Color experiments in the wild internet?

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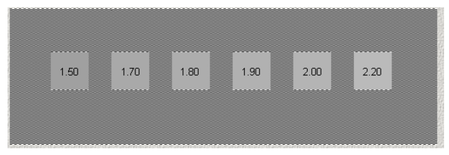
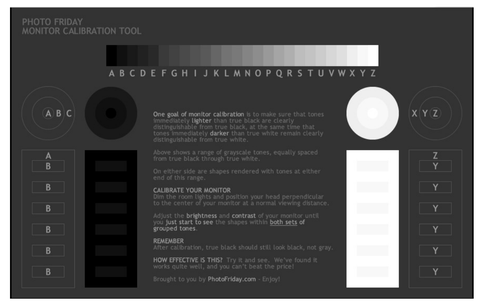
Color 3.0

- Measuring monitors is seen as an absolute necessity for color vision research, although monitors usually come already calibrated from the factory
- Accurate xyY and gamma info is needed when we are concerned with tiny differences between colors or when we need to be sure that color matches are indeed as exact as can be. It is also necessary for studying certain features of adaptation mechanisms.
- But, with the rise of online experimentation and the wide-ranging graphical capabilities of modern browsers, it is worth asking if we can forgo rigorous monitor calibration but still conduct sensible color experiments. Can we make certain assumptions about monitors?
- A first step is to investigate the distribution of differences between common household monitors

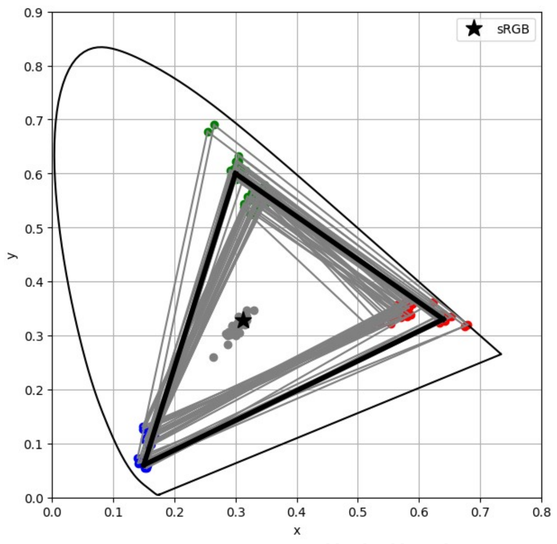




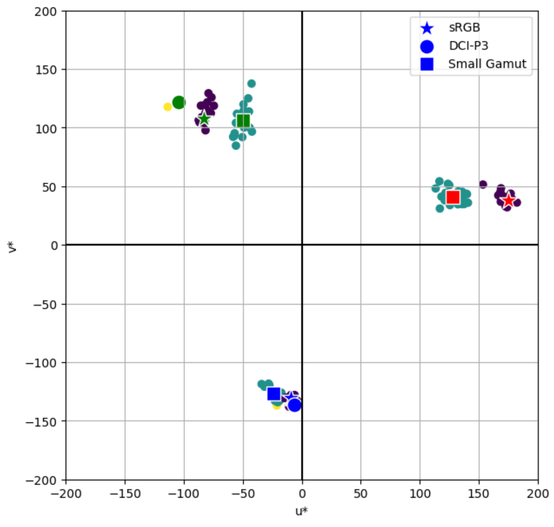
According to online databases, such as the one from rtings.com, the vast majority of newly purchased modern monitors (281 tested) have the properties at right. Most modern TVs have similar characteristics. To have an idea of what the typical observer owns, we measured 43 of our observers' monitors.

Average Gamma Exponent	Average sRGB Gamut Area (xy)	Frequency of HDR10 output	Avg Color Temperature (Kelvin)	• Frequency in sRGB mode	• Color accuracy • (LAB DE2000 Avg)
2.19 +/- 0.1	106.4 +/- 10.39%	16.54%	6769.51 +/- 440.65	• 60.9%	• 2.71 +/- 1.09

