Digital ventilated cage (DVC®) in Chronobiology and circadian rhythms: characterize the locomotor activities and shift to day/night cycle simultaneously in several cages.

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Introduction

Circadian rhythms, a subfield of chronobiology, study the 24-hour cycles that govern physiological processes, including sleep and feeding patterns, hormone production, and nervous system activity. These rhythms are regulated by intrinsic gene sets that respond to environmental cues such as light exposure and temperature. To study these rhythms, researchers often manipulate the light-dark cycle in animal models, such as mice, in a controlled environment.

Methods

The Max Planck Institute in Munich conducted a study using head-fixed mice to evaluate their cognitive abilities. The light-dark cycle was altered by 8 hours to prepare the mice for the experiment. Using the DVC® system to measure undisturbed locomotor activity allowed the researchers to accurately determine the stability of the new active phase over time and gauge the mice's adaptation to the altered cycle (*1*).

Researchers from the University of Oxford studied environmental light's impact on mice's spontaneous behavior in their home cage and chronobiological parameters. The results showed a clear day/night activity pattern, with decreased activity during the day and increased activity at night, the position of the cage relative to the light source greatly impacted the mice's behavior, highlighting the need to consider cage placement when designing experiments comparing cage environments (*2*).

Results & Brief Discussion

Circadian clocks play a critical role in promoting physical and mental health. They regulate insulin sensitivity and various metabolic processes in skeletal muscle. Physical activity synchronizes the circadian clock through changes in body temperature, hormones, and metabolites. Research suggests that misalignment of the muscle clock contributes to metabolic diseases. Helmholtz researchers used the DVC® system to monitor physical activity to assess circadian alignment before, during, and after dietary and pharmacological interventions (example below).

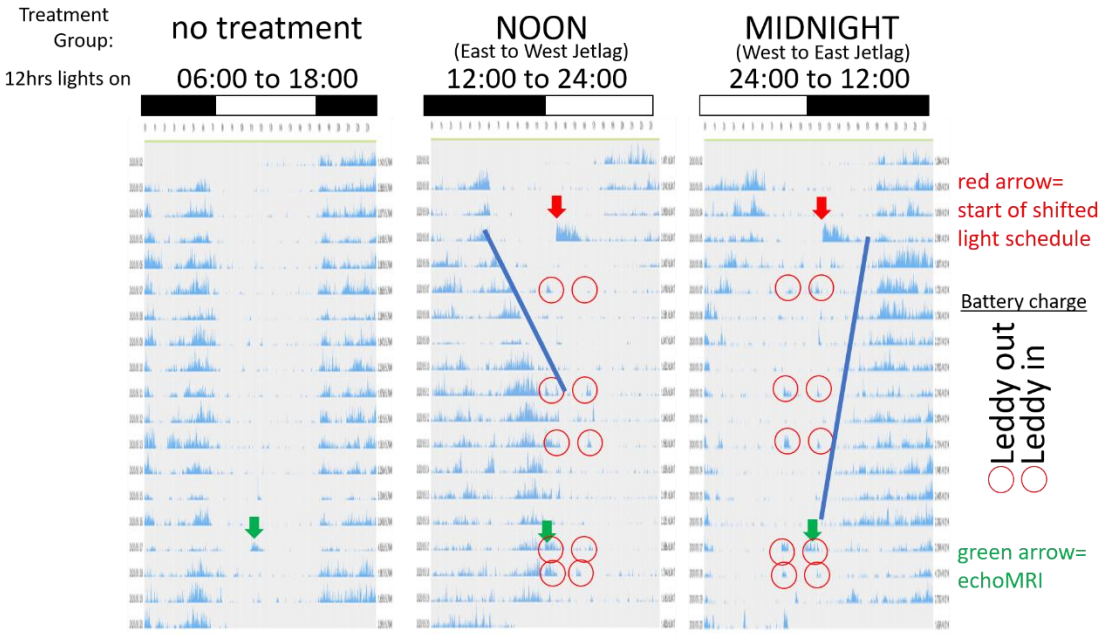

Fig. 1. In this study, the light/dark cycle of C57BL6J mice was adjusted by 6 hours using the Leddy, a battery-powered in-cage lighting system in red-tinted cages. The mice's locomotor activity was monitored with the DVC® system. The red circles in the data representation indicate the timing of Leddy's battery recharge. The blue lines in the figures show the changes in the mice's locomotor activity, with the middle panel depicting the effect of a later morning lights-on time and the right panel showing the impact of an earlier evening lights-off time compared to the standard 6 am-6 pm cycle**.**

Conclusion

Chronobiology preclinical studies would benefit from a combination of red/black tinted cages saving space within the facility and costs for dark rooms while conducting extensive studies with objective assessment onsets of circadian variations in several mouse models simultaneously.

References

1. P. M. Goltstein, S. Reinert, A. Glas, T. Bonhoeffer, M. Hubener, Food and water restriction lead to differential learning behaviors in a head-fixed two-choice visual discrimination task for mice. *PLoS One* **13**, e0204066 (2018).
2. L. C. E. Steel *et al.*, Effects of Cage Position and Light Transmission on Home Cage Activity and Circadian Entrainment in Mice. *Front Neurosci* **15**, 832535 (2021).