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Introducing the ColorADD color coding system in map design

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INTRODUCTION

Colorblindness

- 5 % of world population
- mostly men
- many types

Fig. 1 Example of how color vision impaired percieve traffic lights

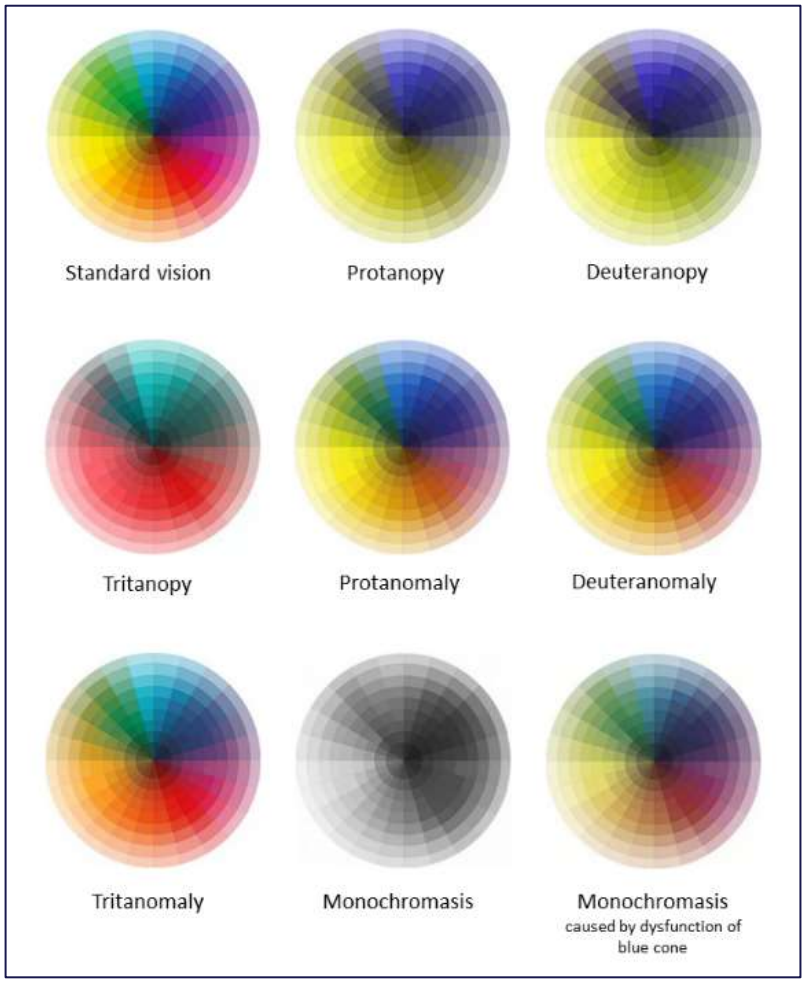


Fig. 2 Types of color vision impairment

Colorblindness & Map Usability

- C. A. **Brewer** (1992, 1994, 1996, 1997)
  - colorblind safe color scales – colorbrewer.org (**Harrower**, Brewer 2003)
  - other recommendations for map design

- B. **Jenny** and N. V. **Kelso** (2007)
  - Color Oracle – colorblindness simulator
  - clear color combinations, labels for important features, alternative visual variables, change in structure and shape

- M. **Okabe** and K. **Ito** (2008)
  - sufficient contrast between background color and object color
  - purple-green color schemes
  - completely avoid using light color shades
  - place labels directly inside the graph

