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2003

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## Recommended Citation

Santo, Jonathan Bruce; James, F. O.; Chevrier, E.; and Boivin, D. B., "Spindle Frequency Activity Following Simulated Jetlag in Young Adults" (2003). *Psychology Faculty Publications*. 16.

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**0265.E**

## **Spindle Frequency Activity Following Simulated Jetlag in Young Adults**

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**Introduction:** Recent evidence indicates that sleep spindles and spindle frequency activity display a circadian pattern. The temporal distribution of spindle frequency activity during the night should thus be sensitive to the circadian phase at which sleep is scheduled. The aim of the present study is to test the effect of a 5-hour advance of the sleep schedule on spindle frequency activity during sleep in healthy young subjects.

**Methods:** Seventeen healthy participants (mean age  $\pm$  SD:  $25.20 \pm 3.29$  years, 4 females) maintained a regular sleep schedule for at least 3 weeks prior to admission. After 3 baseline days, subjects underwent a 35-hour constant routine. They then lived for one week on a schedule that was advanced by 5 hours relative to baseline and were exposed to a daily 6-hour light stimulus of 380 lux administered in a background of 4 lux followed by a 45-hour constant routine. In one group (**late light**;  $n=7$ ), phototherapy was planned prior to bedtime to prevent circadian adaptation. In the other (**early light**;  $n=10$ ), phototherapy was started at the original time of awakening and was advanced by one hour daily until the stimulus start was at the shifted time of awakening. This schedule was designed to achieve circadian adaptation to the shifted sleep schedule. Sleep was polysomnographically recorded in total darkness. Sleep episodes of the last baseline day and of the last shifted day were analyzed. Spectral analysis of frequency ranges consistent with sleep spindles were performed using low (12.25–13.00 Hz), middle (13.00–14.00 Hz), high (14.25–15.00 Hz) and all sigma activity (12.25–15.00 Hz). Data was analyzed by hourly bins for each sleep episode and the bin of peak activity was determined.

**Results:** A phase advance of  $+5.32 \pm 0.76$  hours and  $+1.38 \pm 2.64$  hours was observed in the early light and late light groups, respectively. This shift was significant in the early light group only (Wilcoxon signed ranks:  $p=0.023$ ) and indicated a circadian adaptation to the shifted schedule. A circadian misalignment thus persisted in the late light group in that subjects were going to bed at a circadian phase that was 3.5-hours earlier than on their original schedule. In this group, the peak of low sigma activity was delayed by  $-1.57 \pm 1.51$  hours compared to baseline ( $p=0.033$ ). No significant differences were observed in peak hour of other sigma activity. No within group differences were observed in the early light group.

**Conclusions:** The present study indicates that circadian phase at which sleep is scheduled can significantly affect the time course of low sigma activity. As in previous reports, the low range sigma activity was the most sensitive to circadian phase. These results also indicate that the temporal distribution of spindle frequency activity is sensitive to light-induced phase shifts.

**This study is supported by an operating grant from the Canadian Institutes of Health Research.**