

CNC/CIE Workshop 2012

Improving the CIE Color Rendering Index – how this can be done and why it matters

November 30, 2012
Lorne Whitehead, UBC

Need for
light with high
colour fidelity

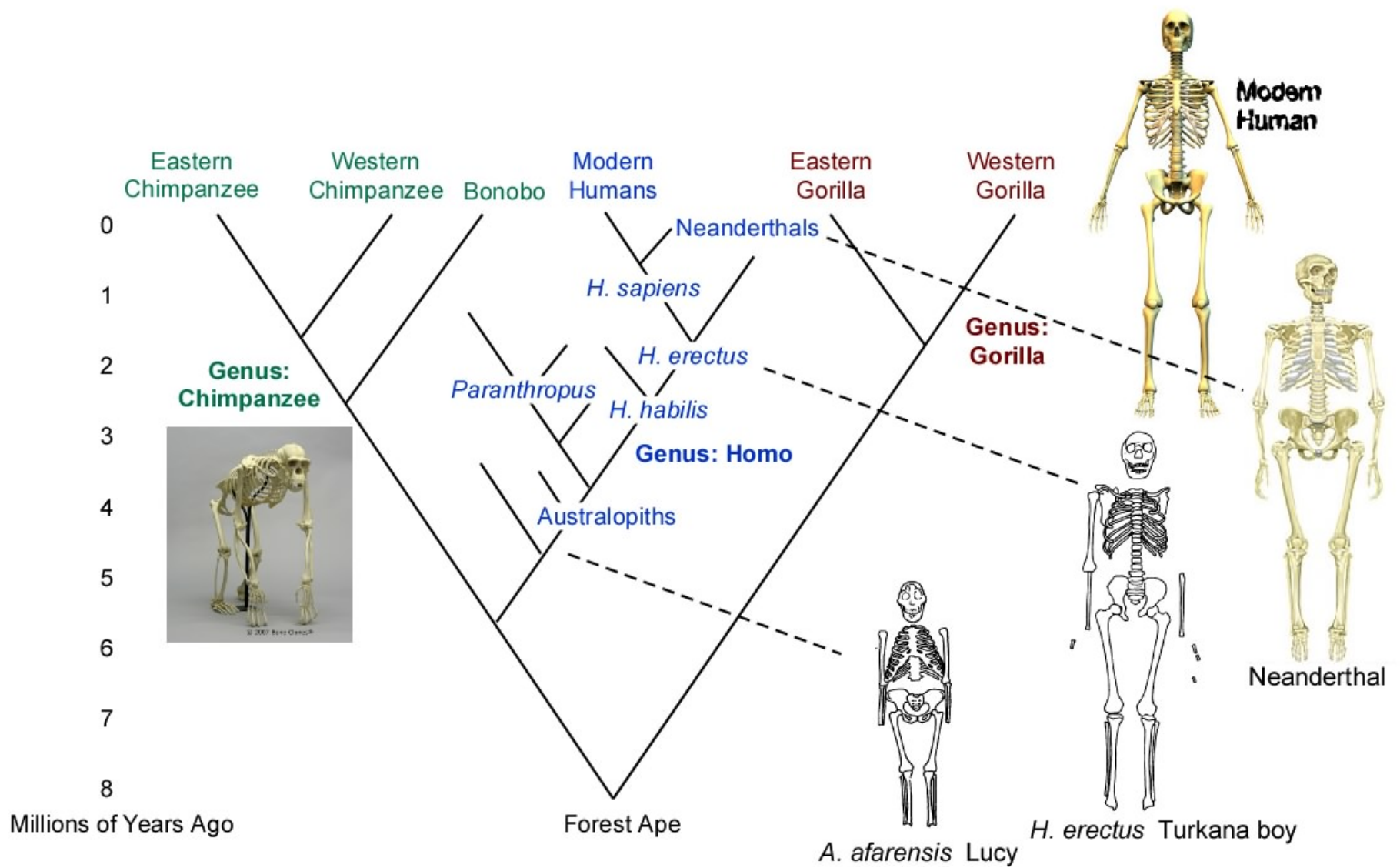


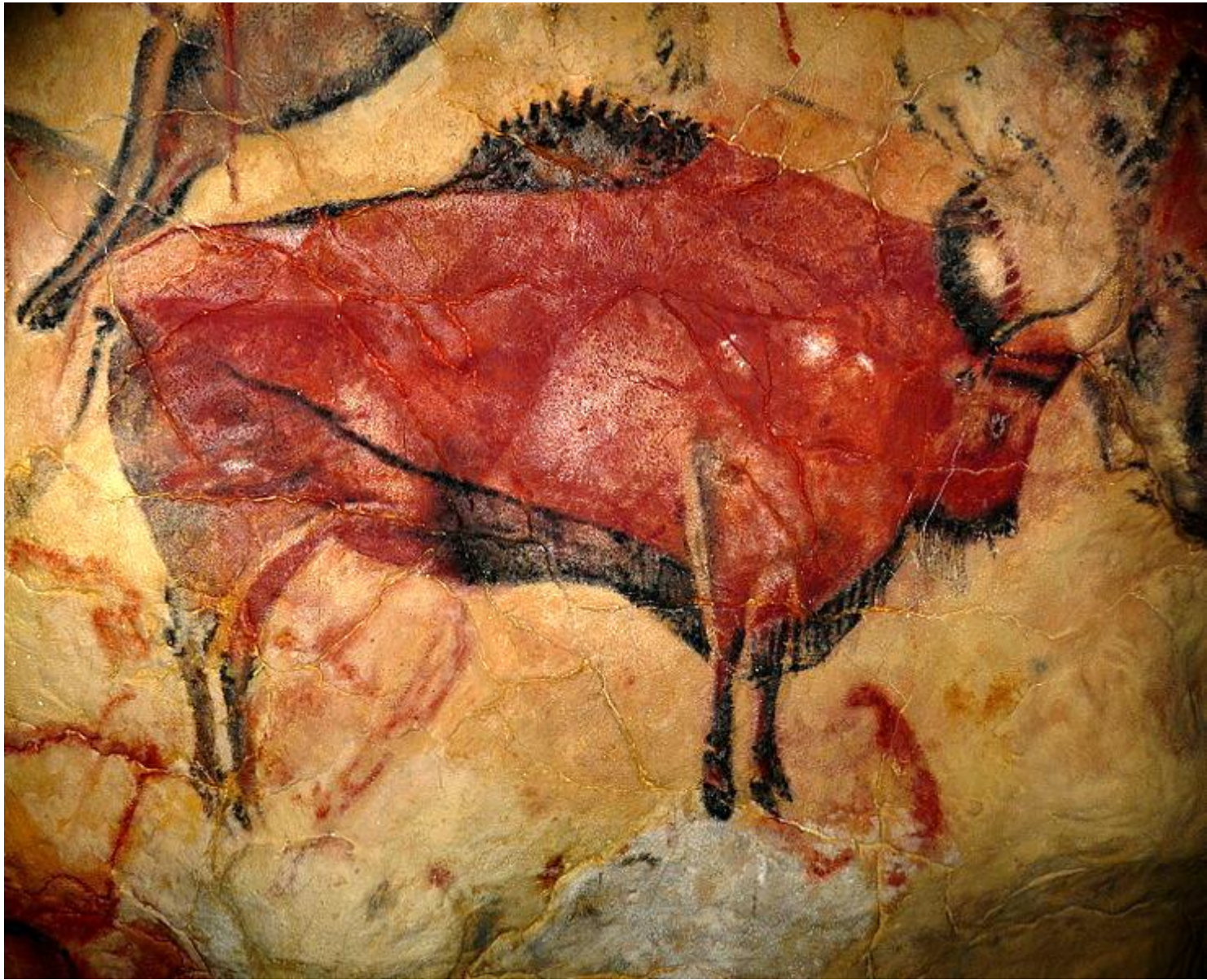
Need to
quantify degree of
colour fidelity

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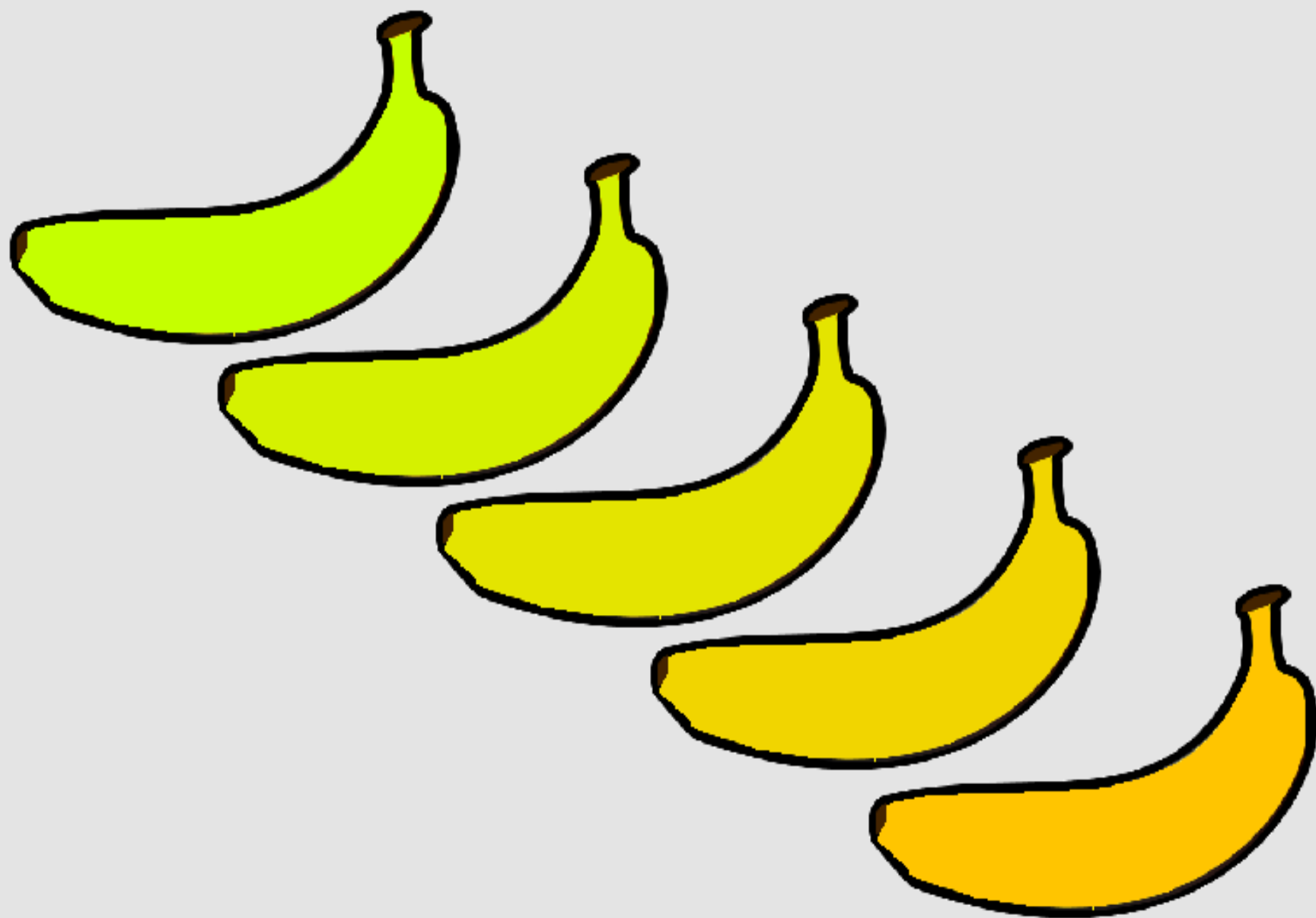


