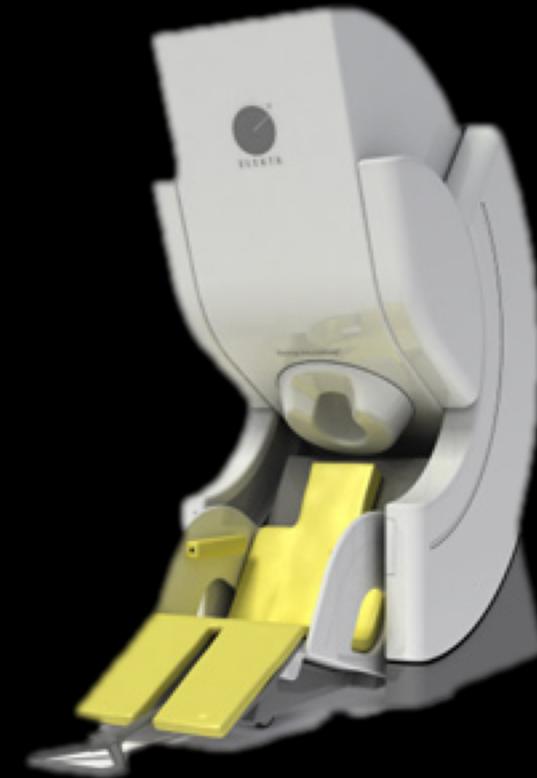
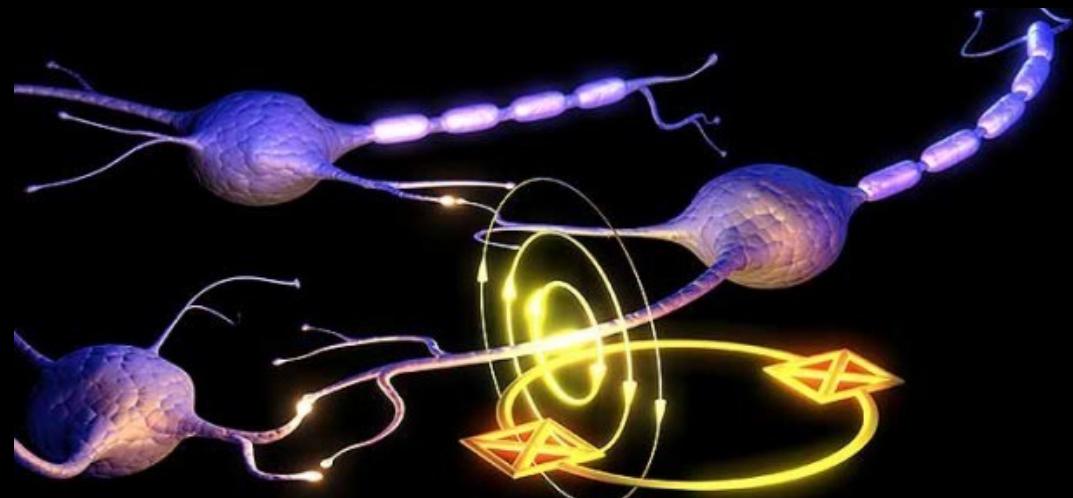


Multifrequency analysis of brain connectivity using MEG

Jeremy GUILLOU, PhD student



Magnetoencephalography?



« Electromagnetic waves are produced whenever charged particles are accelerated »

Multifrequency analysis?



Gamma: 30-100+ Hz

Binding senses, cognition, information processing, learning, perception, REM sleep



