Clarity and Color in Scientific Images

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Criteria for Effective Scientific Images and Figures

For a scientific image to be effective, its meaning must be readily understood. There are three main areas to consider when constructing a graphic image to accurately represent textual data:

1. Clear Messaging
2. Uncluttered Graphics
3. Color Choice

A scientific image or figure represents textual data in a concise, visual manner. Prior to designing a graphic representation of the material, the author must decide what information is crucial and how best to convey that visually. In order for the message to be clear, this graphic must be uncluttered by extraneous material. Edward Tutfe [1] calls this extraneous material "chartjunk". In addition, color choice can be the difference between a readable and a confusing image.

Color Blindness

In the United States alone, color blindness affects as many as 8% of men and 0.5% of women – more than 13 million people. The most common form is called "protanopia," which is the form of color blindness characterized by defective perception of red and confusion of red with green or bluish green. Other forms of color blindness affect the perception of green & brown, blue & purple, green & blue, light green & yellow, blue & grey, green & grey, and green & black.

http://www.somersault1824.com/tips-for-designing-scientific-figures-for-color-blind-readers/
http://www.thefreedictionary.com/protanopia

Authors Masataka Okabe and Kei Ito (both of whom are affected by protanopia), describe the function of color blindness in this way:

The human eye has three types of cone cells. These cells express different types of opsin genes, which are sensitive mainly to red, green and blue, respectively. Colorblindness is the situation where the function of one of these opsins are lost, or perturbed. If the function of one type of the cones cells is lost, the person can still recognize fairly good variety of hues using the remaining two cone cell types, [but a] certain range of colors…becomes harder to distinguish.

Their article, entitled, "Color Universal Design (CUD) – How to make figures and presentations that are friendly to Colorblind people" provides excellent visual representations of how certain colors are perceived by those with color blindness. It's not possible to think of color usage in the same way after examining these charts.
http://jfly.iam.u-tokyo.ac.jp/color/#top

An example would be the common usage of the color red to highlight important information in graphs, charts, and other images. However, if red appears as a brownish color to a reader with color blindness, it certainly won't have the same impact or communicate the same message. Therefore, with so many readers potentially affected by some form of color distortion, the academic publishing community should make color modifications a general practice.

Fortunately, there are many tools to assist scientists and researchers with the creation of effective images. A logical start would be to understand color palettes and how they affect the reader. Brewer palettes were designed by Cynthia Brewer for use in cartography, but the field of data visualization has adopted them as well. These palettes organize color in a way that helps the user determine which colors will appear similar and which will appear as contrasting.

Martin Krzywinski has taken the Brewer palettes and created 15-color palettes for color blindness for each of the three common types of color blindness. In addition, within their article entitled, "Ten Simple Rules for Better Figures," Nicholas Rougier, Michael Droettboom, and Philip E. Bourne list some open source tools that can assist in the development of colorblind-sensitive scientific images:

- Matplotlib
- R
- Inkscape
- TiKZ & PGF
- GIMP
- ImageMagick
- D3.js
- Cytoscape
- Circos

http://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1003833

Preparing Figures and Images

The article by Rougier, Droettbloom, and Bourne, as the title suggests, lists ten fundamental components of an effective scientific image or figure:

1. Know Your Audience
2. Identify Your Message
3. Adapt the Figure to Support the Medium
4. Captions are Not Optional
5. Do Not Trust the Defaults
6. Use Color Effectively
7. Do Not Mislead the Reader
8. Avoid "Chartjunk"
9. Message Trumps Beauty
10. Get the Right Tool

Their full explanations of each point are worth reading. However, suffice it to say that basic elements of clarity and purpose are at the root of each. The reason scientists and researchers use graphics to represent their work is so that the reader can grasp the material quickly and easily. Anything that interferes with or distorts the message should be eliminated.

Okabe and Ito also offer some concise guidance when it comes to preparing figures and images. Focusing on the use of color, they call this "3 (+1) Principles of Color Universal Design":

1. *Choose color schemes that can be easily identified by people with all types of color vision, in consideration with the actual lighting conditions and usage environment*
2. *Use not only different colors but also a combination of different shapes, positions, line types, and coloring patterns to ensure that information is conveyed to all users….*
3. *Clearly state color names where users are expected to use color names in communication*

(+1). …Aim for visually friendly and beautiful designs

Function + Design → Potent Scientific Images

Taking the basic tenets of figure design from such sources as somersault1824.com (see references, below) and merging them with considerations for those with color perception issues will result in a potent scientific image. Used wisely and efficiently, color, varying typeface, highlighting, textures and patterns, simple bolding or italicizing, and identifying the proper format for the audience and environment will serve both the author and reader well.

The message must be paramount to the design and the design must serve the message.

REFERENCES

1. Tufte EG (1983) The Visual Display of Quantitative Information. Cheshire, Connecticut: Graphics Press.

http://www.somersault1824.com/a-simple-strategy-to-bring-focus-to-your-scientific-figures/

http://www.somersault1824.com/dont-let-color-distort-the-meaning-of-the-underlying-data/

SOCIAL MEDIA LANGUAGE

#ScientificImages #PreparingScientificFigures

How to create #ClarityInScientificFigures