Attractors in Velocity Space During 2D Navigation of *C. elegans*

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Introduction

Many organisms migrate efficiently toward a preferred condition to increase survival. While *C. elegans* have previously been described as primitive organisms capable of moving towards such ideal conditions by biased random walk and klinotaxis, their deterministic locomotion have not yet been extensively characterized. Here we observe the movement of *C. elegans* with and without stimuli by implementing different external conditions: absence of stimuli defined as free motion, temperature gradient, and electric field. We present the deterministic locomotive decisions of *C.elegans* in such 2D navigation as attractors in velocity space.

Materials and Methods

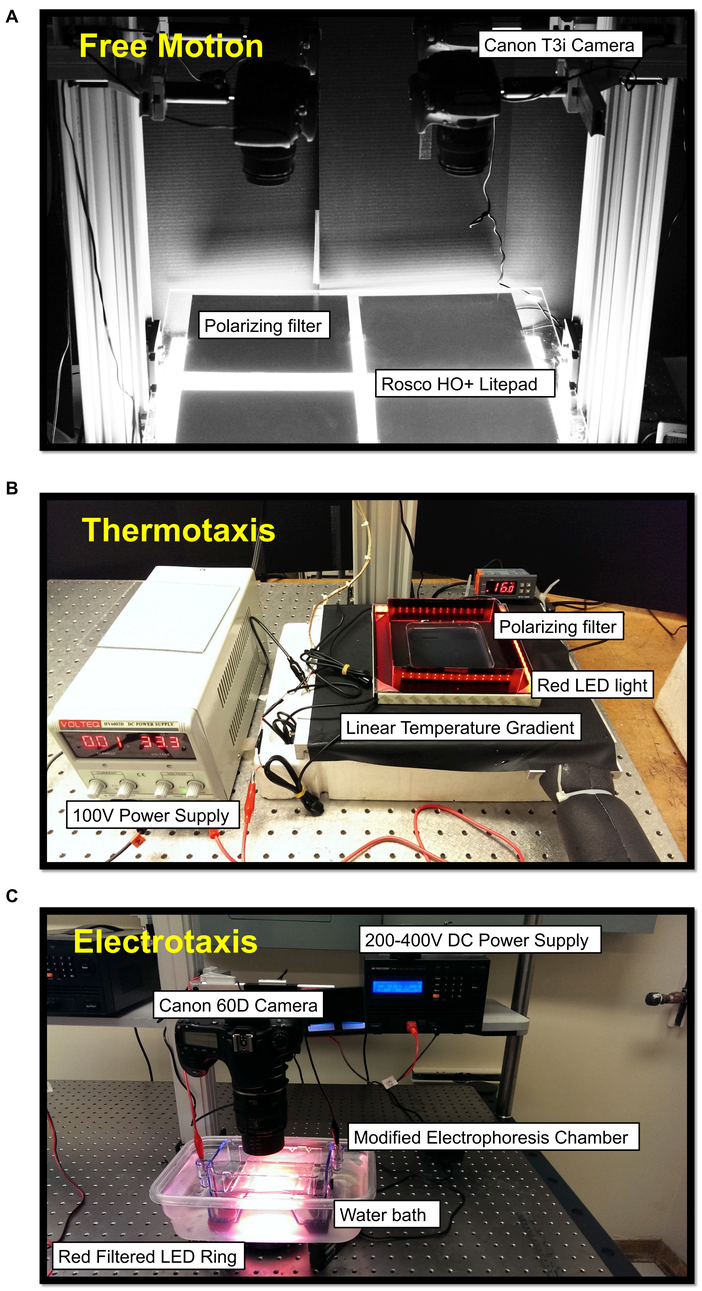

Figure 1:
(A) Free motion setup designed to take data of four plates of agar simultaneously
(B) Linear temperature gradient created with a Tungsten heater and cooling system
(C) Modified electrophoresis chamber designed to exert electric field on *C. elegans* on agar while minimizing resistive heating

Free Motion

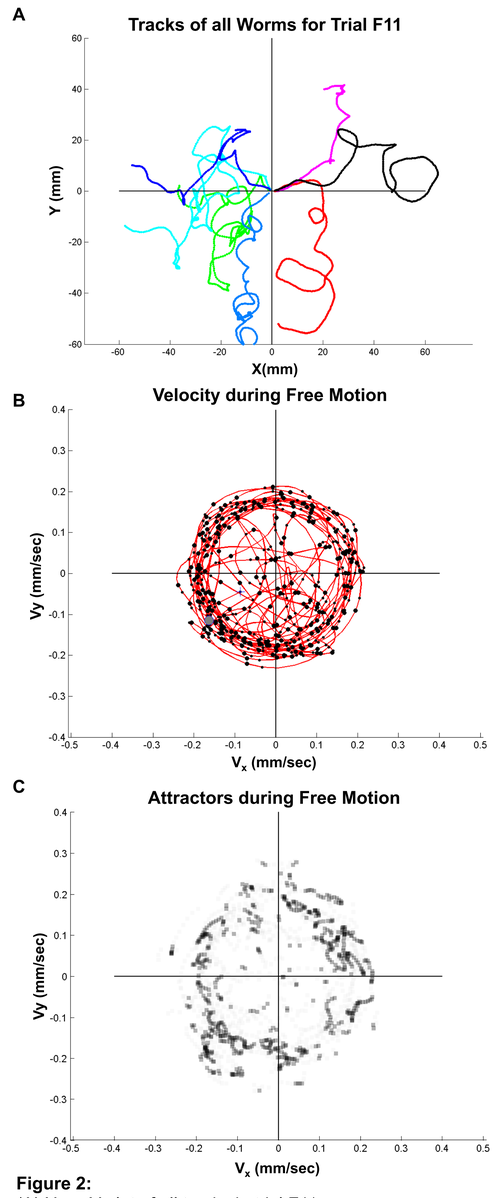

Figure 2:
(A) X vs. Y plot of all tracks in trial F11
(B) V_x vs. V_y plot of worm #3 in trial F11
(C) Attractor plot of trial F11 (acceleration threshold=0.003 mm/s^2)

