



# Assessing evidence for tonotopic organization of auditory-biased regions in prefrontal cortex using fMRI

## Lab in Multisensory Neuroscience

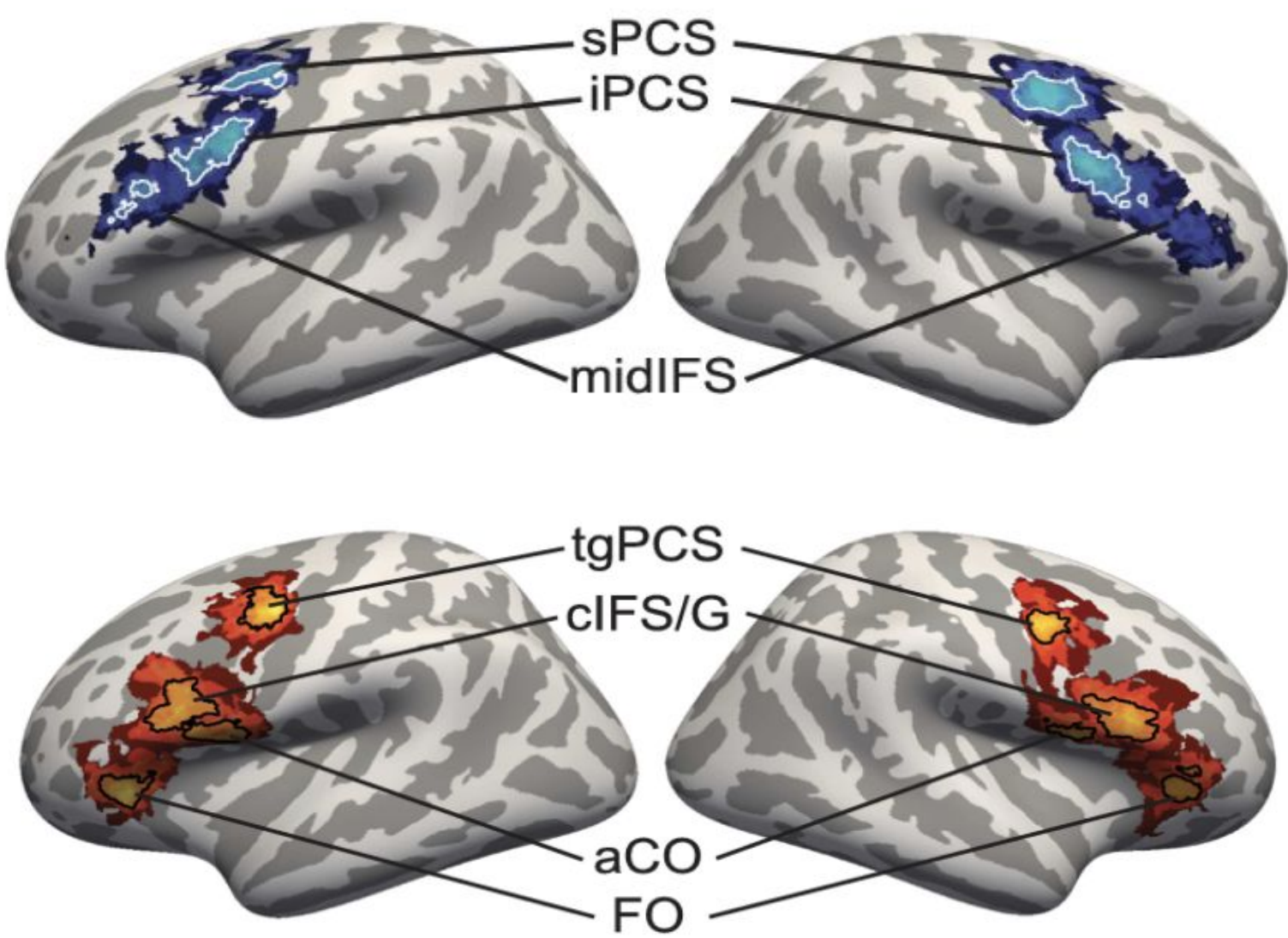
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Prefrontal cortex (PFC) participates robustly in cognitively demanding tasks and has been argued to be a general-purpose processing resource.

