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Dynamic Corrections of Object Motion Under the Influence of Self Motion

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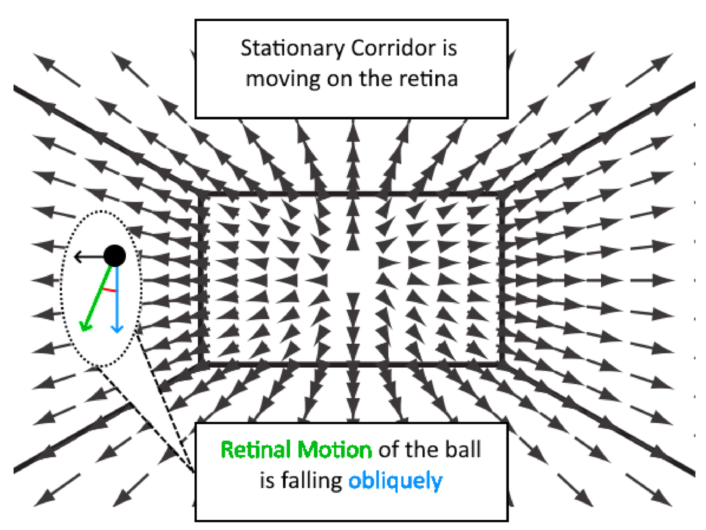
Introduction

- Objects that move in the world create image motion on the retina.
- **Self-motion** through the environment (e.g., walking) creates a global pattern of image motion called **optic flow**
- The **object motion** of object on the retina generally reflects contributions from both object motion in the world and self-motion
- Thus, to compute object motion in the world, the brain must somehow subtract off the image motion due to self-motion. This process is called **flow parsing**[1]
- This project examines how flow parsing depends on various spatial aspects of a visual scene



Measuring Flow Parsing: Relative Tilt

- Simulate self motion with a 3D dot cloud (optic flow)
- Present an object within or near the dot cloud
- Subjects report trajectory of the object

$$\text{Relative tilt} = \text{Actual object trajectory} - \text{Reported trajectory}$$

Measuring Flow Parsing: Gain

- Make prediction for relative tilt based on maximum and minimum flow parsing
- Compare observed data with these benchmarks
- Flow parsing gain is a measure of how much flow parsing we see

Objectives

- Determine contributions of local and global background motion to flow parsing
- Test whether object's proximity to center of the visual field (i.e., **eccentricity**) affects flow parsing
- Test a novel hypothesis that the extent of flow parsing depends on whether the optic flow and moving object are located in the upper *vs*. lower visual field (a.k.a. upper vs. lower visual hemifields)

