*the talk previously known as...*

# Is there a role for melanopsin in chromatic adaptation?


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slides: doi.org/10.6084/m9.figshare.6613919

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# Overview

1. Museum lighting
2. Damage functions
3. Colour Temperature
4. ‘Preference’ prediction
    1. Kruithof
    2. Colour rendering
    3. Melanopsin
5. *My research*

Museum lighting:

Necessary to see objects

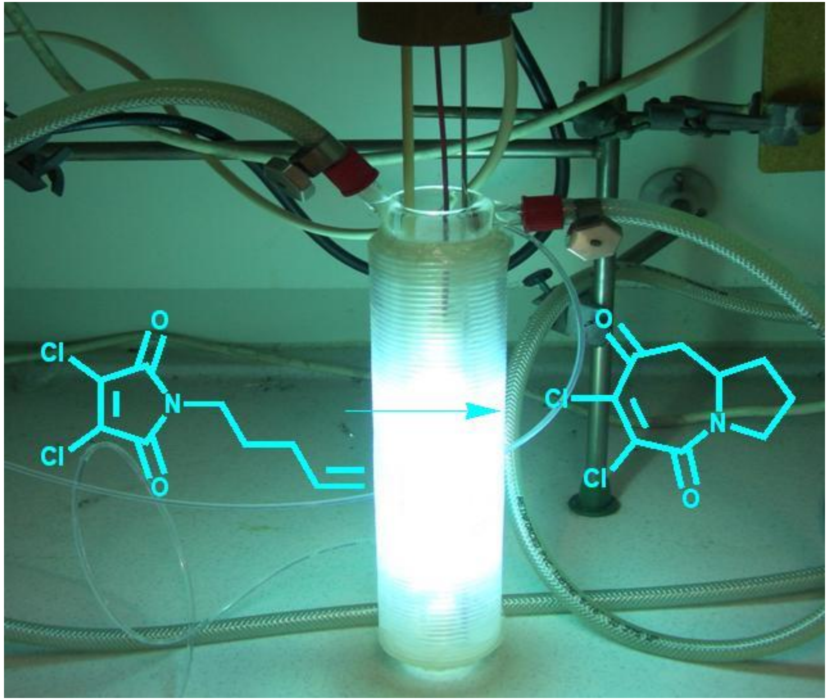
but

damages objects over time

*Close up of light damage on musician Wilf Carter's bright pink suit from NMC's Canadian Country Music Hall of Fame collection. Credit: Gail Niinimaa*
https://nmc.ca/who-turned-out-the-lights/

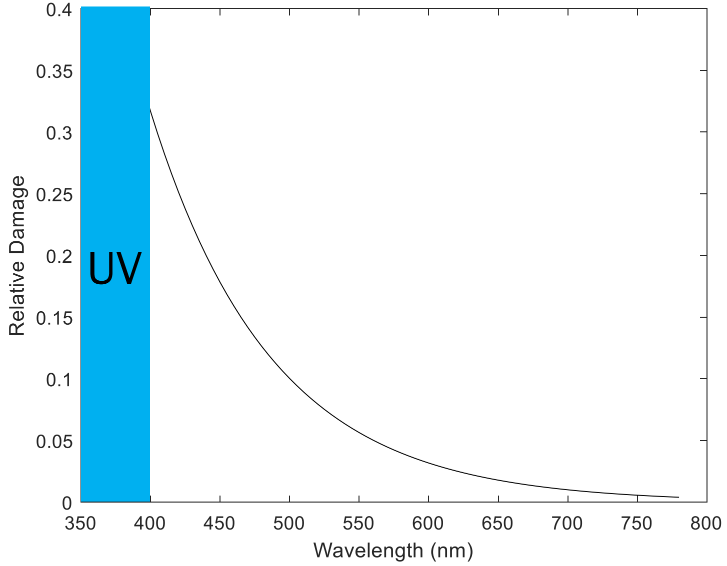
What is it about light that causes damage to objects?