More careful mapping shows that PFC also contains discrete regions with a preference for sensory modality<sup>[1,2]</sup>:

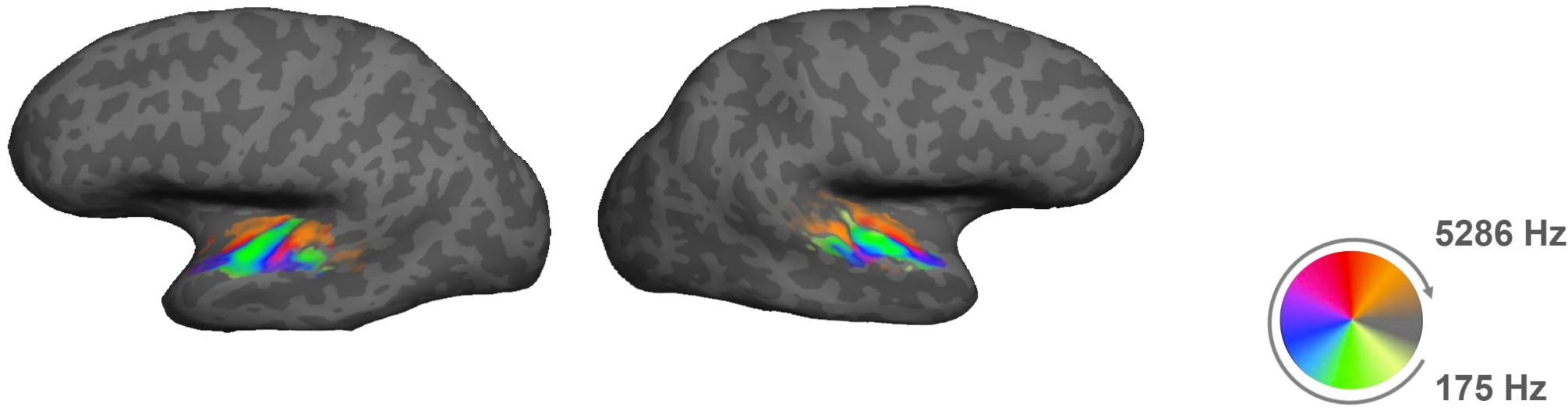
- **Visual-biased regions of PFC** (blue) are recruited for visual and spatial tasks, and are preferentially connected to visual cortex.
- **Auditory-biased regions of PFC** (orange) are recruited for auditory and temporal tasks, and are preferentially connected to auditory cortex.

[3]



Spatiotopic organization is observed throughout visual cortex, including in visually biased PFC regions<sup>[4]</sup>

Tonotopic organization is observed in the auditory periphery, and can be measured with fMRI in auditory cortex<sup>[5,6]</sup>.



Do **auditory-biased PFC regions** exhibit any evidence of **tonotopic organization**?

