

Reduced EEG Beta and Gamma Power as an Early Biomarker for Dravet Syndrome

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Background

- SCN1A-related Dravet syndrome (DS) typically presents in the first year of life with (prolonged) febrile seizures, alongside normal initial development.
- The first routine EEG is often normal, making early differentiation from atypical febrile seizures (aFS) difficult and risking diagnostic delay.
- Early diagnosis matters as it guides treatment choice, avoids contraindicated medication, and enables early initiation of targeted treatment.

Aim

- To assess whether quantitative EEG measures (spectral power, connectivity) can distinguish the first, visually normal EEG of DS patients from aFS and healthy controls (HC).

Data and Methods

- This study was a retrospective study comparing three age-matched groups (n = 16/group; max. 2-month age difference): DS, aFS, HC
- The first routine EEG after seizure onset was included, recorded before the start of anti-seizure medication to avoid confounding effects of medication on the spectrum. All included EEGs were visually normal without epileptiform abnormalities.
- Spectral power (delta, theta, alpha, beta, gamma) was calculated with Welch's method on artefact-free wakeful epochs, and functional connectivity with the weighted phase lag index. Group differences were tested per band and corrected for multiple comparisons (FDR).

Results: Spectral Analysis

- Total beta and gamma power were significantly lower in DS vs. both aFS and HC, most evident in temporo-parietal areas.
- Total alpha power was significantly different in aFS vs. DS.
- Connectivity metrics did not differ significantly between groups.

