The role of landmark depiction style on spatial learning & cognitive load (#80595)

Created: 11/20/2021 01:02 PM (PT)
Public: 02/23/2023 07:39 AM (PT)

Author(s)
Armand Kapaj (Department of Geography, University of Zurich) - armand.kapaj@geo.uzh.ch
Sara Lanini-Maggi (Department of Geography, University of Zurich) - sara.maggi@geo.uzh.ch
Enru Lin (Department of Geography, University of Zurich) - enru.lin@geo.uzh.ch
Ian Tanner Ruginski (Department of Geography, University of Zurich) - iantanner.ruginski@geo.uzh.ch
Sara Irina Fabrikant (Department of Geography, University of Zurich) - sara.fabrikant@geo.uzh.ch

1) Have any data been collected for this study already?
No, no data have been collected for this study yet.

2) What's the main question being asked or hypothesis being tested in this study?
How does landmark visualization style (3D abstract vs. 3D realistic) influence participants' visual attention, spatial learning, and cognitive load during a real-world navigation task?

3) Describe the key dependent variable(s) specifying how they will be measured.
1. Visual attention - normalized fixation duration to examine where and for how long participants focus their attention on the navigation system, specific landmarks on the navigation system, and in the environment. We will record participants' eye movements with a mobile eye-tracking (MET) device.
2. Spatial learning tests [Siegel & White, 1975]:
a. Landmark knowledge test to assess if participants recognize specific landmarks encountered during the navigation task.
b. Route knowledge test to assess if participants remember the sequence of seen landmarks and their associated turn decisions (i.e., left, right, straight).
c. Survey knowledge test to assess if participants learn the angular direction and distance between pairs of seen landmarks (i.e., pointing task).
3. Cognitive load:
a. NASA task load index [Hart & Staveland 1988] to assess participants' self-reported workload during the experiment.
b. Electroencephalography (EEG) to measure participants' cognitive load using alpha and theta oscillations [Klimesch, 1999].

4) How many and which conditions will participants be assigned to?
Two within-participant conditions: 3D abstract landmark symbols vs. 3D realistic landmark symbols.

5) Specify exactly which analyses you will conduct to examine the main question/hypothesis.
1. Paired t-test or a Wilcoxon signed-rank test (depending on the collected data distribution): Comparing the influence of landmark visualization style on participants' visual attention, spatial learning, and cognitive load.
2. Multilevel linear regression: assessing how visual attention (predictor variable) influences spatial learning (dependent variable), and if this effect depends on participants' perspective-taking and spatial orientation abilities (questionnaire measure [Hegarty & Waller, 2004]), and spatial strategies skills (questionnaire measure [Münzer & Hölscher, 2011]).

6) Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.
Exclusion criteria consist of:
1. Failing to comply with the experimental instructions, and/or withdrawal from the experiment.
2. Technical and data quality issues, including failure to record sensory data (MET recording ratio less than 80% [Vansteenkiste et al., 2015] of total wayfinding time).
3. Color vision impairment.

7) How many observations will be collected or what will determine sample size? No need to justify decision, but be precise about exactly how the number will be determined.
We conducted a power analysis for a single-predictor multilevel linear regression model using data simulation in R (v.4.0.2) and the lme4 (v.1.1-27) package [Debruine & Barr, 2021]. Using parameters estimated from past literature and an own pilot study ($\beta 0 = 36.9$, $\beta 1 = -12.5$, $\tau 1 = 10$, $\rho = .2$, $\sigma = 16$) we found that a minimum of 40 participants with 10 pointing task trials each would achieve a power of 83%. We, therefore, plan to collect data from 45 participants to accommodate for data loss.

8) Anything else you would like to pre-register? (e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)
1. Analyzing participants' visual attention using fixation count, dwell time, and gaze entropy [Krejtz et al., 2014].
2. Synchronizing MET and EEG data to analyze how participants' visual attention on the navigation system, landmarks, and the environment affects their cognitive load.
3. Analyzing EEG data to identify participants' differences in the visual cortex activity from processing different visual stimuli.