# Hierarchy of Cortical Population Timescales Inferred from LFP & ECoG

# Richard Gao<sup>1</sup>, Bradley Voytek<sup>1-3</sup>

rigao@ucsd.edu | \_\_\_\_rdgao

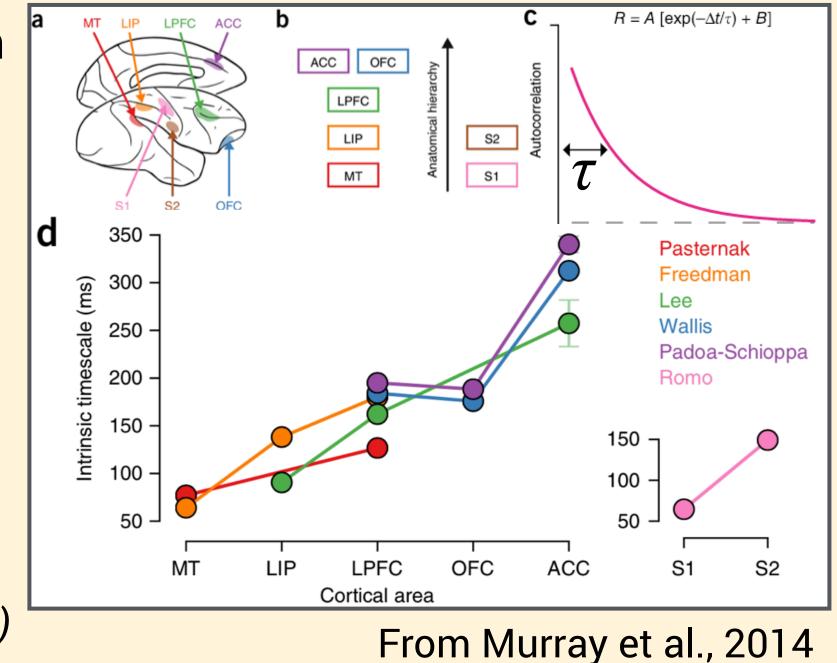
- 1. Department of Cognitive Science
- 2. Neurosciences Graduate Program
- UC San Diego
- 3. Halıcıoğlu Data Science Institute

## Background: Intrinsic Spiking Population Timescale

By measuring the **decay time constant of autocorrelation** in population spiking, previous works report:

- Hierarchical: intrinsic timescale increases along cortical hierarchy, i.e. sensory and association areas exhibit shorter and longer timescales, respectively;
- Functional: intrinsic timescales are functionally significant in working memory and decision-making.

(Murray et al., 2014; Runyan et al., 2017; Wasmuht et al., 2018)

