Avoidance Behavior of Caenorhabditis Elegans at Early Developmental Stages in Response to Blue-Light Stimulation

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ABSTRACT

In animals, complex neural networks have evolved primarily to navigate space-time. Some essential highly deterministic reflexes are likely to be established earlier in an animal's development. Accordingly, the neural pathways controlling such reflexes must have been formed in early development. To investigate C. elegans' behavior while these neural networks form, we stimulated the head photoreceptors of N2- strain worms with a blue-light laser.

INTRODUCTION

C. elegans is a soil-dwelling nematode that goes through several different stages of development in its life cycle.

Previous findings in the Arisaka Lab have shown that adult *C. elegans* demonstrate a two-step avoidance behavior in response to blue light stimulation:

- a reversal (the worm moves backwards)
- omega turn (the worm turns 180° and moves forward)

An adult C. elegans has 302 neurons, but 80 of these (mostly motor neurons) are formed after hatching, in the L1 and L2 stages of development.

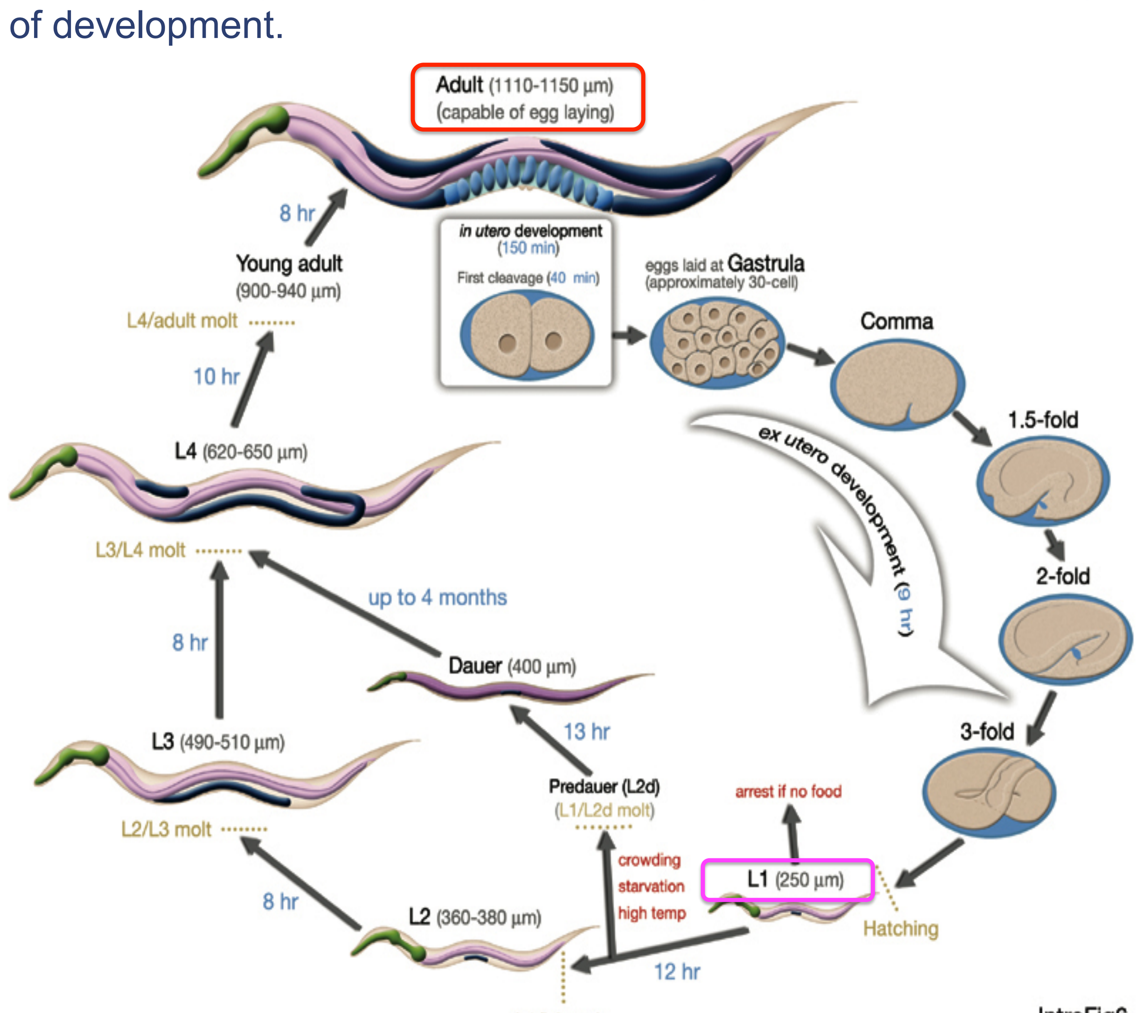


Fig. 1: Developmental cycle for *C. elegans* with the corresponding time period and approximate body length for each stage.

