International Cartographic Association
Association Cartographique Internationale

Examining the preattentive effect on cartographic backgrounds utilizing remote mouse tracking

Athina Pappa [a], Vassilios Krassanakis [a,*]

[a] *Department of Surveying and Geoinformatics Engineering, University of West Attica, Egaleo (Athens), Greece, Athina Pappa – tg13052@uniwa.gr, Vassilios Krassanakis – krasvas@uniwa.gr*

* Corresponding author

Keywords: preattentive effect, cartographic backgrounds, remote mouse tracking

Abstract:

The human visual system has the ability to recognize quickly selected features of the visual field. This mechanism is connected to the preattentive stage of vision (Nessier, 1967). The visual properties (so called "preattentive" or "basic" features) which are available during this stage can guide the process of visual attention. From a cartographic perspective, an interesting point is that the list of identified preattentive features shares several similarities with the basic design variables (i.e. visual and dynamic), implemented in cartographic symbolization. Specifically, color, motion, orientation, and size are undoubted guiding attributes, while closure and line terminations constitute probable features (Wolfe and Horowitz, 2017). Hence, exploring the influence of the preattentive effect in cartographic context could produce critical results regarding the map reading process. This examination could be based on experimental procedures which are able to measure the reaction of map users during the execution of typical visual target search tasks. In this case, an experimental participant is searching for a target-symbol among several distractor-symbols on different types of cartographic backgrounds.

The present study aims to explore the preattentive effect on cartographic backgrounds. The main objective is connected to the examination of the selectivity of a specific shape attribute on different map backgrounds. This attribute is referred to the probable preattentive topological feature (Wolfe and Horowitz, 2017) of having a hole ("closure"). Similar studies have been also performed in cartographic research, based on reaction time and accuracy measurements (Michaelidou et al., 2005), as well as on eye tracking techniques (Krassanakis, 2013). The current study is based on the utilization of the simple method of capturing and analyzing computer mouse trajectories (mouse tracking) performed during searching a specific point on a computer screen (Kieslich et al., 2020). A cartographic experiment was designed and executed remotely (online) according to the framework recently presented by Krassanakis et al. (2021).

The experimental design included the generation of specific cartographic visual stimuli. Initially, four unique target and four unique distractor geometric symbols were designed. Targets' topological feature corresponded to the property of hole, while distractor symbols were compact (with black color). Based on the utilization of four different backgrounds with different levels of cartographic details adapted by OpenStreeMap (https://www.openstreetmap.org), 48 visual scenes were designed having sixteen symbols each. Both the cases of target location in the center and the periphery of the map were examined, while the case of target absent was also investigated. More specifically, each visual scene involves either fifteen distractors and one target or sixteen distractors for the cases of target absence. The experimental procedure was programmed using the MatMouse toolbox (Krassanakis and Kesidis, 2020) in MATLAB. Additionally, based on the used framework, during the experimental procedure the experimental monitor was shared to the participants using the AnyDesk software (https://anydesk.com). In total, 30 subjects (20 males and 10 females, aged between 18 and 52 years) participated in the cartographic experiment.

For each participant, the reaction times, referred to the time needed to locate the target symbol or to identify if the target is located on the examined background, as well as the corresponding mouse coordinates were recorded. Moreover, for each visual scene, a (statistical) grayscale heatmap (48 heatmaps in total), representing the overall mouse behavior produced by all participants (see the study presented by Krassanakis and Kesidis (2020) for more details), were generated. The analysis was based on the definition of specific statistical indices (average, median, standard deviation, minimum, maximum, & range) of the captured reaction times values. Additionally, the performance of each participant was also described using the index of success rate. This index indicates if the map task is performed properly (i.e. if the correct target is located on the cartographic background).

The reaction times produced for all combinations (all targets, targets' locations or absence, all backgrounds). Furthermore, the success rates of the performance of all participants per target and targets' location, as well as per different map

https://doi.org/10.5194/ica-abs-5-111-2022

background, corresponded to percentages higher than 94%. Moreover, the exported grayscale heatmaps indicate the allocation of the overall searching behavior on a specific visual scene since their production was based on the use of the recorded data of all participants. The (preliminary) results of the present study show that the preattentive feature produces the same effect (in terms of reaction times) for all targets used in the experimental study. However, the level of detail (buildings, mixed green and house regions etc.) of cartographic background seems to have an important role in reaction times during the execution of the specific map task.

References

Kieslich, P. J., Schoemann, M., Grage, T., Hepp, J., & Scherbaum, S. (2020). Design factors in mouse-tracking: What makes a difference? Behavior Research Methods, 52(1), 317–341. https://doi.org/10.3758/s13428-019-01228-y

Krassanakis, V. (2013). Exploring the map reading process with eye movement analysis. Proceedings of the International Workshop on Eye Tracking for Spatial Research, Scarborough, UK, 2–5.

Krassanakis, V., & Kesidis, A. L. (2020). MatMouse: A Mouse Movements Tracking and Analysis Toolbox for Visual Search Experiments. Multimodal Technologies and Interaction, 4(4). https://doi.org/10.3390/mti4040083

Krassanakis, V., Kesidis L. A., Pappa A., & Misthos L.-M. (2021). Performing cartographic visual search experiments online: opportunities and challenges. Workshop on Adaptable Research Methods For Empirical Research with Map Users, ICA Commission on Cognitive Visualization, Virtual Workshop.

Michaelidou, E., Filippakopoulou, V., Nakos, B., & Petropoulou, A. (2005). Designing point map symbols: The effect of preattentive attributes of shape. Proceedings of the 22th International Cartographic Association Conference, A Coruña, Spain.

Neisser, U. (1967). Cognitive psychology. New York: Appleton-Century-Crofts.

Wolfe, J. M., & Horowitz, T. S. (2017). Five factors that guide attention in visual search. Nature Human Behaviour, 1(3), 0058. https://doi.org/10.1038/s41562-017-0058

https://doi.org/10.5194/ica-abs-5-111-2022