Sleep and Its Effects On Neural Responses to Blue Light in Caenorhabditis elegans

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SLEEP

- Perhaps the most basic but least understood activity we participate in
- Sleep deprivation may have detrimental effects on brain development
  - Studies shown a correlation between sleep deprivation in children and learning disabilities, cognitive deficits, and hyperactivity
  - Possible disruption of brain plasticity development and structural changes to myelin sheath
- Questions
  - Why do we sleep?
    - What exactly is happening in the brain during sleep state?
      - Neural connections
      - Active neurons vs. Inactive neurons

C. ELEGANS AND DEVELOPMENT

- C. elegans, more commonly known as a nematode, is the first organism to have its full neuron network mapped, making it an ideal model organism.
  - Undergo developmental cycle, marked by periods of increased quiescence at each stage
  - Demonstrate avoidance behavior in response to blue light stimuli

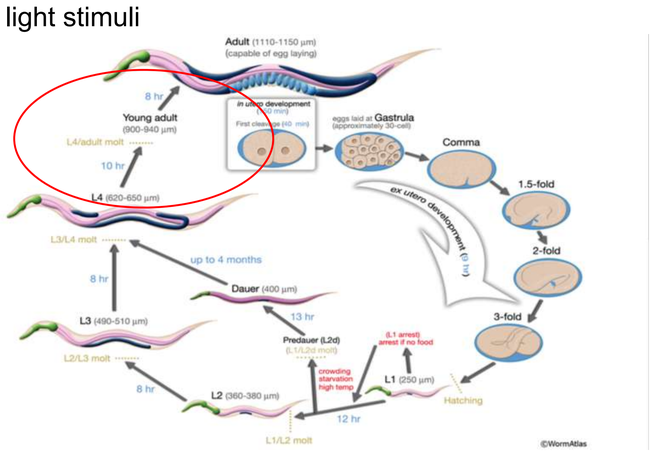


Fig. 1: Developmental cycle for C. elegans with the corresponding time period and approximate body length for each stage.

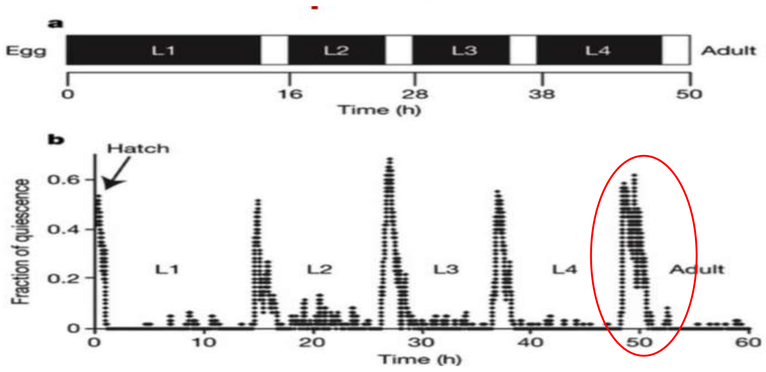


Fig. 2: Lethargus is a sleep-like state in C. elegans that occurs between each developmental stage, characterized by minimal movement.

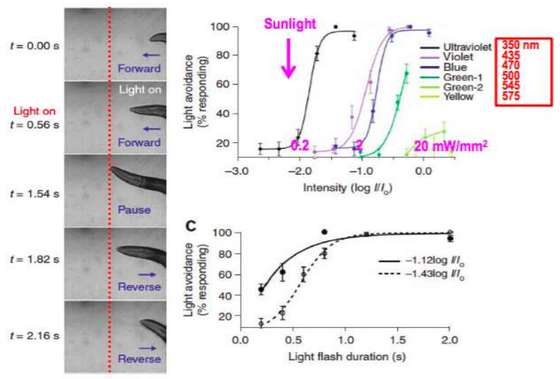
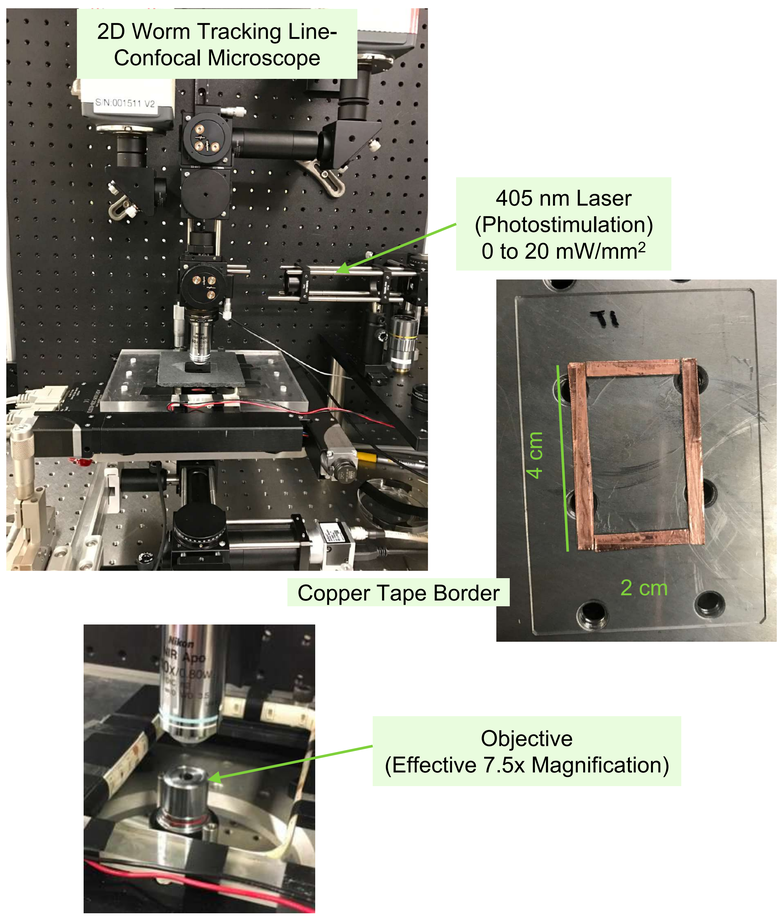


