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# Altered EEG network profile after a first unprovoked seizure: an application of a clinical routine big-data sample

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## Introduction

Diagnosing epilepsy after a first unprovoked seizure, especially without visible lesions and with a normal routine EEG (rEEG), remains challenging.

To understand EEG network changes in this scenario, data acquired close to the acute event is needed as well as follow-up information. Hence, a big-data source is necessary with adequate selection of cases. Here, the UMG database (>34,000 routine EEGs) presents a valuable resource for studying epilepsy and other conditions.

In the current study, considering the exclusion and inclusion criteria, a month was needed to selected 42 rEEGs. AI could significantly reduce the time needed to find adequate data sets and improve case selection, opening the possibility for faster data collection and analysis.

## Objectives

Evaluate the connectivity and power of brain networks in 1) untreated patients after a first unprovoked seizure (vs healthy controls) and 2) patients that developed epilepsy in contrast to the ones that remained with one seizure.

## Sample (>34,000 rEEGs)

- First seizure patients (42)
  - One seizure-only (n = 22) vs Controls (n = 46)
  - Epilepsy (n = 18) vs Controls (n = 46)
  - Epilepsy (n = 18) vs One seizure-only (n = 22)
- Healthy controls (46)

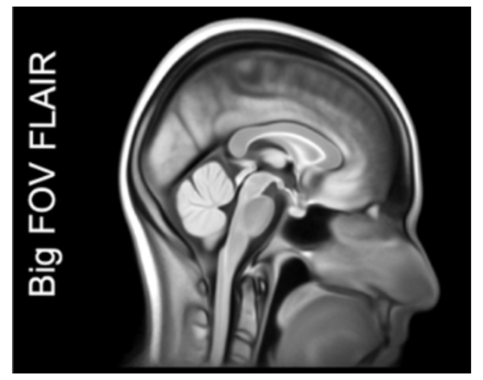
## Methods

- 4 min of resting-state EEG
- First unprovoked seizure patients
- **Retrospective**
- Age and sex matched controls

### EEG signal recording and processing

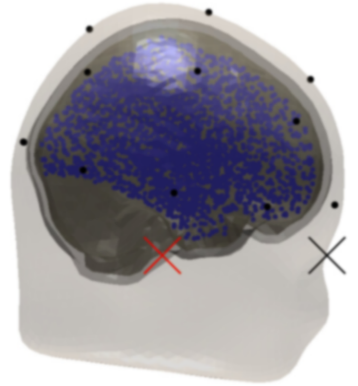
The data exported from the Natus® system with a sampling frequency of 500 Hz. The data was processed as described elsewhere (Marquetand et al., 2019) using Fieldtrip (Oostenveld et al., 2011) and Matlab (v9.0, R2017b, MathWorks). Signal power and cross-spectral densities were estimated on the Fourier transformed sensor data and projected to source space using beamforming (Gross et al., 2001) in six frequency bands (1-40 Hz).

### Source reconstruction



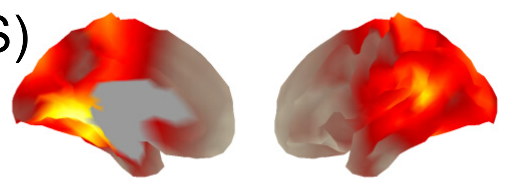

(T1+Flair template)

- Freesurfer
- SUMA



(Canonical headmodel and lead field)

- Vertices as EEG source points (n = 2,338).
- Beamforming method (DICS)



- Sourced-reconstructed power and the imaginary part of coherency between all pairs of vertices
- Group comparison analyzed using Permutation Analysis of Linear Models (PALM). At the vertex level TFCE was implemented. FWE was performed for p-values within each group contrast. Effect sizes (Cohen's d) for vertex-based and global group comparisons were derived from the t- values of the linear models.

