within the same length of record. The AF curve and parameter D were calculated for those random events. For every record 500 combinations of random events were generated and values of 500 parameters D gave us the distribution curve of D. From this distribution we evaluated the probability to get real experimental parameter D by chance. $P < 0.05$ was taken as significant. Results of experiments with four cats were analysed. Up to 30% of studied neurons reached the level of significance thus indicating that changes of their firing during slow wave sleep were connected with the events in gastro-intestinal system. This level of significance was never reached by neuronal activity in wakefulness.

Conclusion: Neuronal activity of the cortical visual areas during slow wave sleep reflects events in gastro-intestinal system.

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Keywords: cerebral cortex, slow wave sleep, gastro-intestinal system, statistical modeling

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Automatic sleep scoring system using two channel electro-oculography

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An automatic sleep scoring system was developed by recording sleep EEG and EOG from 265 subjects. The automatic method is based on the use of two channel electro-oculogram (EOG). Synchronous EEG activity in S2, S3 and S4 was detected by calculating the cross correlation between two EOG channels and the peak to peak amplitude in the 0.5–6 Hz band using two different thresholds. Band 1.5–6 Hz and automatic detection of fast and slow eye movements (SEM) was used to separate wakefulness, S1 and REM. Beta power 18–30 Hz was used for artefact detection. Data of 133 subjects was used to determine the optimum detection thresholds and validation of the scoring system was performed with the data of 132 different subjects. By using simple detection and smoothing rules the Cohen's kappa agreement to the standard visual scoring system was moderate (0.50) and the epoch by epoch agreement was 64% in separating wake, S1, REM, S2, S3 and S4 sleep stages. The advantage of the limited bandwidth automatic method is that it could be applied during online recordings using only three disposable self-adhesive electrodes. Further improvements in classification performance are possible e.g. by spindle analysis and more advanced scoring rules which make better use of temporal information.

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A continuous probabilistic approach to sleep and daytime sleepiness modelling

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We propose and validate a continuous, entirely probabilistic model of the all night sleep and daytime sleepiness processes. The model is implemented as a hierarchical Gaussian Mixture Model (GMM). Features extracted from recordings following a polysomnographic setting are used. In the study we focus on describing sleep and transitions to sleep as a continuous process. The output of a GMM is a set of curves representing probability of each sleep or wakefulness state at a given time point. The new approach is not limited to model the sleep and wakefulness processes using EEG recordings from a single electrode, but through GMMs built on recordings from different EEG electrodes spatial aspects of the processes are revealed. In contrast to the standard discrete Rechtschaffen & Kales (R&K) scoring system we build a new continuous sleep model. The expected outcome of this sleep modeling effort is additional information with respect to sleep quality, pathologies and other clinically relevant aspects not obtained by the R&K scoring. We validate the new sleep representation through a comparison with the R&K sleep profiles. We correlated the features extracted from both the discrete R&K and continuous GMM sleep profiles with 26 external criteria of sleep-psychometric variables. Statistically significant rank correlations were observed with nine psychometric variables (P-values < 0.01). For the alphabetical cross-out and fine motor activity tests the features of the continuous model outperformed the R&K based features. For the drowsiness index statistically significant correlations were observed only in the case of the continuous features. In other cases the values of rank correlations for the continuous and R&K features were similar. Next, we use a set of daytime recordings to model involuntary transitions from wakefulness to sleep. Transitions from full alertness into the periods of drowsiness, lower vigilance levels or sleep were recorded under several different laboratory conditions. We demonstrate ability of the new approach to model these transitions.

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Assessment of sleep quality using wristwatch type optical pulse wave sensor

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The purpose of this study is to propose the simple continuous evaluation method of sleep quality and quantity. Polysomnography is the golden standard for the evaluation of sleep. However, polysomnography impose severe burden on the subject who is needed to evaluate for sleep with long-term recording. Actigraphy can evaluate the quantity of sleep estimating wake time after sleep onset, not quality of sleep. The autonomic nervous activity during sleep fluctuates with shifting of sleep stages, the mental and physical condition in the prior daytime and aging. We developed a wristwatch type optical pulse wave sensor (WOPS) to assess the heart rate variability recorded ECG. Pulse frequency demodulation technique of pulse wave signal recorded WOPS provides a reliable assessment of heart rate variability. (Hayano J et al., BioMedical Engineering OnLine, 2005) Twenty one subjects, 7 males and 3 females, aged 20–22 years old in the young group (YG) and 11 menopausal middle-aged women having subjective poor sleep quality, aged 54–64 years old (MG), were recorded the pulse rate variability and sleep-wake states using actigraph during two night in the home. Total sleep time and wake time after sleep onset estimated by actigram during sleep were no significant different between two groups. Mean values of pulse rate and %LF [LF/(HF + LF)] for the pulse rate variability were no significant different between two groups. On the other hand, HF during sleep was significantly lower in MG than that in YG ($P < 0.01$). These results suggest that the evaluation of the autonomic nervous activity calculated by pulse rate variability measured WOPS might open new ways to assessment of physiological sleep quality during long-term monitoring.