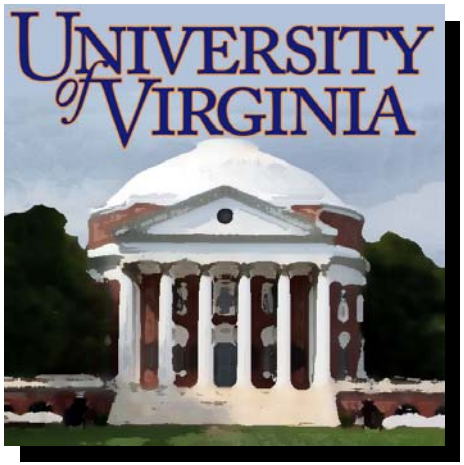
Body-Scaled Metrics in Perception

Dennis Proffitt

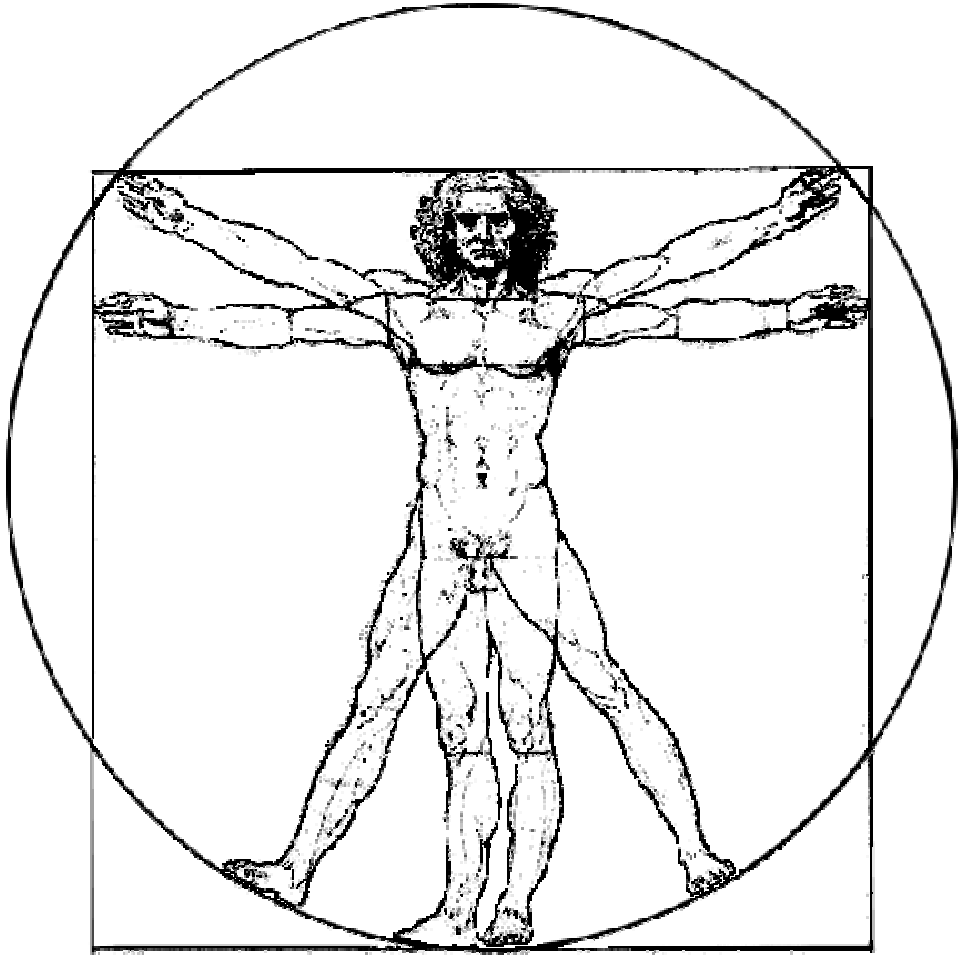
Designing Matter

University of Virginia



March 2004

Perceiving Spatial Layout: Man is the Measure of All Things



Perceiving Spatial Layout

Spatial layout is the geometry of surfaces.

- Form
- Extent
- Orientation

World Provides Optical Structure

- **Information insufficiency**
- Inverse projection problem

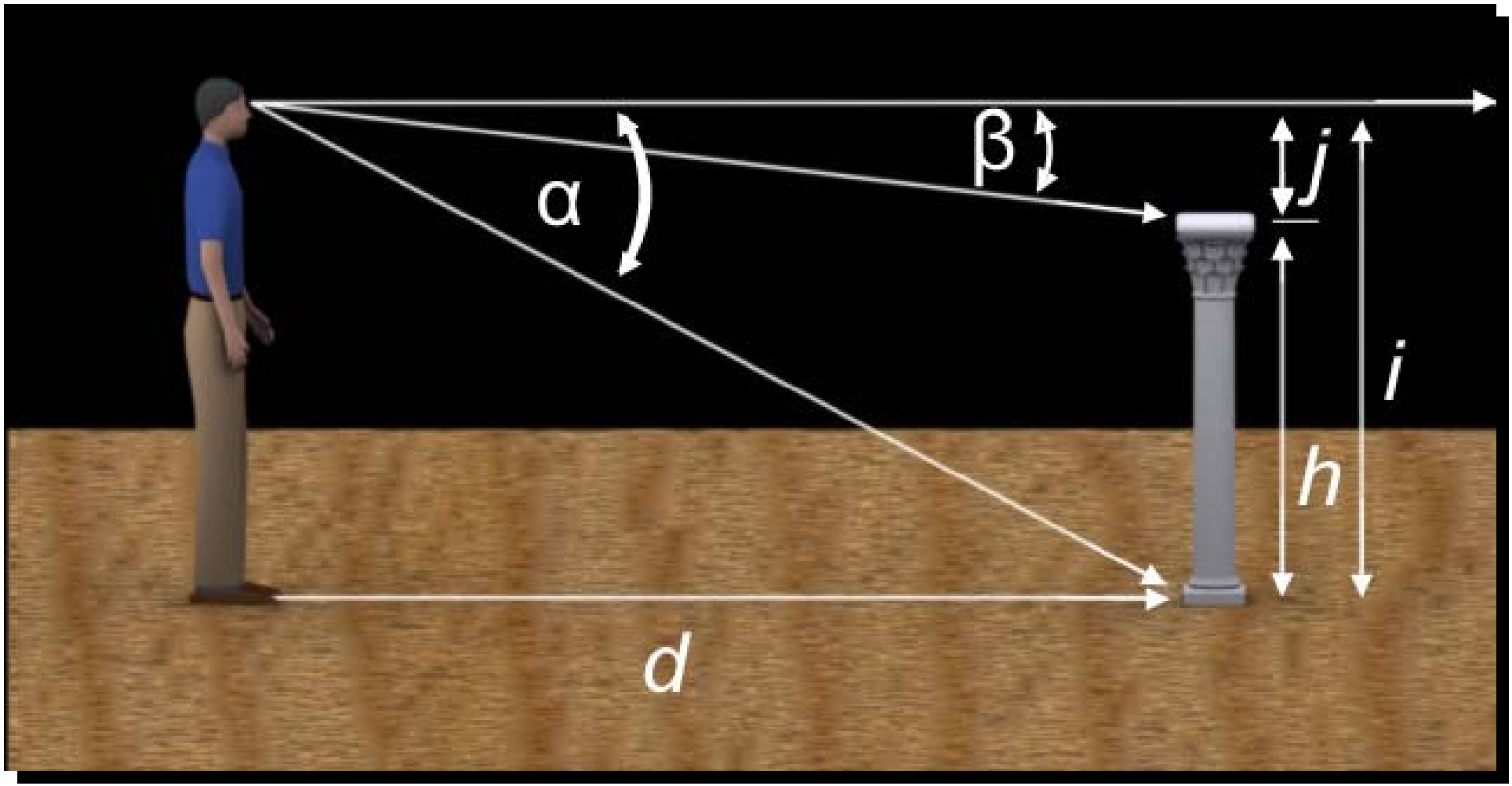
Inverse Projection Problem

Play movie clip >>

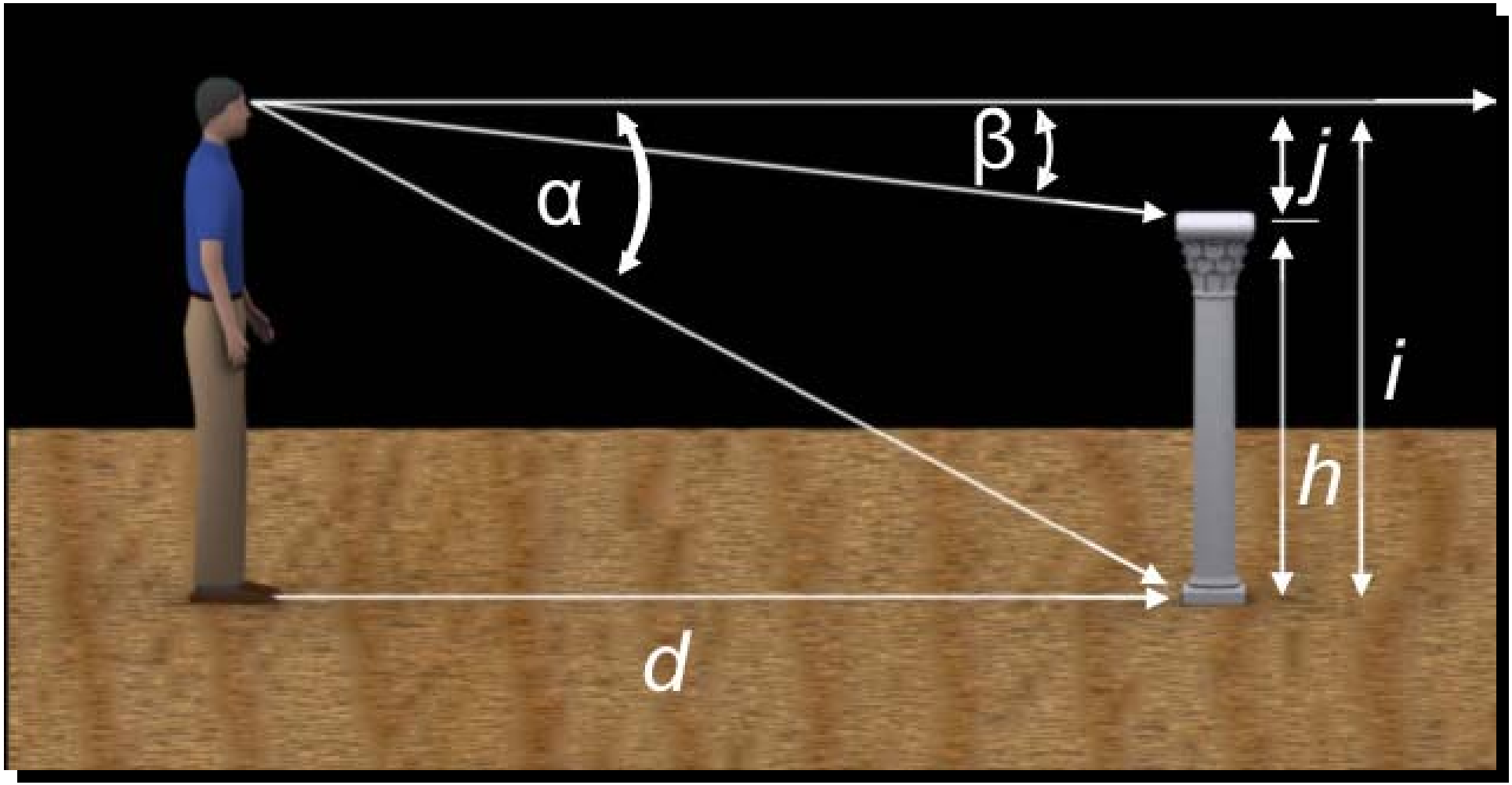
Body Scaling

For objects on the ground, size and distance can be scaled to eye height.