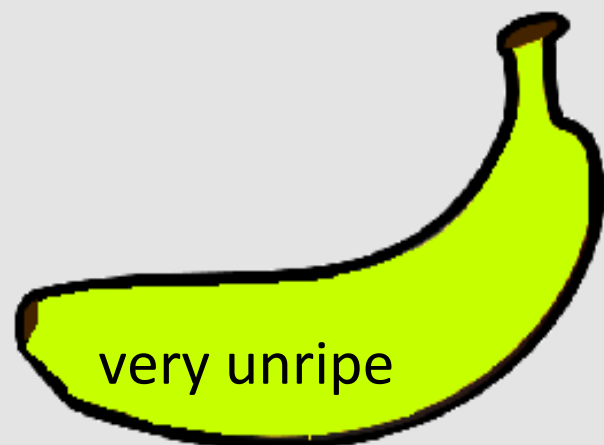
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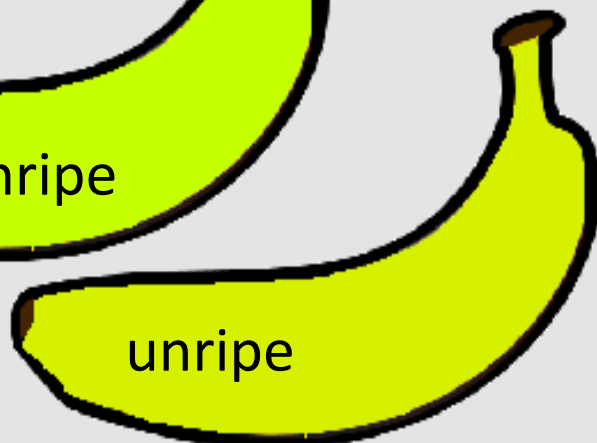


Cave of Altamira, Spain, painted approximately 30,000 years ago





very unripe



unripe



ideal ripeness

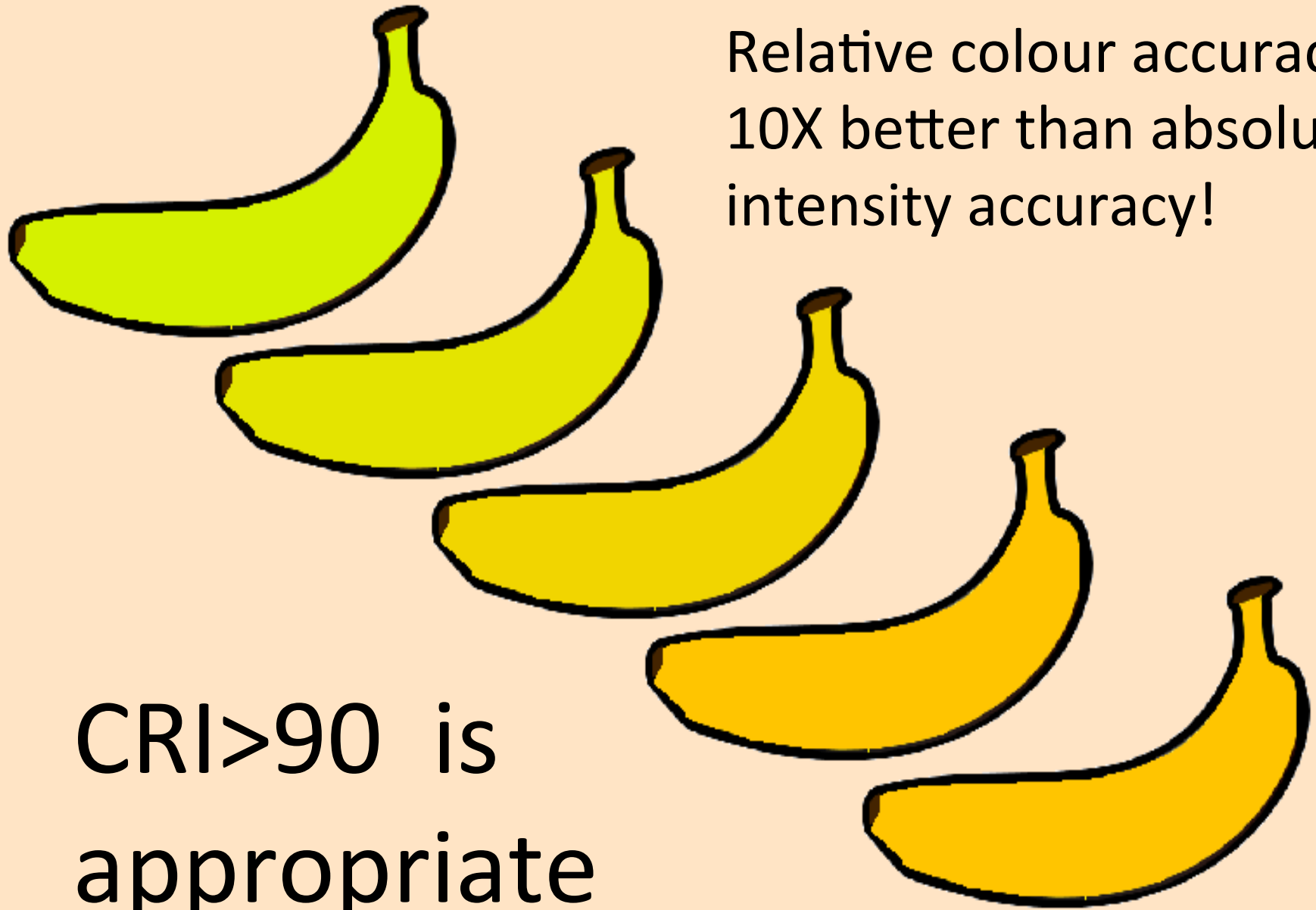


overripe

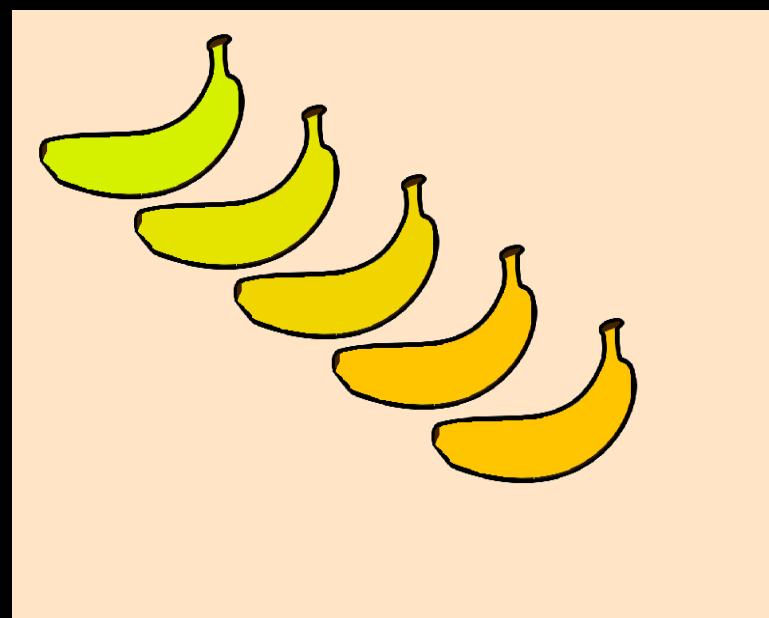
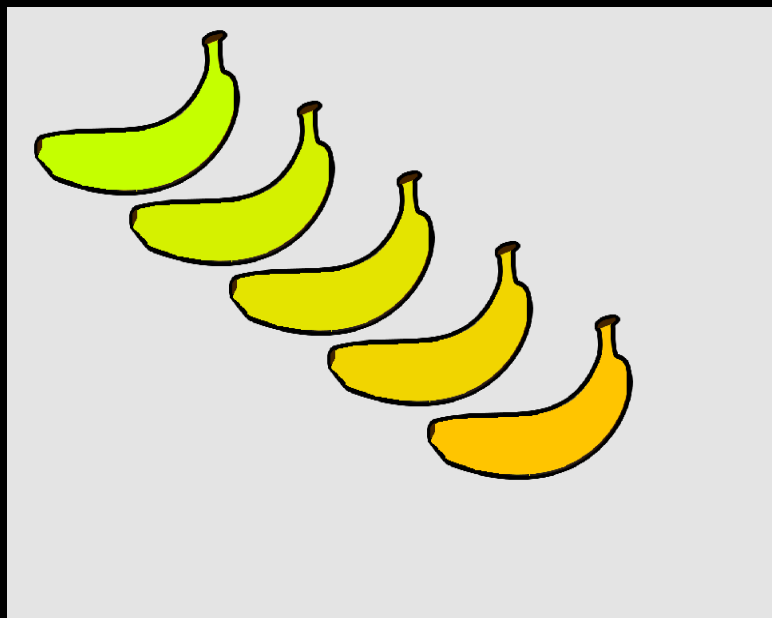


