Abstract

TITLE: Neural correlates of sleep onset period assessed by simultaneous EEG/fMRI

AUTHORS (FIRST NAME, LAST NAME): Julien Q. Ly[1, 2], Sarah L. Chellappa[1], Manuel Schabus[1, 3], Thien Thanh Dang-Vu[1, 2, 4], Gilles Vandewalle[1], Christophe Phillips[1], Pierre Maquet[1, 2]

INSTITUTIONS (ALL): 1. Cyclotron Research Centre (University of Liège), Liège, Belgium.
2. Department of Neurology, CHU Sart Tilman, Liège, Belgium.
3. Department of Psychology, Laboratory for Sleep and Consciousness Research, Salzburg, Austria.
4. Center for Studies in Behavioral Neurobiology (Concordia University), Montreal, QC, Canada.

Introduction : Sleep onset is commonly defined as the first occurrence of a spindle or a K complex on EEG recording. The transition from wakefulness to sleep is however a dynamic process that allows the brain to drift progressively into specific sleep oscillatory modes. To date, this dynamic process has received little attention. Here we characterized the neural correlates of the progressive EEG modifications observed between wakefulness and sleep onset (sleep onset period).

Methods : Sleep was recorded in twelve healthy non sleep-deprived young adults using simultaneous high density electroencephalography (hdEEG) and functional magnetic resonance imaging (fMRI). EEG data were first cleaned from gradient and ballistocardiographic artifacts. We included data from the initiation of the recording until the first identified spindle or K-complex and then computed the spectral power in delta (0.5-4 Hz), alpha (8-12 Hz) and beta (16.25-25 Hz) bands during this period. FMRI data were preprocessed and analyzed using SPM8. Fixed-effect analysis first modeled, in each individual, the variation in the power of the three spectral bands. A random-effect analysis then sought for the neural correlates of these variations across subjects.

Results : As expected, beta and alpha power decreased while delta power increased during transition from wakefulness to sleep. The decrease in beta power was associated with bilateral deactivations in the lateral prefrontal, anterior cingulate, mesial temporal cortices and thalamus. The decrease in alpha power was linked to deactivation in the occipital cortex. Finally, the increase in delta power was correlated to increase responses in brainstem (pons), cerebellum and thalamus bilaterally.

Conclusion: The transition from wakefulness to sleep is associated with frequency-specific modifications in regional brain activity which are simultaneous to a decrease in activity in a widespread thalamo-cortical set of areas and to the recruitment of brainstem and thalamic nuclei in relation to the outbreak of delta activity.

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