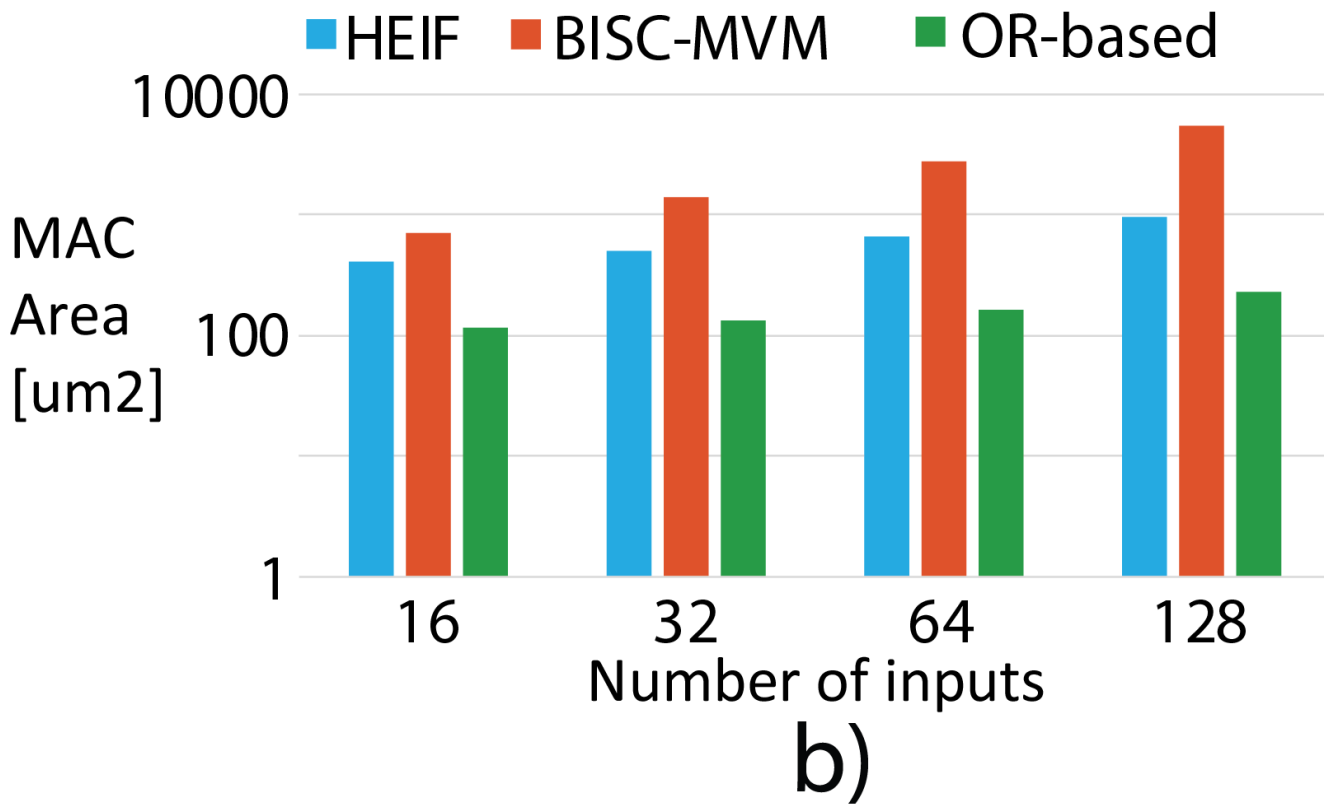
The Misuse of Colour in Science Communication

