Towards the analysis of the behavior of *Drosophila Melanogaster* after and during dyadic interactions

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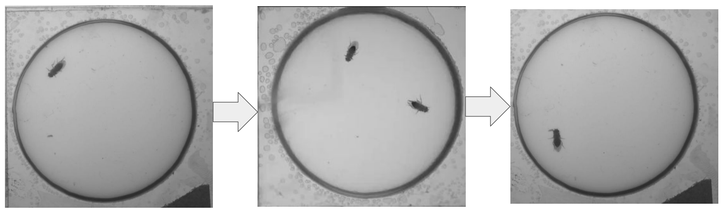
Introduction

- *Drosophila Melanogaster*, or common fruit flies exhibit a range of behaviors. These can include things such as the fly's grooming habits, or the amount of time a fly spends idle.
- With modern developments in machine learning, it is possible to use SLEAP, a postural estimation software to track animals without physical tags.
- Using this software, it is possible to observe and infer behavior of animals from their motion.
- We would like to know how the behaviors of *Drosophila Melanogaster* are impacted by their exposure to long term dyadic social experiences both during and after.

Fig. 1. Experimental Design



Flies are recorded for 3 days

Flies are paired and recorded for 4 days

Flies are separated and recorded for 7 days

Experimental Design

Flies were put into small solo arenas and recorded for three days. Afterwards, they were paired into arenas of the same size and recorded for four days. Finally, they were separated from each other and recorded again in individual arenas for a week. As well as this, there were control groups of flies, which were not paired but still had arena changes. Both male and female flies were used for this experiment.

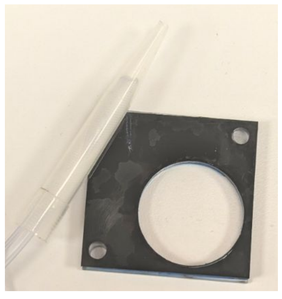
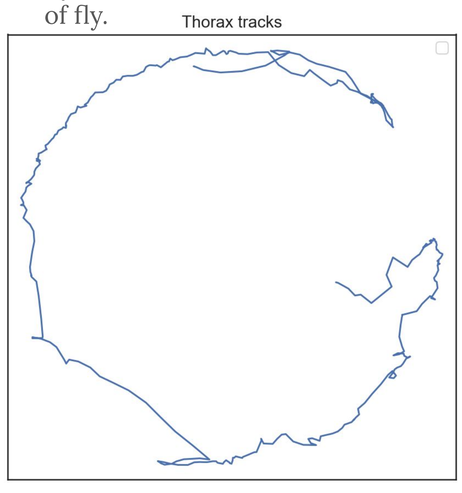


Fig. 2. Aspirator and empty arena. Flies were moved with aspiration.

Fig. 3. Tracked trajectory of a fly.[1] Thorax used to track center of fly.



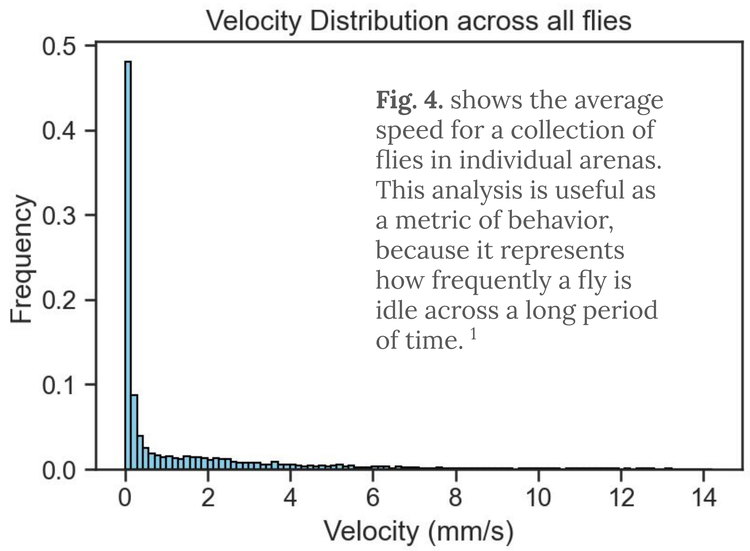


Fig. 4. shows the average speed for a collection of flies in individual arenas. This analysis is useful as a metric of behavior, because it represents how frequently a fly is idle across a long period of time. [1]

