

# Is there a role of optic flow in human path integration?

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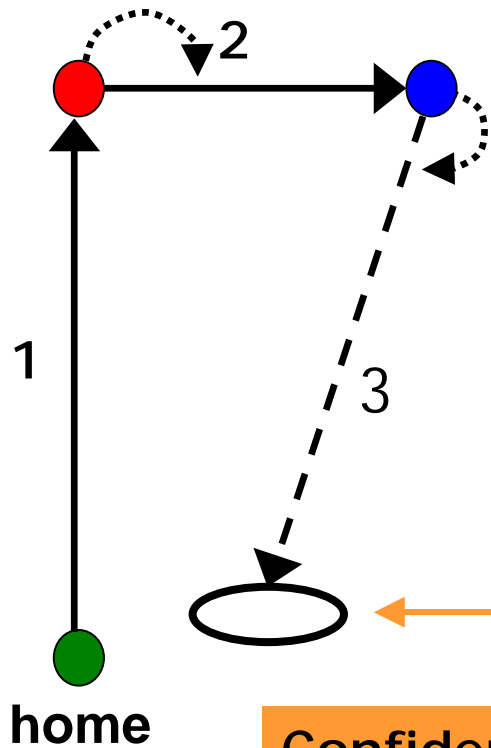
Cognitive and Linguistic Sciences, Brown University



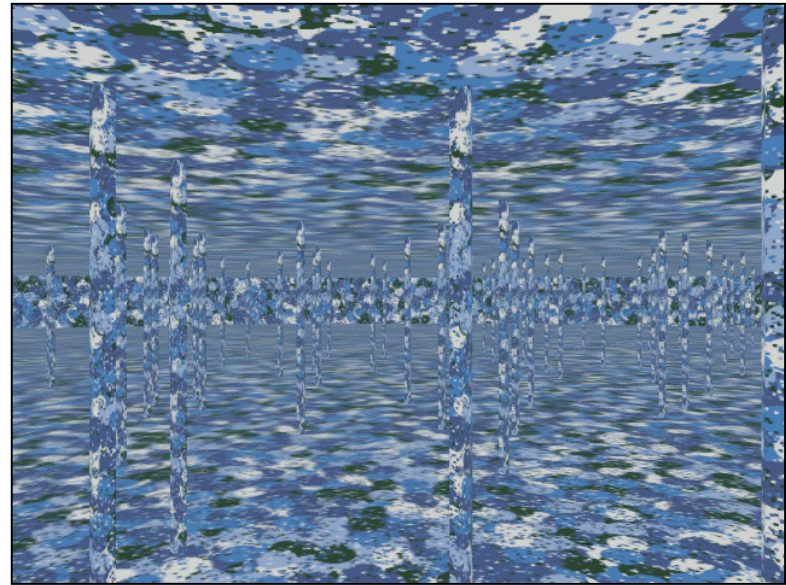
# Path Integration Background

- If only body senses are available, people can use them for path integration (Loomis et al., 1993)
  - body senses = info from proprioceptive, vestibular and efferent systems
- If only optic flow is available, people can use it for path integration (Peruch et al., 1997; Riecke et al., 2000; Bud, 2000)
- When both are available, body senses dominate for path integration (Bud, 2000).
- Current project pits optic flow against body senses by manipulating the visual gain in VR
  - Tested separately for *translation* and ~~rotation~~

