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Understanding the Process of Geospatial Reasoning: Evidences from an Eye-Tracking Experiment

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Abstract:

People always need the help of maps when traveling or finding a restaurant. Maps carry geospatial information of a place with roads, landmarks, coordinate systems and so on. When people are reading maps, the first thing our brains do is to fit the map to the realistic environment, trying to integrate the 2-D maps into the 3-D world. In other words, we are managing to align the two different coordinate systems which the map and external realistic environment provide. However, when the direction of the map is not perfectly aligned with the external realistic environment, a person may need more time and effort to do the alignment. And if the map is near upside down, this task could become a challenge and possibly cause a person making a wrong judgment. This situation is called the alignment effect. Alignment effect is the extra time and effort required to rotate the mental representation of physical maps. When someone is doing map aligning, the ability of rotation is needed, either rotating the actual map or rotating the space in the mind. Mental rotation is one of the fundamental factors that could determine a person's map aligning ability. Previous studies have highlighted the significance of mental rotation ability in map aligning and also confirmed the relationship between mental rotation ability and alignment effect. Measuring mental rotation ability could understand how and where people see on a map. Its significance is not just about designing a map, but also how people process geospatial information on a map. Therefore, the research question of the study is how we quantify people's ability of mental rotation.

Eye tracking approach helps understand how people see or read things, and provide insights into people's ways of reasoning and problem solving. We randomly choose the 12 college students (undergraduate and graduate) as participants in this study, all in the age of 18 – 30, and studied in the same university. The sex ratio is balanced; among the 12 participants, there were 6 males and 6 females. All the participants were required to fill the questionnaires and experiment consents before the eye tracking experiment. Then, we are attempted to profile the geospatial reasoning process by measuring and recording participants' gaze positions and eye movements. The eye-tracking experiment for each participant includes 6 tasks, including different degrees of rotation and quantities of key map elements with high degree of rotation. Each of the tasks contains two stimuli, the first stimuli would instruct the participants to find their own location and the destination, and the second stimuli would examine their abilities of map aligning. When doing map aligning, they would see a map and a street view from their location. The participants are required to decide which direction is the destination from his/her position. This stimulus remains 15 seconds. Then, a participant is requested to give his/her answer in 8 directions and cannot be able to look at the map and the street view. The participant will score one point if his/her answer is correct. Finally, we summarize the scores of these tasks for representing the his/her performance of mental rotation ability.

Our preliminary results showed participants with good mental rotation ability share similar patterns, implying that common rules of geospatial reasoning can be identified. Meanwhile, participants with poor mental rotation ability spent more time to search map information in difficult tasks. Therefore, we conclude that landmarks could be better clues than street names for map alignment and building a sense of direction, which implies that better map design (e.g. more landmarks) may be the key for improving map reading. In sum, we measured people's map aligning performances and identify common rules of geospatial reasoning. This study lightens up the importance and value of eye-tracking approach in cartographic studies, and also brings a new perspective to understand the process of geospatial reasoning.

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