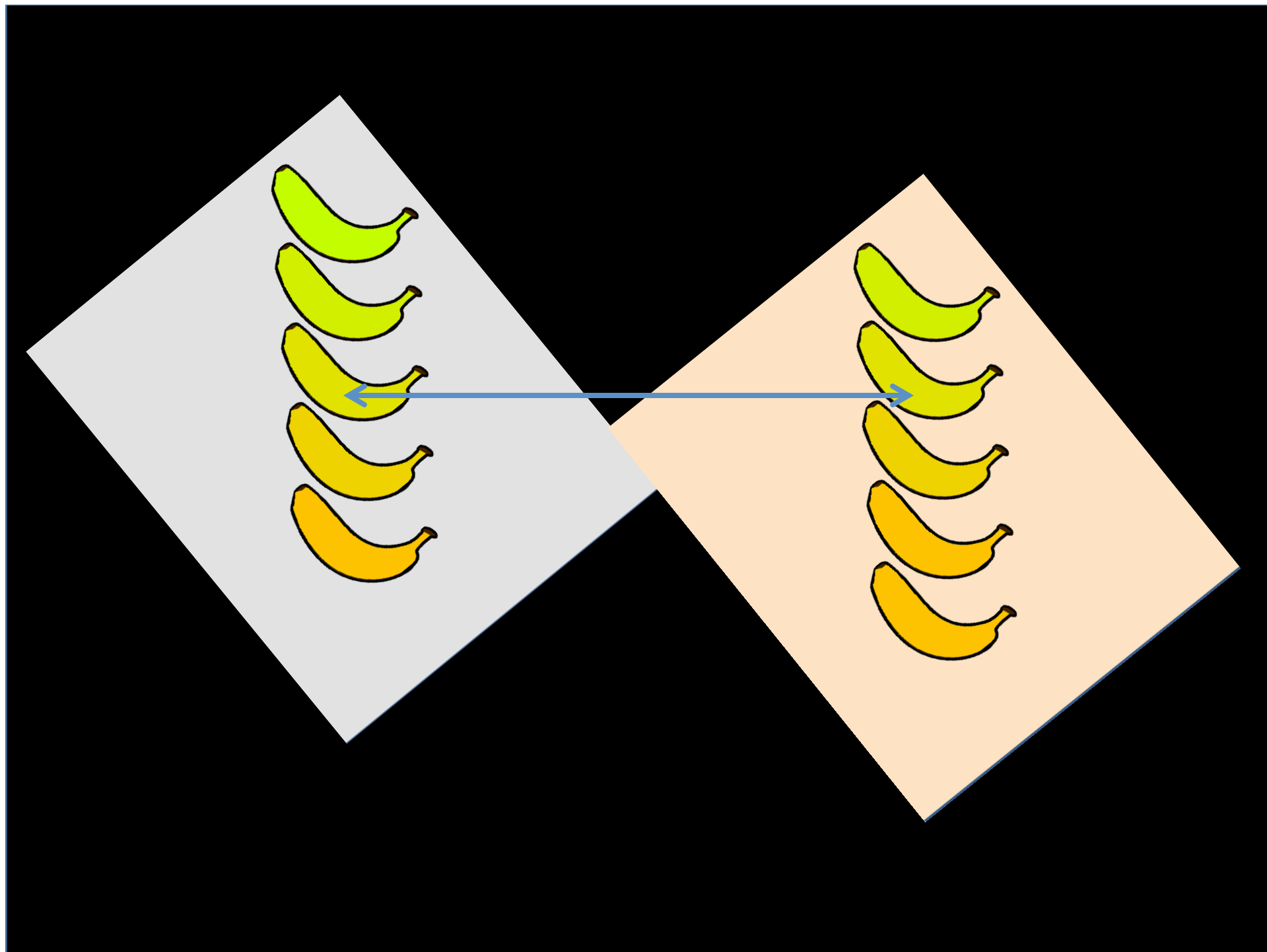
very overripe

Relative colour accuracy
10X better than absolute
intensity accuracy!



