

Predicting Cognitive Impairment from Arousals Events and Sleep Stage Segmentations

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Introduction: Given the association between sleep disturbances and cognitive decline, physiological indicators recorded during sleep may offer early biomarkers of cognitive impairment. Advances in machine learning now enable the analysis of such data at scale. In this study, we assess how well human annotated sleep features predict cognitive impairment and examine whether informative patterns can be learned directly from physiological signals.

Methods: Our approach comprises two main stages. First, we performed an exploratory analysis to evaluate the predictive value of all human annotations by training a random forest model to infer cognitive impairment directly from the raw annotations. Secondly, we identified those human annotations with statistically significant predictive power and used them as ground truth to train a temporal segmentation model. Polysomnography (PSG) signals were converted to mel spectrograms, where each bin represents 60 seconds, and the corresponding human annotations were resampled to the same sampling frequency as the mel spectrogram. We trained a U-net–based convolutional neural network (CNN) to map PSG to annotations. Human annotations were then used to train a random forest model to predict cognitive impairment. The trained segmentation model was applied to the internal held-out validation set, and the predicted segments were subsequently used to predict cognitive impairment.

Results and Discussion: Arousal events and sleep stages demonstrated statistically significant predictive capability and, as reported in Table 1, the CNN-derived segmentations from spectrograms appear to retain this predictive information, as indicated by the minimal reduction in classification performance.

Table 1. Classification performance on the internal held-out test data

	Human annotations	Predicted annotations
Limb Movement Events	0.51	-
Respiratory Events	0.48	-
Arousal Events	0.61	0.59
Sleep Stages	0.61	0.60
Sleep Stages+Arousal Events	0.65	0.63