Effects of Short Photoperiod on Sleep and Carbohydrate Consumption in Diurnal Grass Rats

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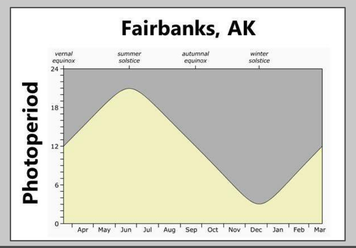
Background

- Seasonal Affective Disorder (SAD) is a significant mental health issue, particularly among Alaskan women [1]
- Mice and rats are the most prevalent rodent models for biomedical research; however, because they are nocturnal, they may be poor models for SAD [2]
- Grass rats (*Arvicanthis niloticus)* have emerged as a potentially useful diurnal model for SAD, as they exhibit depressive-like behaviors under short photoperiods [3] [4]



Specific Aims

- Measure sleep, activity, and sucrose consumption in response to shortened photoperiod in a diurnal rodent model, the Nile grass rat (*Arvicanthis niloticus*)
- Determine how well this species' responses to short photoperiod parallel those of humans diagnosed with SAD

Predictions

- Grass rats subjected to a short photoperiod will consume more high sucrose solution compared to controls
- Grass rats under short photoperiod will experience sleep disruption (shorter sleep bouts, smaller percentage nighttime sleep) relative to controls

Methods

- Animals were either maintained on a neutral photoperiod (PP) (n=23, 12L:12D), or transferred onto a short PP (n=22; 4L:20D)
- Half of the animals in each PP group were given access to a second water bottle containing 8% sucrose solution; the other half were given a second water bottle
- We monitored sleep-wake behaviors using piezoelectric sheets

Four Groups:
- ❑ Neutral PP, no sugar
- ❑ Neutral PP, high sugar
- ❑ Short PP, no sugar
- ❑ Short PP, high sugar

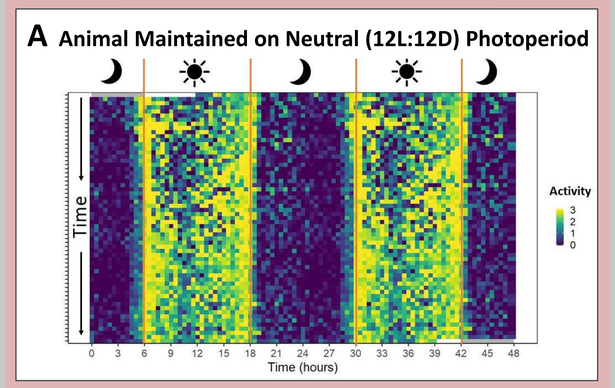


Figure 1. Actograms of individual grass rats on (A) neutral and (B) short PP. Areas in yellow represent high activity levels. The short bout of activity in darkness under short PP occurs 12h before lights off, indicating the duration of the subjective day was not altered by exposure to a short PP.

Results

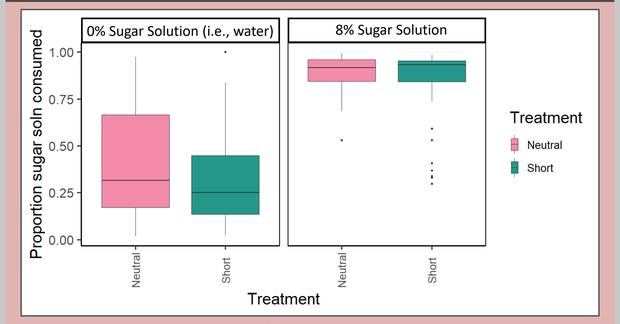


Figure 2. Proportion of the 0% (pure water) and 8% sugar solution consumed by grass rats, relative to water in their original water bottle.

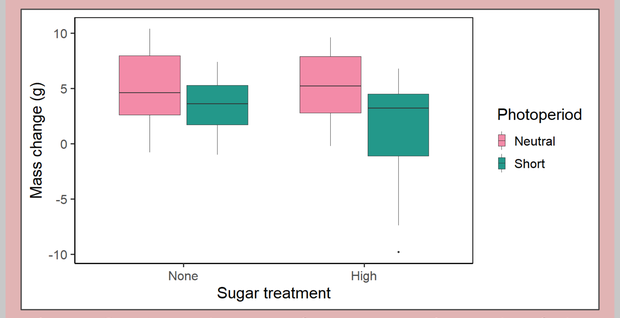


Figure 3. Mass change of grass rats in each of the four treatment groups.

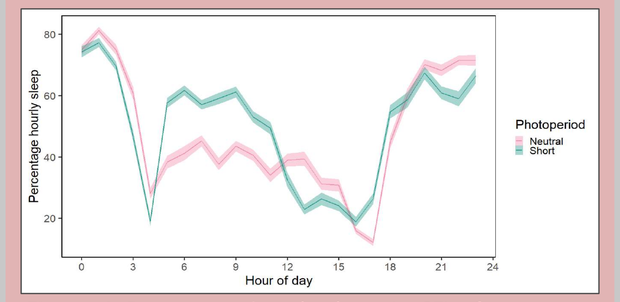


Figure 4. Percentage hourly sleep (± SE) of grass rats in both photoperiod treatments.

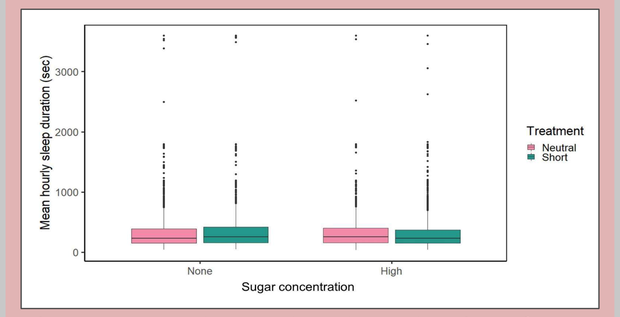


Figure 5. Mean hourly sleep bout duration of grass rats was not affected by photoperiod or by sugar treatment (none = water, high = 8% sucrose solution).

Findings

- Grass rats with access to high sucrose solution consumed this preferentially over water, but sucrose consumption was not affected by photoperiod (Fig. 2)
- Neutral photoperiod animals gained significantly more weight than animals exposed to short photoperiods, but weight gain was not affected by access to sugar (Fig. 3)
- Patterns of activity and sleep were disrupted under short photoperiods (Fig 1 & Fig 4), but sleep bout duration was unaffected (Fig. 5)
- Most grass rats had fatty livers with microvesicular and/or macrovesicular steatosis (data not shown), though this was not clearly influenced by PP or access to sugar

Conclusion

Short photoperiods disrupted patterns of activity and sleep in grass rats. However, while some humans that suffer from SAD exhibit carbohydrate craving and mass gain, a similar response to short PP does not appear to be present in the grass rat model.

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