Legibility Of Transitions In Dynamic Geovisual Displays: Determining The Influence Of Change Blindness In Geovisual Analytics

Kirk Goldsberry[1], Carolyn Fish[2]

[1]Michigan State University, 116 Geography Building, East Lansing, MI, USA, 48824
Email: kg@msu.edu

[2] Michigan State University, 116 Geography Building, East Lansing, MI, USA, 48824
Email: cfish11@msu.edu

1. Introduction

To ensure effective communication of spatio-temporal geographic ideas, observers must accurately perceive and comprehend dynamic visual representations of geographic information. However, some of the most fundamental perceptual questions about the effectiveness of dynamic displays of GI remain unanswered. Furthermore, misunderstood issues about the legibility of dynamic displays threaten to undermine the effectiveness of dynamic geovisual representations. This research investigates legibility in dynamic displays of GI. More specifically, we report on "change blindness" and "change blindness blindness," and how these perceptual phenomena can reduce the effectiveness of dynamic geovisual representations. We report the findings of two experiments designed to assess how well people 1) detect shifts in dynamic displays of GI, and 2) assess their own change detection abilities. We found that not only do people miss important shifts in geovisual displays, but perhaps more importantly they also overestimate their own change detection competencies. These results suggest that change blindness and change blindness blindness have important consequences that are specific to geovisual displays, and that more research is required before designers of geovisual displays can be confident that the meanings encoded in their displays are legible to observers.

2. Background

"Change blindness" is defined as the "surprising difficulty observers have in noticing large changes to visual scenes" (Simons and Rensink, 2005, p. 16). Change detection, the opposite of change blindness, is the "apprehension of change in the world around us" (Rensink, 2002, p. 246). Recent studies indicate that observers often fail to perceive or even notice seemingly important changes, in both the real world and within multimedia displays (for overview: Rensink, 2002; Simons and Rensink, 2005). As it relates to GIScience, change blindness would cause map-readers and analysts to fail to perceive important dynamics within geovisual displays, yet the magnitude of this effect remains unknown.

The phenomenon of "change blindness blindness" adds another element of complexity to these issues. Change blindness blindness can be defined as individuals' tendency to overestimate their own change detection competencies. In previous studies most people believed incorrectly that they would notice changes within their visual field. Levin et al. (2000 and 2002) tested this phenomenon using stimuli from previous

change blindness experiments (Levin and Simons, 1997 and Simons and Levin, 1998) and found that not only will observers miss important changes between visual scenes, they will also be "blind" to their own change blindness. This metacognitive error of overestimating change detection abilities has large implications not only for cognitive science, but also for many other domains, such as geovisual analytics (Simons and Rensink, 2005).

2.1 Implications for GIScience

Both change blindness and change blindness blindness have specific implications for GIScience, where the inability to apprehend visual changes can result in the misinterpretation of the information encoded within geovisual displays. For example, imagine a case of an analyst using geovisual displays to explore historical unemployment trends in the US. Since changes in attributes over time are often symbolized by graphical changes in visual variables (Bertin 1983), the incidence of change blindness in this case may cause the viewer to miss the extreme increase in unemployment during the 1930s. The negative effects of this perceptual shortcoming could propagate due to effects of the change blindness blindness phenomenon; due to the overestimation of change detection abilities, viewers might not only miss a change such as this, but also incorrectly believe that they comprehended it. Consequently these observers could be less inclined to review the animation and more inclined to underestimate the overall dynamics of the mapped phenomenon.

3. Experiments

Unfortunately, despite multiple investigations of these perceptual phenomena, it remains unknown just how change blindness or change blindness blindness affect dynamic map-reading behavior. Our research investigates how well observers detect changes within dynamic geovisual scenes. We report on two human subjects experiments that both examine the abilities of participants to notice, attend to, decode, and recall simple changes in dynamic thematic map displays.

The first experiment was designed to simply assess the impacts of change blindness in dynamic geovisual displays. The goals of this experiment were to 1) determine the extent of change blindness effects in a geovisual context and 2) examine how common transitional design strategies affect change detection. 78 participants viewed 108 choropleth map transitions and responded to two kinds of change detection inquiries: basic presence-absence of change inquiries, and more complex recall inquiries that required participants to remember the origin status of display elements prior to the occurrence of a visual transition. The results from the first experiment indicate that change blindness can obstruct geovisual analytics. On a regular basis, consistent with findings in non-GIScience contexts, observers failed to notice changes to, or were unable to recall the origin state of geovisual display elements. These results suggest that change, as currently presented in many geovisual displays, is frequently illegible and that readers/users commonly both 1) fail to detect visual changes in geographic information, and 2) fail to detect their own inabilities to detect these changes. This is due in part to the complexity of geovisual transitions in which many change events can occur simultaneously throughout the display. However, another cause is the implicit nature of change depiction in visual displays of GI; often changes occur during invisible intermediary segues between scenes, leaving observers to "read in between the lines."