# Triangle Completion Task

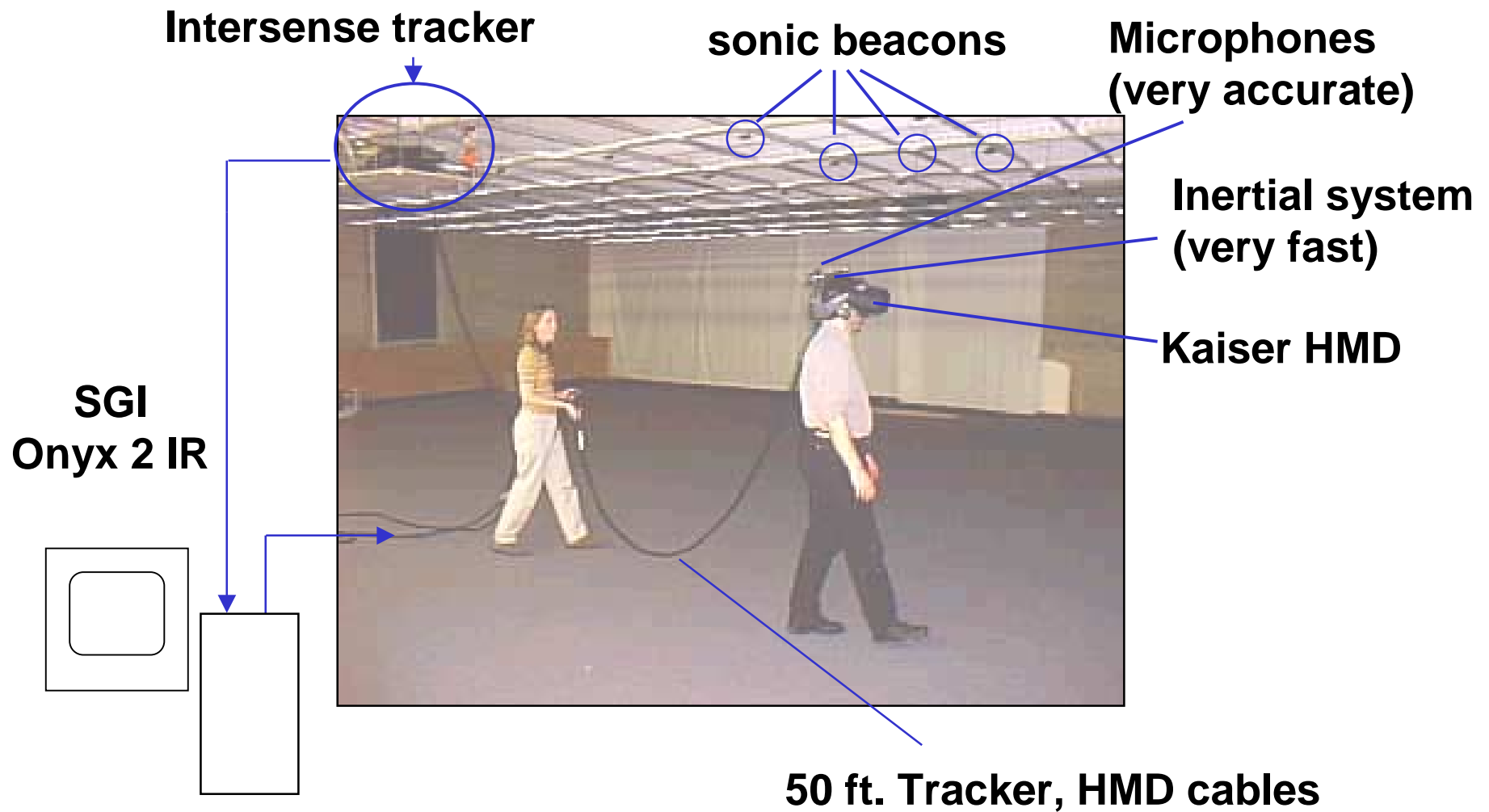


Confidence Ellipse:  
pop. mean is in ellipse  
95% of the time



Virtual environment:  
Visually rich

# Virtual Environment Navigation Lab (VENLab)



# Two Frames of Reference

PHYSICAL SPACE



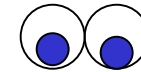
Movement in the physical room



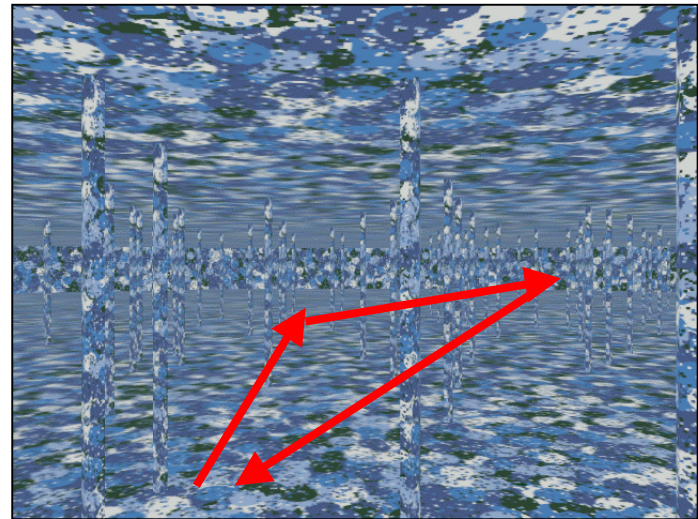
gain



VISUAL SPACE

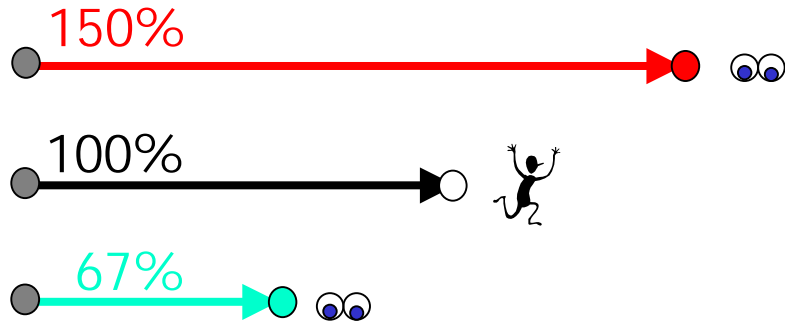


Movement in the virtual environment