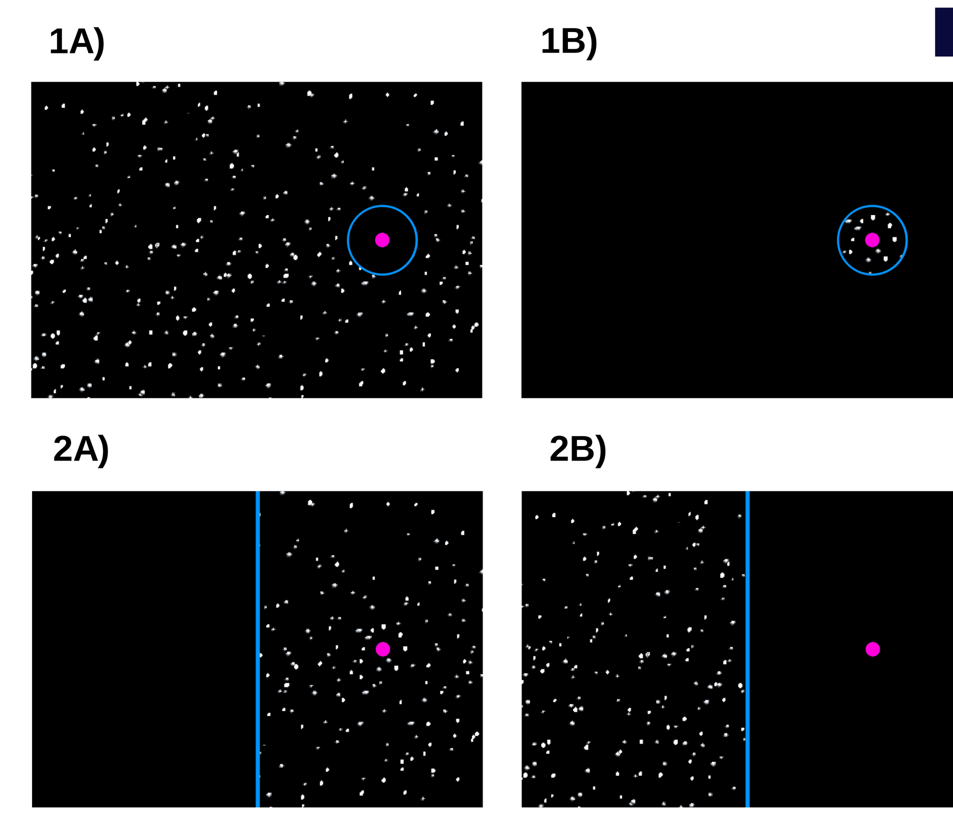
Experiments 1 & 2

1A. Global condition: optic flow outside an aperture

1B. Local condition: optic flow inside a variable aperture

2A. Same condition: optic flow in the same hemifield with the probe

2B. Opposite condition: optic flow in the opposite hemifield of the probe.



Conclusions Exp. 1 & 2

- Global and local processing of object motion contribute to flow parsing
- Flow parsing mainly relies on global information

Experiment 3

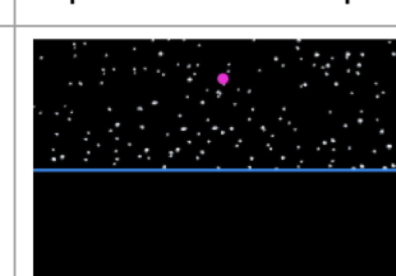
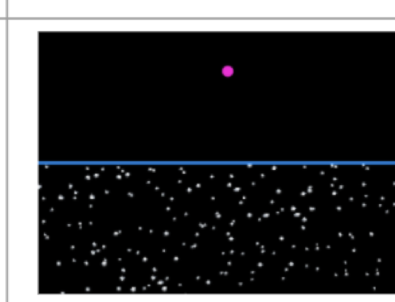
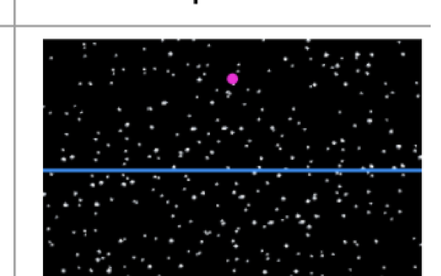
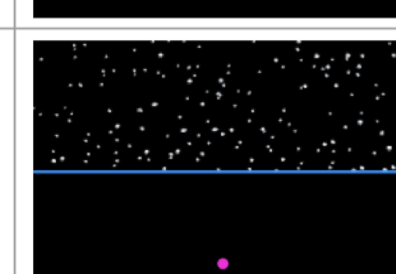
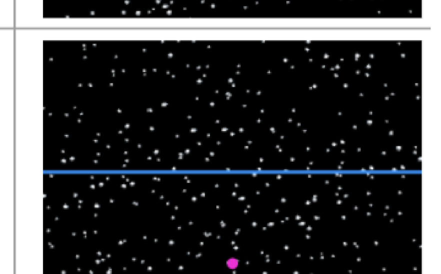
- Control for local and global optic flow
- Test probe location (upper vs. lower hemifields)

