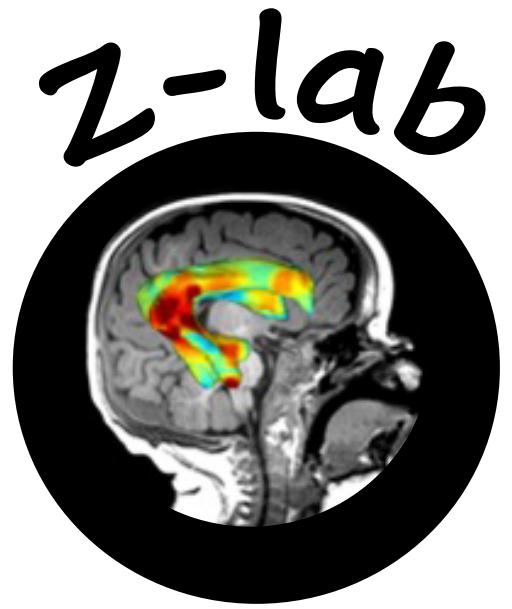




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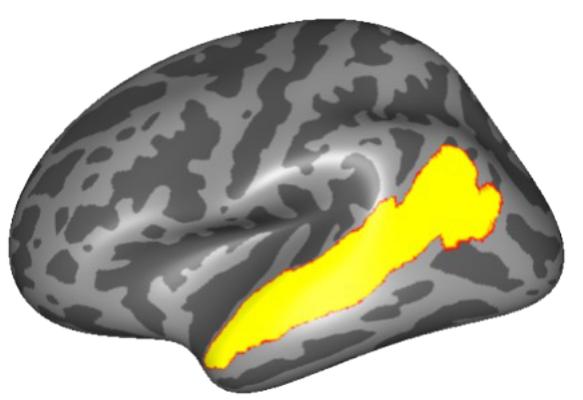
# Examining the functional organization, specificity, and laterality of language and theory of mind (ToM)



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## Lang & ToM: Social Skills in the STL



- Language and ToM selective brain regions are both in the Superior Temporal Lobe (STL)<sup>1</sup>.
- In adults, language and ToM brain regions are distinct<sup>2,3</sup>, and have opposing, and perhaps overlapping laterality<sup>4</sup>.
- In children, language and ToM development support one another<sup>5,6</sup>.
  - Do complex cognitive functions like **language** and **ToM** develop from a common neural substrate for social communication?

H1: Overlapping in development

H2: Distinct like in adults

## Participants, Data & Analysis

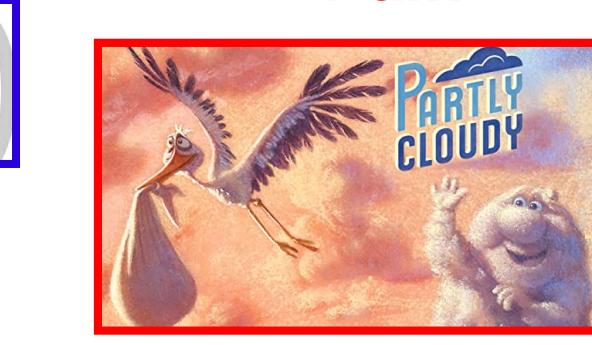
### Participants:

- Kids: N=35, all unique (ages 3.4-13.3 yrs)
- Adults: N=36, all unique (ages 18-X yrs)



### Tasks:

- 2 runs of auditory language localizer<sup>7</sup>
- 1 run of Partly Cloudy ToM localizer<sup>8</sup>