FABIO CRAMERI, GRACE E. SHEPHARD, PHILIP J. HERON

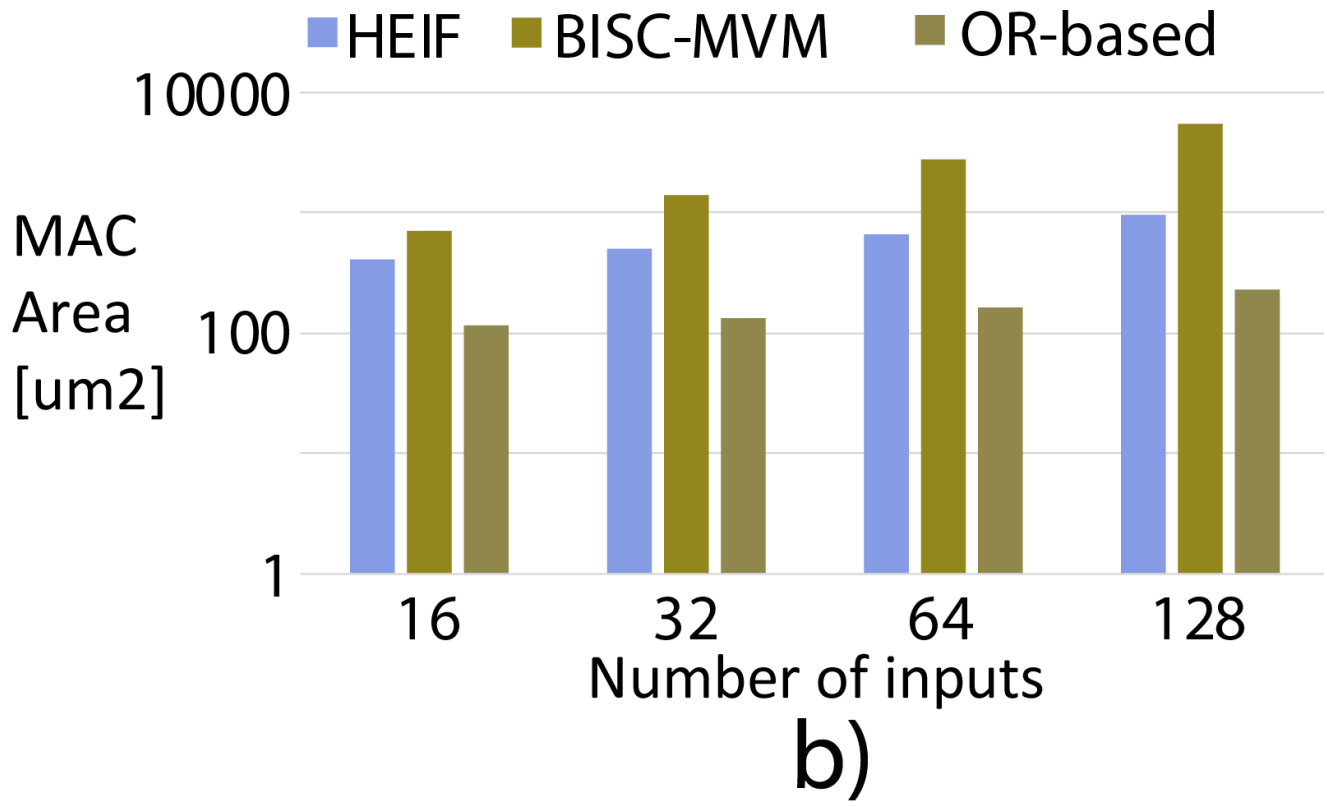
PRESENTED BY WOJCIECH ROMASZKAN

What's Wrong with this Figure?



Source : Own. Unpublished.

6% of Male Population* See This:



b)

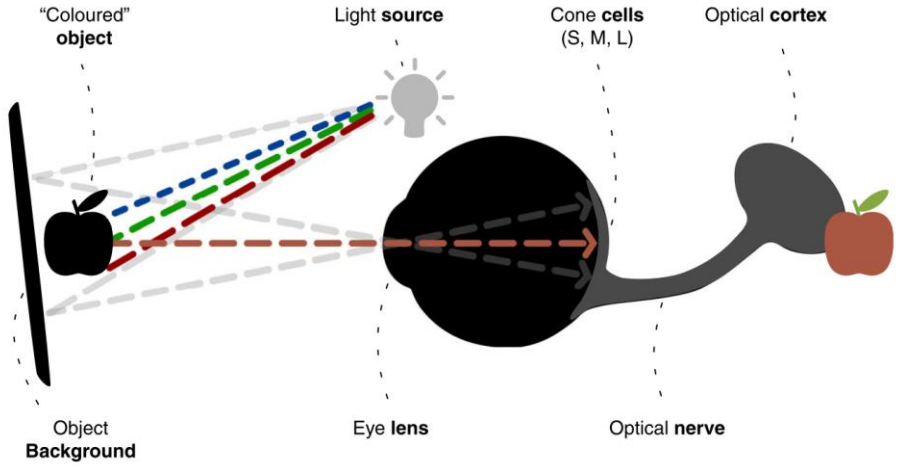
Source : Own. Unpublished.

Never put red and green together.

*Mostly white men for some reason.

What is Color?

- Things are not inherently of a given color.
- It's perceived via hue (dominant color family), tint (mix + white) and luminosity (brightness).
- Within the eye there are two types of receptors:
  - Rods – process lightness (grayscale) – light's energy.
  - Cones – process hue – light's wavelength.
- 2/3 of cones process longer wavelengths
  - Red, orange, yellow.
- Human color perception is non-uniform.
- Color-Vision Deficiency (CVD), aka color blindness:
  - Shift in color perception.
  - Deuteranopia – red-green dichromatism (M-cones – middle wavelength).



Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Rainbow (Jet) is Bad.

