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Elucidating the Influence of Magnesium Deficiency on the Hippocampal Neural Activity

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Summary

This study is aimed at elucidating the effects of magnesium deficiency on neural activity in the hippocampus, a brain region crucial for memory and learning. As local field potentials (LFPs) in the hippocampus are closely related to sleep, memory, and learning, this study focuses on the analysis of LFPs during sleep and behavior to scrutinize the impact of magnesium on neural activity.

In this study, rats and mice were fed a low-magnesium diet (extremely low Mg content) or a standard control diet for two weeks. Electrodes were implanted to record electrocardiograms (ECG) and electromyograms (EMG). Furthermore, electrodes for recording LFPs were implanted in the medial prefrontal cortex (mPFC) and dorsal hippocampus. A novel object recognition task was conducted, and various biosignals were recorded and analyzed during task performance and sleep. Animal behavioral states were classified based on EMG and LFP data. Frequency analysis of LFPs in each state and cross-correlation analysis of LFPs between the hippocampus and mPFC were performed.

In the novel object recognition task, the low-magnesium diet group (MgD group) was likely to exhibit impaired memory performance.

In a home cage, no significant differences were observed in LFPs from the hippocampus and mPFC between the two groups during the dark phase. However, analysis of the light phase revealed a trend towards increased low-gamma power in hippocampal LFPs during the awake state in the MgD group. Furthermore, ECG analysis, including heart rate and the LF/HF ratio (an indicator of autonomic nervous system activity), suggested potential alterations in the MgD group.

The impaired memory performance is thought to be associated with alterations in hippocampal LFPs during task execution. The absence of LFP changes during the dark phase in a home cage suggests that the effects of magnesium deficiency may not be prominent under physiological conditions such as active states. On the other hand, changes in hippocampal activity during the awake state in the light phase in a home cage, particularly around sleep periods, suggest that magnesium deficiency may affect sleep-related brain functions, contributing to cognitive decline.