### Experimental Setup

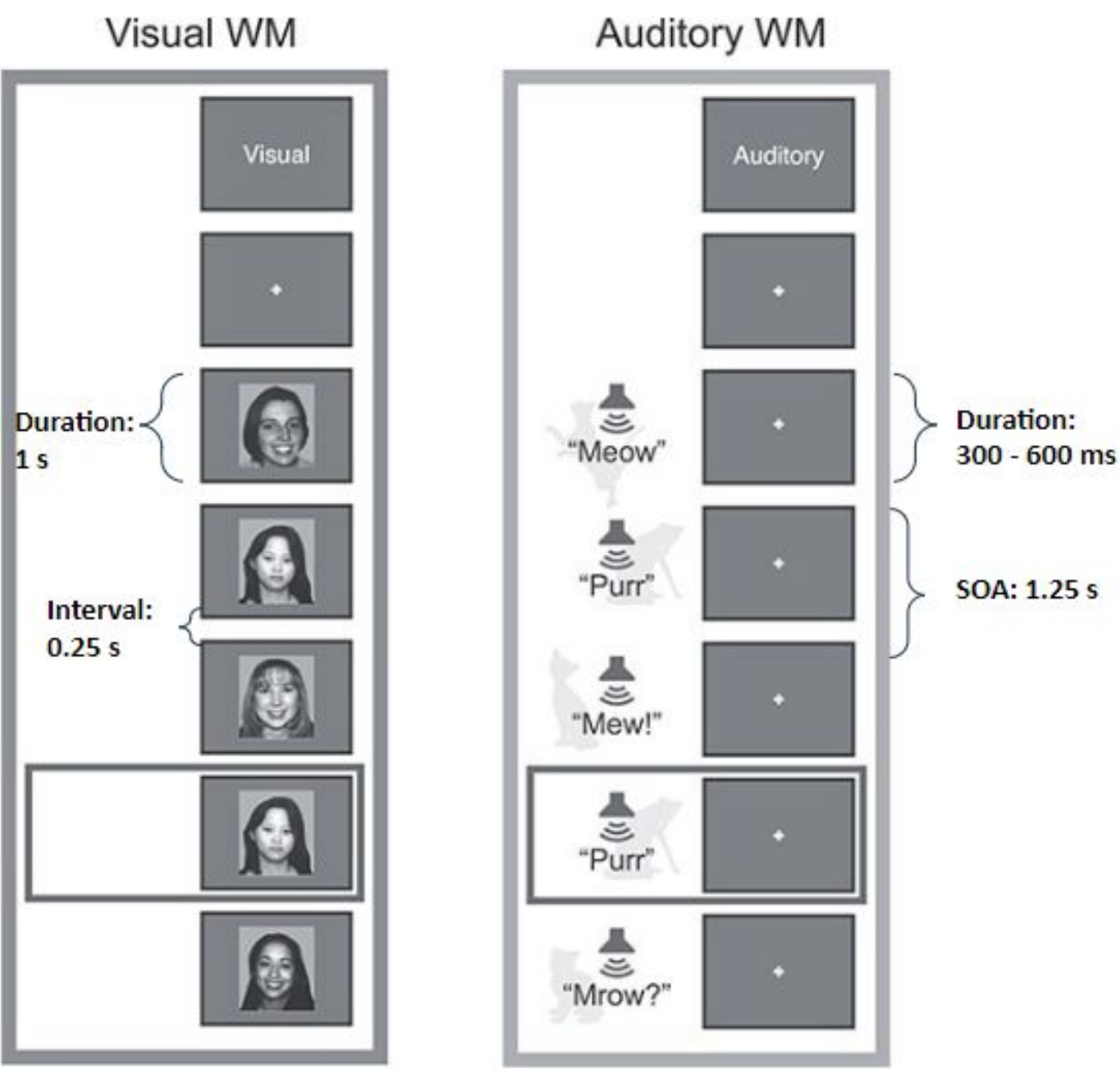
- N = 10 (total planned enrollment 24).
- Functional scans:
  - AV 2-back localizer task (4 runs)
  - Tonotopy 2-back task (4 runs)
- Structural images: High-resolution T1w and T2w scans were collected for cortical reconstruction.

### AV Localizer<sup>[2]</sup> (3-4 runs)

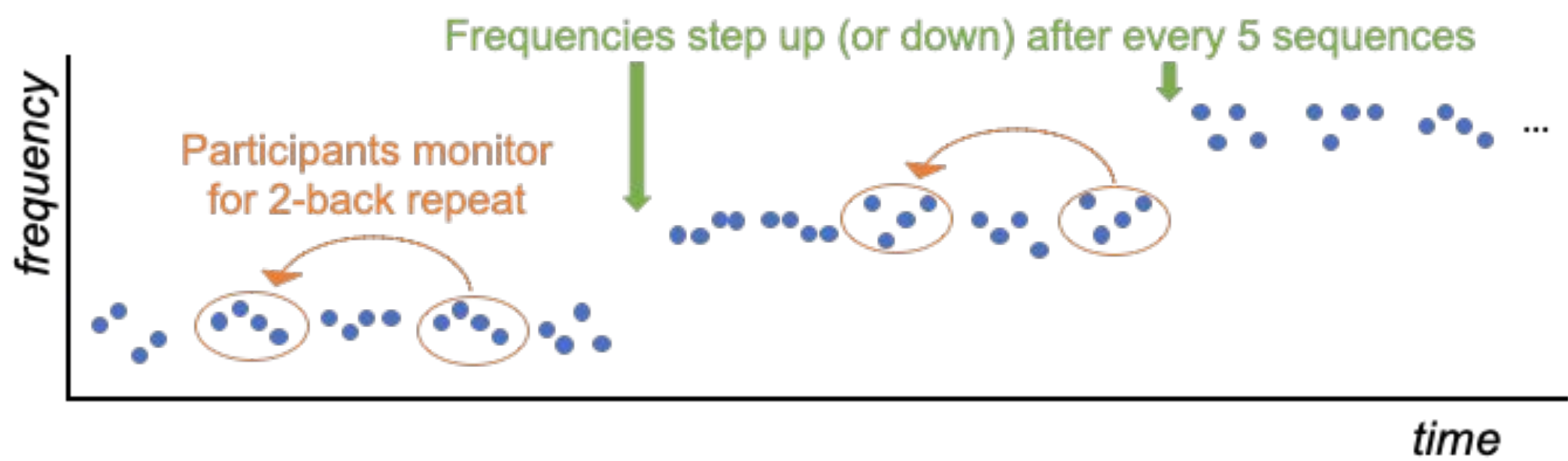
2-back WM task for visual (faces) or auditory (cat/dog vocalizations) items.