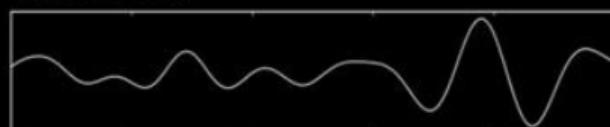
Beta: 12-30 Hz

Conscious focus, memory, problem solving



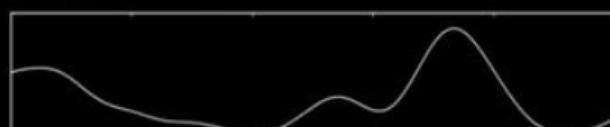
Alpha: 8-12 Hz

Relaxation



Theta: 4-7 Hz

Creativity, emotional connection, intuition, relaxation



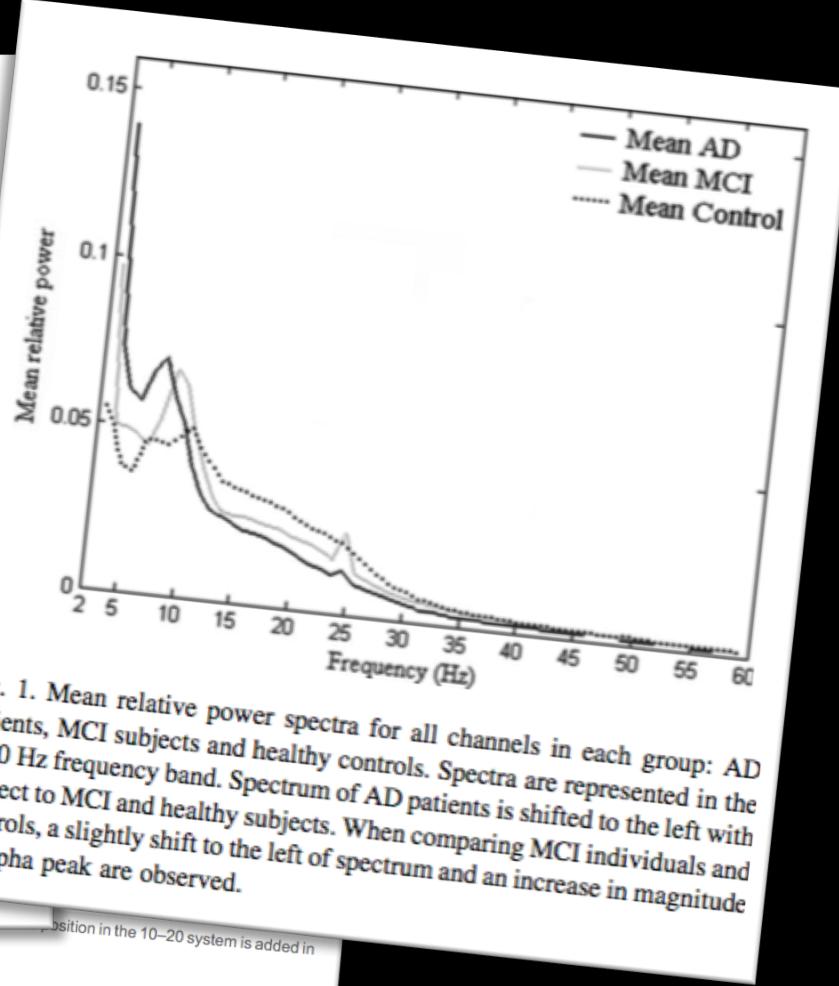
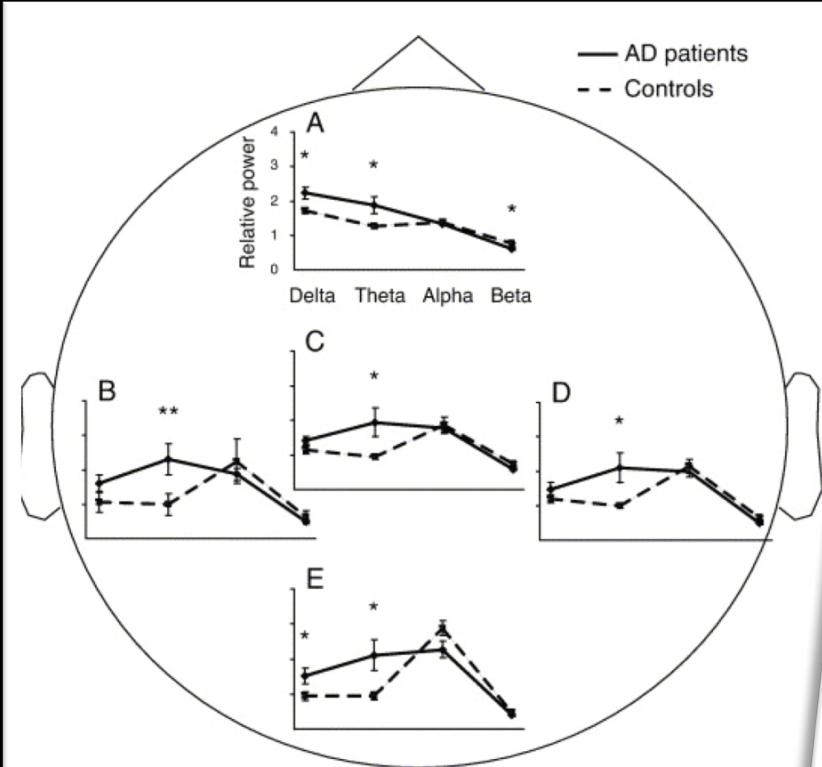
Delta: 0-4 Hz