*Photodegradation*



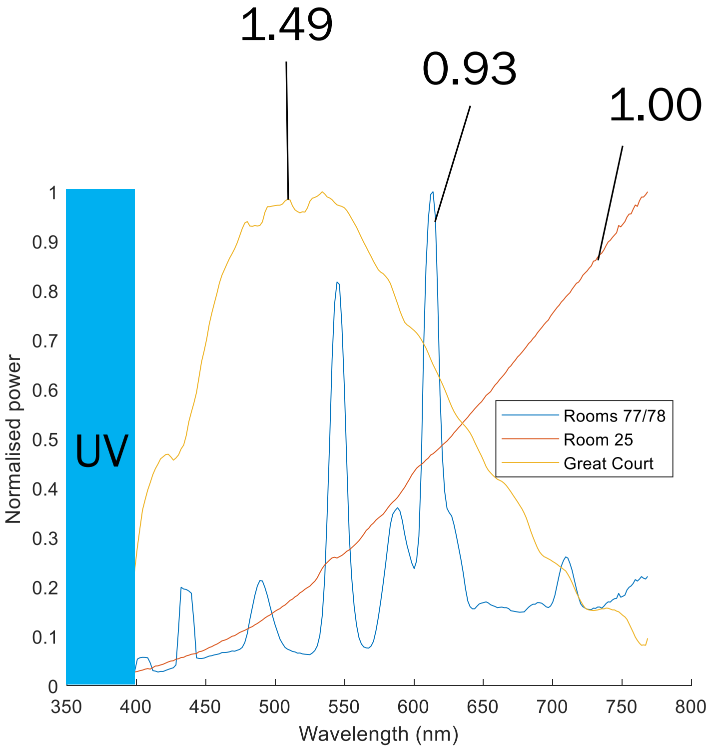

https://chemicalengineeringmatters.files.wordpress.com/2014/12/photochemical-reaction.jpg

# Not all lights are equal




Harrison’s Damage Function

Harrison (1953), CIE (2004)




British Museum Lighting Measurements

# Damage functions

*Saunders, D., Kirby, J., 1994.*
***Wavelength-dependent fading of artists' pigments.***
*Studies in Conservation 39, 190–194.*

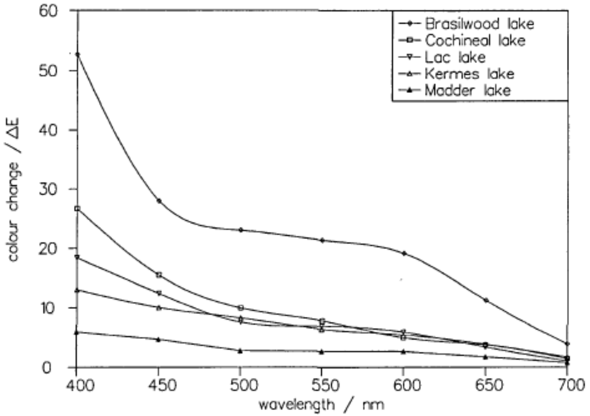
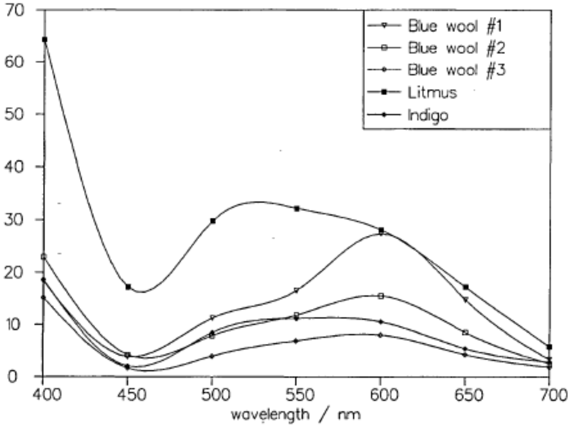



Fig. 3 Plot of colour change against wavelength for the five red lake pigments studied.




;. 4 Plot of colour change against wavelength for litmus, indigo and the blue wool standards.