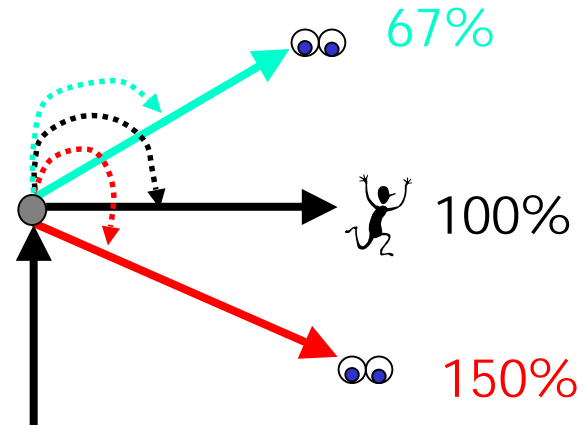


# Gain Manipulations

*Translation*



*Rotation*







- **High gain:**
  - Movement in physical space < Movement in visual space
- **Normal gain:**
  - Movement in physical space = Movement in visual space
- **Low gain:**
  - Movement in physical space > Movement in visual space

# General Method

- Two sessions: *Translation* and ~~Rotation~~ gain changes
- Each session:
  - blocked by gain (**high**, normal, **low**,)
  - randomized presentations of 4 triangles, 4 trials each