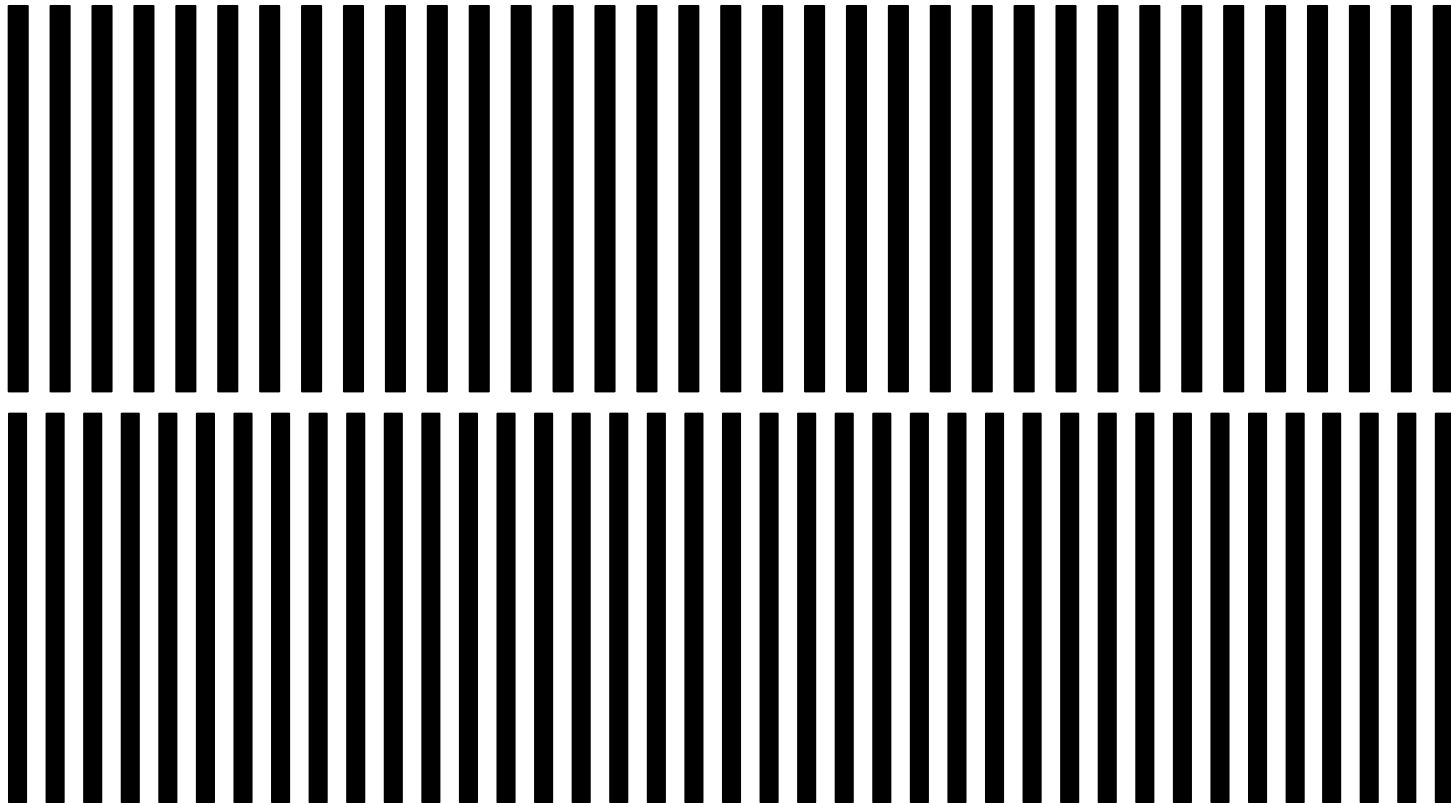
CRI > 90 is
appropriate



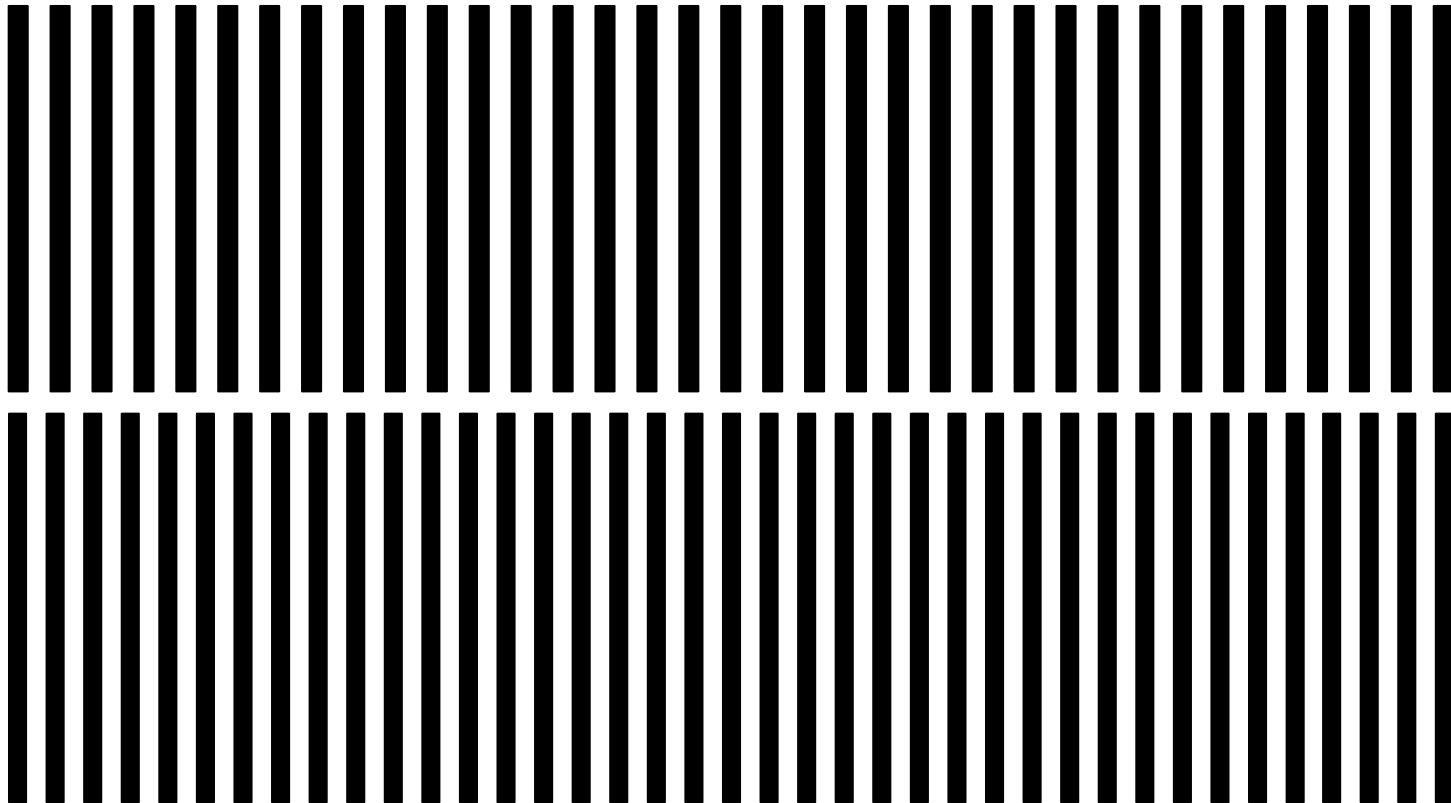


Challenge:
Colour rendering is difficult to explain

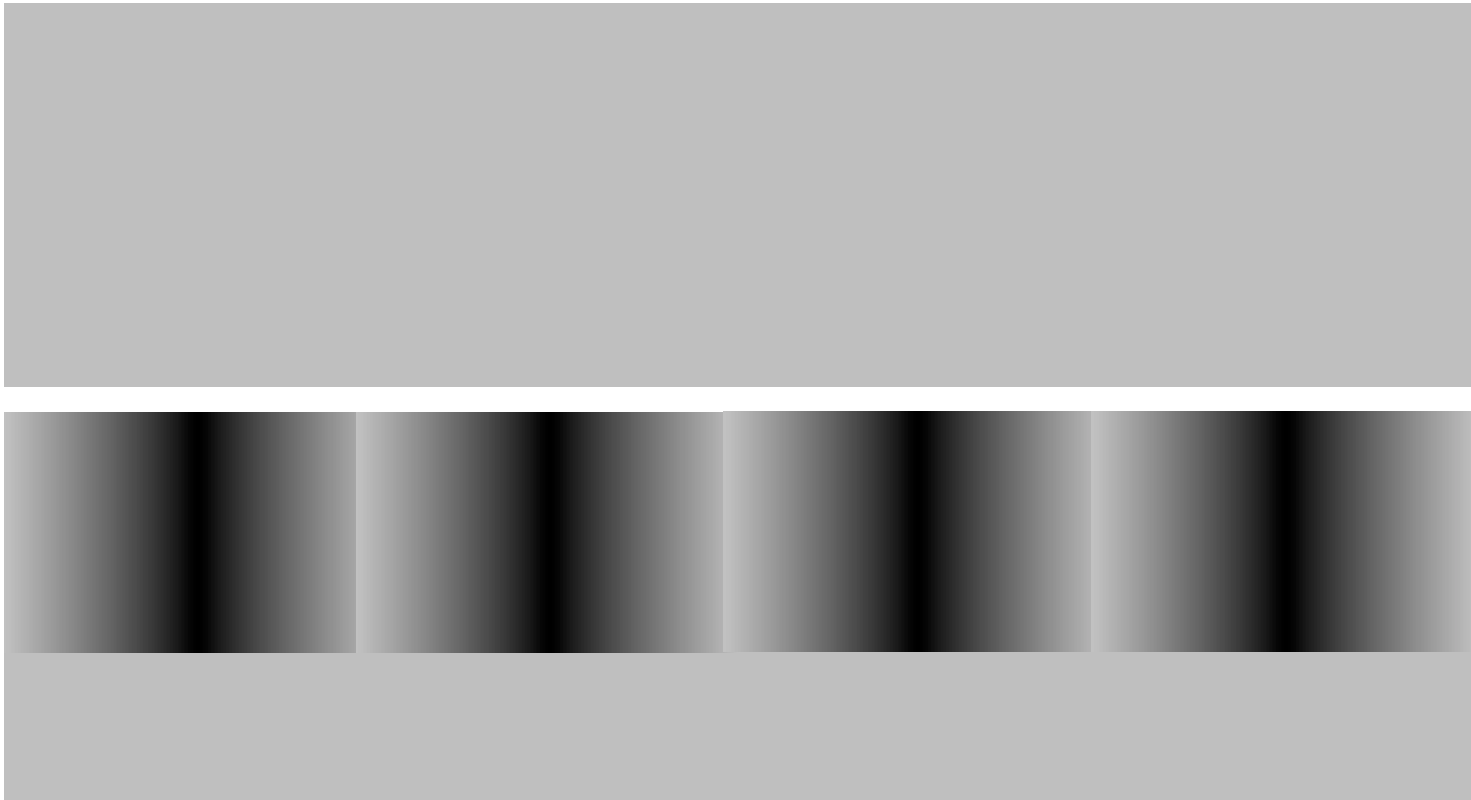
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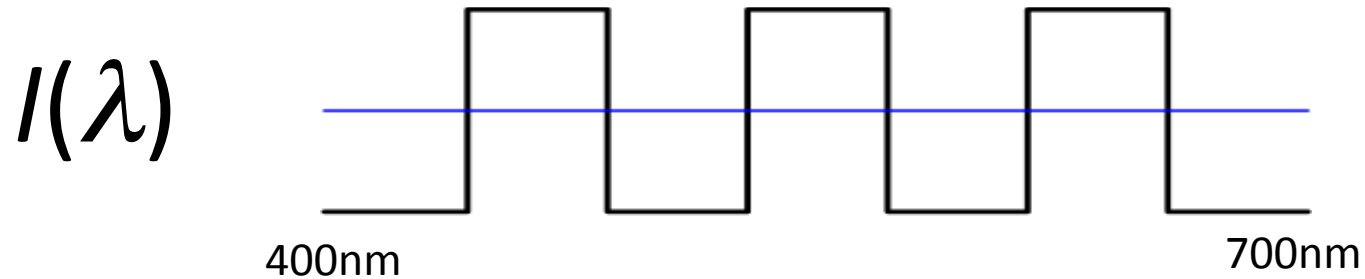


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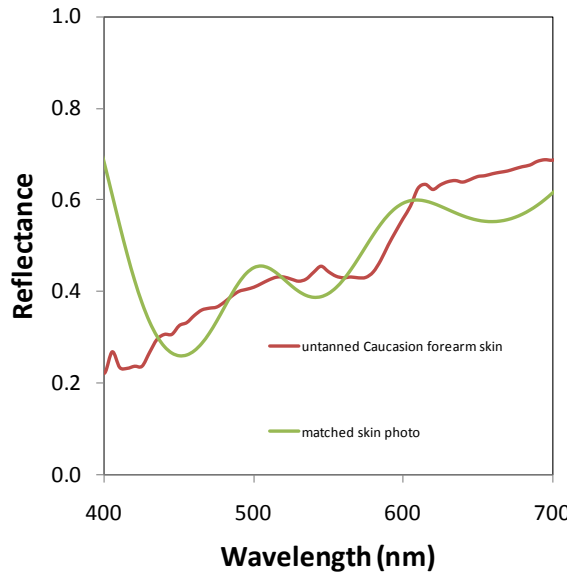


Challenge:

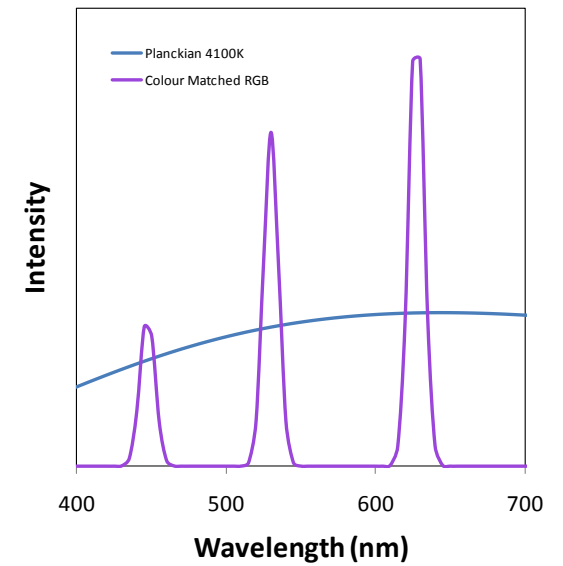
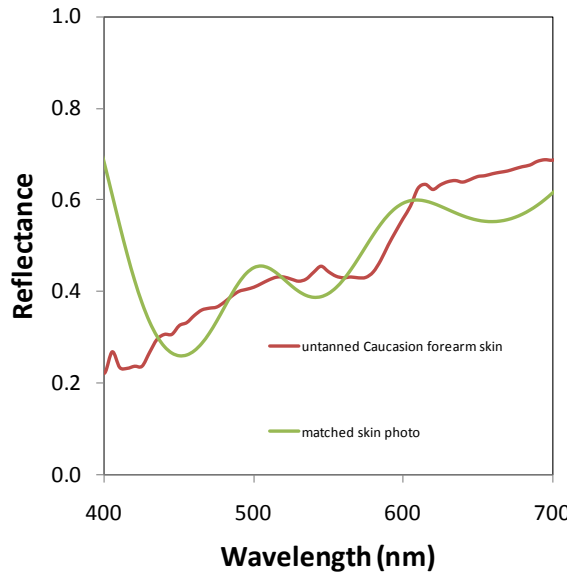
Colour rendering is difficult to explain



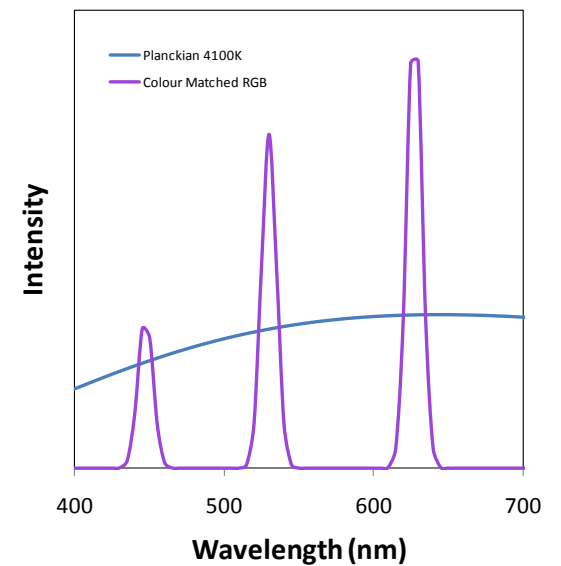
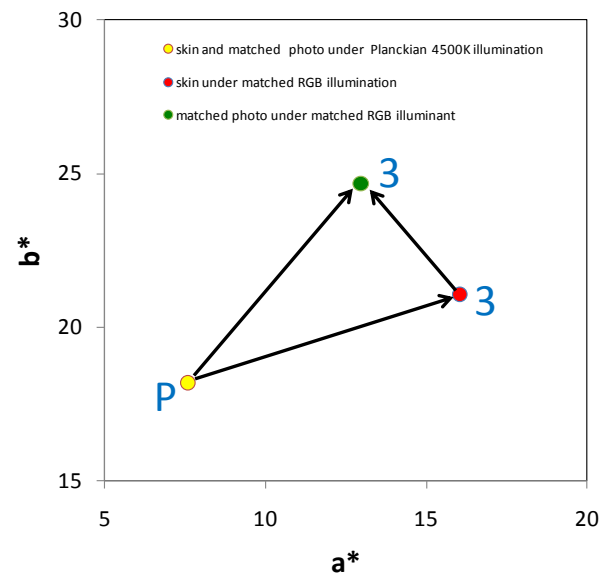
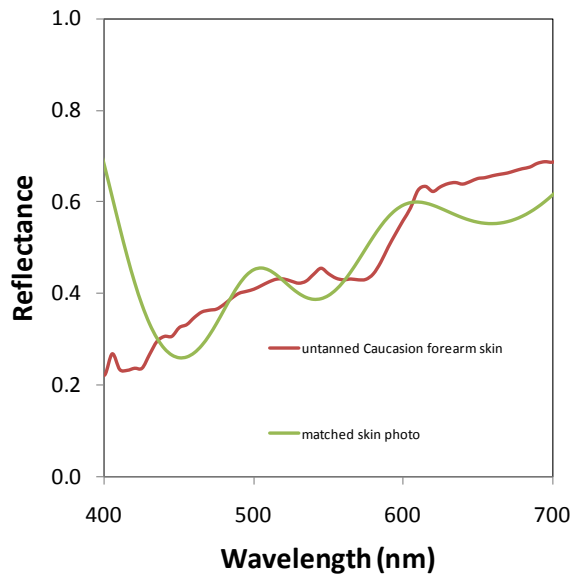
An important case: “Flesh Tone”



