Evaluating Color Quality (Part 2): Food for Thought

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Managing expectations

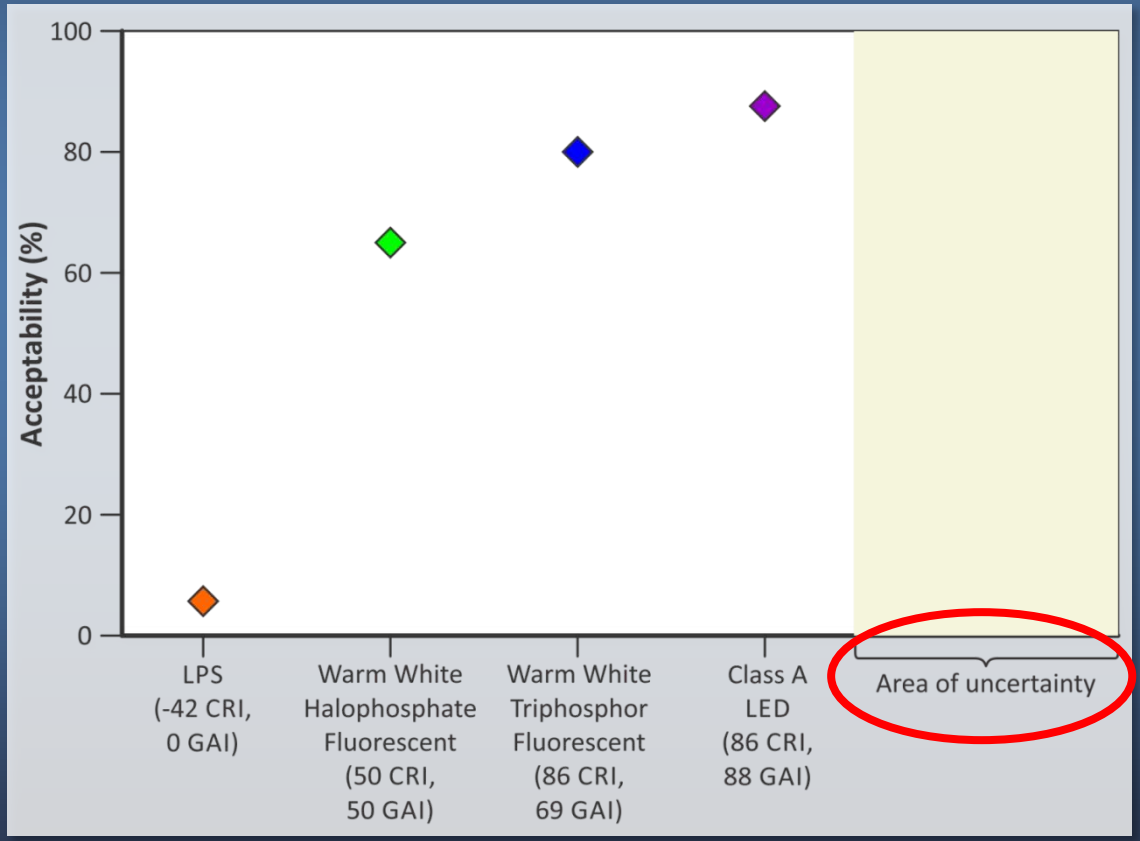
- First, we need to be clear on our expectations of color metrics
- Color metrics for light sources do not guarantee good results
- Just as metrics for grocery store products do not guarantee a good home-cooked meal

Acceptability

Acceptability

Why aren't color metrics for light sources enough?

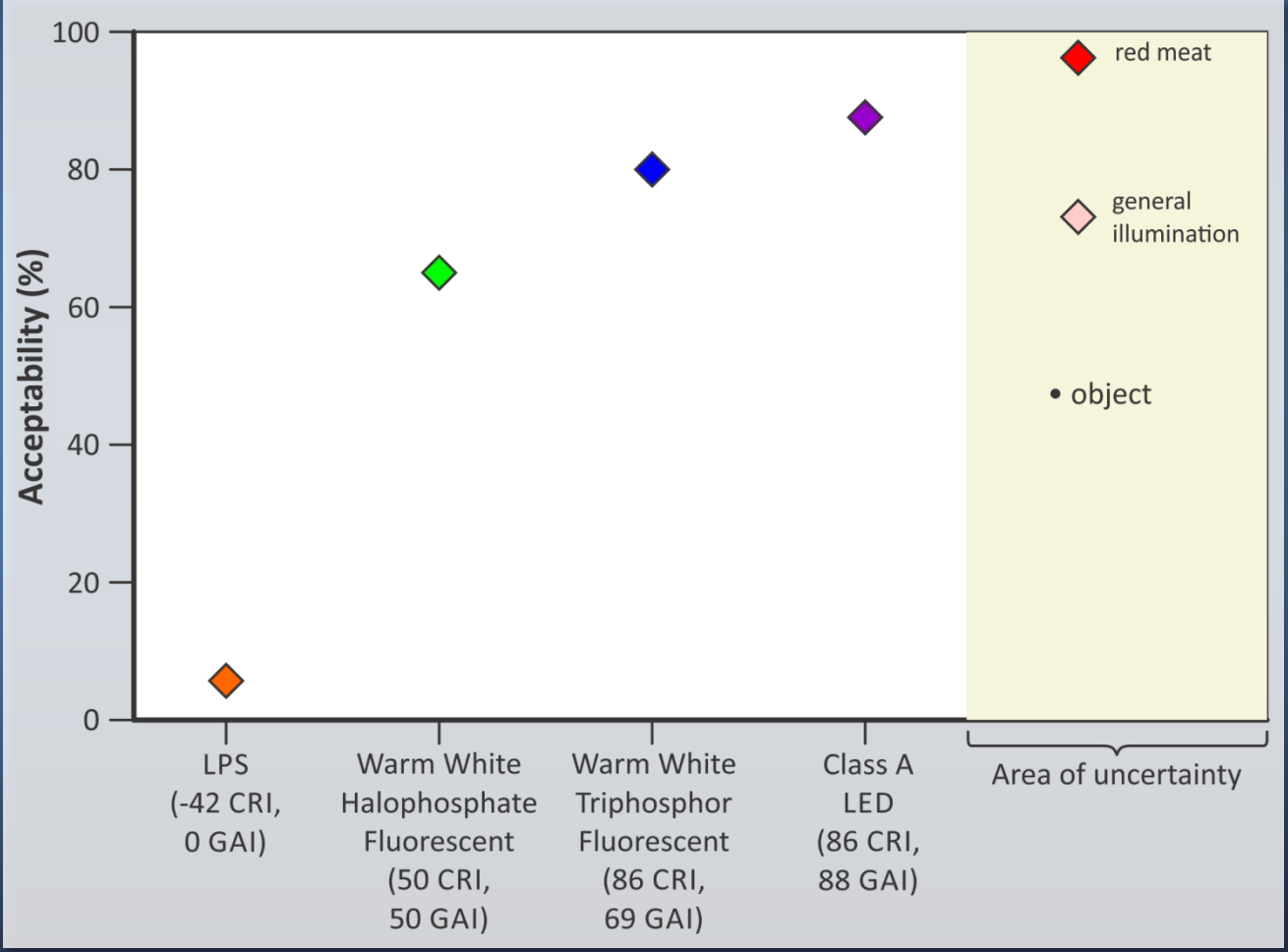
- Because we need to know what we are lighting, how much light are we providing, who is looking, and the color of illumination