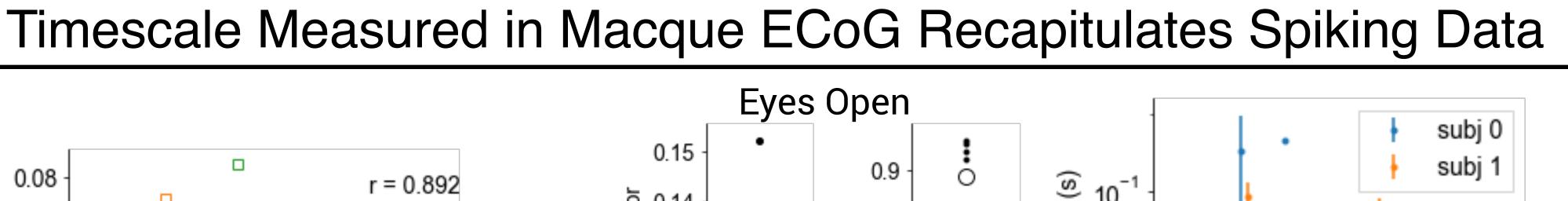


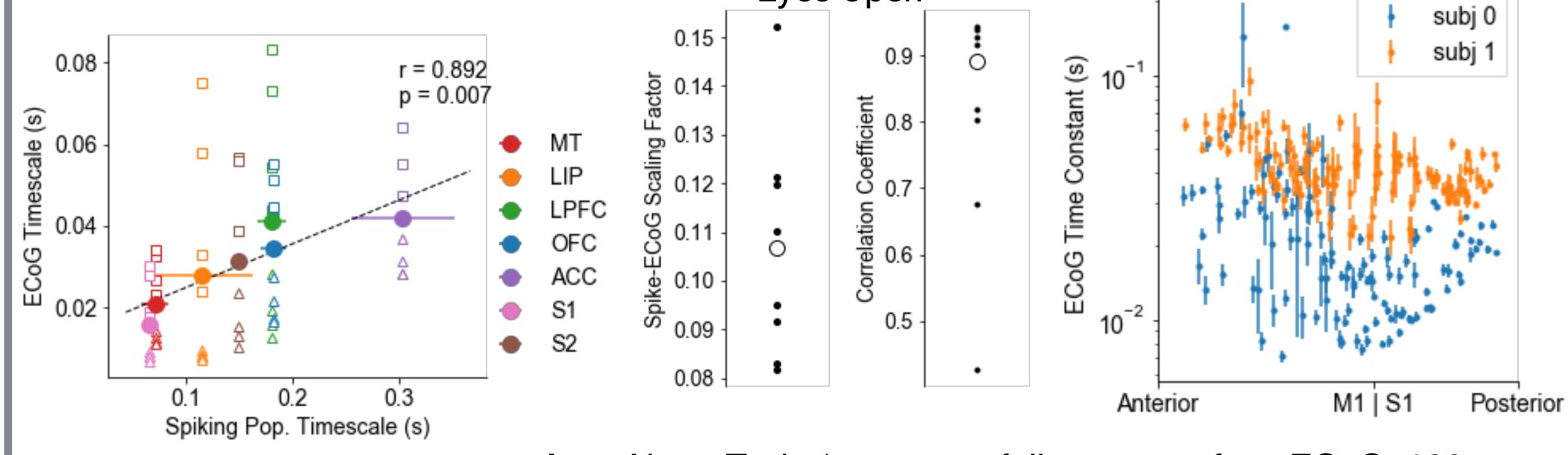
rioni ividitay et al., 201-

**Summary**: we recapitulate & extend these results in **broad coverage** macaque and human intracranial data via spectral parameterization.

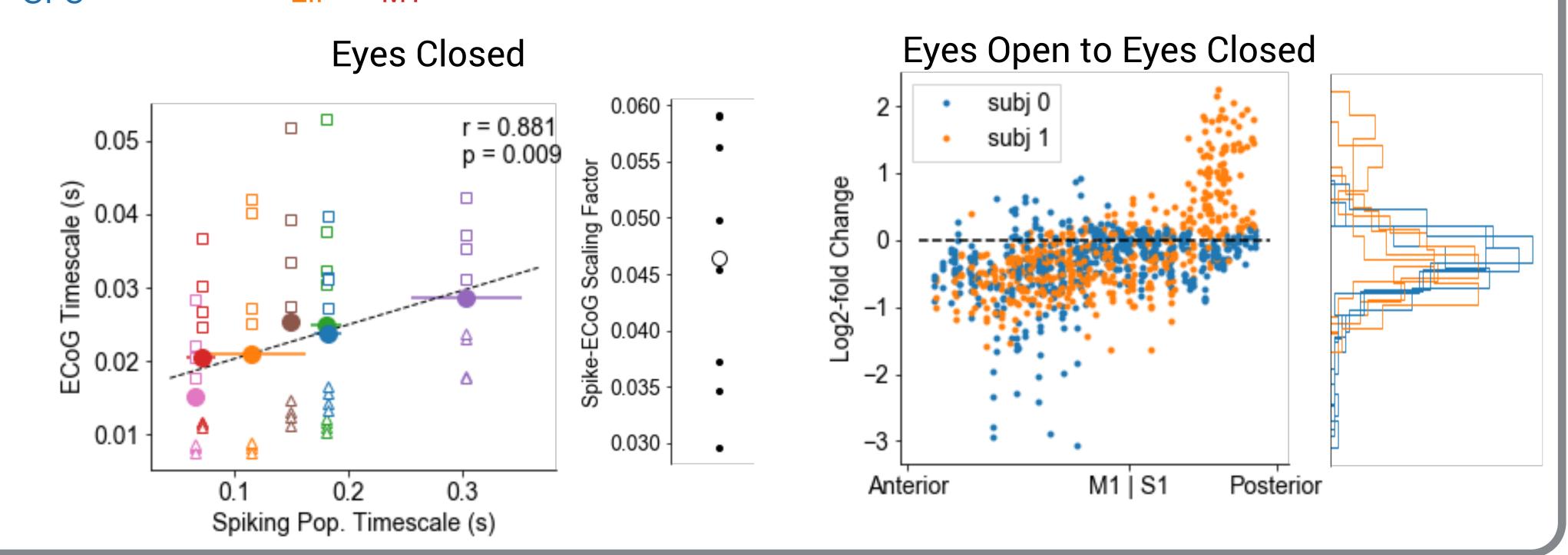
# Method & Simulation: Inferring AC Timescale from Power Spectra $P = \frac{A}{(k+f^{\chi})}$ A: 'offset' k: 'knee' x: 'exponent' "Knee" in PSD is equivalent to temporal decay constant in autocorrelation. https://fooof-tools.github.io/fooof/

