Developing a Streamlined Data Pipeline for Quantifying Ionic Liquid Effects on Locomotive Activity

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Background

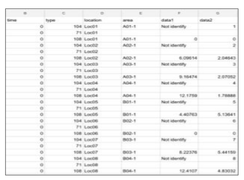
This project aims to investigate how different types and concentrations of ionic liquids—**emim-oAc**, **emim-dmp**, and **omim-Cl**—affect the locomotion of horseshoe crab larvae across two developmental stages, 20-1 and 20-2. Animals were exposed to these chemicals for varying durations and tested using a behavioral assay with alternating **light and dark** visual stimuli to probe stimulus-responsive movement.

The goal of this project, from a computational neuroscience perspective, was to develop a **streamlined and efficient approach** to quantify and visualize the movement we consistently observe in video recordings and path traces. We sought to establish whether differences in locomotion across groups were **statistically meaningful**, and to build a reproducible framework that translates raw tracking data into interpretable movement metrics.

Methods

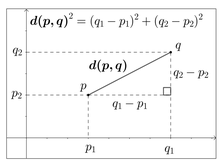
Behavioral Experiments (Video and Traces of Horseshoe Crabs)

Collecting raw data (x, y coordinates)

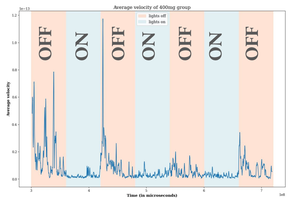


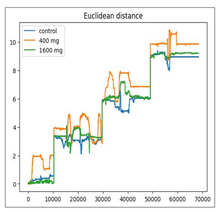
Cleaning data (removing missing values)

