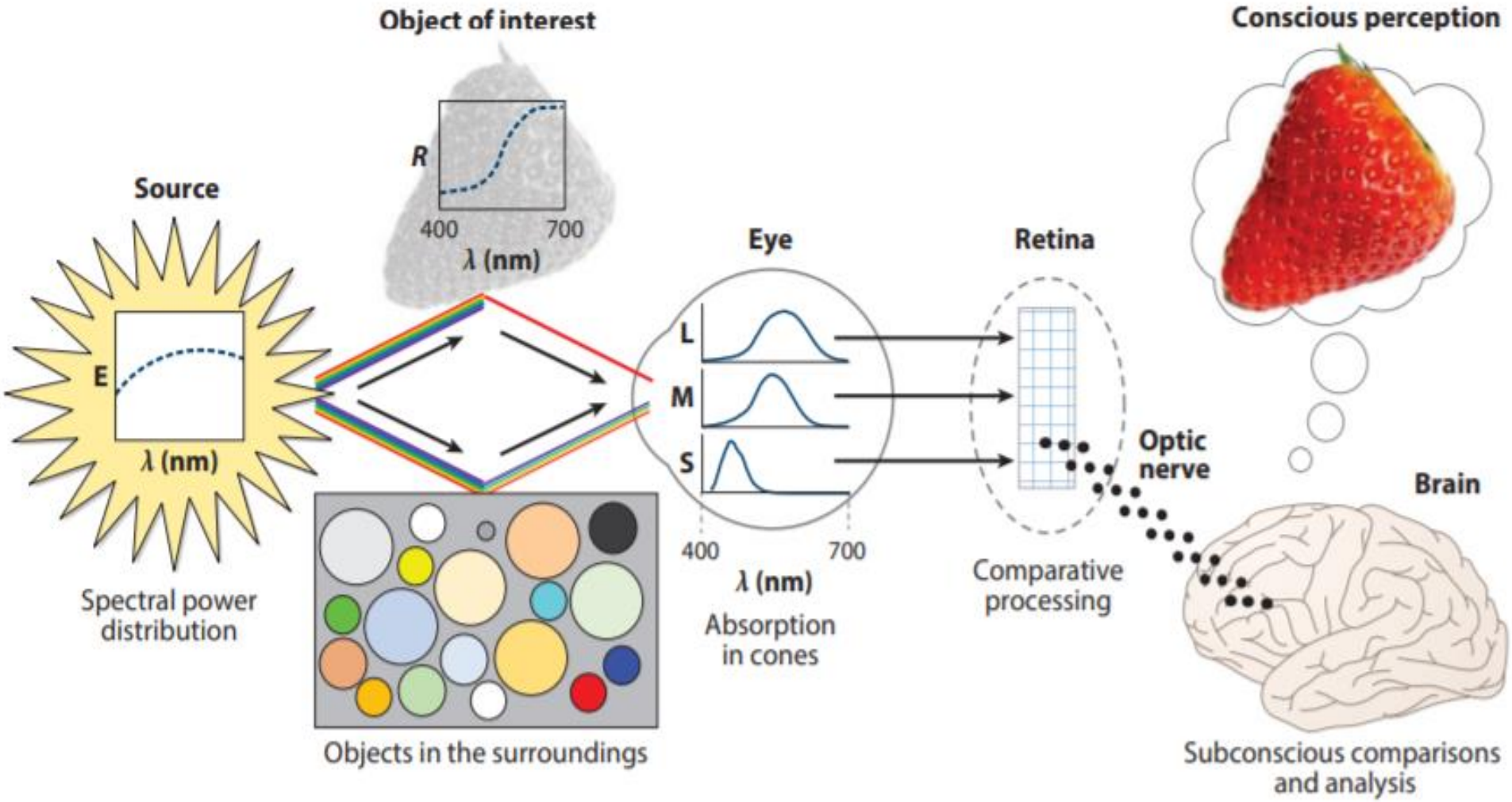
Predicting Color Perception Shifts for Wide-Gamut Displays Due to Differing Cone Fundamentals

