The Relationship Between Diet and Sleep-Related Behavior

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Abstract

Metabolic processes are crucial for an organism's survival, being closely tied to development and energy production. Their effectiveness is dependent on factors like sleep, diet, and physical health. While it is acknowledged that within this biological relationship model, sleep and metabolic processes share a strong relationship, there is a lack of analytical research into the relationships between the various specific factors themselves that contribute to the strength of this relationship. This project seeks to focus on two of them, sleep and diet, to gain an understanding of how they are connected, and ultimately to draw inferences on how malnutrition affects an organism's ability to cope with sleep deprivation. Their relationship will be analyzed through a series of experiments performed on Drosophila to understand how they influence each other and the metabolic processes that drive them. The subjects will be fed specialized diets that represent three common types of diets of human beings: high fat, high sugar, and high protein, in order to observe how they affect the sleeping habits of the *Drosophila*. Observations will be done through sleep experiments that will analyze their sleeping habits, rebound rates, and behavior. Poor dietary habits can have adverse effects on the quality of life of an organism, impacting its energy, life span, holistic health, and sleeping habits (Everson, 1993; Yamazaki, 2012). In analyzing the relationship between the vital survival habits of sleep and diet, we can better understand the human condition and work towards ways of improving public health from an individual level.

Methodology

Sleep Duration

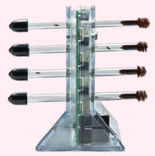


Figure 1. The Drosophila Activity Monitoring (DAM) system. Sleep was measured starting at ZT0 and averaged over 3 days (Pfeiffenberger *et al.,* 2010).

Metabolic Rate

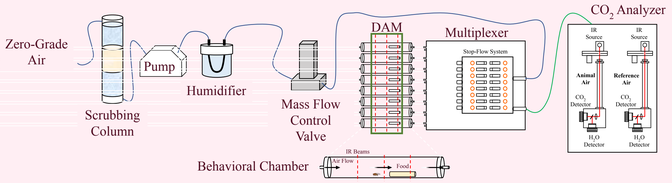


Figure 2. Metabolic rate was measured in the Sleep and Metabolic Monitoring (SAMM) system. Metabolic measurements were taken using a stop-flow respirometry system that measured CO_2 produced over time (Brown *et al.,* 2022). Sleep was measured simultaneously using the DAM system.

Diets

Standard Diet
Cornmeal/yeast/agar recipe used in many *Drosophila* labs

High Fat
Standard diet + Coconut oil

High Sugar
Standard recipe + Sucrose

High Protein
Standard recipe + Peptone

Research

Background

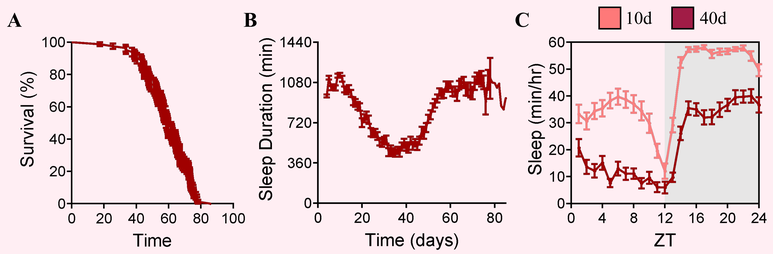


Figure 3. Sleep across the lifespan in wildtype flies. Female flies were fed a standard food diet. (A) Survival curve. (B) Measurements of sleep duration across the lifespan. (C) Sleep profile of young (10 day) and old (40 day) flies.

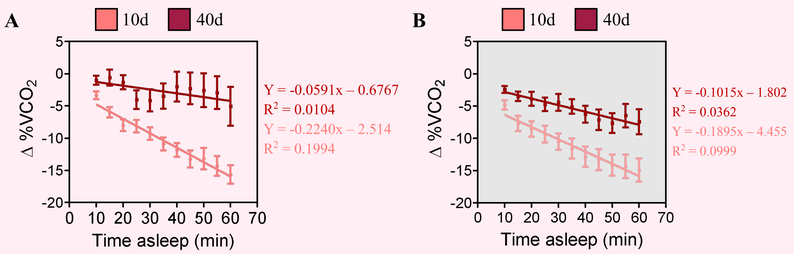
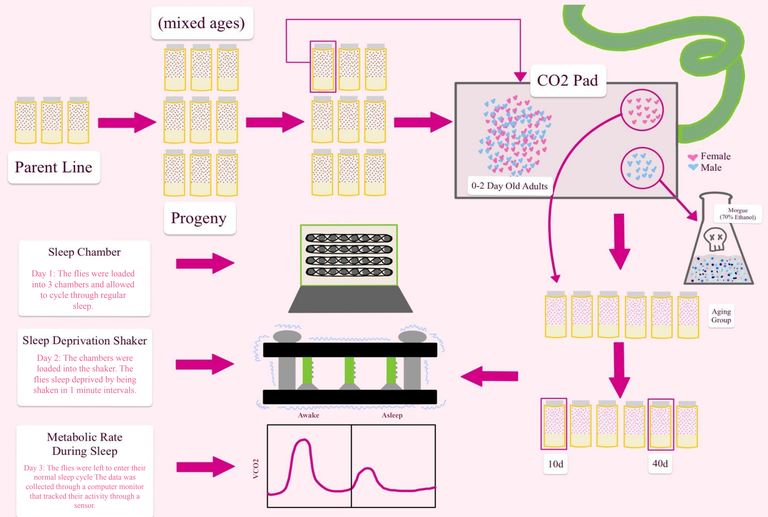


Figure 4. Metabolic rate as a function of time spent asleep. Female flies were fed a standard food diet and metabolic rate was measured in sleeping flies during the **(A)** day and **(B)** night. In both cases, the change in metabolic rate during sleep is significantly greater in young (10 day) flies, compared to old (40 day) flies.

Question

Does diet influence sleep depth across the lifespan?

Preliminary Processes



Conclusions

Preliminary Thoughts

- The experiments presented here are still underway.
- Control sleep experiments on standard diets have been conducted, and they will serve as a good basis to compare any possible changes seen in the specialized diet fly groups.
- We predict dietary manipulation will change sleep duration and metabolic rate, and the magnitude of the effect may differ depending on age.

Future Directions

- Now that the sleep experiment controls were conducted, the progeny of the original fly lines will be transferred to a specialized diet, and then placed into sleep deprivation experiments of their own so the data from the specialized diets can be compared to the standard diet control.
- Afterwards, we plan to conduct experiments on metabolic rates and food consumption to further explore the relationship between sleep and diet, especially in regards to exploring how dietary habits can help or hinder sleeping habits.
- This approach will be applied to models of neurodegenerative disease, including Alzheimer's Disease, to examine how diet may affect sleep and metabolism in these models.

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