Merging PET and MEG Neuroimaging Graphs to Predict Alzheimer's Conversion in People with Preclinical Alzheimer's Disease Pathology

PRESENTER:

Kevin Louie,
Santiago I. Flores Alonso,
Angelica Lim, Alex I. Wiesman,
Simon Fraser University

BACKGROUND: Decades before the onset of Alzheimer's disease, individuals may already be unknowingly accumulating harmful amyloid and tau proteins associated with the disease.

In this study, we aim to identify whether the influence of key neurochemical systems on brain connectivity can differentiate healthy agers from those that will progress to Alzheimer's.

METHODS

PREVENT-AD Research Group

neuromaps

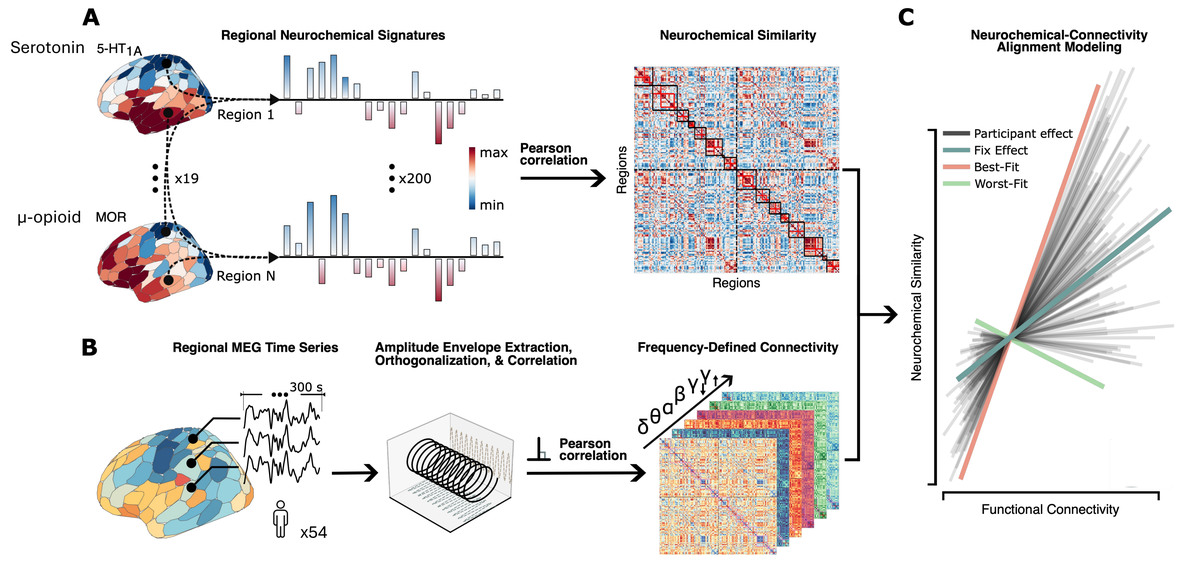
Datasets

- **PREVENT-AD**: Processed MEG, T1w MRI, and PET (amyloid & tau concentration) data from 54/129 asymptomatic adults (ages 50-55+) for analysis.
- **Neurochemical Similarity Atlas**: Matrix containing the average neurochemical similarity scores for each pair of brain regions. Constructed from the neuromaps dataset consisting of healthy individuals.