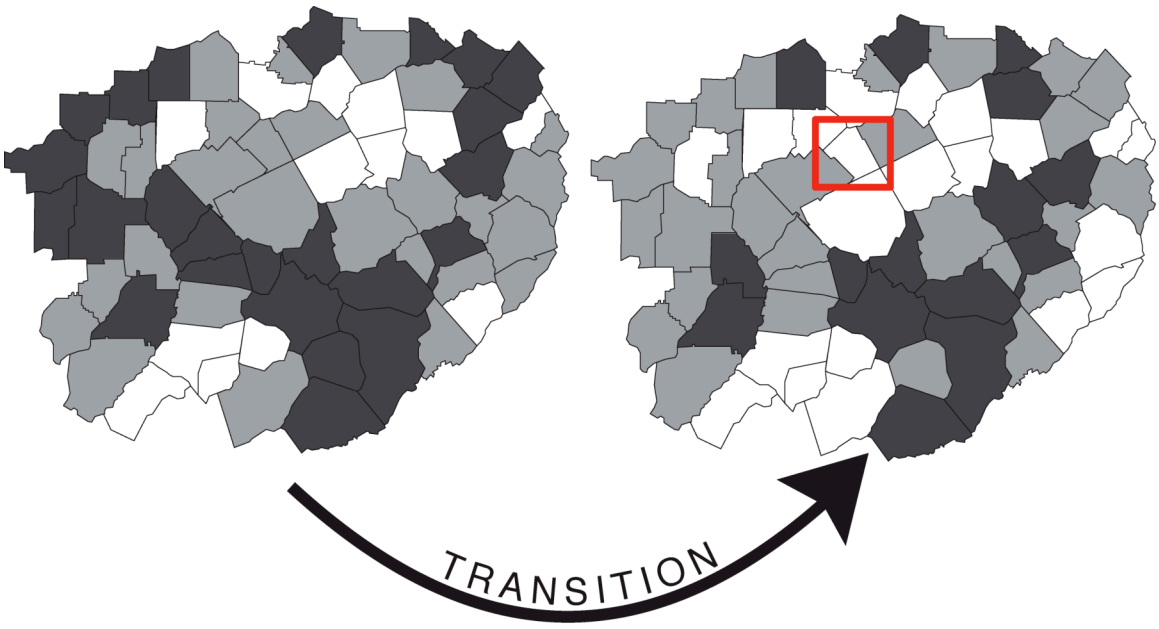

Figure 1. Example of a transition between two scenes. The rectangle was intended to highlight an enumeration unit of the map. The participant was asked to determine whether the highlighted unit changed classes between the two scenes.

The goal of the second experiment, which is ongoing, is to examine how various design approaches could improve the legibility of changes in geovisual displays. Given the low rates of change detection revealed in the first experiment, we designed a second investigation to determine if explicit change depiction strategies can improve change detection rates in dynamic geovisual scenes. Using results from the first experiment as our baseline, the second experiment asks a new group of participants to complete the same 108 tasks using slightly altered stimuli. By applying basic "highlighting" functions (Ware 2005)) we are evaluating whether explicitly symbolizing changes during geovisual transitions will improve observers abilities to detect and recall changes.

4. Discussion

Since the world's first maps and charts, legibility has always been critical to graphical models of geographic information and many seminal investigations have cited it as an important goal. However, as our geovisual displays become more complex and more dynamic it is critical that researchers both identify and overcome emerging legibility challenges. One of the primary utilities of dynamic geovisual displays is their ability to depict change over time (Harrower 2007), yet if observers are failing to perceive these graphical changes, than this utility is lost. The legibility of transitions within geovisual displays has a significant bearing on its utility, yet to this point the designs of these transitions have yet to be investigated.

References

Bertin, J. (1983). Semiology of graphics: University of Wisconsin Press.

Harrower, M. (2007). The cognitive limits of animated maps. Cartographica: The International Journal for Geographic Information and Geovisualization, 42(4), 349-357.

Levin, D. T., Momen, N., Drivdahl, S. B., & Simons, D. J. (2000). Change blindness blindness: The metacognitive error of overestimating change-detection ability. Visual Cognition, 7(1), 397-412.

Levin, D. T., & Simons, D. J. (1997). BRIEF REPORTS Failure to detect changes to attended objects in motion pictures. Psychonomic Bulletin & Review, 4(4), 501-506.

Levin, D. T., Simons, D. J., Angelone, B. L., & Chabris, C. F. (2002). Memory for centrally attended changing objects in an incidental real-world change detection paradigm. British Journal of Psychology, 93(3), 289-302.

Rensink, R. A. (2002). CHANGE DETECTION. Annual Review of Psychology, 53(1), 245-277.

Simons, D. J., & Levin, D. T. (1998). BRIEF REPORTS Failure to detect changes to people during a real-world interaction. Psychonomic Bulletin & Review, 5(4), 644-649.

Simons, D. J., & Rensink, R. A. (2005). Change blindness: Past, present, and future. TRENDS in Cognitive Sciences, 9(1), 16-20.

Ware, C. & Bobrow, R. (2005). Supporting visual queries on medium-sized node–link diagrams. Information Visualization (4) 49-58.