Greater Plasticity in the Language Network in Children than Adults During Statistical Learning
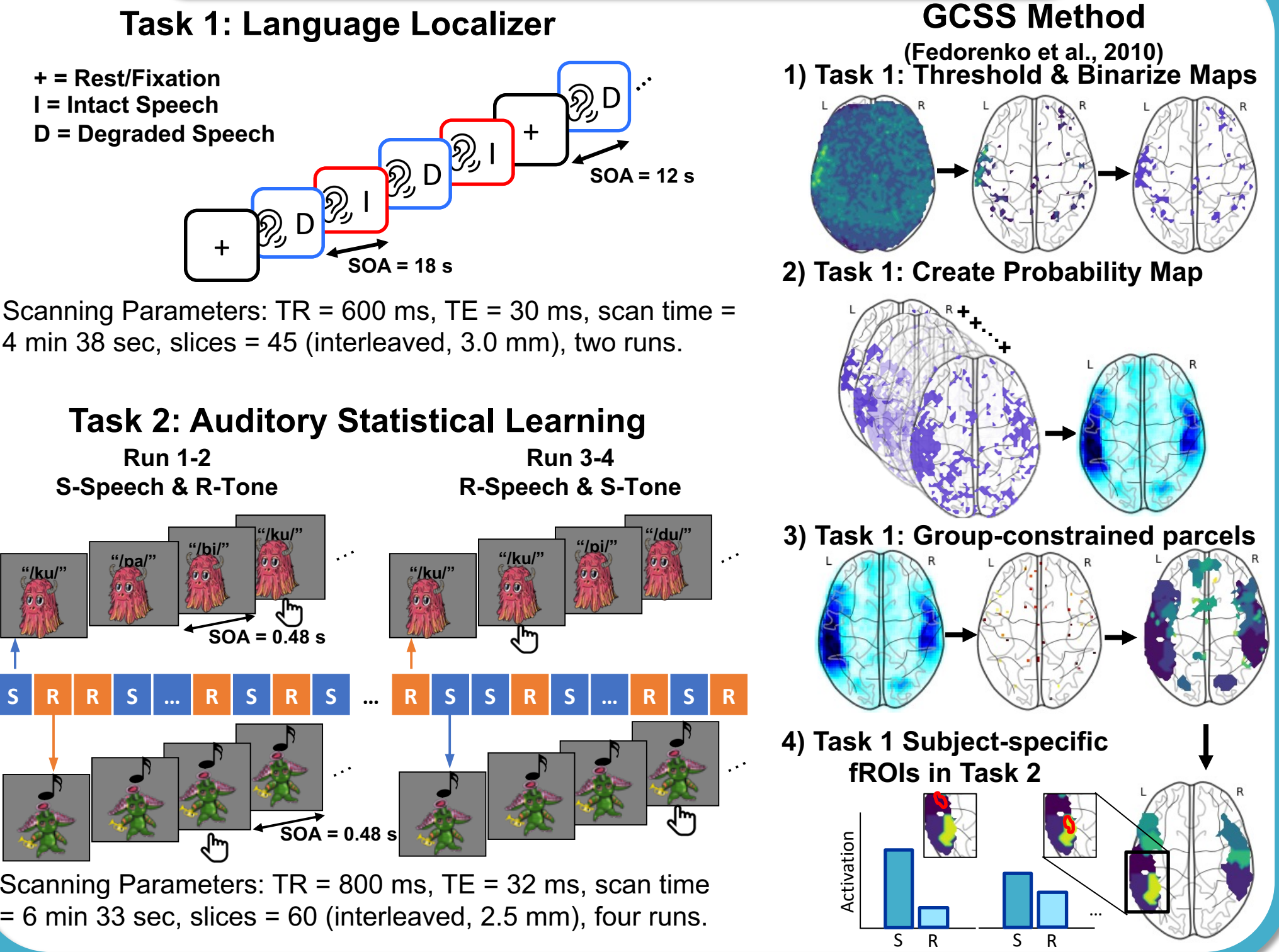