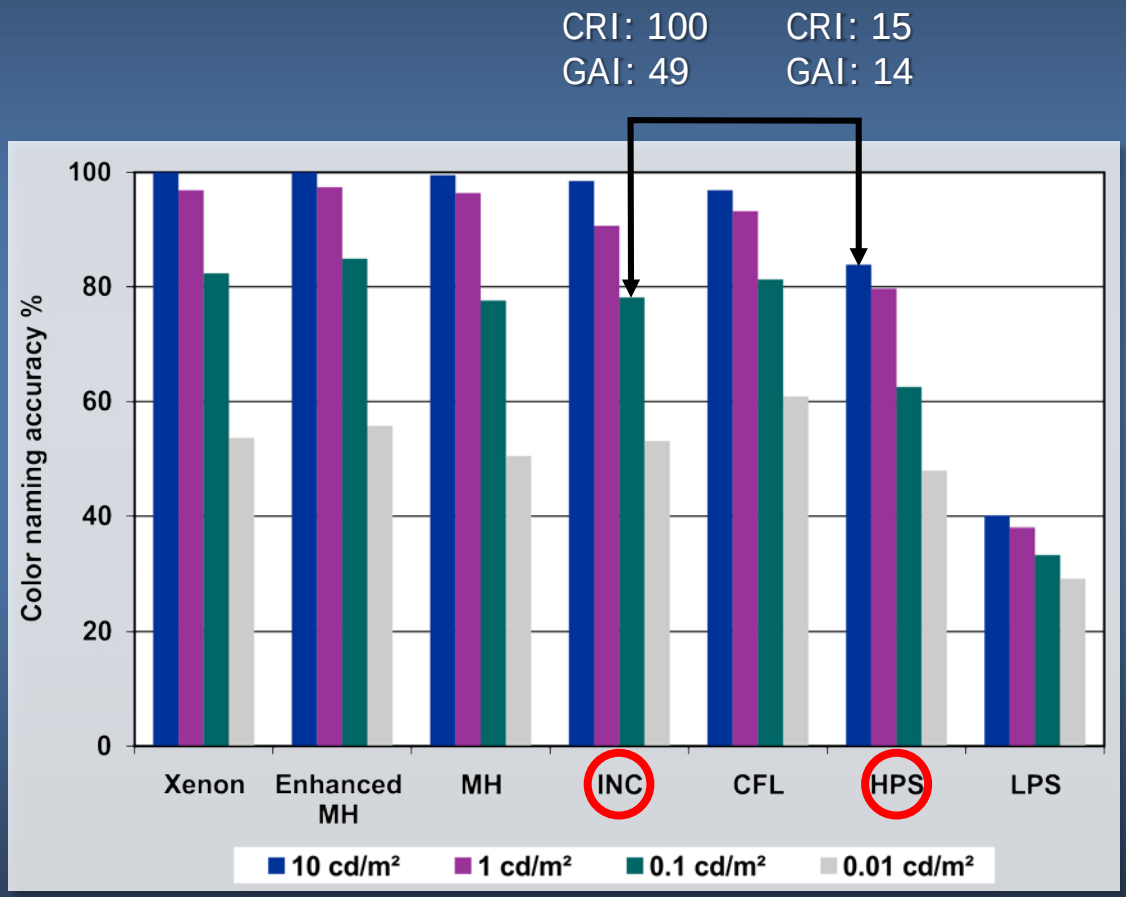
Butcher's case lighting

Better than daylight!