Lorne Whitehead (University of British Columbia),

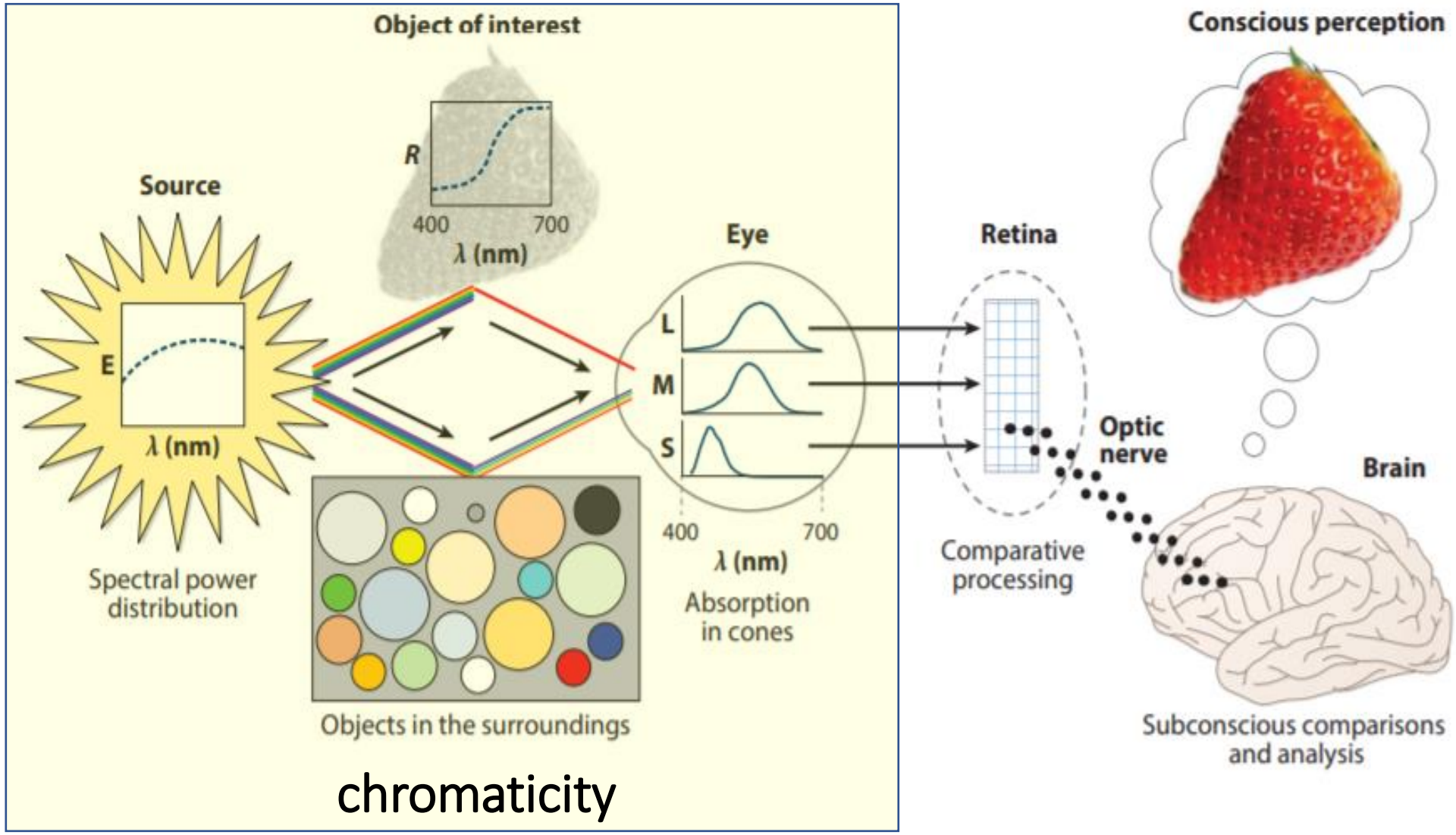
Kevin A.G. Smet (KU Leuven),

Michael Webster (University of Nevada, Reno)