ColorAdd Color Coding System

Fig. 3 Usage of ColorAdd color coding system

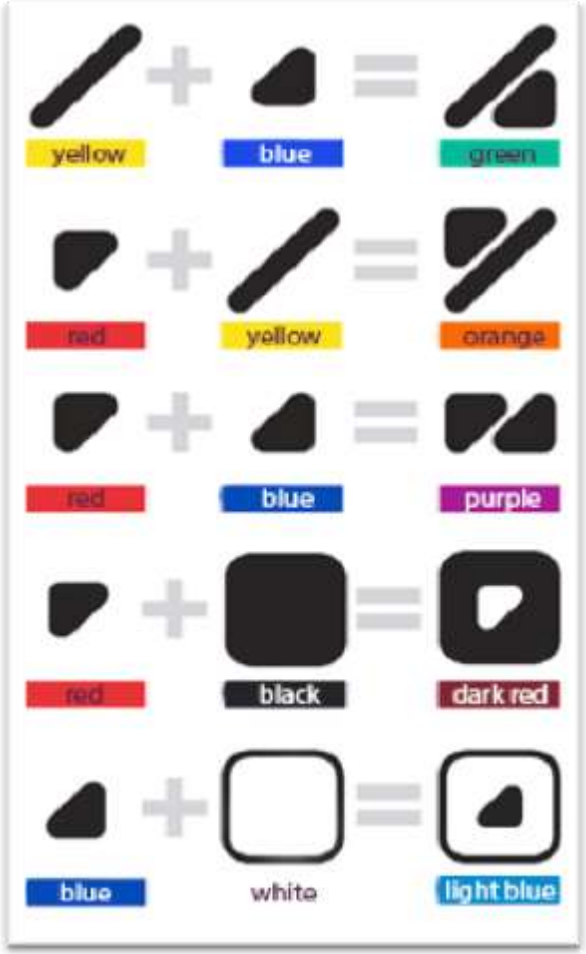
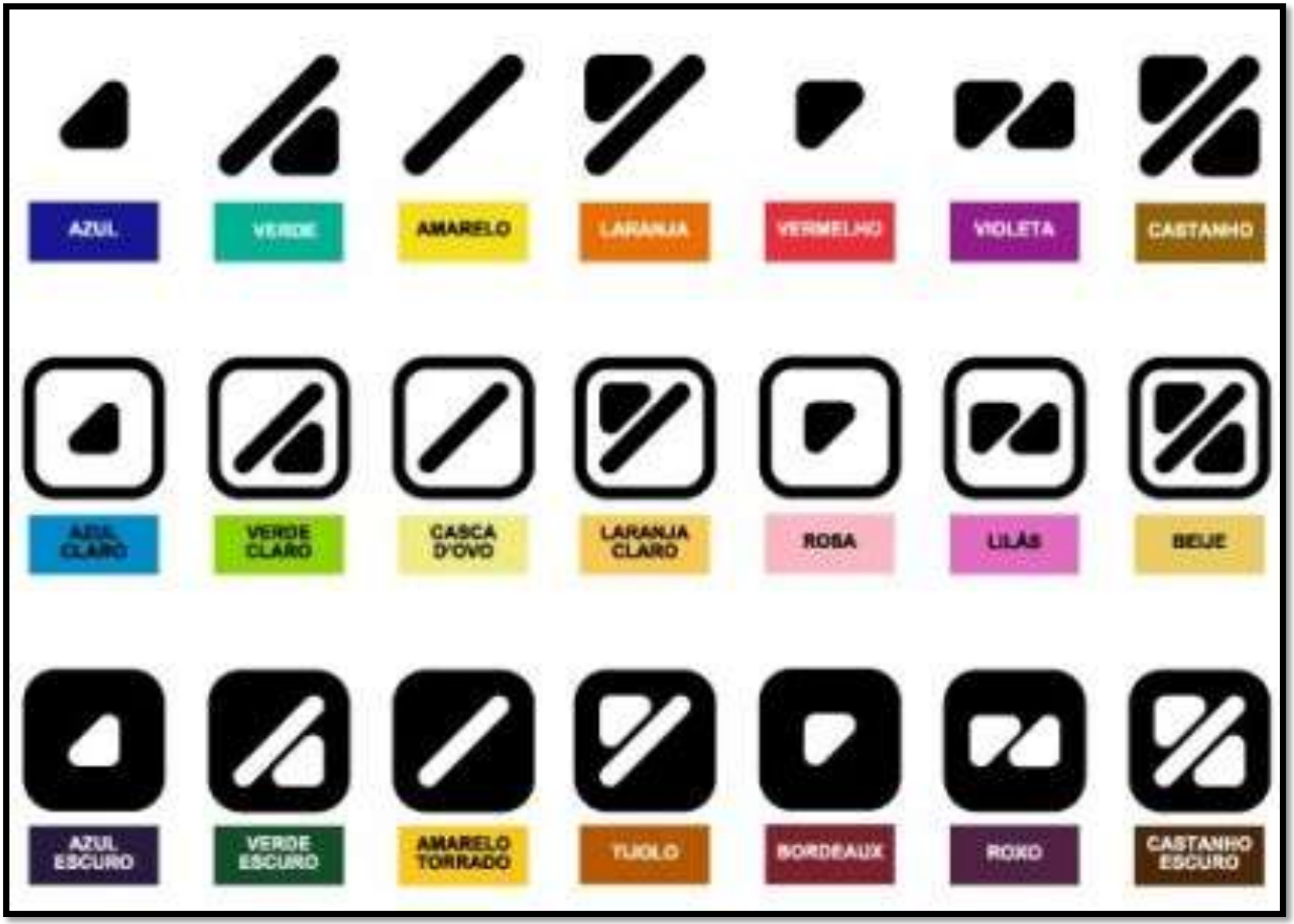