## Results

**Fig.1. First seizure vs controls**

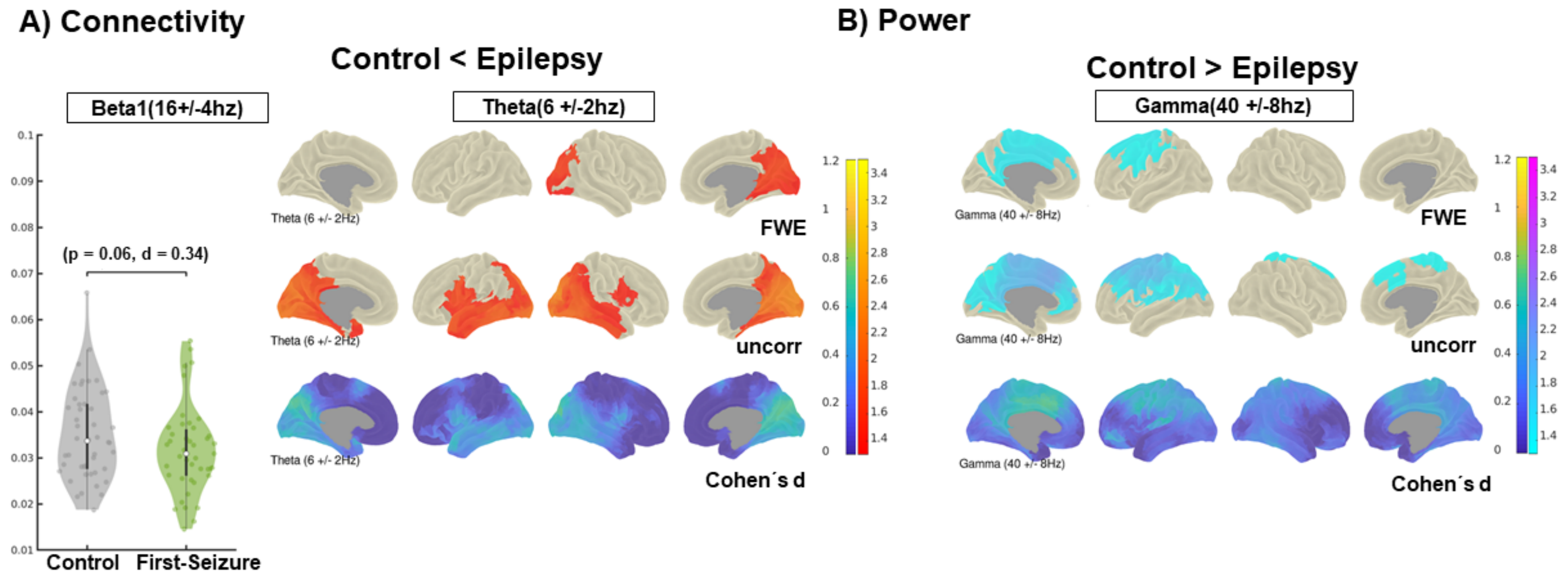



**Fig.2. Epilepsy vs controls**

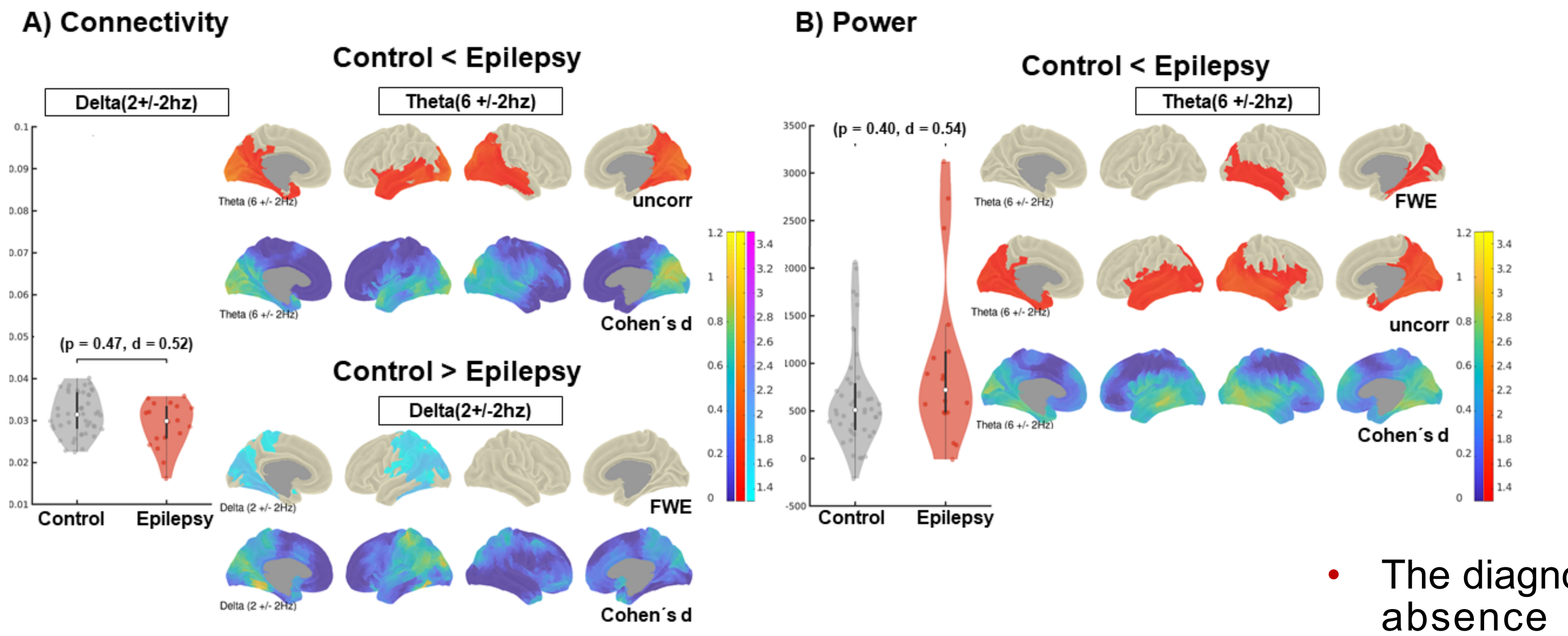



**Fig.3. First seizure-only vs controls**

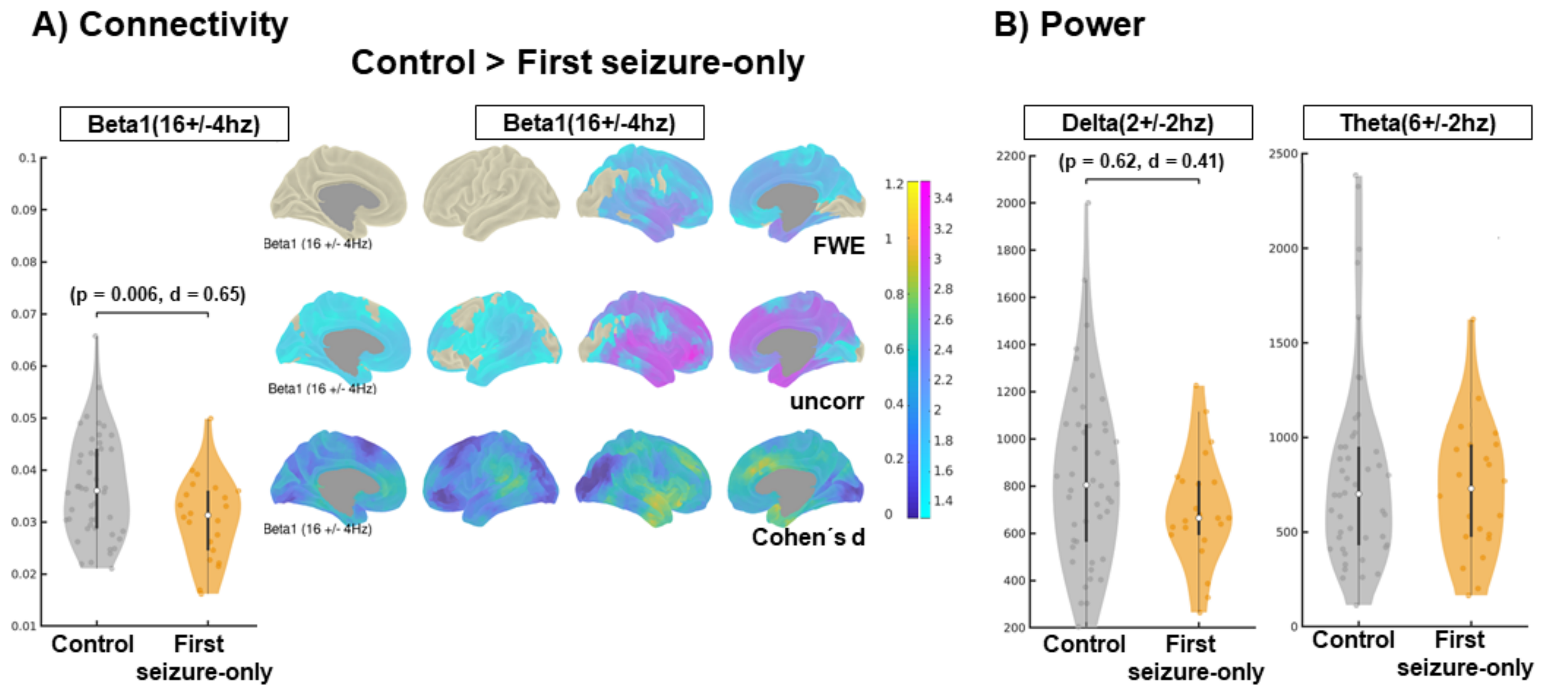
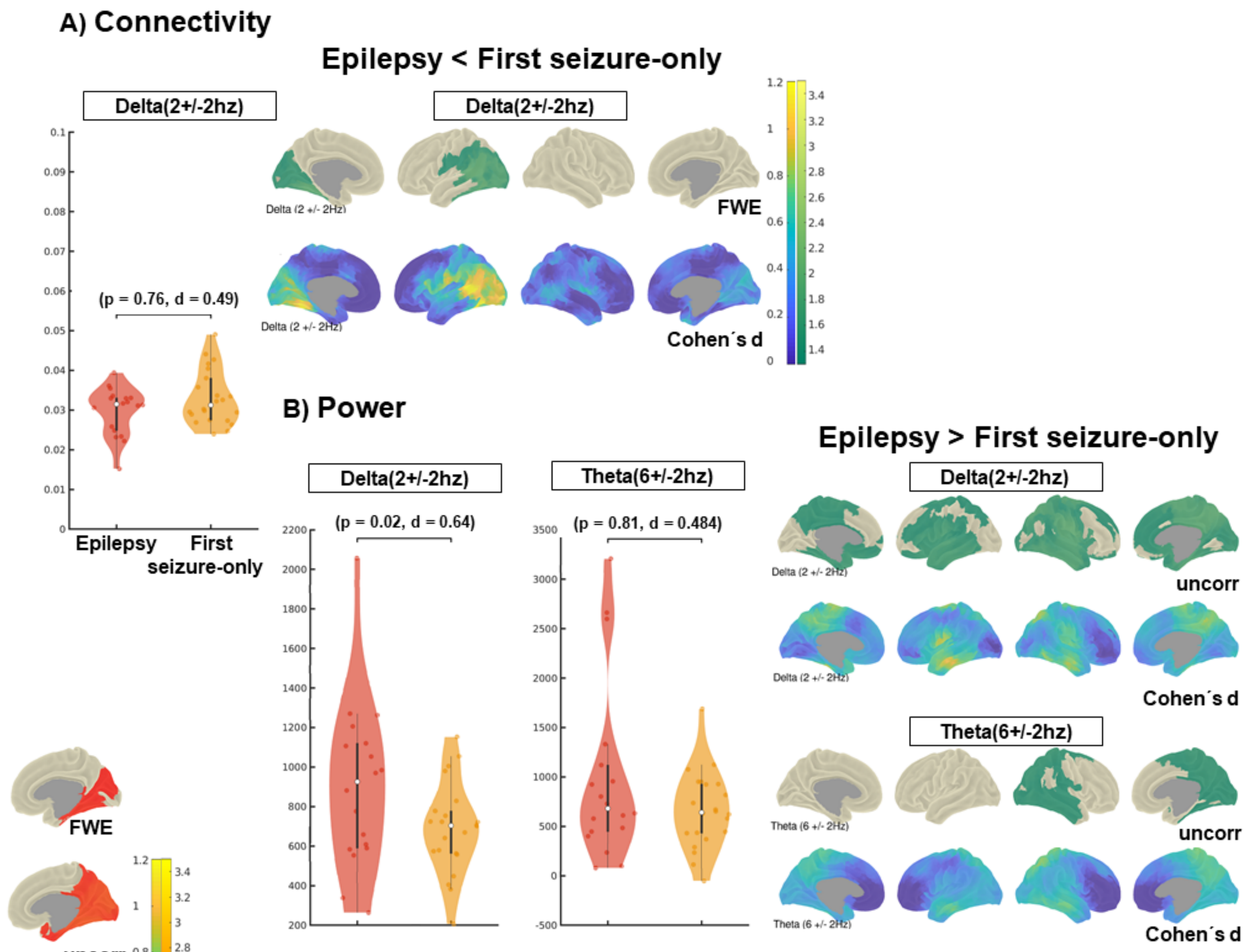



**Fig.4. Epilepsy vs First seizure-only**




## Conclusions

- The diagnosis of epilepsy after a first unprovoked seizure in the absence of visible lesions and an abnormal routine electroencephalogram (**rEEG)** remains a challenge.
- Power and functional connectivity brain networks have shown promising results in identifying patterns across diverse epileptic syndromes.
- Increased connectivity and power in **rEEG** could be a possible biomarker to predict which patients will develop epilepsy after a first seizure.
- AI offers the potential to significantly reduce data selection time and improve case detection, enabling faster and more efficient analysis, ultimately enhancing our understanding of epilepsy and other diseases.

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**References:** [1]. Li Hegneret al., 2018. *Brain Topography*; [2]Marquetandet al., 2019., *Brain Connectivity*;[3]Kreilkampet al., 2023. *SciData*;[4]Winkler et al., 2014. *Neuroimage*; [5]Smith et al., 2009. *Neuroimage*; 6Cohen, J., 1992. *PsycholBull*