Per run: 8 32-sec blocks (4 A, 4 V).

Individual auditory-biased PFC labels defined from Aud > Vis contrast.



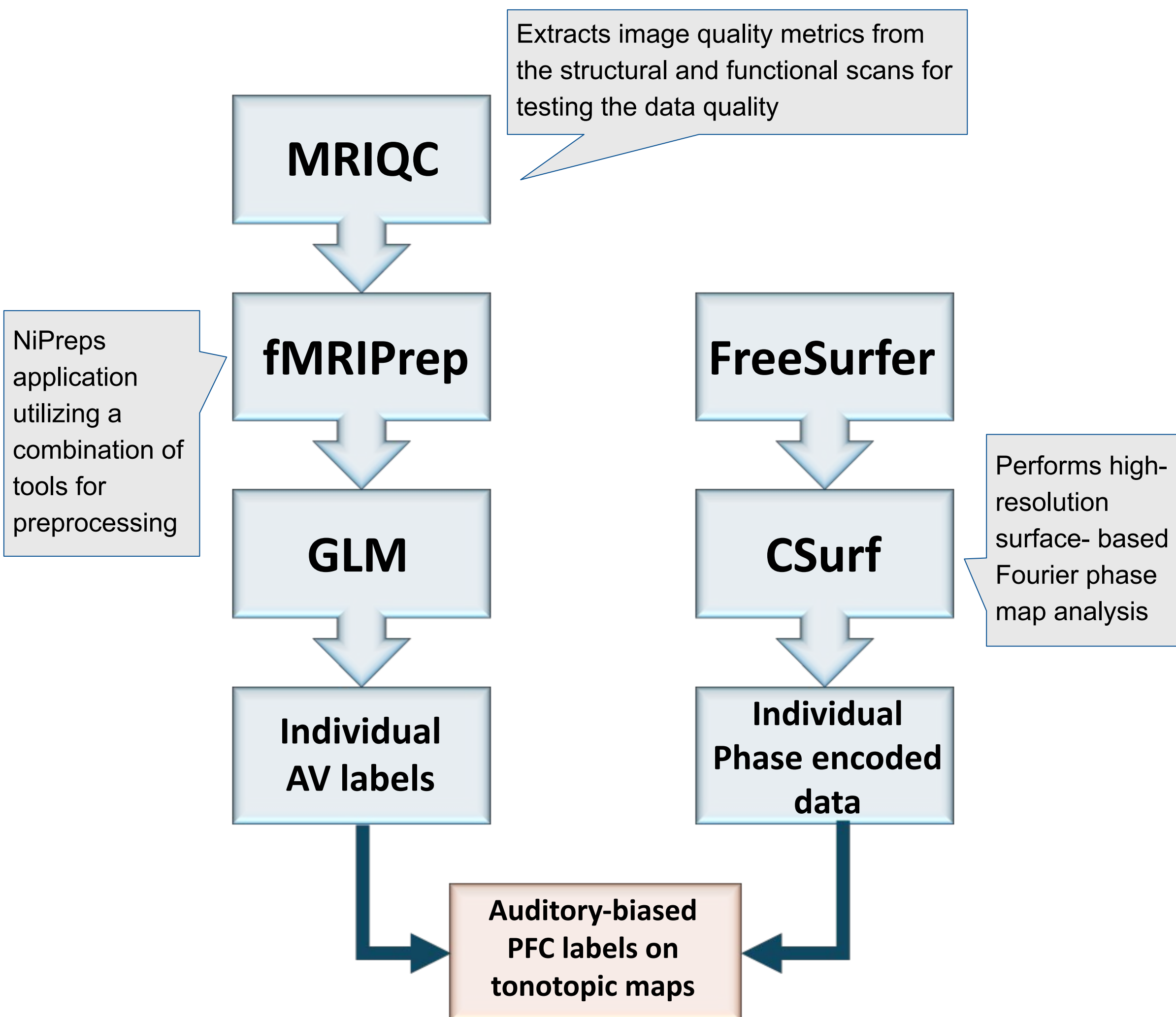
### Tonotopic mapping<sup>[5,6]</sup> (4 runs)