Fig. 4 Principles of ColorAdd color coding system

Fig. 5 ColorAdd color coding system



Research Design

- explorative usability study
- variation in shape vs. variation in color
- fictional administrative units
- diagram maps – 4 economic indicators: criminality, unemployment, attained university education, religiosity
- each group – same test (both map variants)
- increasing difficulty of questions

- **efficiency + effecitveness**
- **Eye Tracking**
- **retrospective interviews**

Fig. 5 Color map variant

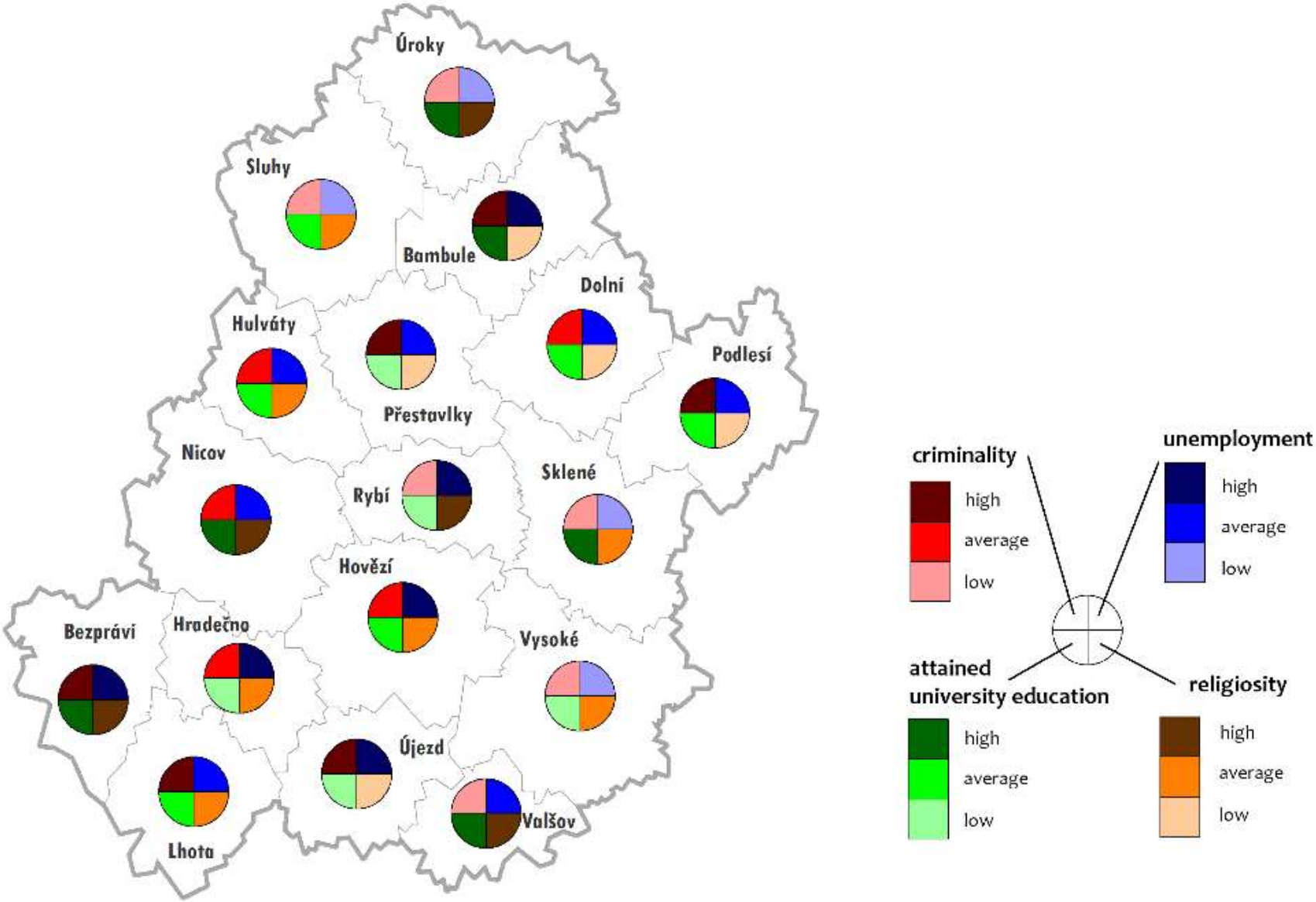
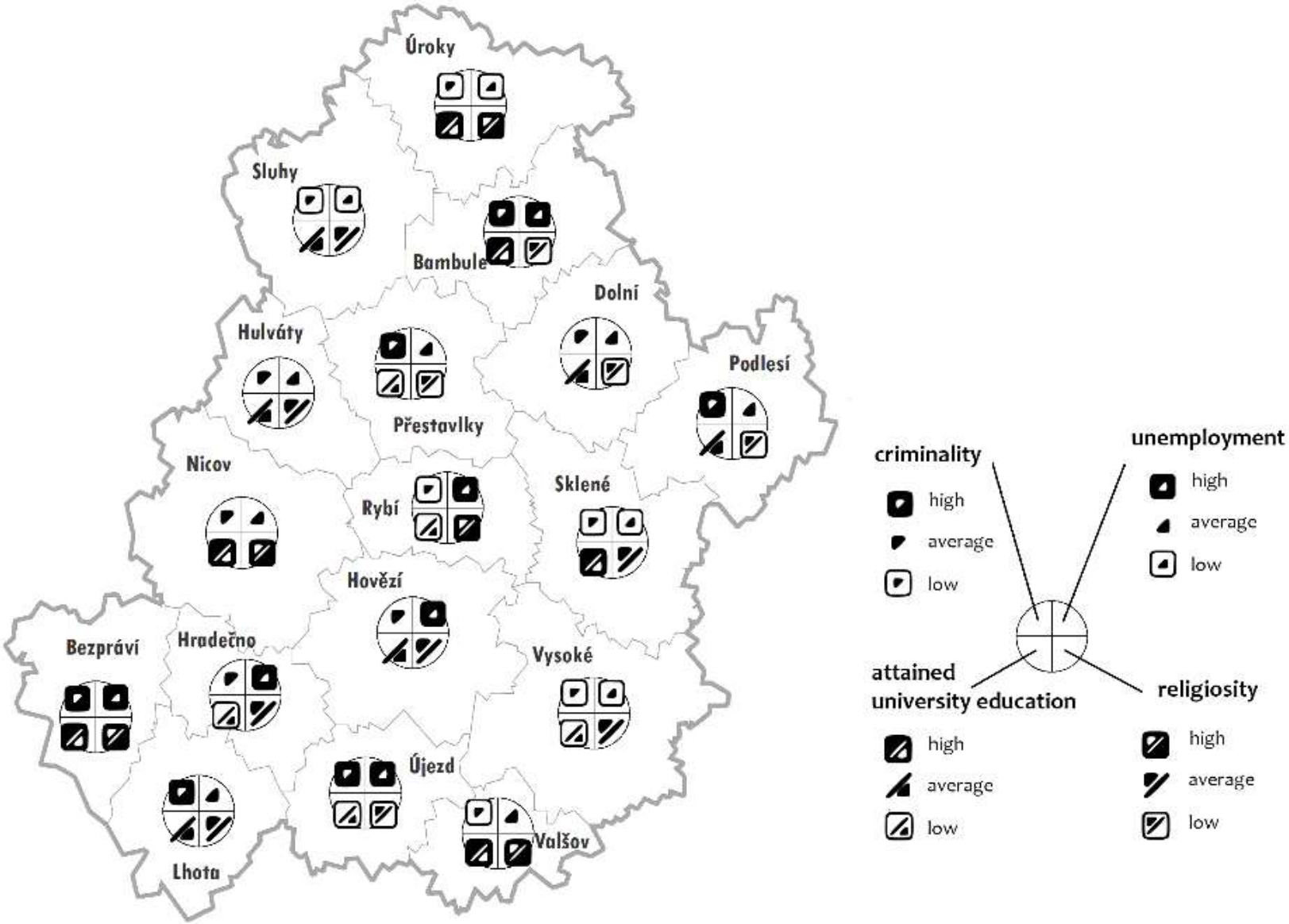