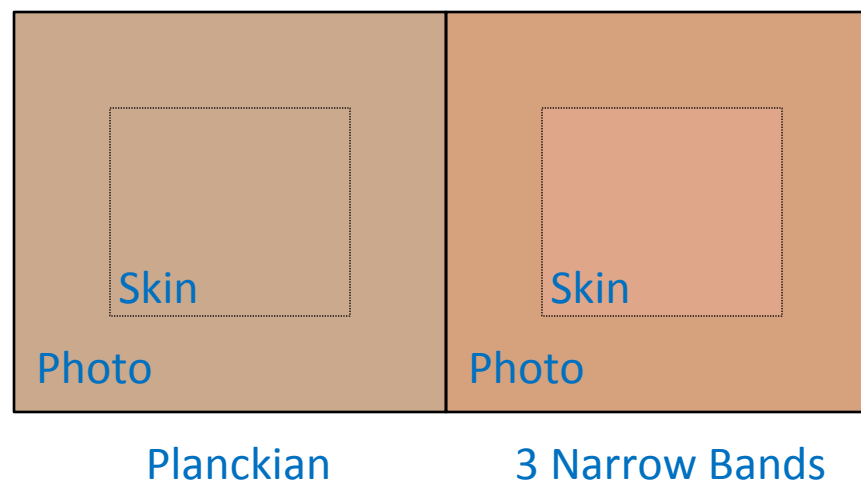
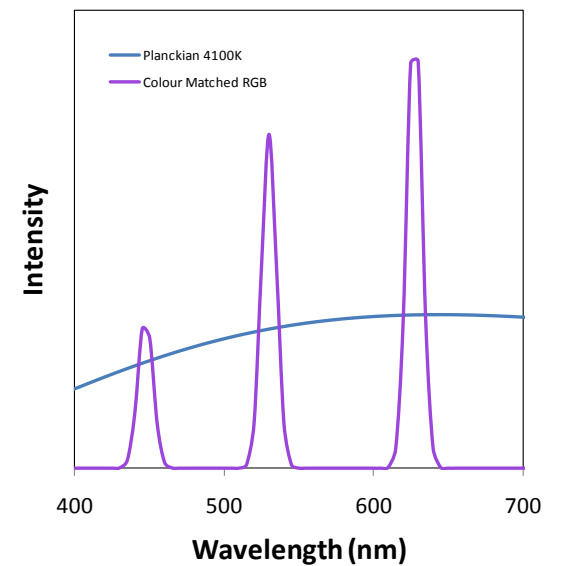
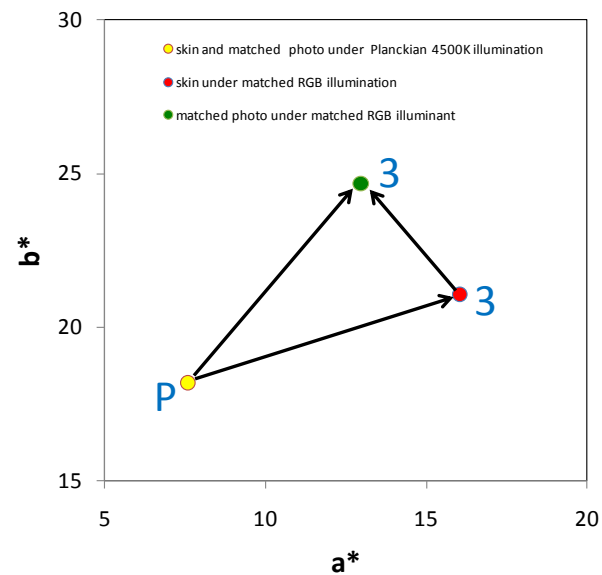
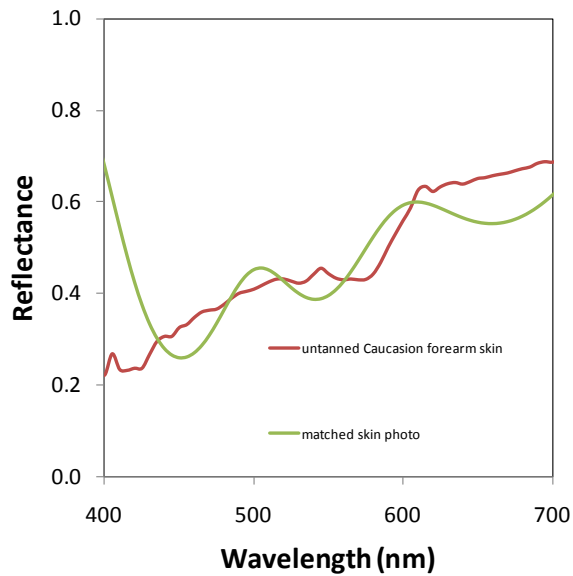
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An important case: “Flesh Tone”



Key Ideas

- Different spectra can appear the same color
- But may ***render*** colors of surfaces differently
- We don't adapt to poor color rendering
- This causes some people ***discomfort***
- Critical issue: ***efficacy/rendering trade-off***

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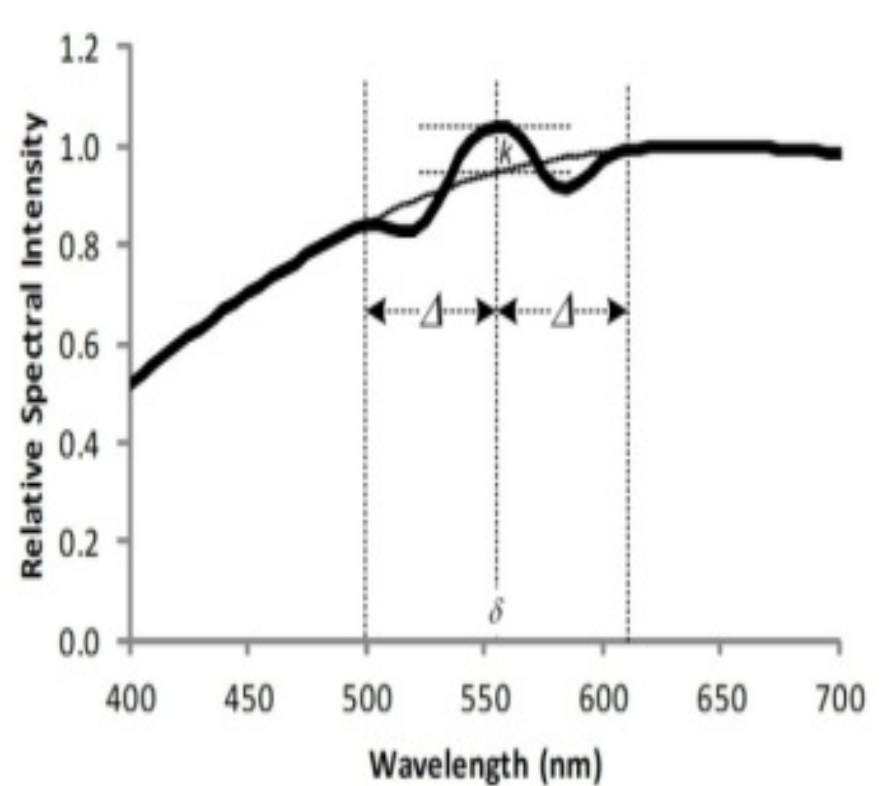
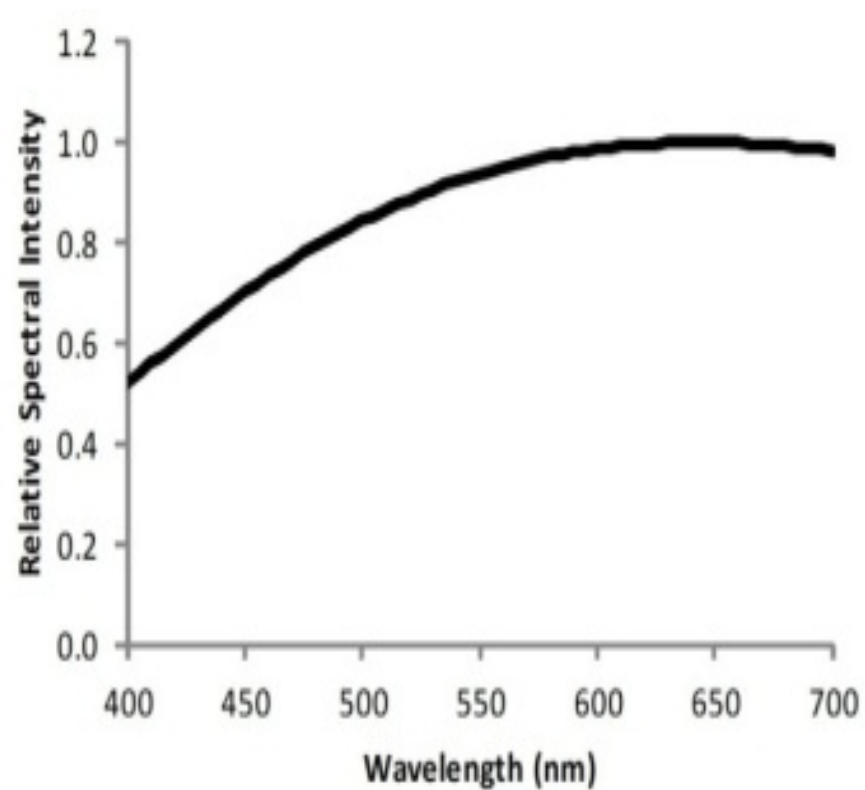