$$h = i - i(\tan\beta / \tan\alpha)$$

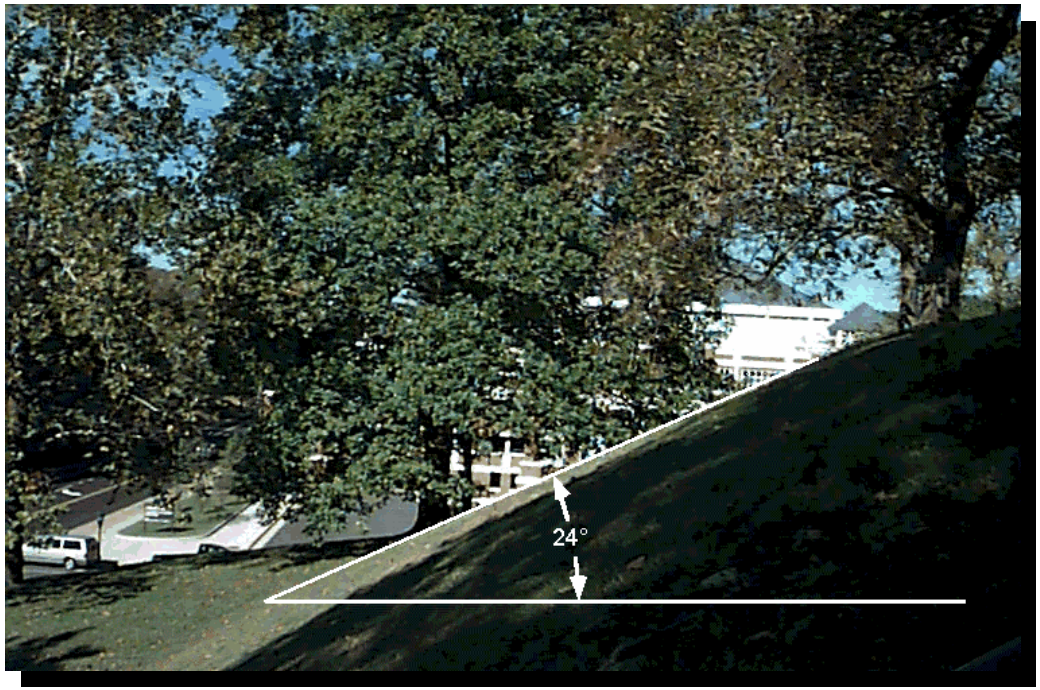


$d = i/\tan\alpha$



Ground: Two Parameters

Slant



Extent

Perceiving Geographical Slant

Proffitt, D.R., Mukul Bhalla, M., Gossweiler, R. & Midgett, J. (1995). Psychonomic Bulletin & Review.

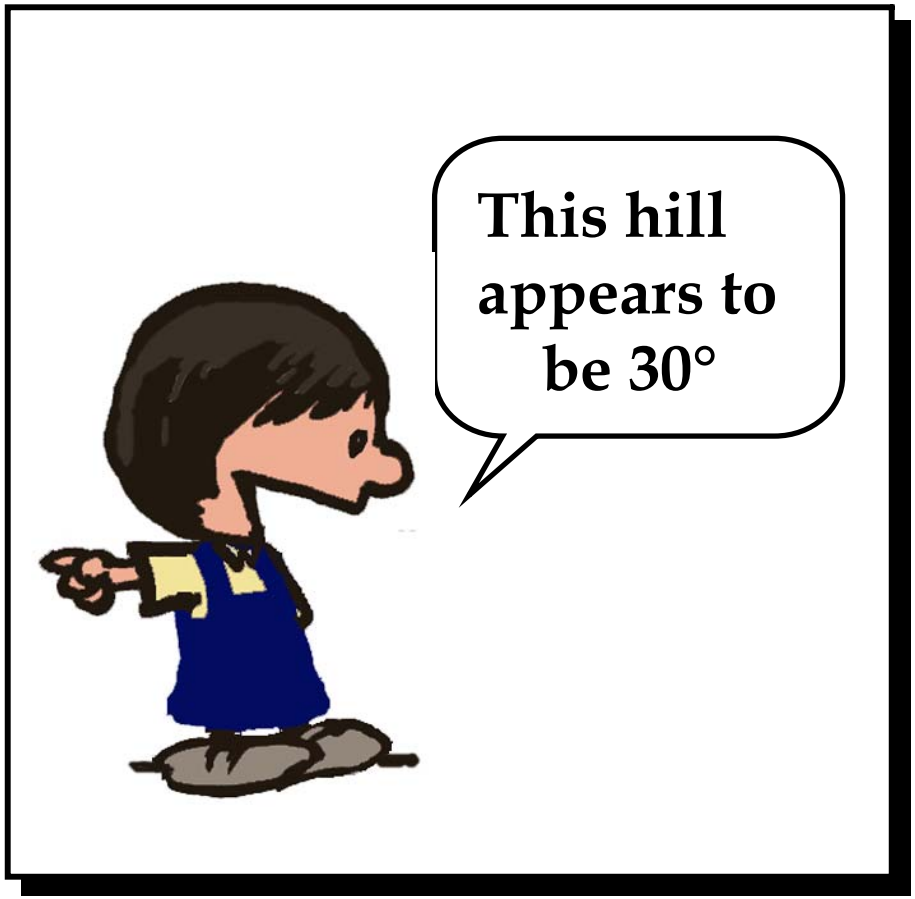
Bhalla, M. & Proffitt, D.R. (1999). Journal of Experimental Psychology: Human Perception and Performance.

Proffitt, D.R., Creem, S.H., & Zosh, W. (2001). Psychological Science.

Geographical Slant Perception

- Conscious perceptions
  - Exhibit large overestimations
- Visually guided actions
  - Accurate

Dependent Measures: Verbal



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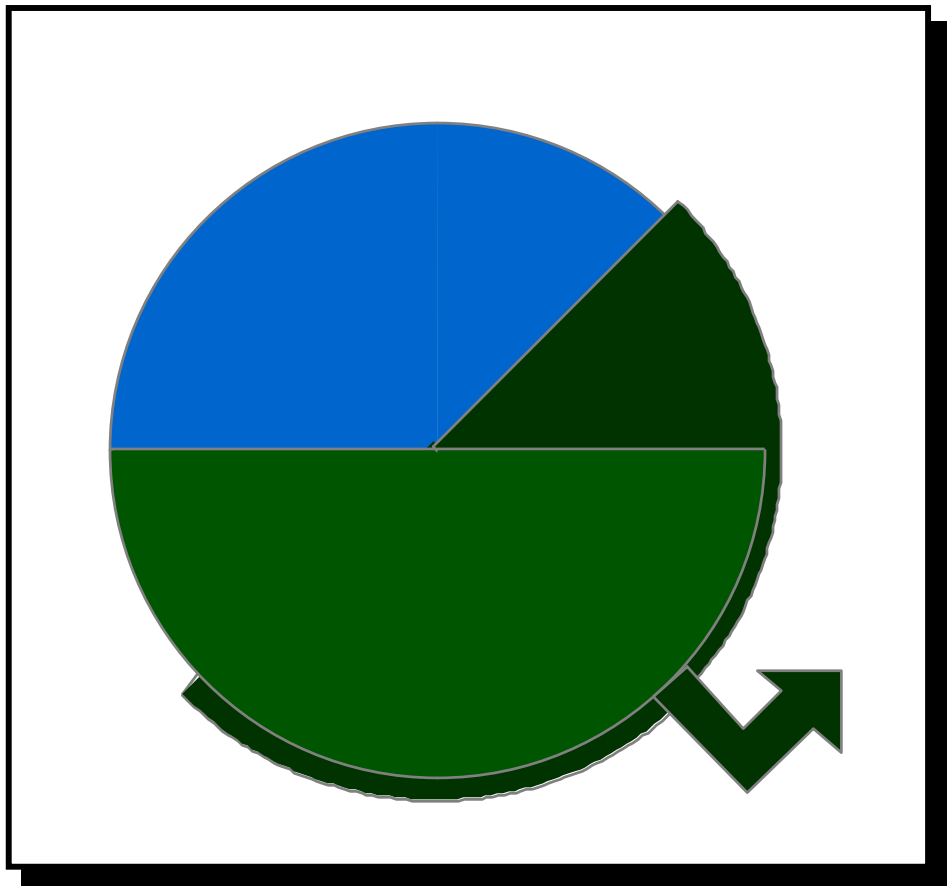
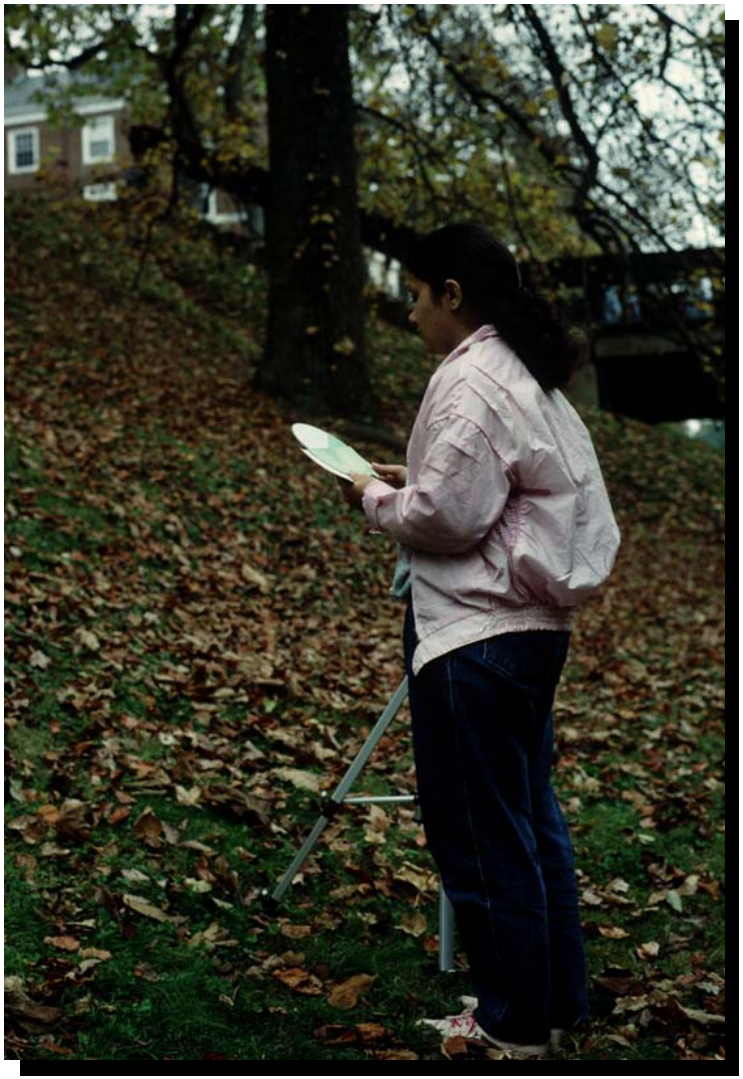
Dependent Measures: Visual



