Blunted Brain Responses to Emotional Conflict Predict Anxiety in Adolescents with Epilepsy using Magnetoencephalography

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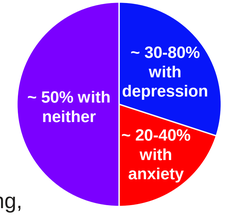
RATIONALE

BACKGROUND

- Many people with **epilepsy** suffer from **depression** and **anxiety**, which often develops in **adolescence.**
- Deficits in **emotion regulation** are thought to underlie **depression** and **anxiety** and could be a potential mechanism for it as an **epilepsy comorbidity**.
- Though emotional conflict processing is well studied in depression using functional magnetic resonance imaging, its **spatiotemporal profile** has not been investigated in **epilepsy**.



GOAL

- Study the spatiotemporal profile of **emotional conflict** processing in adolescents with **epilepsy**, relative to controls using **magnetoencephalography** (MEG)

HYPOTHESES

Adolescents with epilepsy will exhibit deficits in emotional conflict processing:

- **Longer** response times and **lower** accuracy compared to controls
- Relatively **lower brain** activity in amygdala, insula, cingulate & prefrontal cortices

METHODS

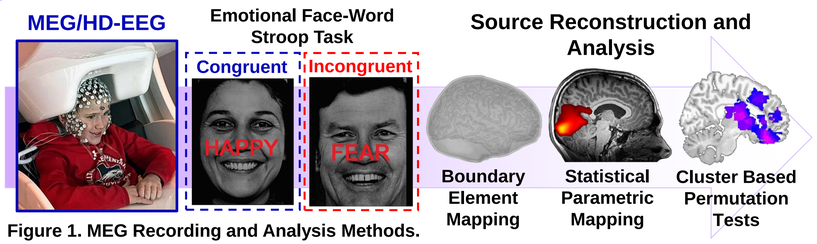


Figure 1. MEG Recording and Analysis Methods.

MEG RECORDING & PROCESSING

- 306-channel MEG recording (MEGIN, Finland)
- Pre-processed in Brainstorm (Tadel, 2019)

PARTICIPANTS

	Sample	Age	Male
Epilepsy	28 (14 Focal)	15.7	11
Control	25	13.5	15

DATA ANALYSIS

- **Behavior:** Response times & accuracy compared between groups using t-tests.
- **MEG:** Source maps compared between groups using cluster-based permutation tests across ten 100 ms time windows post-stimulus. Regions of interest (ROIs) extracted from significant clusters based max T-values in AAL atlas regions for time-frequency analysis and clinical measure analyses.
- **Clinical Measures:** Anxiety (GAD7) & depression (PHQ9) regressed with ROIs.

RESULTS

BEHAVIORAL RESULTS

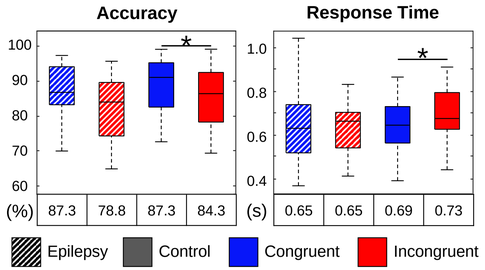


Figure 2. Response time and accuracy. Average accuracy (left) and response times (right) for **adolescents with epilepsy** and healthy **controls**, for **incongruent** and **congruent** trials. *indicates significant differences at p < .05

MEG EVOKED FIELDS

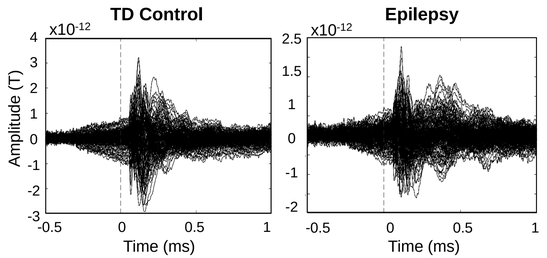


Figure 3. MEG Evoked Field Butterfly Plots. Grand average evoked responses across conditions of **controls** (left) and **adolescents with epilepsy** (right) from 306 MEG channels, including 204 gradiometers and 102 magnetometers.

