



Exploring the mechanisms of visual place learning in the fruit fly

João Rodrigues
Nº 103250

Supervised by
Eugenia Chiappe
Hugo Marques
Jorge Vieira

Argument for *Drosophila*

We want to understand the sensory and motor features underlying place learning in insects.

Why use the fruit fly as a model for our purposes?

- Complex and quantifiable navigational behavior
- Replicable in artificial settings
- Many experimental advantages:
 - Short life cycle
 - High fecundity
 - Small size
 - Low cost

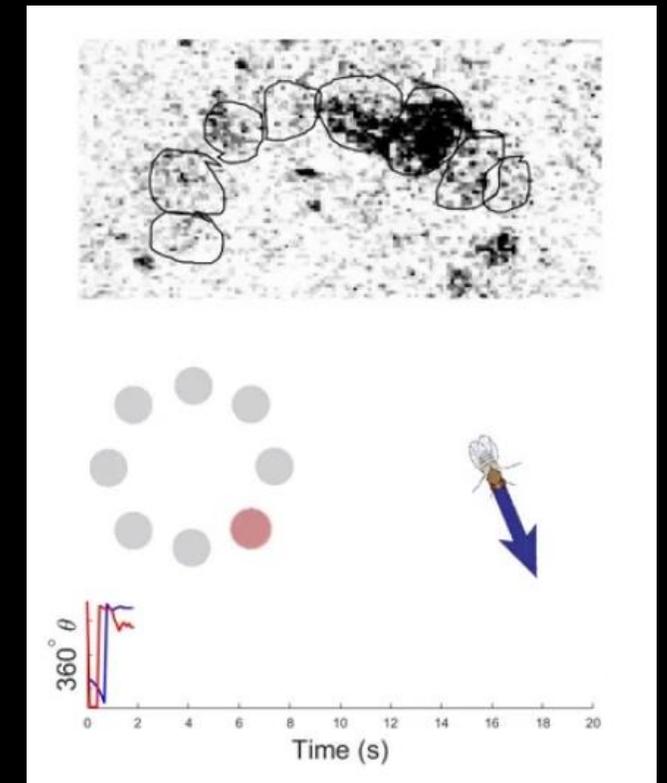
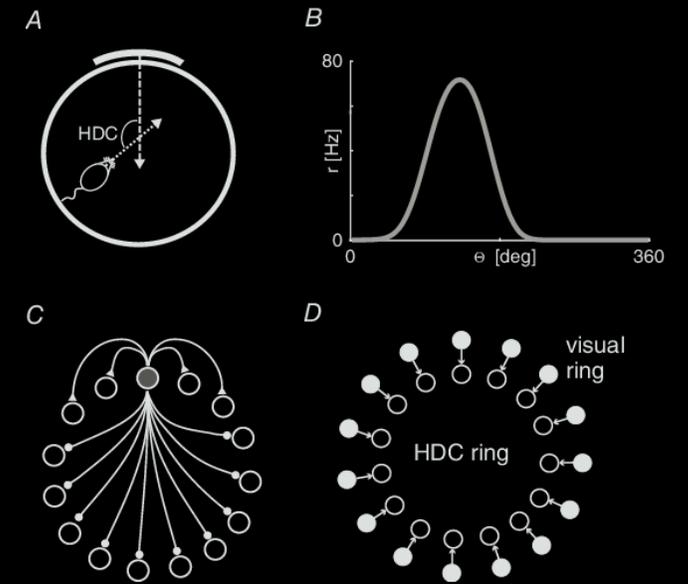
} Great statistics
Short time



Argument of significance

Why study insect navigation?

