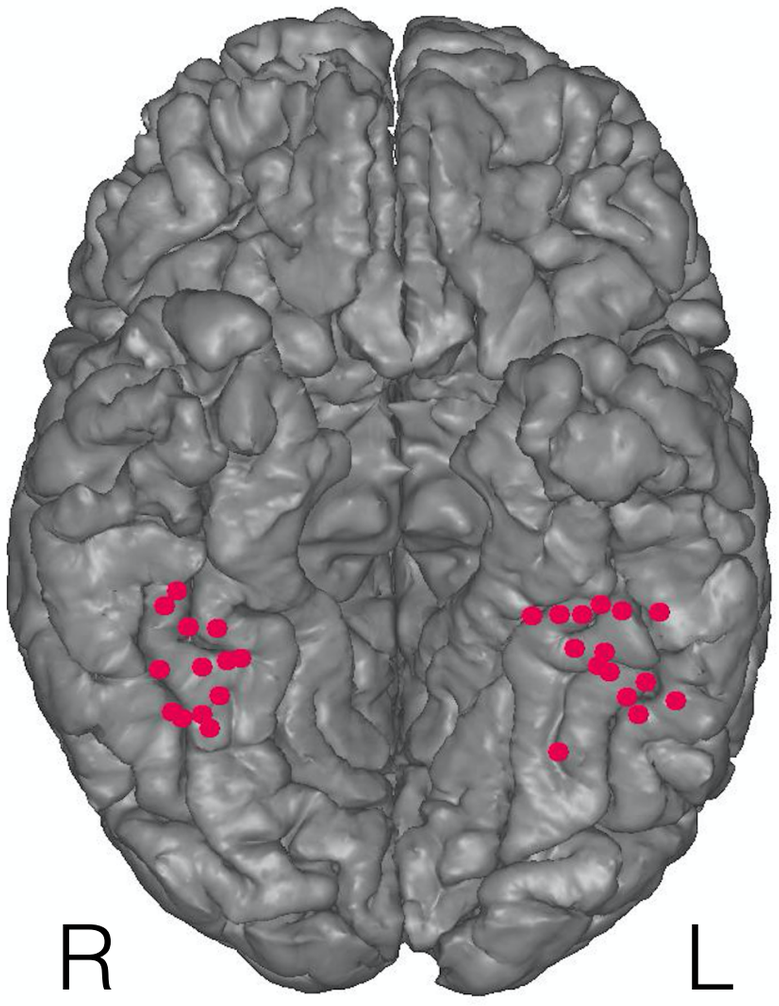
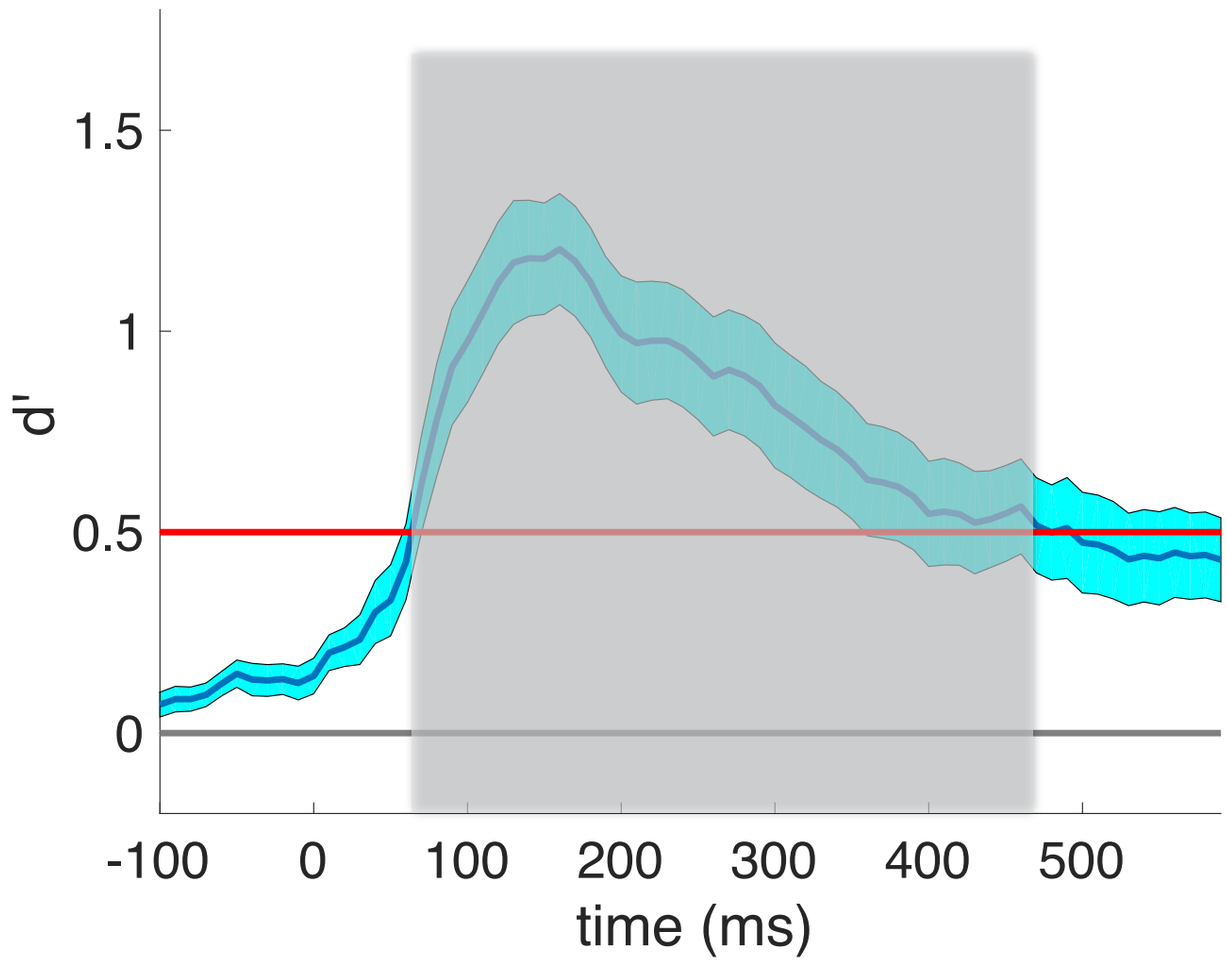