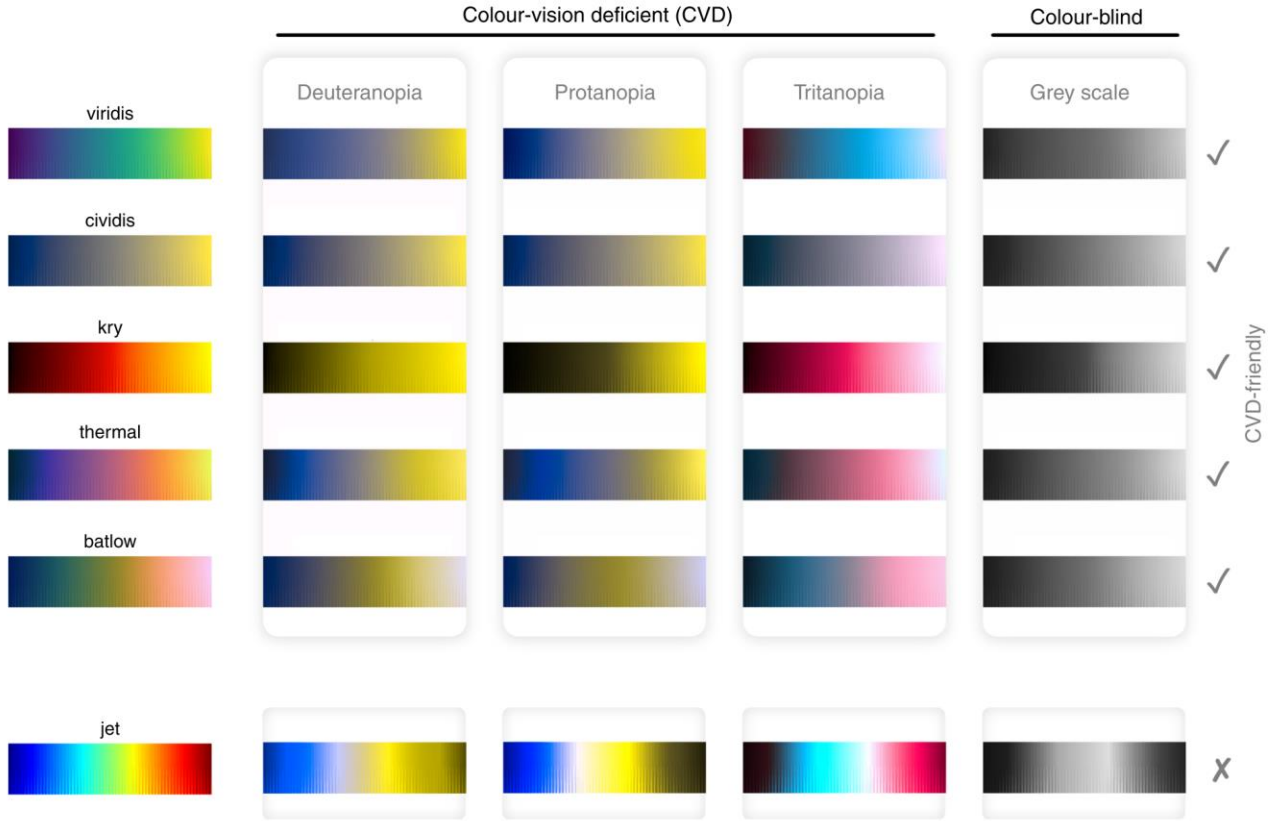
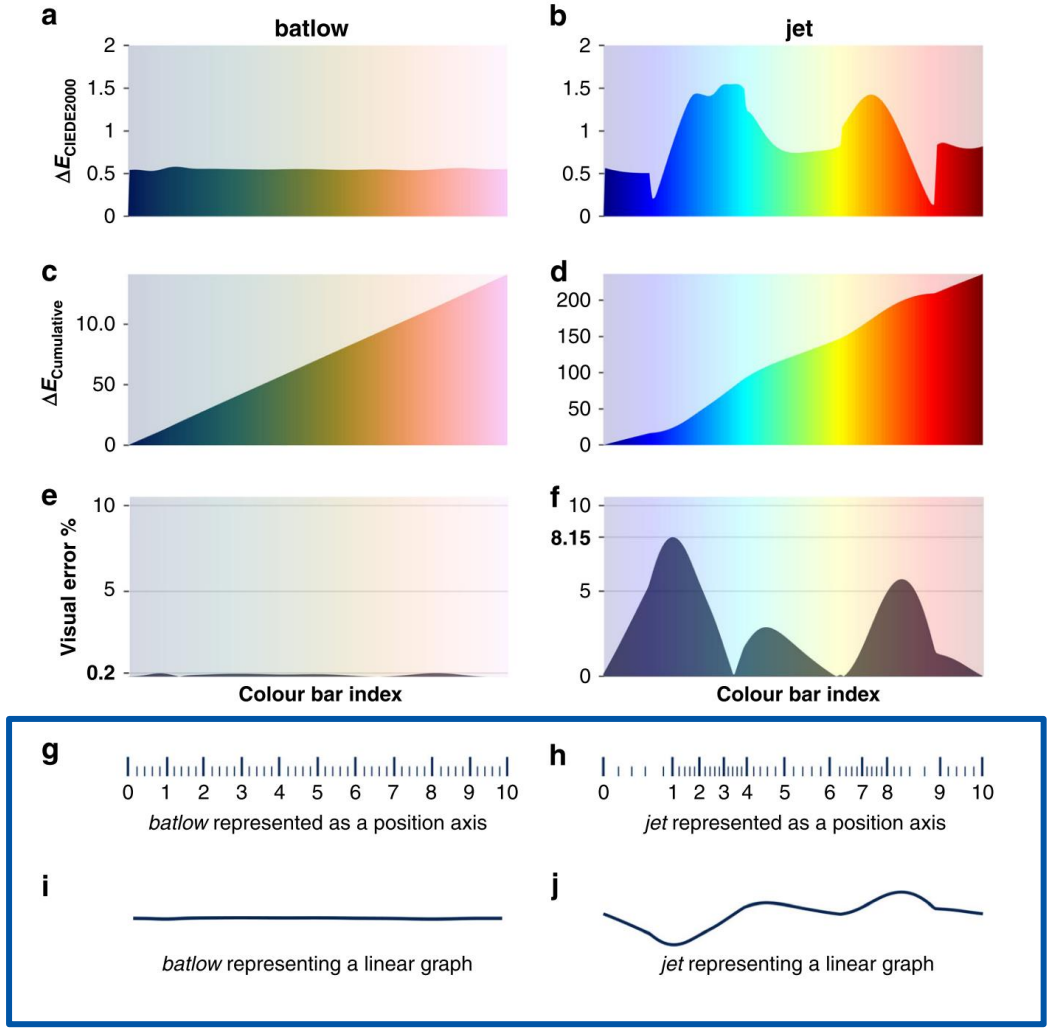


Fig. 2 Colour vision tests. Available perceptually uniform colour maps versus the non-uniform rainbow (i.e., jet; bottom row) as seen with either of the three common forms of human colour-vision deficiency (deuteranopia, protanopia, and tritanopia), and for grey-scale (representing total colour-blindness or simple black-and-white prints). Rainbow, the most-widely used colour map, fails to reproduce a meaningful smooth gradient, yet the other colour maps (see Box 2) are all universally readable.

Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Color can Distort Your Data

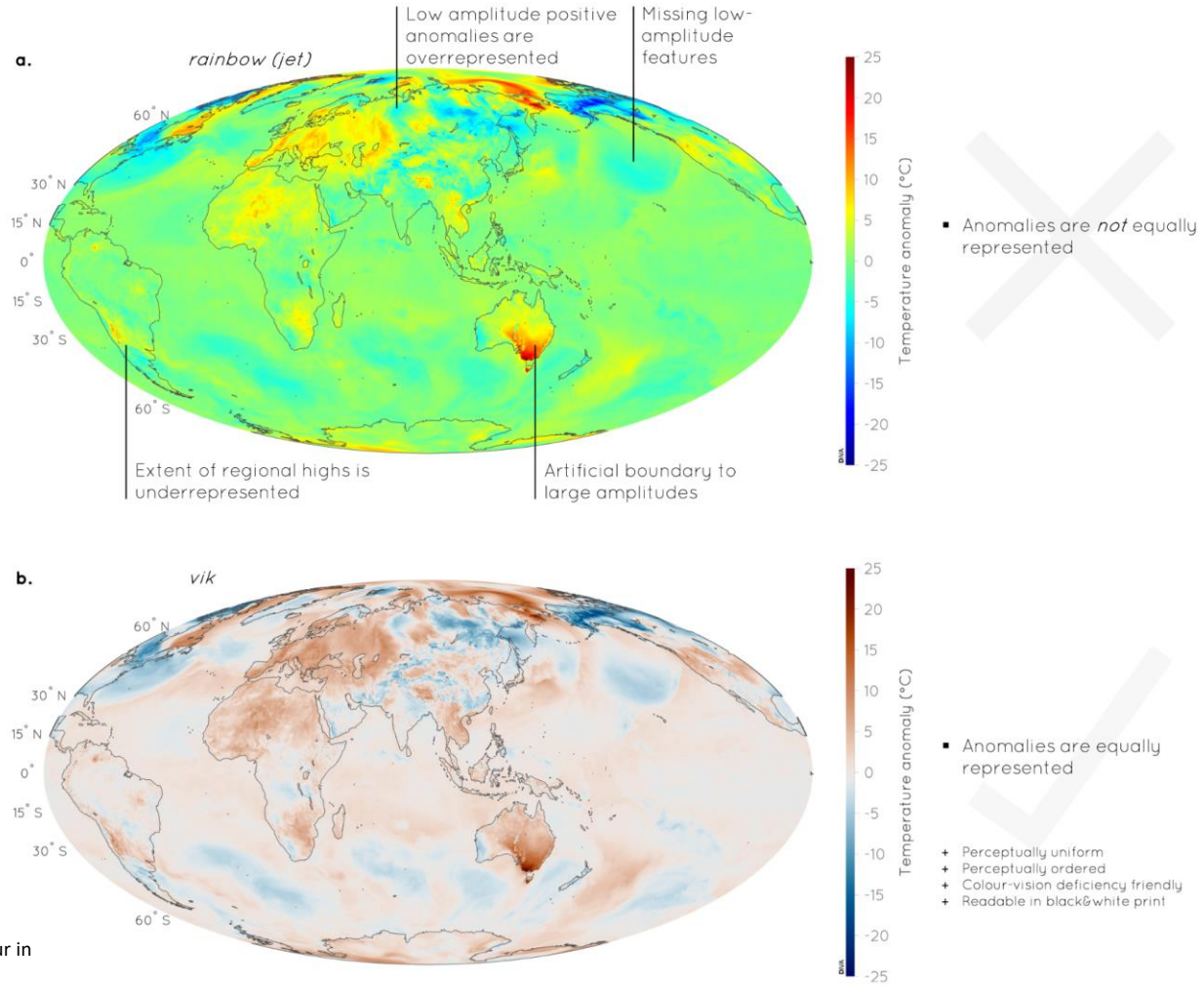
- When using color maps, it is important that perceived variation matches the data variation.
  - I.e. a “legend” is not required to interpret it.
  - **But you should always include it.**
- Jet (“rainbow”) introduces significant visual distortion.
  - >7% difference between perceived and objective interpretation.



Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Distortion Example

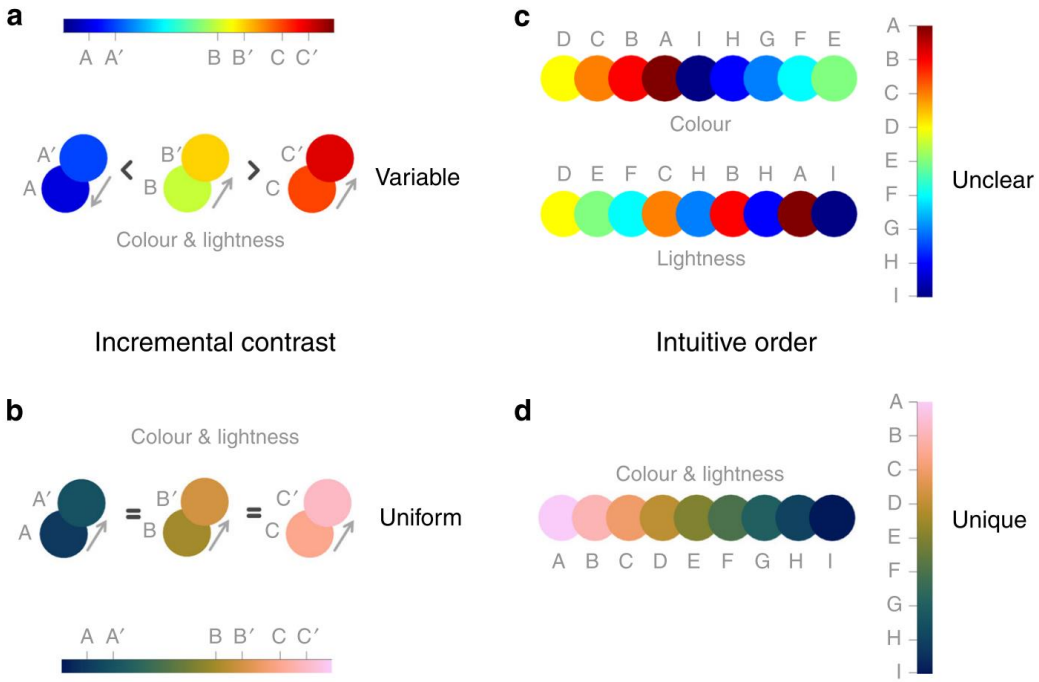
- On the upper map, the same data variation (e.g. 5-degree drop) appears different at high and low temperatures.
- **<u>Perceptual uniformity.</u>**



Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Scientific Color Maps

- Perceptual uniformity.
  - Does not distort the scale.
- Perceptual color order.
  - Intuitive qualitative understanding.
  - Linear change in lightness and brightness.
- Color-deficiency friendly.