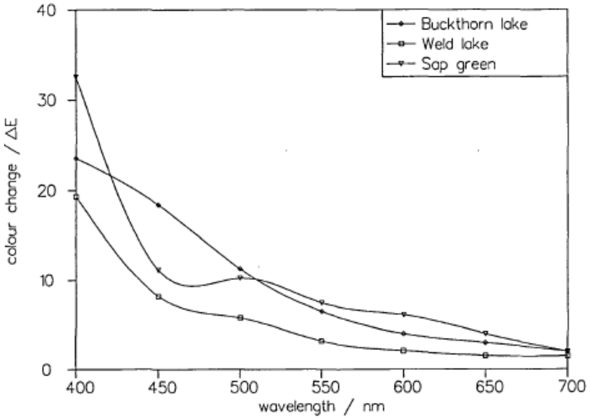



Fig. 6 Plot of colour change against wavelength for the yellow lake pigments and sap green.

# Damage functions

*Nakagoshi, K., Yoshizumi, K., 2011.* ***Degradation of Japanese Lacquer under Wavelength Sensitivity of Light Radiation.*** *Materials Sciences and Applications 2, 1507.*

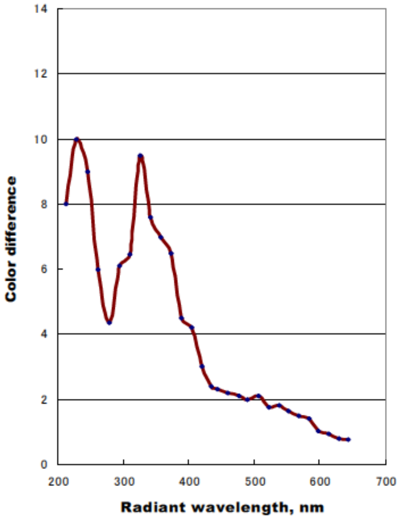


Figure 8. Wavelength sensitivity characteristics for the fading of Tame-Urushi under a radiant energy of 5 $MJ/m^2/nm$ at each wavelength.

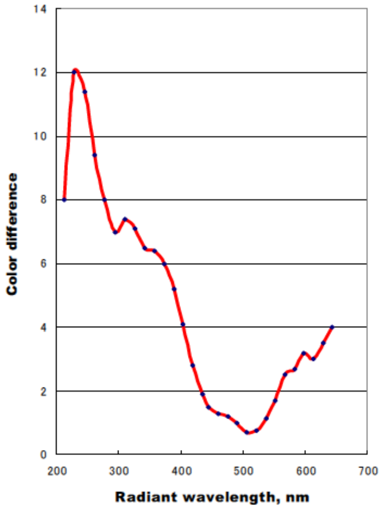


Figure 9. Wavelength sensitivity characteristics for the fading of Shuurushi under a radiant energy of 5 $MJ/m^2/nm$ at each wavelength.

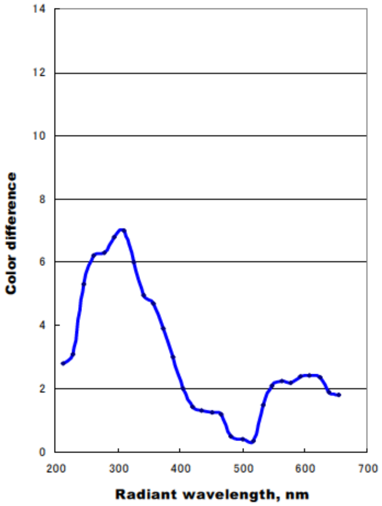


Figure 10. Wavelength sensitivity characteristics for the fading of Ao-Urushi under a radiant energy of 5 $MJ/m^2/nm$ at each wavelength.