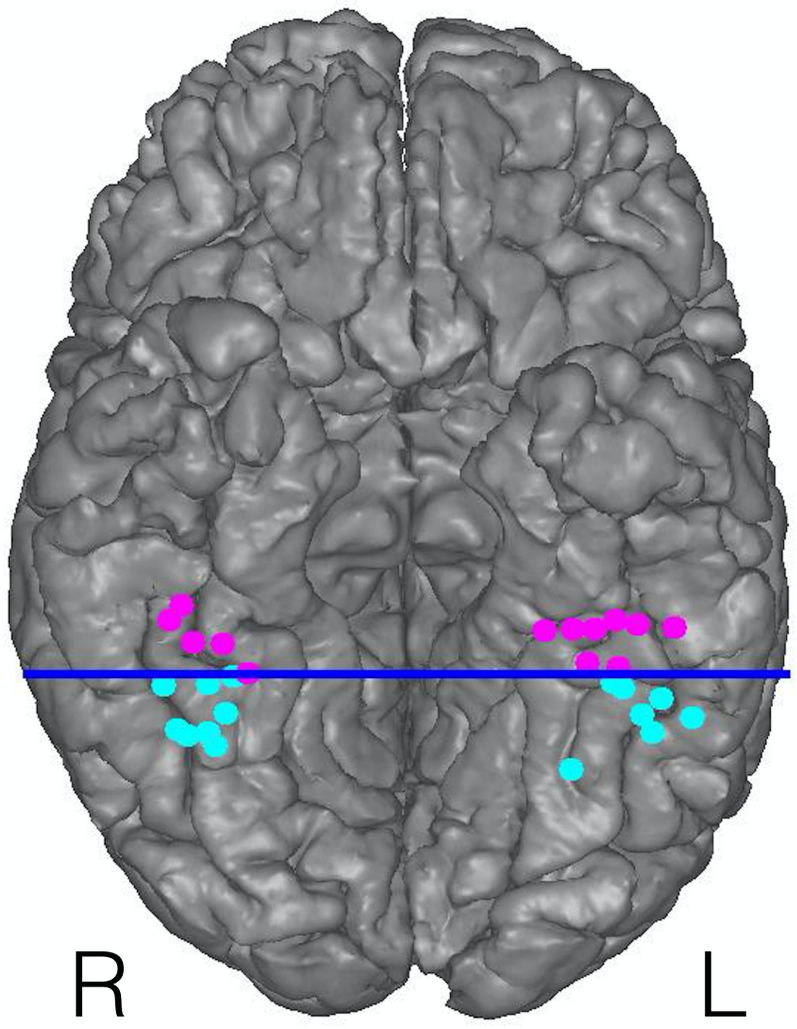




Results: face sensitivity

- mean face sensitivity across all fusiform