Acceptability

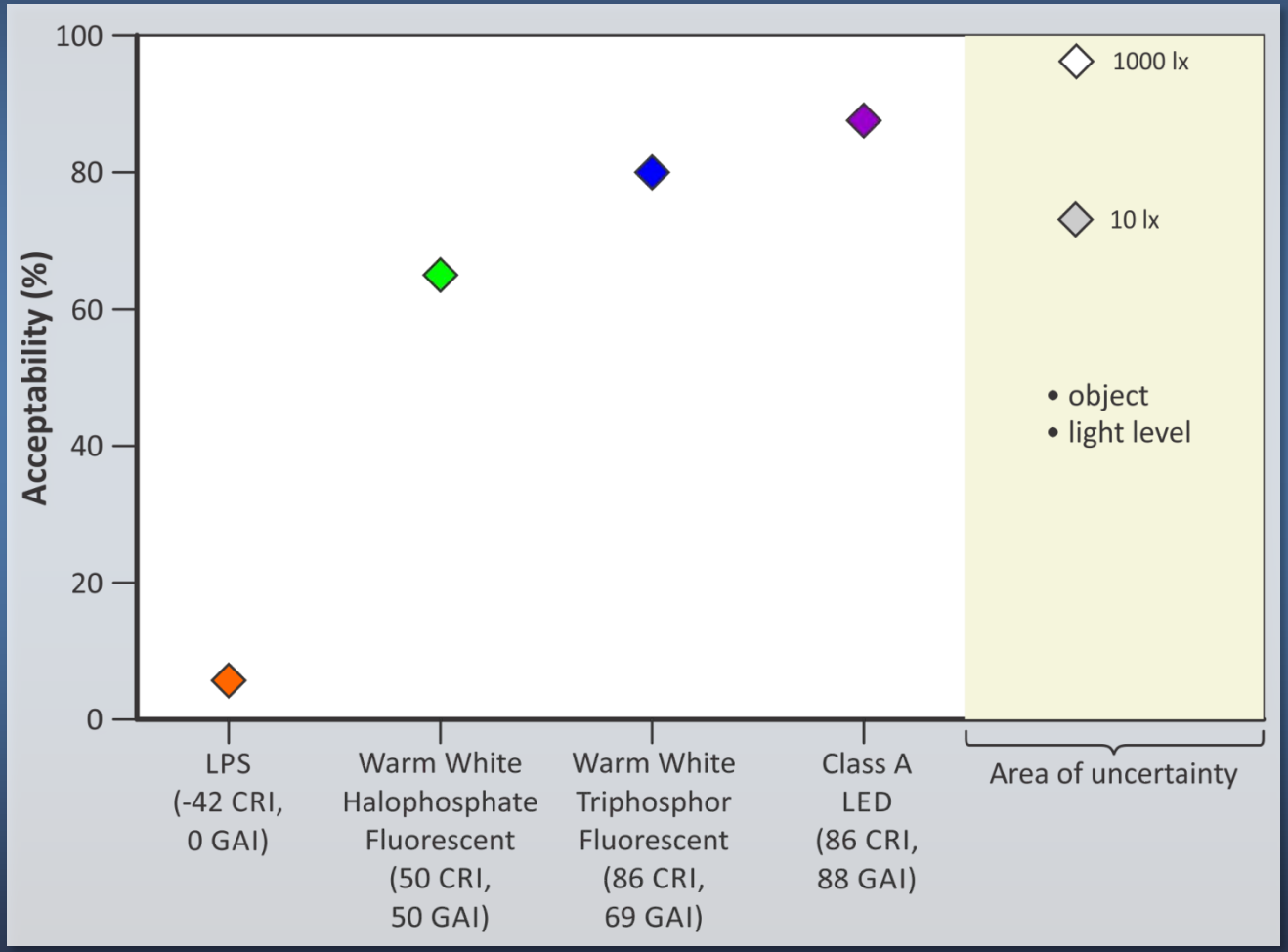


Light level



Deng L et al. 2004. An evaluation of the Hunt94 color appearance model under different light sources at low photopic to low mesopic light levels. *Color Research and Application*. 30(2):107-117.

