Determining Behavioral Sex Differences to Chronic Sleep Deprivation in Mice

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INTRODUCTION/BACKGROUND

In today's society of stressful work days and lack of emphasis on rest, over one-third of Americans suffer from chronic sleep loss (NCOA). This is especially prevalent in occupations where irregular working hours are common, such as healthcare, transportation, and even college students. This global health issue has a multitude of effects on health, especially in regards to cognitive performance and memory. Chronic lack of sleep has also been tied to neurodegenerative diseases and larger neurological health problems. Previously, it has been studied that acute sleep loss affects genes in the hippocampus, the part of the brain tied to memory, learning, and cognitive abilities (Prince & Abel 2013). Specifically in male mice, it has been shown that after experiencing acute sleep deprivation, hundreds of genes in the hippocampus had been altered (Lyons et al 2023).

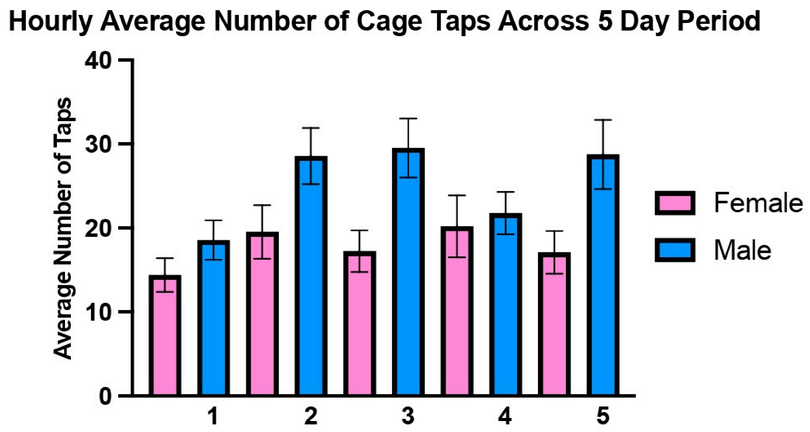
Despite the vast amounts of research analyzing the effects of sleep deprivation, little information has compared the difference and relationship between the effects of sleep deprivation and gender. Females produce many different hormones during their menstrual cycle. Estrogen, a hormone found in women to regulate their menstrual cycle, has been shown to activate areas of the brain such as the hippocampus to increase cognitive function (Hara et al 2015). Because the hippocampus is affected during acute sleep deprivation, our experiment will compare the difference in how females and males behaviorally respond to chronic sleep deprivation. By recording the instances of physical intervention (shaking and tapping) necessary to keep the mice from sleeping, our research aims to address and possibly establish a difference between female and male resistance to sleep deprivation.

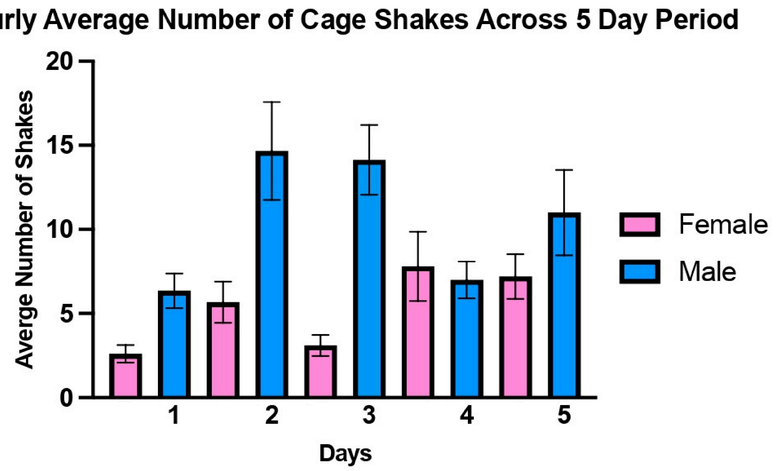
METHODS

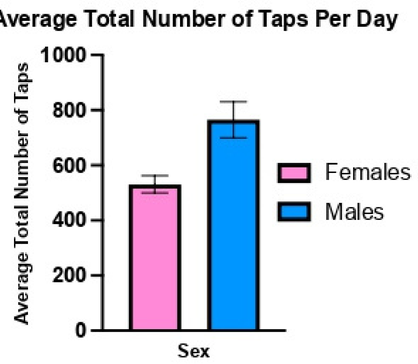
Six male and six female mice aged 3 to 5 months old from Jackson Labs (C57BL/6J) in two separate sleep deprivation studies were single-caged with corn cob bedding, gel water packs, and food, on a reverse twelve-hour light, twelve-hour dark schedule, and another six mice were housed as a control group for each experiment. To prepare for the sleep deprivation, mice cages were tapped for five minutes daily a week before the deprivation experiment to introduce them to the tapping and prevent anxiety and stress-induced responses. The male and female mice were sleep deprived for 5 hours a day, 9:00 am-2:00 pm, for 5 days of the week.

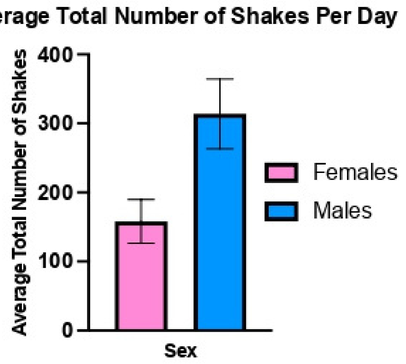
For the sleep deprivation, the six mice were consistently monitored and their cages were tapped if they began to fall asleep. If mice did not respond to the initial tapping, the cages were shaken until the mouse awakened. These taps and shakes were recorded with tally marks for 5 hours daily. The amount of taps and shakes was then analyzed, and the data between the male and female mice was recorded. Following sleep deprivation, mice were sacrificed by cervical dislocation, and brain tissue samples were collected.

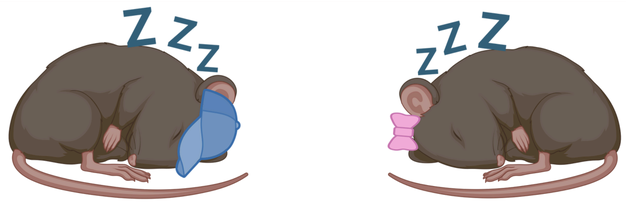
RESULTS











CONCLUSION

It was hypothesized that the female mice would require significantly fewer taps and shakes compared to the male mice due to the difference in hormones affecting the brain. We concluded that there was a significant difference in the ability of the female mice to stay awake compared to the male mice through an unpaired t test for the average taps (p= 0.012) and shakes (p=0.03) per day. Although it can't be determined from this experiment what the root of this ability stems from, we can conclude that the females experience some predisposition to allow them to withstand sleep deprivation.

FUTURE STUDIES

Future experiments could study the implications of possible neuroprotective factors through RNA sequencing and gene expression analysis. Analyzing the over or under expression of certain genes, as well as hormonal fluctuations in females during sleep deprivation could provide insight on a possible neuroprotective effect.
In addition, this experiment studied young mice and future experiments could compare the behavioral differences to chronic sleep deprivation in older female mice compared to younger female mice. This could further identify if female pre-menopausal hormones have an affect on the ability to withstand sleep deprivation.

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