electrodes (face vs. non-face)



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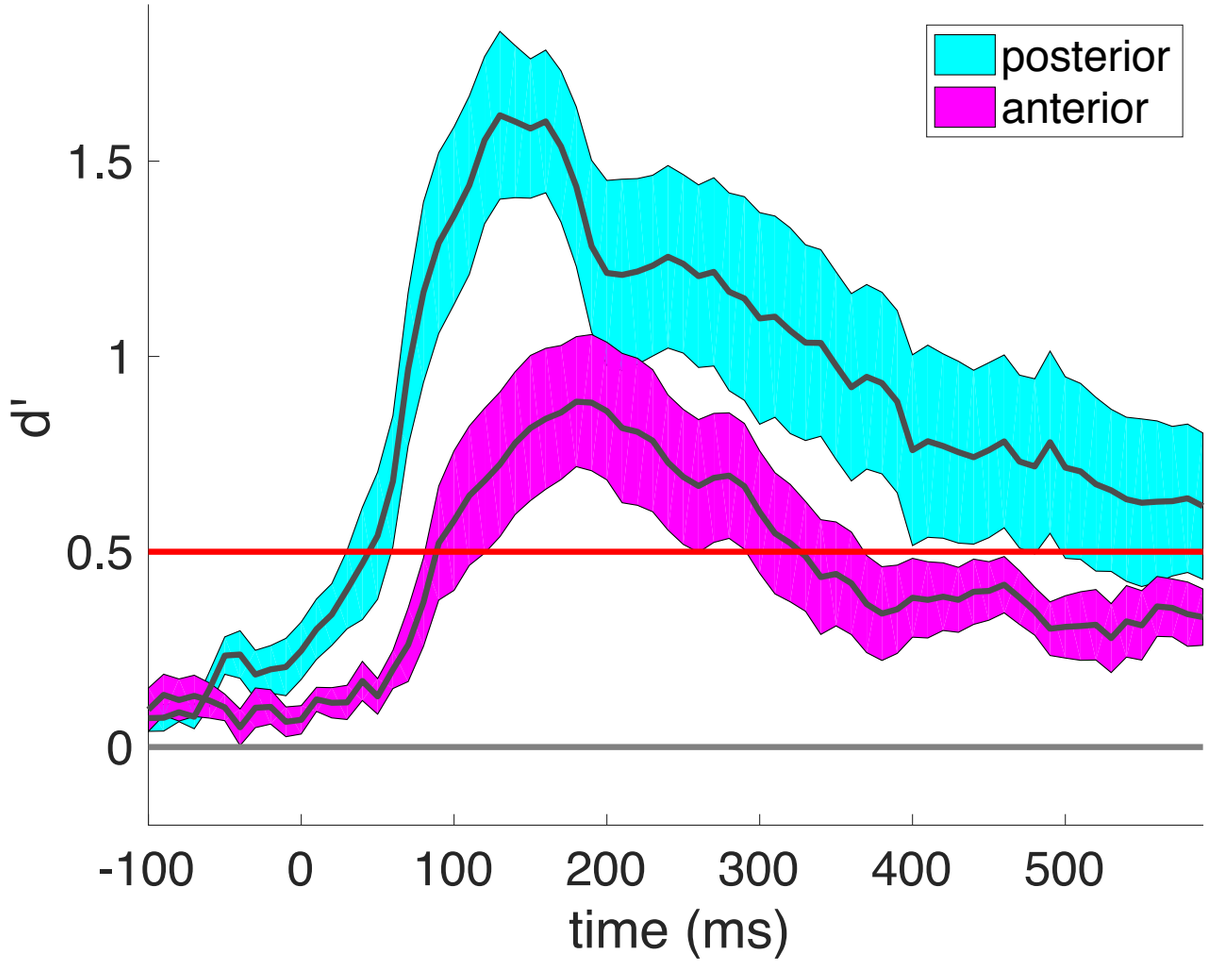

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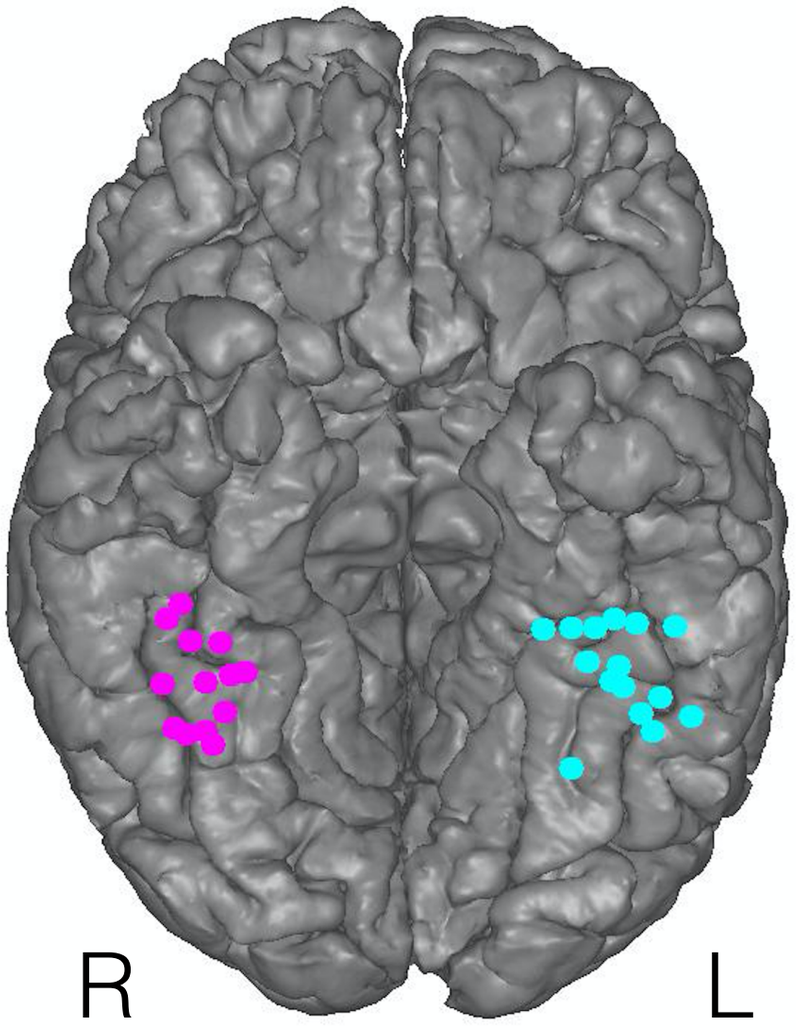
