Understanding the Behavior of Caenorhabditis Elegans Under Combined Electric Field and Blue Light Stimulation

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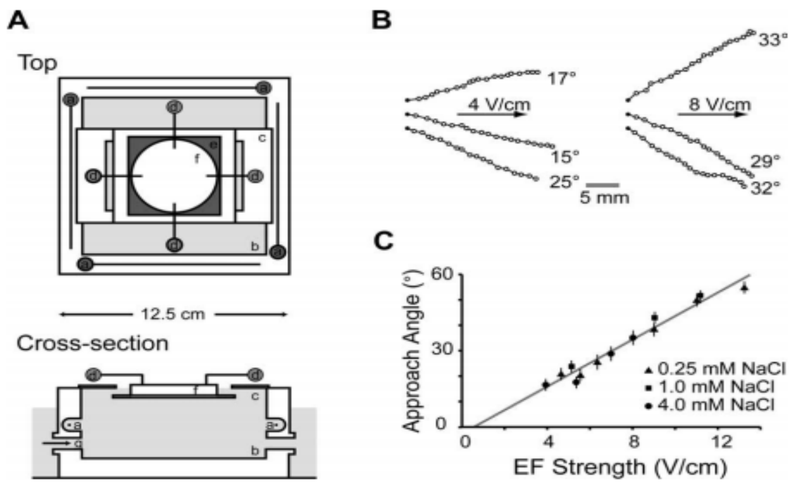
http://www.elegantmind.org

UCLA Science Poster Day on May 24, 2016

ABSTRACT

The neuronal circuits governing the behavior of the Caenorhabditis elegans are well documented and understood. This experiment seeks to compare the behavior of C. elegans in response to competing pain stimuli routed through the same known neuronal circuits, namely through the ASJ neuron. Blue light and electric field are two such stimuli processed by the ASJ neuron, for which the C. elegans responds by exhibiting known avoidance behaviors. Movement towards the negative pole of an electric field and reversal followed by omega turn after specific-wavelength light exposure are the two such observable behavioral patterns expected to result. This experiment seeks to compare the decision making behavior of the C. elegans in response to these competing stimuli when presented together in order to establish a potential model for consciousness. Preliminary results suggest that the effects of these two combined stimuli may have either an additive effect, or a single stimulus may reveal itself to be dominant over the other. It is this threshold that this experiment seeks to further explore and qualify.

BACKGROUND

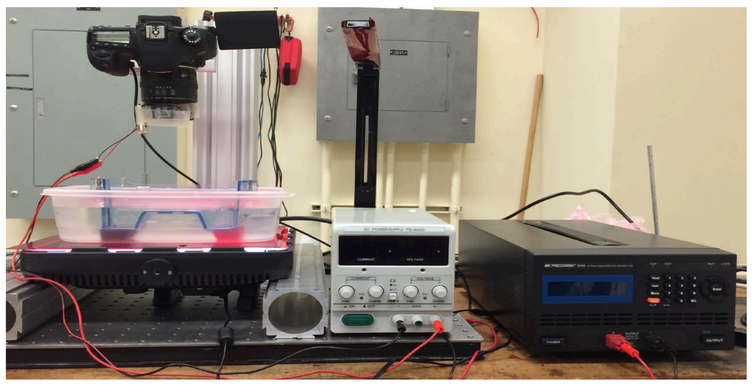


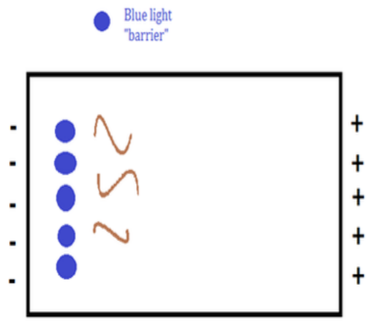
- Gabel et al. (2007) analyzed the movements of individual C. elegans under varying electric field strengths to quantify electro-sensory behavior
  - C. elegans were observed to migrate towards the negative pole of the electric field at angles that increased with higher strength electric fields
- Ward et al. (2008) described the neuronal pathway through which C. elegans process stimulation by light
  - C. elegans executed known avoidance behaviors (omega turns and reversals) in response to photo-stimulation

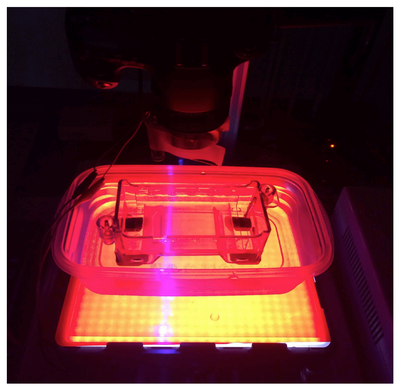
HYPOTHESES

- **HYPOTHESIS 1: Omega Turns**
  - Omega turns often observed in free motion, expect overall time spent in omega turns to decrease under electric field stimulation and increase under blue light stimulation
  - Unknown if time to execute individual omega turns would be affected by blue light and electric field stimulation
- **HYPOTHESIS 2: Speed and Fluency of Motion**
  - Expected to be at consistent angle towards the negative pole when under the electric field
  - Expected halting of motion when confronted with blue light barrier