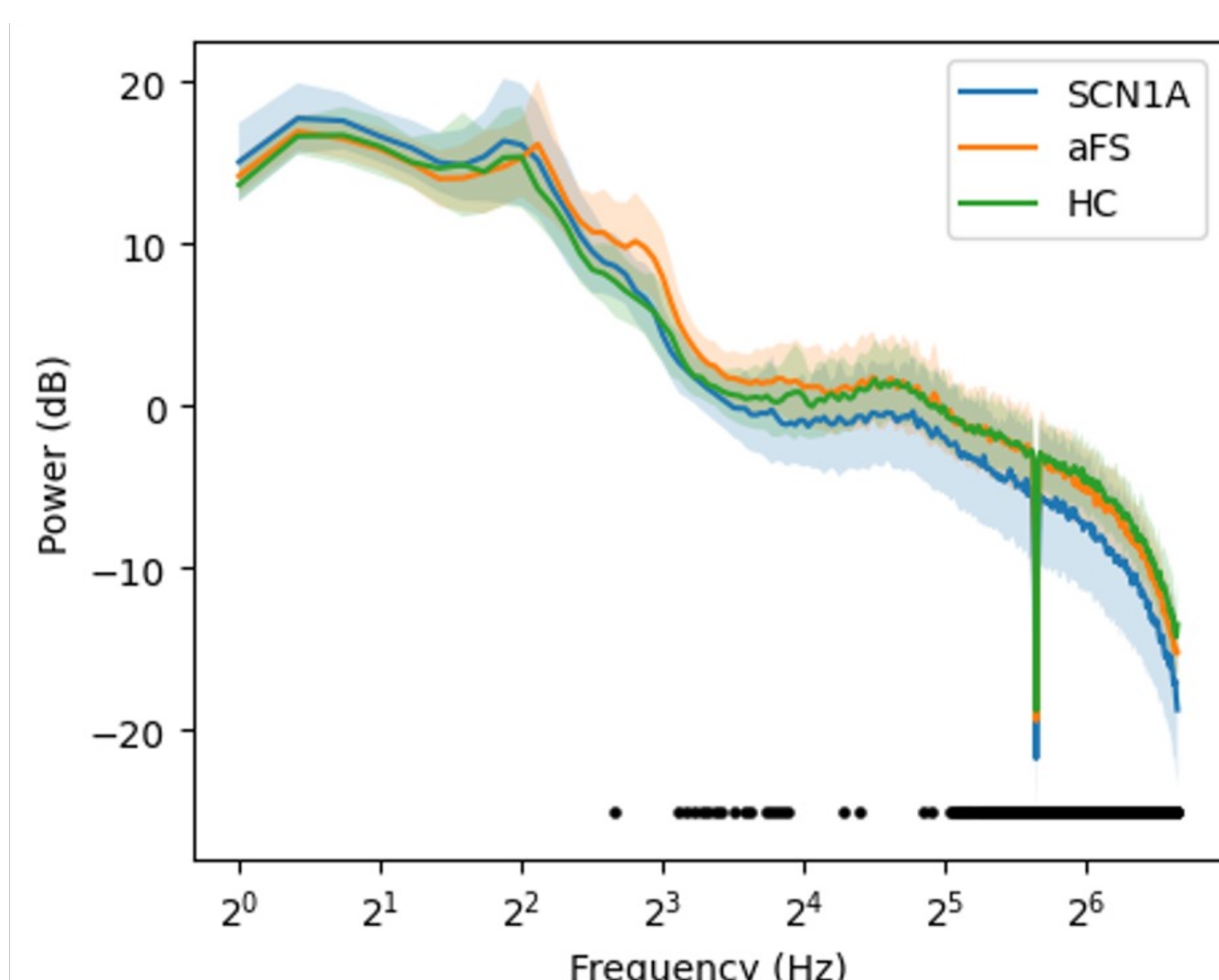


Figure 1: Group-averaged power spectral density SCN1A vs aFS vs HC (n=16/group). Dots mark significant frequency bins.

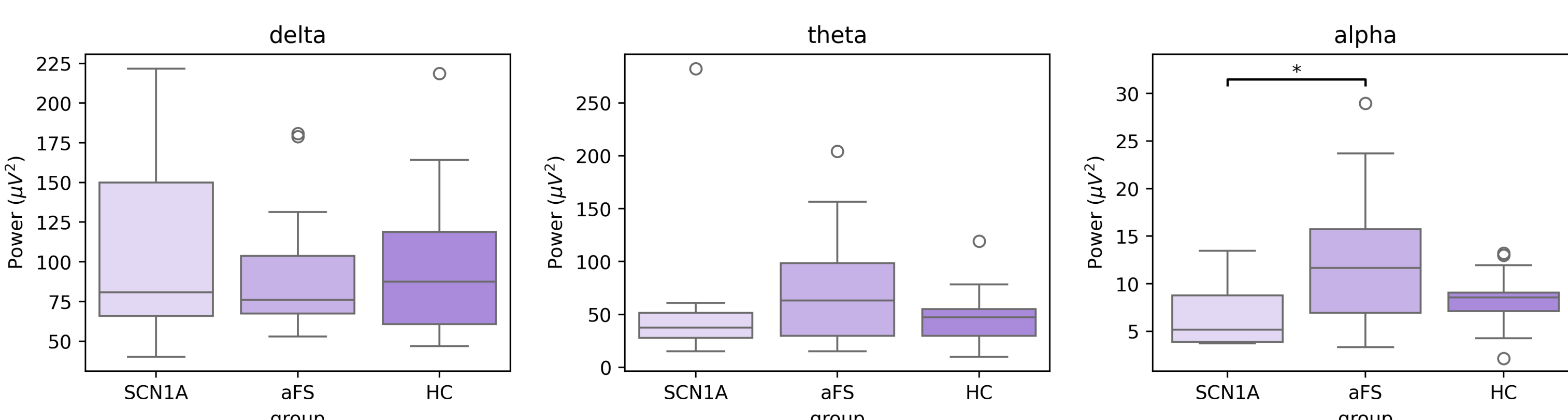


Figure 2: Total power per frequency band (primary analysis, n=16/group). *: FDR-significant group difference.

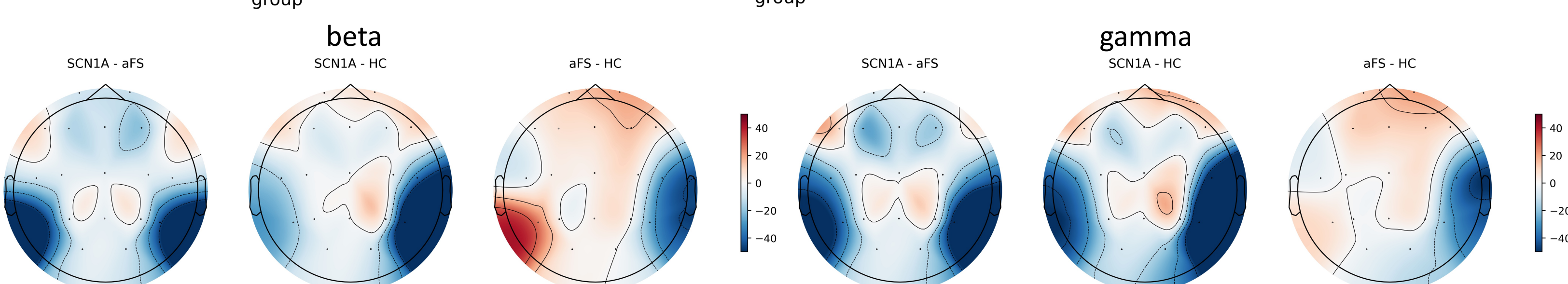


Figure 3: Difference in the topographical distribution of total beta and gamma power between the groups.