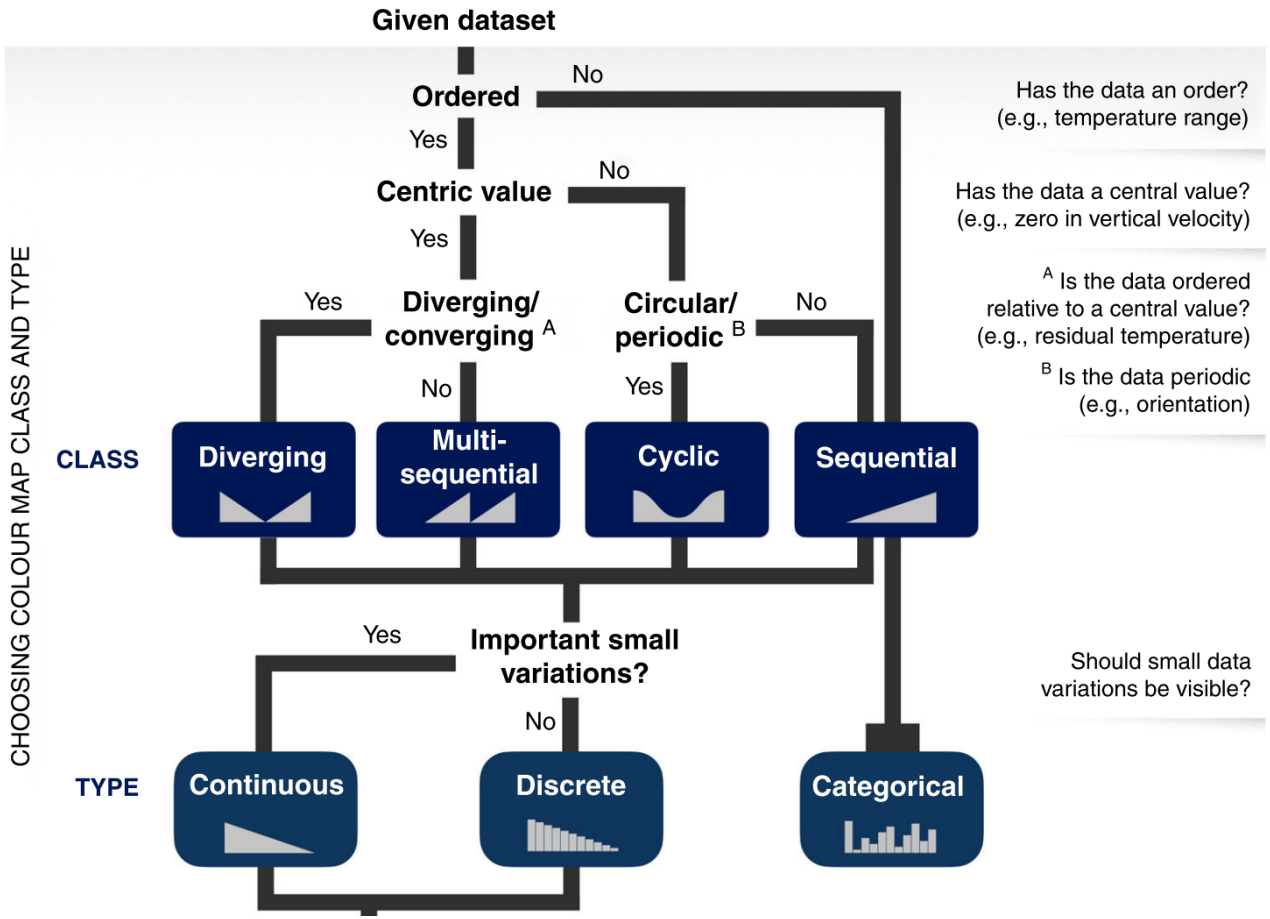


Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Types of Color Maps

Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Use a Flowchart!