EXPERIMENTAL SETUP







MATERIALS & METHODS

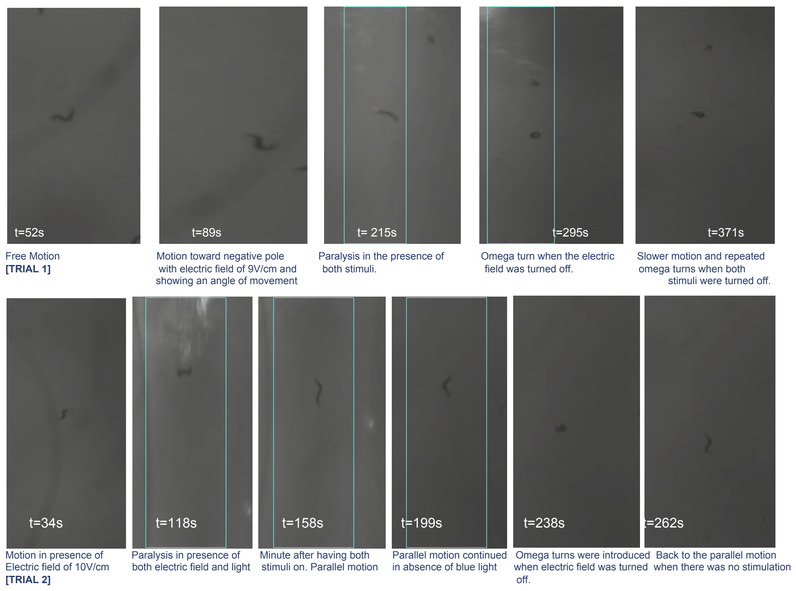
MATERIALS:

- Electrophoresis chamber in ion solution (400-600V power source)
- 1.7% concentration agarose gel on 7cmx9cm plate
- Constant blue light beam (λ=405nm)
- Laser Intensity = 3.5 x 10^{-2} mW/mm^2
- Canon EOS 60D Camera

METHODS:

- N≥10 healthy L2 C. elegans placed on agar plate following 30 minutes of starvation
- Agar plate situated in electrophoresis chamber, a switch on the voltage source introduces a uniform electric field across the plate after a set amount of time (varied by trial)
- Blue light barrier set up proximal to the negative pole, enabled after a set amount of time (varied by trial)
- Trials conducted between 8-12 V/cm

RESULTS



* □ = Blue Light Beam

Average Quantity of Worms Per Trial Under Electric Filed:	Worms Interacted With Blue Light:	Paralyzed Upon Stimulation:	Omega Turn Upon Stimulation:	Continued at Constant Speed Upon Stimulation:
35	7	2	1	4

CONCLUSIONS

- Straight, consistent motion toward the negative pole observed at apparent angles consistent with Gabel et al. (2007) results
- Average of 2 C. elegans per trial appeared paralyzed in the presence of both stimuli (paralysis incited by confrontation with blue light barrier)
- Avoidance behaviors (most notably the omega turn) were executed in response to painful stimuli in an average of 1 C. elegans per trial
- Turning off the electric field after the C. elegans had been under the influence of blue light as well resulted in complete reversal away from the blue light and former negative pole
- Overall qualitatively slower motion observed, C. elegans were less vigilant and mobile under the influence of blue light

FUTURE DIRECTIONS

EXPANDING ON HYPOTHESES:

- Analyze whether time spent executing individual omega turns was changed depending on the different stimuli to a higher degree of accuracy
- Use more sophisticated quantitative data processing programs to better analyze experimental results, instead of constructing graphs manually
- Conduct trials varying the life cycle stage of the C. elegans used

- **GENERAL AMENDMENTS TO THE EXPERIMENTAL DESIGN:**
  - Construct an appropriate, more stable arm for the blue light source
  - Concentrate the beam to result in an overall more controlled experiment

REFERENCES

Gabel, Christopher V, et al. “Neural Circuits Mediate Electrosensory Behavior in Caenorhabditis Elegans.” The Journal of Neuroscience 27.28 (2007): 7586–7596. Web. 20 Apr. 2016.

Ward, Alex, et al. “Light-Sensitive Neurons and Channels Mediate Phototaxis in C. Elegans: Abstract: Nature Neuroscience.” Nature Neuroscience 11.8 (2008): 916–922. Web. 20 Apr. 2016.

ACKNOWLEDGEMENTS

Special thanks to the senior EMC members, in particular the E1 group, whose contributions and guidance were integral to the success of this experiment. Additional thanks to the NSF IDBR, UCLA Dean’s Office, and CNSI for their support in funding this research.