Dependent Measures: Visual



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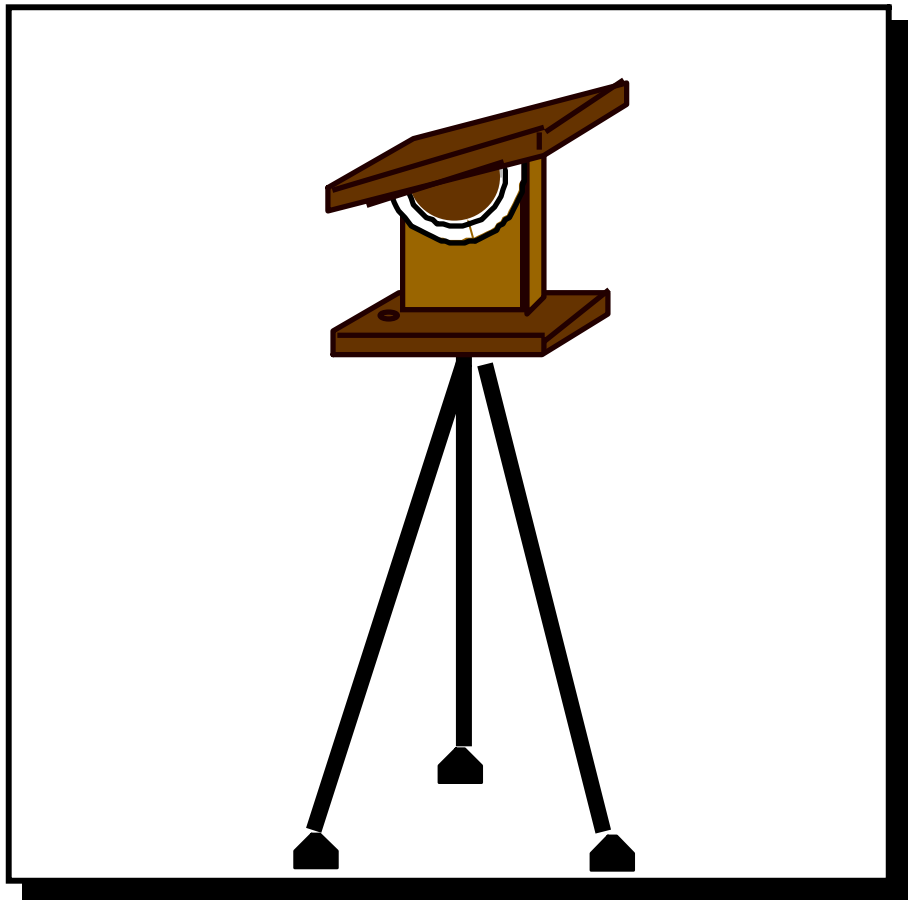
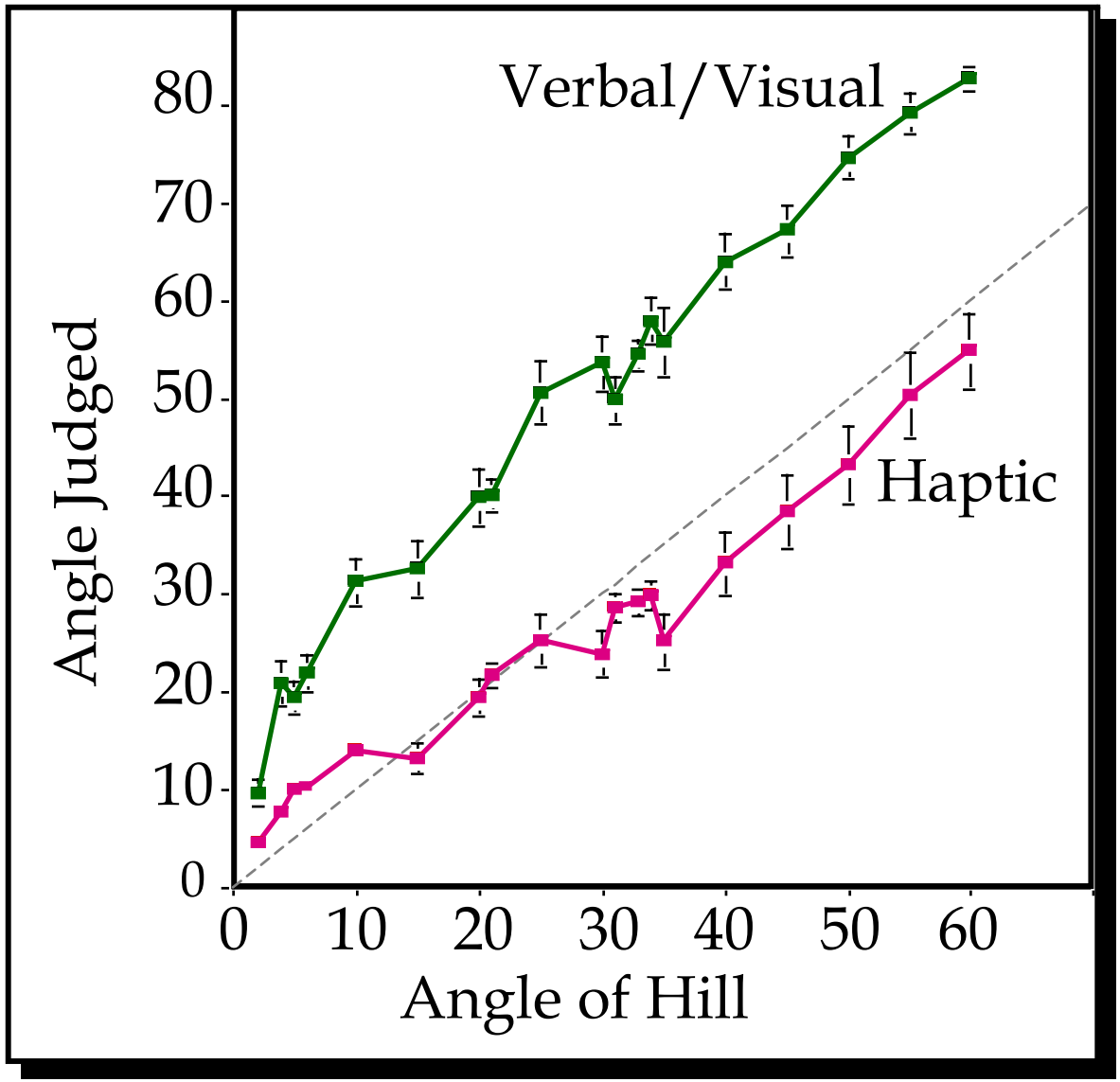
Dependent Measures: Haptic



