Human sleep and its regulation: Individual and trait-like aspects.

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Individual variability in sleep variables is considerable. Thus, it is important to elucidate whether individual differences are of functional relevance or should be considered merely as “noise” inherent in biological data. Investigating inter-individual differences and intra-individual stability provides a powerful approach to address basic questions of sleep regulation, which are relevant also for sleep medicine. Identification of individual traits relevant for sleep regulation will allow a fore focused approach in future genetic analyses.

We studied intra-individual stability and inter-individual variation in sleep and sleep EEG spectra across four baseline recordings of healthy young men. Cluster analysis based on EEG spectra in both non-REM and REM sleep segregated all four baseline nights of each individual into a distinct cluster. Furthermore, we examined whether a trait-like sleep EEG pattern is detectable across adolescent development. Two consecutive nights of standard sleep recordings were performed in 9 –10-year-old children and 15–16-year-old teens, and were repeated 1.5–3 years later. EEG spectra averaged across the night for non-REEM and REM sleep separately were again classified using hierarchical cluster analysis, which showed that all 4 nights of a participant clustered together for a majority of participants. Our results indicate that a “trait-like” aspect can be detected in the sleep EEG across adolescent development despite considerable neurodevelopmental changes. This finding indicates that the brain oscillators responsible for generating the sleep EEG signal remain relatively stable across adolescent development.

Sleep homeostasis denotes a salient aspect of sleep regulation. Non- REM sleep pressure builds up during the day and dissipates across the night. A sleep deficit results in prolongation and intensification of sleep at the next sleep opportunity. Sleep homeostasis refers to the increase of sleep propensity during waking and the decrease of sleep intensity during sleep. Analysis of recordings of eight nights (12-h sleep opportunity 22:00-10:00) interspersed with three 36-h periods of sustained wakefulness (3 x sleep deprivation) indicated that inter-individual differences in the homeostatic process constitute a trait.

Slow waves represent a salient EEG feature of non-REM sleep. We investigated the activation of brain structures during slow wave sleep under normal conditions and after sleep deprivation. Power maps were computed for the first non-REM sleep episode (where sleep pressure is highest) of both nights (0.5 - 2 Hz). A frontal predominance of all frequencies between 0.5 and 2 Hz was observed. An additional occipital focus of activity was present below 1 Hz. Power maps at 1 Hz and below were not affected by sleep deprivation, whereas an increase in power was present in the maps above 1 Hz. Within a subject we observed a high similarity of power maps in both nights. Within-subject similarity between maps was assessed by hierarchical cluster analysis. The normalized maps of baseline and recovery sleep clustered, pointing to fingerprint-like features of the maps. Fingerprint-like features were observed also at the level of electrical sources.

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