

# Sensitivity to the Gain of Optic Flow During Walking

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# Motivation:

- How sensitive are people to differences in the speed of self-motion specified by optic flow?
- Specifically, measured sensitivity to differences in translational gain:
  - Gain =  $\frac{\text{visual information}}{\text{body sense information}}$
  - The ratio between the self-motion specified by optic flow and that specified by body senses
  - Body senses = info from vestibular, proprioceptive and efferent systems
- In previous homing experiments, only 25% of participants noticed gains of 150% and 67%

# Main questions

- What is the difference threshold for (translational) gain?
- Does the threshold depend on the standard gain value?
- Do abnormally high or low gains influence walking speed?
- Does walking speed influence threshold?

# Virtual Environment Navigation Lab (VENLab)

Intersense tracker

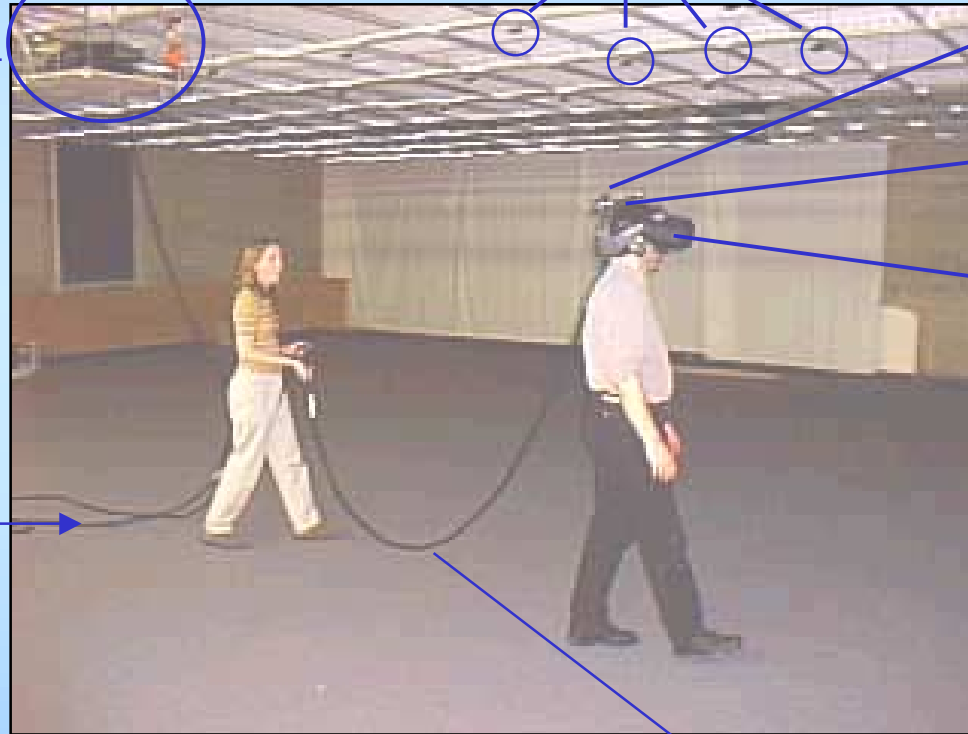
sonic beacons

Microphones  
(very accurate)

Inertial system  
(very fast)

