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The effect of dominant background color and visualizing cycling routes on the readability of topographic maps: An eye tracking study

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Abstract:

Topographic maps are visually complex, as they contain numerous types of features that need to be purposefully and harmoniously shown on one canvas. For instance, the dominant background color and stylization of traffic networks affect the readability of other feature types on the map. In order to fully and objectively assess the perception of new cartographic designs by map readers, user testing is essential in map production. Initially, a public survey was conducted by the National Land Survey of Finland to collect feedback on the new map information and cartographic presentation styles of topographic maps. The survey aimed to test how users perceive new map colors and how well key terrain patterns work. For example, it explored the use of green to depict forests in contrast to the traditionally used white color in Finland, and whether the presentation of transport networks is appropriate, such as visualizing cycling and/or pedestrian routes and motorized traffic differently (see Figure 1). Measuring the usability of map designs qualitatively through questionnaires, but also via quantitative methods, will help gain more objective and holistic user insights before launching them. Therefore, we aim to complement a public survey with an eye-tracking user study by extending the two mentioned examples:

Use case 1. New green background *vs.* traditional white background
RQ1. What differences occur in map exploration between white and green background? How does the dominant background color affect the perception of green areas and forests?

Although green is the most commonly used color to represent forests and green areas in many maps, depicting forests in green can be debated as a drastic change for the public in Finland, as the white background has been typical - *i.e.*, status quo- in Finnish topographic maps for decades. We know that people tend to favor a status quo or default options when they make choices, rather than taking time to consider and adopt an alternative, a new option (Kahneman et al., 1991; Samuelson & Zeckhauser, 1988; Thaler & Sunstein, 2008; Eidelman & Crandall, 2009), especially when they have a series of alternatives. Selecting the default and easiest option that is already available is called *status quo bias* and it has been blamed for a wide range of undesirable outcomes (e.g., Venkatachalam, 2008). Yet if carefully designed, these behavioural tendences can be used to help people toward beneficial behaviours (Vandenbroele *et al.*, 2018; Thaler & Sunstein, 2008). Therefore, we hypothesize that when the design serves its purpose (e.g., salient, less cognitive demands, no visual clutter, etc), the users will not be negatively affected by it, and they might not even stick to status-quo depending on the task at hand. To the best of our knowledge, green forests are only a tradition in many countries and are not theoretically better than white forests. Furthermore, red-green disability is probably the main weakness of green forests. During the map design stage, this issue is being considered by using color testing software against color disabilities.

Use case 2. Cycling routes *vs.* motorized traffic
RQ2. What is the impact of visualizing cycling routes for sustainable transport modes on map users' spatial cognition and behavior?

Illustrating cycling routes on topographic maps separately is not a common practice in cartography. However, walking and cycling are the top two sustainable mobility options, according to EU Green Deal and green transition plan (URL1, 2). If bike lanes and sidewalks were emphasized on maps through effective cartographic design, these transport alternatives would become more potential for map users. The insights derived from usability studies contribute to the research on nudging and behavioral insights by linking the procedures of visual perception and information processing, task completion strategies, and cognitive load. High cognitive load leads to the use of simplifying heuristics and decision biases such as the status quo bias. Therefore, providing map designs with low cognitive processing demands can overcome the most common biases. We hypothesize that making sustainable transportation choices more accessible and

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salient/recognizable on maps, both physically and cognitively, might help map users to choose green transport modes - *i.e.*, nudge theory (Thaler and Sustain, 2008). This might even drive a societal change to overcome the threads of climate change and environmental degradation. This use case is ethically based not only to decrease climate and traffic burden of cities but also to increase health benefits for citizens (see Massink et al. 2011; Götschi et al. 2016).

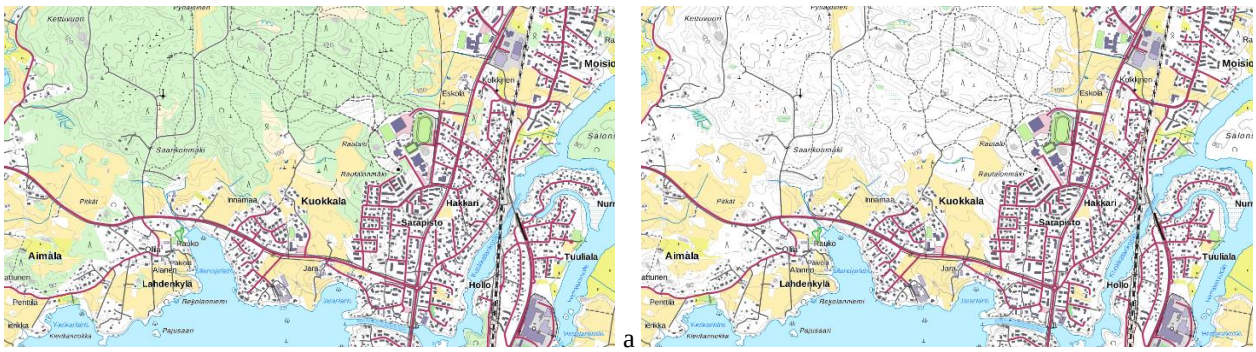

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Figure 1. Example experimental stimuli: Topographic maps (a) with green background; (b) with white background (*motorized traffic is shown in dark red and cycling routes in dark gray*).

This eye-tracking study will support cartographic decisions about the choice of the dominant background color on topographic maps. The study will also provide understanding about map-reading impacts of cartographic design choices of a linear network on topographic maps. Use of the quantitative empirical method, eye tracking, along with questionnaires, and structured interviews, will provide a firm base for easier map design decisions in topics that may divide both common users' and experts' opinions.

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