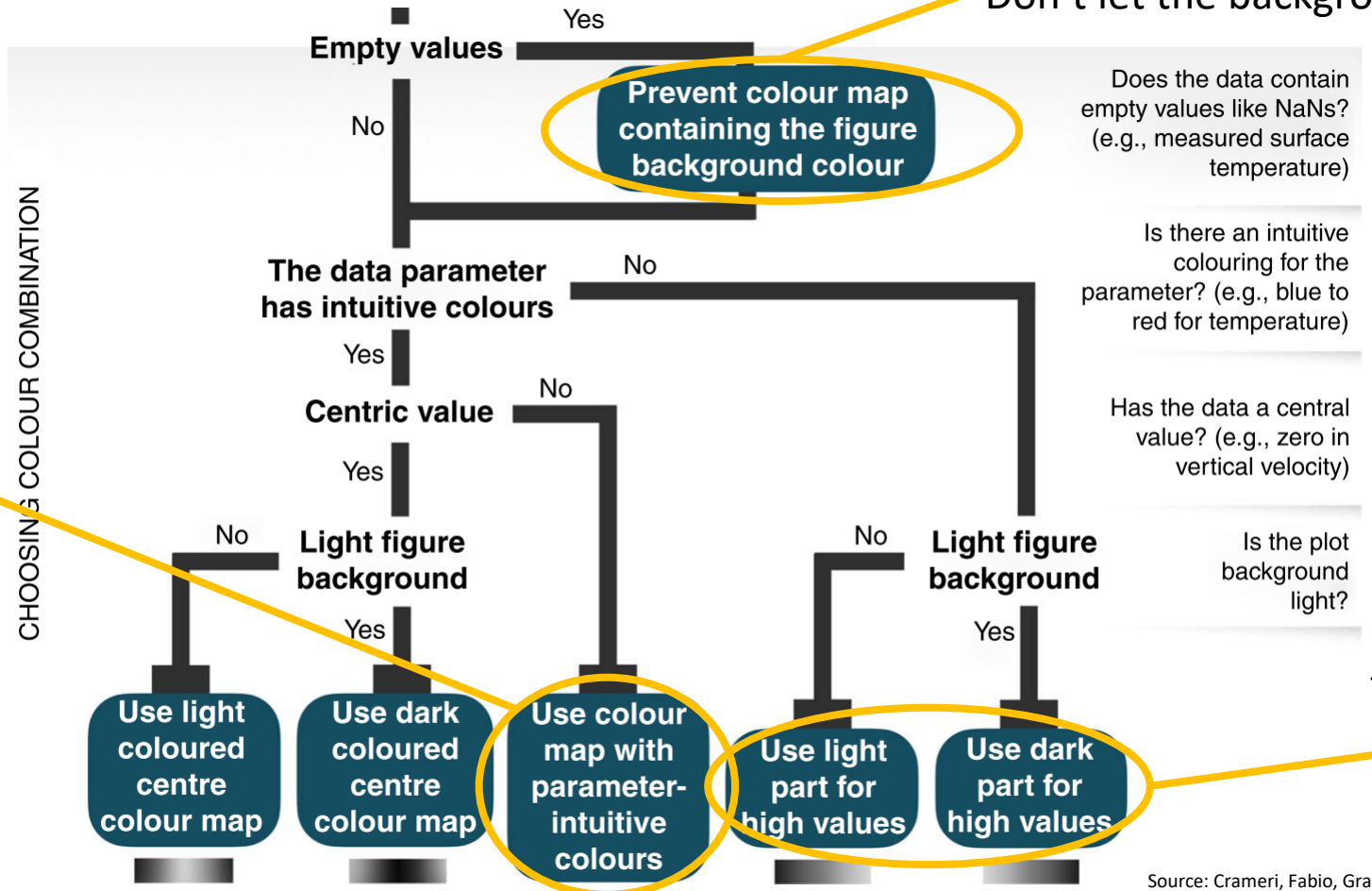


Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

Background is Impoartant

Don’t let the background blend with the figure

Pick a scale based on the type of data



Order the scale based on the background

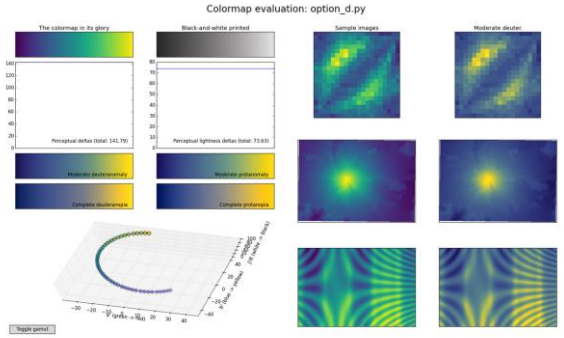
Source: Crameri, Fabio, Grace E. Shephard, and Philip J. Heron. "The misuse of colour in science communication." *Nature Communications* 11.1 (2020): 1-10.

What to Look out for?

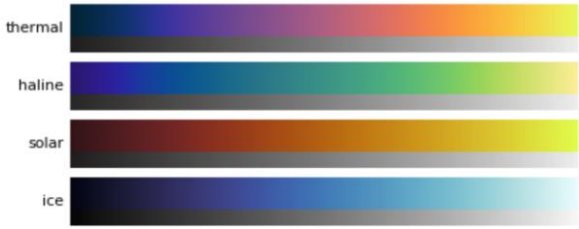
- Perceptual non-uniformity.
  - Hard to judge.
- Red and green at similar luminosity (like the original figure I showed).
- Rainbow (jet).
- Make sure the color map is described as scientifically derived.

Where to get Color Maps?

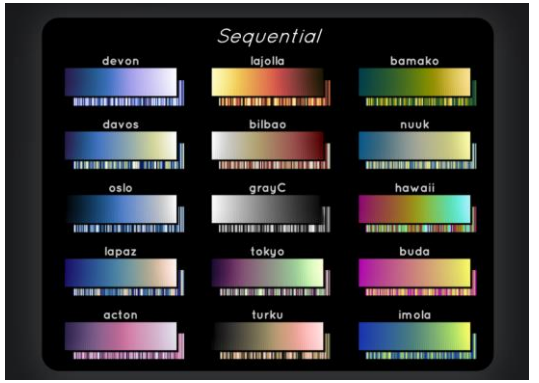
- **Colorbrewer** – can manually specify and export maps, optionally CVD friendly. Sequential, diverging and categorical (no continuous).
- **Matplotlib** – aimed at perceptual uniformity. Popular: viridis, magma, plasma, inferno. Sequential and continuous only (no discrete, diverging, cyclical etc).
- **Cividis –** single color map, aims to look identical to people with red-green deficiency.
- **CMOcean –** inspired by oceanography. Aim at intuitive colors for specific physical parameters.
- **CET –** continuous, sequential, diverging and cyclic.
- **Scientific colour maps -** perceptually uniform, ordered, CVD-friendly, readable in black-and-white print, dataset specific, parameter intuitive. Sequential, cyclic, diverging.