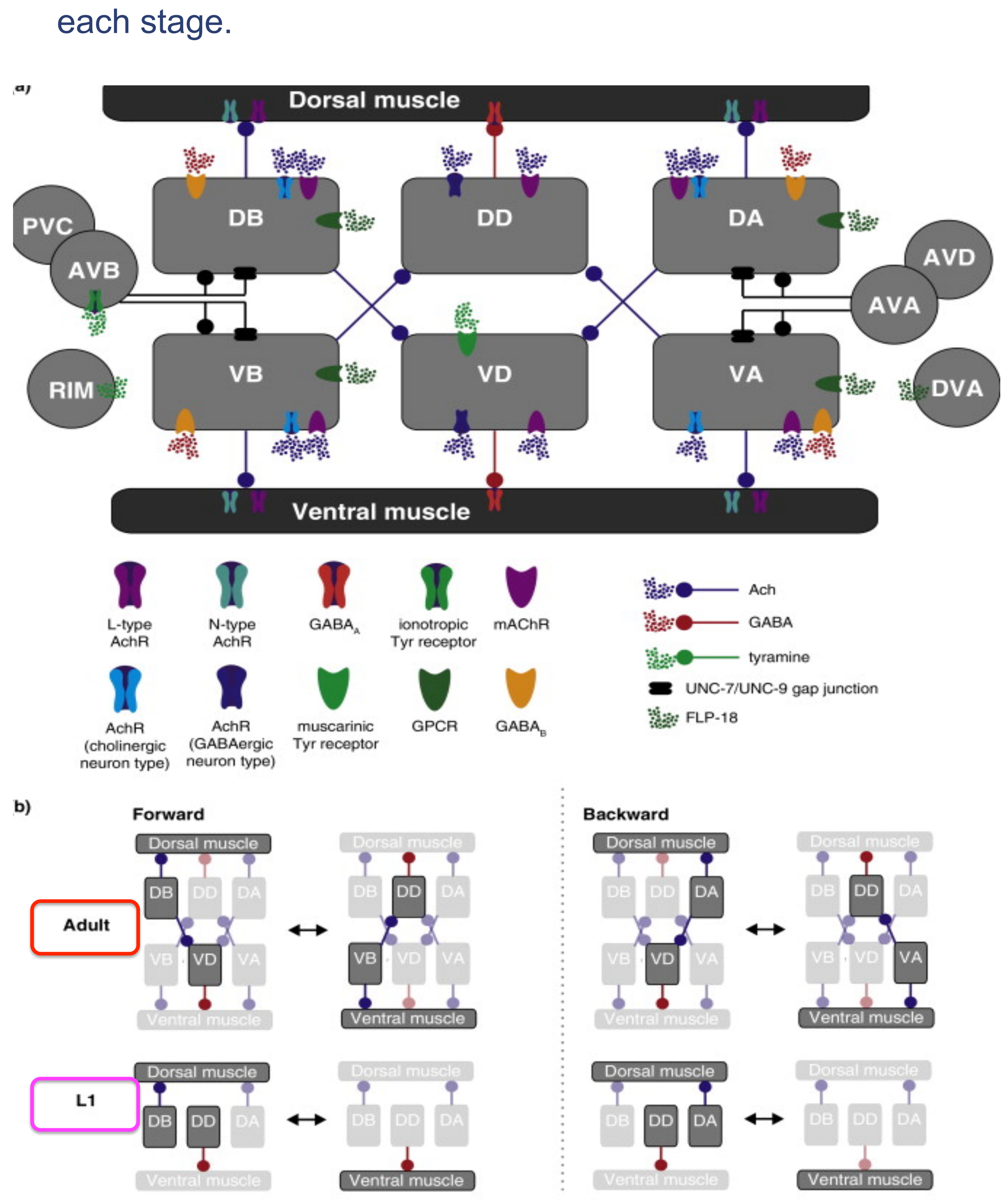


Fig. 2: Diagram of the *C. elegans* motor circuit. In L1 worms, only the DA, DB, and DD motor neurons are present.