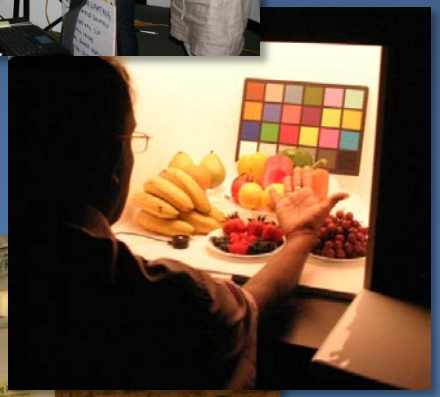
Acceptability



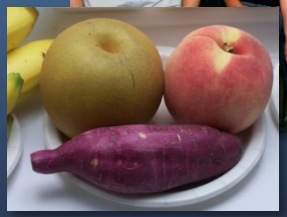
Different populations

- South Asia
- US Northwest
- US Northeast
- Japan
- Northern Europe

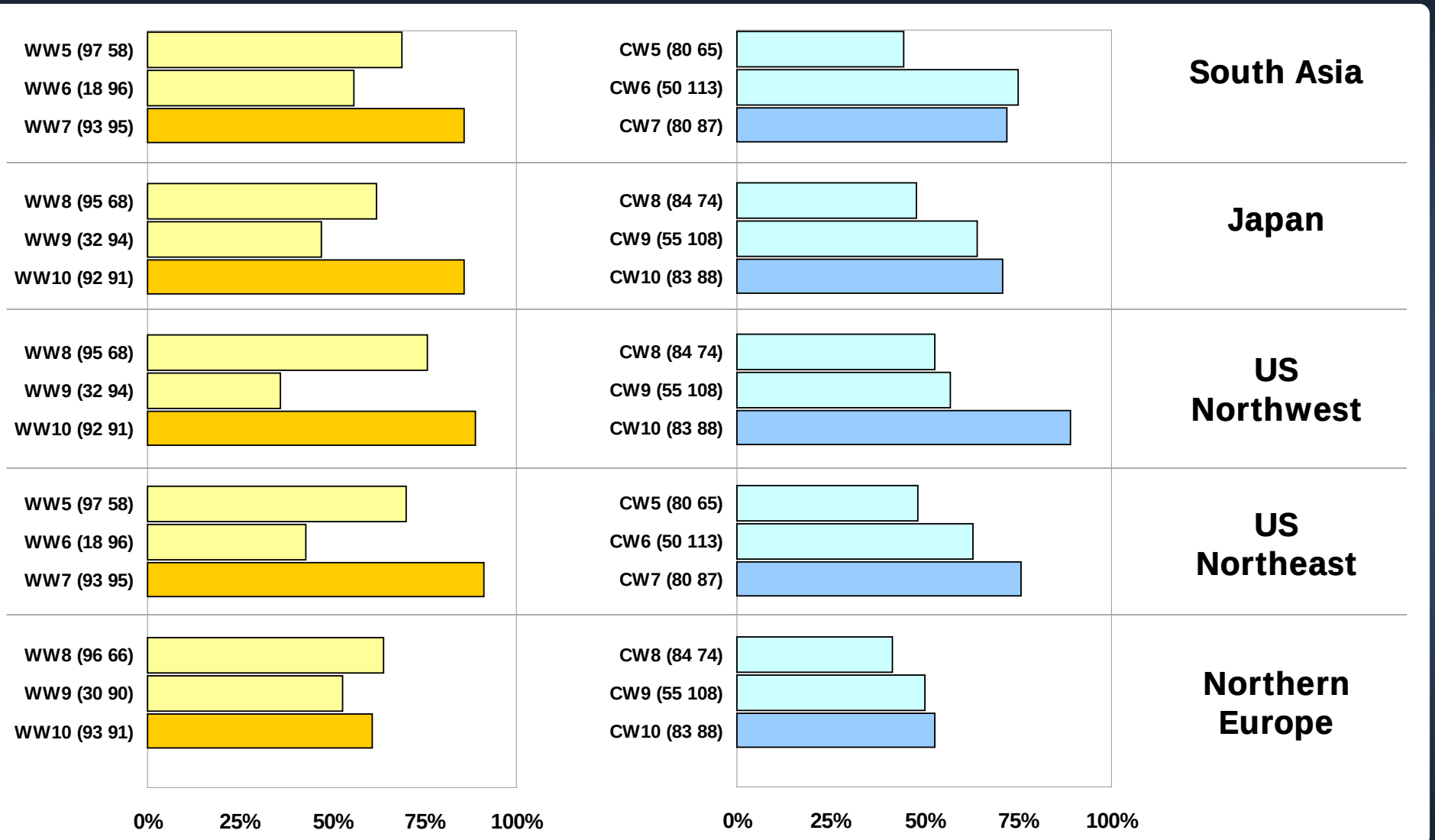


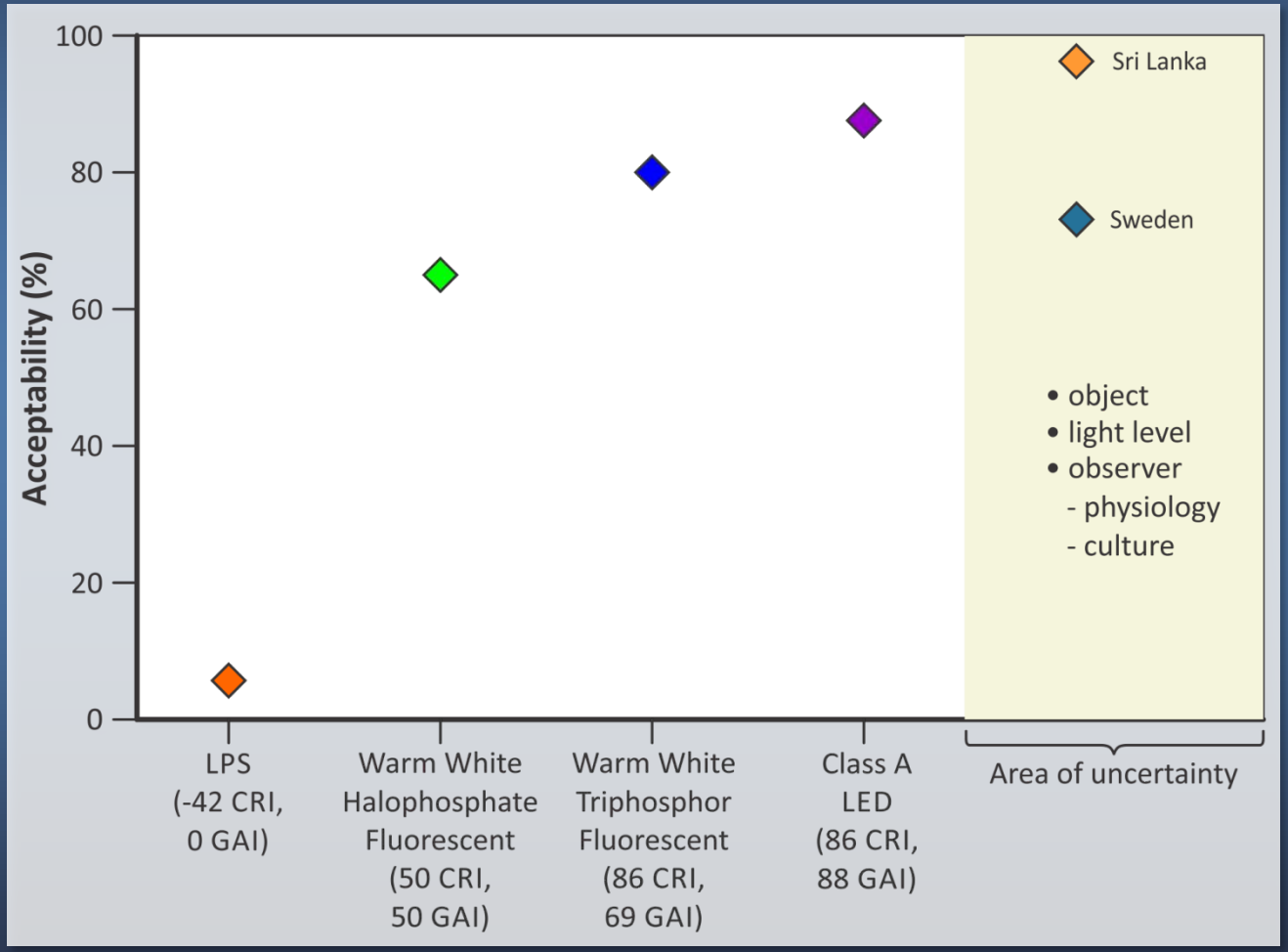




Overall acceptability

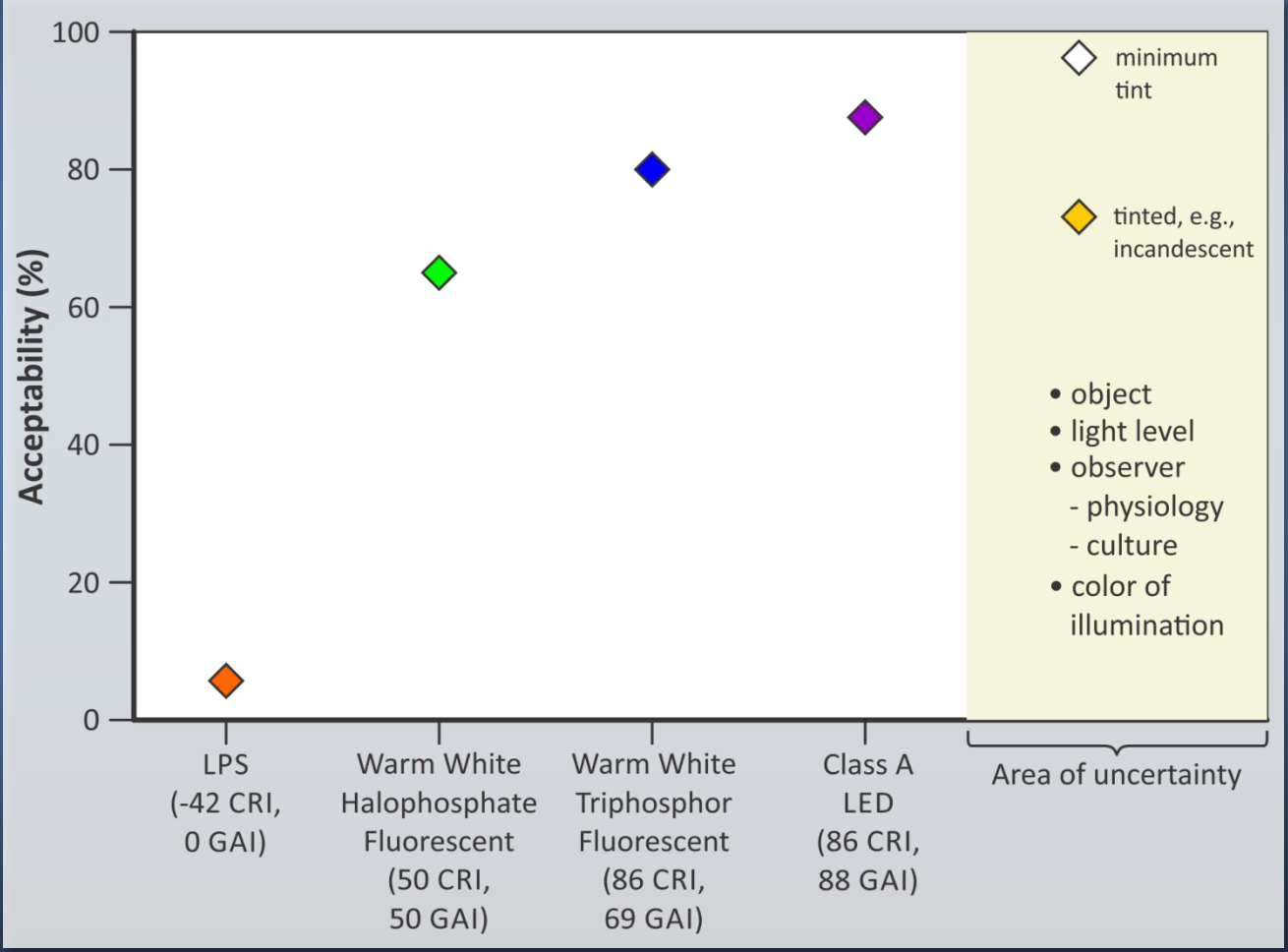