Immune system, natural healing, restorative / deep sleep

...and in Alzheimer disease?

MEG Signals Power Spectra

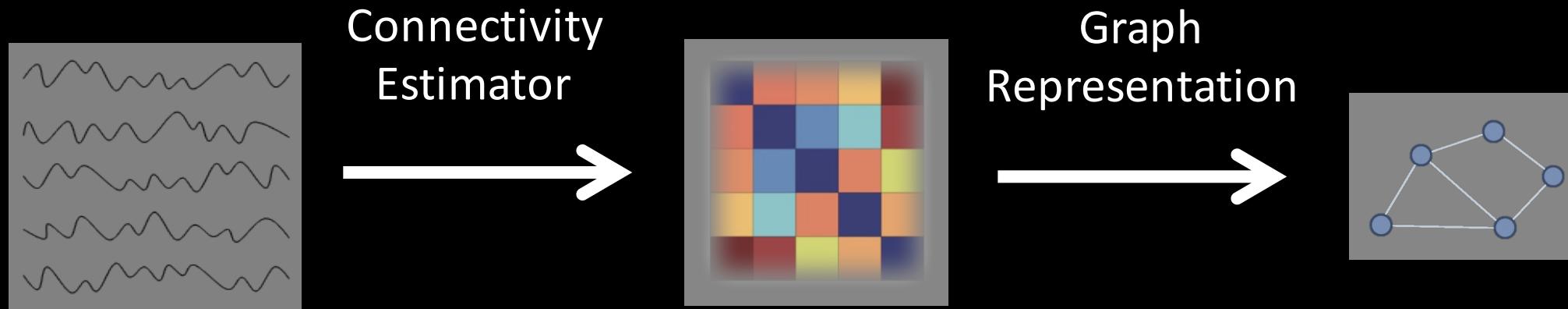
What does the literature say?



Fernández et al., 2006
Berendse et al., 2000
Osipova et al., 2005

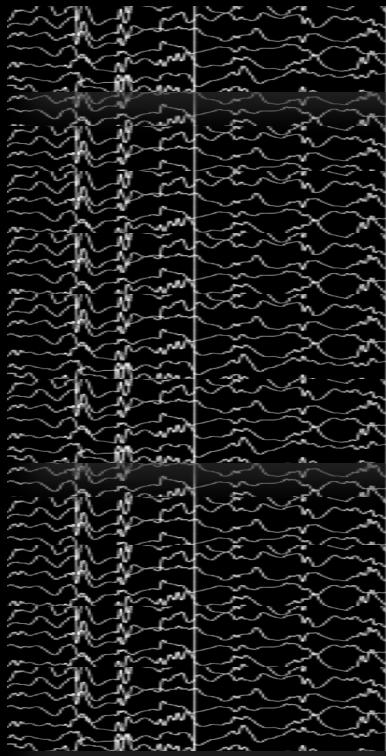
> Values are means (SE).
: * $P < 0.05$; ** $P < 0.01$ (Mann-Whitney U test for two independent samples).

