Feature selection for sleep analysis using heart rate variability and fMRI functional connectivity

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Introduction

Previous research proved that by using fMRI functional connectivity and heart rate variability (HRV), alone or in combination, the classification of sleep stages is possible. As applied classifiers are complex and hardly interpretable, the presented work tries to contribute to the understanding of joint HRV and fMRI functional connectivity sleep scoring by assessing the relevance of features by means of feature selection (FS).

Methods

Data: 26 subjects (52 minutes recordings) from a previous polysomnographic fMRI study were analysed. Sleep stages (Awake, NREM1, NREM2, NREM3) were manually scored following the AASM standard. Feature extraction was done within non-overlapping, 3-minute epochs showing no change in sleep stage resulting in 178 Wake, 39 NREM1, 41 NREM2 and 30 NREM3 epochs.
Features: For fMRI functional connectivity 22 ROIs were defined in MNI-space. The elements of the linear correlation matrix were used as features. As HRV features we used a total of six standard time and frequency domain parameters.
Feature selection: For feature selection ReliefF and Fast Correlation Based Filter (FCBF) were used.

Results

Using ReliefF, FS assigned the highest relevance to pNN50 (probability of variability more than 50 ms between consecutive beats and measure of parasympathetic activity), followed by the correlation between *Middle-Occipital-Gyrus-Right* and *Superior-Temporal-Gyrus-Left* and normalized low frequency power. Using FCBF, the most important parameter was again the aforementioned correlation. From HRV parameters total power was rated best (fourth rank).

Conclusion

Given that our previous research proved fMRI functional connectivity based classifiers to outperform HRV-based classifiers, our findings from FS are surpising. A possible explanation might be related to the extent and construction of feature vectors based on exclusively non-overlapping epochs of uniform sleep stages. Particularly HRV features seem to suffer from non-uniform epochs and applied averaging schemes that were used within classification. However, a more detailed examination is in progress.