Fig. 6 Coded map variant



EXPLORATORY STUDY

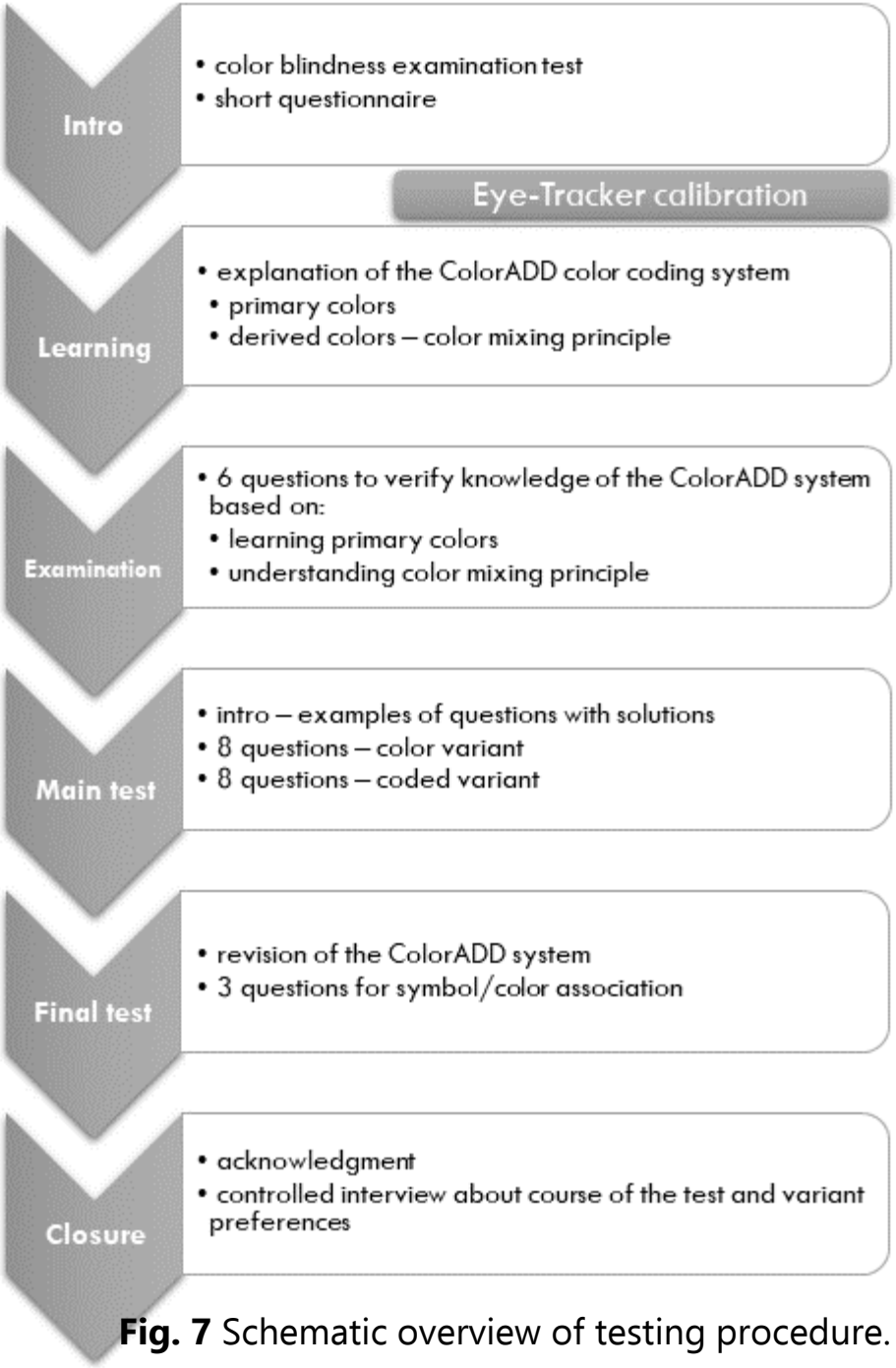


Fig. 7 Schematic overview of testing procedure.

Test Run

- March 2016
- 35 subjects (21 – 58 years)
- 10 colorblind + 25 normal vision (4 women)
- approx. 35 min

Basic statistics

- number of errors was not dependent on map variant nor on user group
- users with normal vision performed **significantly** faster on *colored variant* compared to the color blind users
- on the *shape coded variant* there were **no** significant **differences** between groups