About Color Perception

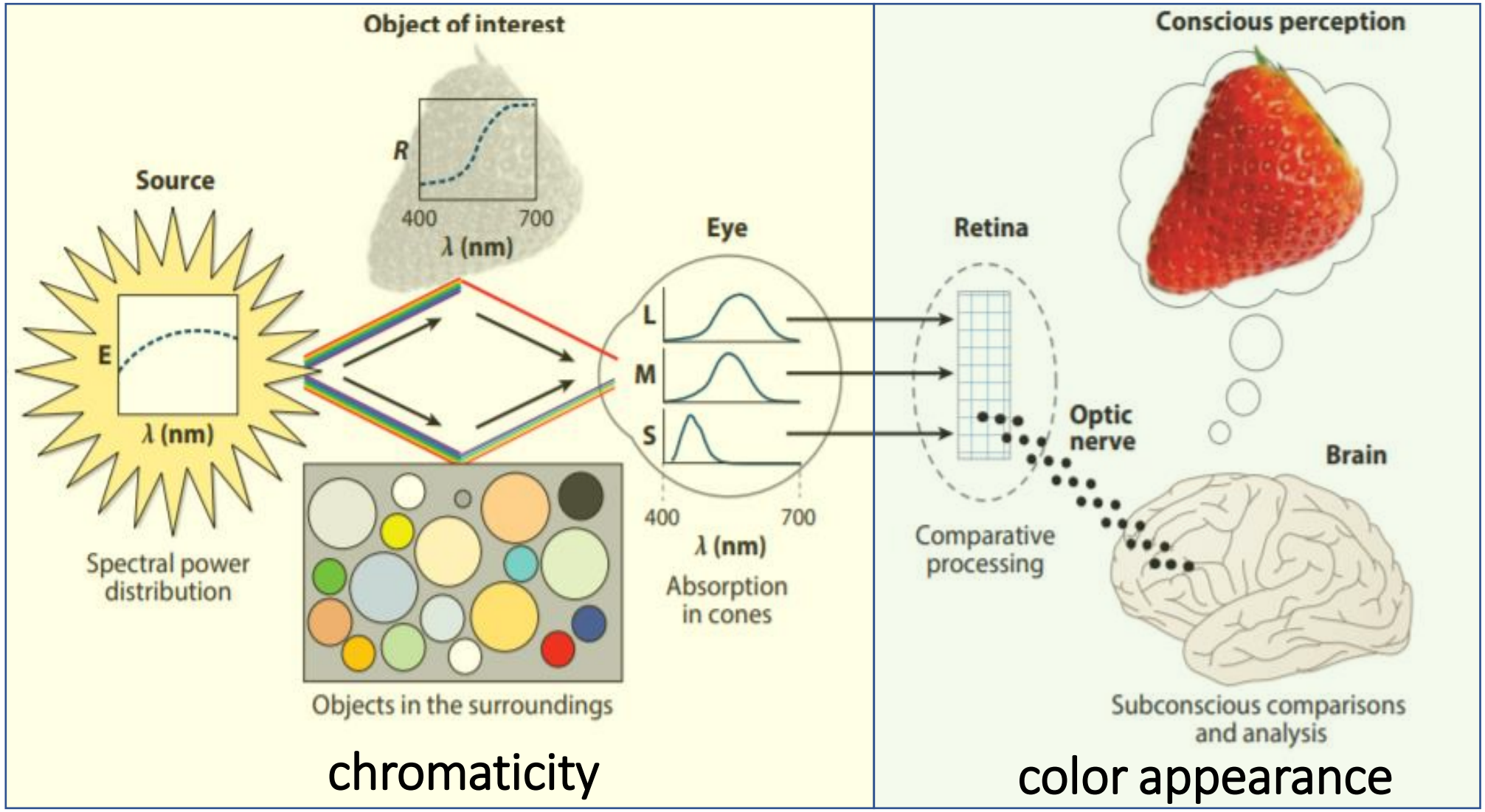


About Color Perception



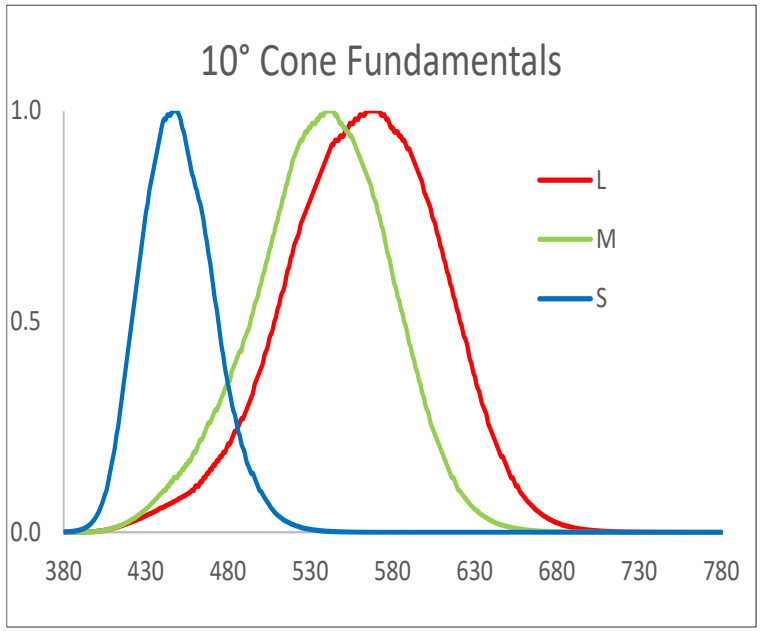
chromaticity

About Color Perception

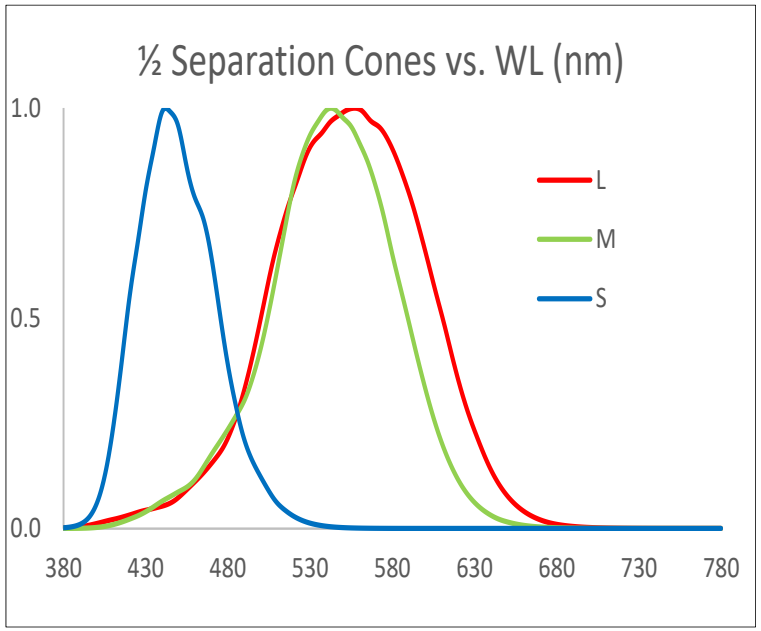


chromaticity

$$\frac{L_i}{L_w} = \frac{\int_0^\infty \bar{l}(\lambda) E_{e,\Omega}(\lambda) R_i(\lambda) d\lambda}{\int_0^\infty \bar{l}(\lambda) E_{e,\Omega}(\lambda) d\lambda}$$, and same for M and S



