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Dynamic Corrections of Object Motion Under the Influence of Self Motion

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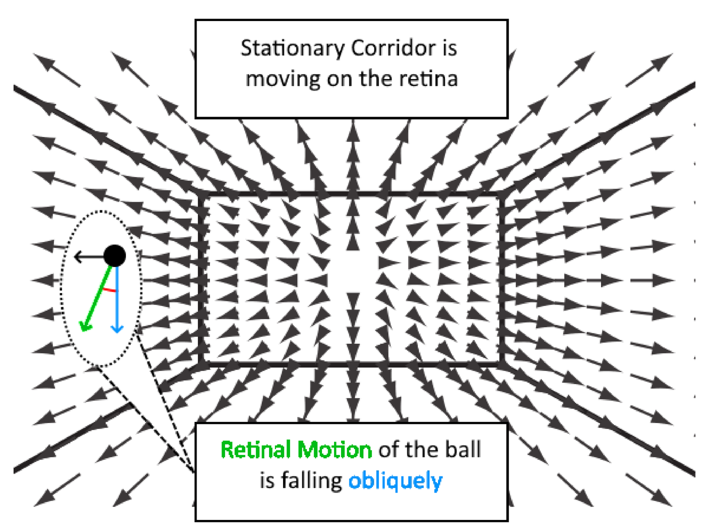
Introduction

- 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

Relative tilt = Actual object trajectory – 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)

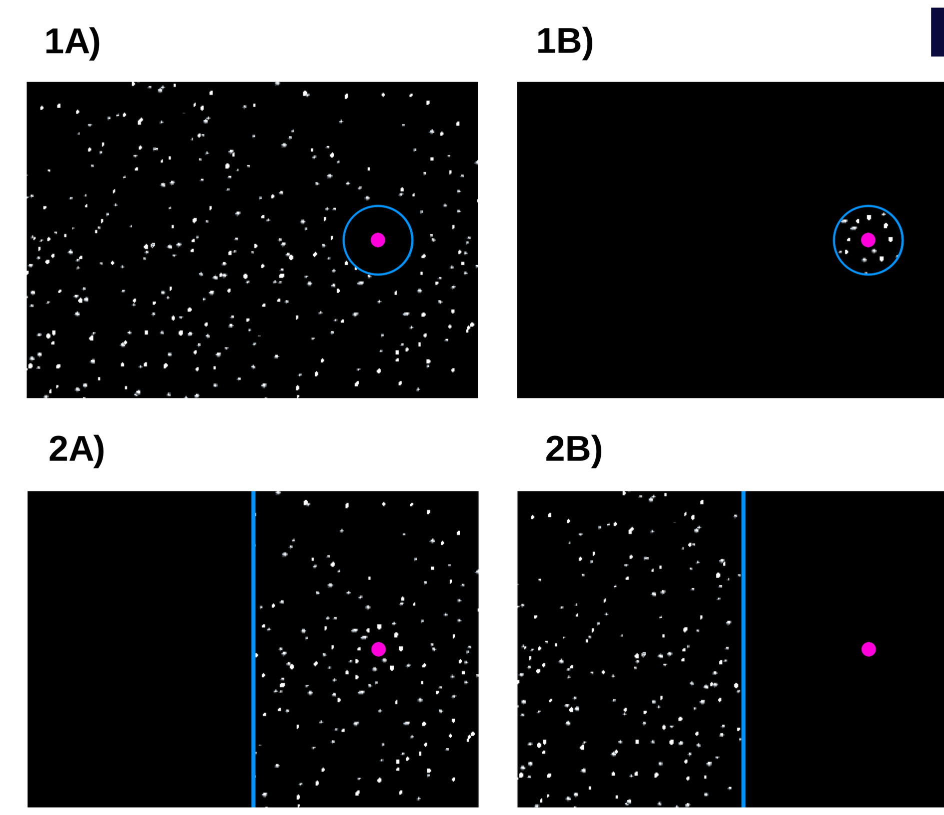
Experiments 1 & 2

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

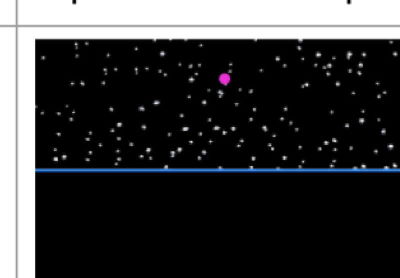
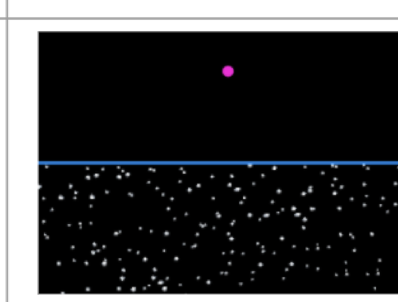
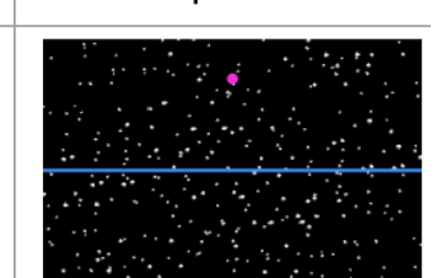
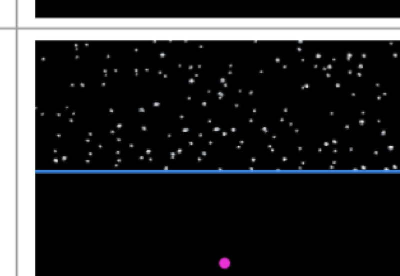
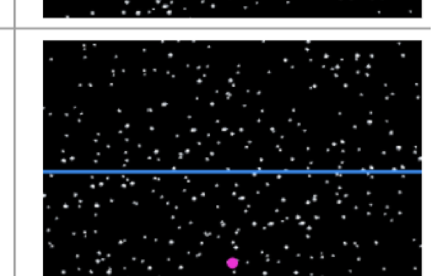
- Control for local and global optic flow
- Test probe location (upper vs. lower hemifields)