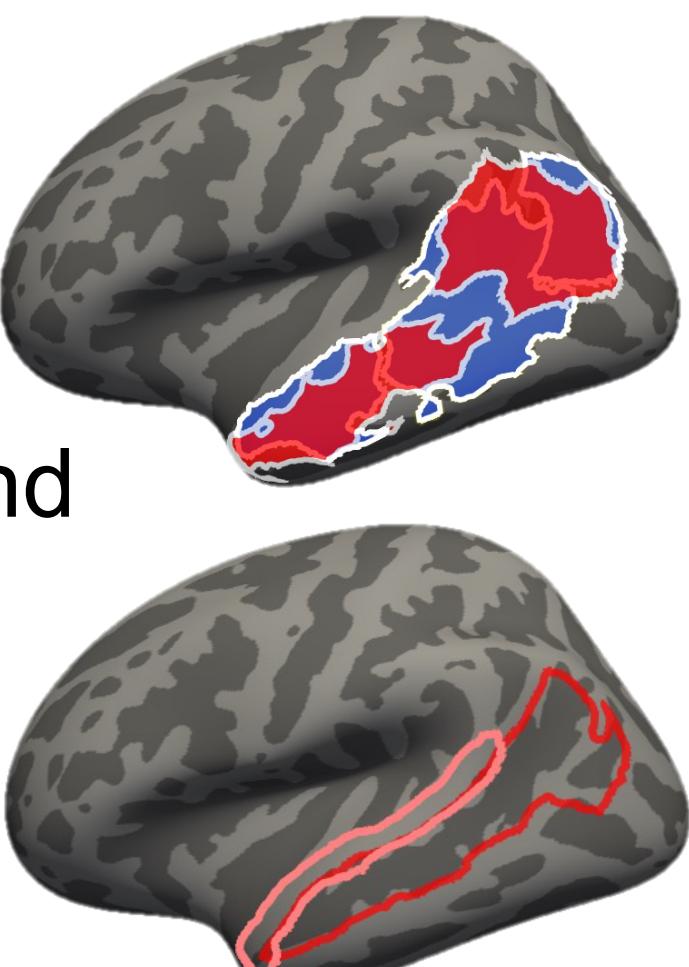


### Processing:

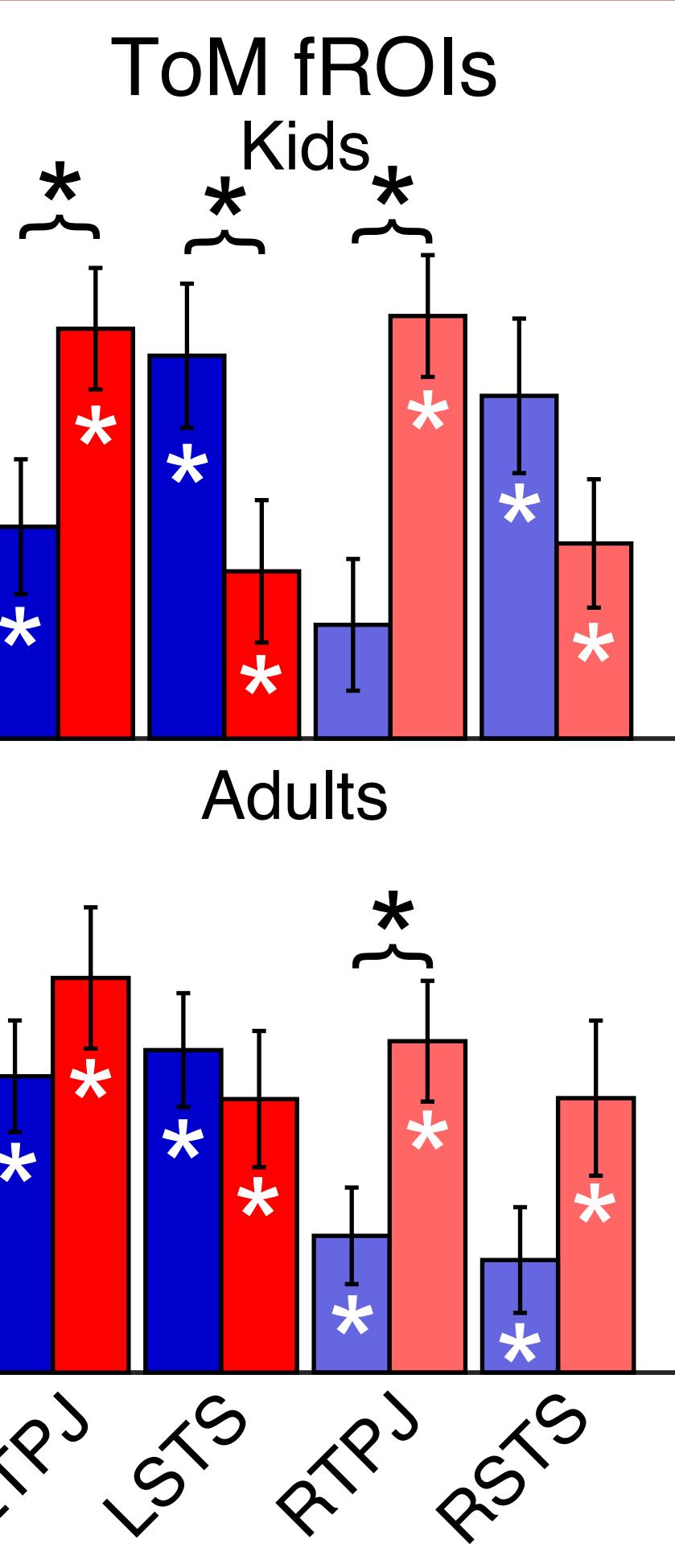
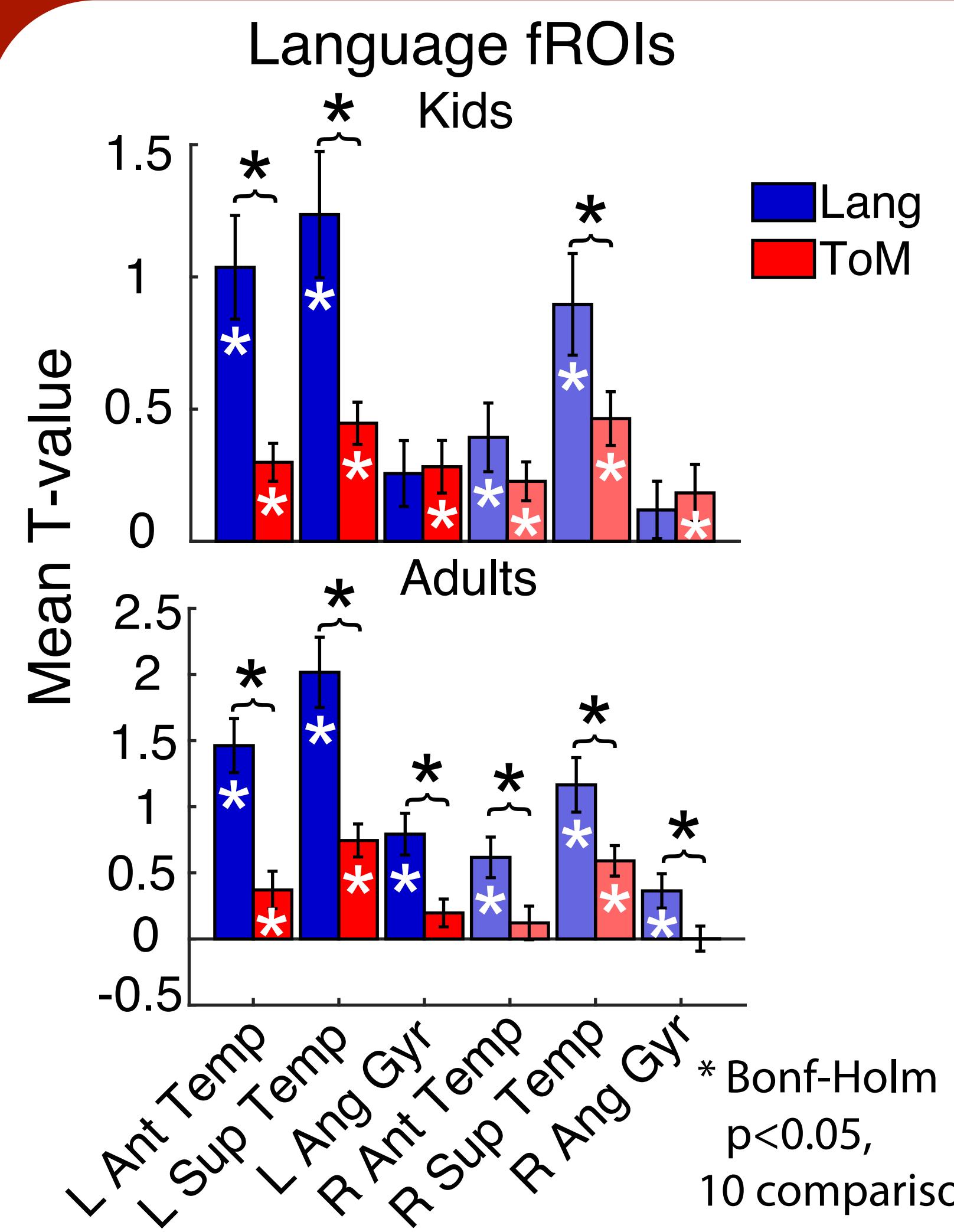
- Freesurfer anatomical boundaries of sulci and gyri
- Registration apriori parcels (search spaces) for fROI definition
- Combination of FSL and Freesurfer was used for preprocessing and analysis of fMRI data
- Data scrubbed: 75% of volumes <1mm total vector motion
- Data registered to fsaverage\_sym for laterality analysis