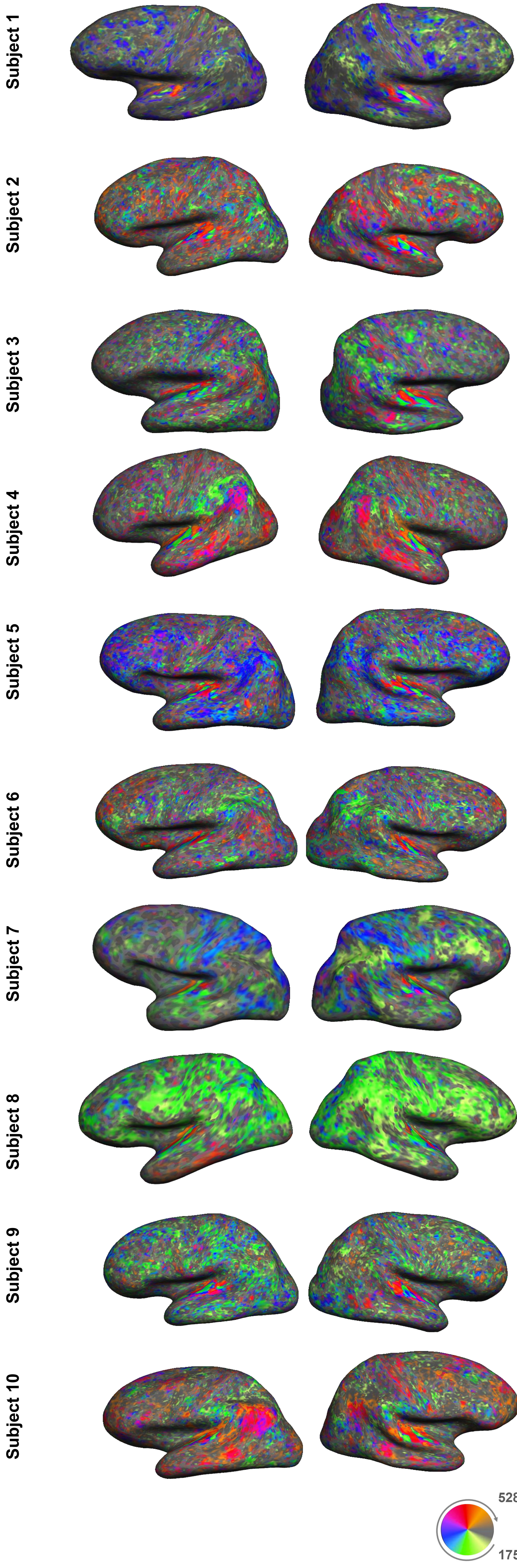
2-back WM task with 4-tone motifs (previous studies used 1-back), with tones stepping up or down in frequency across run (range: 175-5286 Hz); 4 sweeps/run (64 sec/sweep)

Critically, task employs a **phase-encoded design**: Each frequency range is presented at regularly spaced intervals. Coarse frequency preferences across cortex can thus be recovered from Fourier phase of functional data.