Results: Predictive Index

- Beta and gamma power as predictors result in an area under the curve (AUC) of 0.728 ± 0.205 .
- The predictive index reached a positive predictive value of 75.0%, and a negative predictive value of 68.4%.

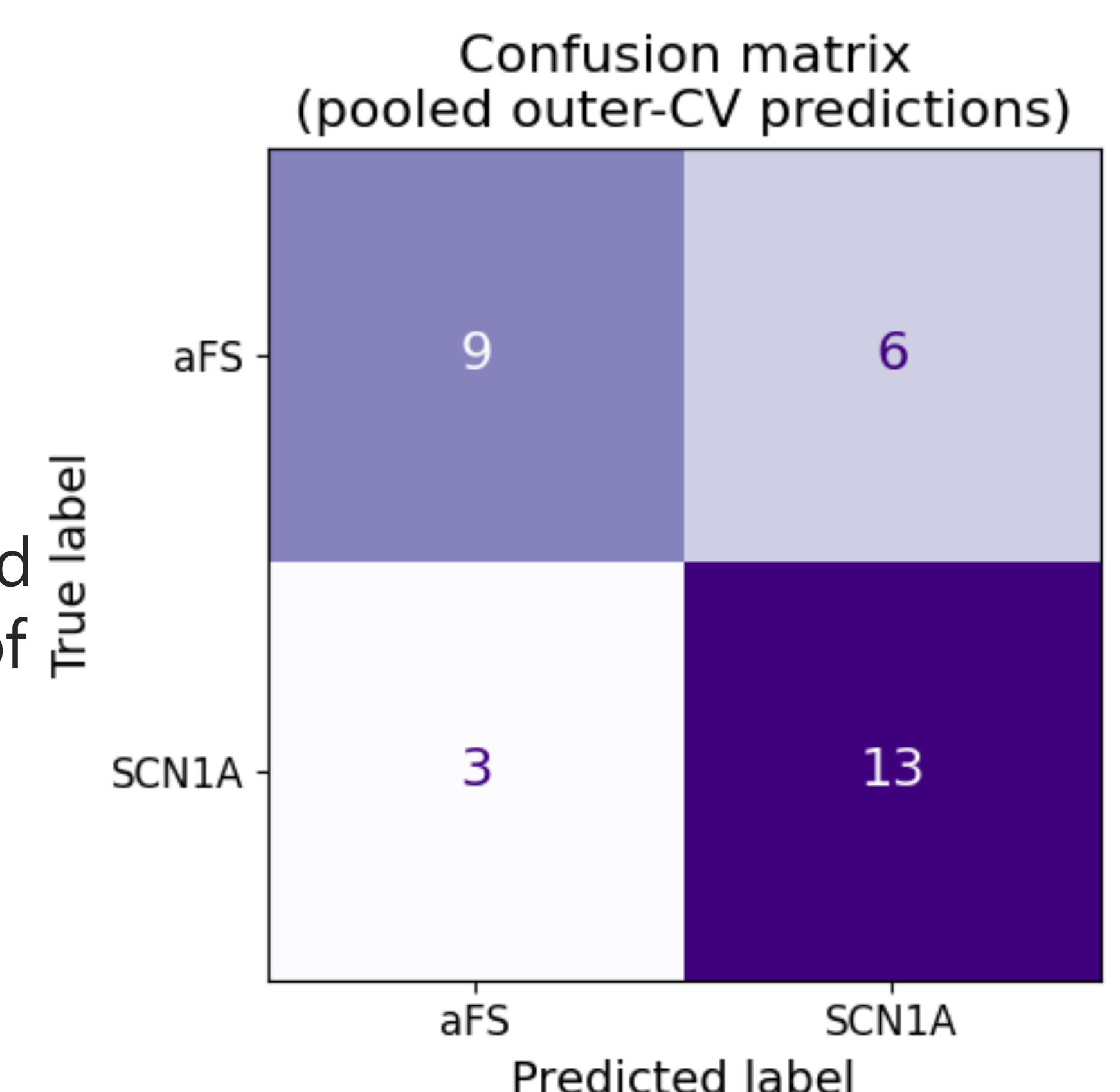


Figure 4: Confusion matrix of the predictive index

Discussion

- Spectral EEG analysis may help distinguish DS from aFS earlier, before the full DS phenotype emerges.
- Our results could help select patients with an indication for prompt genetic testing directly after the first seizure. Earlier diagnosis makes these patients eligible for precision treatment sooner, when it is likely most effective.
- Due to the small sample size, these findings are considered exploratory and validation in larger cohorts is needed.

Conclusion

Reduced high-frequency (beta/gamma) EEG power is a promising early biomarker to help distinguish Dravet syndrome from atypical febrile seizures on the first routine EEG.