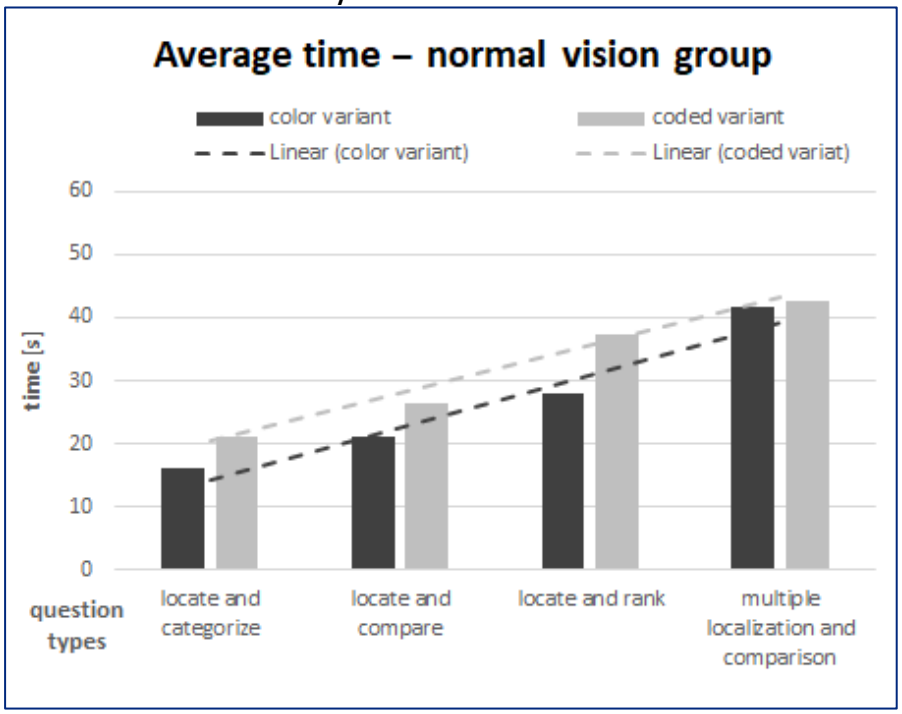


Fig. 8 Average task completion time [s] for standard vision group

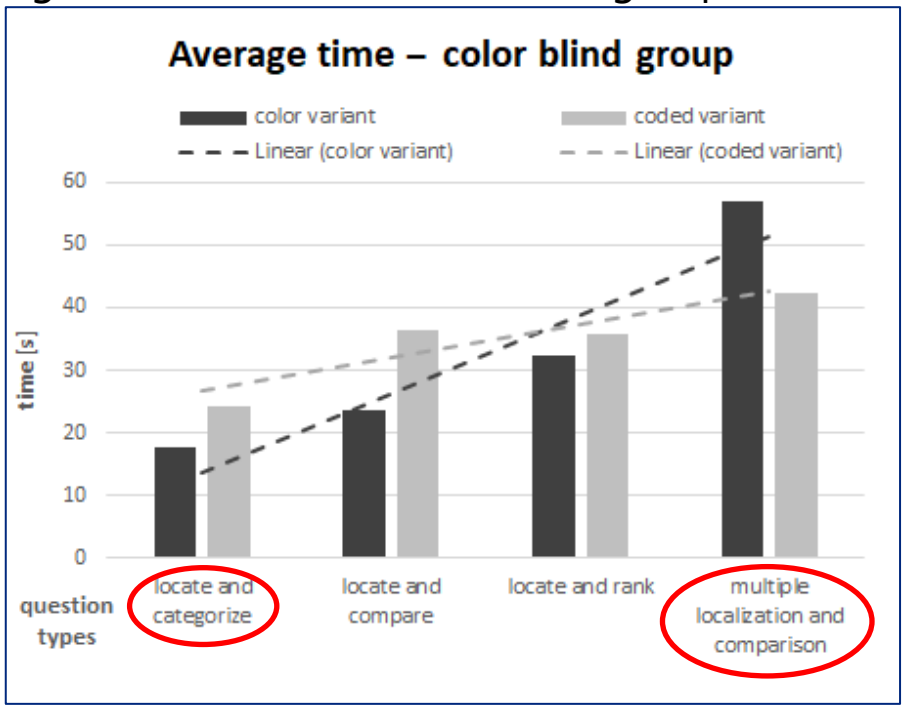


Fig. 9 Average task completion time [s] for color blind vision group

Interviews

- subject with standard vision preferred color variant
- half of the colorblind subjects preferred coded variant (distinguishable color shades and few categories)

- ColorAdd – usable, maybe with slight modifications (red – blue)

- association between colors and symbols was not developed

HOW TO USE ColorADD?