- Low neuron counts -> tractable circuits
- Analogous functions & conservation across species
- Applications for neuroscience and bio-inspired robotics



Conclusion

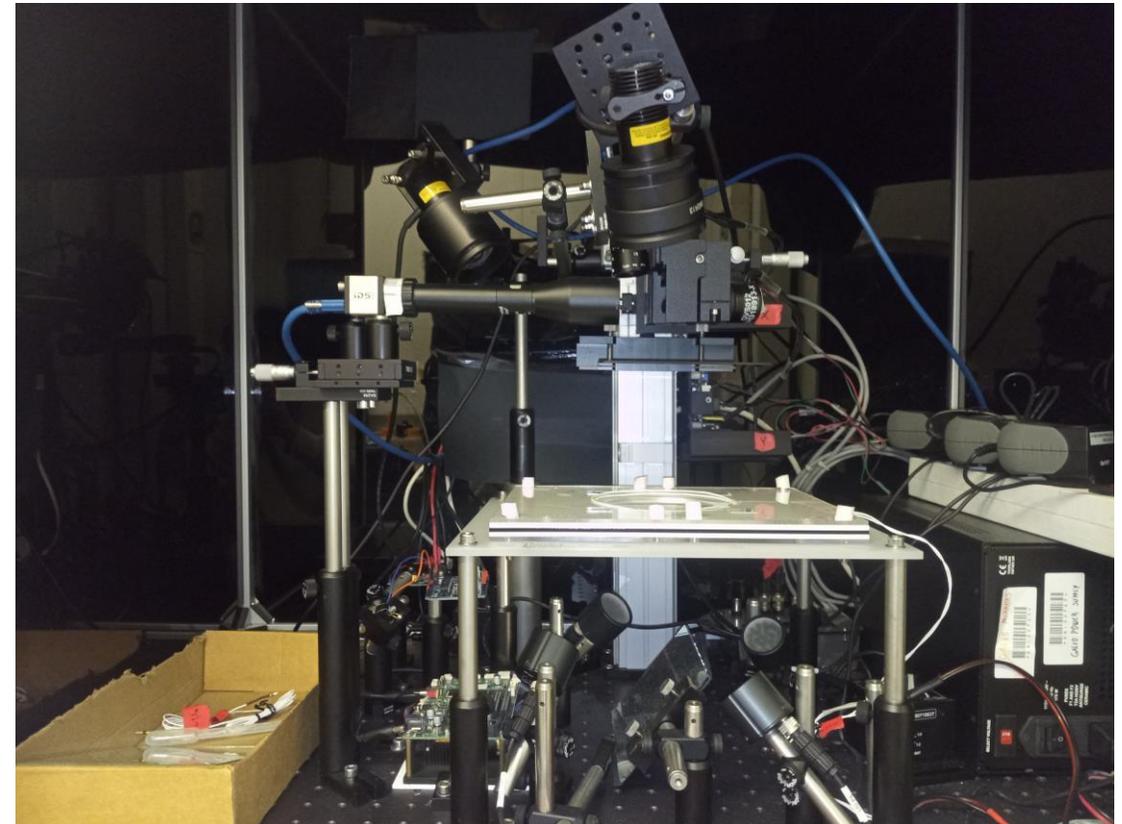
- Future goal – build a navigational system for a robot
- Understand the mechanisms of place learning in insects
- Build an experimental paradigm for path integration in fruit flies

Methods & experimental setup

- **Aim 1: comparing exploratory behavior with and without the presence of projected landmarks**

1. Acclimation phase: fly is placed in the arena and left without stimuli (5min)
2. Gradual projection of landmark at position A for (2 min)
3. No projection (30 sec)
4. Sudden projection of a landmark at position B (2 min)
5. No projection (30 sec)