A TYPICAL AVOIDANCE BEHAVIOR

C. Elegans (Adult)

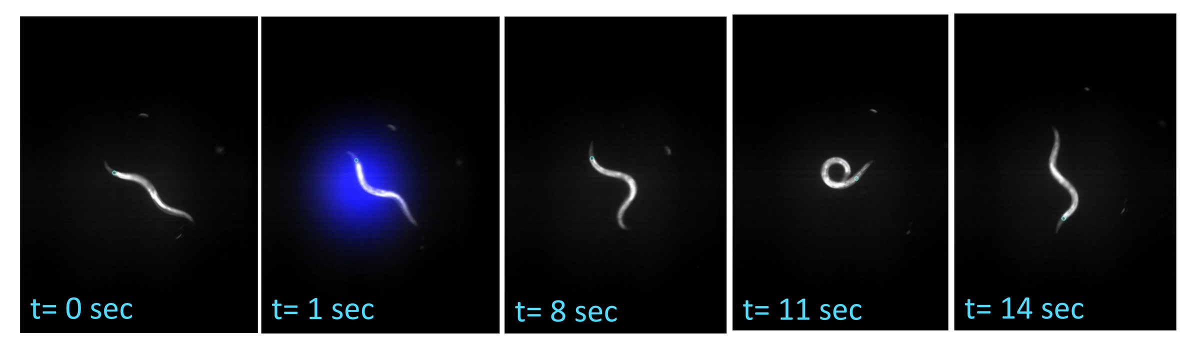


Fig. 3 : Sequence of standard adult *C. elegans* avoidance behavior to 2 second pulse blue light .

C. Elegans (L1 Stage)

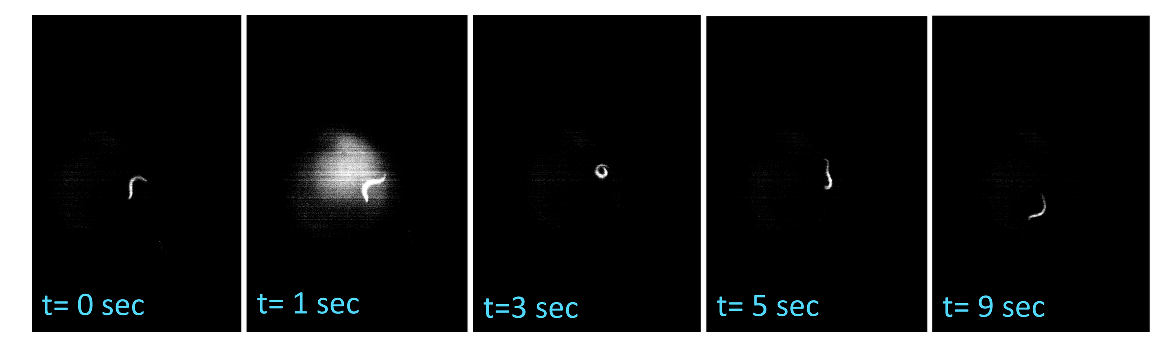


Fig. 4 : Sequence of L1 *C. elegans* avoidance behaviors. These images were taken with 20X magnification and highlight the difference in the worms' sizes.