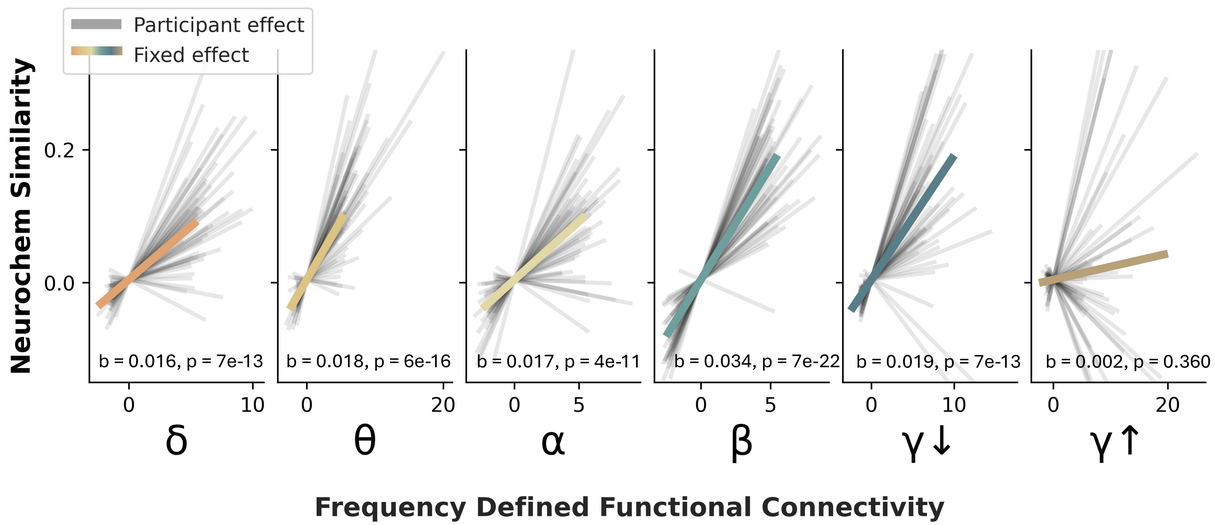
Procedure

1. **FreeSurfer**: Processed structural MRI scans to reconstruct 3D brain, skull, and scalp surfaces.
2. **Boundary Element Model (BEM)**: Computed the BEM of the brain, skull, and scalp to model the conductivity from the brain out to the scalp (forward solution).
3. **Coregistration**: MEG sensors and structural head model were aligned to the same coordinate space.
4. **Preprocessing & Beamformer**: Cleaned noisy MEG data and ran a beamformer algorithm to estimate the true brain signal activity (delta, theta, alpha, beta, low gamma, high gamma) for each brain region.
5. **Functional Connectivity (FC) Matrices**: Built matrices using amplitude envelope correlation for each pair of brain regions.
6. **Linear Mixed Models**: Modelled the baseline effect and the effects of both amyloid and tau separately on the relationship between FC and neurochemical similarity.

Baseline brain **connectivity-neurochemistry** alignment persists in people with **Alzheimer's disease** pathology.

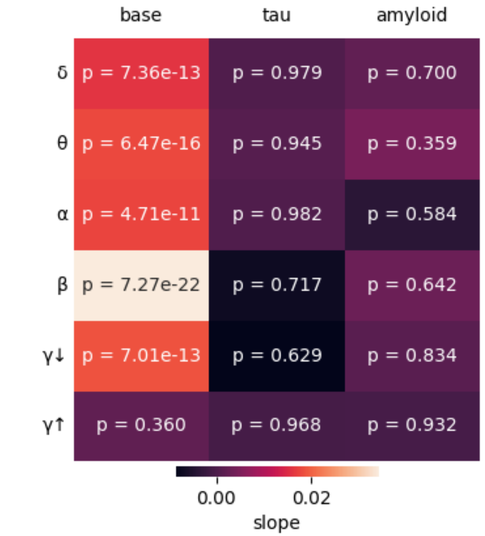


Pipeline integrating PET-derived neurotransmitter maps with frequency-resolved MEG connectivity.
(A) Neurochemical similarity from parcellated PET maps. **(B)** Band-limited MEG Amplitude Envelope Correlation (AEC) functional connectivity. **(C)** Linear mixed-effects modelling of neurochemical-connectivity alignment.



(D) Baseline models show significant linear relationship between FC & neurochemistry

RESULTS



(E) Tau and amyloid interaction had no significant effect on relationship

DISCUSSION

- The established alignment between FC and neurochemistry generalizes to individuals with amyloid and tau accumulation.
- No evidence that amyloid and tau pathology significantly moderates this relationship.

FUTURE RESEARCH

- Differentiating healthy agers from individuals who will progress to Alzheimer's disease.
- Adjust data processing to clean major subject-specific artifacts in MEG signal data for subjects who failed QC to increase sample size.
- Non-parametric spin tests to address spatial auto correlation between brain regions.

Kevin Louie,
kevin_louie_2@sfu.ca

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