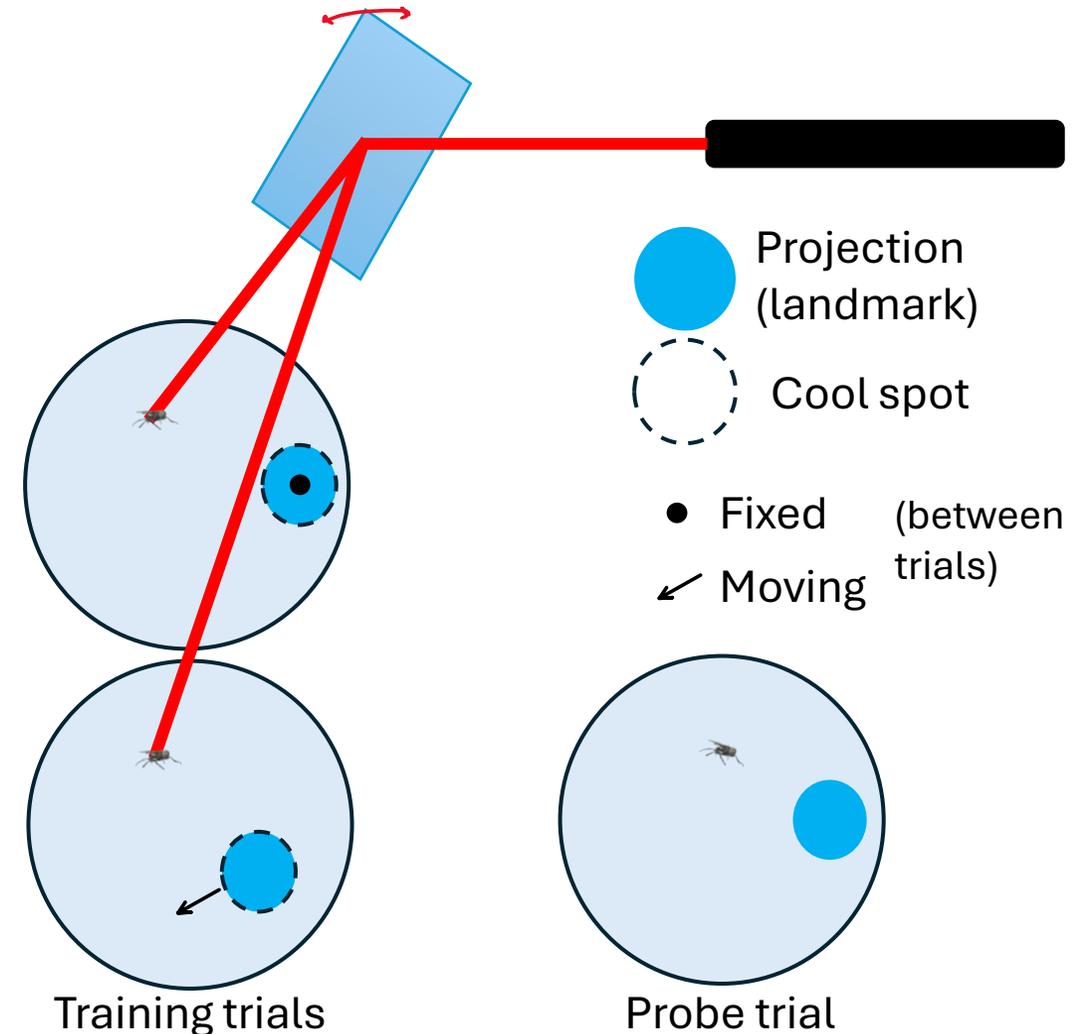
- Quantitatively analyze the behavior of flies when presented with 2D landmarks
- Understanding their reaction to visual stimuli provides a basis for the next experiments



- **Aim 2: testing visual place learning abilities with projected landmarks and evaluating the contribution of internal cues**

- The fly will be tracked live using the low resolution camera;
- Its coordinates will be translated to mirror movement, redirecting the laser
Whenever it is not in the area defined as the 'cool spot', the fly is irradiated