Dependent Measures: Haptic

VR

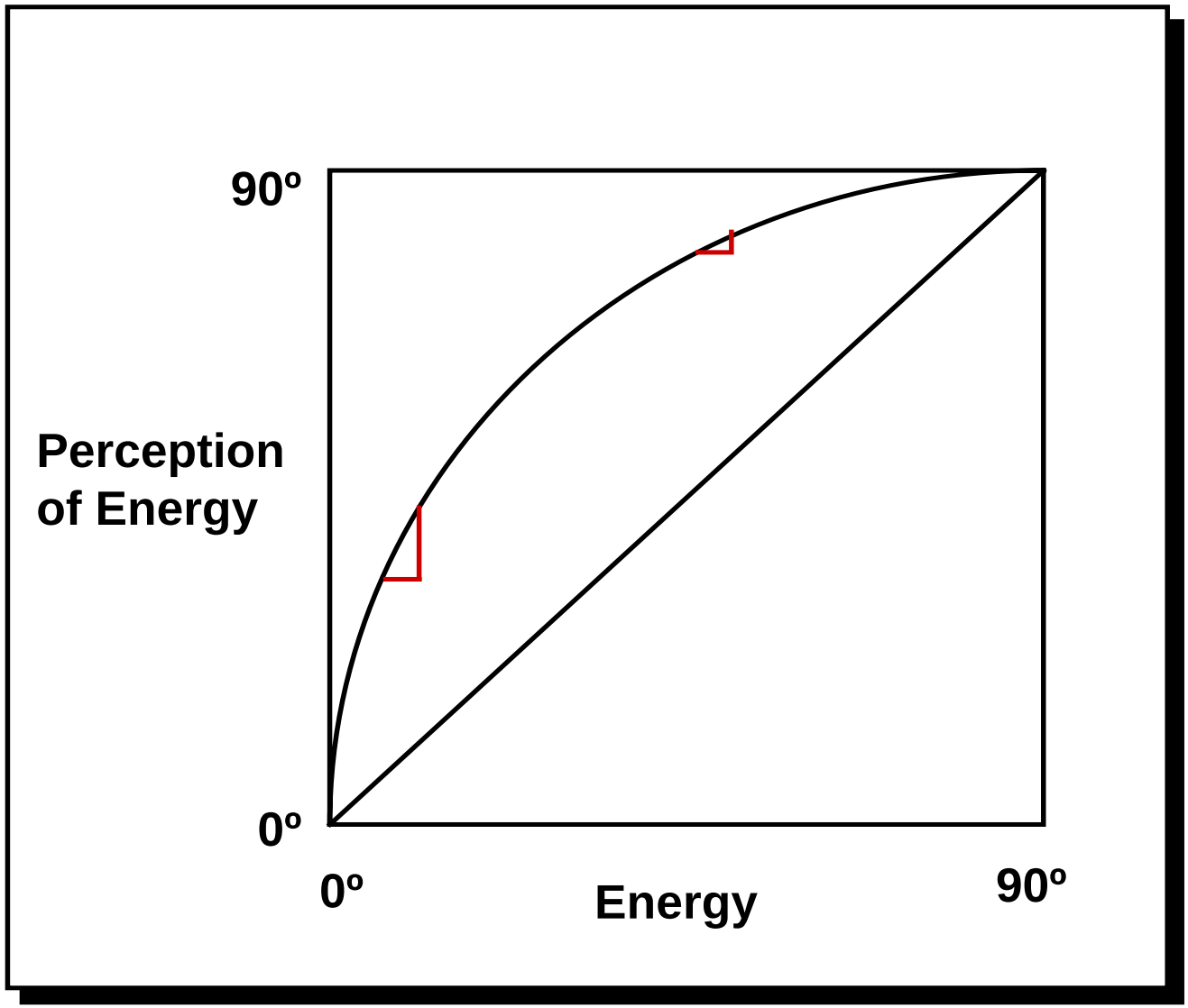
Normative Data



Overestimation is Useful

- Overestimation of slant promotes **heightened sensitivity** to slants within the effective range of locomotion.

A Little Psychophysics



Explicit Awareness of Slant

- Informs long-term planning.
  - Selection of gait style
  - **Energetics**: Regulation of energy expenditure

Explicit Awareness of Slant: Behavioral Energetics

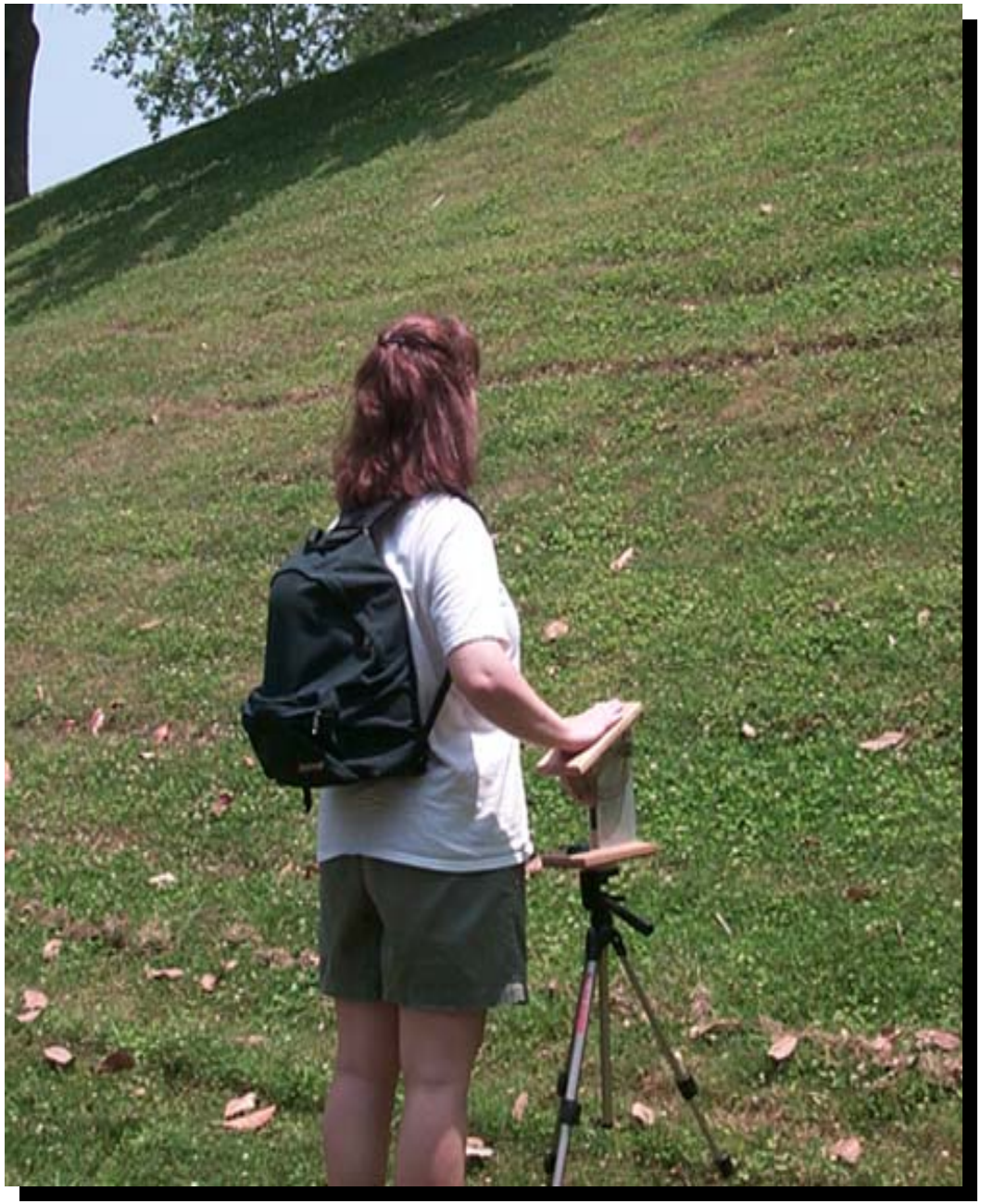
- Relates anticipated **energy** expenditure to distal **slant**.

- Thus, perceived slant should change as a function of both **slant** and **effort**.

Effort and Slant Perception

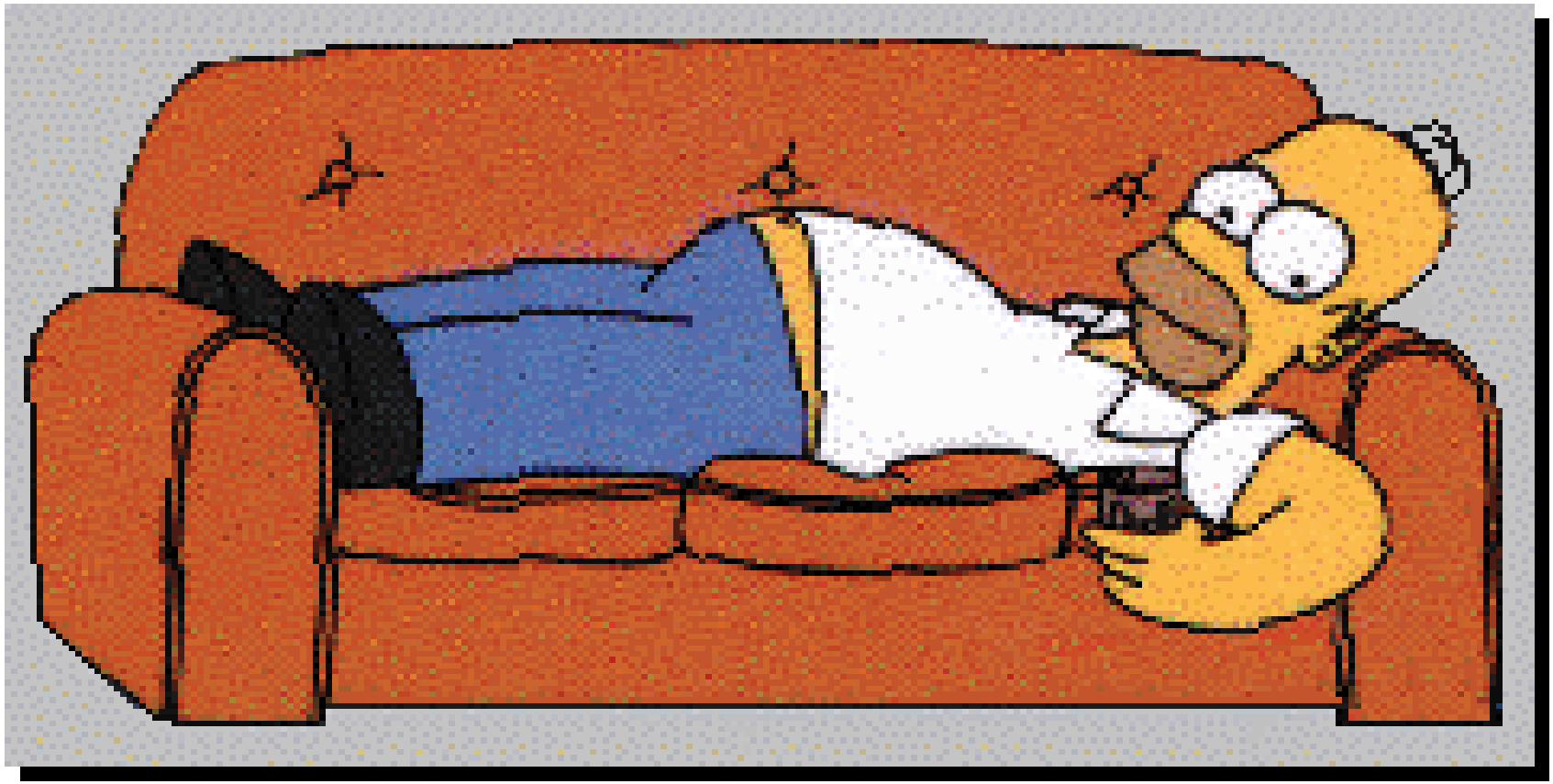
- Perceived slant **increases** as a function of…

