Applying Principles of Visual Cognition to Information Visualization

When designing a visualization, it is critical to consider the needs of the viewer. An important consideration is the amount of time and attention that can be dedicated to interacting with the visualization. The present essay addresses important cognitive considerations across such attentional contexts, from the most superficial, to the most engaging.

One of the more ephemeral forms of information visualization is outdoor advertising, such as highway billboards. Typically, a billboard viewer will only dedicate a few seconds of attention, if any, thus, a billboard will be most successful when its message is communicated with as little attention as possible. An effective example of outdoor advertising that considers perceptual principles is presented in Figure 1. The high contrast between the vivid red, and other colors associated with highway driving is a strong pre-attentive cue that draws the viewer to the target. Once the target has the viewer's attention, it communicates its message: "a 24 hour Mcdonald's restaurant is coming up on the right in 50 metres," using no words, only a small number of easily decoded symbols. Color contrast between symbols and the background facilitates decoding. The tall, curved shape of the McDonald's logo has orientation and spatial frequency information that distinguishes it from a traditional capital or lowercase m, also facilitating decoding.

Greater time and attention can be expected of a viewer decoding a structural equation modelling path diagram in an academic journal, such as that presented in Figure 2. Figure 2 displays a series of 8 related regression equation in a manner that promotes rapid decoding. Such diagrams apply visual cognition of texture in the categorization of manifest and latent variables as boxes and ellipses, respectively. Munzener notes that spatial position is the most accurate visual channel for all types of data. In Figure 2, spatial position encodes causal order, such that the latent variables on the left side of the diagram are said to cause those connected to them by an arrow. Given that causal order is communicated via spatial information, the use of arrows indicating direction of causation is an example of redundant coding, which further simplifies decoding causal order. Figure 2 is limited in that spatial position only encodes causal order of latent variables, while the position of manifest indicators is meaningless. This visualization could be improved by always positioning indicators under their associated latent variables. Causal order in path diagrams could be further clarified with color coding, with different hues used to distinguish between exogenous variables, endogenous variables, mediators, and latent variable indicators.

A visualization context in which significant time and attention can be expected of the viewer is the use of software to explore the viewer's own geospatial data. Consider a hypothetical tool which allows geospatial data to be explored using an interactive globe. Summary statistics for variables of interest are presented based on selected geographic regions. Hue contrast could be used to distinguish between adjacent geographic regions, such as countries or counties, depending on the scale of interest, and saturation contrast could be used to

distinguish between selected and unselected regions, with more vivid colors highlighting selected regions via positive pre-attentive cues, facilitating the identification of selected regions when verifying that the correct regions have been selected for one's analysis.

Knowledge of cognition of visual information such as color, texture, and salience can be applied in different ways to the design of visual displays depending on the amount of time and attention can be expected from the viewer.

Figure 1.

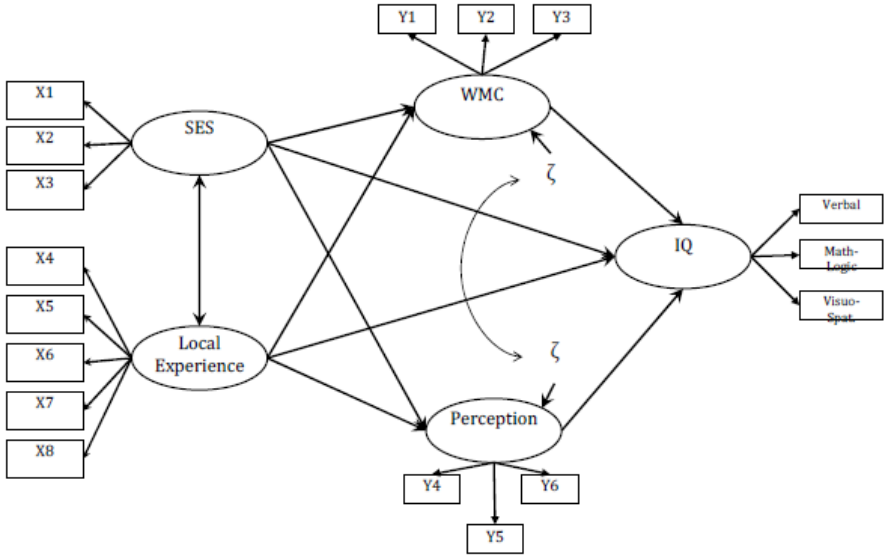

Figure 2.