Kaiser HMD

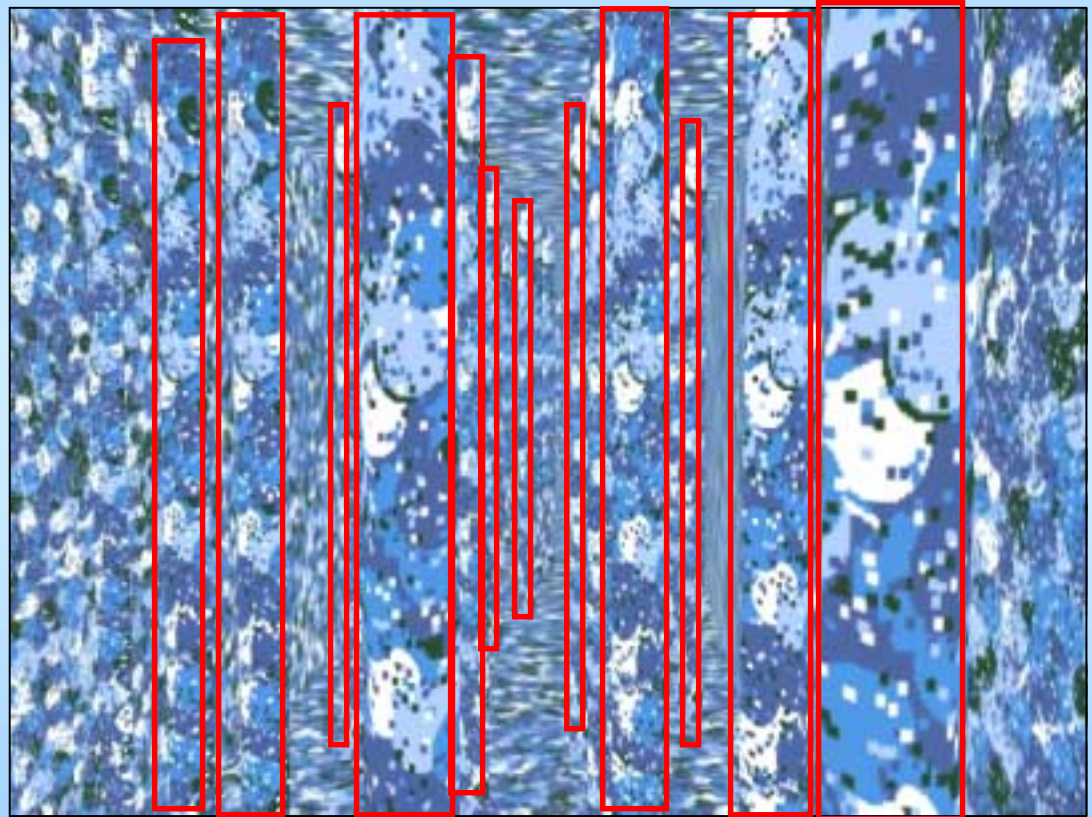
SGI  
Onyx 2 IR



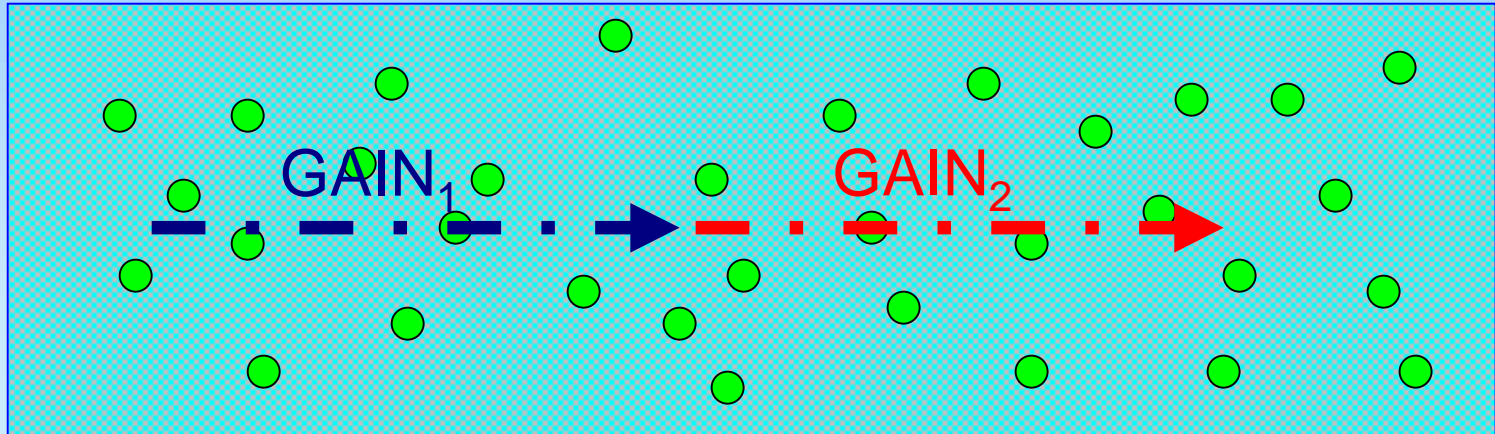
50 ft. Tracker, HMD cables

# The Virtual Hallway

- 2m x 2.5m x 100m
- Random texture on all surfaces
- 400 randomly positioned poles (10cm diameter)