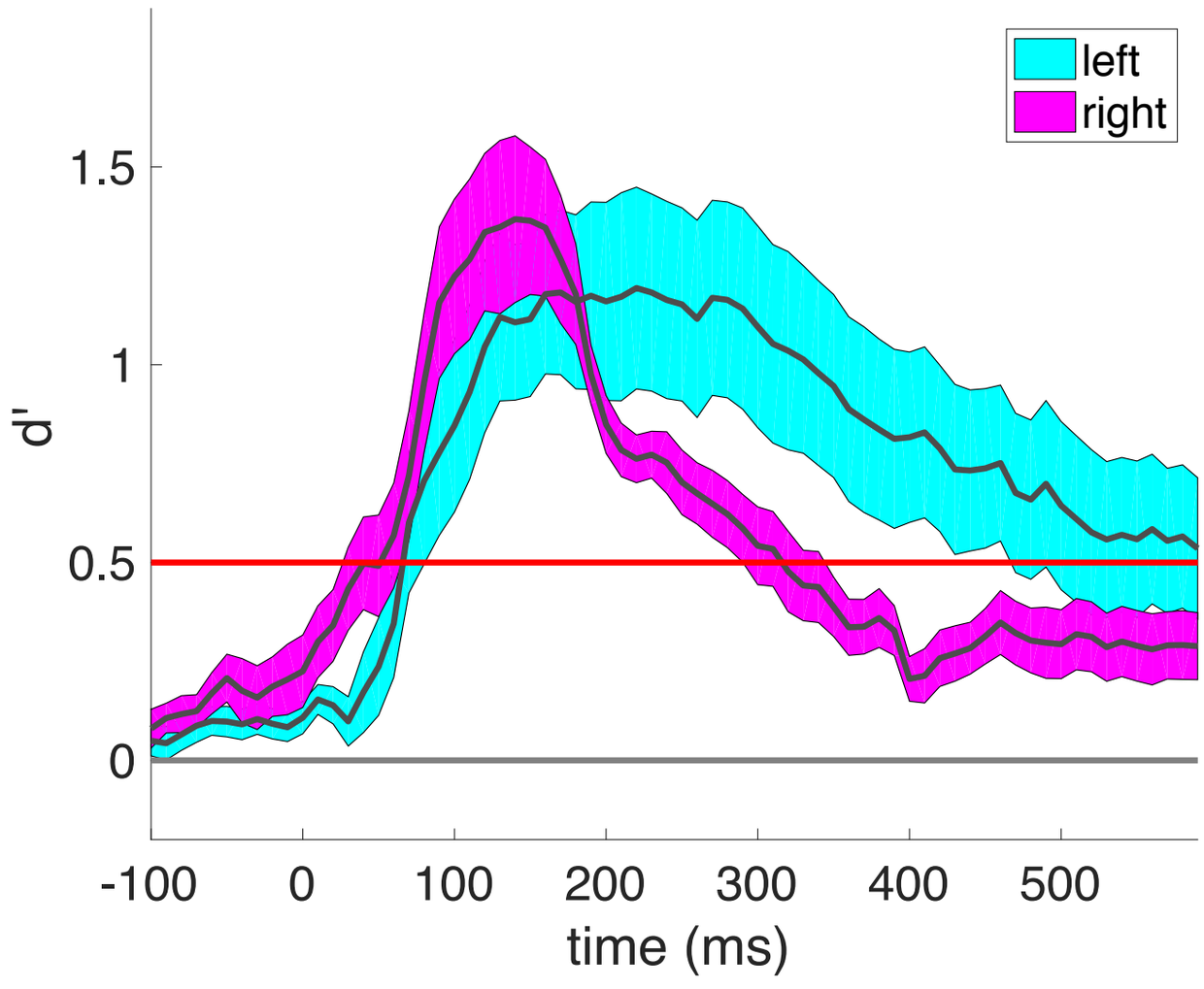


left vs. right