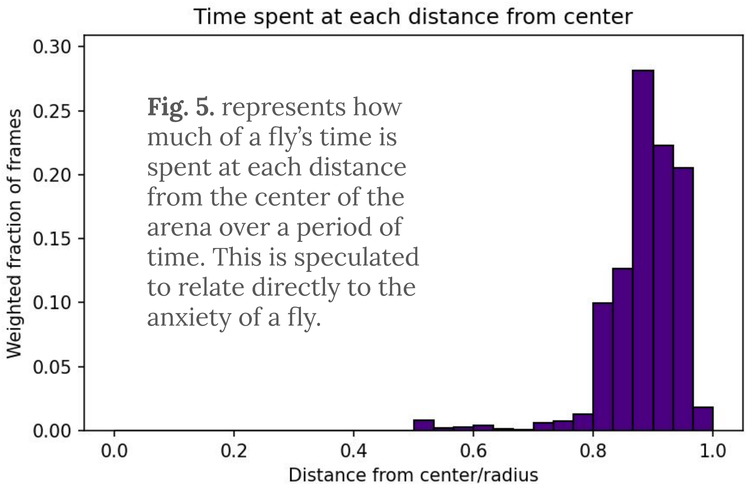


Fig. 5. represents how much of a fly's time is spent at each distance from the center of the arena over a period of time. This is speculated to relate directly to the anxiety of a fly.

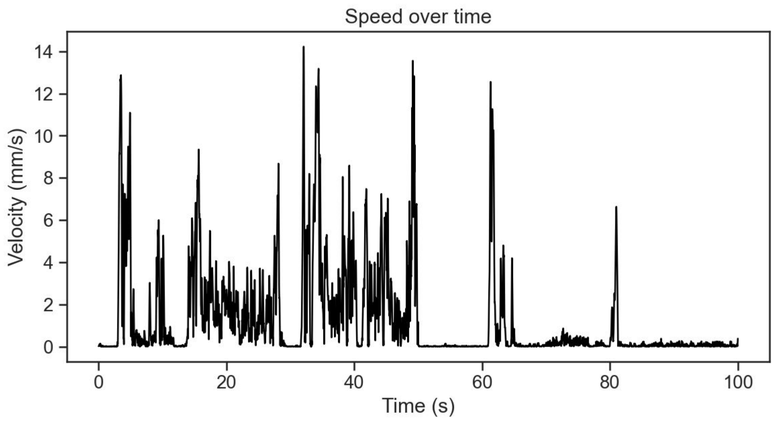


Fig. 6. depicts the speed of a fly at each given moment in time. This data can be useful in long term analysis in order to determine when a fly is active over the course of a few days.[1]

Moving Forward

- The next step in our analysis of *Drosophila Melanogaster* behavior are to implement a more robust tracking SLEAP model. This would enable us to run the analysis pipeline on the data we collected.
- This will also enable us to utilize the Motion Mapper pipeline, which requires tracking the movement of the fly's limbs, an unsuccessful but promising product of the postural estimation.

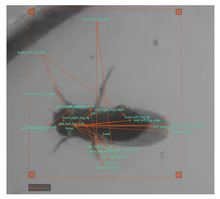
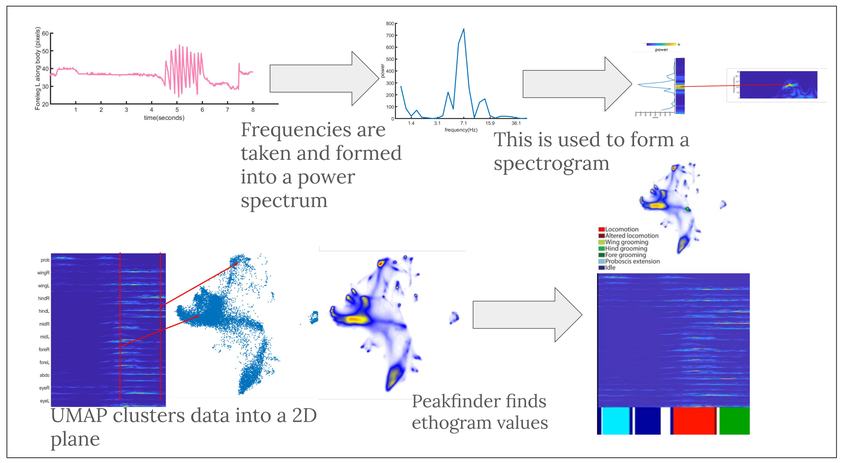


Fig. 6. Shown is a fly that SLEAP labelled incorrectly.

Fig. 7. MotionMapper analysis pipeline



Motion Mapper Pipeline

- This pipeline will enable us to use dynamic limb tracking to understand the behavior of an animal.
- This works by taking the frequency of each limb movements, and clustering similar movements into a UMAP 2-Dimensional space where denser areas are likely to represent behaviors.
- Ultimately we will be able to label these actions as stereotyped behaviors, producing ethograms that can compare different fly's behaviors over the course of their lives.

References

1. McKenzie-Smith, Grace C., Ayroles, Julien F., Shaevitz, Joshua W., & Wolf, Scott W. (2023). Drosophila melanogaster Long Timescale Data 2022 [Data set]. Version 1. Princeton University. https://doi.org/10.34770/1sab-8845
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- Gordon J. Berman, Daniel M. Choi, William Bialek, Joshua W. Shaevitz; Mapping the stereotyped behaviour of freely moving fruit flies. J. R. Soc. Interface. 6 October 2014; 11 (99): 20140672.