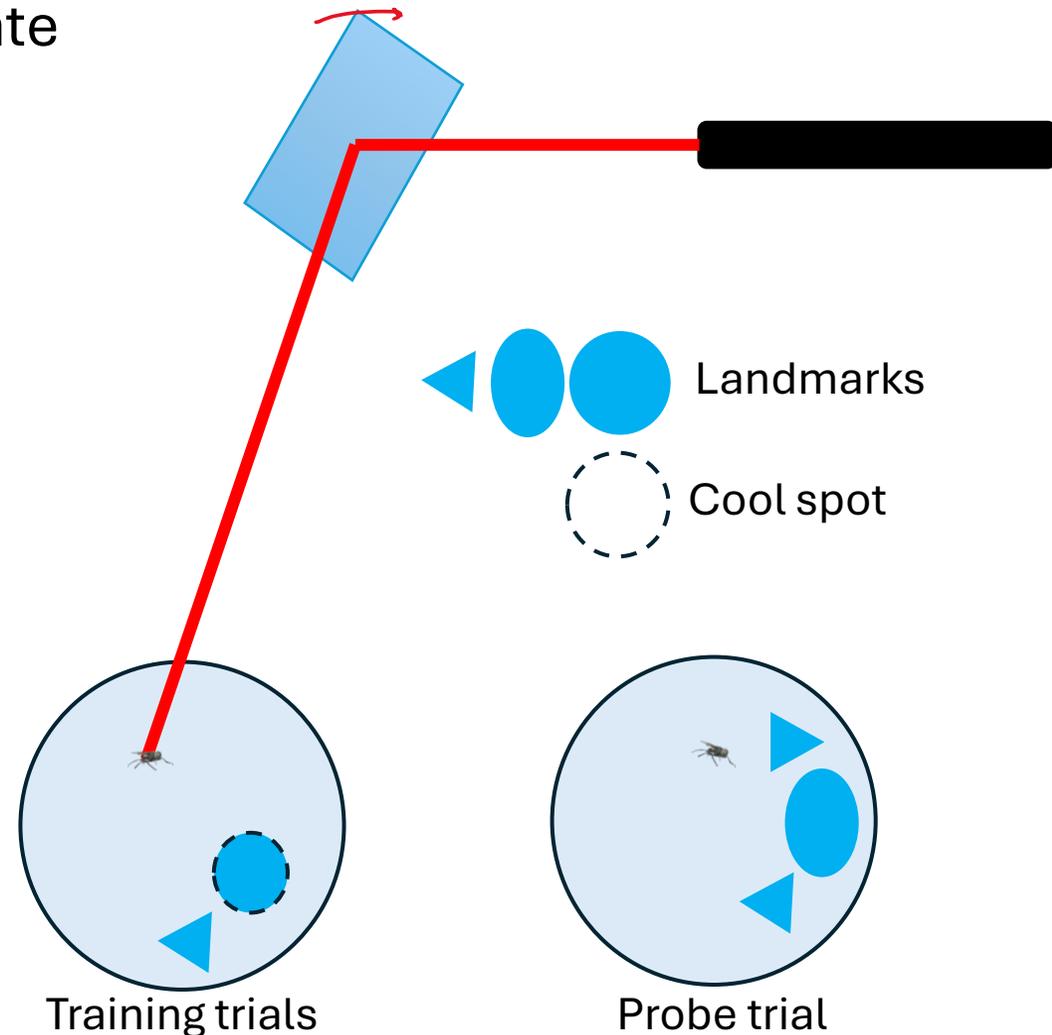
1. Place fly in the arena; no stimuli (1min)
2. Activate the laser, define a cool spot and project landmark on it (5min);
3. No stimuli (or heat entire arena) (1 min)
4. Repeat steps 2 and 3 ten times or until fly shows evidence (or lack thereof) of place learning;
5. Probe trial with projection but no laser (also 5min)



- **Aim 3: investigating the nature and complexity of visual memories**

With **similar setup and training**, we will investigate how place learning performance changes when using more complex visual panoramas with changing landmark parameters, such as:

- Shape
- Number
- Size
- Distance from cool spot
- **We predict** place learning scores will drop when features are changed for the probe trial.
- **Analyzing** which features make the score drop and by how much will give insight on the nature and complexity of visual place memories