Load

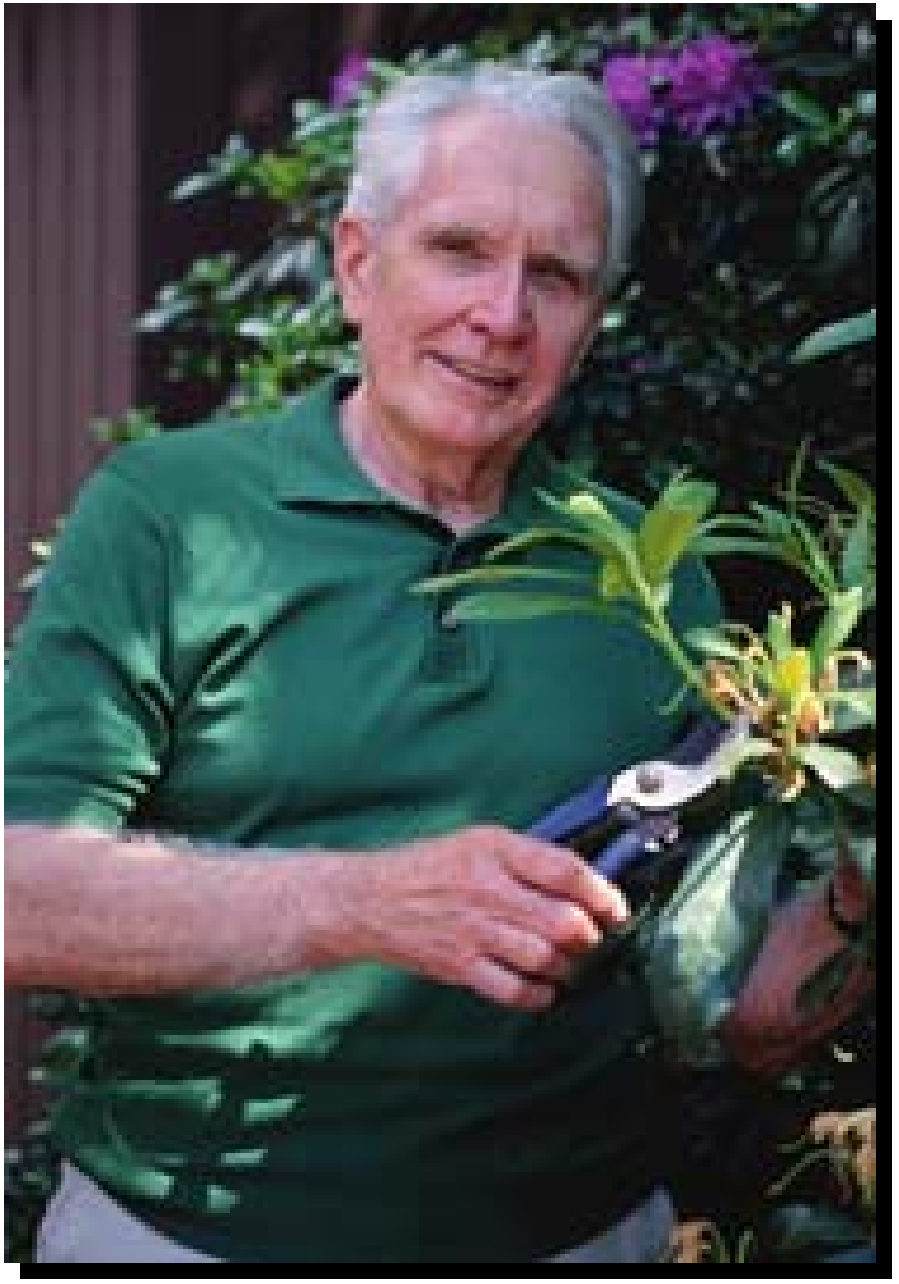


Fatigue

Low Physical Fitness



Old Age & Declining Health



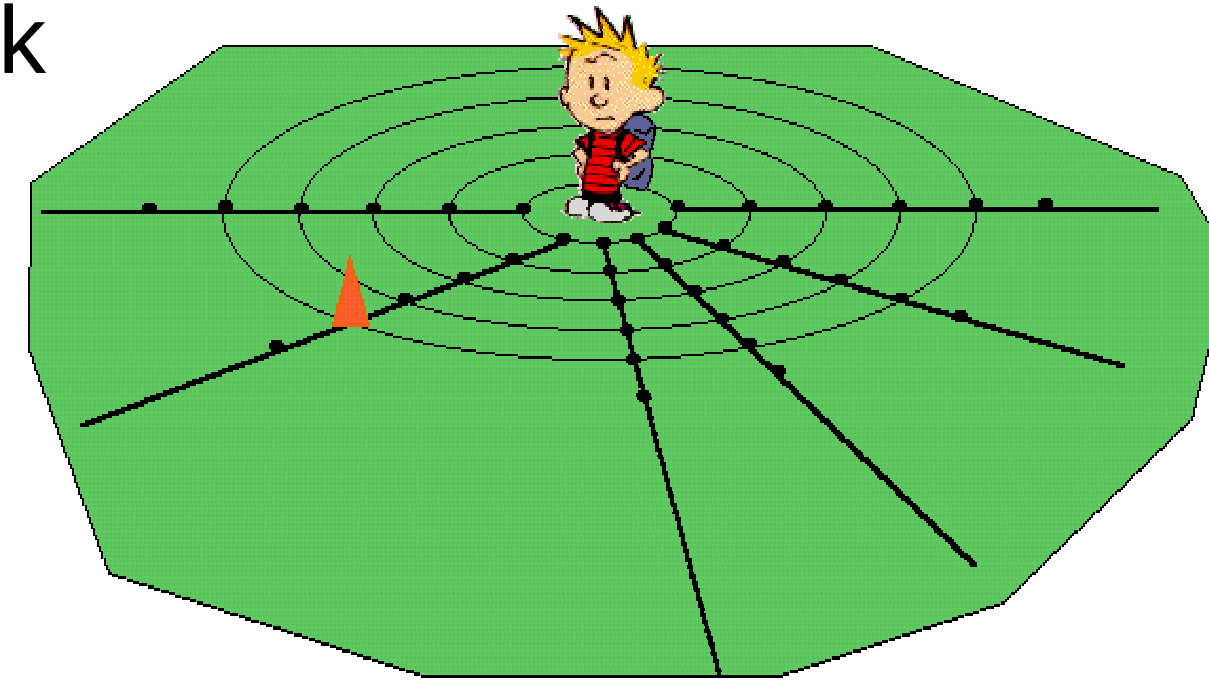
The Role of Effort in Perceiving Distance

Proffitt, D.R., Stefanucci, J., Banton, T., & Epstein, W. (2003). Psychological Science.

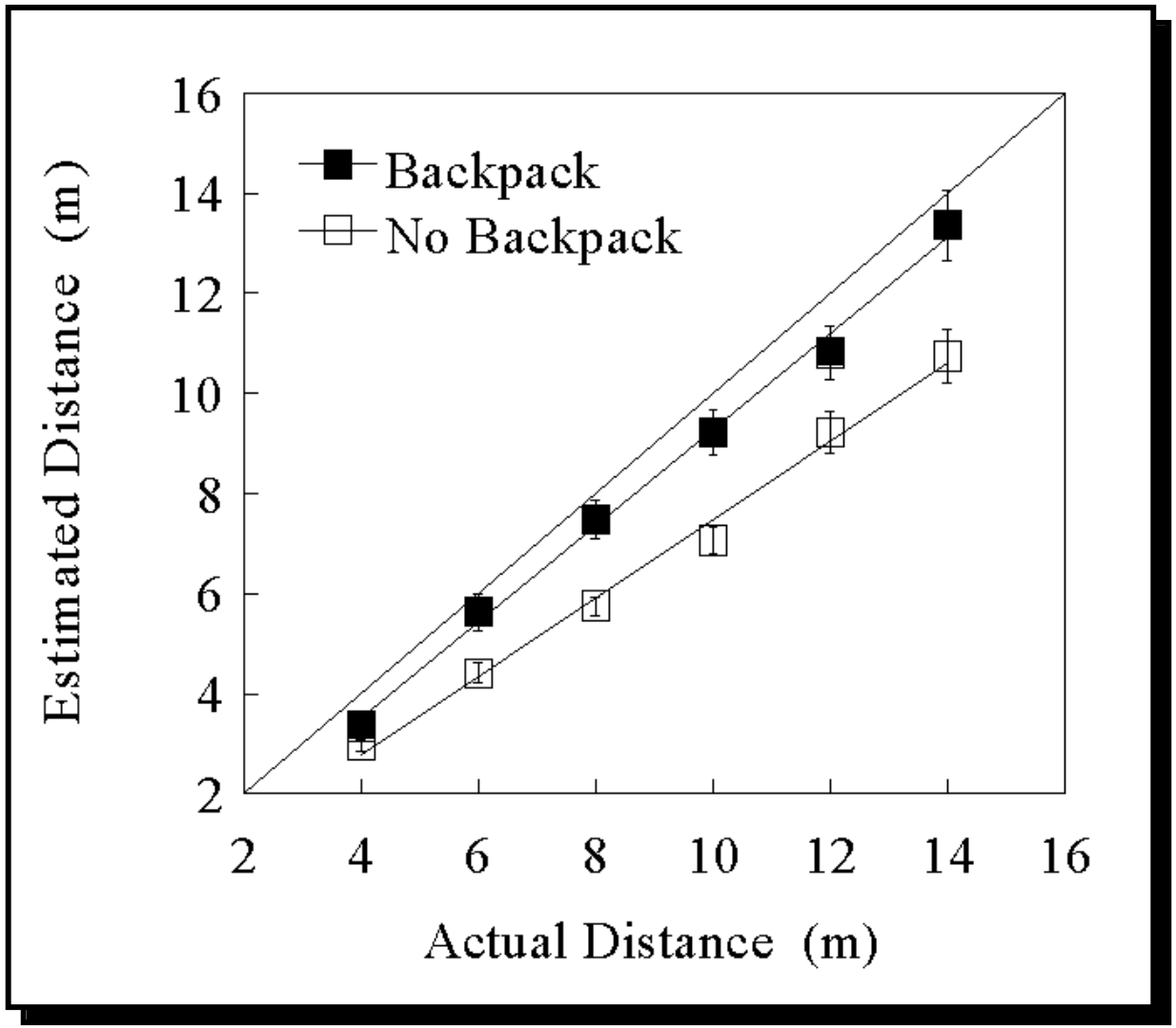
Wearing a Backpack Influences Perceived Distance

Two groups:

1. Wearing a heavy backpack
2. No backpack



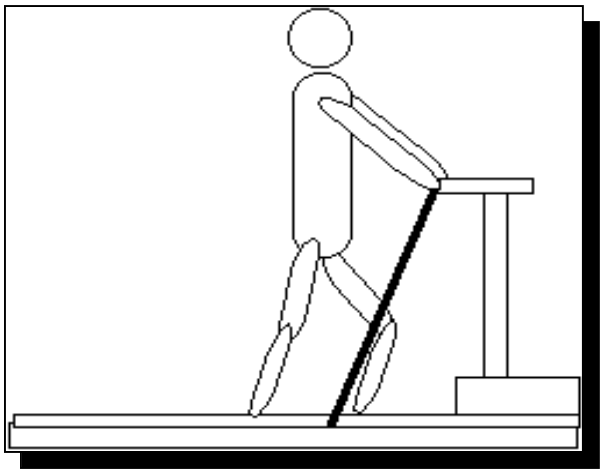
Wearing a Backpack Influences Perceived Distance



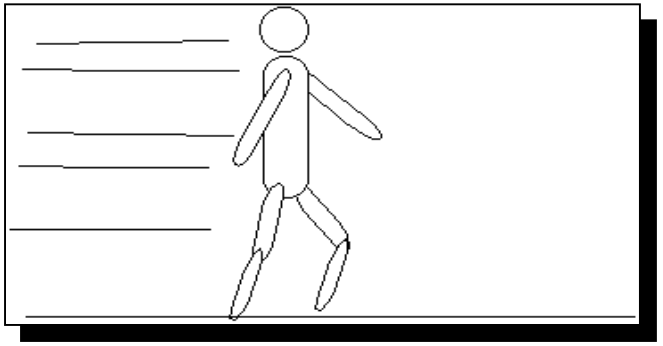
Experiment 2:
Visual / Motor Adaptation

- Recalibrate effort associated with optic flow.