# 2 Interval Forced Choice Task

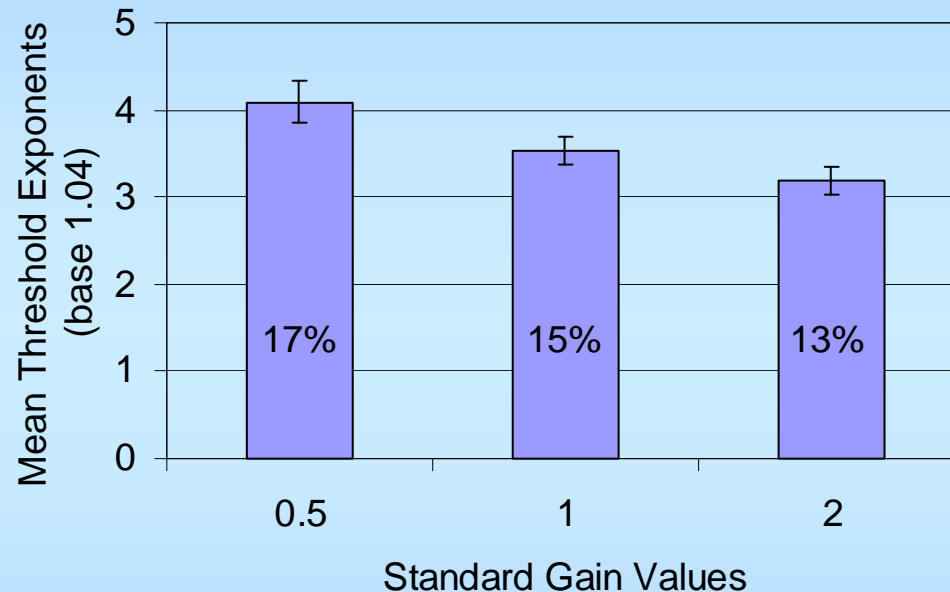


- Feedback on every trial
- Adaptive staircase method
  - 2 staircases, (“1-up/2-down” method)
  - Eight turns to termination
  - Step size was logarithmic (ratio of 1.04)
  - staircases initialized at five steps (20% difference)

# Experiment 1: Method

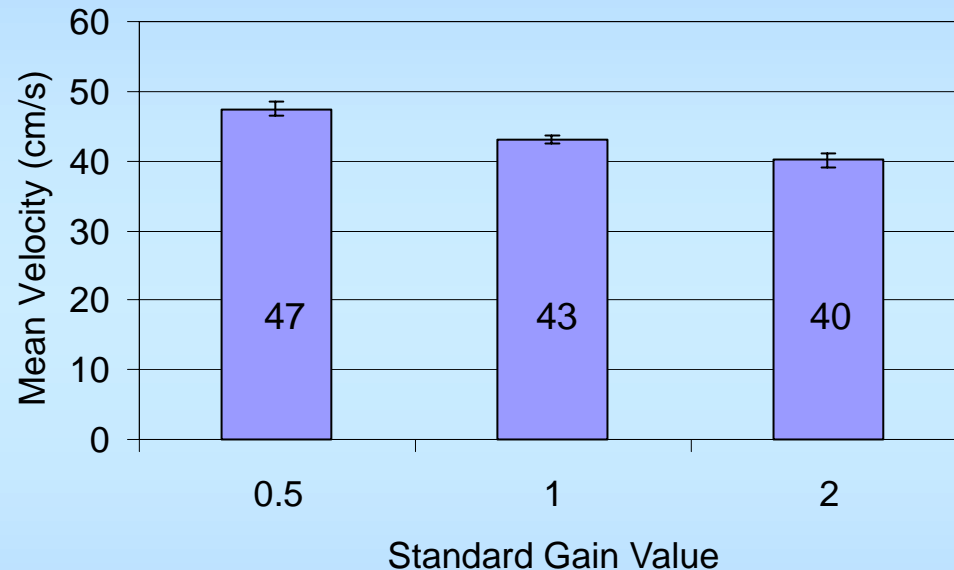
- Tested thresholds around three different standard gains: 0.5, 1.0, and 2.0
- Blocked by standard gain value, counterbalanced blocks
- Condition 1: “Which interval is faster?”  
Condition 2: “Which interval is slower?”
- 8 participants in analyses (3 females, 5 males)

# Experiment 1: Thresholds



- Overall, people sensitive to ~15% gain differences
- Significant difference between 0.5 and 2.0 ( $p \approx .05$ )
  - Scaling of thresholds at different standard gains?

# Experiment 1: Walking Speed



- Significant differences of walking speeds between gains
  - Paired t-tests, at least  $p < .05$  for all comparisons
- People walk about 10% faster or slower than normal depending on the condition