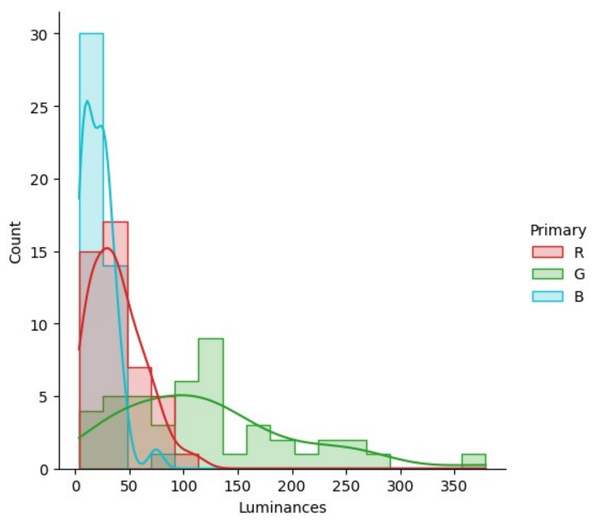
Monitor primaries seem to have substantial differences in xyY space



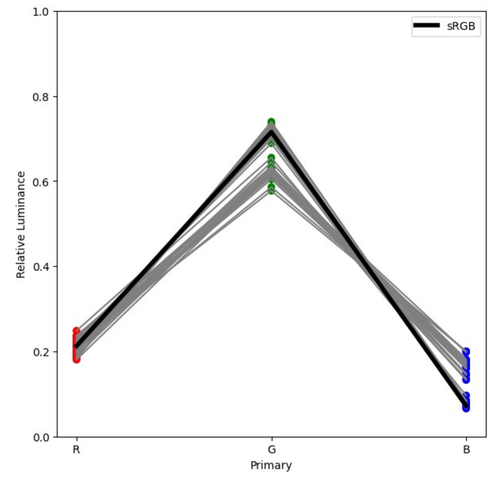
In LUV space, it is easier to see that they cluster in three groups



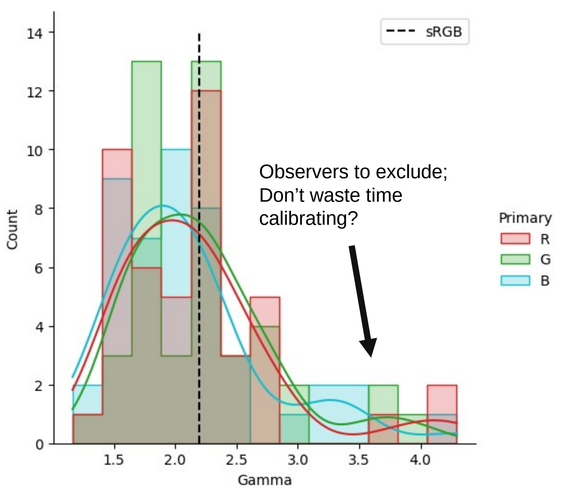
The green primary shows the most variability in luminance



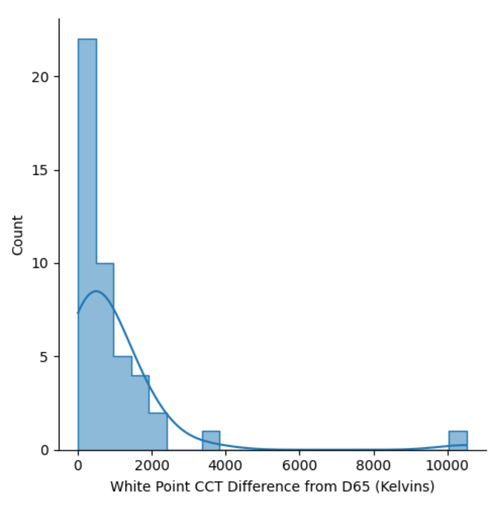
But they have similar relative luminance contributions to white, clustering in two groups.