Brain connectivity networks construction

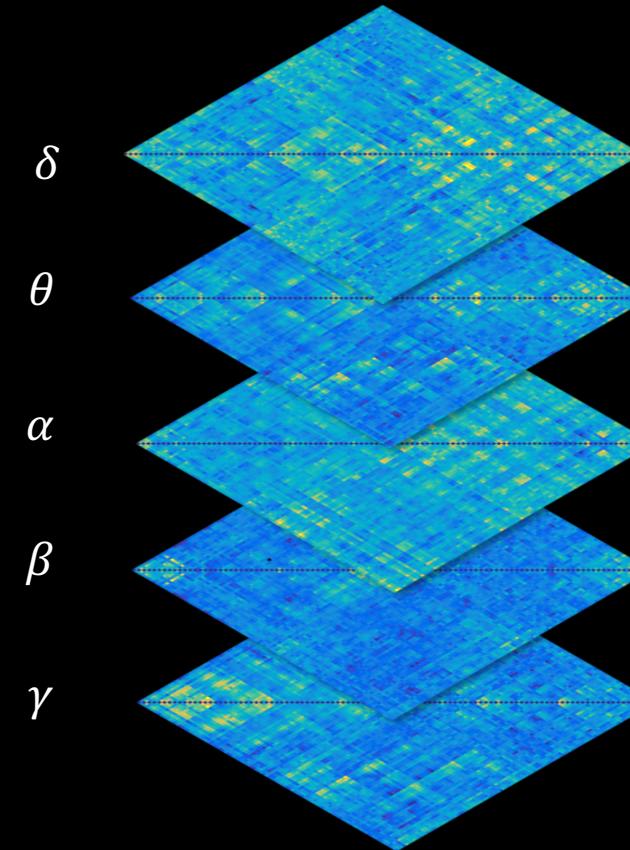


Ex.: Cross-Correlation $(f \star g)[n] = \sum_{m=-\infty}^{\infty} f^*[m]g[m + n]$

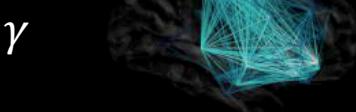
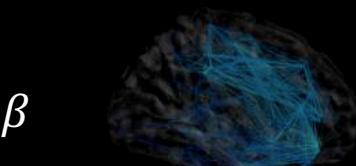
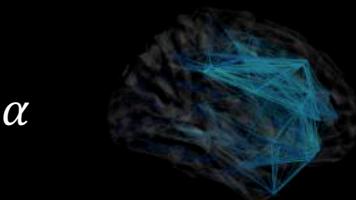
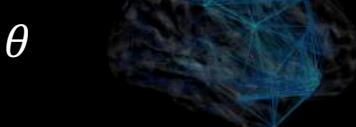
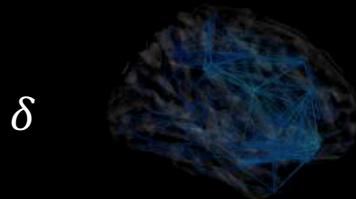
Brain networks in Alzheimer patients



Spectral
Coherence



Topological network characterization



Index
Extraction

- Clustering coefficient
- Average shortest path length
- Participation coefficient

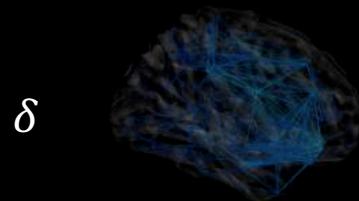
Topological analysis?

Results

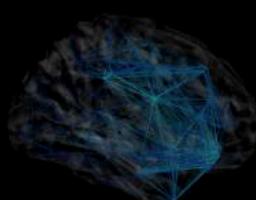
- 
- Clustering coefficient in AD > HC in δ -band
 - Clustering coefficient in AD < HC in α -band
 - Path length in AD < HC in δ -band
 - Path length in AD > HC in α -band
 - Nothing for the Participation Coefficient

