# COLOR DISTANCE ON CHOROPLETH MAPS
## AN EYE-TRACKING STUDY ON LEGIBILITY OF SPATIAL INFORMATION

## COLOR DISTANCE

In cartography color is used as a way of cartographic visualization. During map creation it is important to use colors which can be easily distinguished, and thus map users are able to interpret the visualized information not being confused with other information.

Color distance allows to quantify the ability to recognize difference between two colors.

In order to ensure conformity between the calculated color distances and real perception of colors it is necessary to work with perceptually uniform color spaces. Perceptually uniform color space is the one, where equal distances are intended to represent perceived color differences of equal size. The change of the same amount in a color value should produce a change of about the same visual importance.

In this study the perceptually uniform CIE 1976 L*a*b* color space is applied. The distance between two colors (E00) is computed by method $CIEDE_{2000}$. L*a*b* values are related to CIE standard illuminant D65.

## DESIGN OF THE EXPERIMENT

Total amount of 40 stimuli was prepared in order to see the influence of color distance and legend localization on map readers perception. Participants were asked to mark the category in the map legend, that corresponds to the area depicted in the map.

There are 5 groups of stimuli distinguished by applied color ramp with color distance between categories E00= 2, 4, 6, 8 and 10 (see Fig. 1).

There are 6 groups of stimuli distinguished by changing position of the legend within the map sheet (see Fig. 2).
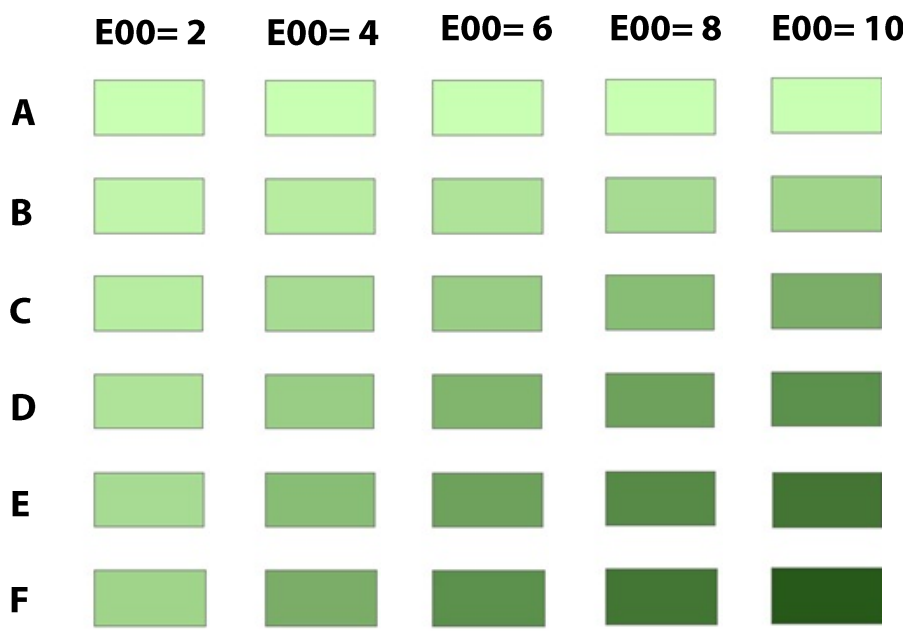


Fig. 1: Visualization of 5 color ramps of choropleth maps with different color distance (2-10) between 6 categories of choropleth maps (A-F).