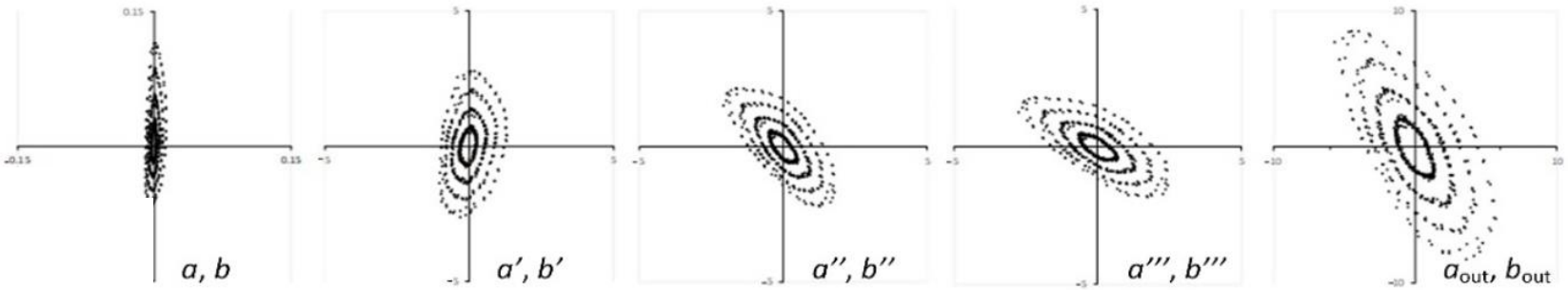
an average observer



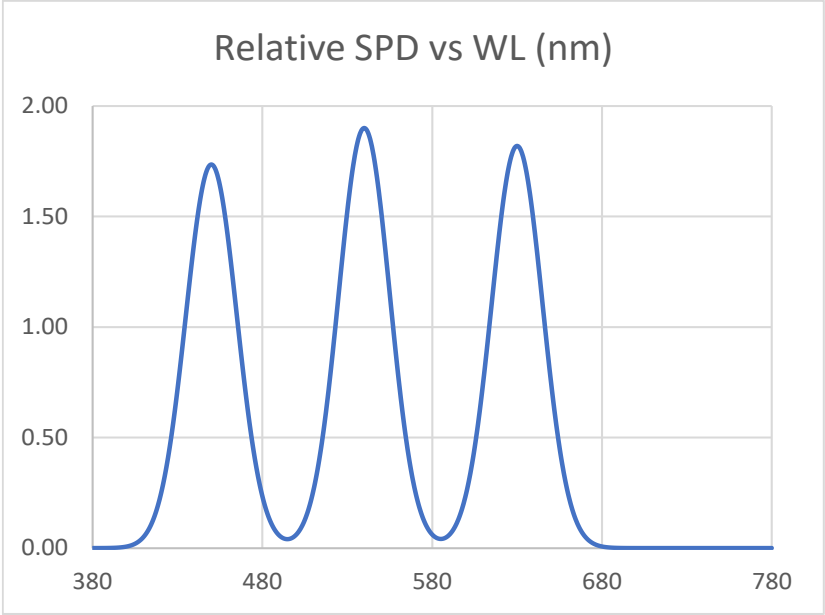
an observer with less R-G sensitivity

A non-average observer adapts to see colors normally under broad-band illumination

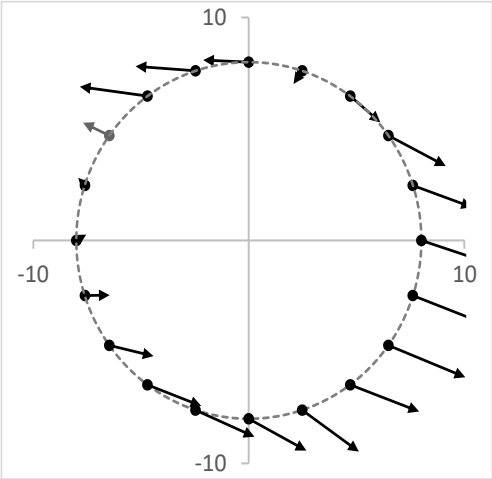
unadapted



Unfortunately, narrow band three-primary source distorts colors for the non-average observer.