Conclusions Exp. 3

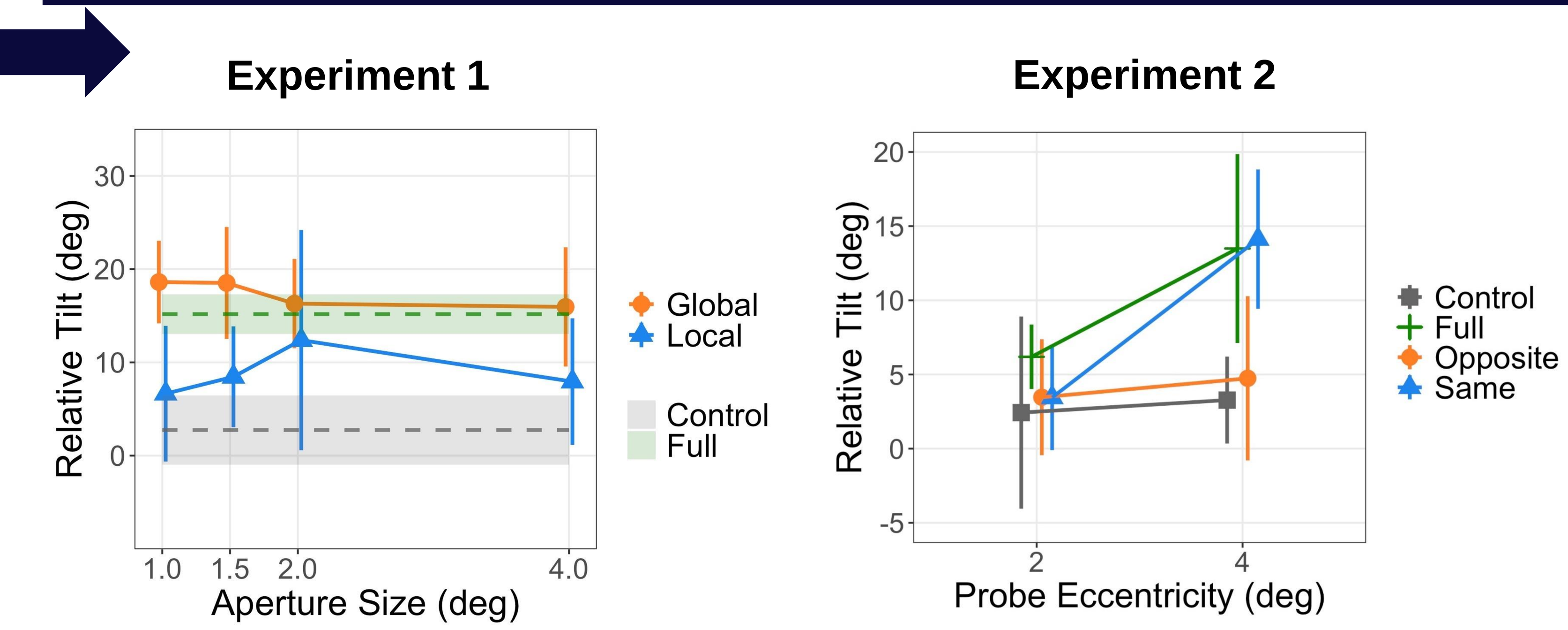
- Probe location has weak effect on flow parsing
- Optic flow location has weak effect on flow parsing
- Robust flow parsing effect when optic flow & probe share same hemifield

Table of Conditions:

Demo of our stimulus

	Optic Flow on Top	Optic Flow on Bottom	Full Optic Flow
Probe on Top			
Probe on Bottom			

