

The sense of North

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Abstract:

In recent decades, cartographic, and more broadly geovisualisation and geoinformatics research has increasingly focused on multidisciplinary approaches to the user as part of the system, investigating cognitive abilities and processes (Fabrikant - Lobben 2009). The first Hungarian studies based on tracking the gaze of the map reader were carried out in 2012 at the Department of Cartography and Geoinformatics of ELTE (Török - Bérces 2013), and in the following years further cognitive experiments were developed (Török et al. 2018) to study the interaction between graphical interfaces and spatial cognition.

Every person in our world uses spatial orientation skills in daily life, be it for learning, working or even during outdoor sport like orienteering. This general ability is present in all of us, but how we solve spatial tasks varies from person to person. The place where we use our spatial knowledge also changes, but it is still contained in some spatial frame. The spatial reference frame is a key issue in cartography and geovisualization. Egocentric and allocentric spatial representations are both activated during spatial navigation. The transformation of the human subjects' body-centred, egocentric reference system into an object-centred, allocentric reference system is a complex task.

Maps and map-like representations play an important role in navigation. Maps are cognitive tools, traditionally representing large environmental spaces in visual, graphic form (Török 2019). In 1948 Tolman proposed that the mammalian brain could represent spatial relationships among the elements of the environment in a mental representation. He called this representation a 'cognitive map' and speculated that this structure could support higher human cognitive functions such as navigation, decision making, and imagination.

Apart from personal experience, learning larger environments from maps is a common practice (Meilinger et al. 2015). Learning from maps influence the structure of the cognitive map. Generations learn and experience geography from North oriented maps and school atlases. However, having a map or learning with/about it does not mean that we are good at navigating ourselves. Finding directions in unknown areas can be difficult since we should use different reference frames during these tasks. Although the North-is-up reference frame is a rather modern cultural convention modern-day maps and navigation devices may show an orientation where the north is at the top - but frequently the representation is forward-up oriented.



Figure 1. The actual location of the experiment (A) in ELTE Lágymányos Campus, Budapest. True North (N), the approximate viewing direction of test group 1 (V1) and group 2 (V2) are marked.

This paper presents a navigation experiment that studied the interaction of local and global reference frames and more specifically tested the sense of geographical North among students. We created an ecologically valid experimental setting by selecting a special location at ELTE Eötvös University campus in Budapest. In an enclosed vista space, positioned near the river Danube and heading in an easterly direction, our participants were asked first to point to the north (see Figure 1). With good visibility of the river, a major structural landmark in the configuration of the city test subjects pointed towards the north. We were interested in how the misleading direction of the Danube influenced their sense of direction. While the general course of the river is north-south, at the site of the experiment the river course changes to northwest-southeast, with a deviation of 30-40° from true north. We expected that the direction of the only visible global landmark, with all the local landmarks, would result in a similar, regular pointing error. In the first test series they were asked to point/draw toward salient urban landmarks in the city, that is in environmental space. In the second test series they pointed towards important cities in a large, geographical space. Finally, they once again indicated the direction of true North in the same geographic space.

The accuracy of the two guidelines was analysed in R software (Török – Török 2019). First of all, we investigated whether the Danube and the geometry of the Danube and the environment influenced the guidance. As a result of the analysis we found that the accuracy of the geographic north direction was significantly lower to true north than to the occulted axis. In most cases the difference was $\pm 5^\circ$ - which is a surprisingly good result. However, in some cases outliers were found, with some participant having a second with a deviation of more than 100° in the second series.

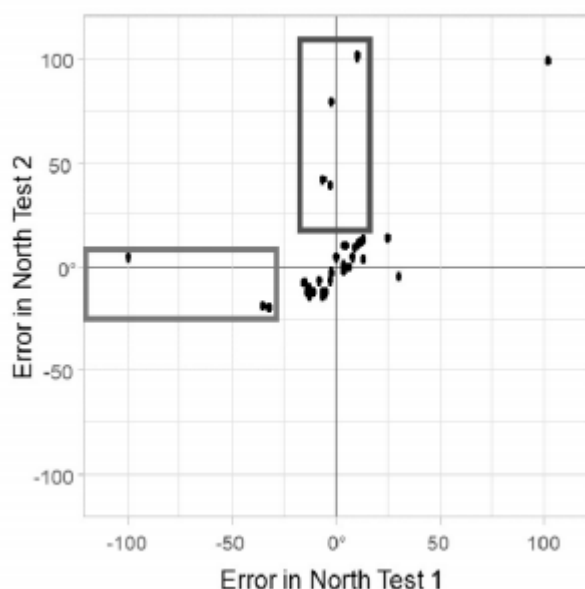


Figure 2. The high accuracy of the north pointing shows significant individual differences

Our results demonstrated generally excellent performance with some marked individual differences, which correlated but the habitation of the subjects. The participants had a clear sense of geographical North learned from maps, moreover, contradicting our expectations, the misleading course of the Danube and local geometry had little effect on the overall high accuracy of pointing to North. However, a few results deviated from the average and suggested high individual differences, presumably due to different spatial thinking strategies of participants. Test subjects living longer in Budapest had a much better sense of North, supporting the importance of learned components in this directional knowledge. Our experiment in the physical world resulted in supporting evidence that North is present in human cognitive map as the cardinal direction for orientation. The implications of the results of our experiment should be considered relevant when designing new maps and user interfaces. Another important result, our experiment suggest that local and global reference frames are not separate systems but structured hierarchically and integrated in spatial orientation tasks.

This experiment was the first step of our planned, longitudinal research of spatial frames of reference. In the future, we plan to continue our pointing experiments to explore the connection of reference frames and learning from maps, a subject where cartography matters. Similar experiments will follow, including preschool children, since this age group is presumably less influenced by the former use of conventional maps than young adults.

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