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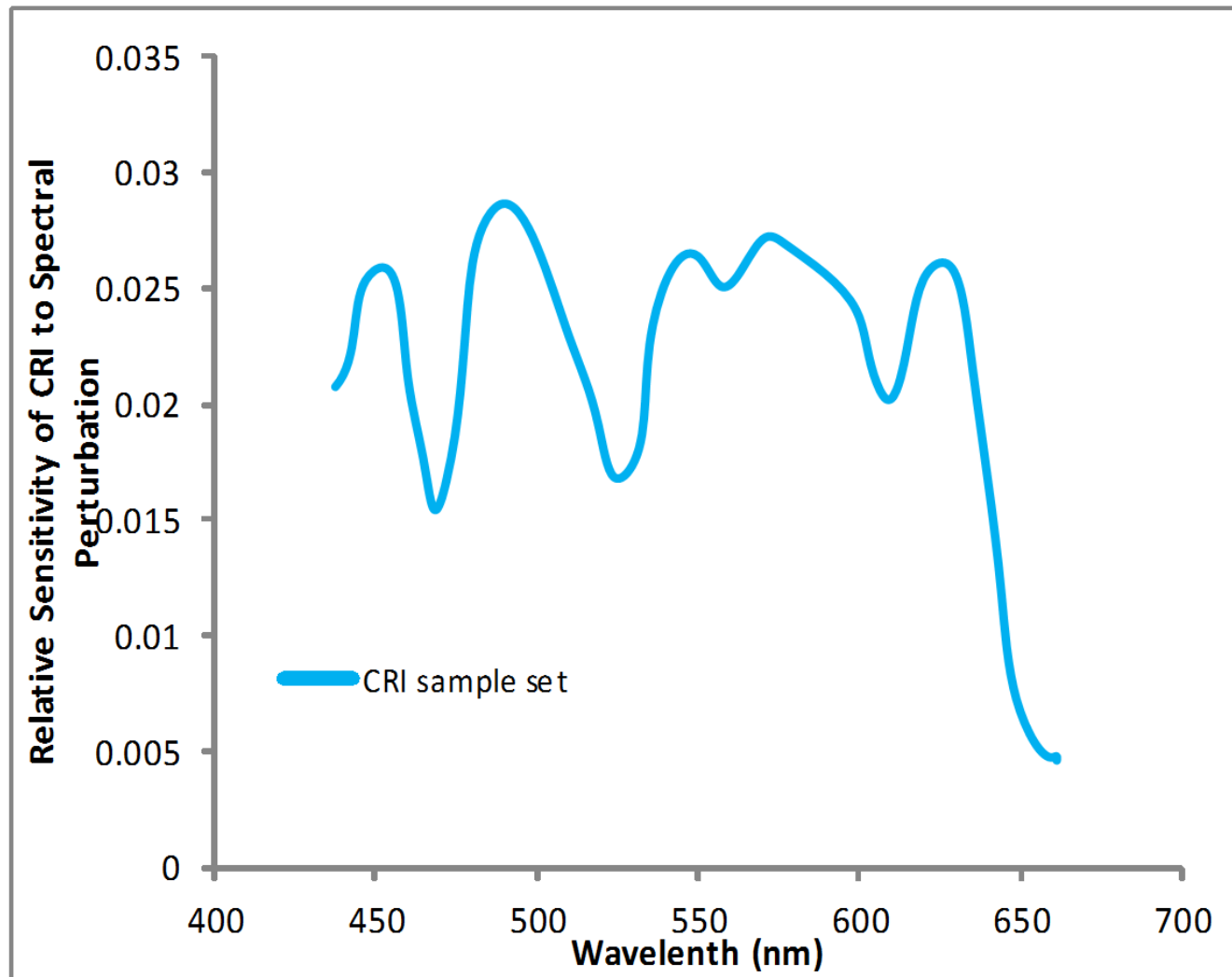
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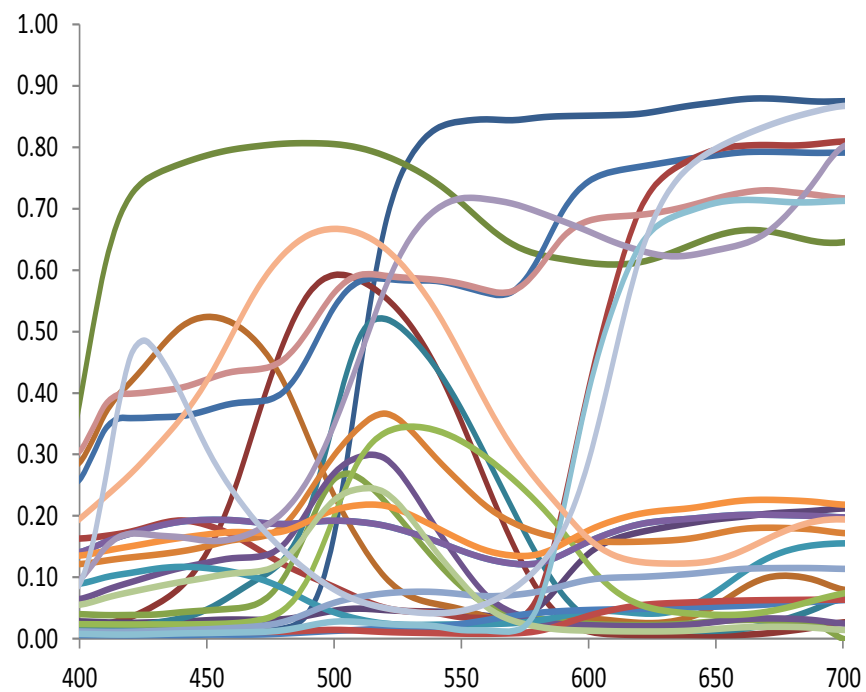
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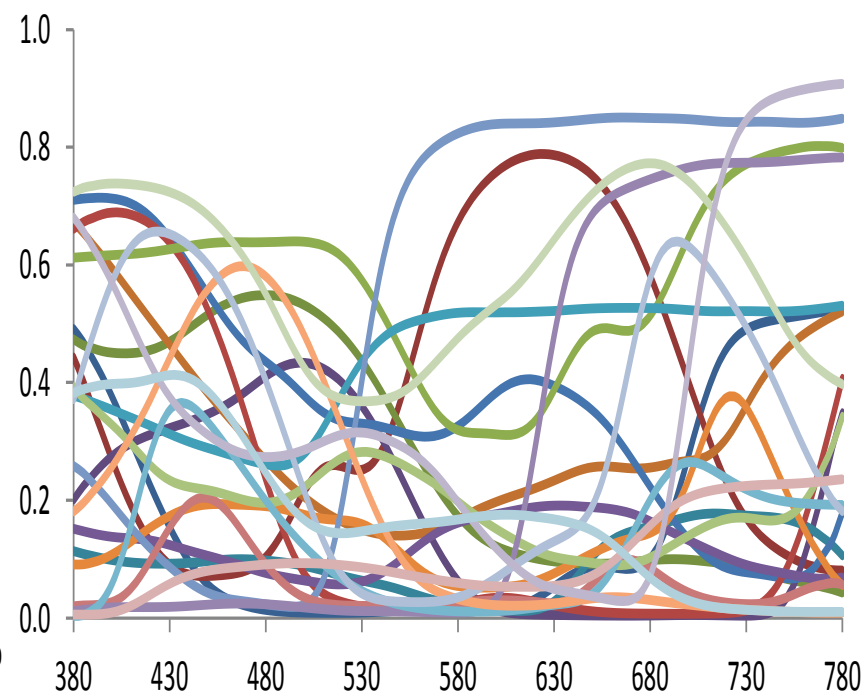
Color-Neutral Perturbation of Planckian



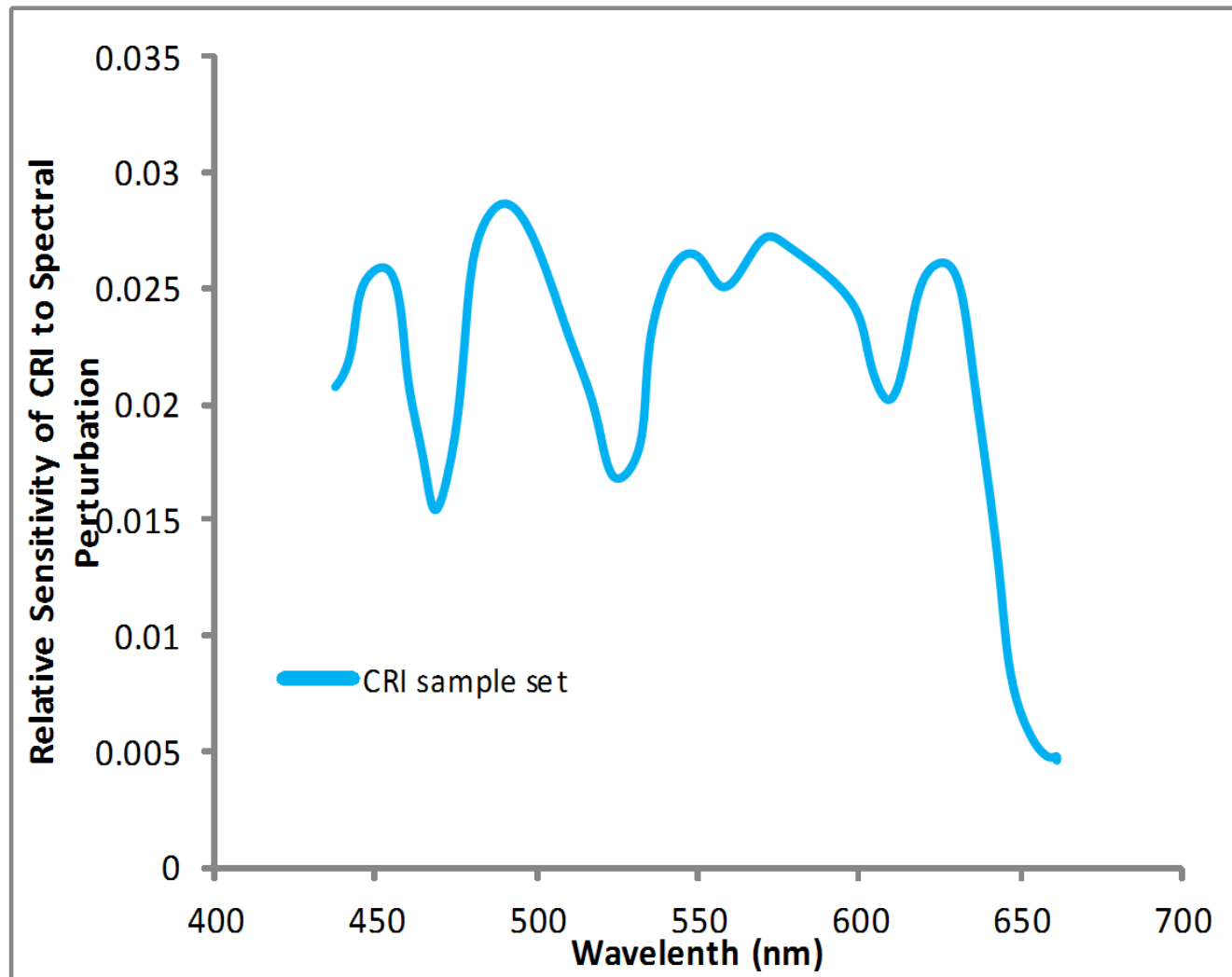
Sensitivity of CRI to Perturbations vs. Wavelength