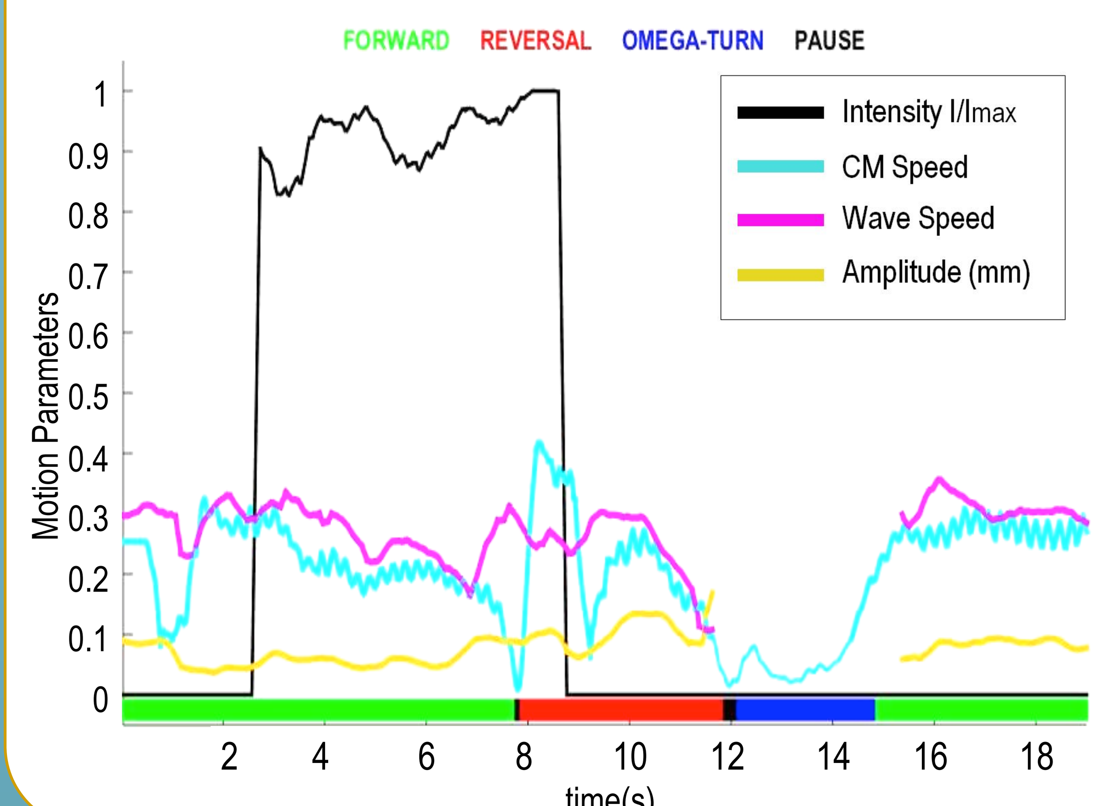
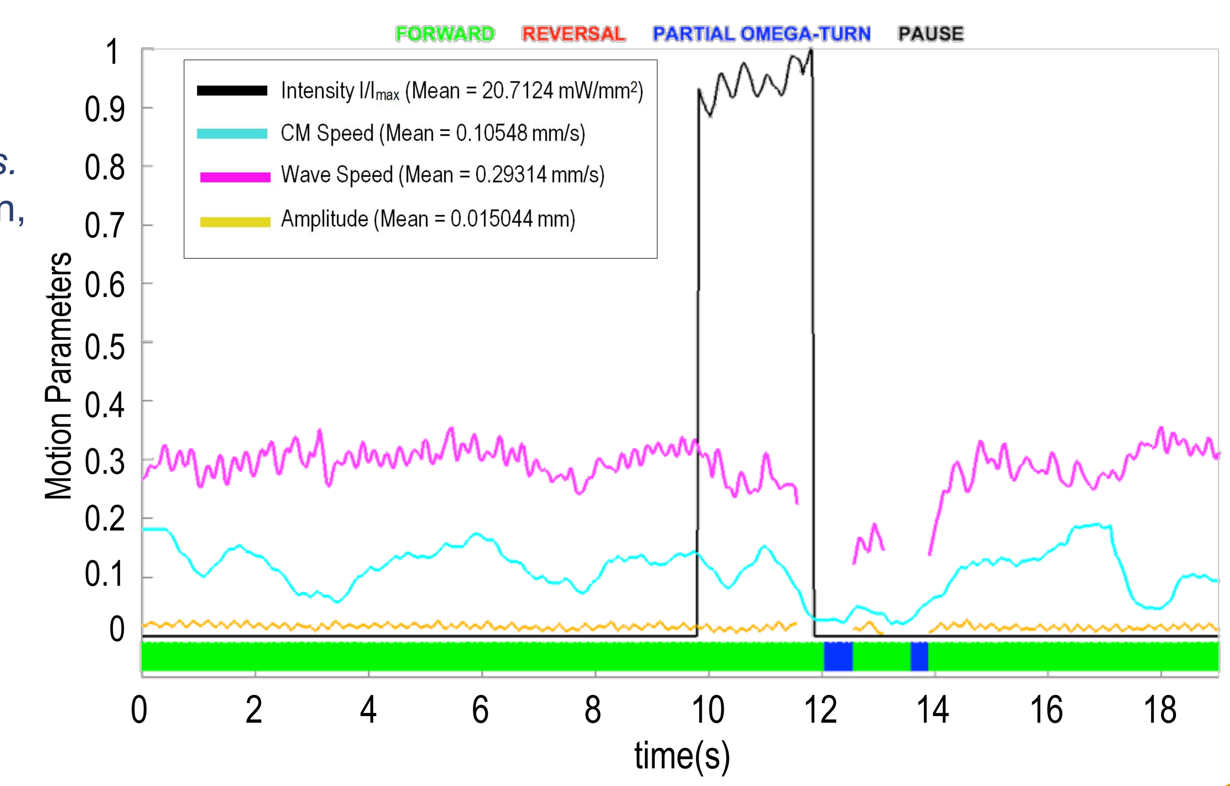


