

Applying Theories of Object Recognition to Visualization Design

A considerable amount of research offers support for structure-based and image-based theories of object recognition. The present essay outlines the implications of such research for visualization design.

Ware (2012) applies Biederman's geon theory – a structure-based theory which argues objects are recognized in terms of simple geometric components – to the design of flow charts and finds that geon diagrams are easier to decode and remember than conventional diagrams. One implication of this research is for the design of subway diagrams. Taking Figure 1 at face value, one would assume distances between consecutive stops on the Canada Line are uniform, and that no horizontal translation takes place. Neither of these inferences are correct. Instead, the designers choose to sacrifice accuracy for elegance. One could apply geon theory to redesigning this map to increase accuracy about the relative positions of stops, with minimal impact on its elegance. For example, line thickness could indicate the amount of time between stops. Further, curvature of lines between stops could indicate change in longitude relative to the previous stop. While less accurate than a topographic map, such a redesign could give passengers a better idea of where the train is taking them.

Rapid Serial Visual Presentation (RSVP) is a technique where images are rapidly displayed to a viewer. The ability of viewers to recognize images previously viewed for fractions of a second is evidence for image-based object recognition. Wittenburg et al. (1998) applied RSVP to searching an image database. While roughly 2.5 times faster, and more accurate than traditional search using a grid of thumbnails, RSVP is limited in that termination of search is problematic: when viewers recognize their image, they must stop presentation and backtrack to it, an issue absent from grid-based search. This research has implications for visualization when the objective is for the viewer is to process all images in a series, rather than search for a specific image. Spritz is an app which applies RSVP to text reading. Instead of images, individual words are rapidly presented to the reader without requiring them to move their eyes. While the average reading rate of conventional text is about 200 WPM, the average rate using Spritz is about 500 WPM, consistent with Wittenburg et al.'s (1998) observations.

Faces are unique objects in human perception, as evidenced by early recognition in infants, and activation of the fusiform gyrus. We are much more sensitive to subtle changes in facial expressions than we are to subtle changes in other objects. Herman Chernoff capitalized on this and proposed using drawings of faces to represent multivariate information. Different variables are mapped to eye, nose, mouth, and face shape and size. These drawings are referred to as Chernoff faces. A major limitation of Chernoff faces is that certain facial expressions are more salient than others, so just-noticeable differences will vary across faces. Despite this issue, Chernoff faces do have their uses. De Los Reyes et al. (2017) mapped the heart rates of adolescents with social anxiety to the width of Chernoff face features. High inter-rater reliability was observed for comparisons of these faces to normative faces. Further, latent class analysis of ratings produced three classes of responses which were found to be predictive of both self-reported social anxiety, and physiological reactivity, suggesting Chernoff faces are valid and

reliable indicators of social anxiety profiles. Because this study only maps variables to feature width, there is no risk of issues associated with emergent facial expressions.

Despite ostensibly competing, all theories of object recognition have contributed to the development of effective visual displays.

References

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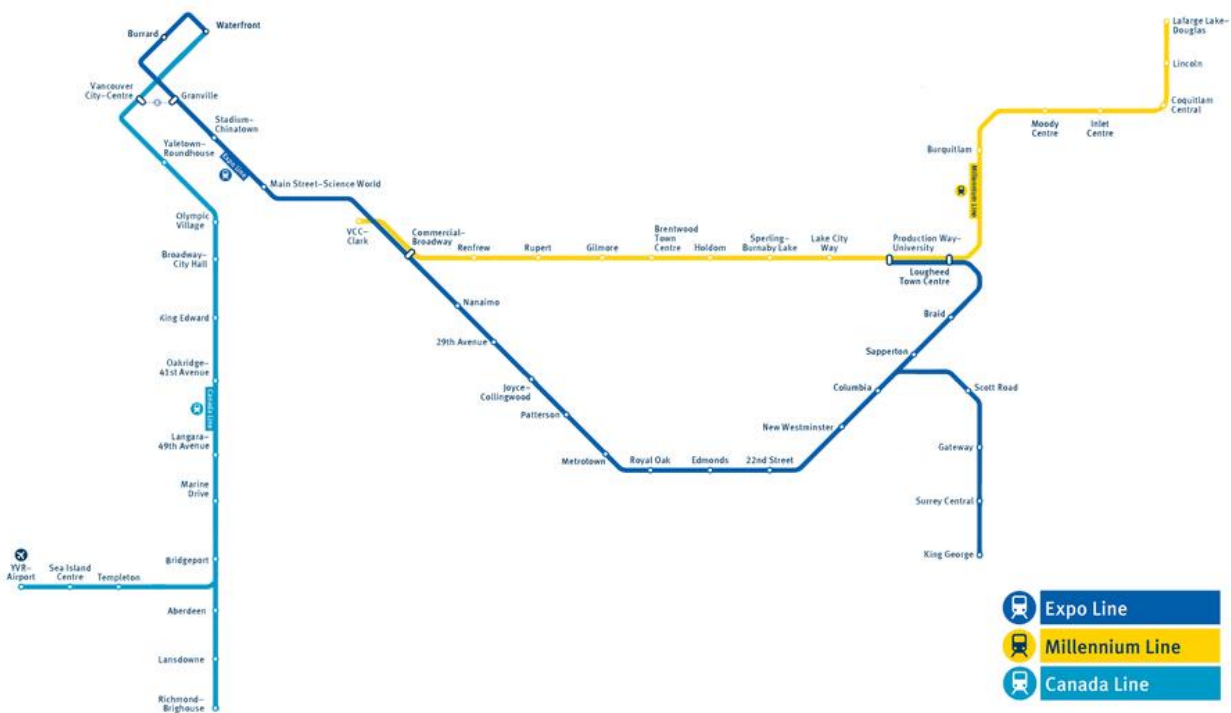


Figure 1.