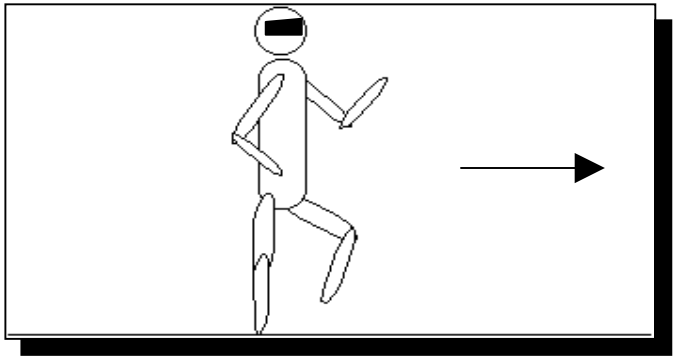
Adaptation to Treadmill Walking



After walking
on a treadmill:

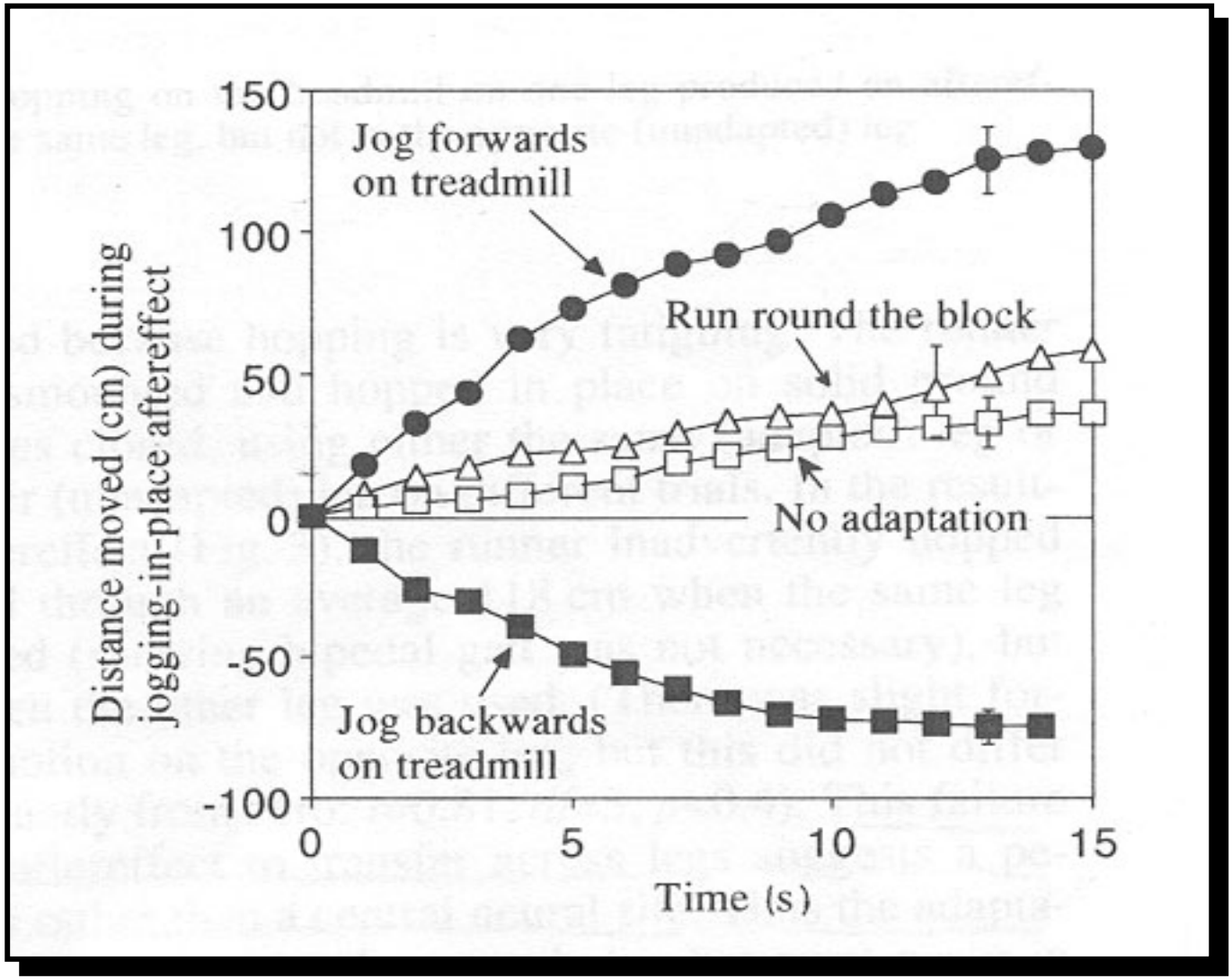


1) Normal walking feels accelerated
(closed loop after-effect)



2) Walking in place with eyes closed results
in forward movement (open loop after-effect)

Anstis (1995)


150
100
50
0
-50
-100
0
5
10
15
Time (s)
Distance moved (cm) during jogging-in-place aftereffect
Jog forwards on treadmill
Run round the block
No adaptation
Jog backwards on treadmill

Treadmill Adaptation: With and Without Optic Flow

Virtual Visual Environment

Experimental Task

Walk in place
for 20 sec.

(pre-test)

Walk on treadmill
for 2 min.

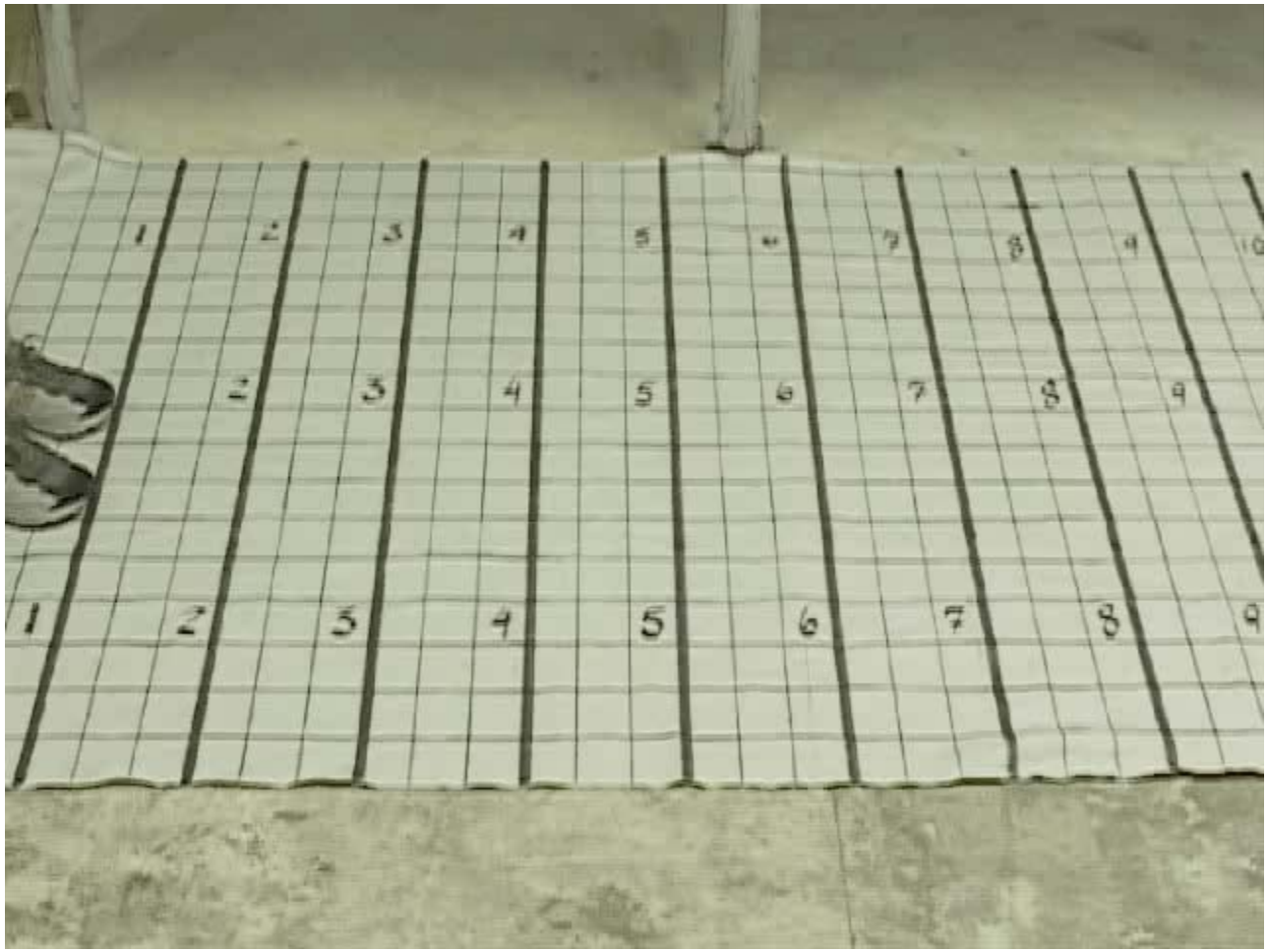
(adaptation)

Walk in place
for 20 sec.