Stam et al. 2007 and 2009
de Haan et al. 2009

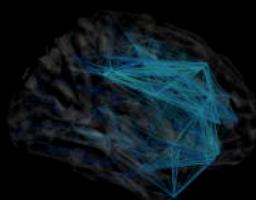
Topological network characterization



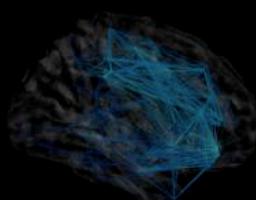
δ



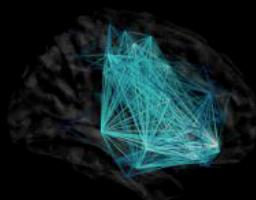
θ



α



β

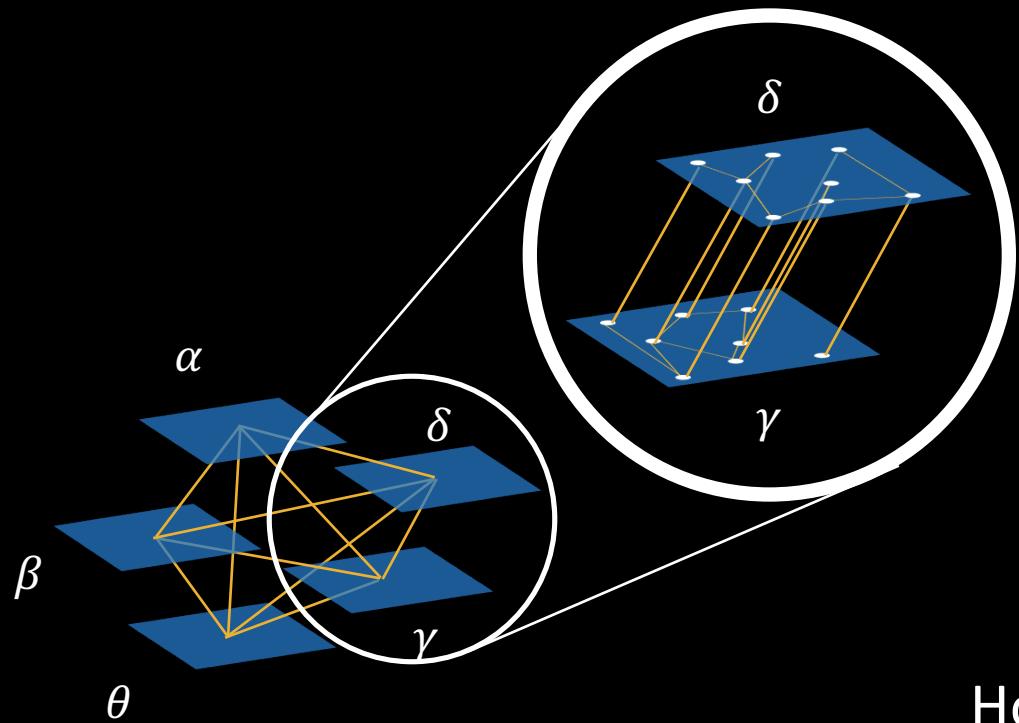


γ

Index Extraction

- Clustering coefficient
- Average shortest path length
- Participation coefficient

Multiplex Construction



How to characterize such
networks?