Fig. 5 (left): Motion graph analysis of adult *C. elegans*. It consists of forward motion, reversal, omega turn, and forward again.

Fig. 6 (right): Motion graph analysis of L1 *C. elegans*. This graph emphasizes the lack of reversal that is typical of adult avoidance behavior.



MATERIALS & METHODS

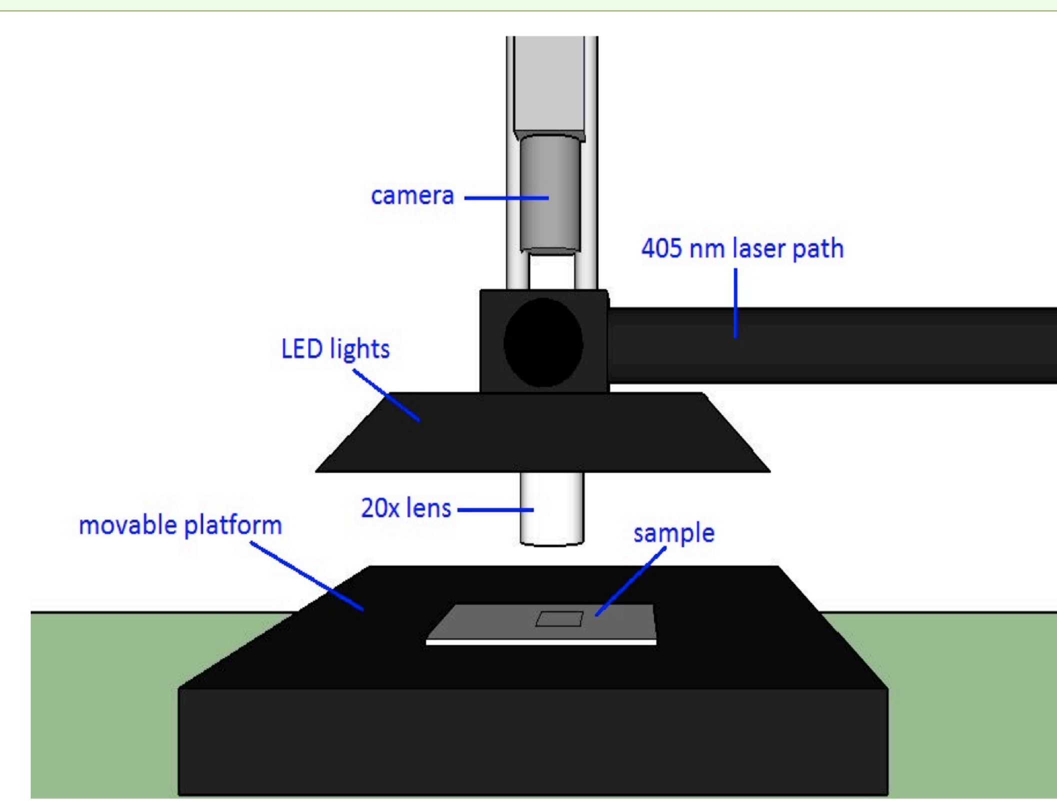
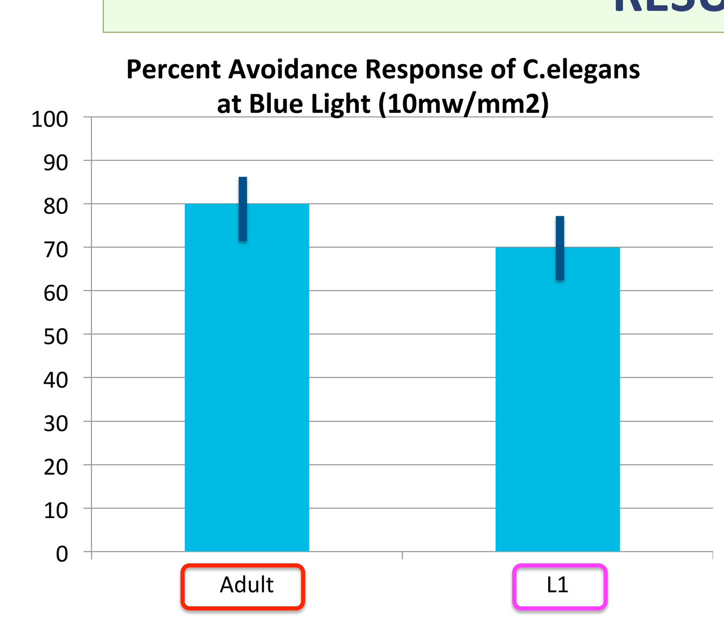