I. Understanding of Spatial Patterns

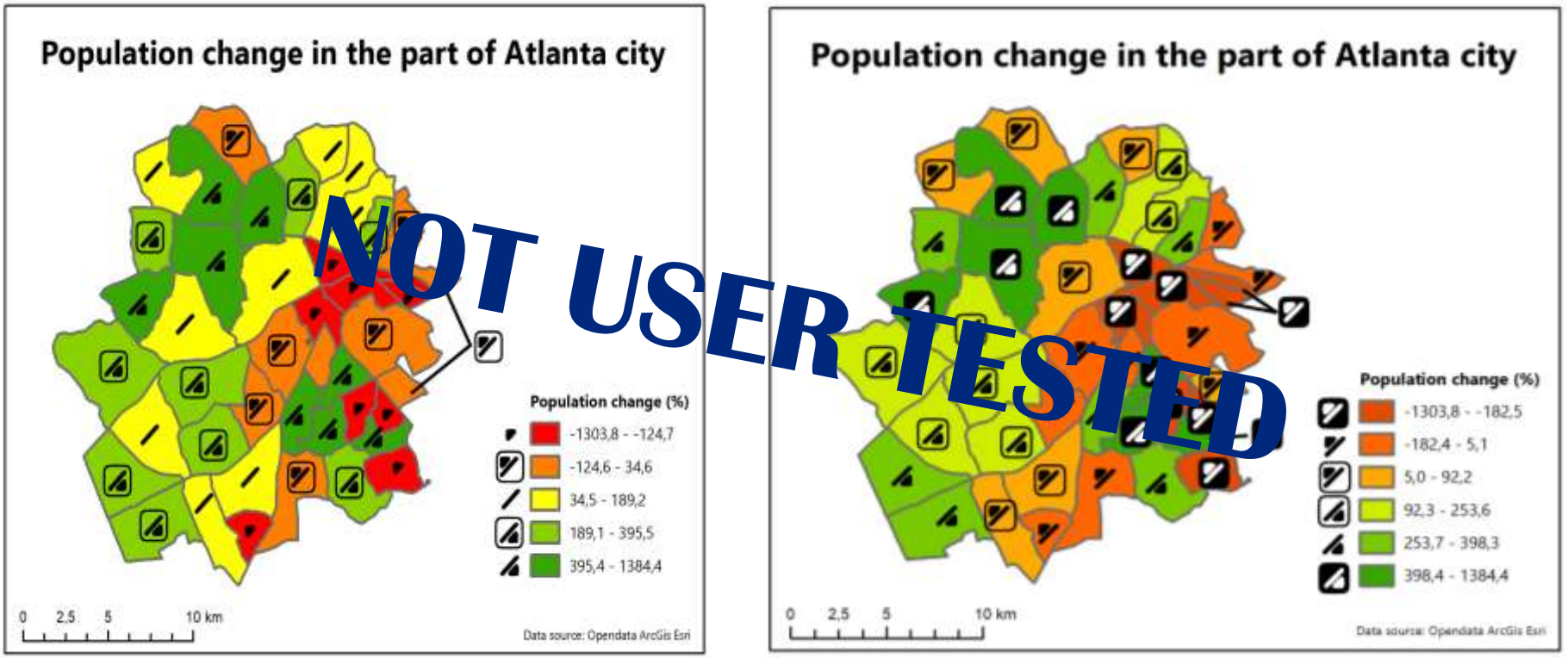


Fig. 10 Model example of the implementation of the ColorADD system on a choropleth map with a bivariant color scheme.

HOW TO USE ColorADD?

II. Navigation

Fig. 11 Model example of the implementation of ColorADD system on tourist maps: a) original b) simulation of color blind vision (author; Hiking.sk, 2017).

HOW TO USE ColorADD?

III. Interactive visualizations

- mouseover event – not visible spatial patterns (one feature at a time)
- zoom in zoom out – symbol size problem **SOLVED**
- replacing area symbol with point symbol – generalization methods (clustering, spider maps...) – graphic clutter problem **SOLVED**

http://cartocoloradd.geogr.muni.cz/app.html

Conclusion

- The conducted **exploratory study supports** the research question focused on the possibility of the **implementation of the ColorADD** system in cartographic visualizations.
- The two groups of participants do not have significantly different strategies of task solving but the **ColorADD** system seems to provide an **advantage for color blind users** while solving **more complex tasks** on the map.
- The general **validity** of results is limited by the **small number of color blind participants**.
- The **ColorADD** system represents a form of **informational redundancy**. It also increases the **graphic clutter** of the map field. However this issue can be addressed in **interactive maps** design.

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Thank you for your attention

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