### Analysis:

- Define subject-specific fROIs, examine mean t-stat in independent run:
  - one-tailed t-test vs 0
  - paired, two-tailed t-test to compare ToM and language responses
- Measure overlap of hotspot fROIs (most responsive voxels in the STS and STG)
- Laterality:
  - group level GLM of language/ToM laterality
  - overlap of laterality hotspots



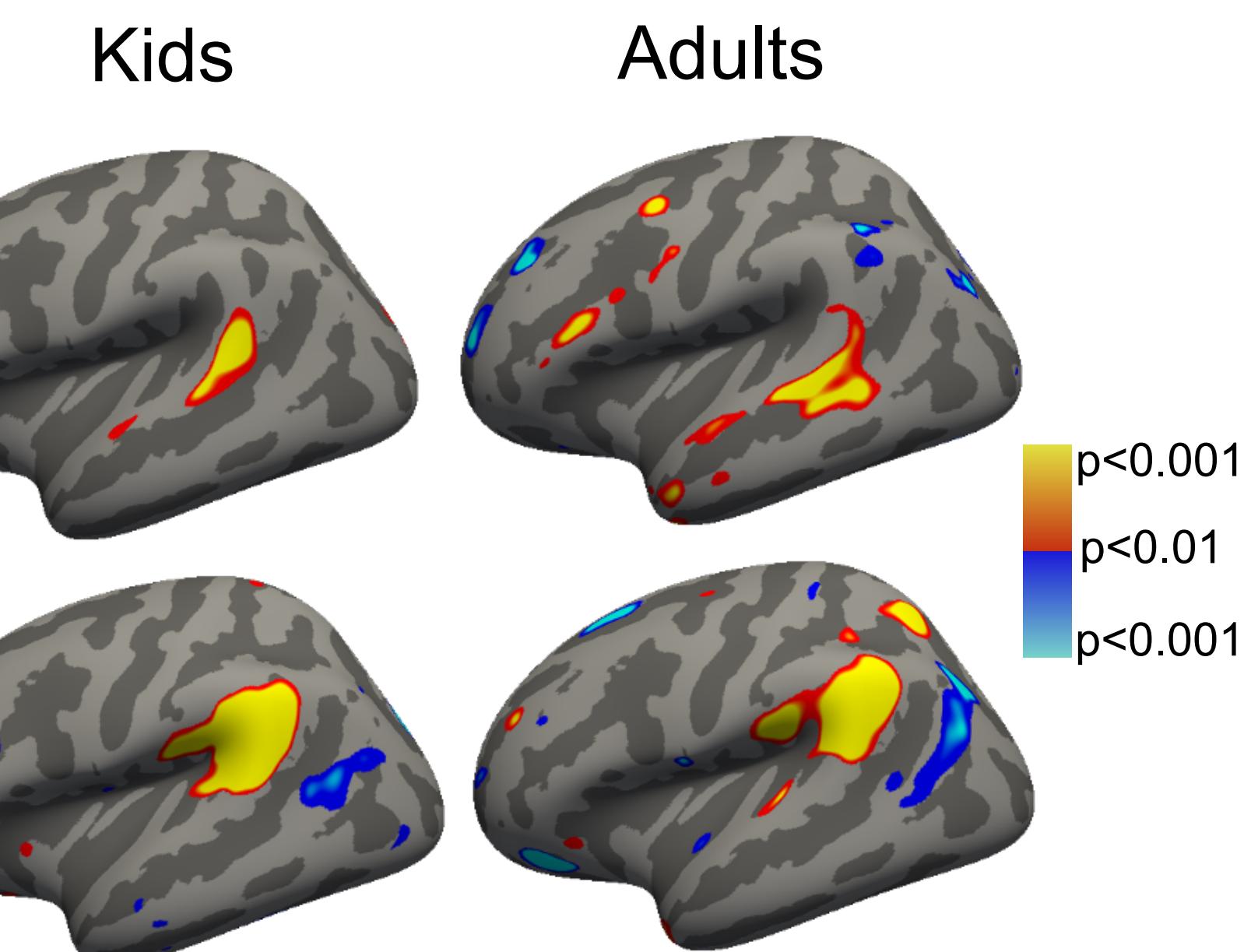
## Specificity of Lang & ToM fROIs



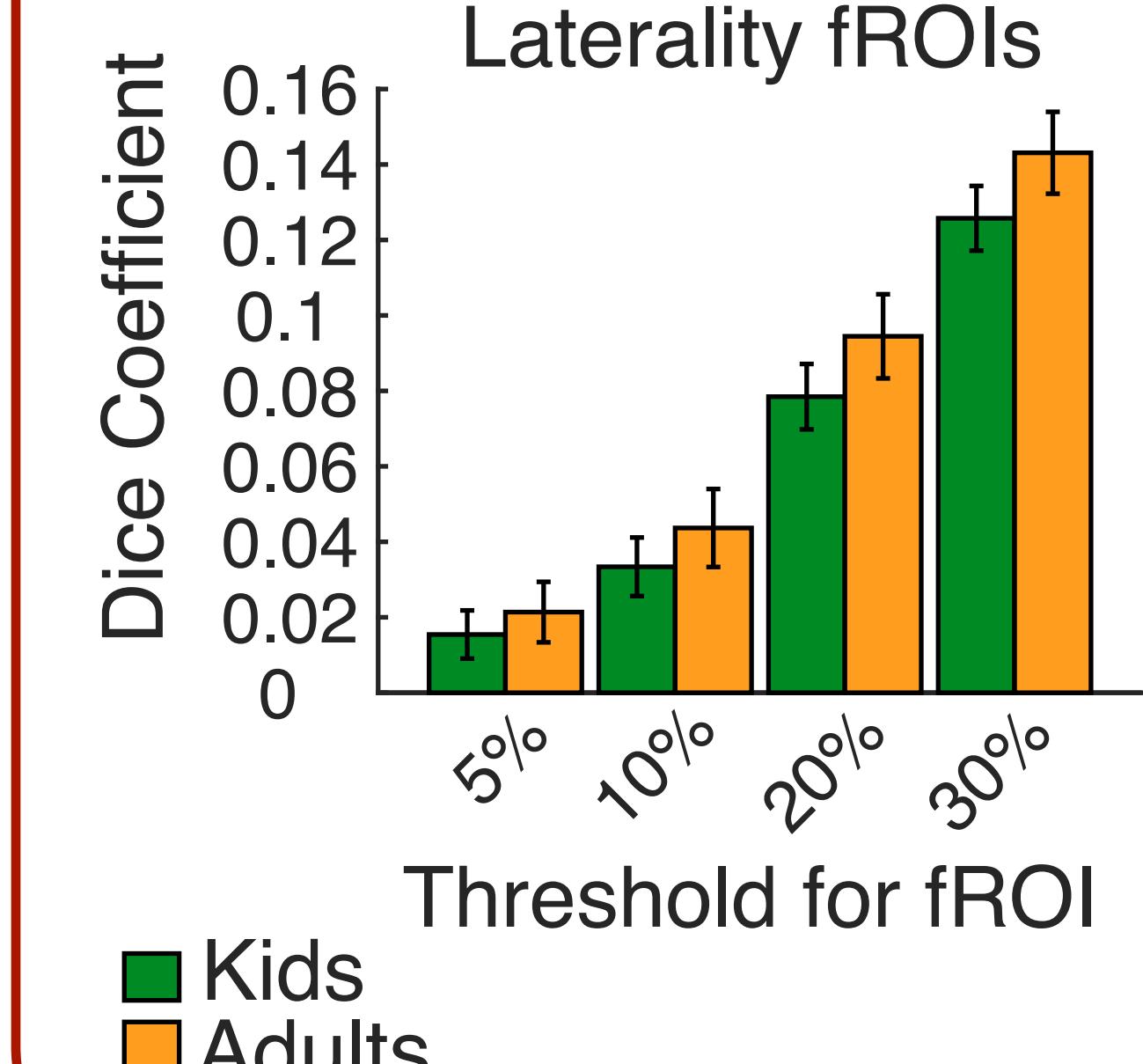
- Kids: LH Ant Temp, bilateral Superior Temp are **language specific**.
  - Bilateral Ang Gyr is only **ToM responsive**.
  - RH Ant Temp is sensitive to both **ToM & language**.
- Adults: All language fROIs are **language specific**.
  - Kids: Bilateral TPJ is **ToM specific**
    - RSTS does not differentiate
  - LSTS is **language selective**
  - Adults: RH TPJ is **ToM specific**
    - Bilateral STS and LH TPJ do not differentiate.