Multilayer Networks



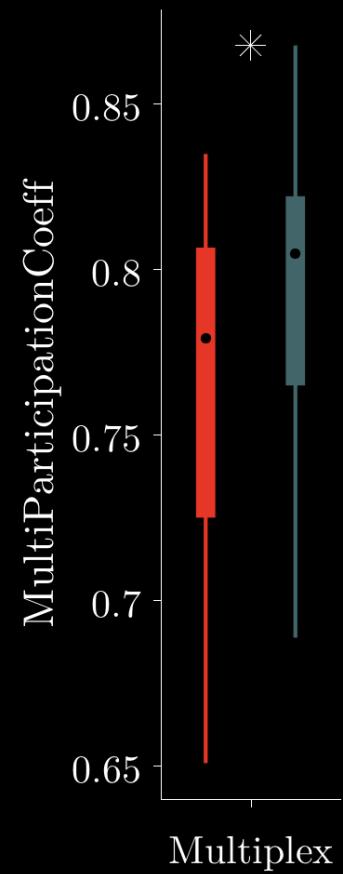
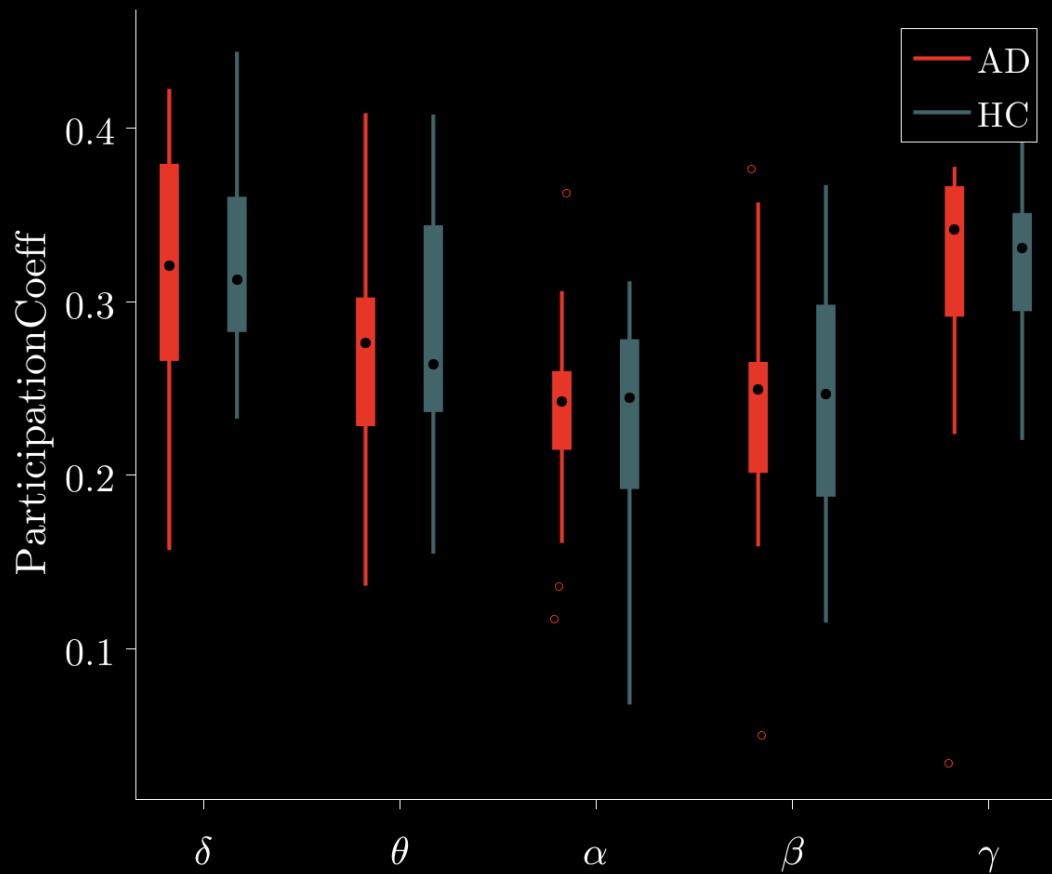
Topological Characterization

Index Extraction

- Clustering coefficient
- Average shortest path length
- Participation coefficient
- Multi-1/2-Clustering coefficient
- Interdependence
- Multi-Participation coefficient

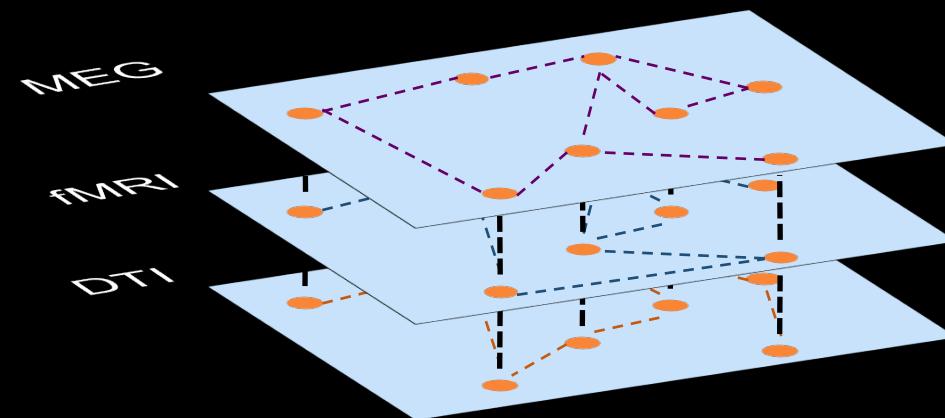
$$P_i = \frac{M}{M-1} \left[1 - \sum_{\alpha=1}^M \left(\frac{k_i^{[\alpha]}}{o_i} \right)^2 \right]$$

Preliminary Results



What about the future?

Apply this methodology to multimodal networks



Thank you for your attention



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[Co-Supervisor]



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Fabrizio
De Vico Fallani
[Supervisor]

Power spectrum density

