

Circadian and homeostatic sleep pressure modulate fMRI correlates of vigilant attention.

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Objective: Vigilant attention is believed to participate in cognitive performance decline during sleep deprivation. We assessed fMRI responses to the psychomotor vigilance task, during sleep loss, to investigate possible circadian and homeostatic sleep need modulations.

Methods: Thirty-three healthy young volunteers (age 21.12 ± 1.7 ; 17 women) participated in a 42 h sleep deprivation protocol under constant routine conditions. Cerebral responses were quantified across 12 fMRI sessions during sleep deprivation and one fMRI session following recovery sleep. We identified circadian modulation of brain response during intermediate RT by fitting a 24-h sine and a cosine function to the data which were aligned to the onset of melatonin. From the parameter estimates of the sine and cosine functions, we derived the amplitude and circadian phase of the brain responses. The effect of homeostatic sleep pressure was modelled as monotonic increase with time awake.

Results: A significant circadian modulation was observed over almost the entire cortex (pFDR whole brain < 0.05). Interestingly, the phase of the circadian modulation varied across brain regions (Friedman, $\chi^2 = 30.13$; $df = 4$; $P = 4.60 \times 10^{-6}$). A significant effect of homeostatic sleep pressure (all $P_{\text{corr}} < 0.05$) was observed in a large set of cortical areas, characterized by a decrease in brain response with time spent awake.

Conclusion: Our results indicate that brain correlates of vigilant attention are modulated by both circadian and homeostatic sleep factors. Moreover, the data show, for the first time, evidence for a local circadian modulation of brain activity.

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