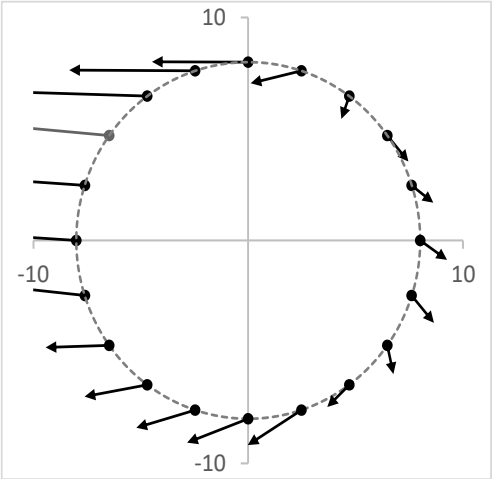


post-adaptation color perception deviations for various displayed hues



Relative Error = 1.79 Munsell Units

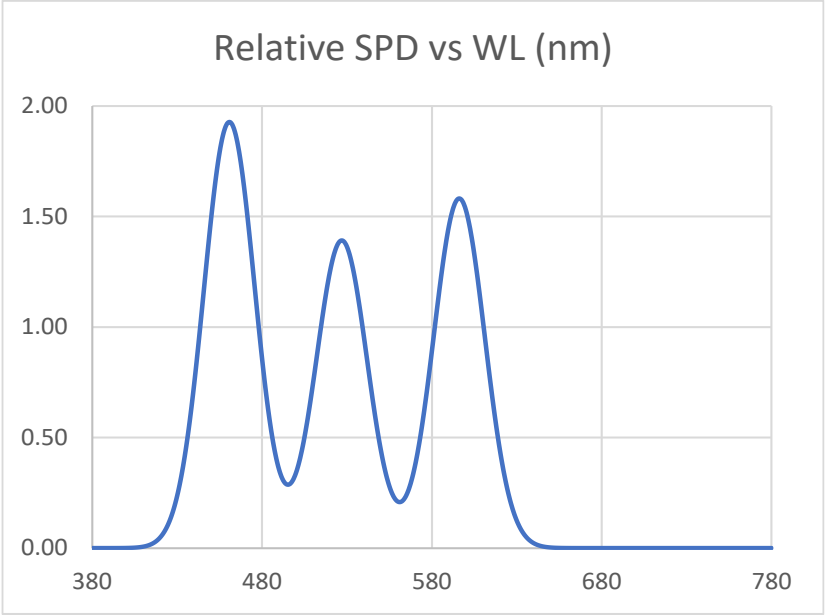
standard observer



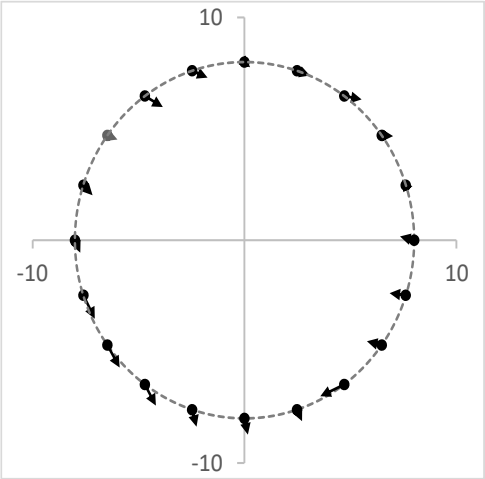
Relative Error = 3.25 Munsell Units

less R-G sensitive observer

Adjusting the peak wavelengths reduces the problem somewhat, but at the cost of gamut.