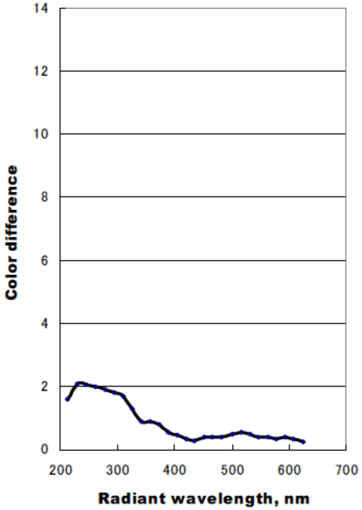
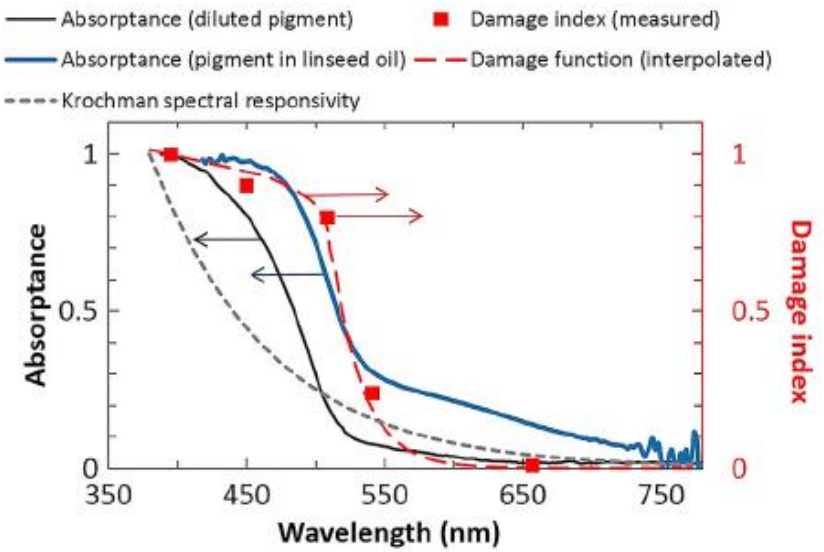


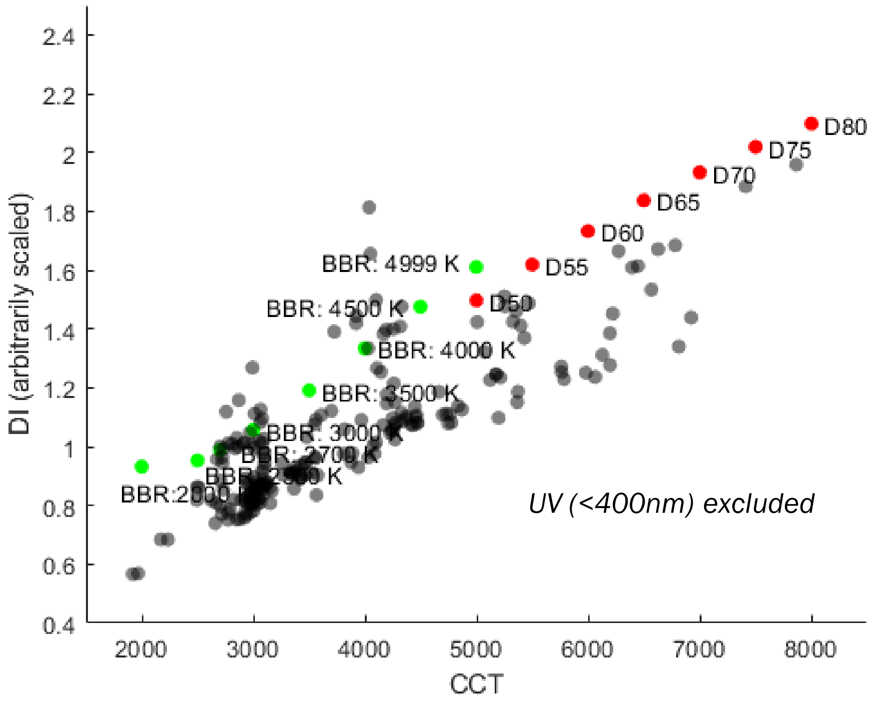
Figure 11. Wavelength sensitivity characteristics for the fading of Shin-Urushi under a radiant energy of 5 $MJ/m^2/nm$ at each wavelength.

# Damage functions

*Lunz, M., Talgorn, E., Baken, J., Wagemans, W., Veldman, D., 2017.*
***Can LEDs help with art conservation?***
***– Impact of different light spectra on paint pigment degradation.***
*Studies in Conservation 62, 294–303.*
*doi.org/10.1080/00393630.2016.1189997*