## RESEARCH TASK

The aim of the experimental study is particularly focused on the color distance influence on the legibility of choropleth maps. This study is part of wide dissertation project. Results of the experiment should provide answers on two research questions:
- Which level of color distance is optimal for correct and effective reading of choropleth maps?
- How is the influence of changing position of the map legend within the map sheet?
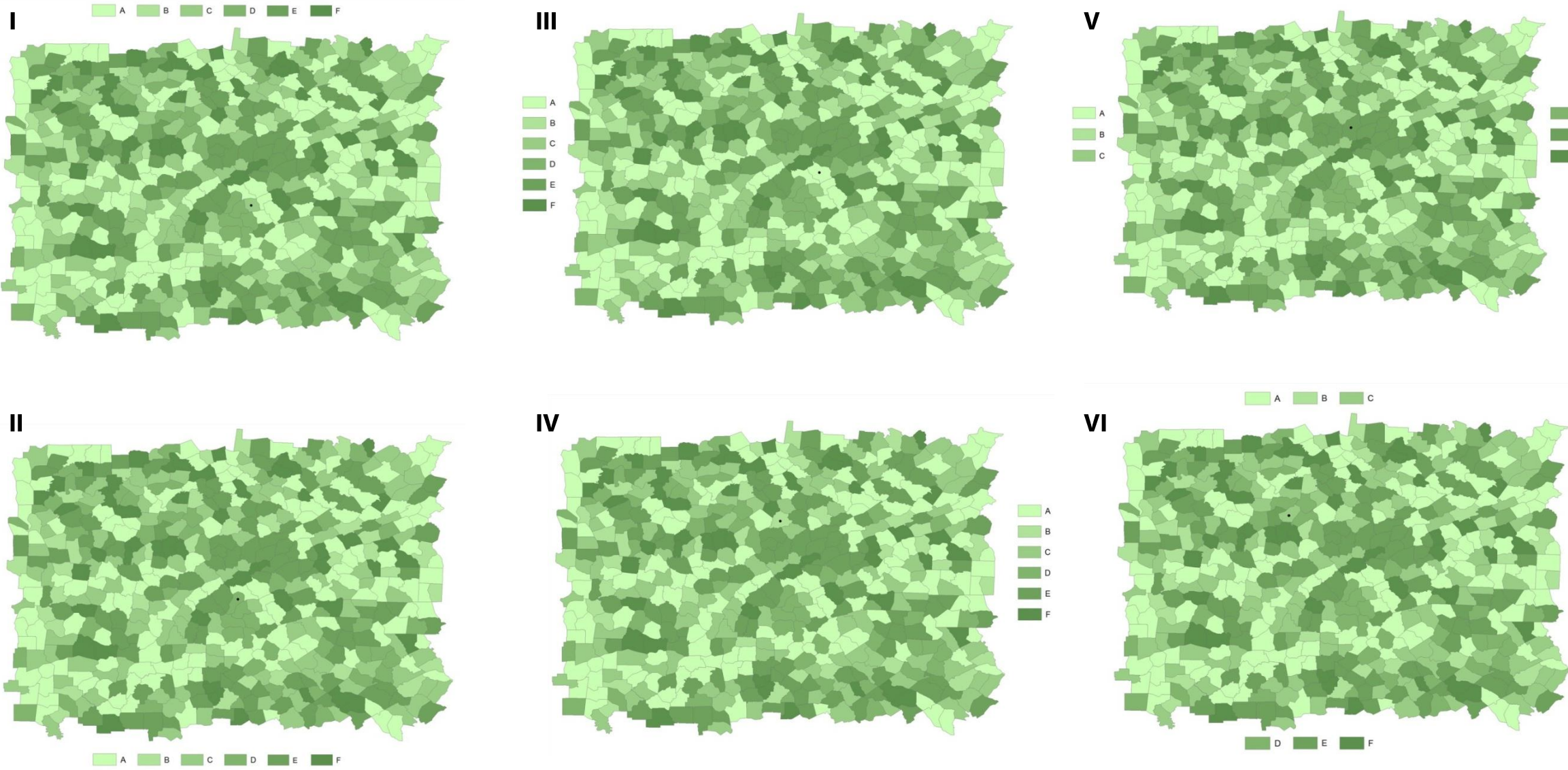- Are all categories within the color scale the same legible?



Fig. 2: Six groups of stimuli with varying position of the map legend: I up; II down; III left; IV right; V vertically split; VI horizontally split.