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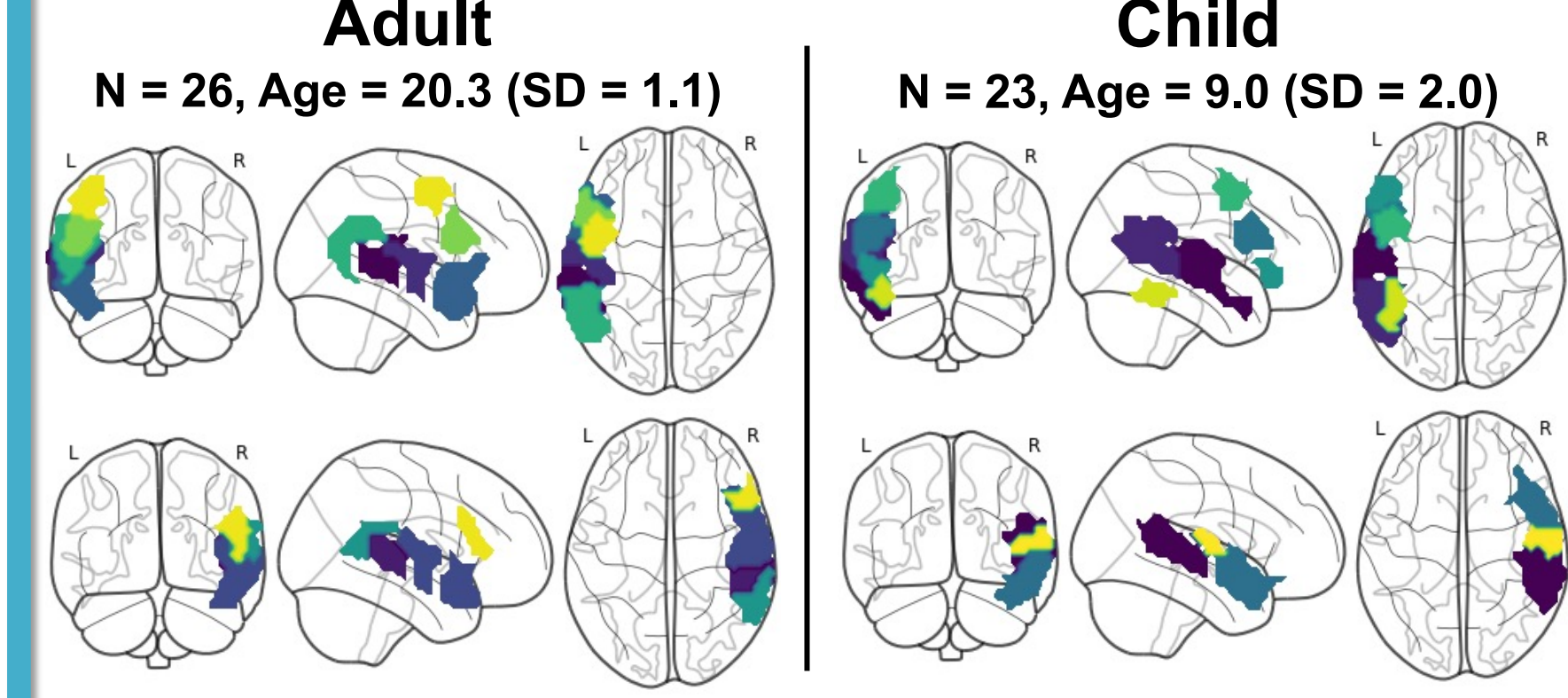
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THE GOALS