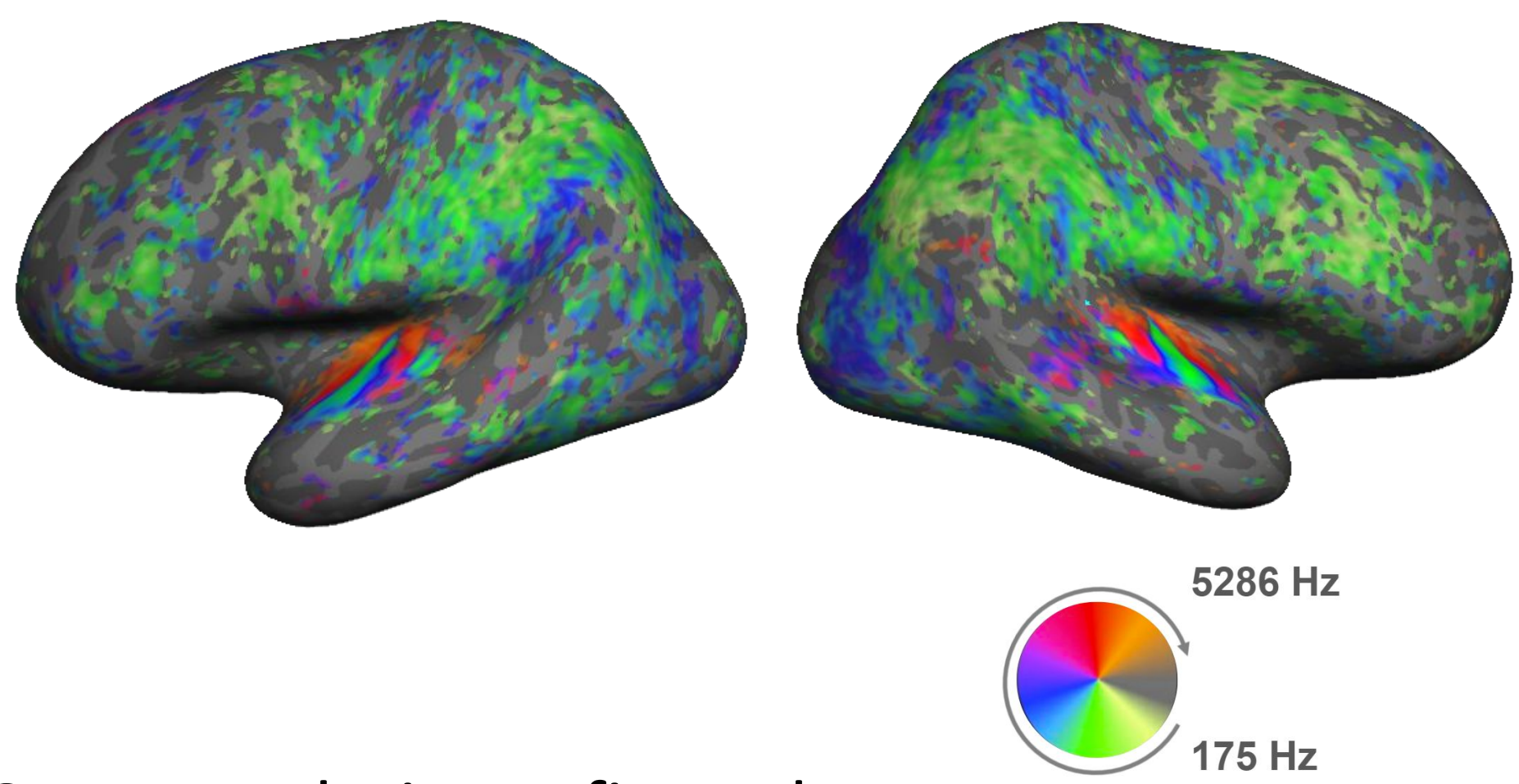
### fMRI Analysis



### Preliminary Results



### Group Analysis:



Group analysis confirms that there is a strong tonotopic arrangement in the auditory cortex but no such organization in the PFC regions

### Discussion

- Modifying the AV-localizer task by having four runs instead of eight runs showed efficient activation in the PFC regions similar to previous hypothesis<sup>[2]</sup>.
- We confirm **robust tonotopic organization in the auditory cortex**, similar to previous studies<sup>[5,6]</sup>.
- **Auditory biased regions in the PFC regions show no apparent frequency-selective organization** in spite of using a challenging two-back tonotopy task paradigm.
- Therefore, our findings suggest that there is no tonotopic arrangement in the auditory biased PFC regions.

### Future Scope

- Region-specific quantification of functional results
- Further investigation of specialization within auditory-biased PFC regions (e.g. language processing<sup>[7]</sup>).
- Assessment of functional connectivity between PFC and posterior regions.

### Acknowledgements

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### References

- <sup>1</sup> Michalka et al. (2015). *Neuron*.
- <sup>2</sup> Noyce et al. (2017). *Journal of Neuroscience*.
- <sup>3</sup> Noyce et al. (2022) *Cerebral Cortex*.
- <sup>4</sup> Mackey et al. (2017). *Elife*.
- <sup>5</sup> Dick et al. (2017). *Journal of Neuroscience*.
- <sup>6</sup> Luthra et al. APAN 2024 Poster A55.
- <sup>7</sup> Fedorenko et al. (2024). *Nature Reviews Neuroscience*.