Owl or lark? Stroop-related cerebral activity is modulated by time of day and chronotype

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Introduction: The interaction between circadian and homeostatic systems modulates our sleep-wake cycle but also variations in cognitive performance. Additionally, individuals exhibit differences in their preferred schedules for sleep and performance. Here we investigated the cerebral bases of these differences in the context of an interference task.

Methods: Thirty extreme chronotypes (16 early (ETs), 14 late types (LTs)) underwent 2 fMRI sessions, 1.5 and 10.5 hours after preferred waking up controlled throughout actimetry the week prior testing. Circadian phase was asserted by saliva melatonin samples. Polysomnography was recorded the nights preceding test sessions. During fMRI scanning, subjects performed a Stroop conflict paradigm where subjects must name the printed colour of a colour name, with congruent (C), incongruent (I) and neutral (N) trials. Results are reported at the group level, $p<0.001$.

Results : ETs and LTs significantly differed in their sleep timing and mid range crossing times of melatonin expression. Circadian phase angles were similar in both ETs and LTs indicating a stable relationship between the adopted sleep timing and circadian phase. At the behavioral level, RTs were lower for I than N trials, but no significant time of day or chronotype effects were observed. In the morning, the interference-related activation effect (I vs. N events) was significantly higher in LTs than ETs in the inferior and medial frontal gyrus as well as a parietal and a parahippocampal region. Conversely, in the evening, orbital, inferior and medial frontal gyri, superior temporal and occipital regions were more activated in ETs than LTs.

Discussion: In this study, we found an interference-related activation in inferior frontal areas known to be involved in a conflict resolution network. Interestingly, activation in this area was higher for LTs than ETs in the morning, whereas it was higher for ETs than LTs in the evening. Such an interaction pattern cannot be easily accounted for in terms of time spent awake and circadian phase *per se*, since our procedure was designed to equate early and late chronotypes for these aspects. Previously reported chronotypical differences in the dynamics of the sleep-wake homeostat, mainly differences in its built up and dissipation are however potential candidates to explain our data.