## RESULTS

The experiment was attended by 12 volunteers (19-30 years, 5 males and 7 females, 6 advanced cartographers and 6 cartography novices). Experimental data were aggregated and averaged within groups of stimuli with a) same color distance between categories, b) same legend position and c) same target category of the color scale, which represented the correct answer. Averaged results are shown in charts below.

Based on the proportion of correct and incorrect answers we can deduce, that most problematic color distance between categories of color ramps is E00=6 and E00=2. The less troubling legend position is IV (on the right from the map). The most problematic reading was observed for categories in the middle of the color scales. Participants were most correct when they had to find the brightest and darkest shades.

Eye-tracking metrics observed for correctly answered tasks supports the correct/incorrect results. The interpretation of metrics needs deeper investigation. Authors are currently confused by resulting values, which doesn't correspond to expected values and its common interpretation.

Pictures below shows examples of AOI transitions over selected stimuli with E00=8.

## CORRECTNESS OF ANSWERS | EYE-TRACKING METRICS*
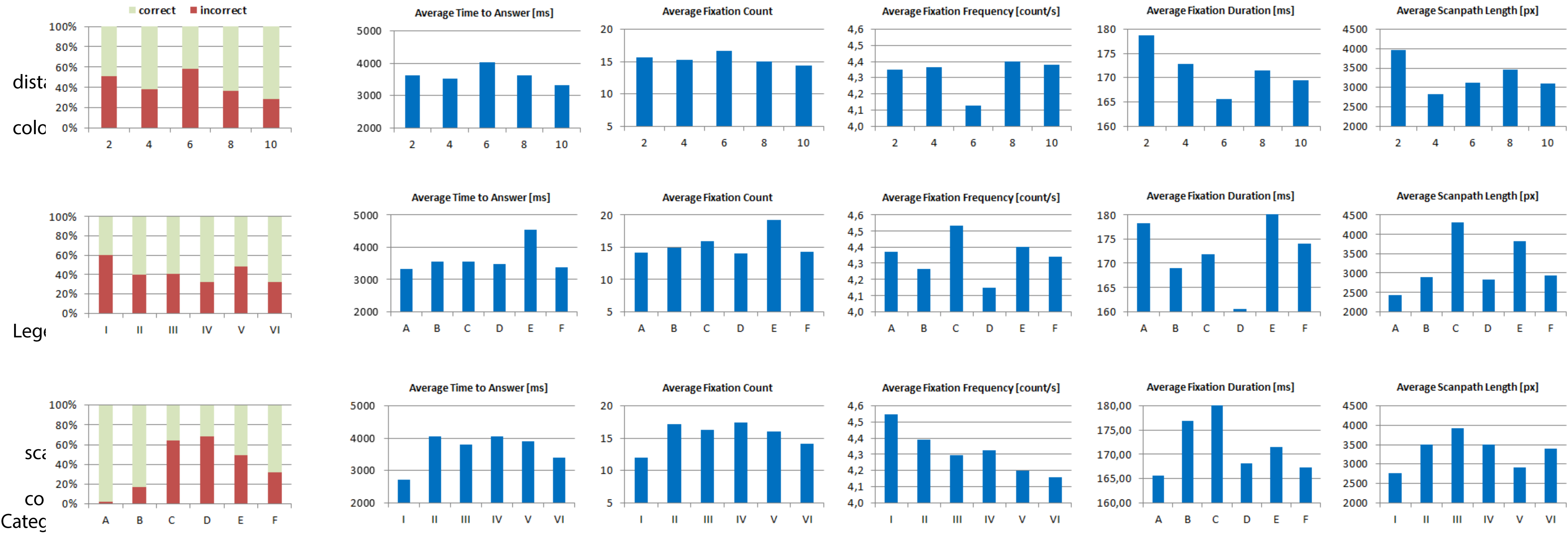
\* Data from correct answers only



12 of 12 correct answers (correct answer was „F")
Pink circles corresponds to total fixation count.

3 of 12 correct answers (correct answer was „D")
Pink circles corresponds to total fixation count.

7 of 12 correct answers (correct answer was „E")
Pink circles corresponds to total fixation count.

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