Nonpharmacological Regulation of the Ultradian Sleep-Wake Cycle in Mice

Asmaa Ajwad, MS [1] • Dillon Huffman [1] • Bruce O'Hara, PhD [2] • Sridhar Sunderam, PhD [1]

[1]F. Joseph Halcomb III, M.D. Department of Biomedical Engineering, University of Kentucky • [2]Department of biology, University of Kentucky

Abstracts will be considered for both poster and platform presentations

Neurorehabilitation

Introduction: The timing and duration of sleep and wake are influenced by many factors including the circadian rhythm, homeostasis, and environmental temperature (Ta).The thermoregulatory response to ambient temperature (Ta) change is known to alter sleep. Rodents have polyphasic sleep cycles in which the timing and duration of sleep and wake bouts are influenced by the circadian rhythm. Here, we investigate whether this ultradian sleep-wake cycle can be entrained to an externally imposed rhythm by manipulating Ta.
Methods: Young adult C57BL/6 mice (5F/6M) were instrumented for EEG/EMG monitoring with IACUC approval. Ta was manipulated so that the error between Q, the instantaneous EEG delta/theta bandpower ratio, and a dynamically varying target value Q*, was minimized. Q* was programmed to exponentially decay (over 30 min) and grow (over 60 min) to alternately approach values of Q typically observed in wakefulness (“wake”) and NREM sleep. This 30:60 min cycle was repeated for each mouse from 8:30 a.m-7 p.m every other day for three days. Trends in EEG measures Q and the Hi-Lo bandpower ratio (8-30 Hz / 0.5-8 Hz) were compared against sham control days (Ta fixed at 22ºC) to determine the effect of the regulatory cycle.
Results: The average trend in Q clearly followed negative and positive trajectories over the 30-min decay and 60-min growth in Q* respectively. During the exponential decay in Q*, Ta decreased gradually and induced a reduction in Q and an increase in Hi-Lo, which point to a wake-promoting effect. Conversely, when Q* approached its peak in the following hour, the trends were reversed to promote sleep. Cross-correlation analysis showed that the response in Q lagged Q* by about 12 min.
Conclusion: Our results indicate that the duration of wake and sleep bouts can be externally paced. Further analysis is needed to characterize the effect of pacing on REM sleep. Understanding interactions between sleep and thermoregulation could provide insights useful for the development of therapies for sleep-related disorders.
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