Texture Perception and Ensemble Coding

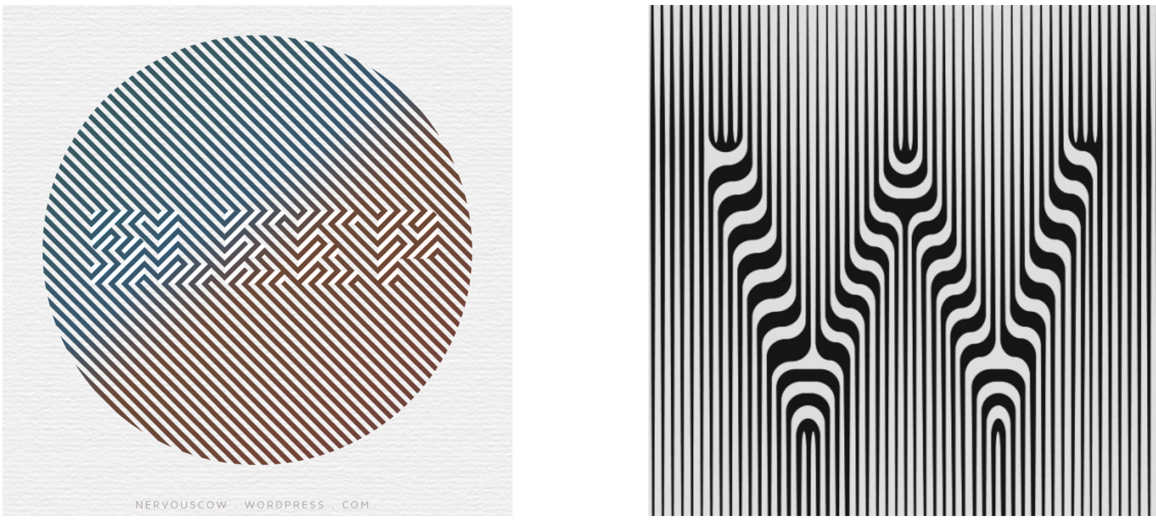
Perceiving the visual world can involve extracting visual information from a large number of objects at once. One way that we extract information from many objects is through *texture segmentation*, where the brain breaks a scene of objects into different components based on texture. The issue of understanding a dispersal of objects this way falls under the broader concept of *ensemble coding*, where distributed visual content is rapidly processed for information extraction. We can apply knowledge of ensemble coding and texture segmentation to visual display design.

Texture segmentation allows us to differentiate surfaces based on texture, and thus extract overall forms. This knowledge has been applied to map design (as in Ware, 2013), but we can also apply this to graphic design. For example, a modern trend in graphic design is overlaying textured letters over a textured background, creating a sort of optical illusion for the viewer. Evidence shows that optimal texture segmentation requires that textures be distinct in multiple dimensions (Ware, 2013). More specifically, due to the nature of the brain's *Gabor detecors*, it is said that textures should differ in spatial frequency by a factor of at least three, and in orientation by at least 30 degrees (Blake & Holopigan, 1985). This concept is demonstrated in Figures 1a and 1b. The text in Figure 1a's graphic is difficult to read because the font texture differs from the background texture only in orientation, while the letter in Figure 1b is easily read as its texture differs in both orientation and size. Thus, texture segmentation best supports the perception of these kinds of graphics when the textures differ in multiple dimensions.

Ensemble coding also supports segmentation, or the process of seeing subsets in information, by feature information like space and colour (Szafir, Haroz, Gleicher, & Franconeri, 2016). Consider a website click-map, where a heat map style of visualization is used to show the frequency of user's clicking activity in different areas of a webpage. Ensemble coding supports a user's ability to break this visual into subsets of areas with high, medium, and low clicking activity. It is suggested that the ability to perceive subsets through ensemble coding is best when only a single feature is used to differentiate the data (Szafir et al., 2016). For example, one might consider adding another layer to the visualization where the "hovering" activity of a web page is encoded using different luminance levels. However, a viewer's ability to segment different areas that have the same hue may be inhibited by the variation in luminance that is representing the "hover" variable. Thus, while ensemble coding can support the segmentation of items in a set, it is most effective when a single feature is used.

Outside of segmentation specifically, we can discuss ensemble coding in relation to the general process of perceiving the "gist" of visual environments (Sweeny, Haroz, & Whitney, 2012). For example, ensemble coding supports our ability to perform statistical tasks on data visualizations, such as summarizing sets of visual data (Szafir et al., 2016). One way of summarizing visual data is quickly determining the relative numerosity of data points. We can apply this to map visualizations that communicate quantity of events or landmarks. For example, consider a map that uses different dot types to represent the sighting locations of two rare bird species in British Columbia. Ensemble coding would support the viewer's ability to quickly interpret which species had more sightings. Studies suggest that this ability to summarize numerosity is best when data points differ by features other than luminance, as darker items can be perceived as more numerous than lighter ones (Ross & Burr, 2010).

These are just a few examples of how ensemble coding supports visual design features. Continued research on perceptual mechanisms like this can foster the creation of new and better designs.



(a) (b)

Figure 1. Two graphic images that use overlaid textures to create an optical illusion for the viewer (Hanks, 2014; van Halem, 2014). Because the textures in (a) only differ in orientation, it is difficult to see the displayed word, “sleep”. The textures in (b) differ in both size and orientation, and so it is easy to see the displayed letter “W”.

References

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