The role of visual landmarks during homing

Melissa Bud Kearns & William H. Warren, Jr.
Cognitive and Linguistic Sciences, Brown University

Psychonomics Society 42nd Annual Meeting
November 15-18 2001
Path Integration Background

• When both body senses and optic flow are available, body senses dominate path integration (2000).
  – Body senses = info from proprioceptive, vestibular and efferent systems

• If optic flow is pitted against body senses, there is a small contribution of optic flow (2001)
  – ~15% optic flow + 85% body senses

• Will landmarks increase the visual contribution to homing?
  – Flow of salient features for path integration
  – Markers of orientation and position
Using landmarks for homing

• **Global** landmarks = objects far away from our path, seen from one orientation
  - Flow information for rotation
  - Azimuth information for orientation

• **Local** landmarks = objects close our path that we can see from multiple views
  - Flow information for rotation and translation
  - Angular information about orientation and distance information about position
Triangle Completion Task

Confidence Ellipse: pop. mean is in ellipse with 95% probability

Virtual environment: Example w/no landmarks
Virtual Environment Navigation Lab (VENLab)

- Intersense tracker
- sonic beacons (very accurate)
- Microphones
- Inertial system (very fast)
- Kaiser HMD
- 50 ft. Tracker, HMD cables

- SGI Onyx 2 IR
Two Frames of Reference

PHYSICAL SPACE
Movement in the physical room

VISUAL SPACE
Movement in the virtual environment

gain
Gain Manipulations

**Translation**
- 150%
- 100%

**Rotation**
- 100%
- 150%

**High gain:**
- Movement in physical space < Movement in visual space

**Normal gain:**
- Movement in physical space = Movement in visual space

**Predictions:**
- If body senses dominate, no difference between gains in physical space
- If vision dominates, no difference between gains in visual space
Method

• Two sessions: Local and Global Landmarks
  - All objects could be seen from home by turning one’s head

• Each session:
  - blocked by gain:
    • Local session: (normal, **rotation**, and translation)
    • Global session: (normal and **rotation**)
  - Within blocks, randomized presentations of 4 triangles, 4 trials each
  - Each trial: landmark locations randomly assigned within bounded regions

• For *translation* only, gain was reset to normal for return path
Environments

Global

Local

Bird's eye view

Participant's view

Arena scale: 30m radius

Bird's eye view

Participant's view
Translation Gain

Local
No Landmarks

Physical Space

Visual Space

Scale: 1m = 

Note: No Landmarks data from previous gain exp. (2001)
No Landmarks: Significant differences between gains in both visual AND physical space for distance walked (p < .01)
Local Landmarks: Significant differences between gains in both visual AND physical space for distance walked (p < .01)
Comparison: Significantly more accurate with landmarks than without (distance from home, p < .01)
**Local Rotation Gain**

**Physical Space**

**Visual Space**

*Note: No Landmarks data from previous gain exp. (2001)*

**Scale:** 1m = ——
No Landmarks: Significant differences between gains in both visual AND physical space for angle turned (p < .01)

Local Landmarks: Significant differences between gains in both visual AND physical space for angle turned (p < .01)

Comparison: Significantly more accurate with landmarks than without (normal gain - distance from home, p < .01)
Global Gain

Global
No Landmarks

Physical Space

Visual Space

Note: No Landmarks data from previous gain exp. (2001)

Scale: 1m =

150% =
100% =
No Landmarks: Significant differences between gains in both visual AND physical space for angle turned (p < .01)

Global Landmarks: Significant differences between gains in both visual AND physical space for angle turned (p < .01)

Comparison: More accurate with local landmarks than global landmarks (normal gain - distance from home, p < .01)
Relative Contributions of Vision and Body Senses

By comparing gain effects in PHYSICAL and VISUAL space, we can assess the relative contributions of visual information and body senses:

Distance = 46% vision + 54% body senses

Local Landmarks:
   Angle = 59% vision + 41% body senses

Global Landmarks:
   Angle = 60% vision + 40% body senses
Results

• Vision and body senses play roughly equal roles in homing: evidence comes from gain effects in both physical and visual space

• With normal gain, responses are more accurate with local landmarks than with global landmarks or no landmarks

• No subjects reported detecting gain changes
Conclusions

• The addition of landmarks contributed to a greater reliance on visual information

• Accuracy was greater with local than global landmarks, suggesting that they provide visual position information for navigation

• Currently examining whether landmarks that remain at constant positions throughout the experiment contribute to increased reliance on vision for navigation in a homing task

www.cog.brown.edu/Research/ven_lab