(post-test)

“Flow” & “No Flow” Conditions

Treadmill Walking:
With & Without Optic Flow



Experiment 3:
Visual / Motor Adaptation

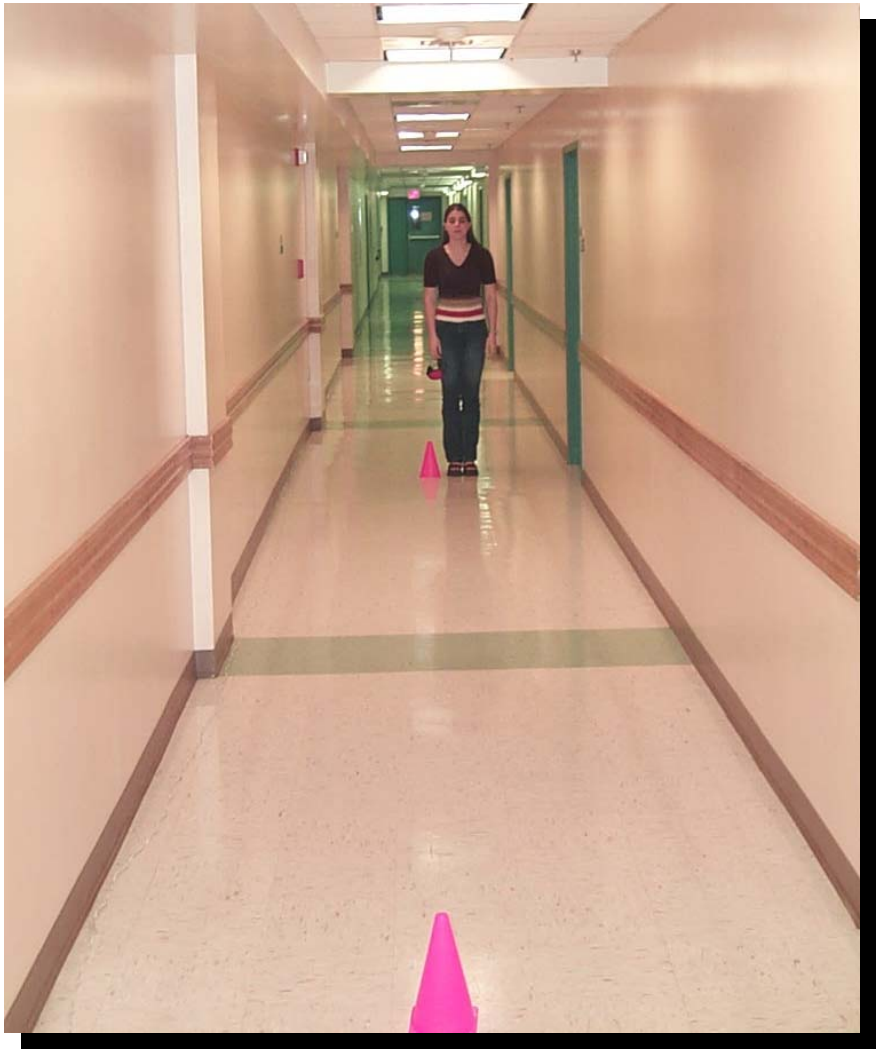
- Recalibration influences distance perception.

Treadmill: Visual / Motor Adaptation

Adaptation without optic flow:

- Effort is required to remain in place.
- **More energy is required to walk a prescribed distance.**

Pre-adaptation Verbal Estimate

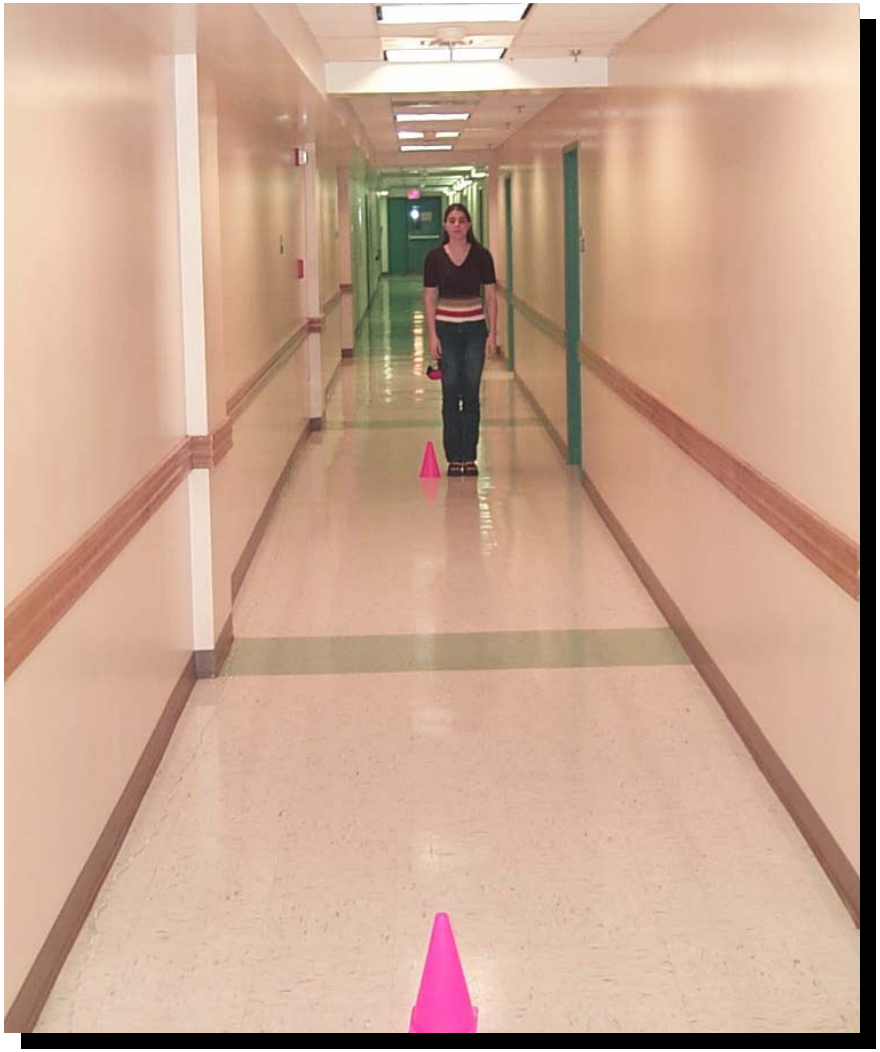


Treadmill Adaptation (3 min's)