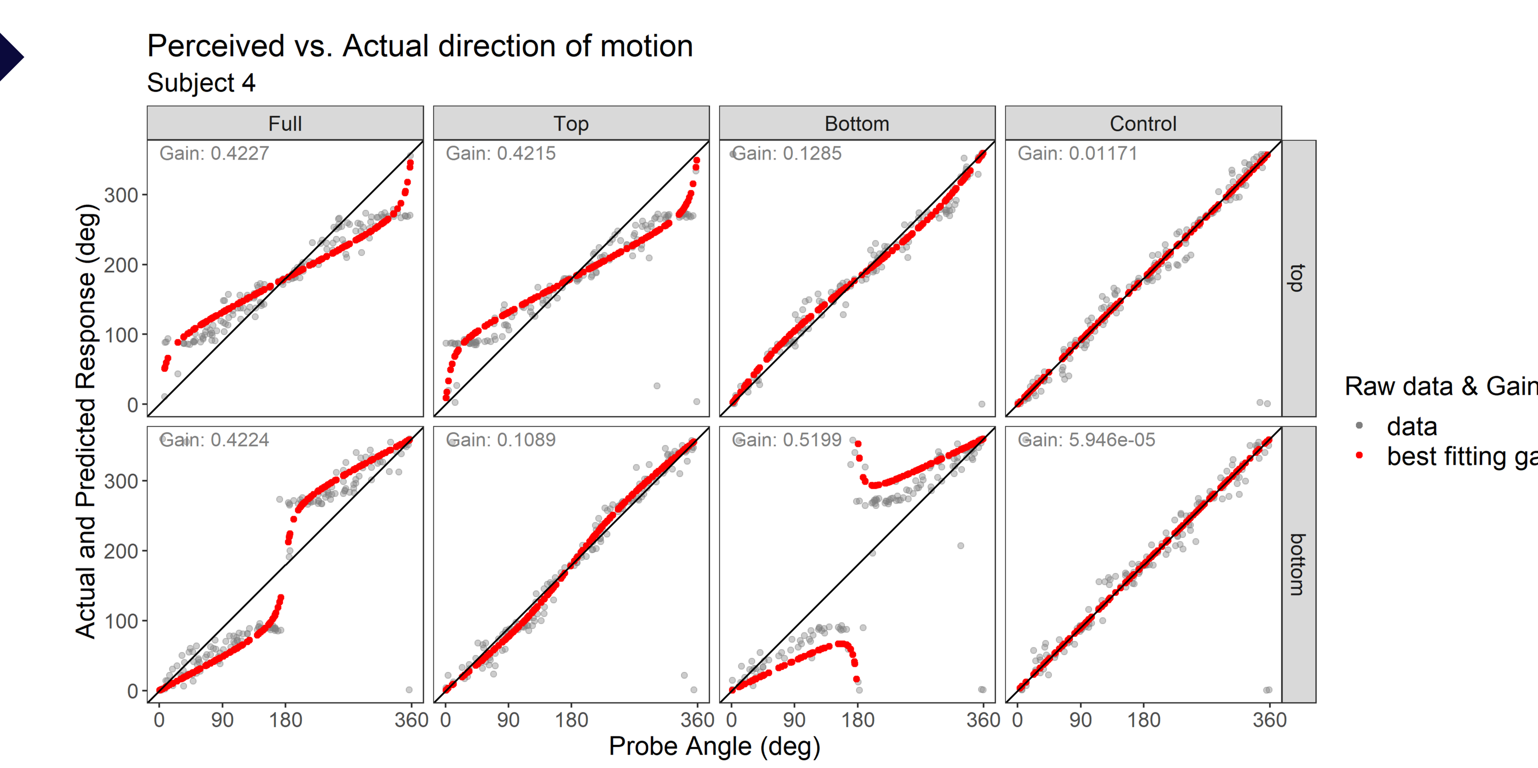
Results Exp. 1 & 2

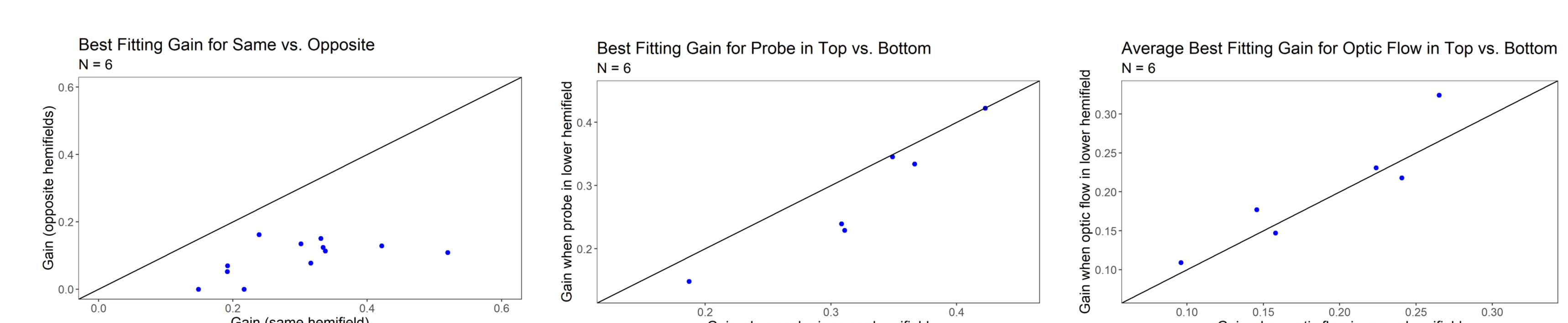


Experiment 1 & 2 Plots. Averaged relative tilt across subjects. Errors bars indicate 95% CIs around the mean relative tilt.

- Global-only information had largest effect on subjects' flow parsing
- Local-only information had a small but significant effect on flow parsing
- Greater flow parsing for objects farther from center of the visual field

Results Exp. 3





- A stronger gain is seen when the probe is in the same hemifield as the optic flow
- This effect is slightly more pronounced when the probe is in the upper hemifield
- Whether the optic flow appears in the upper or lower hemifield does not have a significant effect on gain

References

[1] Warren, P. A., & Rushton, S. K. (2009). Optic Flow Processing for the Assessment of Object Movement during Ego Movement. Current Biology, 19(18), 1555–1560.
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Acknowledgements

Thank you to Professors Ralf Haefner and Gregory DeAngelis for their mentorship, and to Professor Florian Jaeger, Professor Chigusa Kurumada, Sabyasachi Shivkumar, Brian Xu, and our peers from BCS 206/207 for their continued support!