Source: https://bids.github.io/colormap/

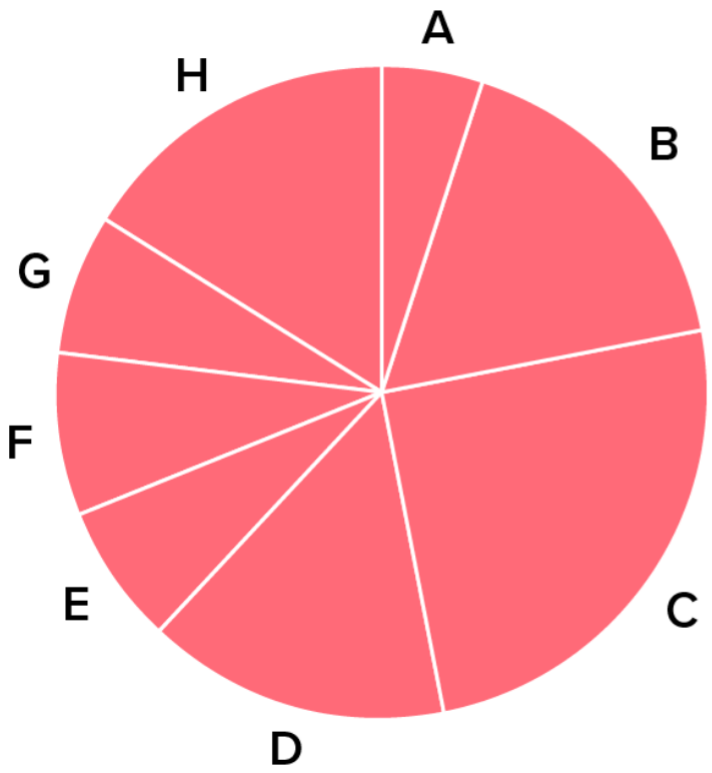


Source: https://matplotlib.org/cmocean/



Source: http://www.fabiocrameri.ch/colourmaps.php

Let's Talk Plot Types

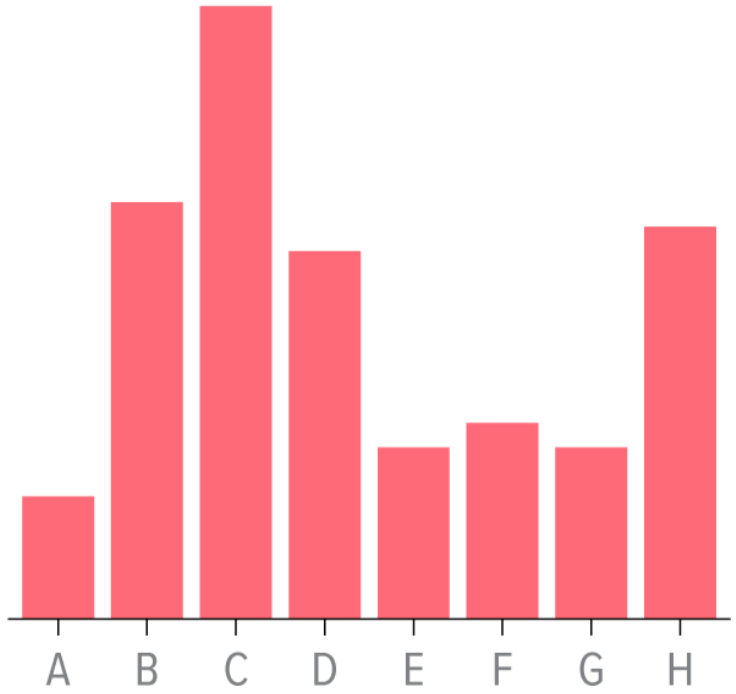


Which is the third largest segment in the pie chart?

- A
- H
- B
- D

Source : Why scientists need to be better at data visualization. https://knowablemagazine.org/article/mind/2019/science-data-visualization

Let's Talk Plot Types ctd.

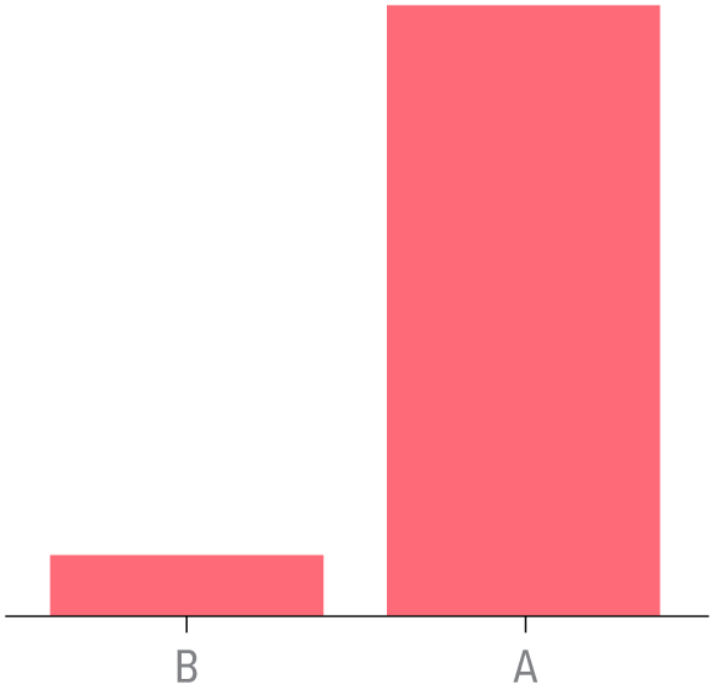


Which is the third tallest bar?

- H
- B
- D
- F

Source : Why scientists need to be better at data visualization. https://knowablemagazine.org/article/mind/2019/science-data-visualization

Let's Talk Plot Types ctd.