Conclusions — Exp. 3

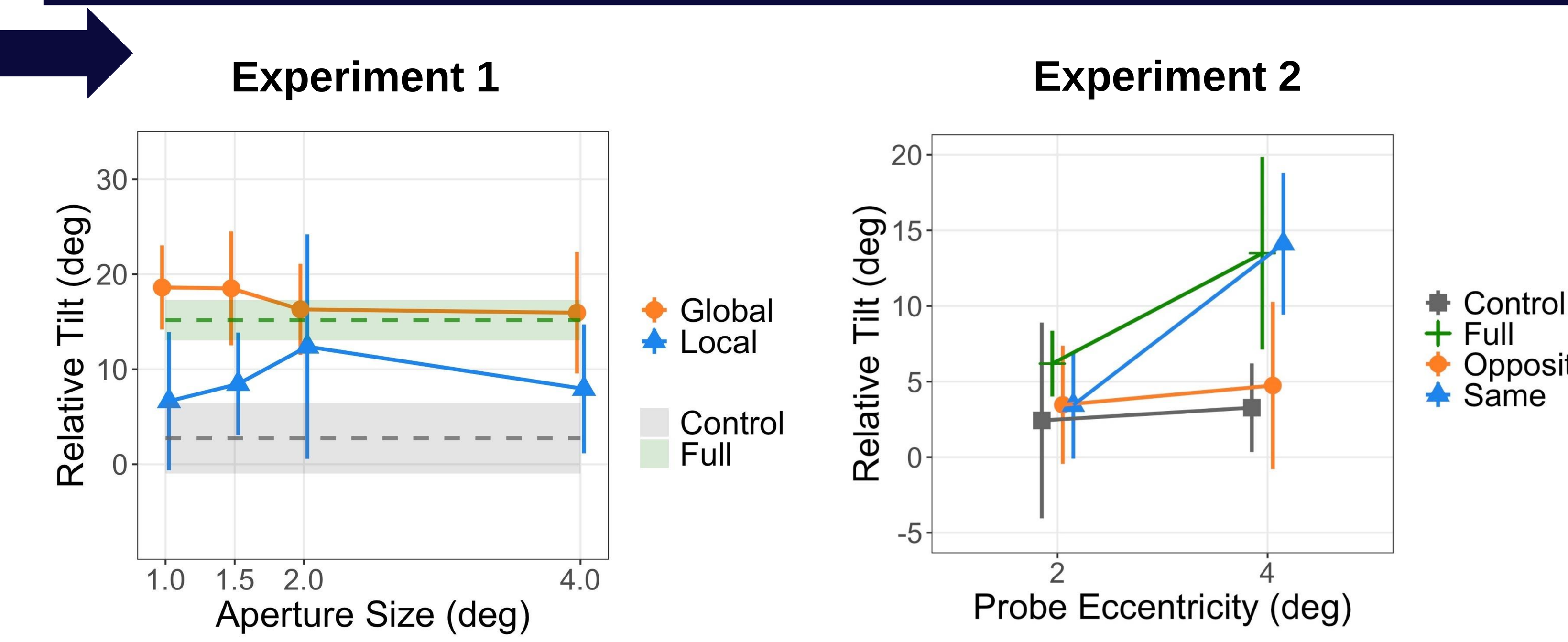
- Probe location has weak effect on flow parsing
- Optic flow location has weak effect on flow parsing
- Robust flow parsing effect when optic flow & probe share same hemifield

Demo of our stimulus

Table of Conditions:

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

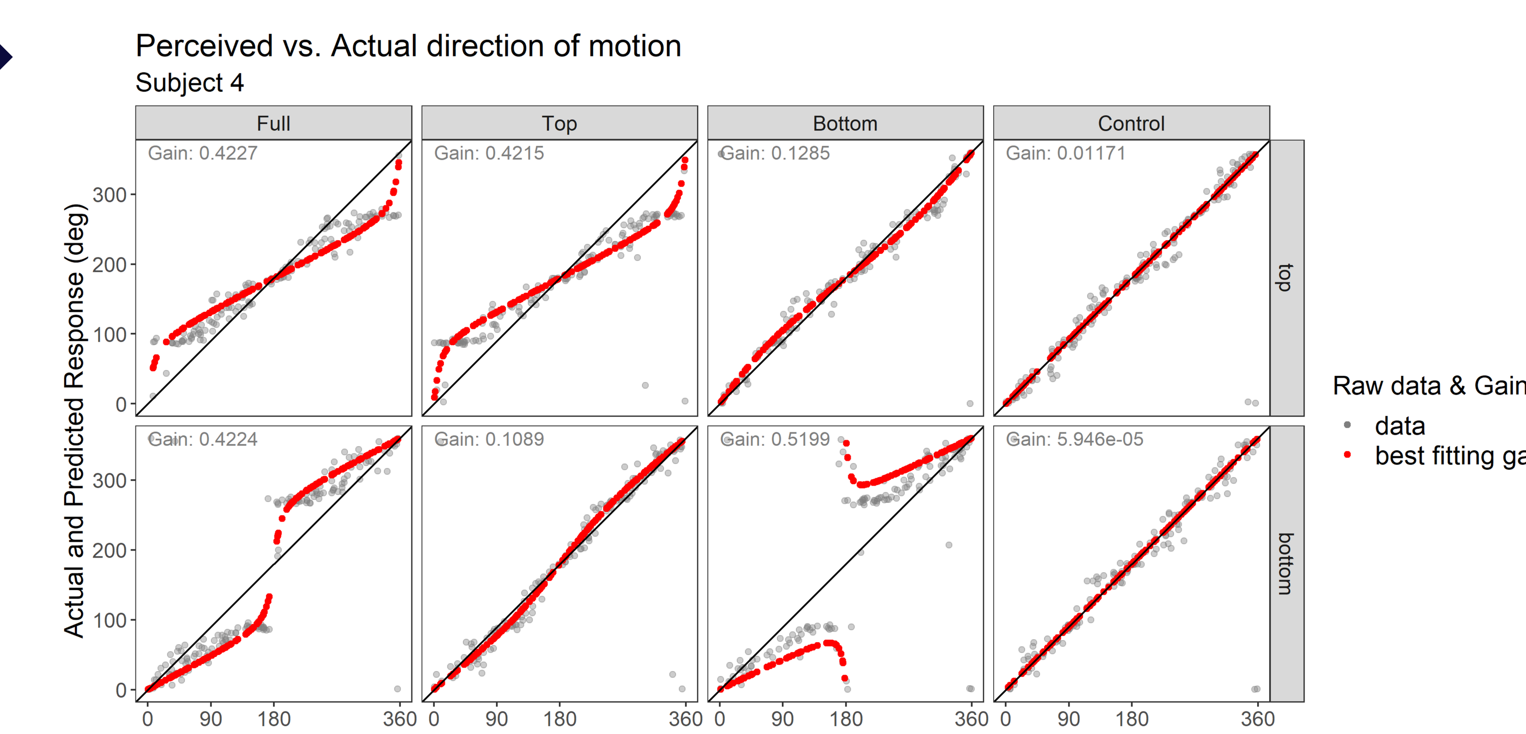
Results — Exp. 1 & 2

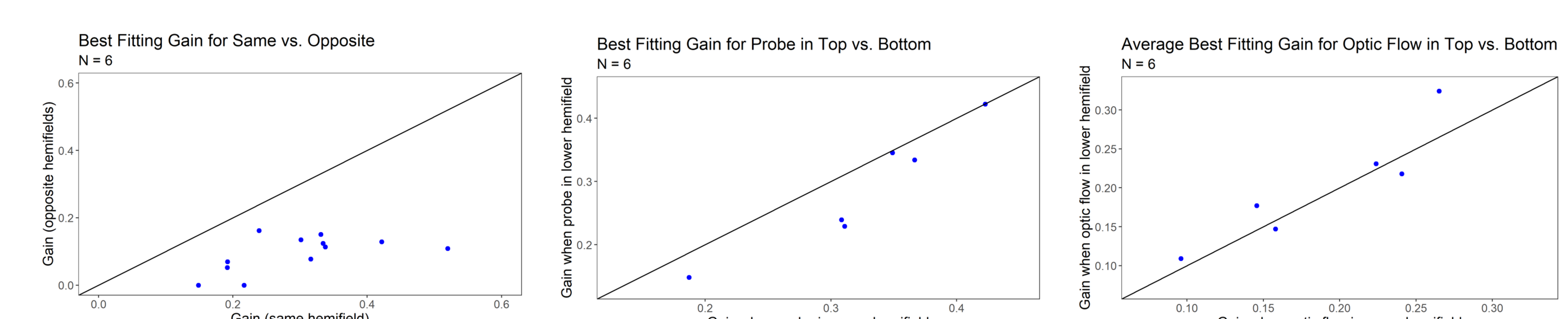


Experiment 1 & 2 Plots. Averaged relative tilt across subjects.
Errors bars indicate 95% CIs around the mean relative tilt.

- 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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