Automatic sleep scoring:
A search for an optimal combination of measures

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ABSTRACT

Objective:

The objective of this study is to find the best set of characteristics of polysomnographic signals for the automatic classification of sleep stages.

Methods:

A selection was made from 74 measures, including linear spectral measures, interdependency measures, and nonlinear measures of complexity that were computed for the all-night polysomnographic recordings of 20 healthy subjects. The adopted multidimensional analysis involved quadratic discrimi-nant analysis, forward selection procedure, and selection by the best subset procedure. Two situations were considered: the use of four polysomnographic signals (EEG, EMG, EOG, and ECG) and the use of the EEG alone.

Results:

For the given database, the best automatic sleep classifier achieved approximately an 81% agreement with the hypnograms of experts. The classifier was based on the next 14 features of polysomnographic signals: the ratio of powers in the beta and delta frequency range (EEG, channel C3), the fractal exponent (EMG), the variance (EOG), the absolute power in the sigma 1 band (EEG, C3), the relative power in the delta 2 band (EEG, O2), theta/gamma (EEG, C3), theta/alpha (EEG, O1), sigma/gamma (EEG, C4), the coherence in the delta 1 band (EEG, O1–O2), the entropy (EMG), the absolute theta 2 (EEG, Fp1), theta/alpha (EEG, Fp1), the sigma 2 coherence (EEG, O1–C3), and the zero-crossing rate (ECG); however, even with only four features, we could perform sleep scoring with a 74% accuracy, which is comparable to the inter-rater agreement between two independent specialists.

Conclusions:

We have shown that 4–14 carefully selected polysomnographic features were sufficient for successful sleep scoring. The efficiency of the corresponding automatic classifiers was verified and conclusively demonstrated on all-night recordings from healthy adults.