Acceptability



Color of illumination

Acceptability

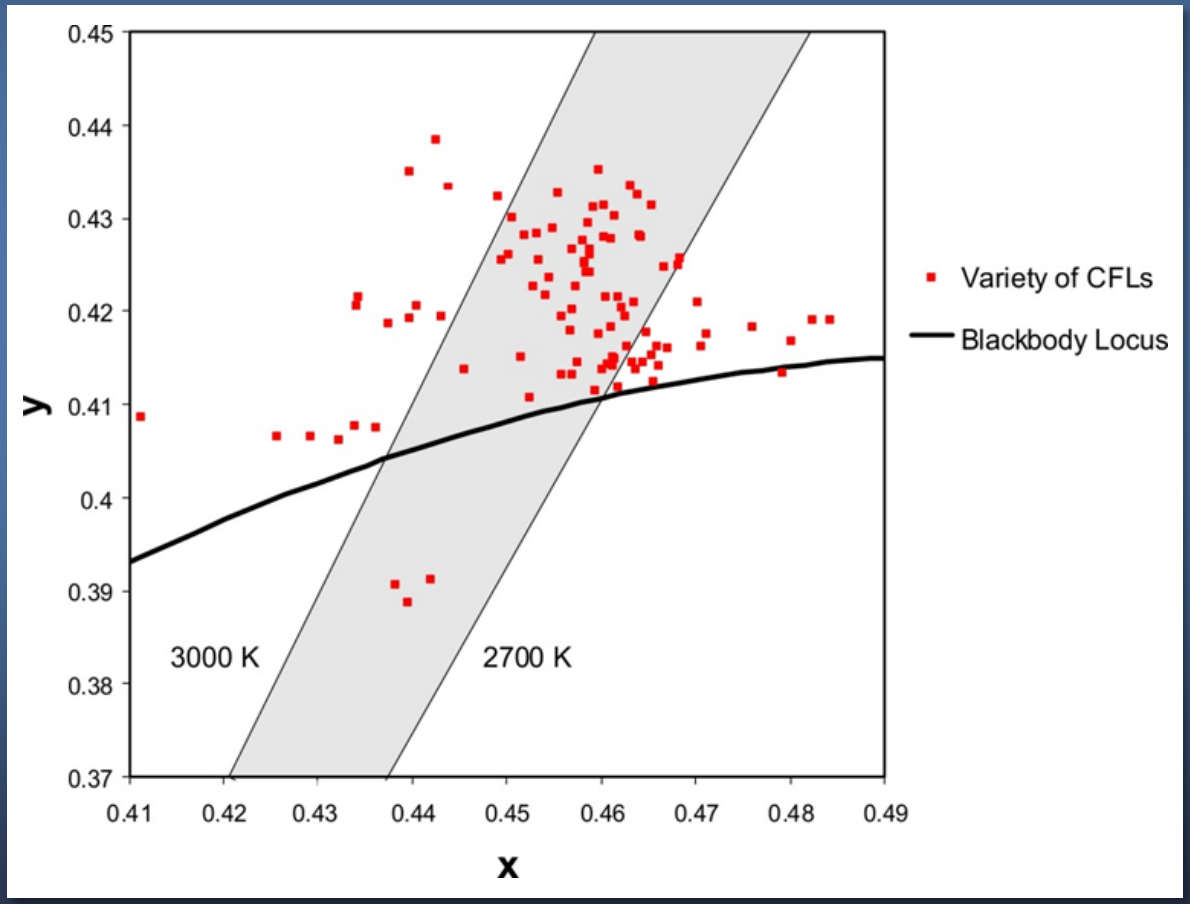


Keeping the bad stuff out – please be careful

- Metrics drive products: Example 1

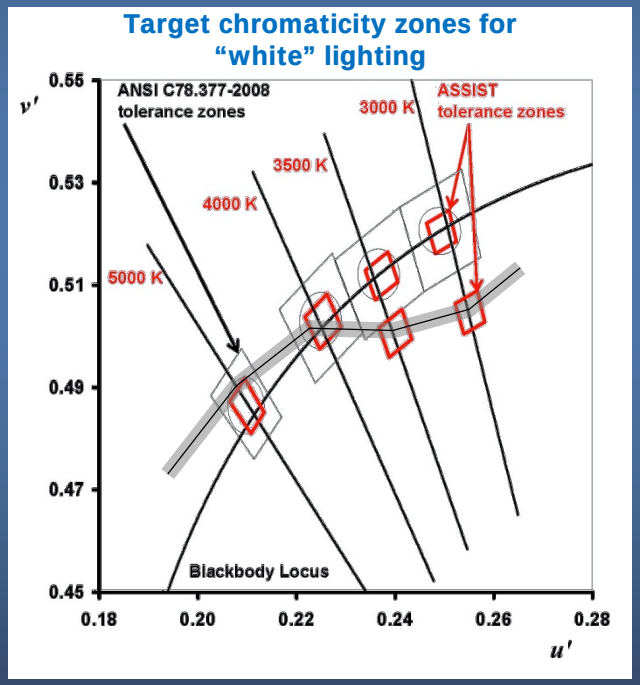
EPA ENERGY STAR®

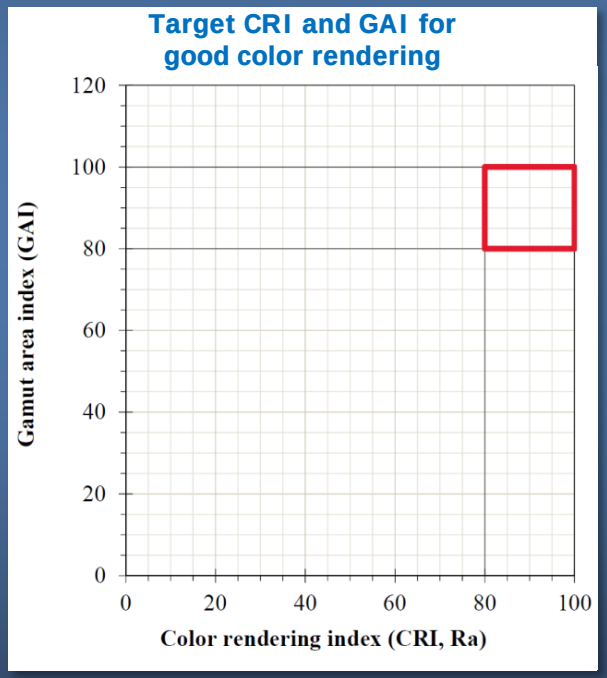
