Perceptual Mechanisms and Design Principles

The Non-Designer's Design Book (Williams, 2015) describes four principles to consider when designing effective visualizations. As the book is targeted towards novices, the author tends to let designs speak for themselves, rather than supporting her recommendations with vision science research which may confuse and alienate the reader. The present essay provides support from perceptual science for three of Williams's four design principles.

The principle of *contrast* states that contrasting elements draw a viewer's eyes into the visualization, allowing the viewer to be directed towards certain elements. Williams would argue that stop signs make use of contrast, as the vivid red contrasts with the duller colors typically associated with driving, drawing the viewer's eye. Williams's perspective is consistent with research on pre-attentive processing. Treisman and Gormican (1988) found that a red target is more quickly identified among a set of black distractors (a strong color contrast) than is a red target among a set of magenta distractors (a weak color contrast). For this reason, a red stop sign on a city backdrop will be detected more quickly than would a gray stop sign on a city background, or a red stop sign on a magenta background.

The principle of *proximity* states that physical closeness implies relatedness among items, so similar items should be grouped together. Consider the park map legend in Figure 1. It is intuitive that this legend is easier to use than if all activities, facilities, and amenities were presented in a single list, rather than grouped together. The Gestalt law of proximity states that things that are physically close together are perceptually grouped together (Ware, 2012). Slocum (1983) noted that we perceptually group regions of similar element density, thus, if a collection of elements are close to each other, and further from elements in other groups, they are perceived as related. In the case of the park map key example, we perceptually group elements of the "activity" column as related to each other, and distinct from the elements of the "facilities" column.

The principle of *alignment* states that the position of elements of a visualization should never be arbitrary; every item should have a visual connection with something else on the page. Consider Figure 2, which depicts how certain types of information can be communicated using different visual features. Williams would argue that this figure makes use of the alignment principle, as the position of every cell in the 4x4 grid is meaningful: horizontal position encodes visual aggregation task, and vertical position encodes visual features. The principle of alignment tells us that, while [Position, Summary] and [Size, Identification] are closer together than [Position, Summary] and [Position, Segmentation], the latter pair still belongs to the same piece (Williams, 2015). Williams's perspective is consistent with the work of Szafir et al. (2016) on ensemble encoding. The authors argue that segmentation into groups is most intuitive when data are mapped onto spatial position: it is easier to discriminate between elements based on similar position than by other visual features, such as color or texture. For this reason, it is easier to navigate Figure 2 in its current state than if cells were positioned randomly on the page, with color coding "visual aggregation task", and texture coding "visual feature."

While the recommendations of Williams in The Non-Designers Design Book may seem simple and intuitive, the non-designer can take comfort in the fact that these recommendations are also supported by perceptual science.

References

Slocum, T. S. (1983). Predicting visual clusters on graduated circle maps. *American Cartographer, 10*(1), 59-72.

Szafir, D. A., Haroz, S., Gleicher, M., & Franconeri, S. (2016). Four types of ensemble encoding in data visualizations. *Journal of Vision, 16*(5), 1-19.

Treisman, A., & Gormican, S. (1988). Feature analysis in early vision: Evidence from search asymmetries. *Psychological Review, 95*(1), 15-48.

Ware, C. (2012). Information visualization : perception for design. Retrieved from https://ebookcentral.proquest.com

Williams, R. (2015). The non-designer's design book (4th edition). San Francisco, CA: Peachpit Press.

Figure 1.

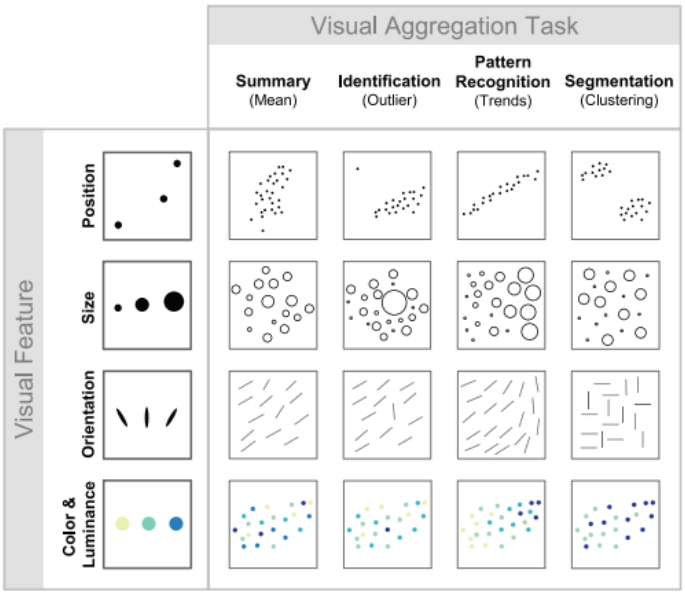
Visual Aggregation Task
Summary
(Mean)
Identification
(Outlier)
Pattern
Recognition
(Trends)
Segmentation
(Clustering)
Visual Feature
Position
Size
Orientation
Color &
Luminance

Figure 2.