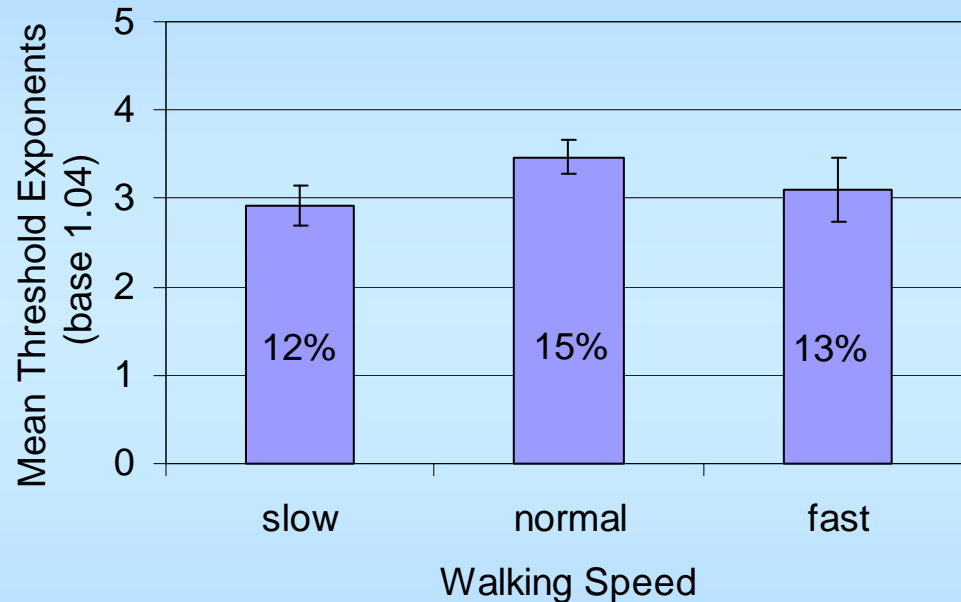
# Experiment 1: Summary

- People can detect ~15% differences in gain
- This sensitivity is reduced when gain is lower
  - Body oscillations during walking may mask differences at lower gains
- People walk different speeds depending on the standard gain
  - People may be trying to produce a normal flow rate
  - Walking speed may have influenced thresholds

# Experiment 2: Motivation/Methods

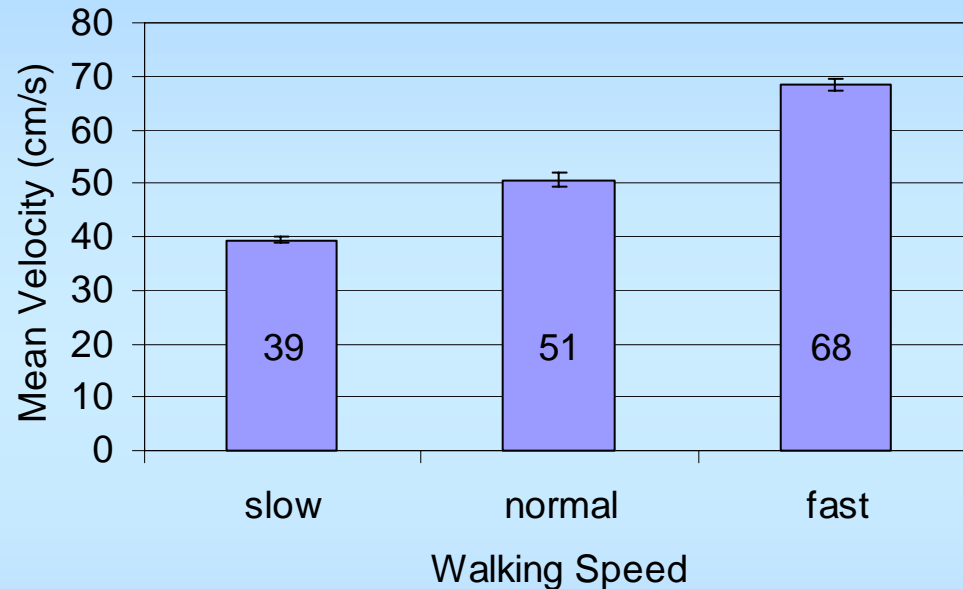
- Do thresholds depend on flow rate or flow gain?
- Are thresholds affected by walking speed?
- Measure gain difference thresholds at 3 walking speeds
- Same methods except:
  - Walk speed manipulated: slow, normal and fast
  - Standard gain value always 1.0
  - 5 participants in analyses (3 females, 2 males)

# Experiment 2: Thresholds



- Gain difference thresholds still ~15%
- No significant differences between walking speeds

# Experiment 2: Walking Speed



- People followed the directions!
- But, not a perfect control:
  - Mean velocities differ by less than a factor of two (flow rates do not match flow gains from Exp 1)

# Conclusions

- Overall, gain difference thresholds ~15%
  - Small scaling effect of thresholds to gains
- Standard gain influences walking speed
  - To approximate normal flow rate?
- Walking speed does not influence threshold
- Gains used in homing experiment were far above threshold
- Next step: determine thresholds for rotational gain differences
  - Same magnitude as translational gain?