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Applying Opponent Process Theory to Visual Display Design

It is hard to imagine vision without colour. Colour is a major component of visual perception, and as such, has been a widely-researched area of vision science. There are a number of perceptual theories that we currently accept as pillars of modern colour theory. For example, Ewald Hering's Opponent Process Theory states that the colour receptors (cones) in our eyes process signals into three distinct channels: the red-green channel, the blue-yellow channel, and the black-white luminance channel (Hering, 1920). Hering's theory has allowed us to understand a number of key aspects of colour vision, including the notion that colour does quite little to aid perception in comparison to luminance. In fact, evidence shows that luminance is a better indicator of form, motion, and spatial detail (Ware, 2013). Knowing this can inform better design decisions.

While observing an object, we use luminance variance in the shading of the surface, rather than chromatic variance, to interpret the form (Ware, 2013). This idea can be applied to the design of interfaces where perceiving shape and form is of particular importance. For example, 3D printing software, which allows users to design three-dimensional objects in an abstract space, uses luminance variance in graphic objects in order for the user to best study their form. Surfaces of objects are primarily displayed in a singular colour, and include shading with only luminance variance. The background colour is also often adjustable, allowing the user to set the background to a different luminance from the object. As such, the user can best perceive the exact shape of their three-dimensional creation.

Evidence also suggests that using only chromatic differences between objects and their backgrounds leads to flawed perception of motion. More specifically, studies show that objects that differ chromatically from their background, but not in luminance, are perceived as moving slower than they are in reality (Anstis & Cavanaugh, 1983). Knowledge of this effect can be applied to the design of systems that require users to effectively perceive motion, such as video games. For example, digital game apps that involve moving objects should make sure to incorporate luminance contrast between the moving object (representing a villain or obstacle, perhaps) and the background colour in order for the user to best perceive the speed of the object. Another method could be to add a "halo" of a different luminance level around the moving object.

Chromatic variance is also not sufficient at distinguishing small details, such as text, from background colours (Ware, 2013). Because of this, we must ensure that detailed visuals such as text have a significant luminance contrast from their backgrounds, in addition to a potential chromatic difference. While a trained designer would be well aware of this technique, many people who are not trained in visual design principles have to create visuals such as slide shows and charts. To aid nondesigners, visualization tools (such as those used to create slide show presentations and data visualizations) could be designed with intelligent interfaces to prevent poor contrast effects. For example, an application for creating visual presentations could present users with live suggestions for appropriate background colour choices based on the luminance of the font or object they have selected (or vice versa). This would ensure that even nondesigners avoid creating visuals that are difficult to interpret.

It seems that part of knowing how to properly use colour in visual design is knowing how to properly use luminance. While colour is useful in perceptual tasks such as categorizing objects, there are a number of instances where chromatic variance alone leads to perceptual obstacles. Taking the nature of colour perception into account, we can design visual interfaces that use colour in intelligent and pleasant ways.

References

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