- For *translation* only, gain was reset to normal for return path

# Experiment 1:

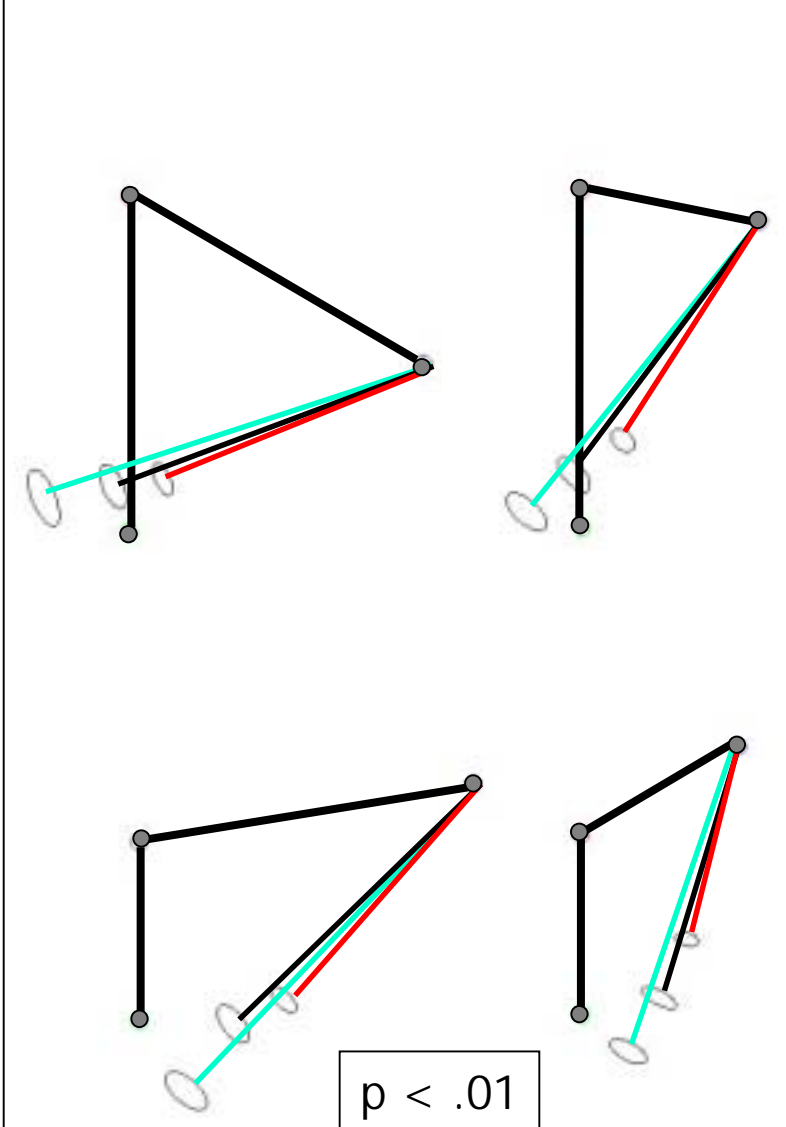
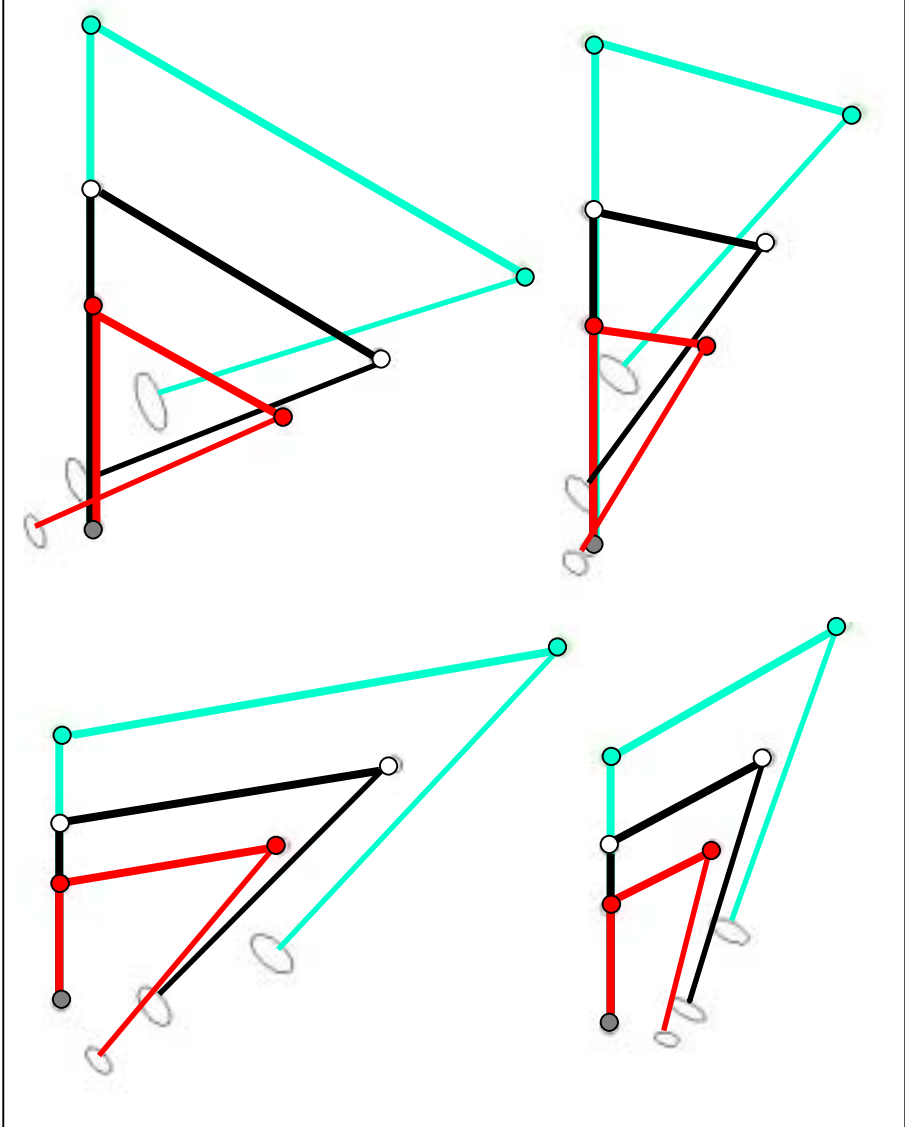
- Triangles were of constant size in VISUAL space  but different sizes in PHYSICAL space 
- Predictions:
  - If people rely only on optic flow, they will perform similarly at all gains in VISUAL space 
  - If people rely only on body senses, they will perform similarly at all gains in PHYSICAL space 