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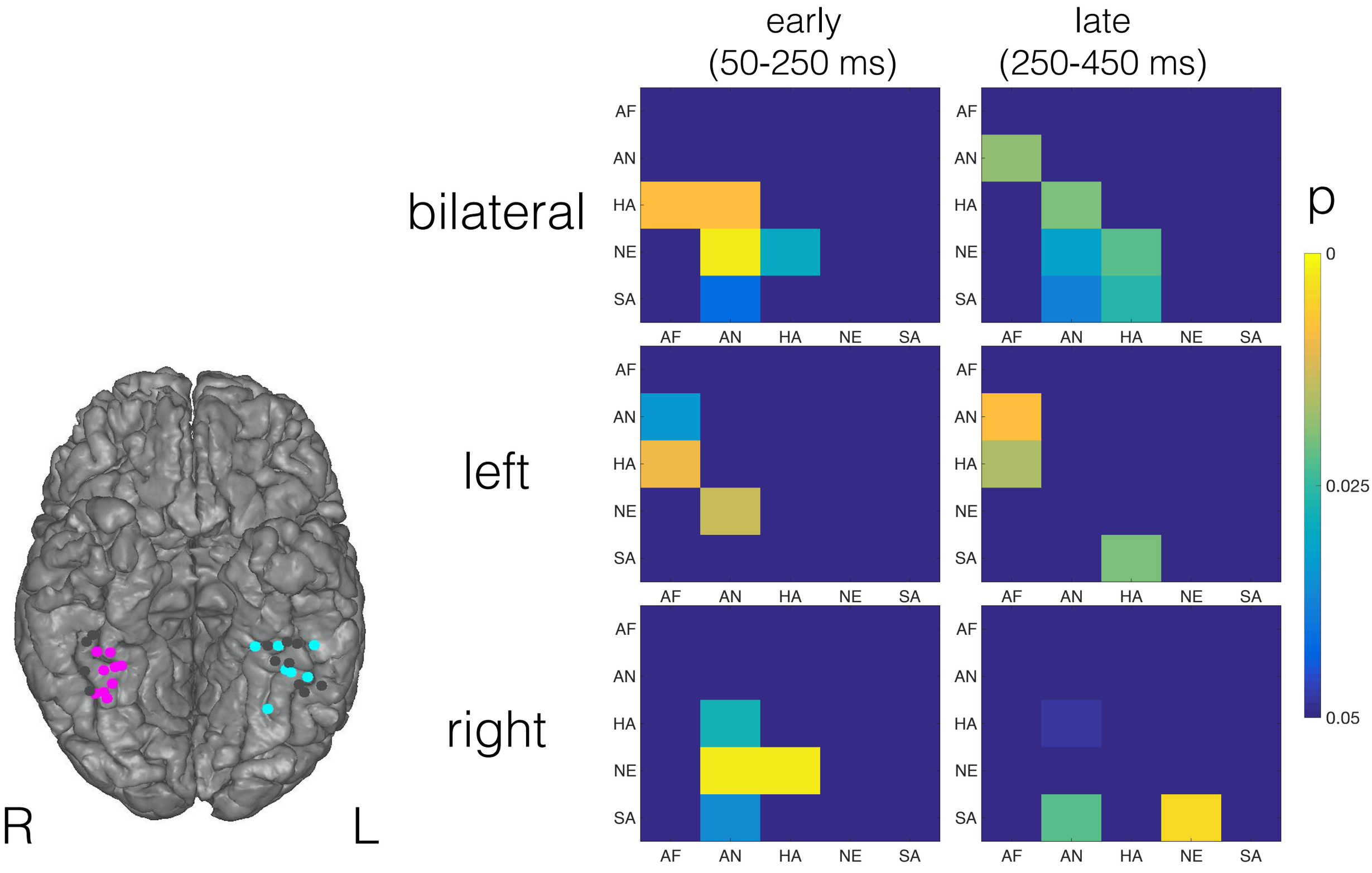