Luminous efficacy requirements based upon V(λ) drove CFLs to be green



Keeping the bad stuff out – please be careful

- Metrics drive products: Example 2





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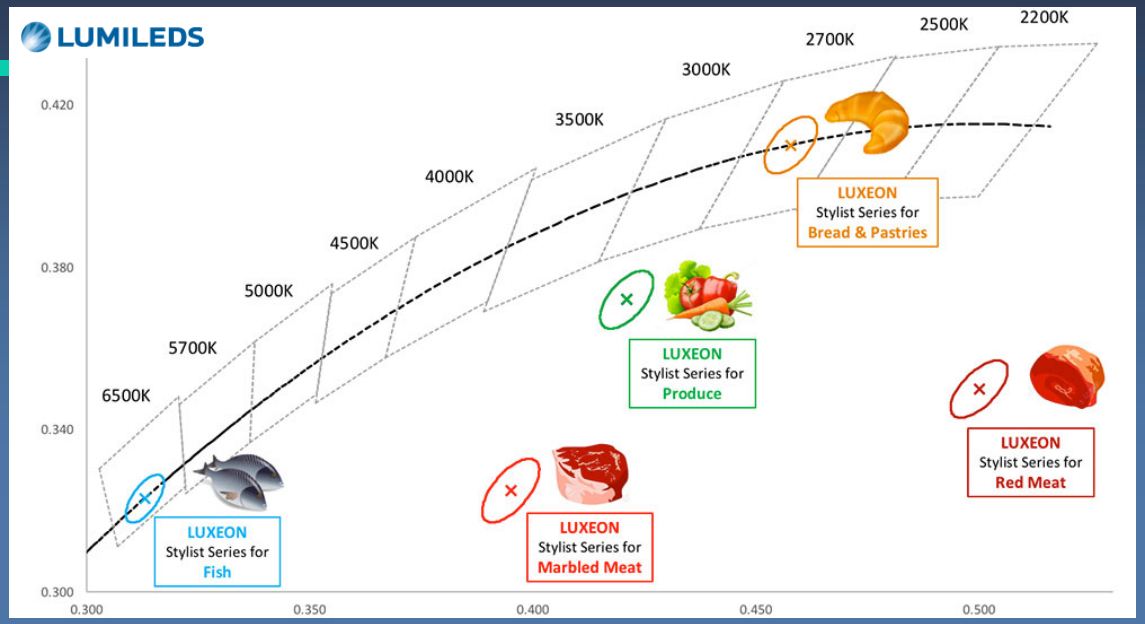
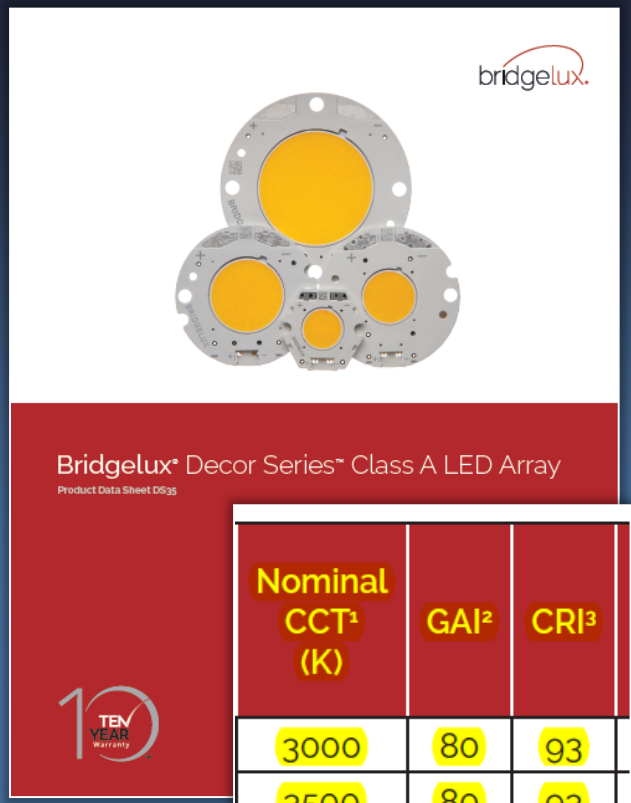
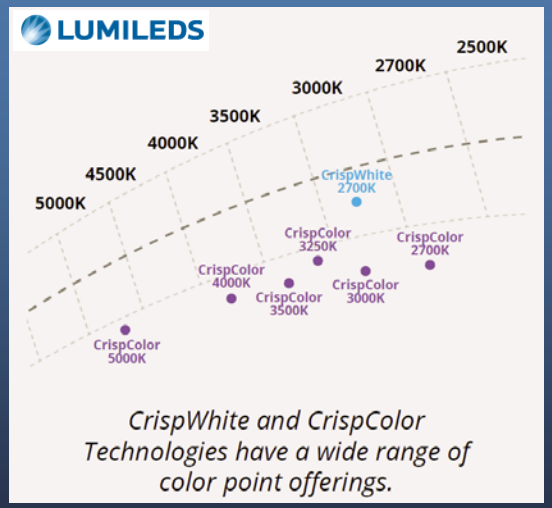
Example 2