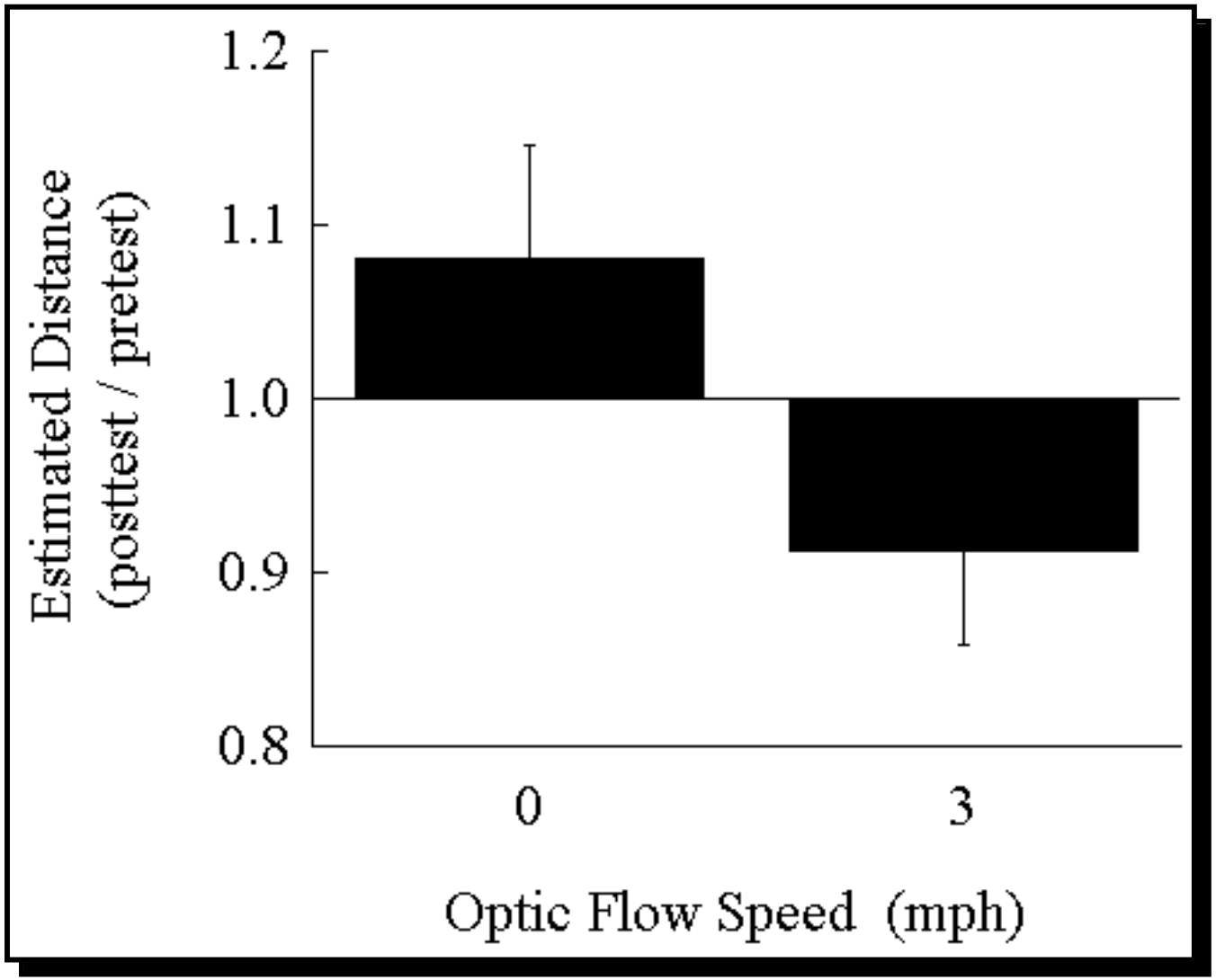
Conditions

Flow No Flow

Post-adaptation Verbal Estimate



Proportional Change in Distance Estimates

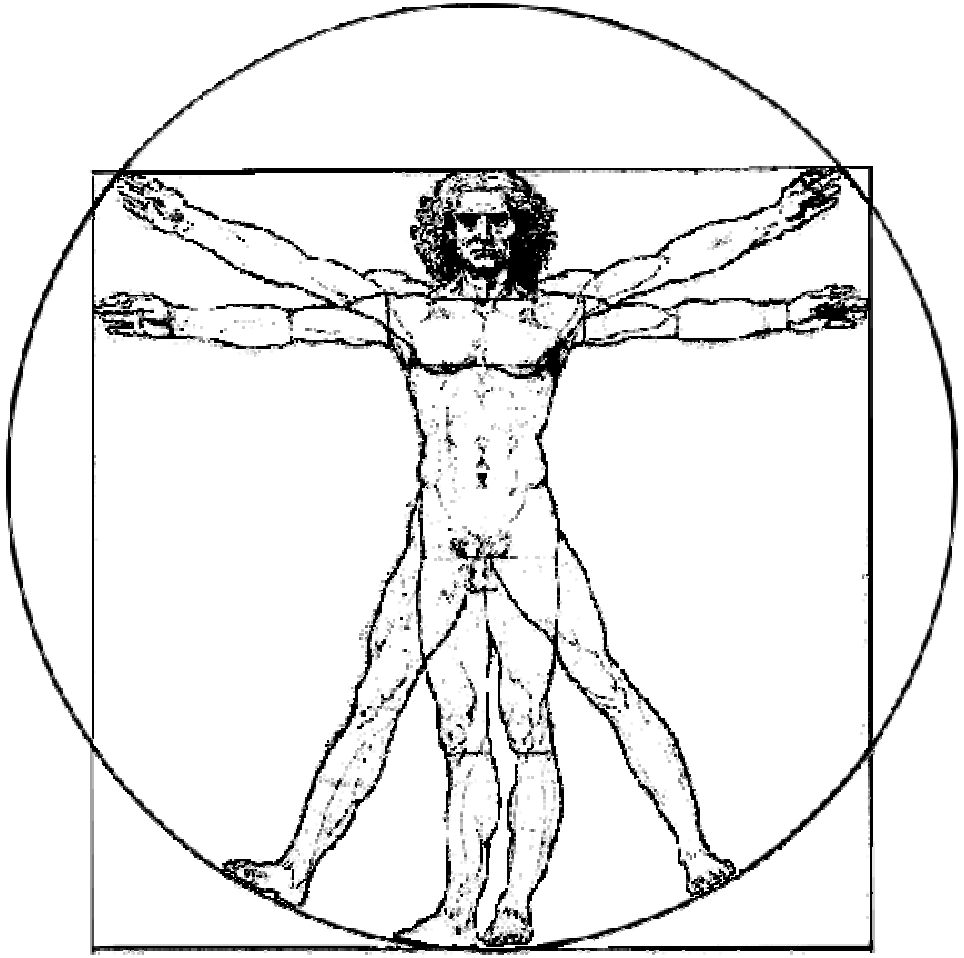


Conclusions

We measure the world with our bodies.

- **Geometry**: Eye-height scaling of size and distance.
- **Energetics**: Effort-scaling of slant and distance.

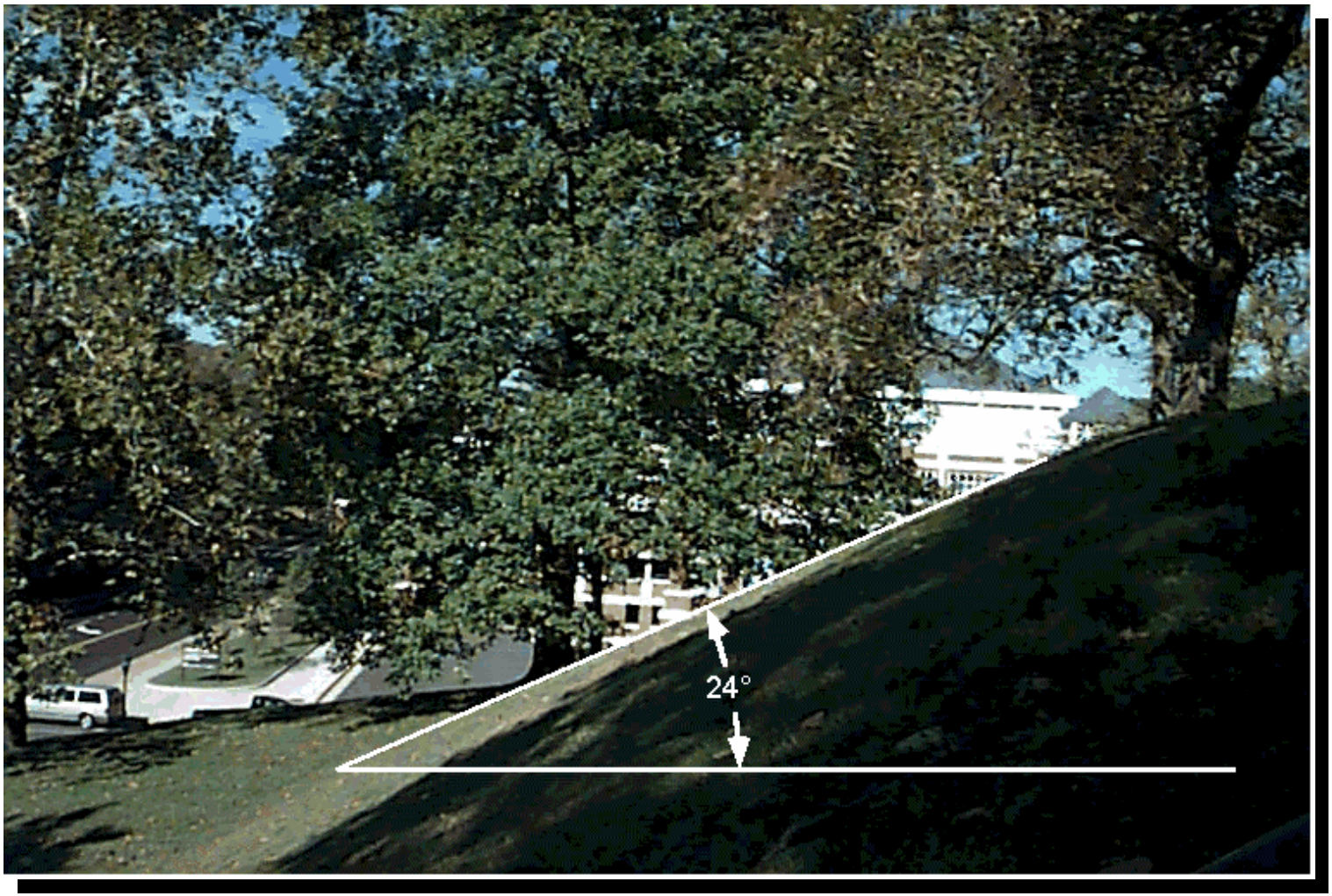
Perceiving Spatial Layout: Man is the Measure of All Things



Seeing Mountains in Mole Hills: Geographical Slant Perception

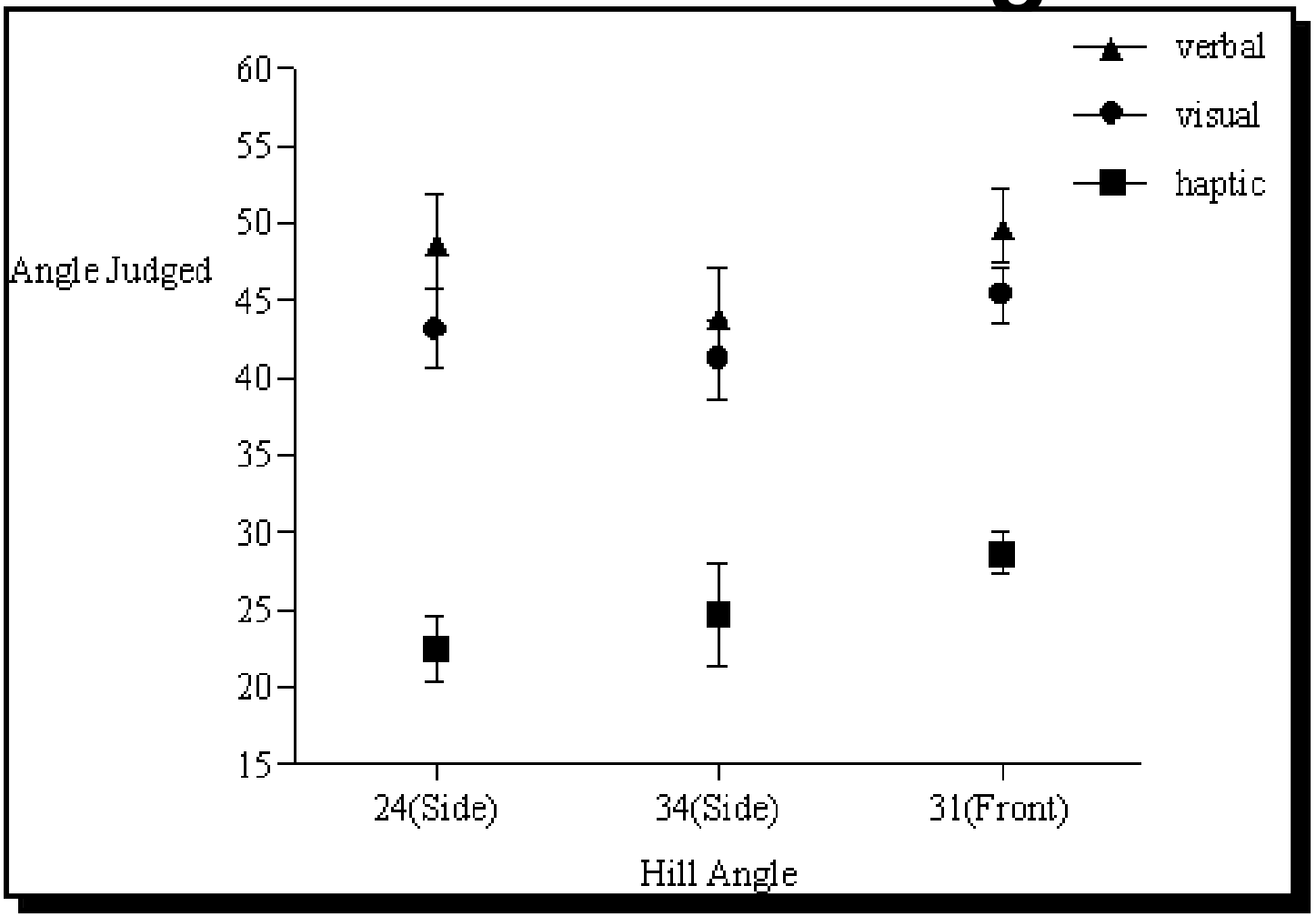
Dennis R. Proffitt, Sarah H. Creem and
Wendy D. Zosh
Psychological Science, (2001)

Hills Viewed in Cross-section



Hills Viewed in Cross-section

Overestimations in Cross-section Viewing



Cross-section Viewing in VR

Overestimations in Cross-section Viewing