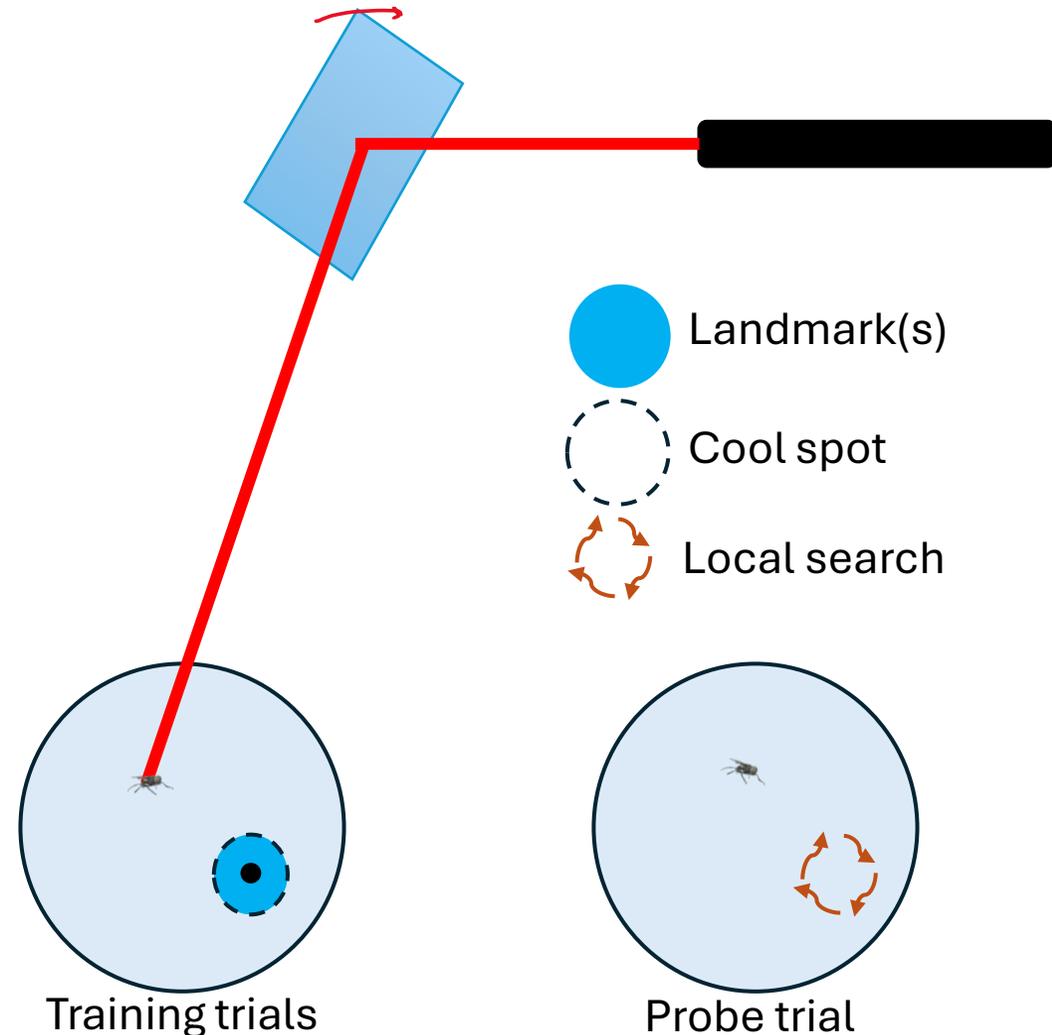
- **Aim 4: Testing path integration in this system**

Procedure: Same setup and training as previously, but remove projection/landmarks for probe trial (turn everything off)

We expect that:

- Fly should start a 'local search behavior' around the place it last saw the cool spot

This is a basis for the next experiment



- **Aim 5: Looking at the interaction between path integration and visual place learning**

Procedure: Same setup and training as before, but in probe trial a landmark will reappear after some time.

We expect that:

- Flies will start 'local searching behavior' around last seen location
- As fly moves outwards without finding cool spot, it should begin less structured, more random exploration

At some point, the same landmarks will reappear at a **different location**.

Question: When path integration and visual memory disagree, how does the fly choose between the two systems?

