Transfer Learning for Multimodal Polysomnography-Based Cognitive Impairment Screening

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Aims: Cognitive impairment is associated with alterations in sleep architecture and physiological dynamics, but extracting clinically useful information from polysomnography (PSG) remains challenging because sleep studies are high-dimensional, multimodal, and heterogeneous. This study aimed to investigate a transfer-learning framework for cognitive impairment screening using multimodal PSG data in the PhysioNet Challenge 2026 setting.

Methods: Raw PSG recordings were resampled to 128 Hz and grouped into four modalities: brain activity signals (BAS), respiratory signals (RESP), electrocardiography (ECG), and electromyography (EMG), following the pre-trained sleep foundation model (SleepFM). PSG data were segmented into 5-s tokens and encoded by the SleepFM backbone to obtain sequence representations. Algorithmic annotation channels were converted to token-level features and processed with a lightweight convolutional-transformer encoder. Demographic variables were encoded from age, body mass index, sex, race, ethnicity, and site information. PSG, annotation, and demographic features were then fused for binary cognitive impairment classification. The framework was designed to accommodate heterogeneous channel availability across sleep studies while leveraging prior representation learning to improve generalization in a limited-data challenge environment.

Results: In a local random 80/20 hold-out setting, the model achieved an AUROC of 0.870. In the unofficial phase submission of the Challenge, team *Matcha* achieved an AUROC of 0.655 on the leaderboard, ranking 16th among 88 teams and 24th among 243 submissions.

Conclusion: These findings demonstrate the feasibility of transfer learning with a pre-trained sleep foundation model for multimodal PSG-based cognitive impairment screening. The proposed framework achieved competitive preliminary benchmark performance and supports further development of foundation-model-based approaches for automated analysis of complex sleep physiological data.

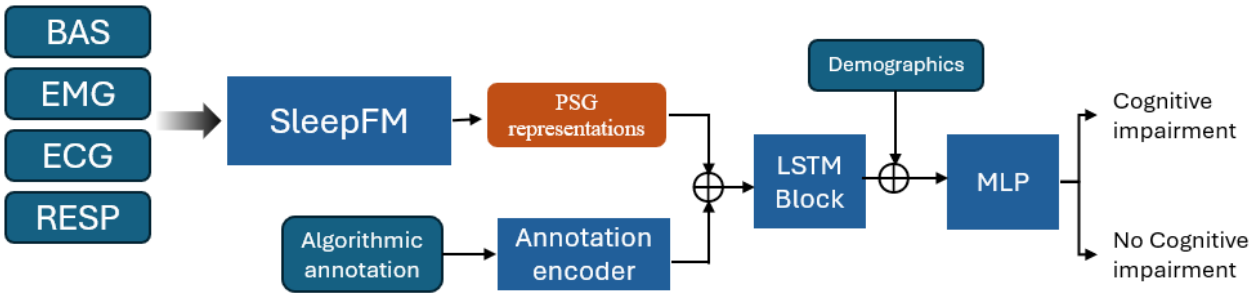

Figure 1. Overview of the proposed multimodal framework for cognitive impairment screening from polysomnography.