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THE INFLUENCE OF ATTRIBUTES OF SHAPE IN MAP READING PROCESS

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Cartographic research based on experiments analyzing eye movement appears since 1970s. Initially these studies were purely experimental, but later on, in the 90's, cartographic studies on visual search were also based on theories of perception and cognition. The present study is based on Marr's theory of vision, according to which edges and blobs are elements of visual scenes that are preattentively processed. However, psychological studies suggest that "preattentive" or "basic features" are not clear issues and underline the need for further experimentation. The models that psychologists have developed to explain visual search process offer to cartographers a basis for studying how map users search for specific information on maps.

The purpose of the present experimental study is to examine the influence of attributes of shape, like terminations (edges according to Marr) and the topological property of having a hole (blob according Marr), for which there are remarkable indications that are preattentively processed, and the structure of the way point-symbols of different levels of abstraction are perceived. Four experiments (experiments A, B, C and D) performed in the Cartography Laboratory of NTUA are presented. In the experiments, subjects were asked to search on computer monitor for a designated target symbol with a unique feature among geometric and pictorial distractor symbols on maps of different quantity of data. Two methods of analysis were used:

-The first method (used in Experiments A, B and C) was based both on time recording and the accuracy of the answers given by the subjects.

-The second method (used in experiment D) was based on eye movement analysis using ViewPoint Eye Tracker ® by Arrington Research.

Subjects had to detect targets on different cartographic backgrounds: simple (experiment A), smooth (experiment B) and real cartographic (experiment C) background. At the cases that were examined, targets were located in the center, the middle and the periphery of the base map. The number of subjects was 63, 31 and 60 for experiments A, B and C correspondingly. Subjects were tested individually. In order to familiarize each subject with the procedure, a practice session was executed. Application of t-test of dependent samples was used in order to examine the signification of time differences in experiments A, B and C. In experiment D, subjects had to detect both a geometric and a pictorial symbol, with the unique feature of having a hole, on the same simple cartographic background as in experiment A. Eight subjects participated in experiment D. It should be mentioned that in all experiments the case where the targets were absent was also studied.

The results reveal the followings:

-Geometric symbols were detected faster than pictorial ones in experiments A, B and C.

-In case of target-absent trial, search time was longer than for target-present one and the duration of search task is shorter for geometric symbols.

-In case of pictorial symbols, unique feature (termination line or topological property of having a hole) contributes to the faster detection of the target.

-In case of geometric symbols, the topological property of hole is the attribute that contributes to the faster detection of the target.

-The topological property of having hole seems to be more robust for the target detection than the property of line terminations.

-Search time of a target-symbol was shorter when the target was located near the center and longer when near the periphery of map.

The experimentation with the methodology of recording eye movements seems to be very robust for the examination of the map reading tasks. Experiment D indicated that in most of the scenes visual search started from the place where the target was located in the previous scene. In all other cases, the place where the target was located in the previous scene was included in the scan path. When target was located in the periphery of the map, scan path was complicated and it covered a large area on the map. When target was located in the middle or in the center on the map, the scan path was simpler. Furthermore,

fixations corresponded to places of the background where point symbols were present. The process of searching through target and other symbols were depicted as saccadic movements of the scan path. Analysis of the subject's eye movements did not reveal a special pattern of searching task when target was absent. In this case, the scan path was more complex than when target was located on the scene. Another remarkable indication of eye movement analysis also is that the verification of target's detection was independent of the location that it was depicted.

In our days, the accuracy of eye tracking devices has highly increased and the appliance of them in experimentation is much simpler. Eye Tracking is providing an alternative way to examine the map reading process, which enriches the traditional method of measuring the visual search through the accuracy and the speed of target's identification. The methodology of measuring the eye movements provides the opportunity to capture the scan path, during a realistic procedure of map searching that represents the results of subject's cognitive process.