# Exp 1: *Translational Gain*

150%  
100%  
67%

Physical Space 

Visual Space 



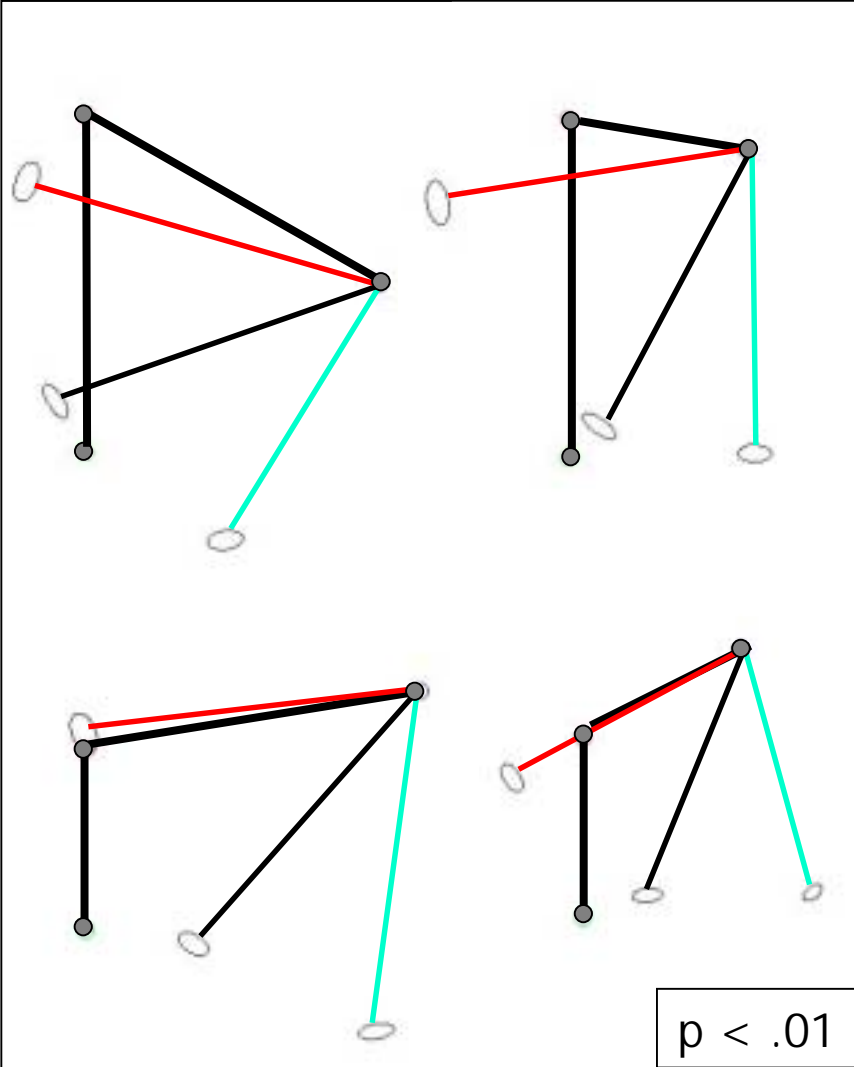
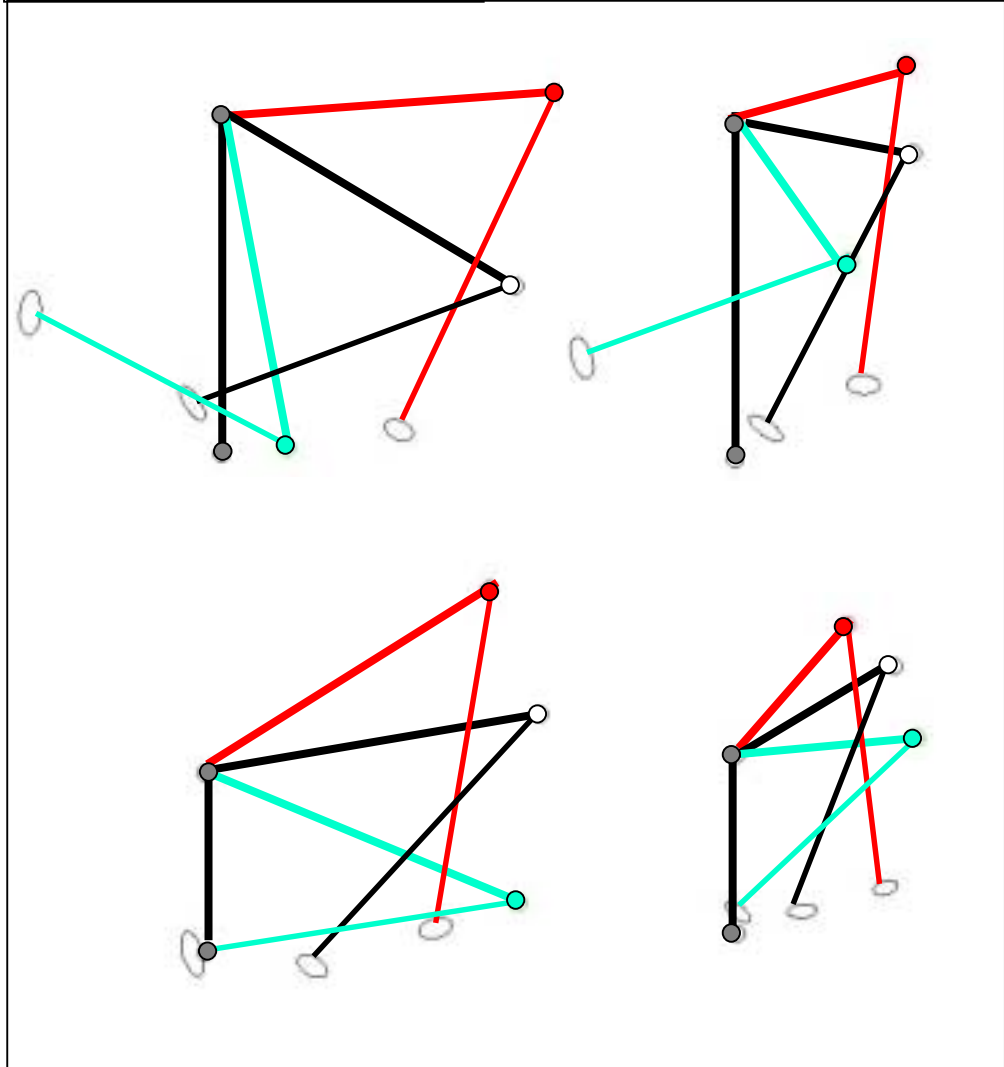
Scale: 1m = 


