Memorizing Slope but not Elevation Facilitates Navigation in a Virtual Environment

Hiroyuki Tsuda[1, 2] and Jun Saiki[1]

[1] Kyoto University [2] Japan Society for the Promotion of Science

tsudahiroyuqi@gmail.com

Question

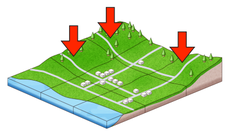
The World is Not Flat

Environments with slopes or slanted terrain have the potential to facilitate navigational performance (Restat et al., 2004).

This Study: Slope vs Elevation

Here we consider different effects of **slope** and **elevation** on learning to navigate in a virtual environment.

Slope



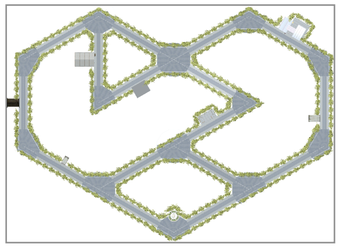
Slopes on roads can serve as local landmark

Elevation

Relative height of places in relation to each other

Which cue boosts performance in navigational task ?

Stimuli



Virtual Environment

Desktop VE implemented with Unity.

There were 8 landmarks positioned at different heights.

Of the 16 roads, 12 were sloped. (side view of the VE is shown below)

Learning Phase

Arrows were placed at the junctions in learning phase, directing participants through the environment four times with different routes. Arrows were removed in the subsequent tasks.

Misc.

Avatar position in xyz coordinates and heading orientation (yaw) were measured at 100 ms intervals.

25% faster walking speed downhill, 25% slower walking speed uphill.

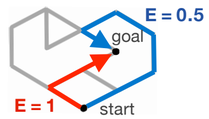
Task

Learning Phase

In an initial learning phase, participants were instructed to learn the locations and heights of 8 landmarks during they were navigating through the environment.

Navigation Task

A sequence of 8 successive navigation trials, in which a landmark name were displayed and participants were required to reach the goal as fast as possible. **Navigation efficiency (E)** was calculated for each trial.



E = Do / Da

Do = Optimal nav duration

Da = Actual nav duration

Memory Test of Elevation

Pairs of landmark names were presented and participants had to decide which location had appeared at a higher elevation in the VE.

Memory Test of Slope

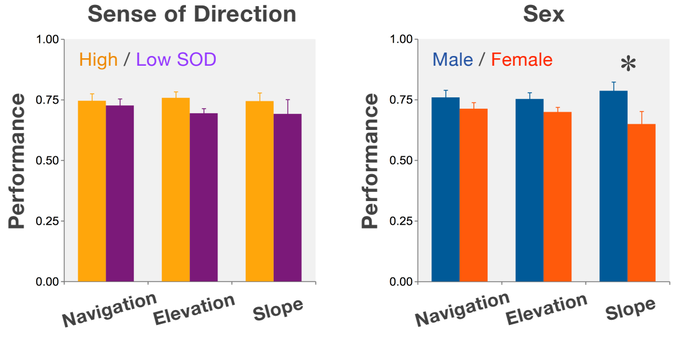
A road was shown in a snapshot (pointed by an arrow) and participants had to decide whether the road was going uphill or downhill.

SOD Questionnaire

Individual differences in navigation ability were assessed with Santa Barbara Sense of Direction Scale (Hegarty et al., 2002).

Results

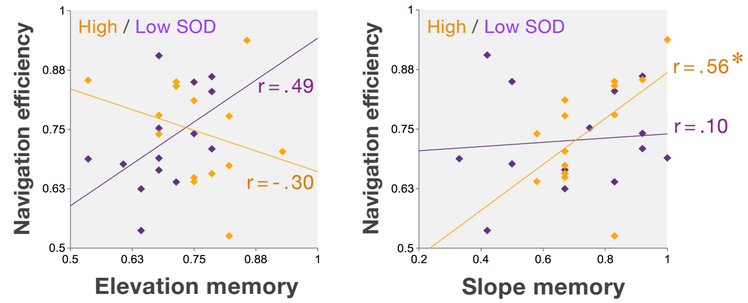
Individual Differences in Task Performance



- No significant difference between high and low SOD groups.
- Male performed better in slope memory task.

Results

Correlation between tasks



- Significant correlation between slope memory and navigation performance for high SOD group.
- No difference between sex (with no correlation betw. tasks).

Discussion

Slope knowledge facilitates navigation

Correlation between slope memory and navigation efficiency suggests that participants used slope knowledge in wayfinding, but those with high SOD could use it successfully.

Sex difference

Male had better memory of slope than female, which is in line with previous study (Chai & Jacobs, 2009). However, correlation between slope memory and navigation performance was not significant for both sex groups, suggesting that not sex but SOD predicts successful use of slope memory for navigation.

Future work

Directly test the causal relationship between slope memory and navigation is necessary.

References

Chai & Jacobs. (2009). Sex differences in directional cue use in a virtual landscape. *Behav Neurosci.* 123(2):276-83.

Hegarty, Richardson, Montello, Lovelace, & Subbiah. (2002). Development of a self-report measure of environmental spatial ability. *Intelligence*, 30(5), 425–448.

Restat, Steck, Mochnatzki, Mallot. (2004). Geographical slant facilitates navigation and orientation in virtual environments. *Perception*. 33(6):667-87.

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