Fig.7: 2% gelatin samples of L1 *C. elegans* contain 10 - 20 N2 strain worms of the same age. A worm was tracked via the Wormtracker to observe its motion, and its health was noted. Healthy worms (worms traveling at around .05 mm/sec) were then stimulated using a 405 nm laser. Their phototaxis behaviors were recorded and then analyzed using MATLAB programs.

RESULTS



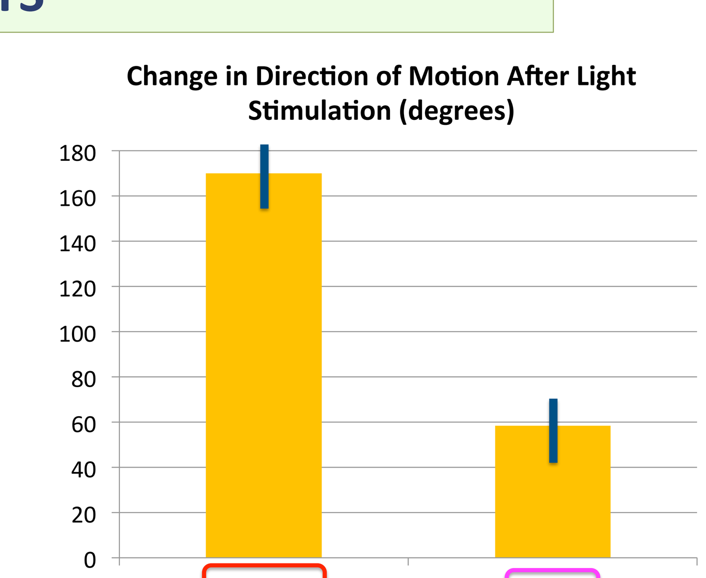


Fig. 8 (left): The rate of avoidance behavior was similar in adult worms and L1 worms.

Fig. 9 (right): This graph highlights a difference between the adult and L1 responses. In adult worms, the avoidance response consisted of a reversal and omega turn, after which the adult would move away nearly opposite the original direction of motion. In contrast, the typical L1 response (seen in Fig. 4) consisted of the worm curling into a loop and then uncurling (which we call a partial omega turn) and moving forward, in a direction much closer to the original direction of motion.

CONCLUSIONS

- The data reveal that under the same light stimulation, adults and L1 worms have similar rates of avoidance behavior. However, the appearance of this response differs; adults reverse, omega-turn, and move forward, while L1 worms curl up, uncurl, and move forward.
- Previous findings have stated that *C. elegans* is still missing several motor neurons during the L1 stage. Our data support this point and suggest that these missing motor neurons limit the ability of the L1 worms to execute the typical avoidance response of reversal and omega-turn, though they are still sensitive to blue light stimulation.

Future Directions

- We can use a range of gelatin concentrations from 0.0% to 2.5% and see at what point the L1 worms stop moving to support the established finding that L1s have fewer developed muscles than adults.
- With the establishment of typical L1 motion data, we can explore possible habituation of *C.elegans* to blue light.

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