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Influence of cartographic training on color scale usability

Stanislav Popelka [a,*], Tereza Vítková [a], Kamila Fačevicová [b]

[a] *Department of Geoinformatics, Palacký University Olomouc, Czech Republic, stanislav.popelka@upol.cz, tereza.vitkova01@upol.cz*

[b] *Department of mathematical analysis and applications of mathematics, Palacký University Olomouc, Czech Republic, kamila.facevivova@upol.cz*

* Corresponding author

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Abstract:

The goal of this research is to conduct a usability study examining how users interact with color scales with different number of classes. As Harrower and Brewer (2003) stated, "isoline maps…can safely use more than seven data classes because similar colors are seen next to each other, making them easier to distinguish". The aim of this study is to empirically verify this assumption. Moreover, this study was inspired by findings from (Popelka, Vávra, & Brychtová, 2014), which examined the maps from the Atlas of Phenological Conditions. In that study, participants were tasked with matching specific colors to the corresponding intervals on phenological map color scales. We found that color scales with more segments posed greater challenges. Interestingly, there were observable differences between participants with and without cartographic backgrounds. Some cartographically trained participants, unable to distinguish between colors, resorted to counting color changes starting from the brightest part of the map. Our current study aims to see if this approach holds true for a larger group of participants.

For this research, we used maps that display continuous geographical phenomena, such as altitude, segmented into five to nine intervals using color scales from ColorBrewer 2.0 (Harrower & Brewer, 2003). Participants were required to match a marked location on the map to the correct interval on the color scale (Figure 1).

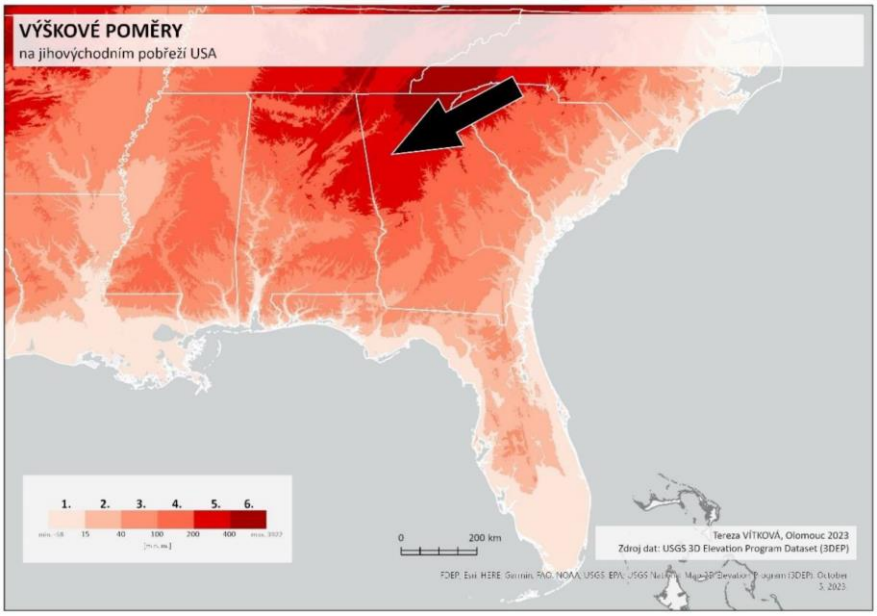

Figure 1. One stimulus from the study.

The study was divided into two parts: a questionnaire survey and an eye-tracking analysis. The questionnaire was conducted using maps with red and green color scales, gathering data from over 100 participants. For the eye-tracking segment, we focused on red color scales, collecting data from 50 participants: 25 students of cartography and 25 without any cartographic training.

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We have verified from both studies that the correctness of answers was lower for tasks performed with color scales with a higher number of intervals. The most problematic were tasks where the correct answer was one of the intervals in the middle of the color scale. The correctness of these tasks was the lowest, and the time needed to solve a task was the highest.

Results from both parts of the study indicated that tasks involving color scales with more intervals had lower accuracy rates, especially for intervals in the middle of the scale, which also took the longest to identify. The eye-tracking data revealed that participants with cartographic training focused more on the map's darkest or brightest areas compared to those without such training. We further analyzed the eye-tracking data using our custom online tool, EyetRack (Kalabusova, Popelka, & Fačevicová, 2022), which facilitates recurrence plot (Figure 2) and recurrence quantification analysis.

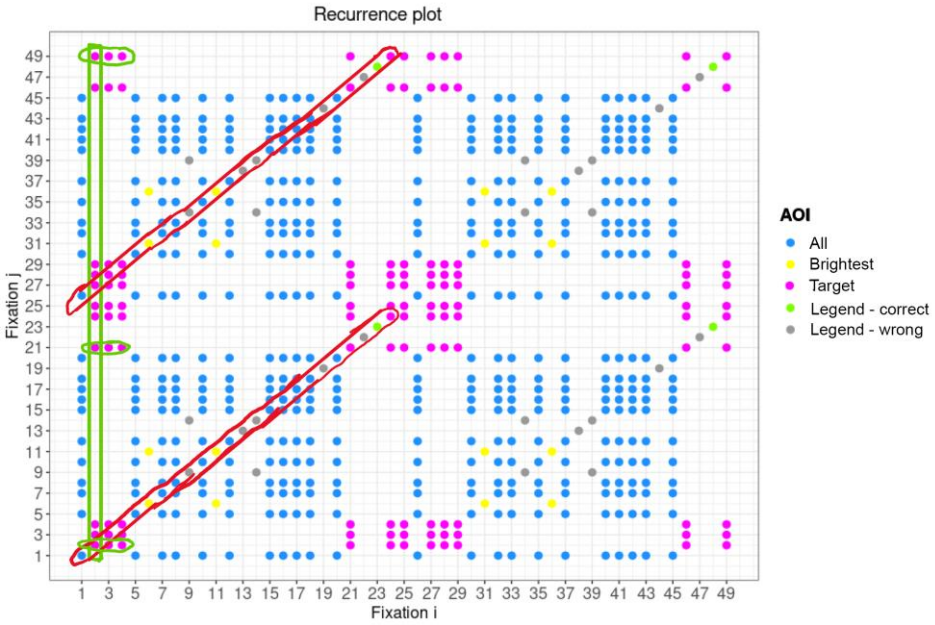

Figure 2. Recurrence plot for one participant and one task (R9dSV). Laminarity is highlighted using green colour; determinism is highlighted by red.

This analysis helped quantify how often participants focused on the same areas of the map. The tool also assessed ambient and focal attention (Krejtz, Coltekin, Duchowski, & Niedzielska, 2017), enabling us to compare eye movement patterns among different groups of participants and to highlight differences in how they used color scales.

Acknowledgements

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