## Results





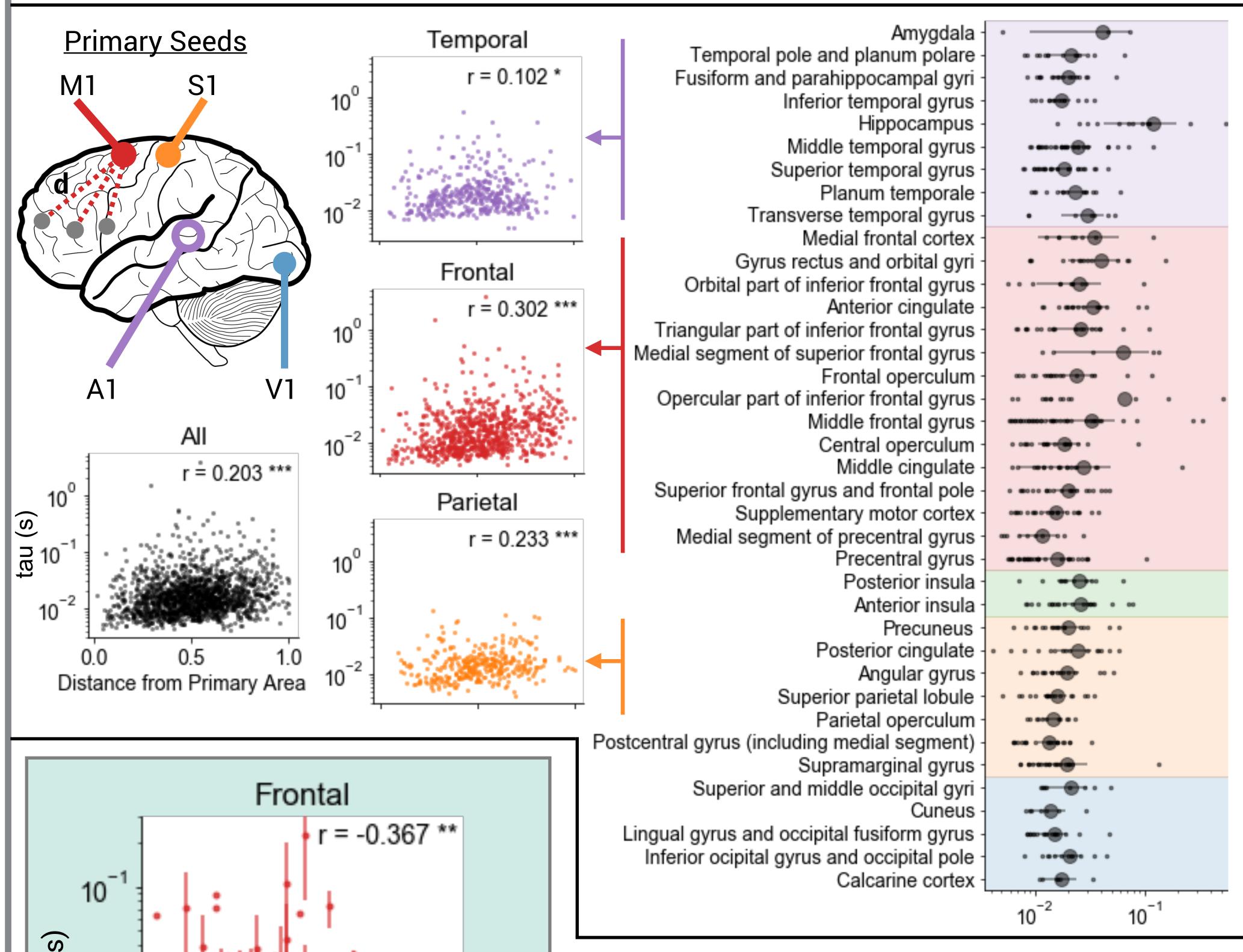
- data: NeuroTycho\* macaque full-cortex surface ECoG: 128 channels, 2 subjects, 4 recordings each
- top row: ECoG timescale correlates with spiking population timescale with a scaling factor of 0.1; increases along cortical hierarchy (away from central sulcus), especially in frontal regions
- bottom row: timescale is decreased in most regions by ~2-fold when subject transitions from eyes open to eyes closed, especially in frontal regions, but not in posterior regions. http://neurotycho.org/anesthesia-and-sleep-task



## Timescale in Human ECoG & iEEG Exhibits Functional Hierarchy

True time constant (s)

Haller, Donoghue, Peterson et al., 2018 (preprint)



60

age

- data: MNI human clinical ECoG\*: 1-min eyes closed resting, 1772 electrodes, 106 patients
- top: timescale increases with distance from respective primary sensorimotor areas.
- **left**: population timescale **decreases with age** in frontal electrodes.
- \* https://mni-open-ieegatlas.research.mcgill.ca/