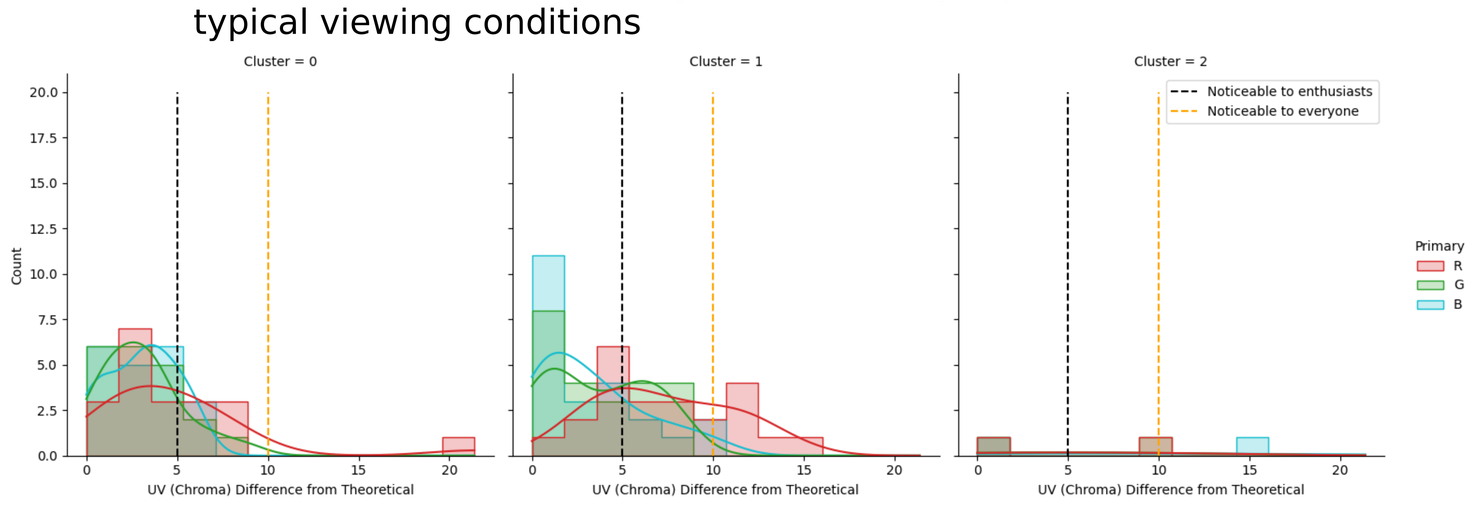
The gamma curves distribute around a mean of 2.16(+/-0.043)



And most of their white points are at D65 or close to it



If we compare each primary's chromaticity to it's theoretical ideal value, then we find that they are essentially equal to their standards for typical viewing conditions



3 typical types of monitors, overall with roughly 2.17 gamma

Most are sRGB or a slightly smaller version of it

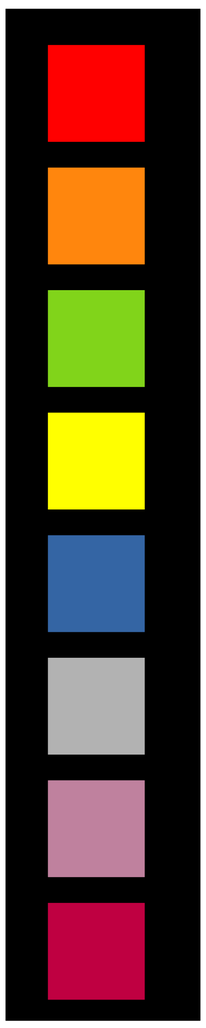
White point is relatively stable

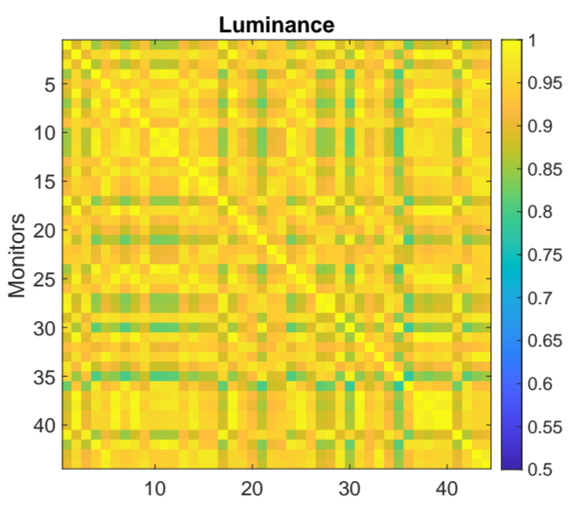
The most variation is in the luminance of the green primary

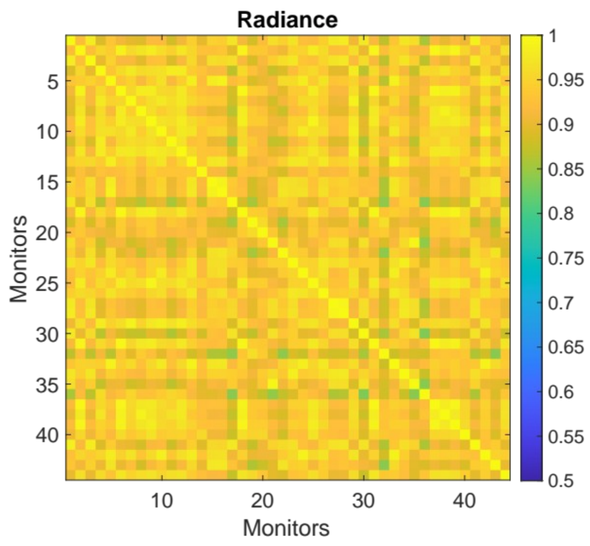
This indicates that for many experiments, we can just ask online observers what monitor they have and then see which of the three clusters it falls into and check the luminances with the online published reports. In the worst case, we can assume sRGB