Fig. 3: Demonstrate avoidance response to stimulation from violet (435 +/- 10 nm) and blue light (470 +/- 20 nm).

ABSTRACT

- Analyze the response of C. elegans to blue light stimulus during their sleep state
- ASJ sensory neuron sends a signal to the AVA motor neuron, inducing reversal response
  - During sleep: link between ASJ and AVA is severed
- Observe sleeping worms
  - Cast a blue light laser on sleeping worms until the intensity of the light was high enough to wake the worms up
  - Determine the light intensity threshold needed to awaken a sleeping worm
- Shed new light on the poorly explored issue of neural connections and stimuli thresholds required to induce behavioral responses during sleep.

EXPERIMENTAL SET-UP



MATERIALS & METHODS

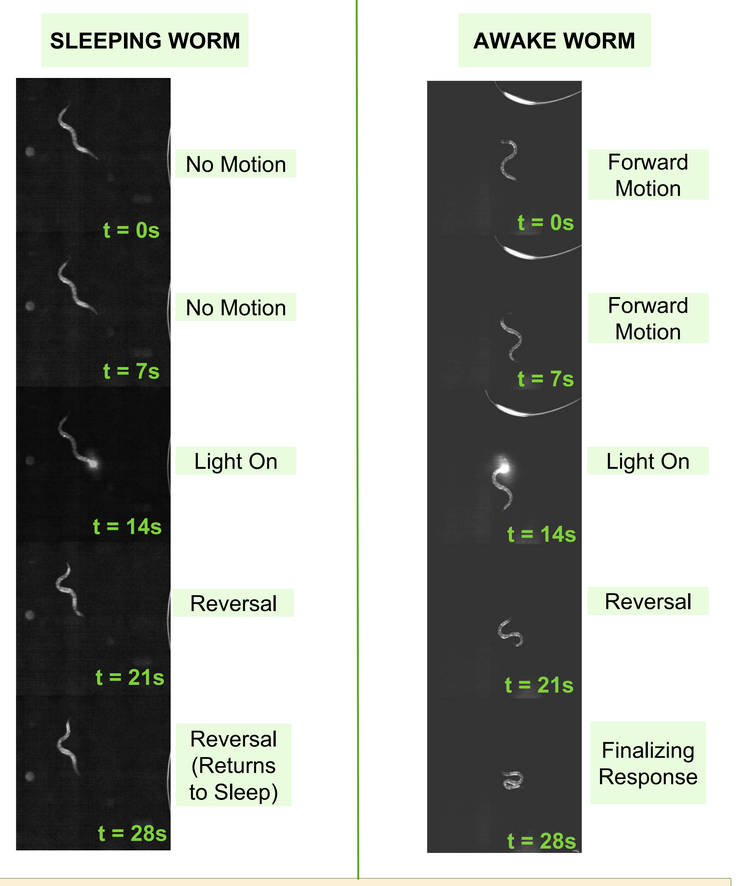
MATERIALS:

- QW1217 Worms
- M9 buffer solution
- 2% Gelatin
- 2 cm x 4 cm plate with copper tape border
- Worm tracking microscope with blue light laser

METHODS:

- Plated QW1217 worms, washed in M9 buffer, onto copper-edged plate with gelatin
- Monitored healthy individual worms until they entered their sleep state
- Stimulated worms using an intensity that has been experimentally shown to have 100% avoidance behavior
  - Compared behavioral response and intensity needed to initiate avoidance behavior between sleeping and awake worms

PRELIMINARY RESULTS



FUTURE DIRECTIONS

- Continue to collect data on C. elegan behavioral response to blue light under sleeping state versus awake state
- Analyze responses during lethargus state in each developmental stage (L1, L2, L3, L4)
- Utilize brain-imaging microscope to capture the neural firings of the worms in their sleep state and awakened state
  - Purpose: Determine what synapses are severed or formed
- Observe C. elegan synaptogenesis during sleep
  - Purpose: Be able to map synaptogenesis in C. elegans and possibly discover the reason behind sleep as a developmental process

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