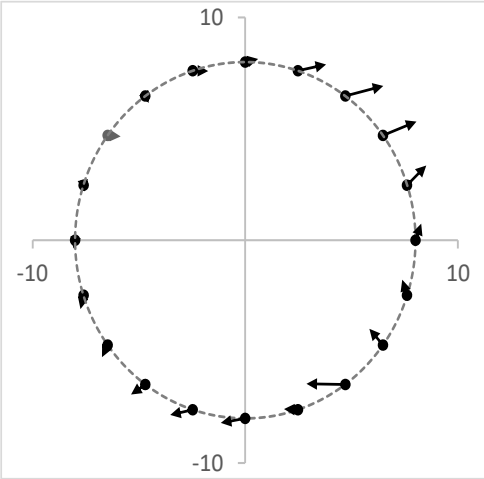


post-adaptation color perception deviations for various displayed hues



Mean Error = 0.61 Munsell Units

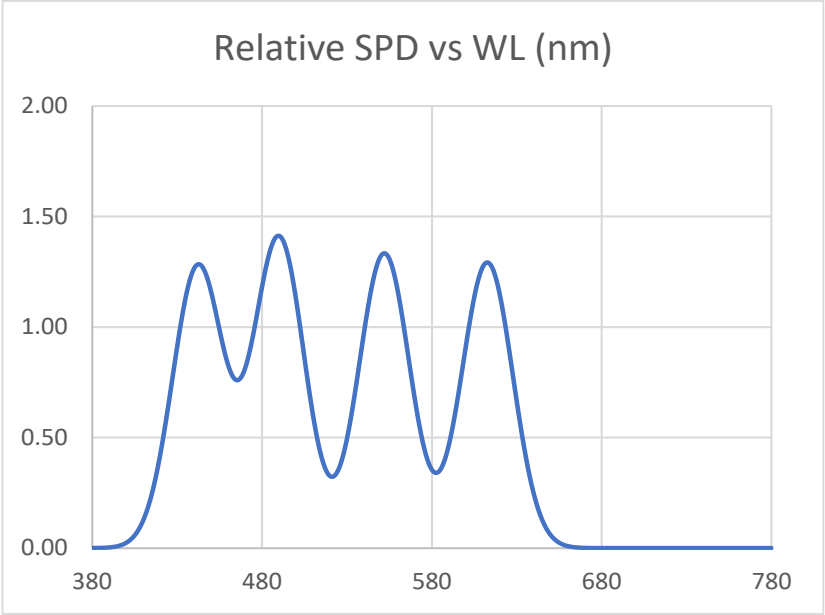
standard observer



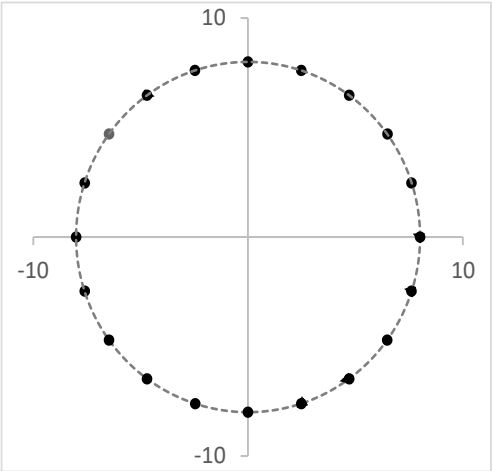
Mean Error = 0.65 Munsell Units

less R-G sensitive observer

Four peaks enables excellent color accuracy for all observers and also provides a wide gamut.