# Exp 1: ~~Rotational~~ Gain

150%  
100%  
67%


Physical Space 

Visual Space 







Scale: 1m = 

# Exp 1: Results

- Participants did not only rely on optic flow
- Body senses clearly contribute to path integration,
  - both *translation* and **rotation**
- The results in PHYSICAL space  could be explained by a triangle size effect:
  - previous research indicates that people tend to underestimate large angles and distances and overestimate small angles and distances

# Experiment 2

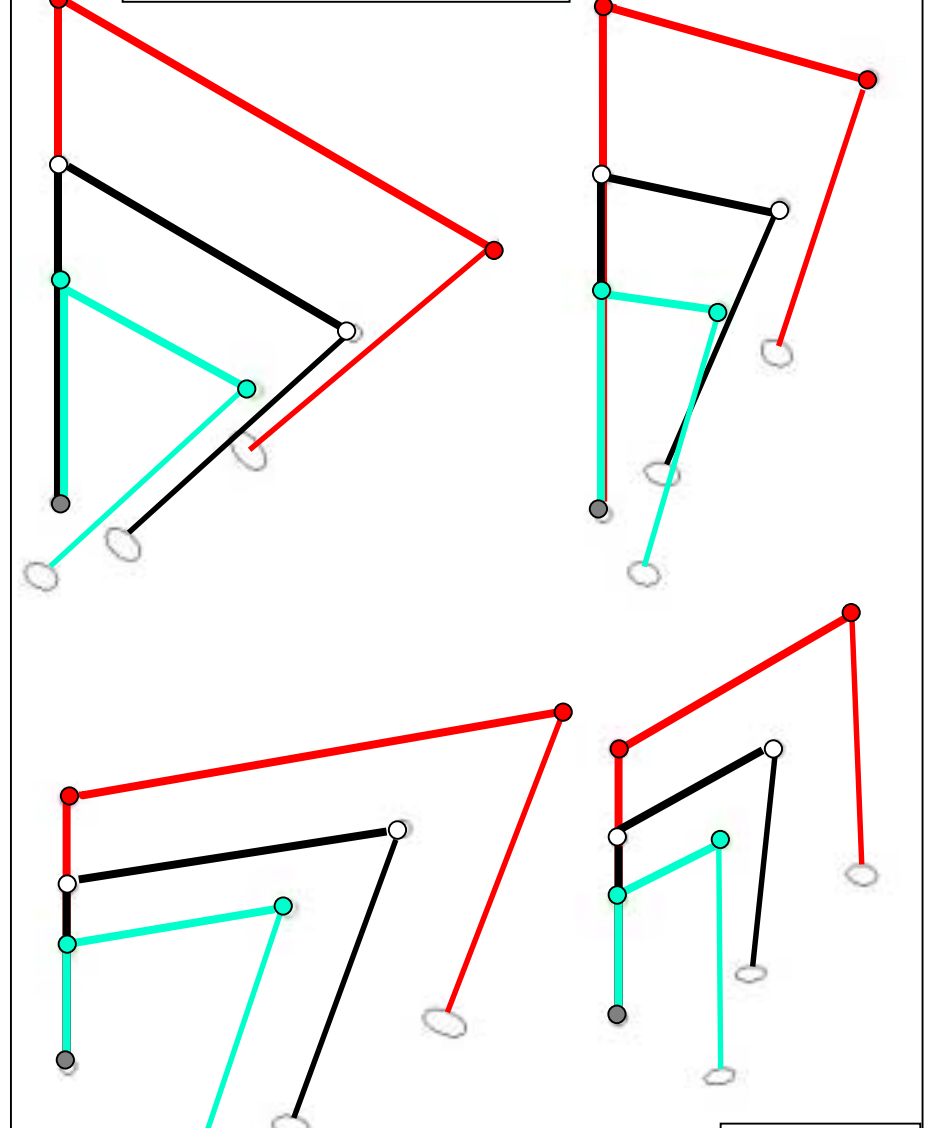
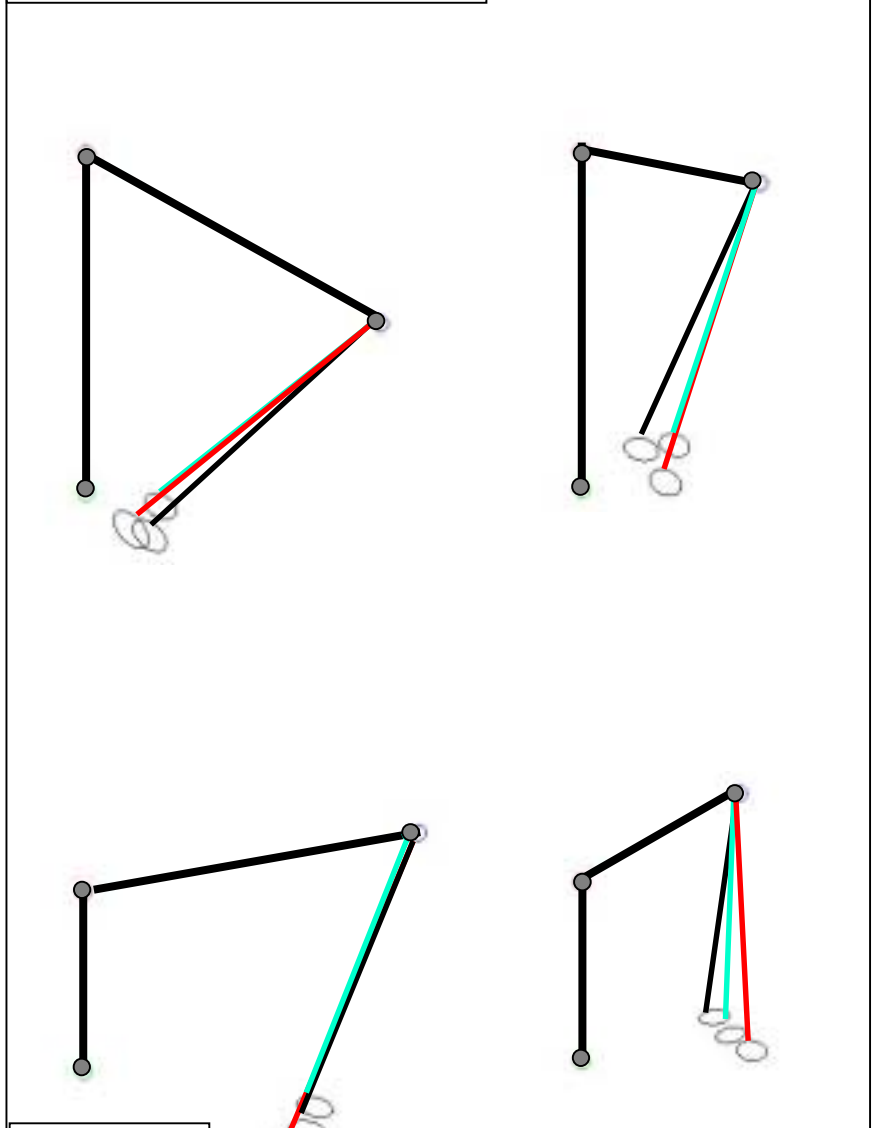
- Motivation: To control for the triangle size effect, triangles were of constant size in PHYSICAL space  but different sizes in VISUAL space 
- Same Predictions:
  - If people rely only on optic flow, they will perform similarly at all gains in VISUAL space 
  - If people rely only on body senses, they will perform similarly at all gains in PHYSICAL space 