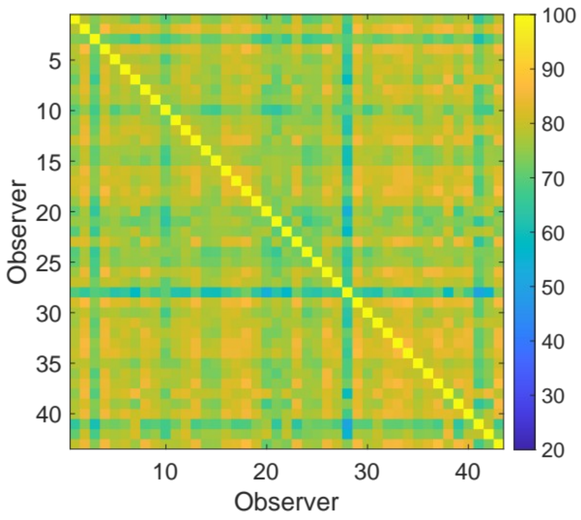
The companies are starting to agree to standardize on default sRGB presentation in canvases and in WebGL2 contexts, but we are not there yet.

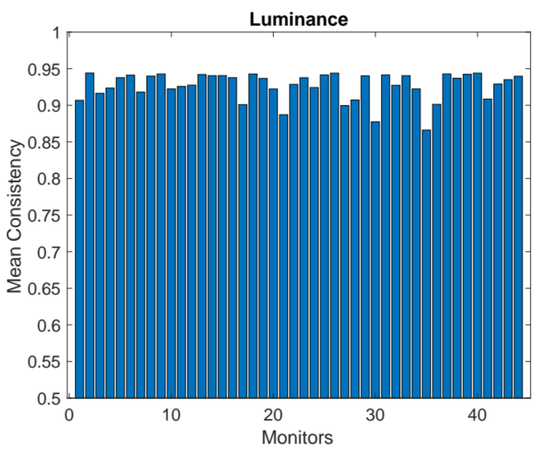
But are there also experiments where we do not need to worry about absolute values or about the specific chromaticities of the primaries?

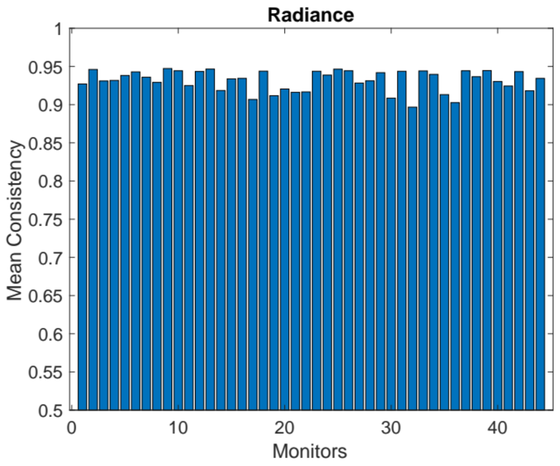


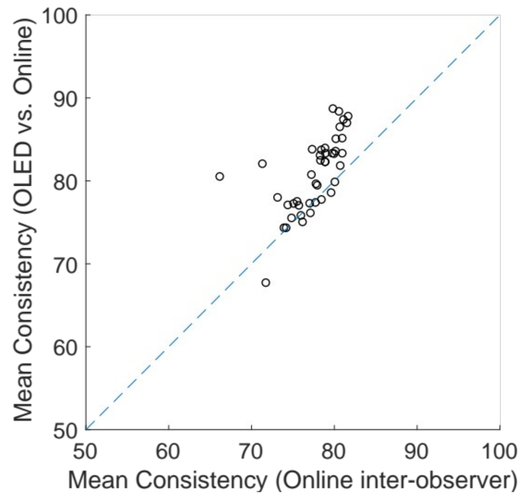












With some precautions, we can already start conducting color experiments online.

We can also consider new classes of experiments that are not tied to absolute values or where observer noise is greater than the scale of small color differences.

The main thing to consider is luminance variations across monitors and the occasional bad white or bad gamma.

Once better color management is available in the browsers, we can target the smallest gamuts and still do a wide variety of useful research.