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Perceptual Distortions in Cartography: Maps for Trickery

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Abstract:

Professionals in cartography know that maps are not perfect representations of reality (Monmonier, 2018, Weissenrieder, 2023). In recent decades, cartographers have highlighted how methods for elaborating maps contain omissions, generalizations, and distortions present when making design choices. The discipline of cognitive science emerged parallel to this trend of analyzing and describing maps' inherent inaccuracies. They have studied the abilities of the human mind to extract and analyze information from our senses, such as sight, hearing, and orientation (Miller, 2003). Because of the advancements in this discipline, we know that humans do not interpret information displayed to them wholly, rationally, and directly. In other words, we have omissions, generalizations, and skewed perceptions. A question arises: how do our limitations interact with the already imperfect and heavily edited information visualized in the maps we read?

Some advancements try to answer this question from information visualization and cognitive science research communities. Researchers have discovered that visual perception challenges, such as contrast, size comparison, shading, and depth comprehension, cause optical illusions and lead to misconceptions(Alexander et al., 2018, Xiong et al., 2022, Gillan et al., 1999). These features are connected to map design in elements such as elevation tints and labels. However, there are crucial gaps in our understanding. First, different terms are associated with misapprehending the content of information visualizations. There can be illusions and deceptions (when information is misunderstood) and cognitive biases (which can cause many different effects related to remembering, associating, and estimating probabilities, among others). Second, in the case of cartography, research has been conducted to prove the effects of singular cognitive functions. For this reason, we are missing the big picture: compiling available evidence about the known perceptual shortcomings and testing other major illusions and biases that could be highly related to cartography.

The ongoing research answers these two challenges. First, it aims to create a new theoretical framework that will encompass the different cognitive effects, whether biases or optical illusions, into one group of phenomena that can be applied to cartography. By elaborating on this theory, it will be possible to understand the potential of map design to trigger different unintended cognitive effects on map readers. Second, the research will use an empirical user studies method to evaluate the impact of biases on map readers but not on the scale of singular effects. On the contrary, it will attempt to prove the effects of multiple biases and illusions to obtain the first big picture of the relationship between cognitive alterations and cartography.

The newly proposed theory considers cognitive distortions as the umbrella term containing all cognitive effects. This term initially emerged from the context of computer science, suggesting that all human perception occurs as a two-way process between what we expect to see and what we end up seeing (Nour and Nour, 2017). Because of this tension, our minds are prone to perceive nonexistent patterns or relationships. This concept is broad enough to accommodate the current biases and illusions identified in information visualization and new phenomena that will be determined in this research project and future ones. With this term in mind, I will compile a series of cognitive biases and other effects from the literature that could be related to cartographic design.

The second part of this research is designing and applying a user studies methodology to find empirical evidence of cognitive distortions in the context of cartography. Tentatively, the research will be conducted by using a survey that will compare users' performance on two series of maps. One will be elaborated with standard authoritative cartographic design guidelines. The second one will contain maps designed to trigger the cognitive distortions explicitly. Then, the results of the user studies will be analyzed to determine the significance of the effects and the relationships between the different types of distortions. The survey results will be used to judge the aforementioned theoretical framework and its capacity to approach the different cognitive effects that affect map reading. Finally, the research results will be used to create an atlas designed for a broader audience; it will show how our visual perception might not give us a clear picture of data during map reading.

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As cartography tools become more accessible, the widespread creation of maps has the potential to spread biases and create an amalgam of unintended effects on readers. Worryingly, the surge of AI technologies will probably accelerate this trajectory even more. This research aims to raise awareness among cartographers and cognitive scientists, paving the way for developing map guidelines about design choices. This research will help experts and non-experts approach any map more cautiously and better prepared.

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