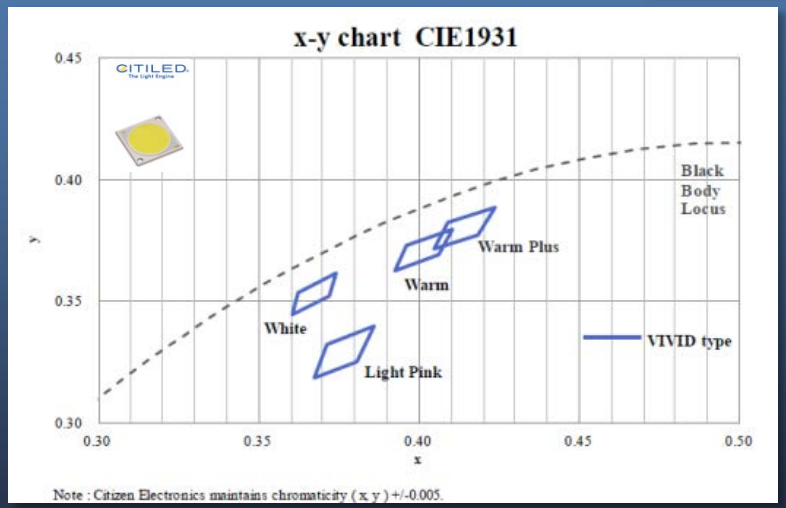




Nominal CCT[1] (K)	GAI[2]	CRI[3]
3000	80	93
3500	80	93
4000	80	93



CrispWhite and CrispColor Technologies have a wide range of color point offerings.



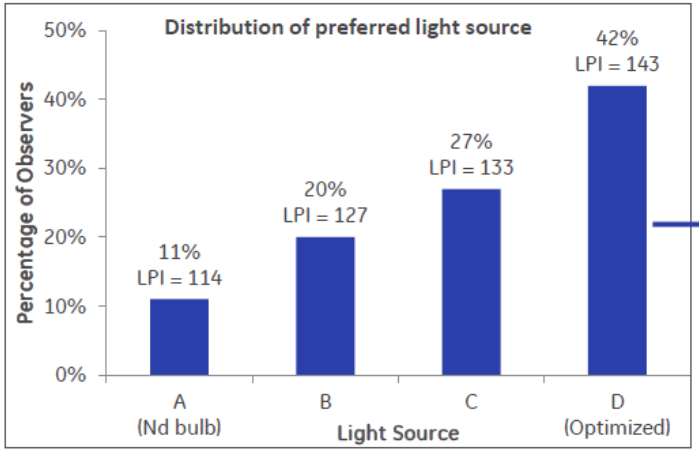
Example 2

- GE's Lighting Preference Index (LPI)
  - Relative weighting of components determined empirically using color-tunable sources

LPI α 0.38 × whiteness + 0.62 × color rendering (CRI and GAI)

Validation Study

- Four LED sources at 2700K with enhanced levels of LPI
- Observer study with 86 participants

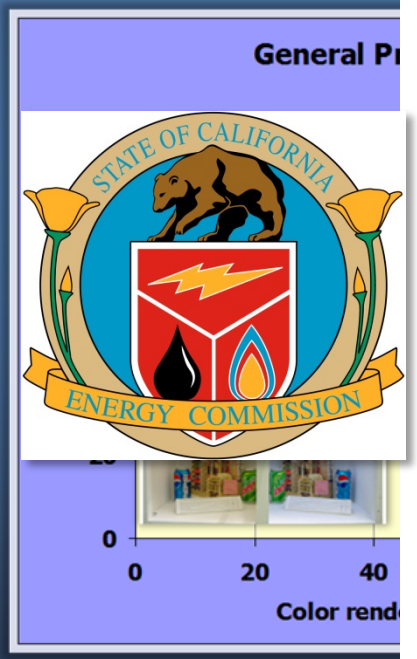


LPI = 143
CRI = 62

Vick and Allen 2015

Keeping the bad stuff out – please be careful

- Remember too, precision is not accuracy
  - What's the real difference between a CRI of 80 and of 90?



Color Rendering Propertie
N. Narendran and L. Deng. 2

JA8.4.4 Color ~~Temperature~~Characteristics

The light source shall meet the following CCT, Duv, and color rendering requirements when measured in accordance with the test method of Section JA8.3.4:

(a) Inseparable SSL luminaires, LED light engines, and GU24-based LED lamps shall be capable of providing a nominal Correlated Color Temperature (CCT) that is 4000 Kelvin or less and within 0.0033 Duv of the black body locus in the 1976 CIE color space.

(b) ~~The~~ All other light sources shall be capable of providing a nominal Correlated Color Temperature (CCT) that is 3000 Kelvin or less and within 0.0033 Duv of the black body locus in the 1976 CIE color space.

~~(a)~~

~~(b)~~

~~**JA8.4.5 Color Rendering**~~

(c) ~~The~~All light sources shall provide a Color Rendering Index (CRI) of 90 or higher and color rendering R9 value of 50 or higher when measured at a correlated color temperature and Duv value that comply with Section JA8.4.4.

~~EXCEPTION to JA8.6: Luminaires used for compliance with the outdoor lighting requirements in Section 150.0(k)3.~~

Appendix JA8– Qualification Requirements for High Efficacy Light Source

Keeping the bad stuff out – please be careful

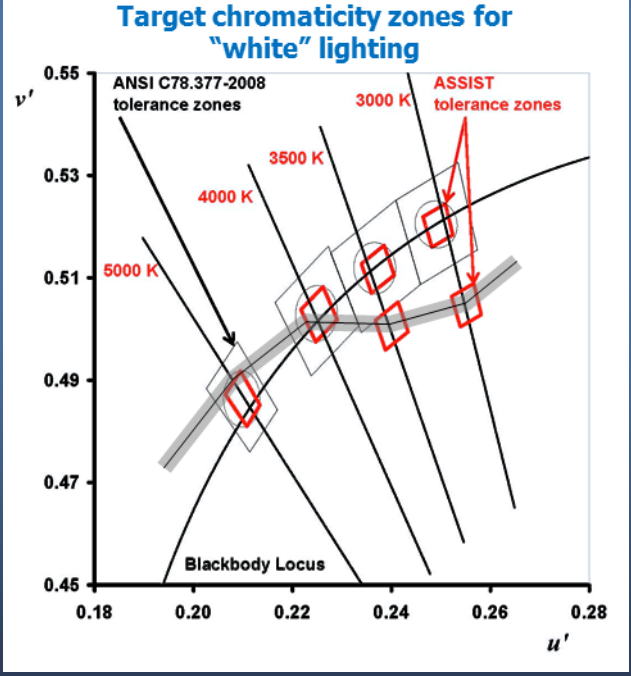
- Again, regulating or incentivizing grocery store products does not guarantee a good home-cooked meal

So, what do we believe

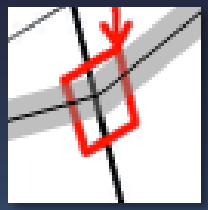
- Chromaticity and color rendering metrics are important, but not *all* important
- Recognizing that...

So, what do we believe

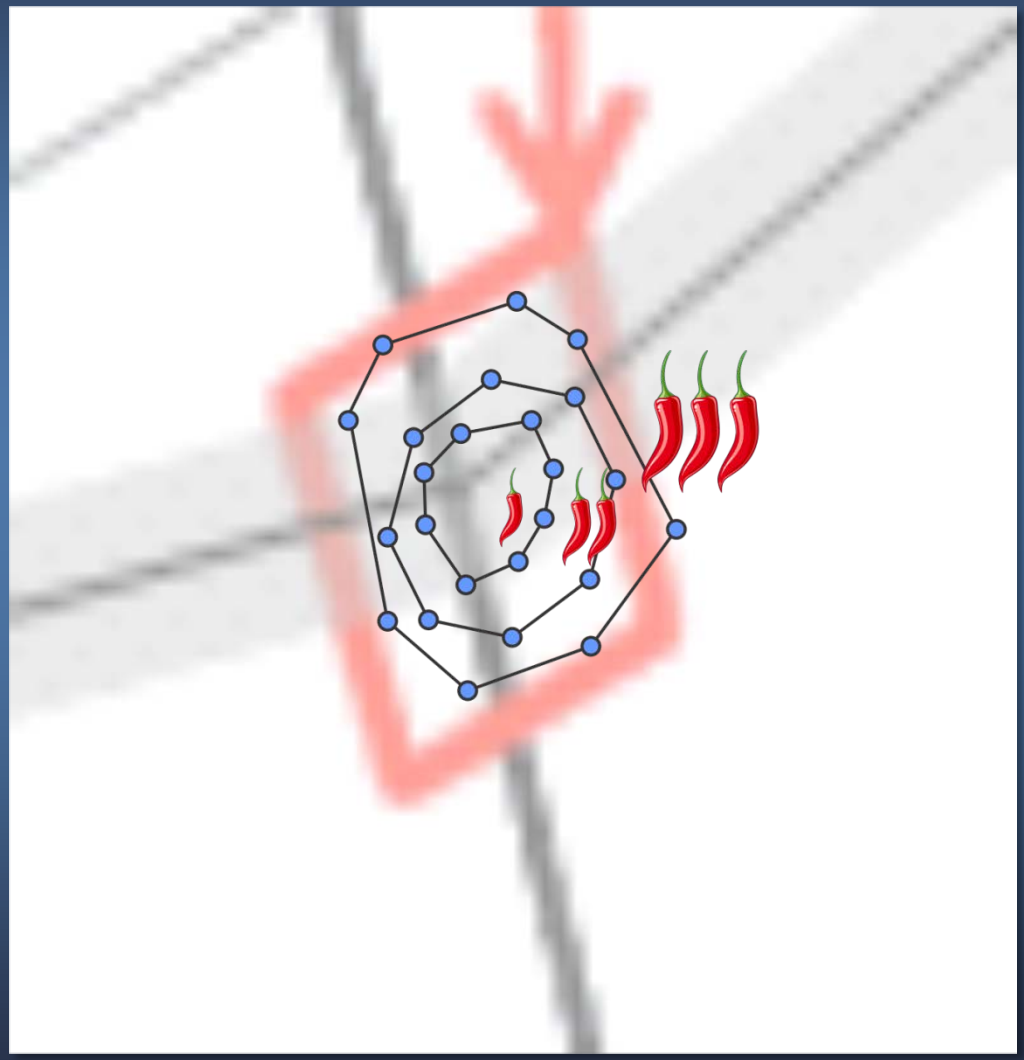
- Decide on the desired color of illumination – warm, cool, or neutral - based upon chromaticity targets, NOT on CCT which is ambiguous with regard to color of illumination



So, what do we believe



- Decide on the desired amount of object color saturation using an absolute metric such as GAI – one, two, or three “chili peppers” – reference based metrics such as CRI limit color distortion (if that is important)



So, what do we believe

- Regarding regulations, CRI = 80 is good enough with perhaps a few chromaticity targets (not CCT) to minimize confusion among consumers
- GAI is a color saturation metric for how many chili peppers go into the salsa, not what you *should* put in the salsa

Thank you

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