# Exp 2: *Translational Gain*


Physical Space 

Visual Space 

150%  
100%  
67%



$p < .01$

Scale: 1m = 

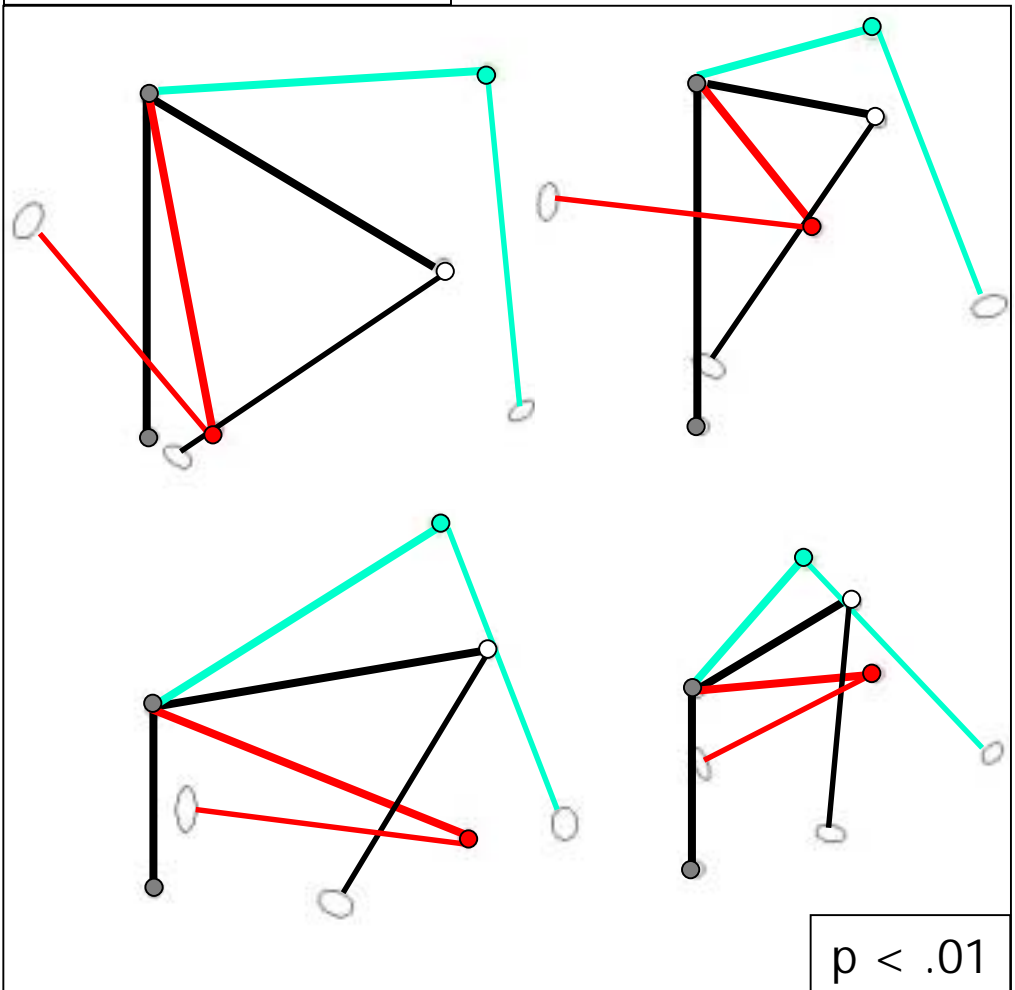
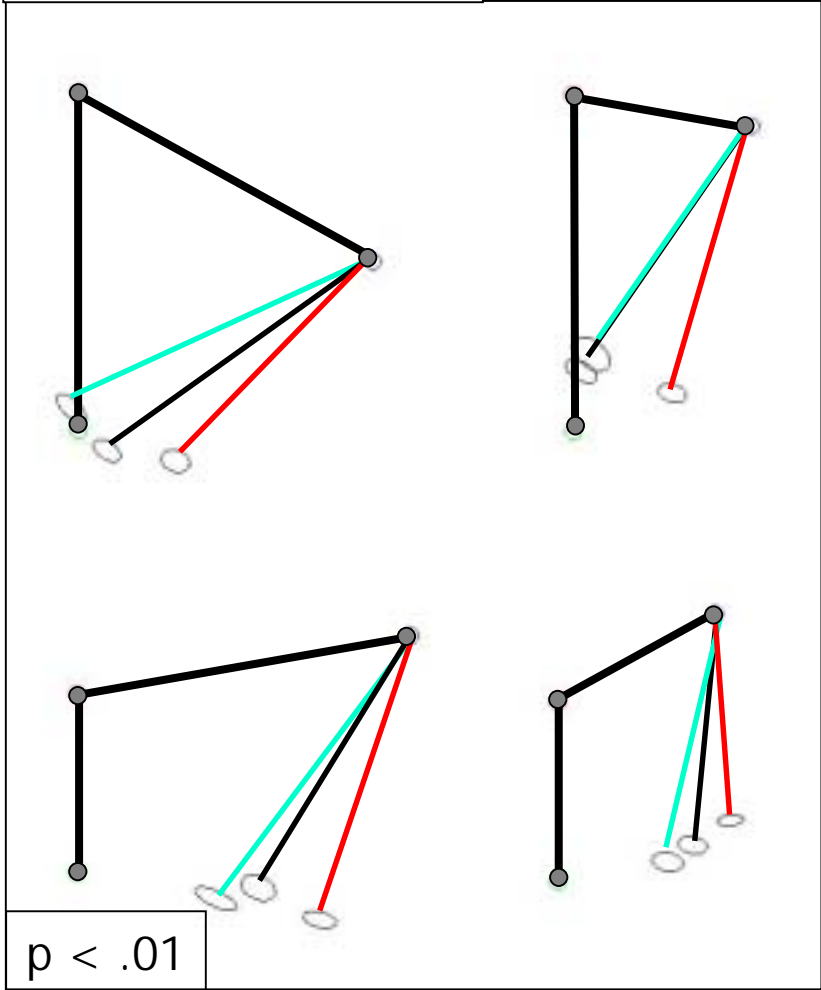
$p < .01$

# Exp 2: *Rotational* Gain

150%  
100%  
67%


Physical Space 

Visual Space 



Scale: 1m = 

# Exp 2: Results

- Optic flow appears to play a small role in path integration - significant differences between gains
  - both translation and ~~rotation~~ in PHYSICAL space 
- Body senses play a dominant role in path integration, but optic flow has a small contribution for distance estimates (*translational* flow) and angular estimates (~~rotationa~~ flow)

# Exp 2: Relative Contributions of Optic Flow and Body Senses

- By comparing differences in errors in PHYSICAL and VISUAL space at each gain manipulation, we can assess the relative contributions of optic flow and body senses
- The relative contributions of optic flow and body senses are:

Distance = 12% optic flow + 88% body senses

If gain is low:

Angle = 12% optic flow + 88% body senses

If gain is high:

Angle = 18% optic flow + 82% body senses

# Conclusions

- There appear to be roles of both optic flow and body senses in path integration, but body senses tend to dominate
- The relative contribution of optic flow was slightly larger for estimating angle from ~~rotationa~~ flow when rotational gain was high

Research funded by:

