

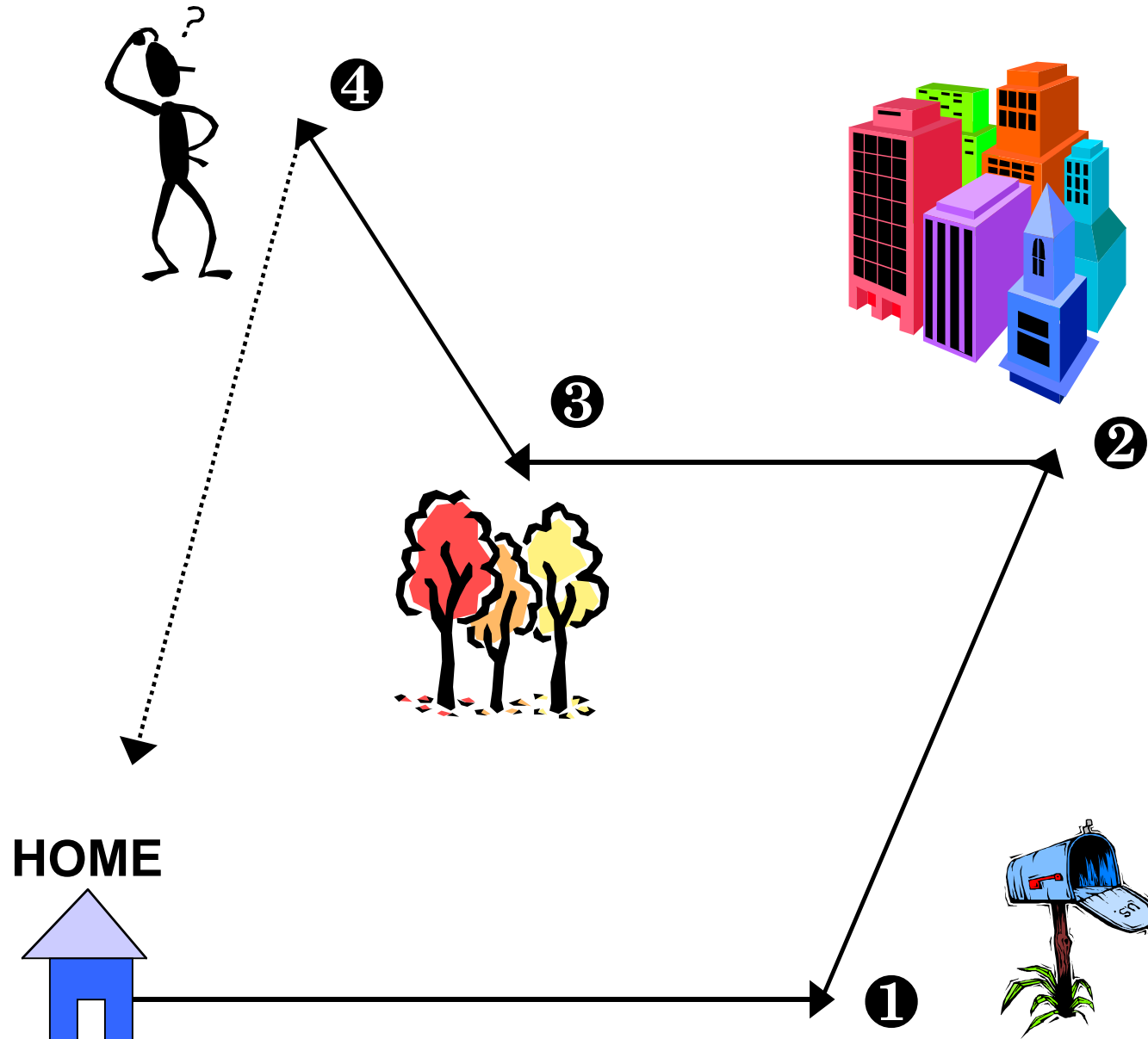
The Role of Optic Flow in Human Path Integration

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William H. Warren, Michael J. Tarr**

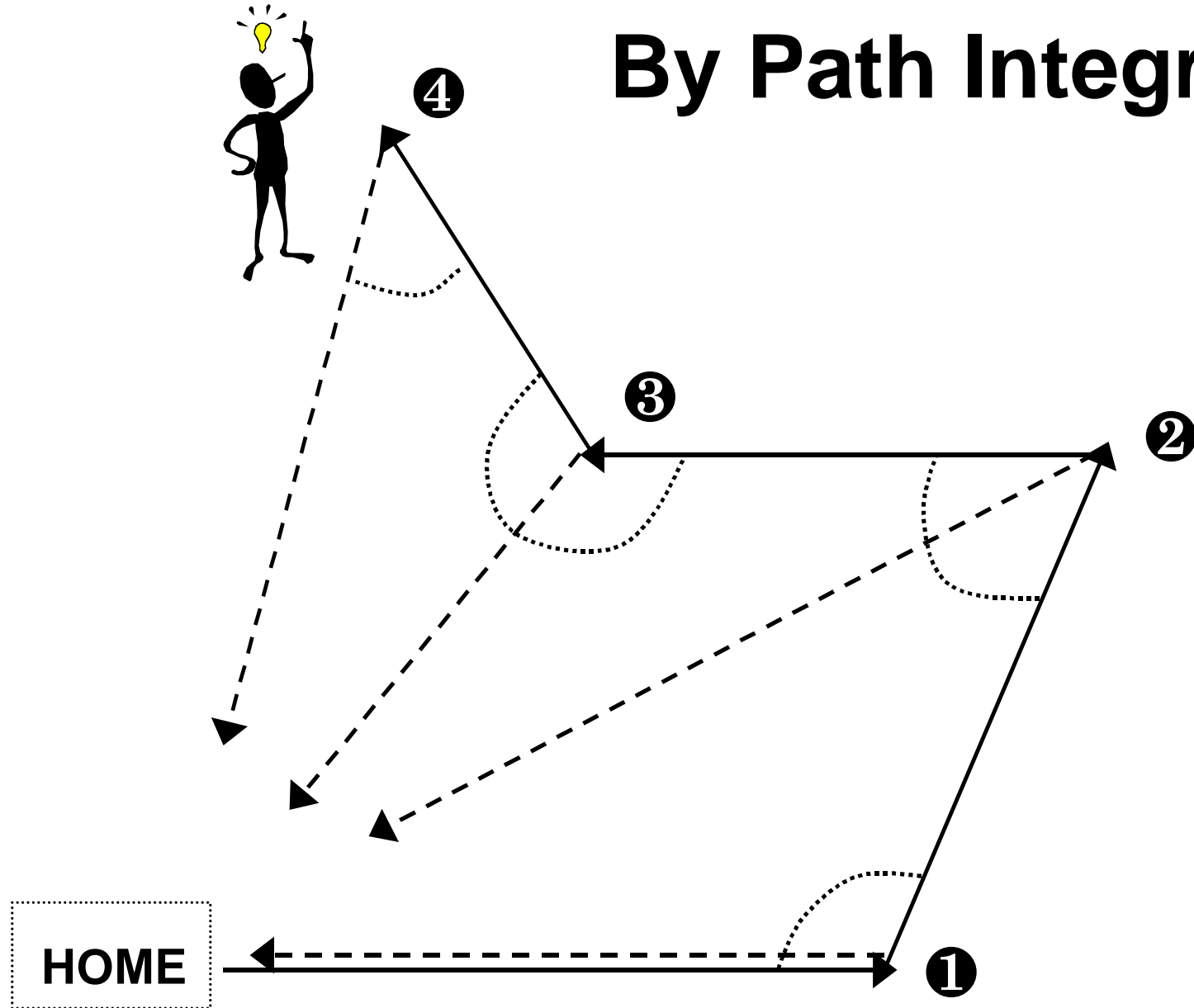
**Brown University,
*Department of Cognitive and
Linguistic Sciences***

***Presented at the 40th Annual Meeting of the Psychonomic
Society, Los Angeles, CA November 18-21, 1999.***

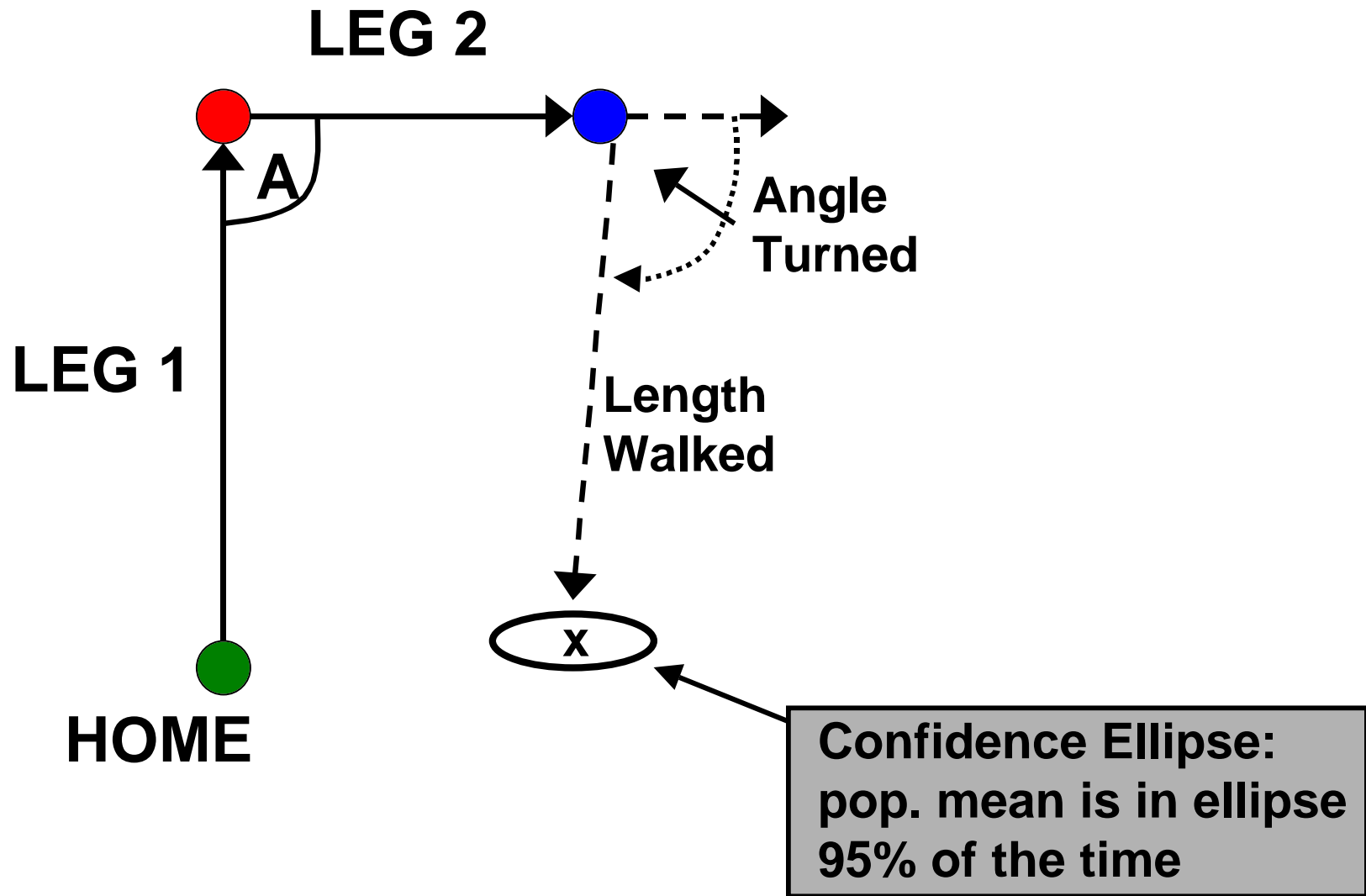
The Problem: Homing



One Solution: Dead Reckoning By Path Integration



The Triangle Completion Task



VENLAB



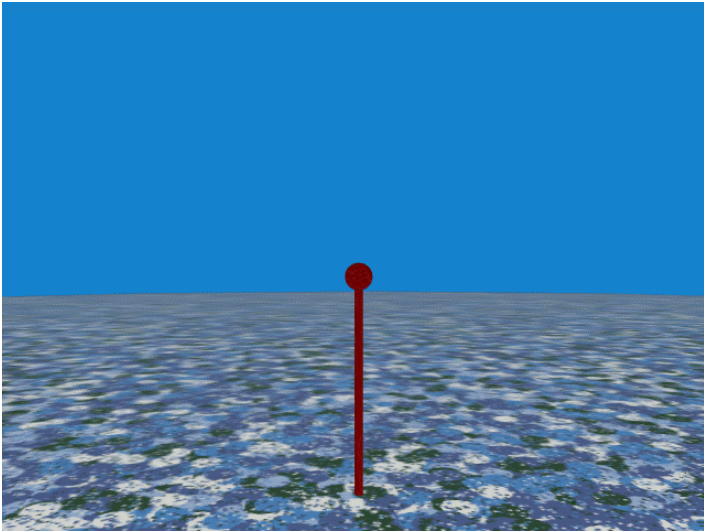
- HMD: Full binocular overlap, 60 deg H FOV
- Motion control with ThrustMaster Serial Joystick

EXPERIMENT 1

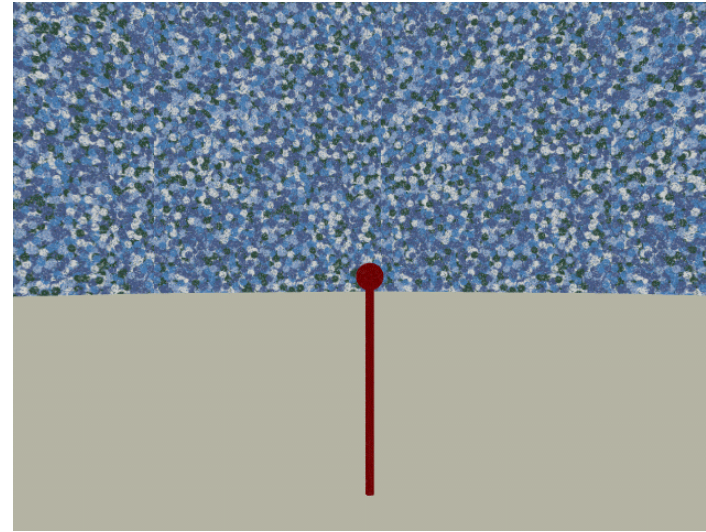
Motivation

- 1. Is integration of optic flow sufficient for dead reckoning?**
- 2. Does flow information about rotation and translation differentially affect performance?**

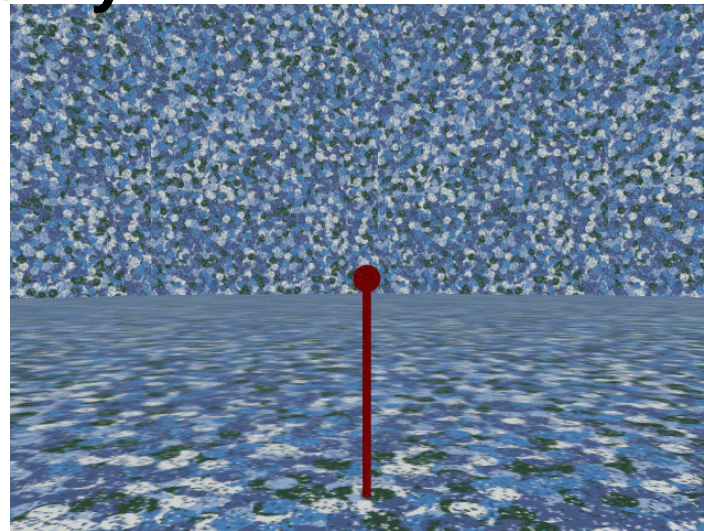
Arenas



**Floor Texture Only
(Arena F)**

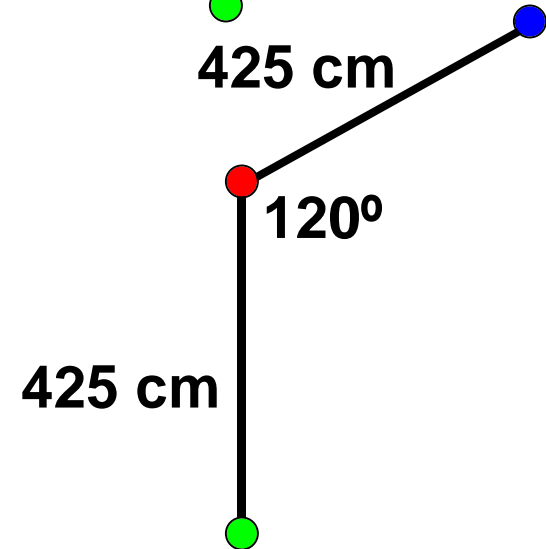
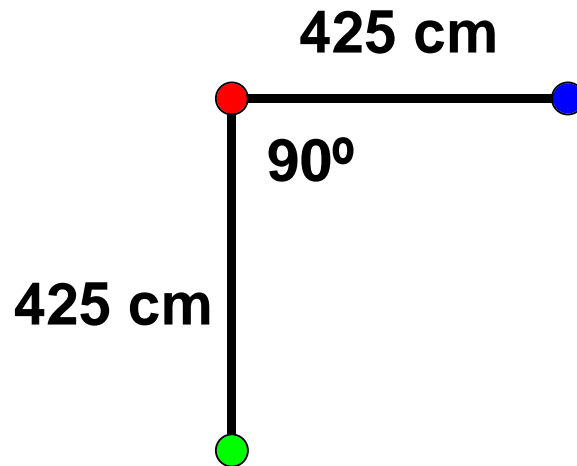
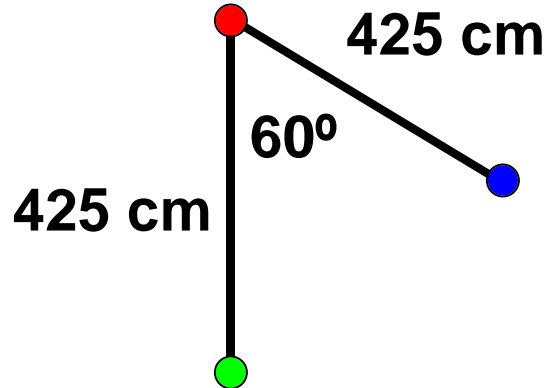
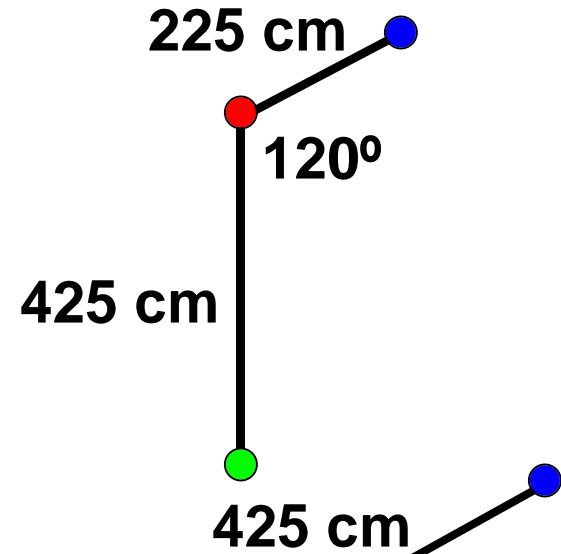
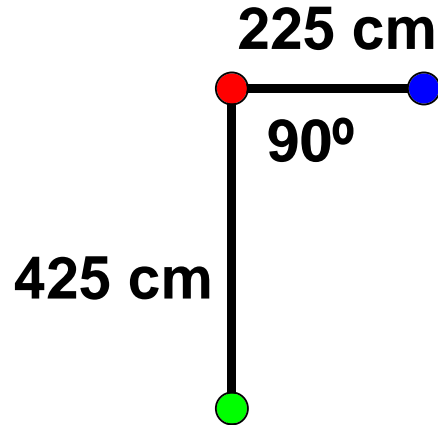
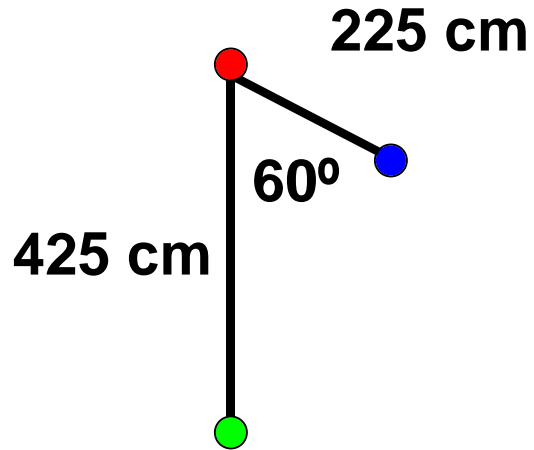


**Wall Texture Only
(Arena W)**



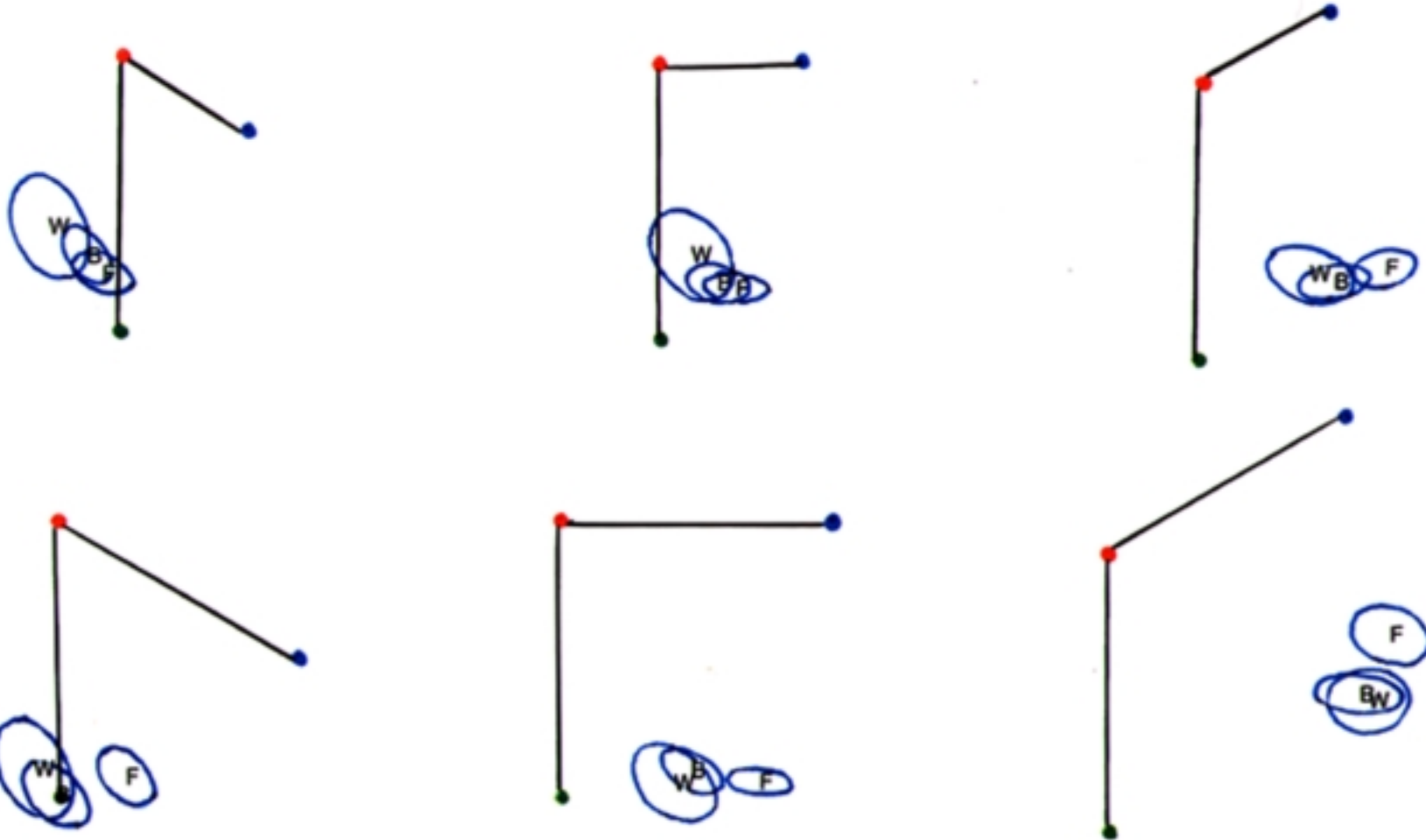
Wall and Floor Texture (Arena B)

Triangles



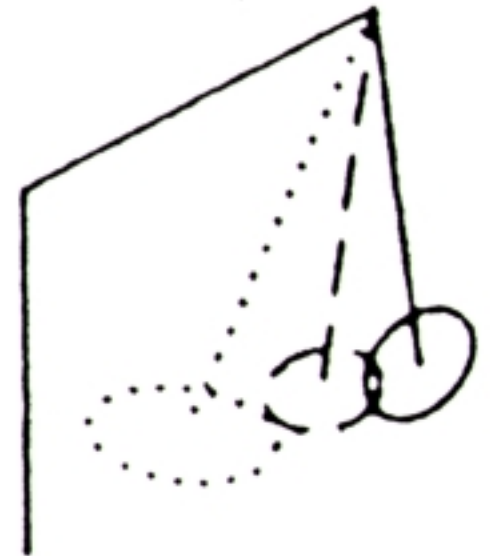
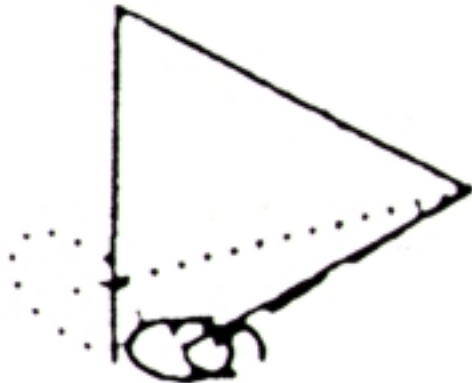
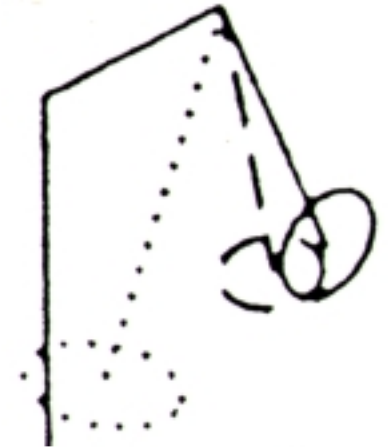
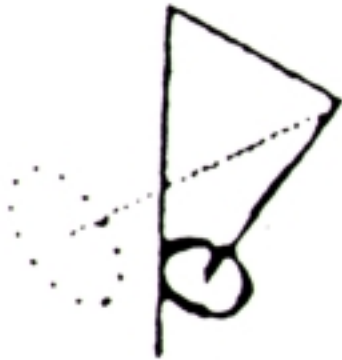
1a

Confidence Ellipses



-
- Arena B most accurate
 - Arena F smaller turn responses
 - Arena W more variable

1b Comparison to Loomis & Peruch



Experiment 1 accuracy: + than Peruch, – than Loomis

..... Loomis: no vision, vestibular

- - - Peruch: vision, no vestibular

Peruch, May & Wartenberg (1997)

Main findings

Arena Effects

- **Participants turned $\sim 10^\circ$ less with reduced flow for rotation (Arena F), $p < .01$**
- **Response variability increased with minimal flow for translation (Arena W), $p < .05$**

Triangle Effects

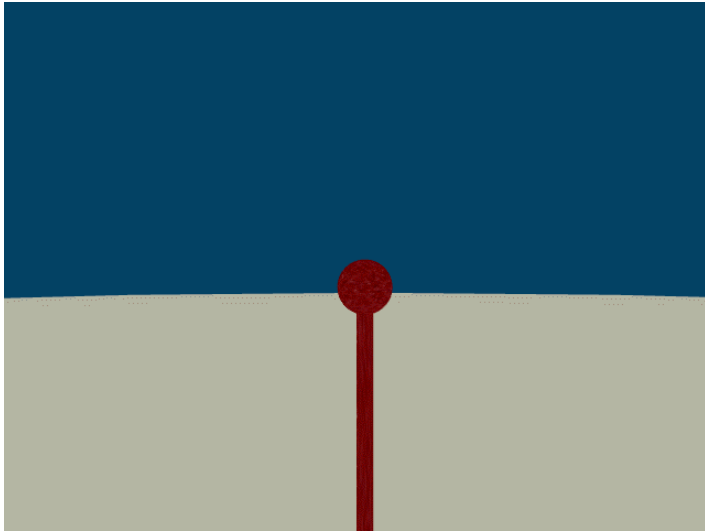
- **Absolute measures were not significant, indicating stereotyped responses appropriate for an equilateral triangle**

EXPERIMENT 2

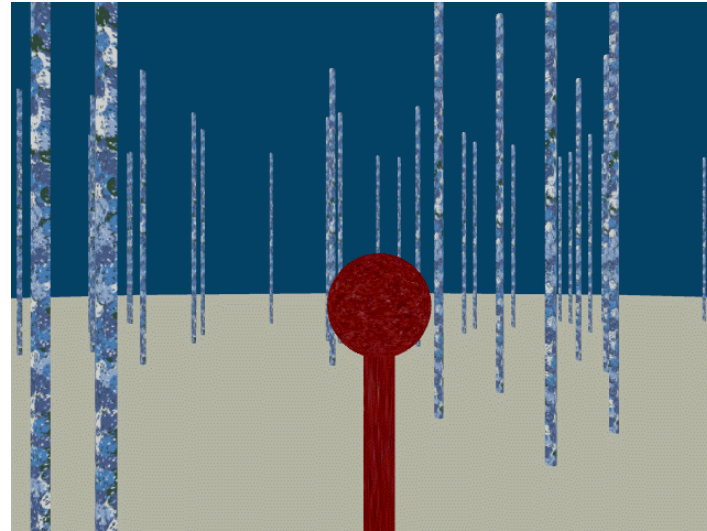
Motivation

- 1. Was a timing strategy employed in Experiment 1?**
- 2. Would local flow from motion parallax improve final leg length estimations?**
- 3. Were the systematic biases found in Experiment 1 the result of a constant Leg 1 length?**
- 4. Are there gender differences?**

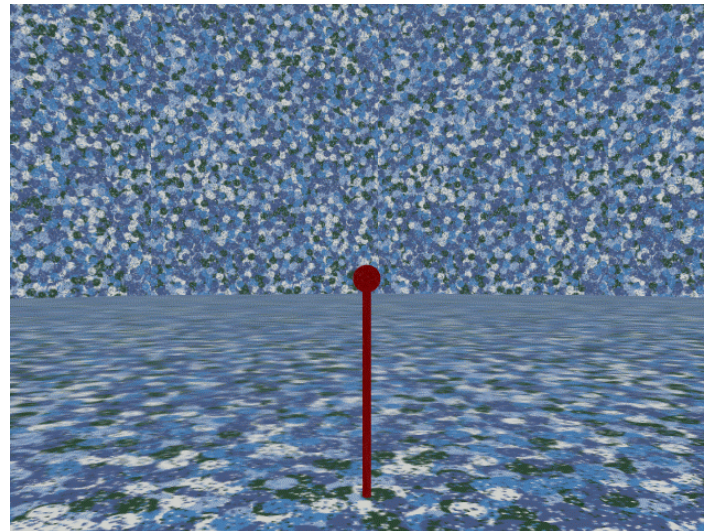
Arenas



**No Texture
(Arena N)**

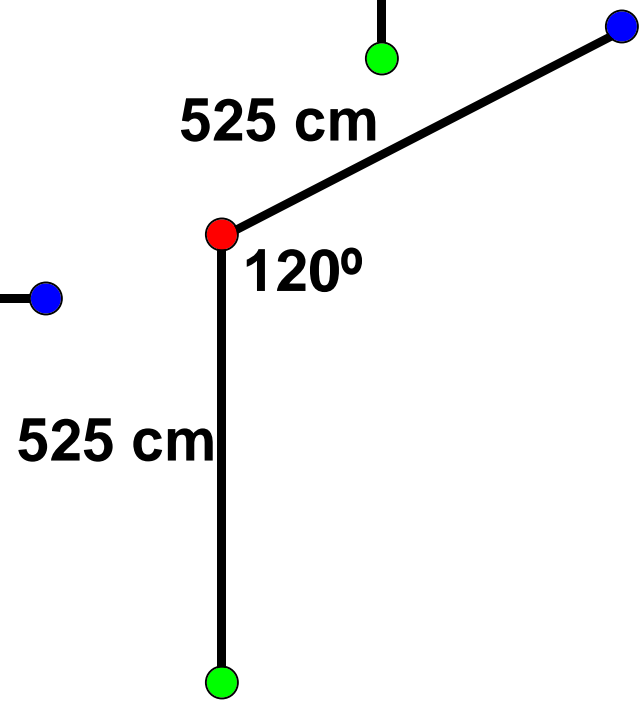
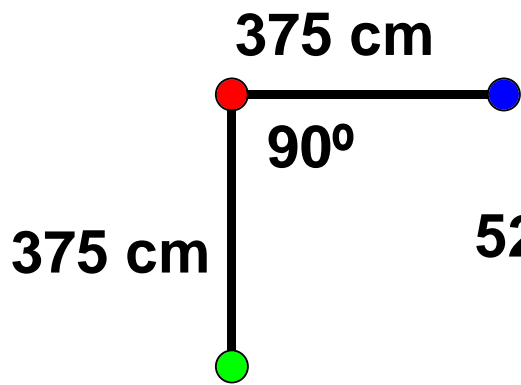
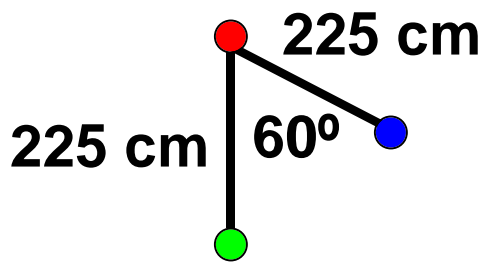
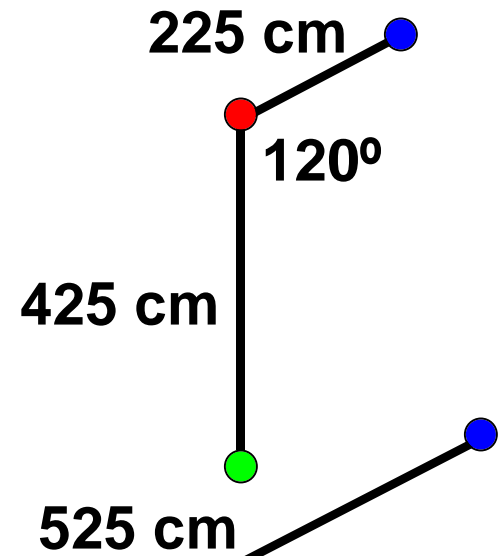
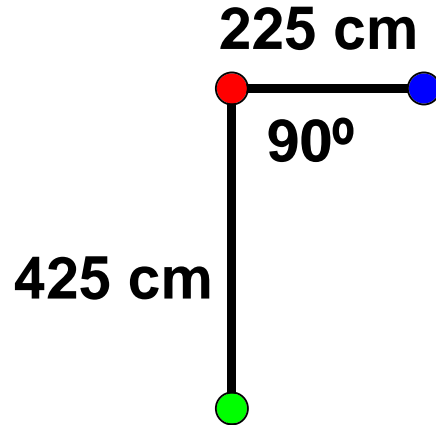
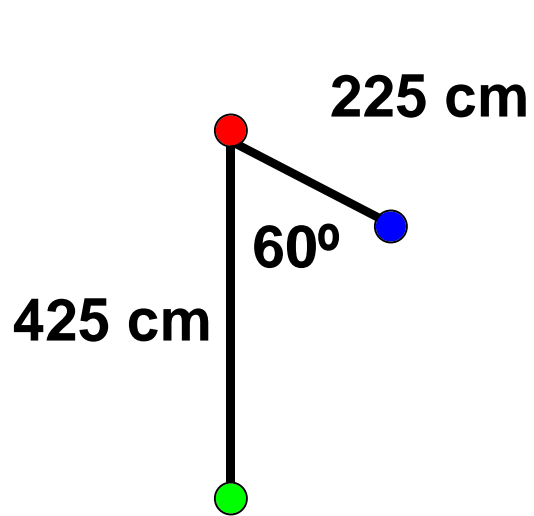


**Textured Poles
(Arena P)**



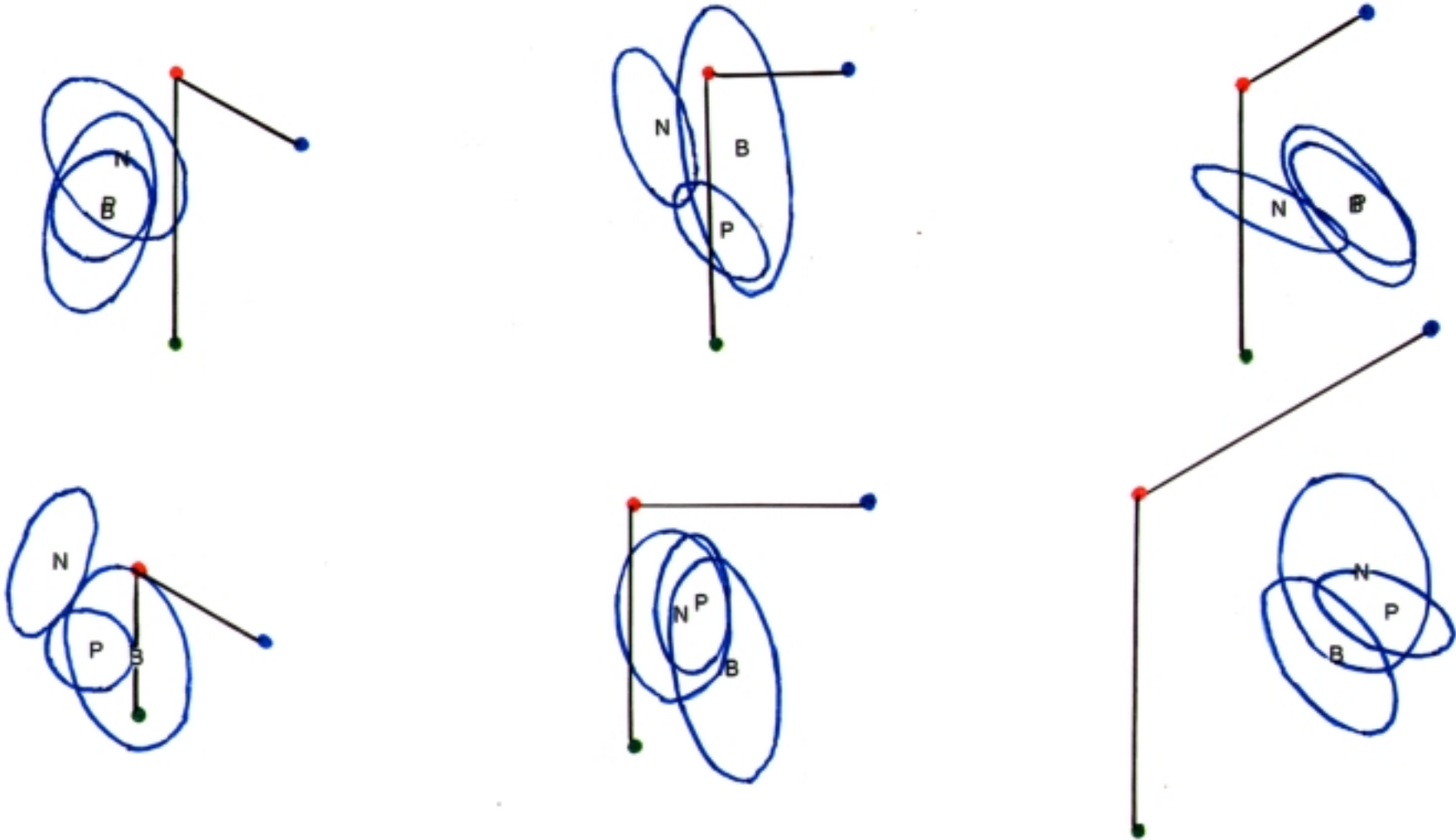
Wall and Floor Texture (Arena B)

Triangles



2a

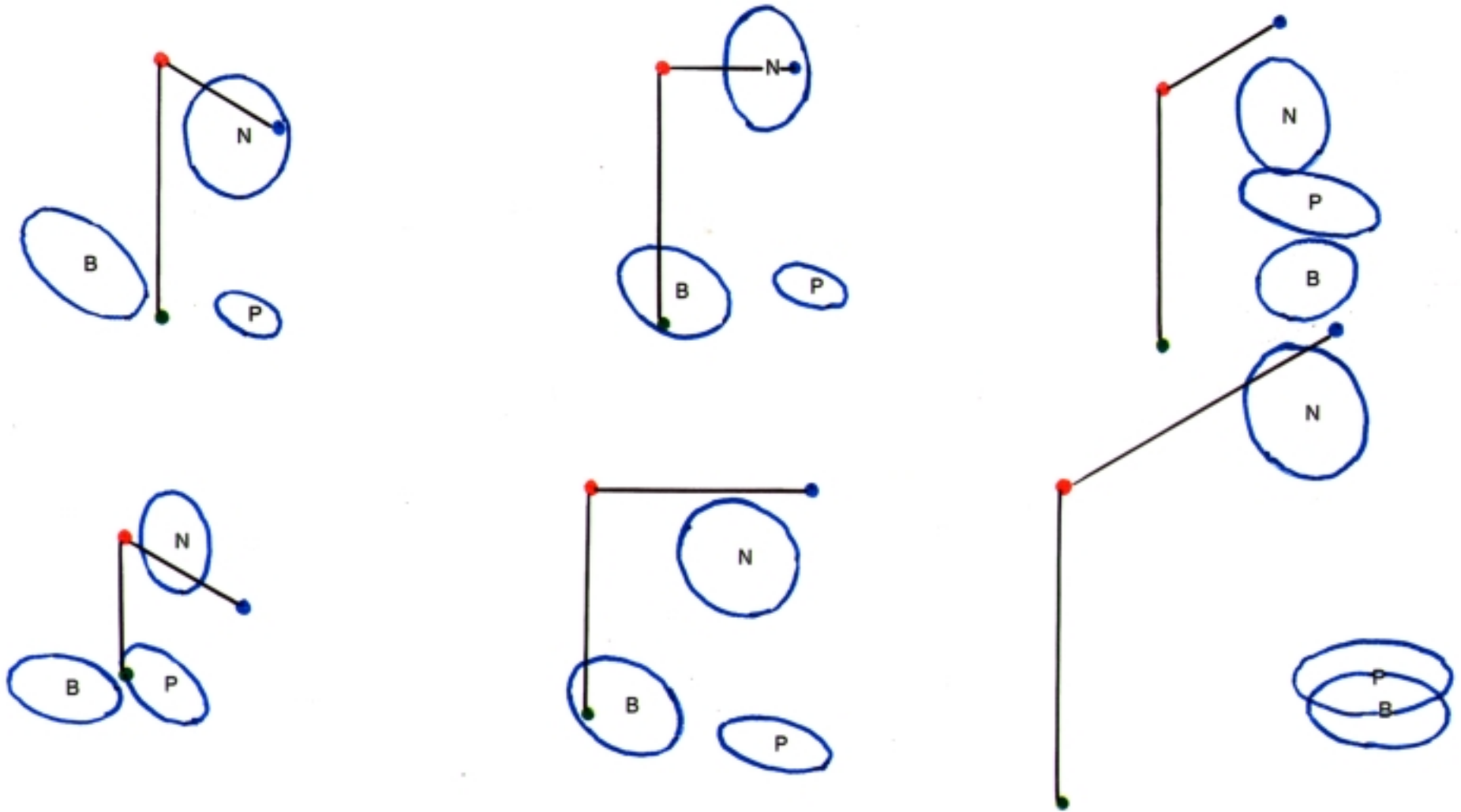
Confidence Ellipses: Females



•Performance is similar regardless of the arena!

2b

Confidence Ellipses: Males



- Arena B most accurate
- Arena P accurate for length
- Arena N no trend, highly variable

Main findings

Arena by Gender interaction, $p < .01$

- Females responses were the same for all displays, indicating use of a timing strategy
- Male responses differed across displays, indicating use of a strategy dependent on integrating optic flow
 - Motion parallax effective for translation

Triangle

- With greater differences between triangles, responses were sensitive to triangle shape, $p < .001$

Attrition

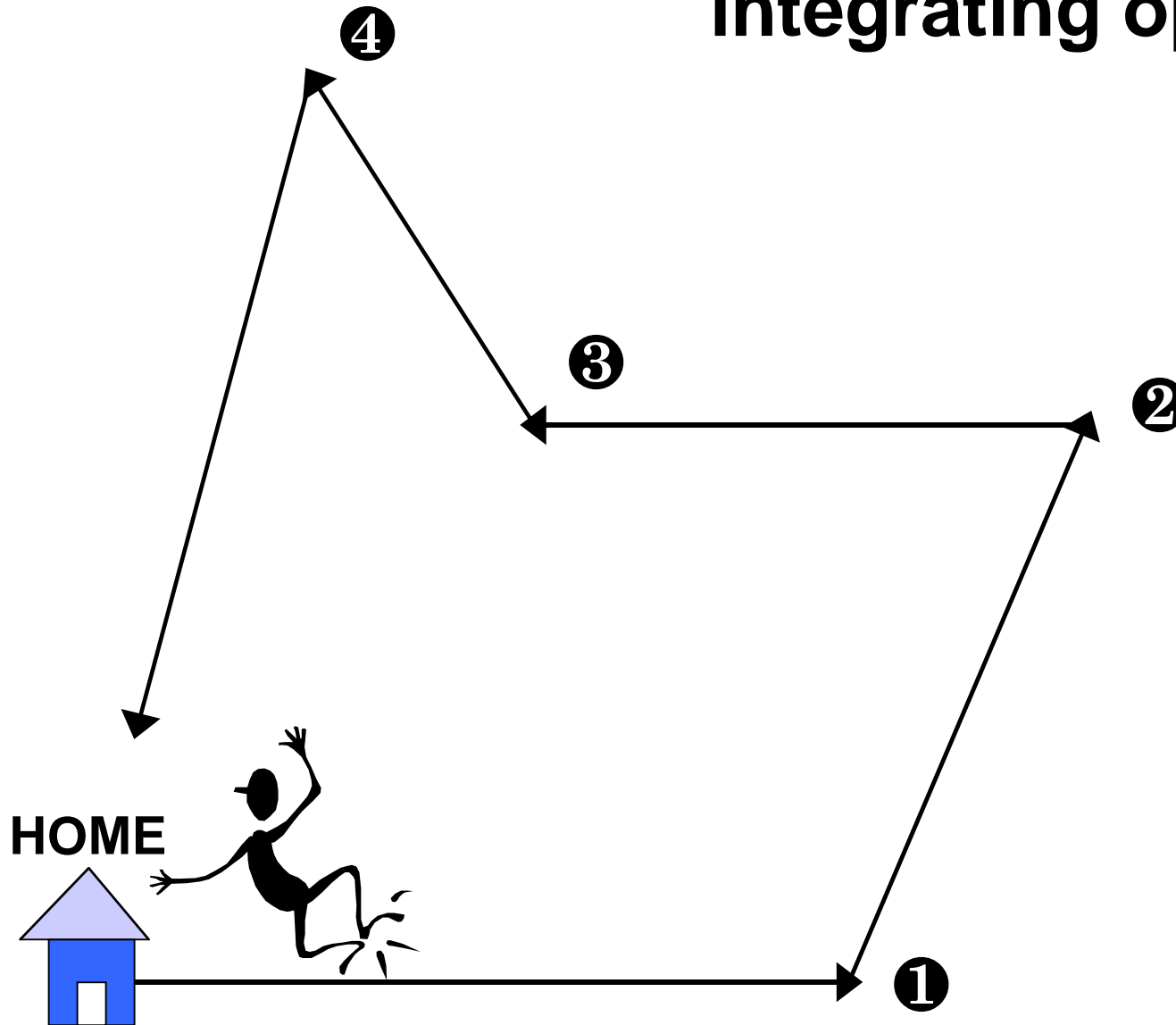
- **Half the women (and only 1 man) dropped out prior to completion due to simulator sickness**
- **Due to visual/vestibular conflict?**
- **Undermines gender effect: women in analyses may not have attended to visual information to avoid conflict**
- **NO attrition in active walking experiments in the VENLAB**

Conclusions

- **Flow for translation and rotation affect length and angle measures, respectively**
- **Males appear to be more dependent on visual information than females**
- **The effects are tempered by a tendency to produce equilateral triangles**

THEREFORE....

Given a richly textured environment, you can get pretty close to home by integrating optic flow!



Future work

- **Replicate current study with active walking**
- **Manipulate degree of vestibular information available during encoding and response**
- **Add landmark cues to the environment**
- **Change goal of task**
 - **foraging and return to home**