## Laterality of Lang and ToM

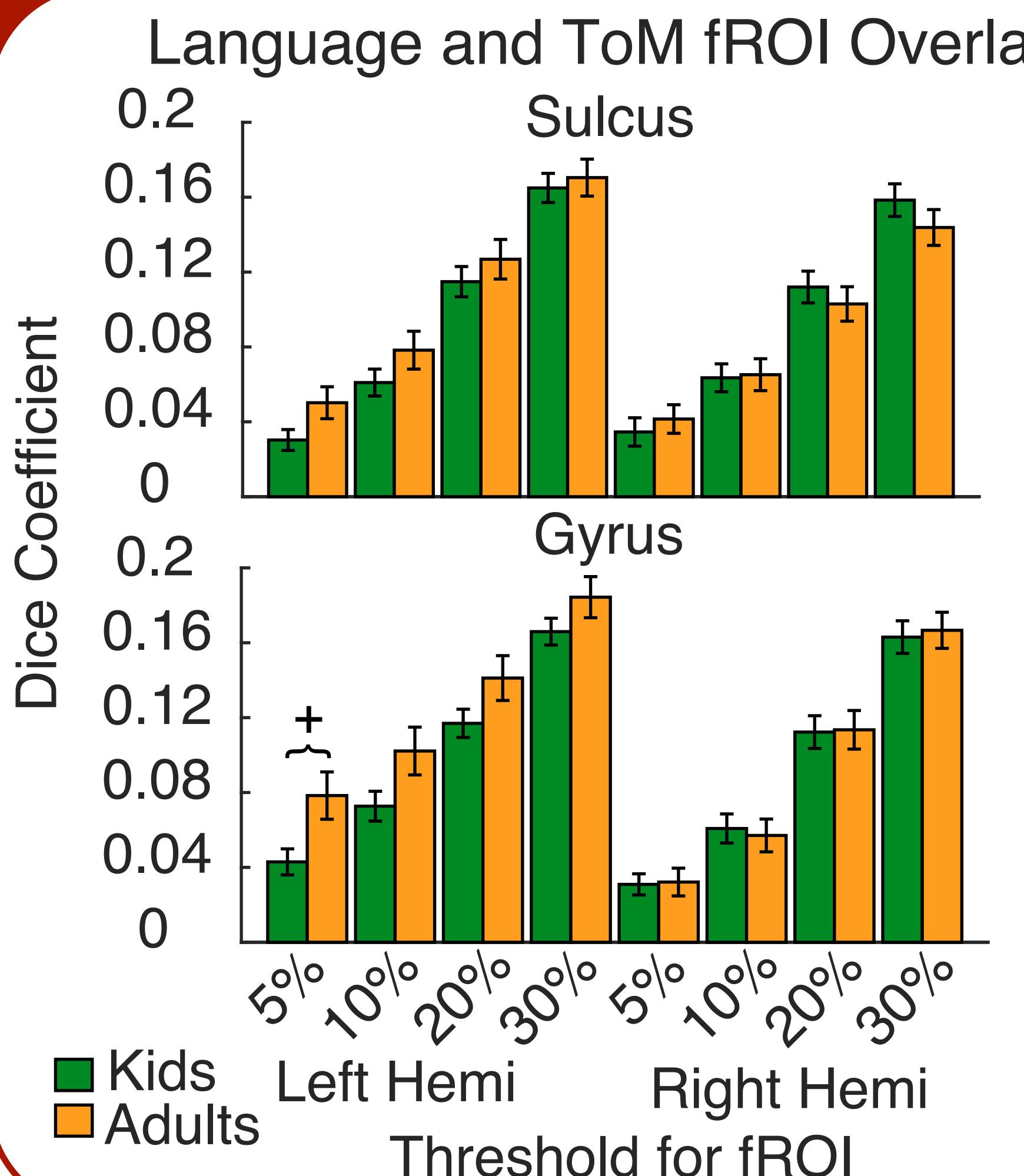
Group-level GLM laterality analysis: **language** and **ToM** have opposite lateralization that is non-overlapping in children and adults.



- Using subject-specific laterality fROIs, the most lateralized **language** voxels (L>R) do not overlap with the most lateralized **ToM** (R>L) voxels in the superior temporal lobe.



## Overlap of Hotspot fROIs



- Regardless of threshold, both adults and children show *minimal overlap* in the most responsive voxels to **language** and **ToM** in the Superior Temporal Sulcus and Gyrus.
- Overlap is *not different* between children and adults.

\*Uncorrected p<0.05

## Conclusions

- Children, like adults, have a *domain-specific core language network*.
- Adult ToM regions show language and ToM selectivity
  - however, the maximally responsive voxels (and the most lateralized voxels) are *non-overlapping*.
- Similarly, the maximally responsive (and maximally lateralized) voxels for language & ToM in children are also primarily *non-overlapping*, on the same scale as adults.

**References:** 1. Hein & Knight, 2008, *J Cog Neuro*; 2. Shain et al., 2022, *Cerebral Cortex*; 3. Deen et al., 2015, *Cerebral Cortex*; 4. Rajimehr et al., 2022, *Cell Reports*; 5. de Villiers & de Villiers 2014, *Topics in Lang Disorders*; 6. Miller, 2006, *American Journal Of Speech-Language Pathology*; 7. Fedorenko et al., 2010, *J. Neurophysiology*; 8. Jacoby et al., 2016, *Neuroimage*

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