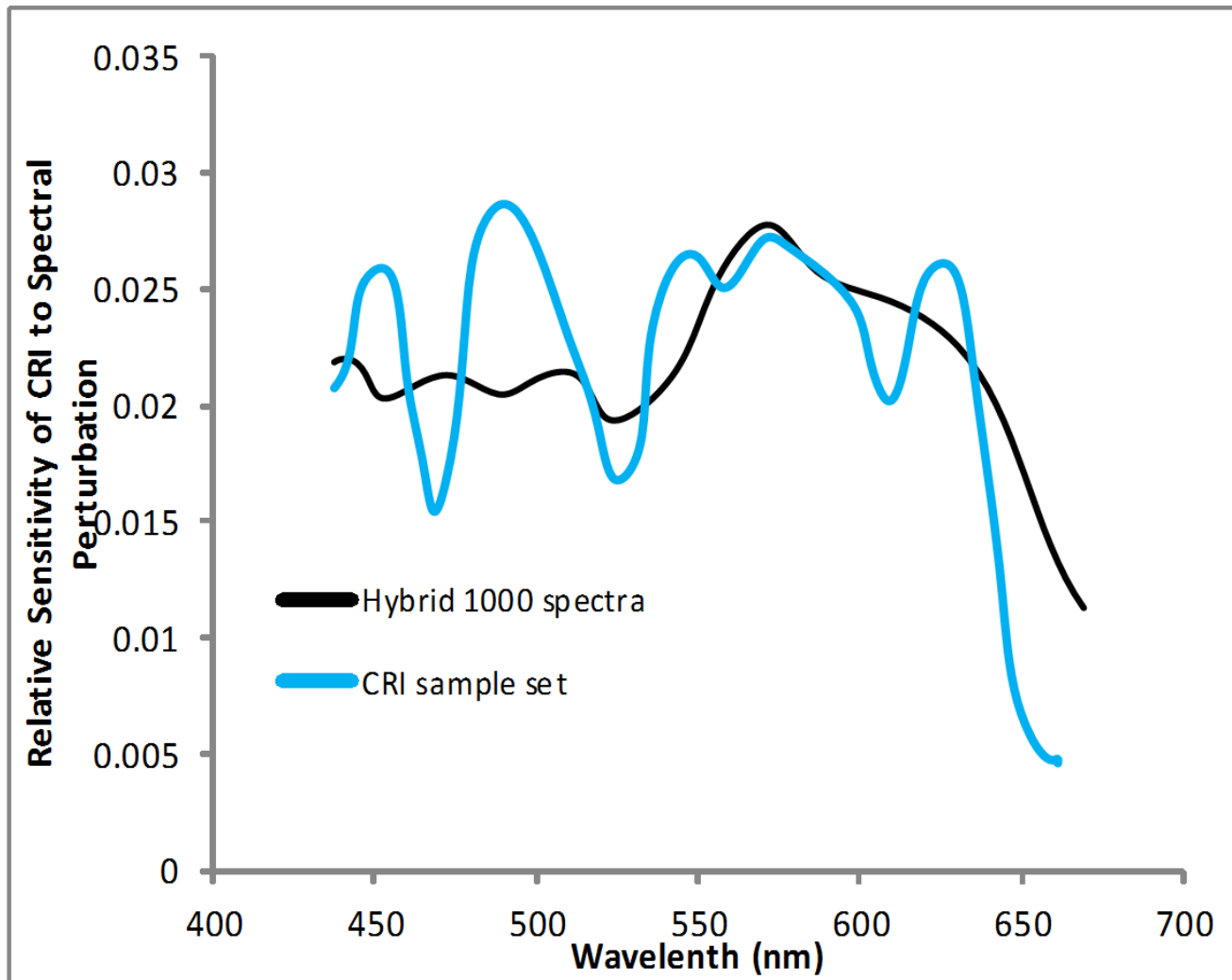
Raw Spectra



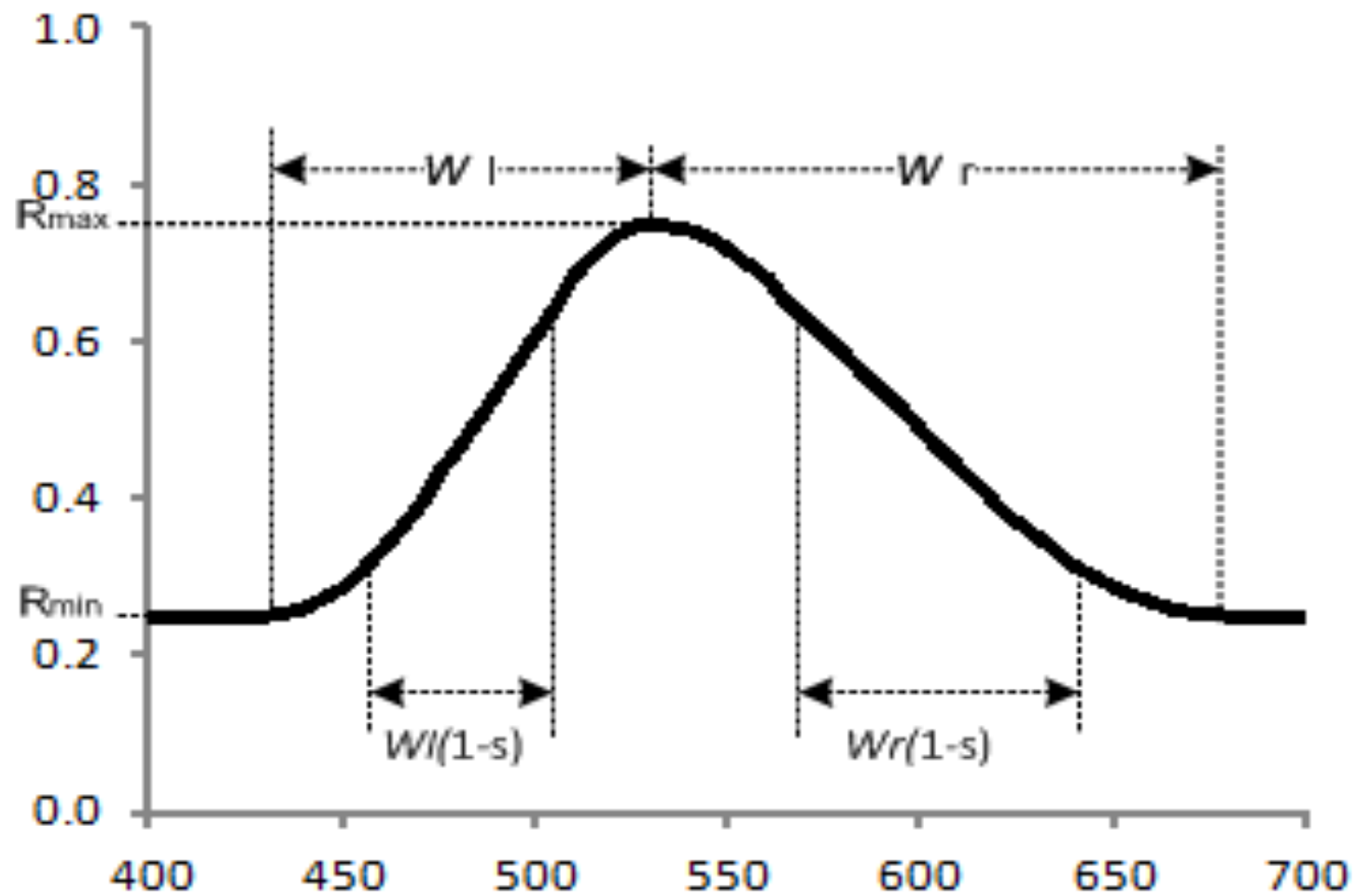
Hybrid Spectra



Sensitivity of CRI to Perturbations vs. Wavelength



Sensitivity of CRI to Perturbations vs. Wavelength



Form of Representative Spectrum

$$i = 1 \text{ to } 17 \quad l_{ci} = 550\text{nm} + 25\text{nm} * (i - 9)$$

$$M_i = 0.5 + 0.001\text{nm}^{-1} * (l_{ci} - 550\text{nm})$$

A) If $\text{ABS}(l - l_{ci}) \geq [125\text{nm}]$:

$$R(l) = [0.01]$$

B) If $[125\text{nm}] > \text{ABS}(l - l_{ci}) \geq [75\text{nm}]$:

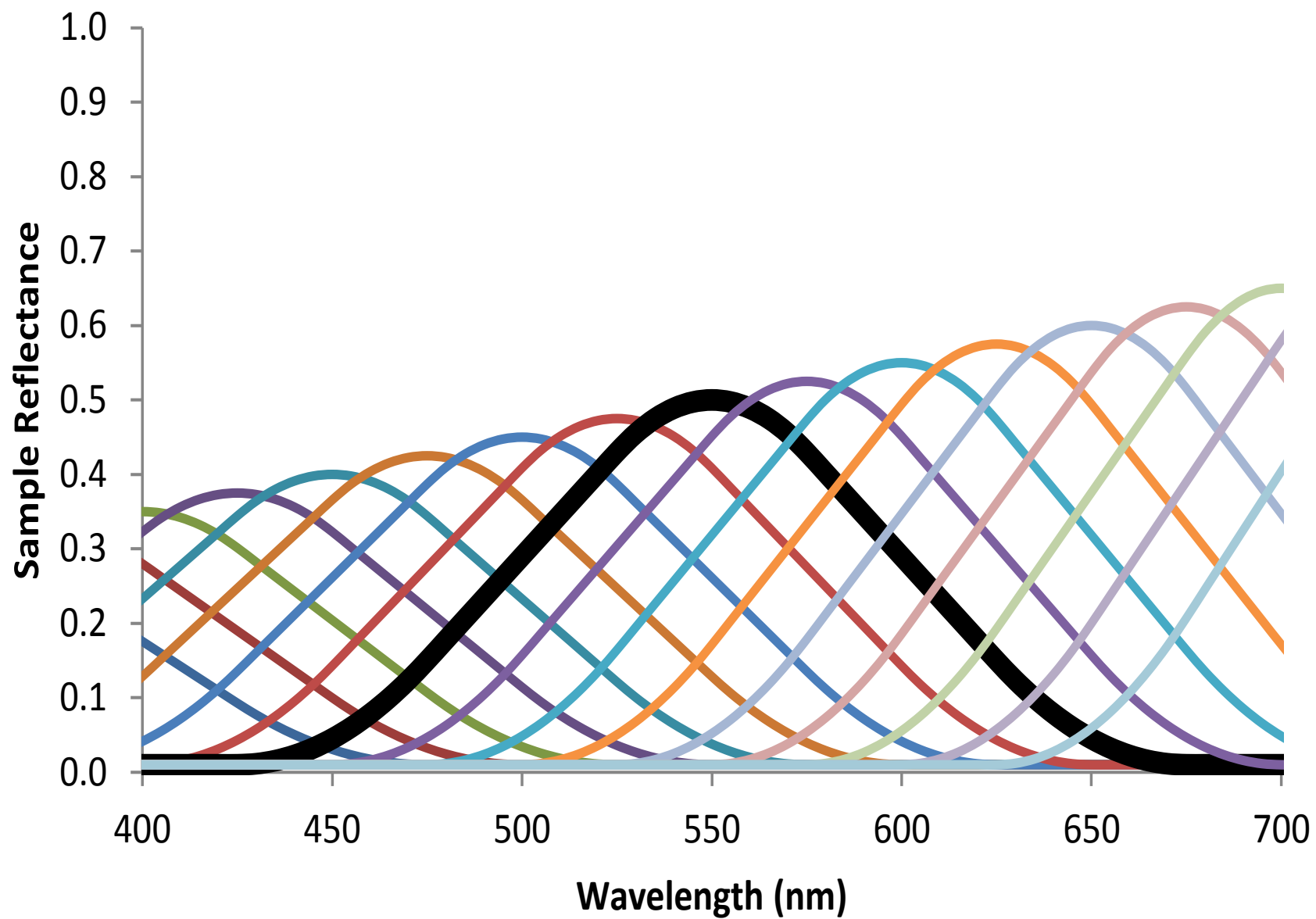
$$R(l) = [0.01] + (M_i - [0.01]) * [1/8750\text{nm}^2] * ([125\text{nm}] - \text{ABS}(\lambda - \lambda_{ci}))^2$$

C) If $[75\text{nm}] > \text{ABS}(l - l_{ci}) \geq [25\text{nm}]$:

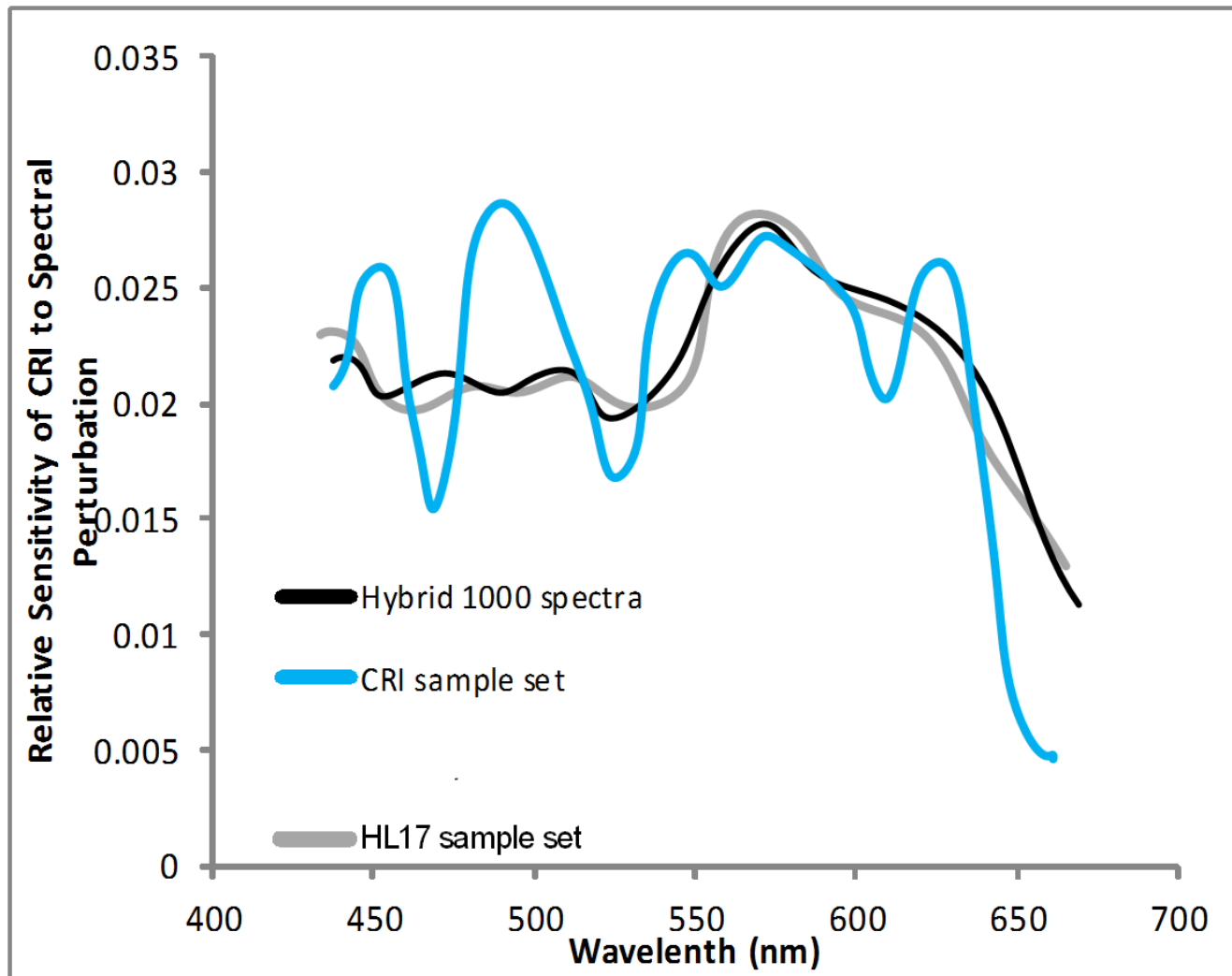
$$R(l) = [0.01] + (M_i - [0.01]) * ([8/7] - [2/175\text{nm}] * \text{ABS}(\lambda - \lambda_{ci}))$$

D) If $[25\text{nm}] > \text{ABS}(l - l_{ci})$:

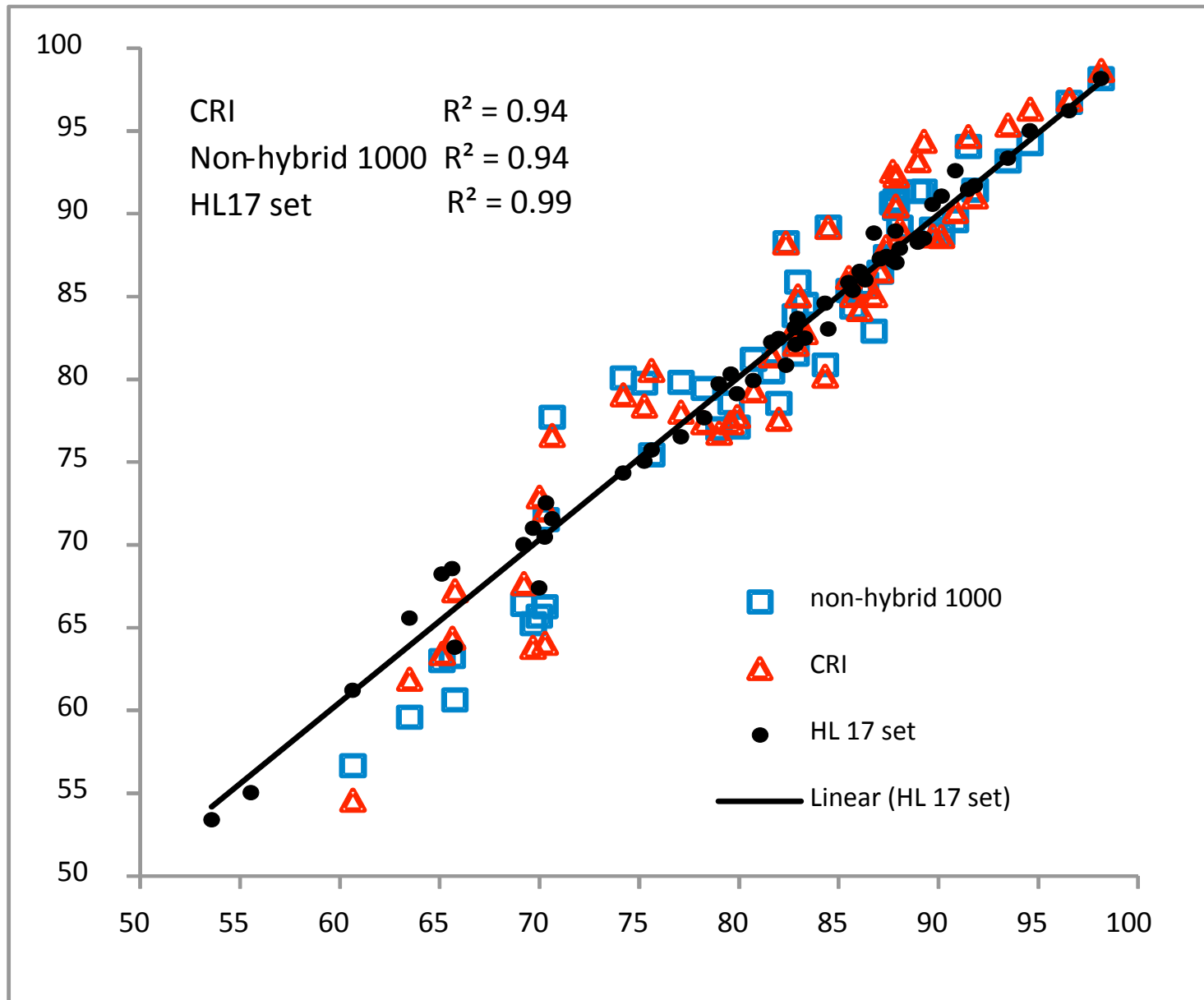
$$R(l) = [0.01] + (M_i - [0.01]) * ([1] - [1/4375\text{nm}^2] * (\lambda - \lambda_{ci})^2)$$



HL17 Spectral Set



Sensitivity of CRI to Perturbations vs. Wavelength



CRI values compared to Hybrid Leeds Data

Conclusions

- The HL17 set is proposed for CRI sample set
- This reduces sample error from 5 points to <1
- The CRI should then work well with LEDs
- More research is needed:
 - to verify good agreement with many observers
 - on psychological benefits of illumination with $\text{CRI} > 90$

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