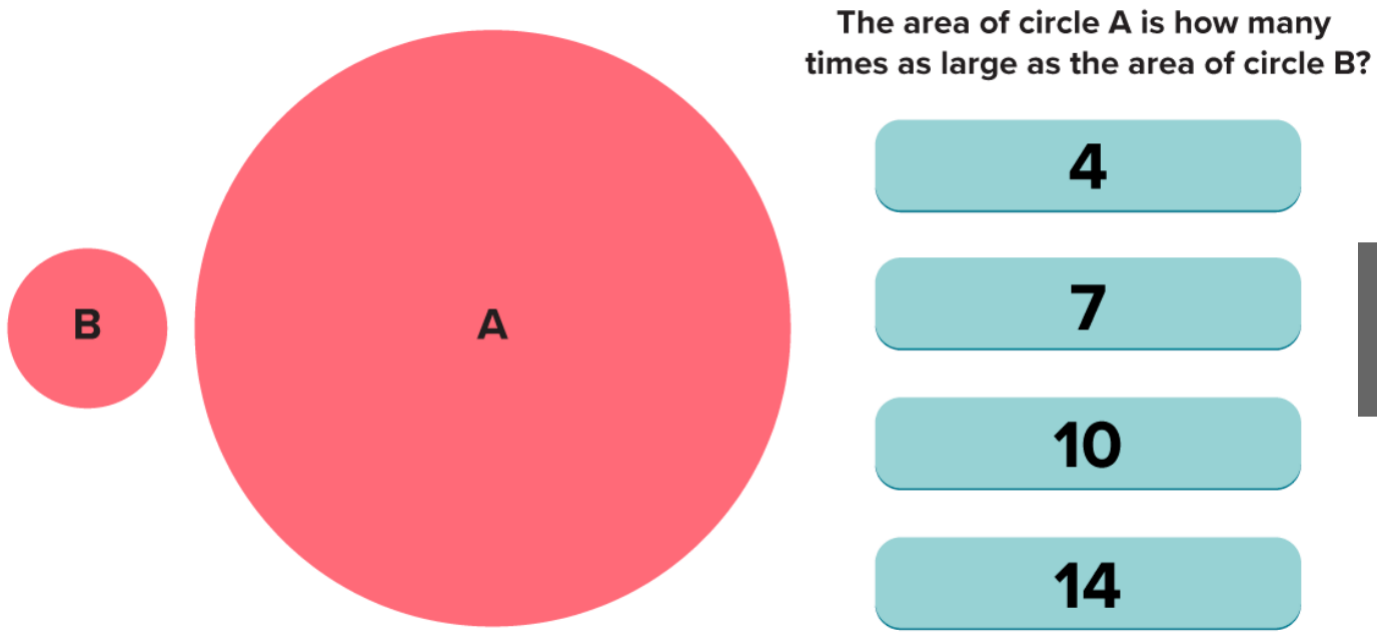


The value of A is how many times as large as the value of B?

- 9
- 8
- 10
- 5

Source : Why scientists need to be better at data visualization. https://knowablemagazine.org/article/mind/2019/science-data-visualization

Let's Talk Plot Types ctd.



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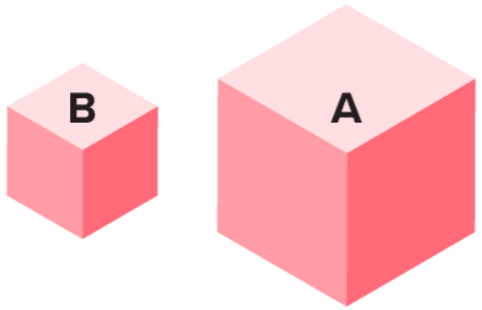
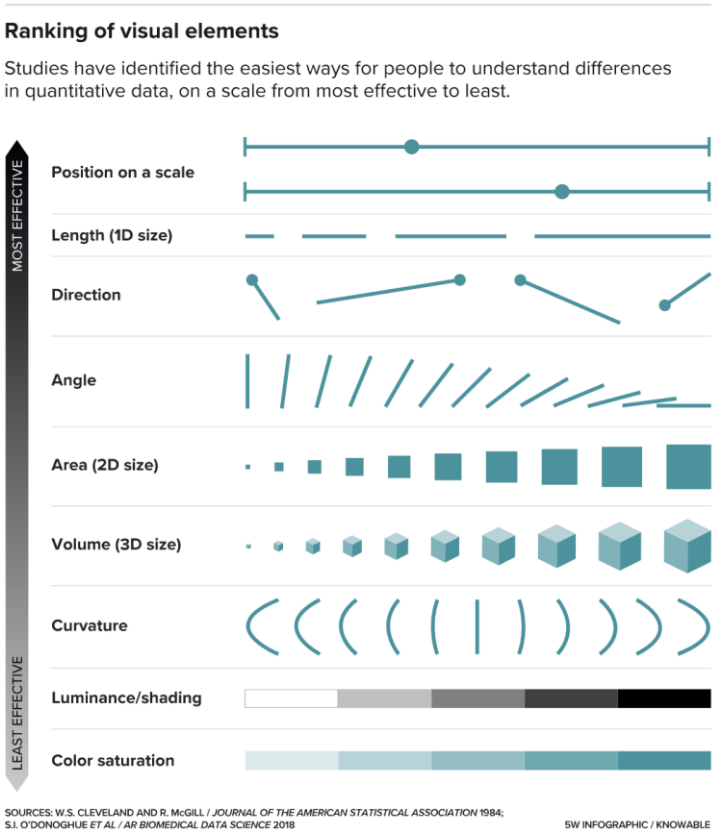


The volume of cube A is how many times as large as the volume of cube B?

- 3
- 5
- 7
- 8

Source : Why scientists need to be better at data visualization. https://knowablemagazine.org/article/mind/2019/science-data-visualization

Don’t Overcomplicate



People are better at discerning subtleties in some types of visuals than others — the length of two lines, for example, or the direction of a line are easier to tell apart than shades of gray or the intensity of a color. Studies show that graphs using visual elements high on this list are easier to read and more effective than those near the bottom.

Source : Why scientists need to be better at data visualization. https://knowablemagazine.org/article/mind/2019/science-data-visualization