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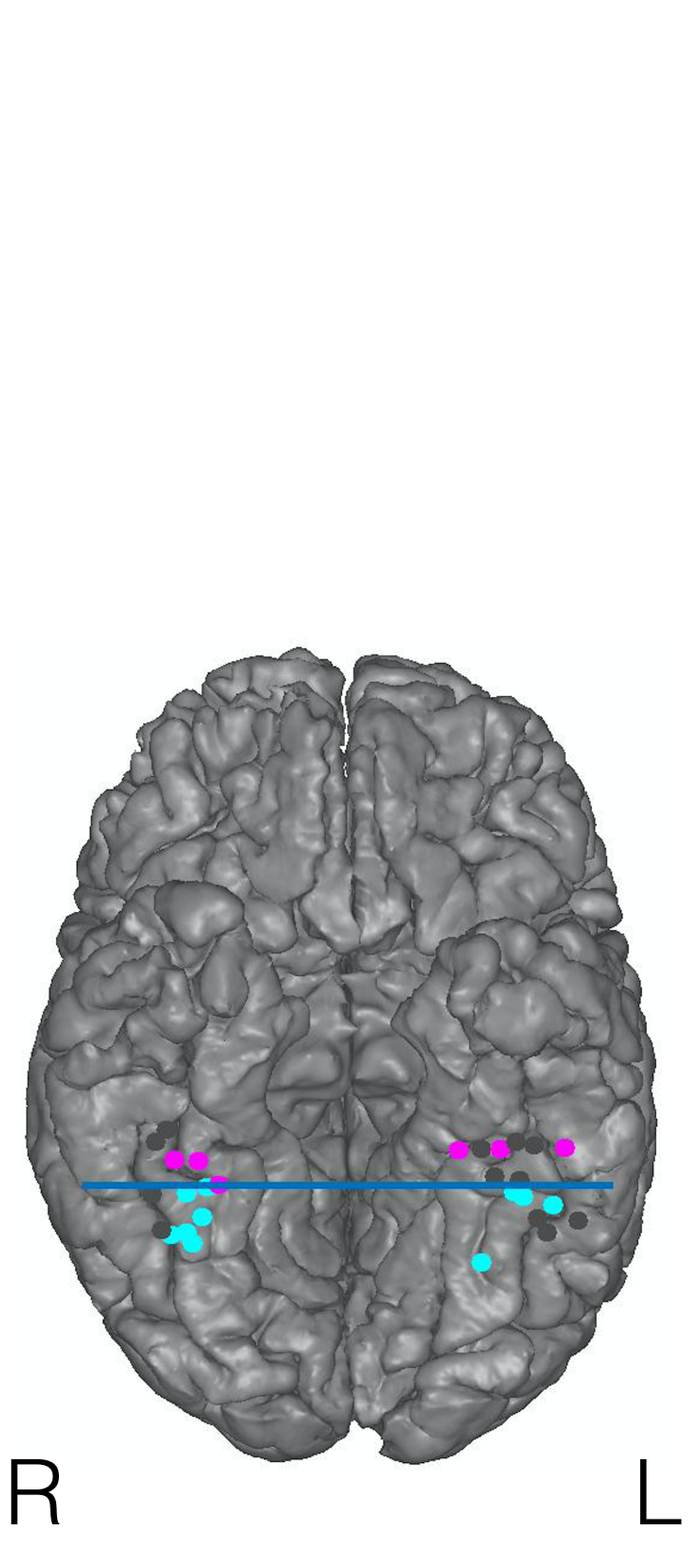

bilateral

anterior

posterior