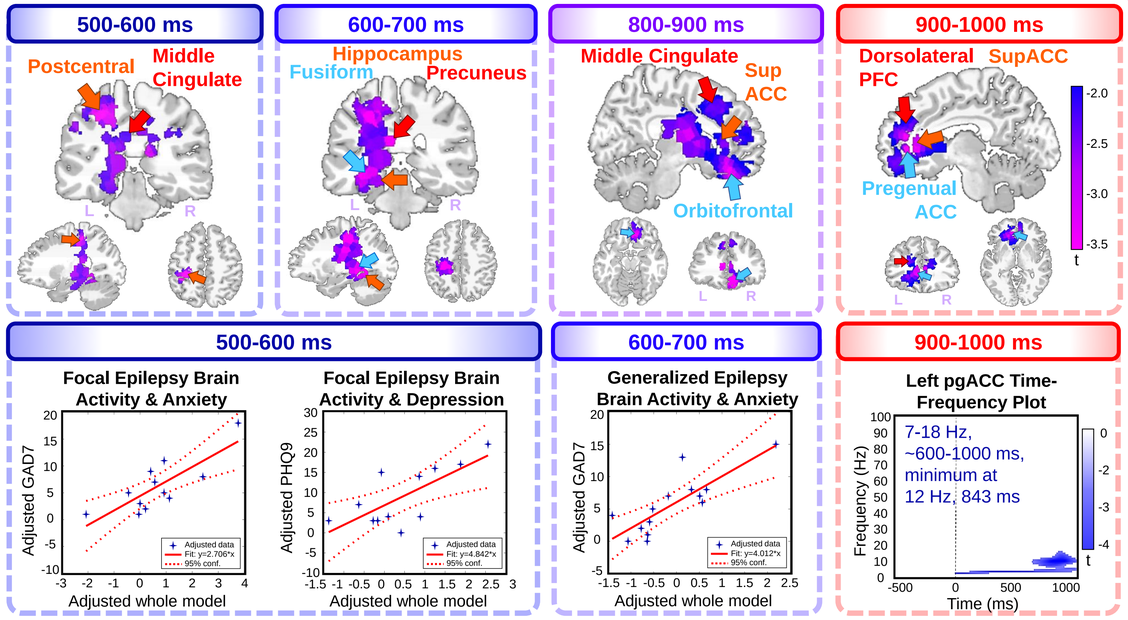


Figure 4. Cluster-based Permutation Test results. (From left to right) Relative to controls, adolescents with epilepsy exhibited blunted brain activity in: **(500-600)** Left Postcentral gyrus & Middle cingulate cortex (p=.048), which predicted anxiety and depression symptoms in those with Focal Epilepsy; **(600-700)** Left Fusiform, Hippocampus & Precuneus (p=.018), which predicted symptoms in those with Generalized Epilepsy; **(800-900)** Right Supracallosal Anterior cingulate (supACC), Middle cingulate, & Orbitofrontal Gyrus (p=.022); **(900-1000)** Left Dorsolateral Prefrontal cortex (dlPFC), Supracallosal & Pregenual anterior cingulate (pgACC; p=.032), with the pgACC ROI showing event-related desynchronization in the lower Beta Band around 600-1000 ms (p=.039, t=-4.30).

BEHAVIORAL RESULTS

- While controls showed **typical behavior**, responding slower and less accurately to emotional conflict, adolescents with epilepsy **responded similarly** across conditions (Fig. 2).

MEG RESULTS

- Relative to controls, adolescents with epilepsy exhibited **blunted** brain activity in:
  - **(500-600)** Left Postcentral & Middle cingulate
    - Predicted **anxiety** and **depression** symptoms in those with **Focal Epilepsy**
  - **(600-700)** Left Fusiform gyrus, Hippocampus & Precuneus
    - Predicted **anxiety** symptoms in **Generalized Epilepsy**
  - **(800-900)** Right Supracallosal Anterior cingulate cortex, Middle cingulate, & Orbitofrontal Gyrus
  - **(900-1000)** Left Dorsolateral Prefrontal cortex, Supracallosal anterior cingulate & Pregenual anterior cingulate cortex
    - Event-related desynchronization in the lower **Beta Band** at ~600-1000 ms

CONCLUSION

DISCUSSION

- **Adolescents with epilepsy** exhibit **blunted** brain responses to emotional conflict which are similar to those seen in **depression** and **anxiety** patients.
- These findings reveal a **shared dysfunction** between epilepsy and its psychiatric comorbidities, which could be a target for epilepsy treatment.

FUTURE DIRECTIONS

- **Future treatments** that target these **shared dysfunctions** could reduce treatment time and **improve outcomes** by treating epilepsy and its **comorbidities** simultaneously.