Isothermal Behavior

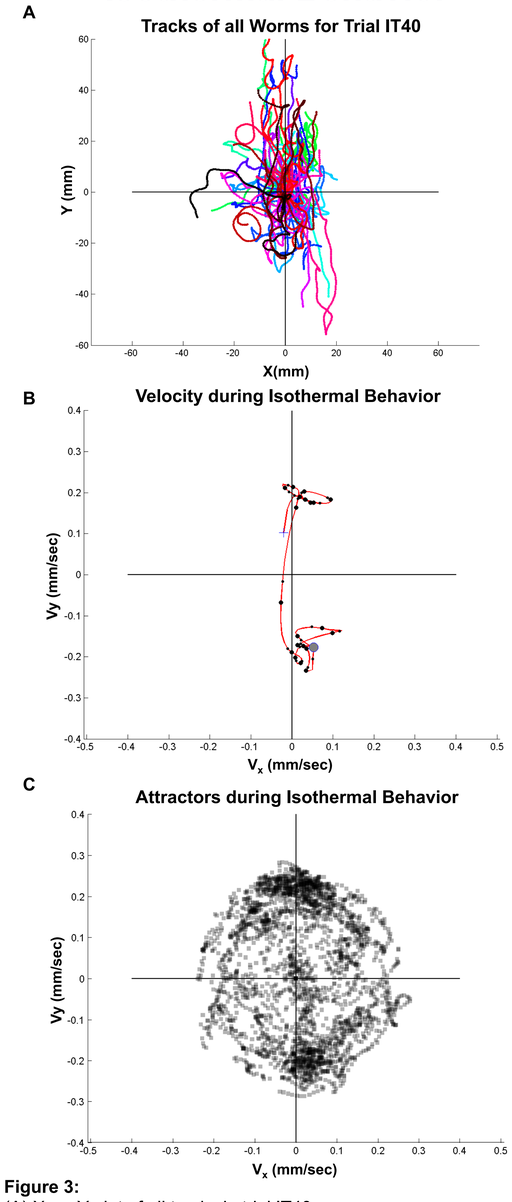

Figure 3:
(A) X vs. Y plot of all tracks in trial IT40
(B) V_x vs. V_y plot of worm #30 in trial IT40
(C) Attractor plot of trial IT40 (acceleration threshold=0.003 mm/s^2)

Electrotaxis

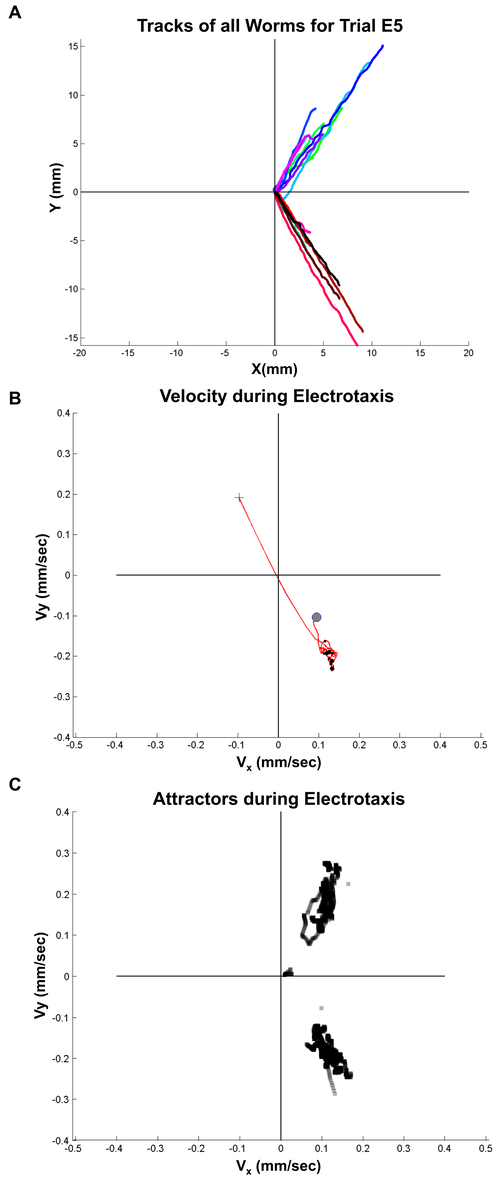

Figure 4:
(A) X vs.Y plot of all tracks in trial E5
(B) V_x vs. V_y plot of worm #16 in trial E5
(C) Attractor plot of trial E5 (acceleration threshold=0.003 mm/s^2)

Discussion

- *C. elegans* locomotion in the absence of stimuli during free motion navigation can be characterized by the lack of attractors and distinct scanning of velocity space in all directions
- *C. elegans* exhibit isothermal behavior most prominently in response to a linear temperature gradient of 0.06 °C/mm. This behavior is characterized by the distinct attractors present in the positive and negative V_y space with the highest velocities in the respective directions
- The attractors in velocity space during electrotaxis can be observed in the distinct clusters that form with mirrored positive and negative bearing angles about the X axis- reflective of the strength of the external potential

Conclusions

- *C.elegans* behavior observed during isothermotatic locomotion and electrotaxis are divergent from random like behavior and indicative of attractors present in the neural network of *C. elegans* for navigating space.
- The findings suggest a more intelligent form of sensory-motor processing and integration that underlies *C.elegans'* locomotion that are further investigated from a neurological perspective.

References

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