- Statistical learning (SL) is an implicit learning process to extract regularities from sensory inputs (Frost et al., 2019; Conway, 2020).
- SL is fundamental to language acquisition (Erickson & Thiessen, 2015) and language experiences, in turn, influence SL (Siegelman et al., 2018)
- Our previous behavioral findings (Hu et al., 2022) show children learn linguistic SL more rapidly than adults.
- What are the developmental changes in the brain when learning new patterns in the linguistic domain?

METHODS

Task 1: Language Localizer

+ = Rest/Fixation
I = Intact Speech
D = Degraded Speech

SOA = 12 s
SOA = 18 s

Scanning Parameters: TR = 600 ms, TE = 30 ms, scan time = 4 min 38 sec, slices = 45 (interleaved, 3.0 mm), two runs.

GCSS Method
(Fedorenko et al., 2010)
1) Task 1: Threshold & Binarize Maps
2) Task 1: Create Probability Map
3) Task 1: Group-constrained parcels
4) Task 1 Subject-specific fROIs in Task 2

Task 2: Auditory Statistical Learning

Run 1-2
S-Speech & R-Tone

Run 3-4
R-Speech & S-Tone

SOA = 0.48 s

Scanning Parameters: TR = 800 ms, TE = 32 ms, scan time = 6 min 33 sec, slices = 60 (interleaved, 2.5 mm), four runs.
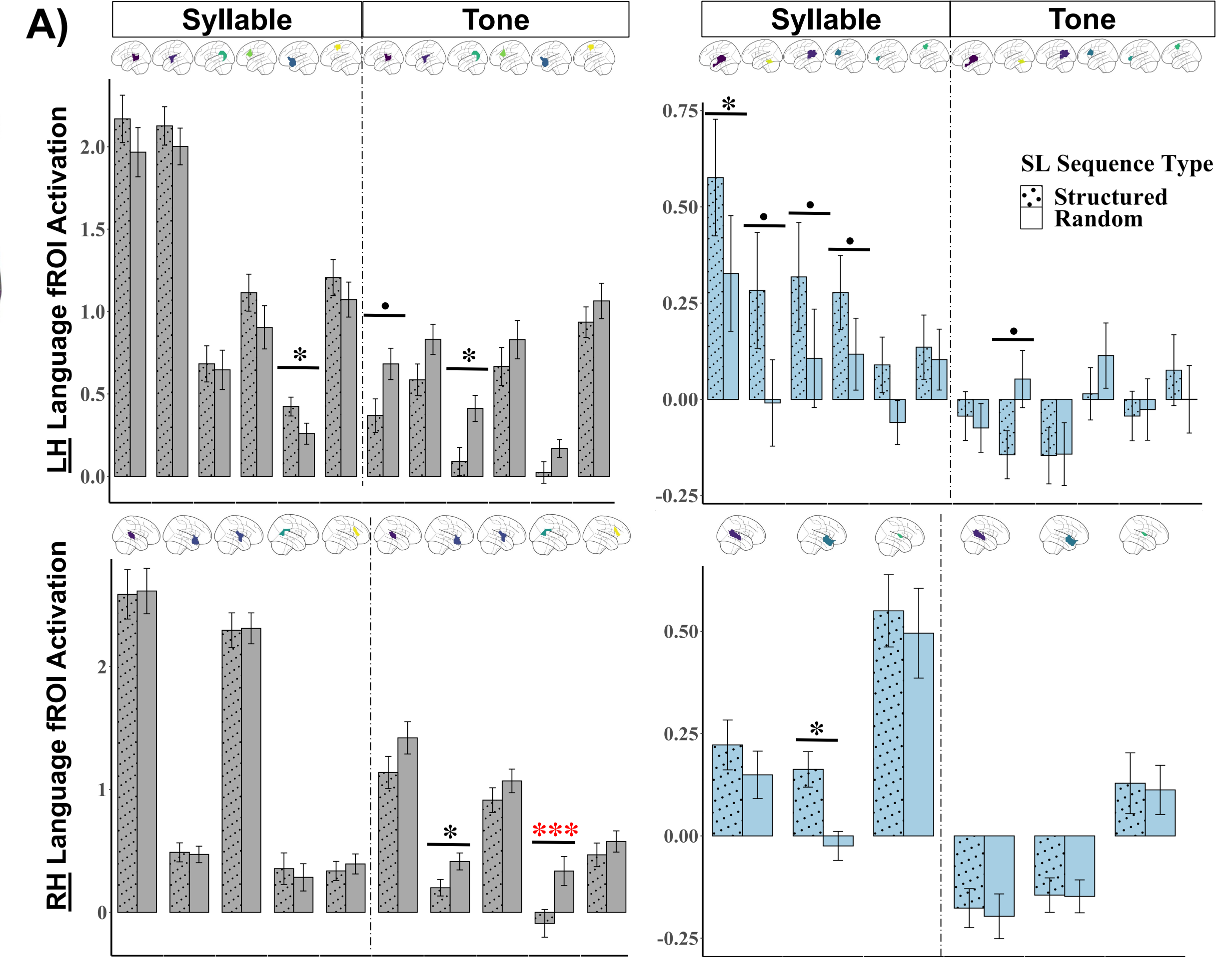

SUMMARY

- Linguistic, but not non-linguistic SL engages subject-specific language regions in the brain.
- Children's language regions show greater sensitivity to linguistic patterns than adults.
- Adults' attentional network is modulated to a greater degree by SL than children.
- Attention is associated with sensitivity in the language regions in children.

Conclusion:

Statistical learning results in 1) greater functional changes in developing than mature <u>language regions</u> and 2) greater modulation of <u>attention</u> in mature than developing brains.
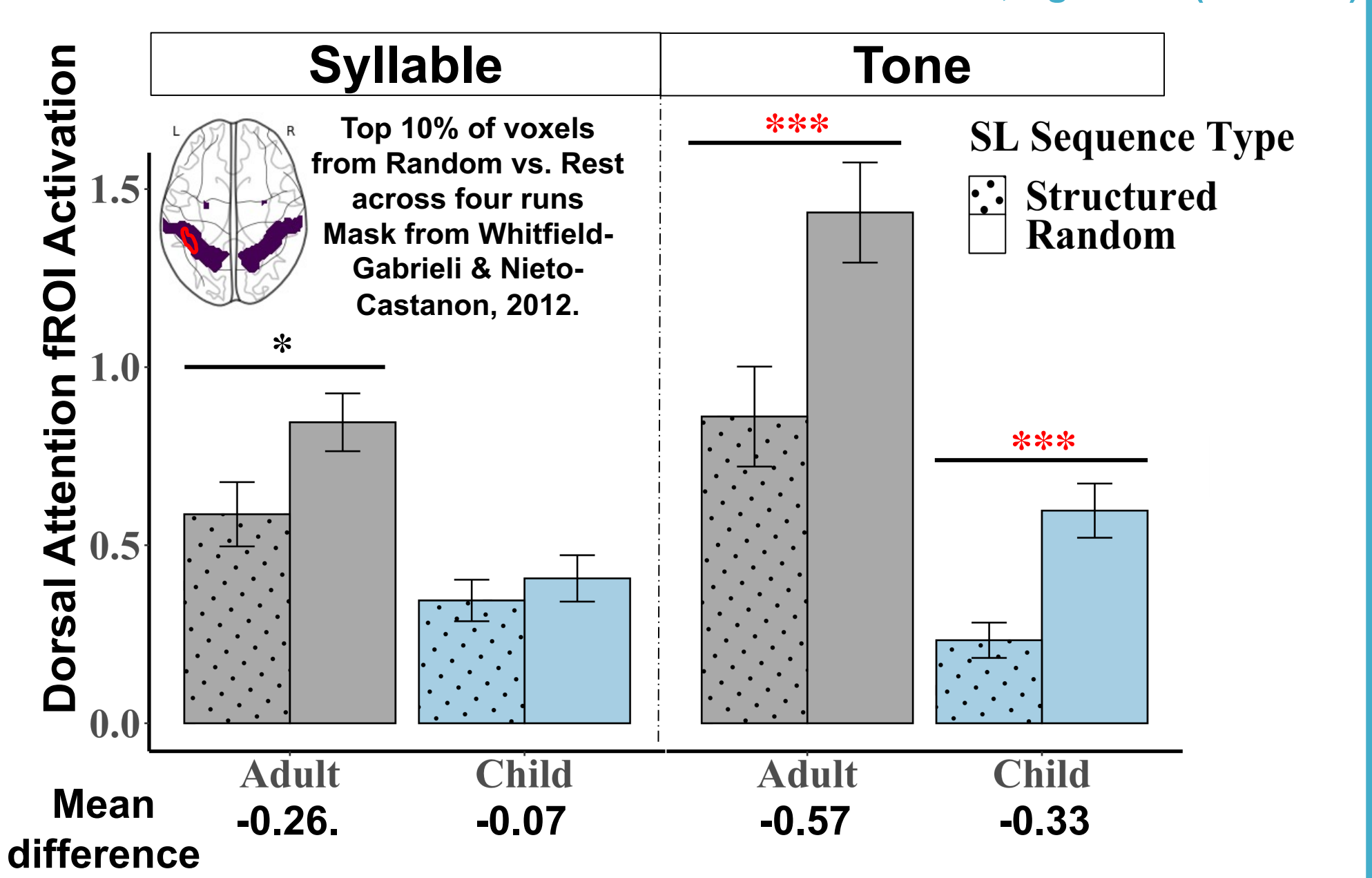
RESULTS

Analysis 1. Group constrained masks

Adult N = 26, Age = 20.3 (SD = 1.1)
Child N = 23, Age = 9.0 (SD = 2.0)

Analysis 2. Language Network in Syllable & Tone SL

Adult: N = 24, Age = 20.3 (SD = 1.2)
Child: N = 20, Age = 9.0 (SD = 2.0)

A)

SL Sequence Type: Structured / Random

LH Language fROI Activation
RH Language fROI Activation

B) Cohen's *d*

Analysis 3. Dorsal Attention Network in SL

Adult: N = 27, Age = 21.0 (SD = 3.0) **Child:** N = 25, Age = 8.6 (SD = 2.1)

Top 10% of voxels from Random vs. Rest across four runs Mask from Whitfield-Gabrieli & Nieto-Castanon, 2012.

SL Sequence Type: Structured / Random

Dorsal Attention fROI Activation

Mean difference	Syllable		Tone	
	Adult	Child	Adult	Child
	-0.26.	-0.07	-0.57	-0.33

Analysis 4. Correlation of the Dorsal Attention and Language Networks during Syllable SL

Adult N = 24, Age = 20.3 (SD = 1.1)
Child: N = 22, Age = 9.0 (SD = 2.0)

Language fROIs that are sensitive to speech patterns
Dorsal Attention fROI Activation

$R = 0.014$, ns
$R = 0.39$, $p < 0.07$

Reference