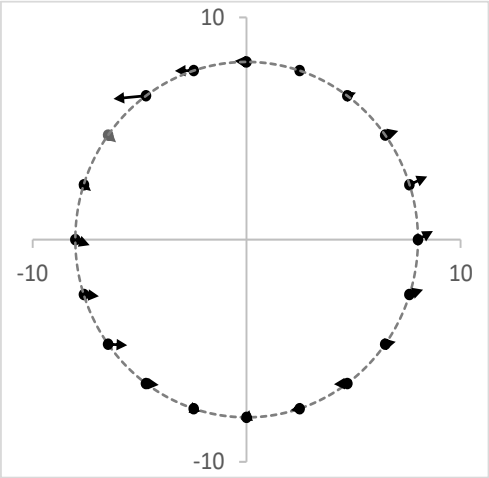


post-adaptation color perception deviations for various displayed hues



Mean Error = 0.15 Munsell Units

standard observer

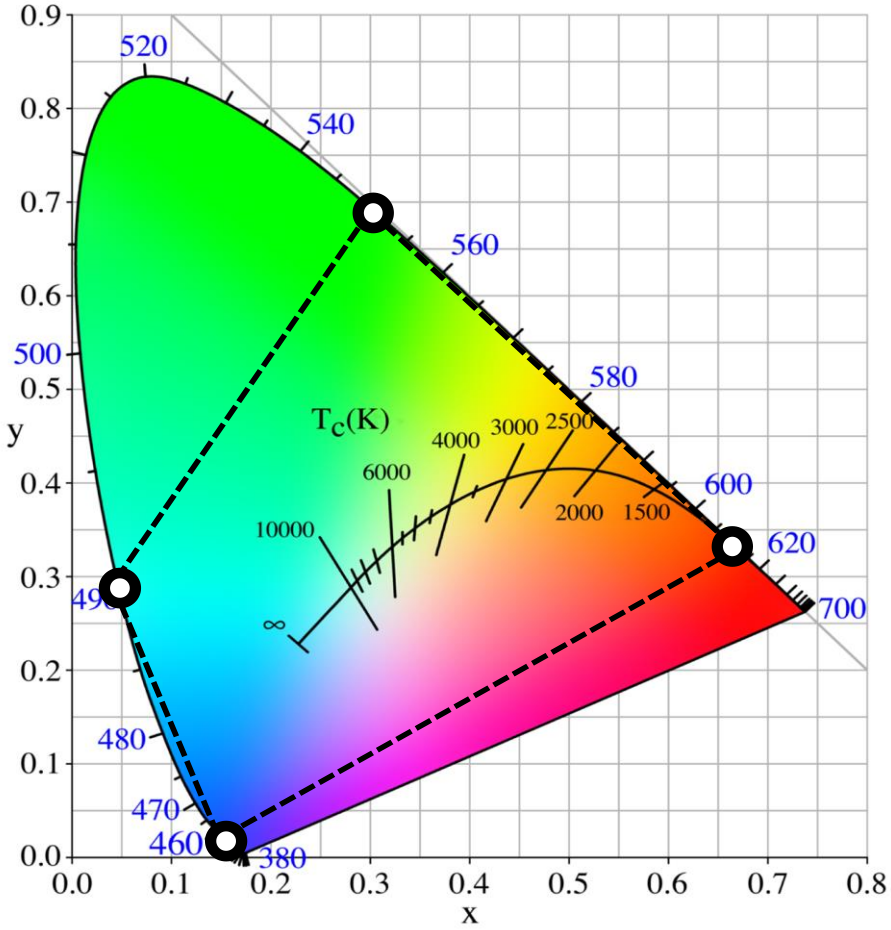


Mean Error = 0.30 Munsell Units

less R-G sensitive observer

This adaptation-friendly four-primary design has several advantages:

- Does not require a modified image signal
- High gamut without metameric error
- Imperceptible metameric error
- Compatible with conventional screens:
  - the green emitter pixel alternates between green and cyan on alternate pixels
  - image processing adjusts accordingly
  - pixel to pixel color steps are below the threshold of perception.
- Fairly Compatible with projectors
  - requires only one additional projector channel



This adaptation-friendly four-primary design has several advantages:

- Does not require a modified image signal
- High gamut without metameric error
- Imperceptible metameric error
- Compatible with conventional screens:
  - the green emitter pixel alternates between green and cyan on alternate pixels
  - image processing adjusts accordingly
  - pixel to pixel color steps are below the threshold of perception.
- Fairly Compatible with projectors
  - requires only one additional projector channel

Thanks for attending…