
12 Facts of Perception

(Lecture 5: Perception)

F1: Memory plays an important role in human cognition, but working memory is extremely limited

-> Visualization must serve as an external aid to augment working memory

F2: To see an object change, it is necessary to attend to it

-> Make changes visible in visualizations to reduce the cognitive load

F3: Our visual system sees differences, not absolute values, and is attracted to edges

-> Use high contrast between objects that should be distinguishable

F4: The visual system has different channels for shape, color, and motion

-> Use different visual channels to separate pieces of information

F5: Visual perception is selective, as awareness of everything would overwhelm us

-> We must encode data in ways that allow what's interesting and important to stand out

(Lecture 6: Patterns)

F6: The brain constructs surface color based largely on edge contrast information

-> To make areas of interest stand out adjust the background to make the edges more distinct

F7: Texture information depends on the size, orientation, and frequency of the features

-> To make textured areas of interest distinct adjust the orientation and frequency appropriately

F8: Gestalt principles are powerful and influence the way we see patterns

-> Use the Gestalt principles to arrange your visual patterns to maximize perception

(Lecture 7: Color)

F9: Color in small regions is difficult to perceive, and bright colors in large areas appear bigger

-> Use bright, saturated colors for small regions, and use low saturation pastel colors for large regions and backgrounds

F10: Only a small number of colors can be used effectively as nominal labels

-> Keep the number of colors for nominal data to less than eight, and use quiet medium grey backgrounds

F11: Lightness and saturation are effective for ordinal data because they have an implicit perceptual ordering

-> Show ordinal data with a discrete set of color values that change in lightness or saturation

F12: Quantitative data can be shown with a discrete or continuous colormap

-> Use colormaps with a limited hue palette and redundantly vary lightness and saturation, and use discrete colormaps for accuracy

13 Rules of Color Design

From: Color Design for Illustrative Visualization, L. Want, J. Giesen, K. McDonnell, K. Mueller, IEEE Transactions on Visualization and Computer Graphics, October 2008.

R1: Vivid colors (bright, saturated colors) stand out. They guide attention to a particular feature, generating the pop-out effect.

R2: An excessive amount of vivid colors is perceived as unpleasant and overwhelming; use them between duller background tones.

R3: Foreground-background separation works best if the foreground color is bright and highly saturated, while the background is de-saturated.

R4: Colors can be better discriminated if they differ simultaneously in hue, saturation and lightness.

R5: The low end lightness steps should be very small, while the high end

requires larger steps (Weber's Law).

R6: Discrimination is poorer for small objects. Hue, saturation and lightness discrimination all decrease.

R7: Complementary (opponent) colors are located opposite on the color wheel and have the highest chromatic contrast. When mixing opponent colors they may cancel each other, giving neutral grey.

R8: Some hues appear inherently more saturated than others. Yellow has the least number of perceived saturation steps (10). For hues on both sides of yellow, the saturation steps increase linearly.

R9: An opposite effect of R8 is that the brightest lights fall in the yellow range, while blues, violets (purples) and reds are least bright.

R10: For labeling, apart from black, white, grey, there are 4 primary colors (red, green, blue, yellow) and 4 secondary colors (brown, orange, purple, pink), Also, the number of color labels should be $\leq 6-7$.

R11: Warm colors (red, orange, yellow) excite emotions, grab attention. Cold colors (green to violet) create openness and distance.

R12: Important for hue-based labeling is the fact that increasing the lightness (and saturation) does not change the perceived hue.

R13: Also important for labeling is that objects of similar hue are perceived as a group, while objects of different hues are perceived as belonging to different groupings.