Euclidean distance



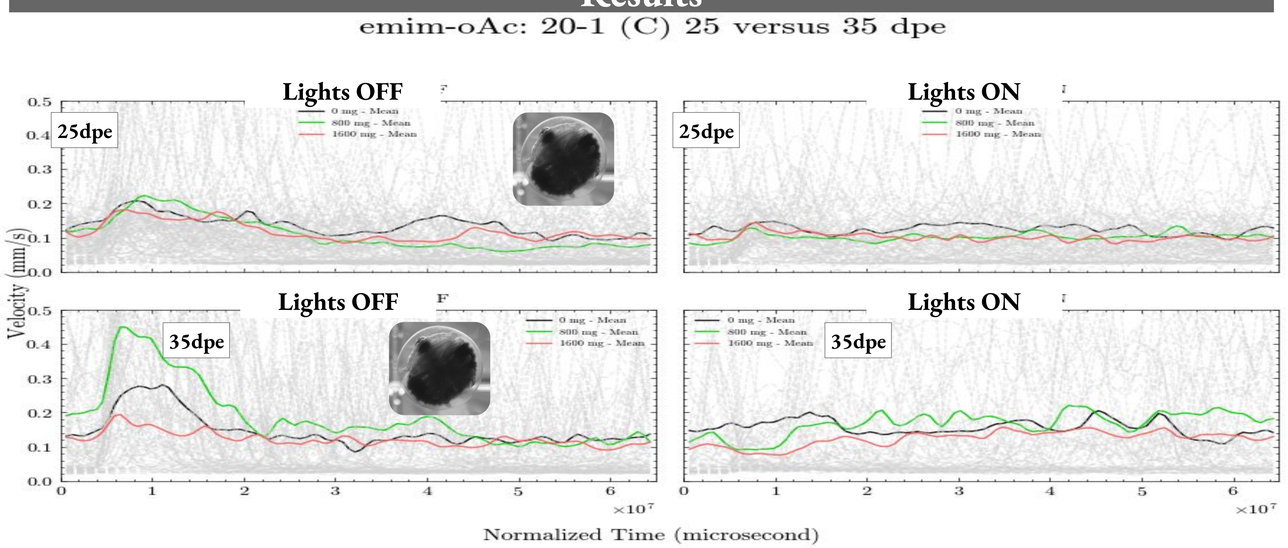
Velocity plot

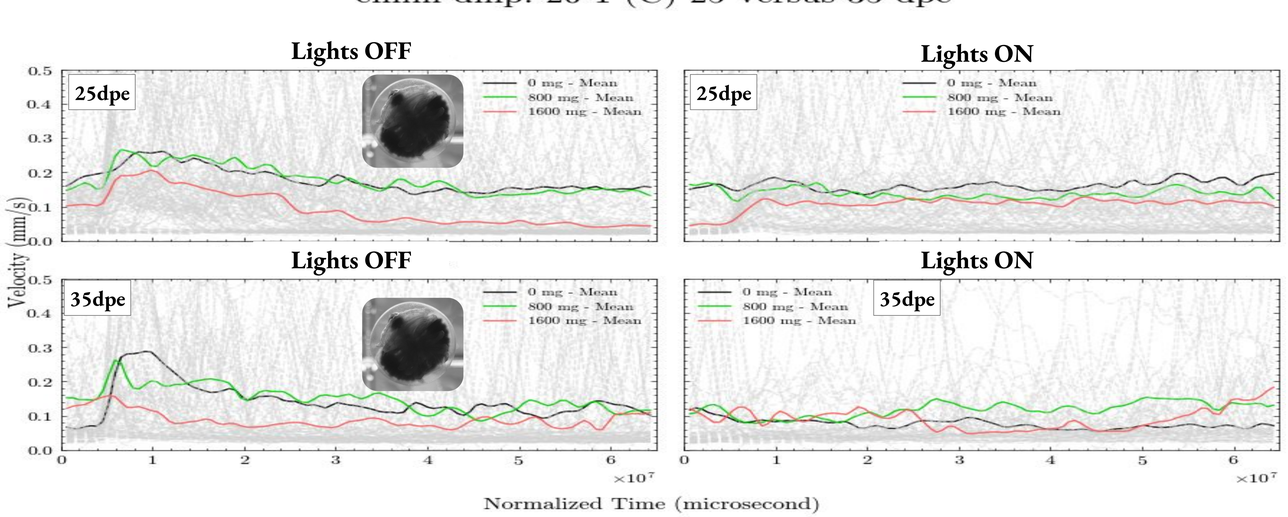


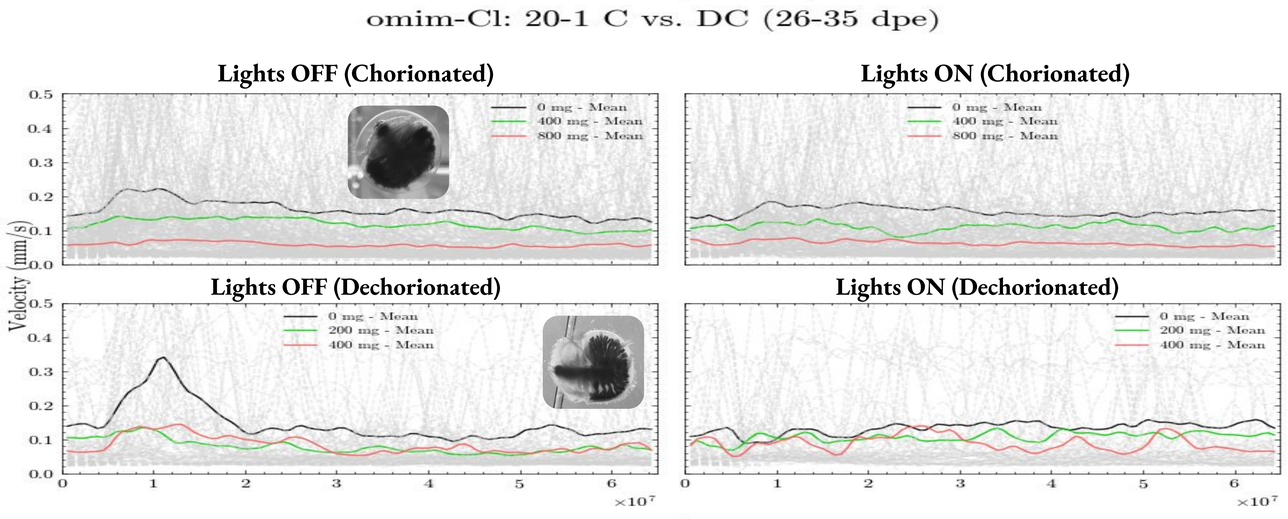


Cumulative distance over time

Results







Discussion

Mapping data automation

This project centered on developing a streamlined data pipeline to process behavioral tracking data from Zebralab. Due to inconsistent experimental setups—varying in concentration levels, ionic liquid types, and number of animals per dish—we implemented a flexible group-mapping system to automate assignment of animals to their respective conditions based on a custom file naming system.

Data validation via cross-reference approach

Raw x-y coordinates were preprocessed, and velocity was computed using Euclidean distance, followed by Gaussian smoothing and time normalization to align animals across light stimulus bins (**lights ON** vs. **lights OFF**). We validated movement traces by cross-referencing velocity graphs with complete path images and raw video footage, addressing false positives from the tracking system.

Statistical analysis

To support quantitative comparisons, we automated one-way ANOVA and post hoc Tukey HSD tests, applied at fixed time bins (e.g., 10 seconds). Significant comparisons to the control were visualized using color-coded asterisks directly on the velocity plots. This approach ensures rigorous, reproducible analysis while communicating findings effectively to non-technical audiences.

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References

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