# Damage indexes for different light sources



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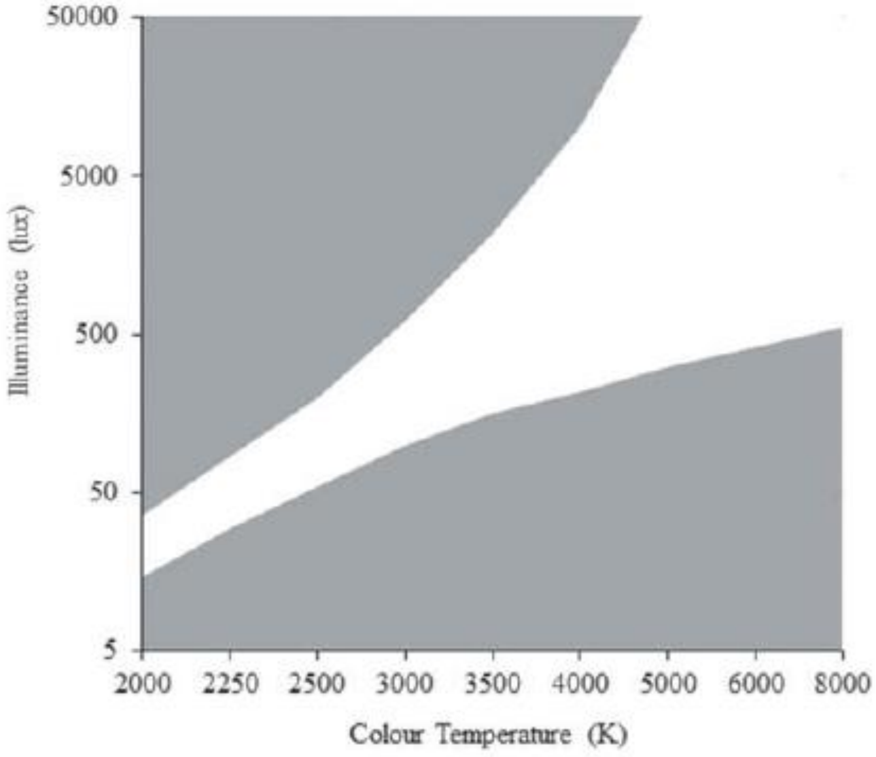
# Visual effect of different CCTs

# ‘Kruithof curve’

*Fotios, S., 2017.*
***A Revised Kruithof Graph Based on Empirical Data.***
*LEUKOS 13, 3–17.*
*doi.org/10.1080/15502724.2016.1159137*

*Kruithof, A.A., 1941.*
***Tubular luminescence lamps for general illumination.***
*Philips tech. Review 6, 65–96.*



# Visual effect of different CCTs

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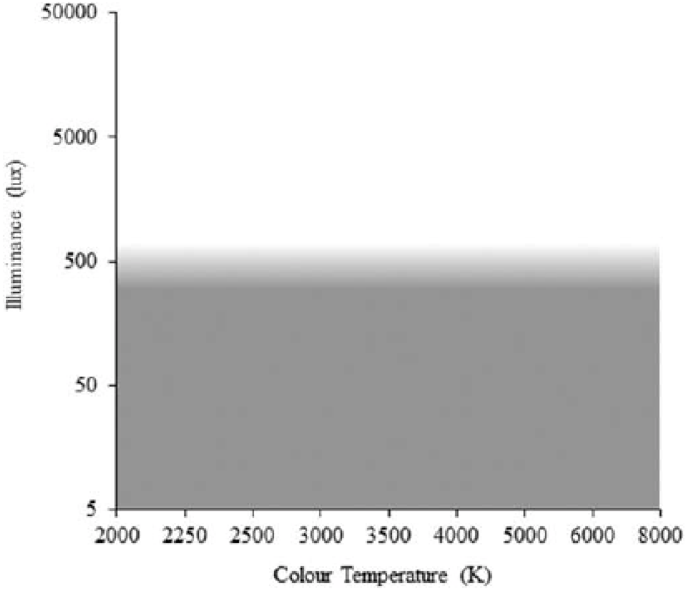



*Cuttle, C. ‘Kit,’ 2017.* ***Review of a Published Article.*** *LEUKOS 13, 19–20.*
*https://doi.org/10.1080/15502724.2016.1187910*

*Fotios, S., 2017.* ***Author’s Reply to Review of a Published Article.*** *LEUKOS 13, 21–22.*
*https://doi.org/10.1080/15502724.2016.1187911*

# Visual effect of different CCTs

One reason for disagreement between studies is an imprecise specification of the SPD of the light sources.

…

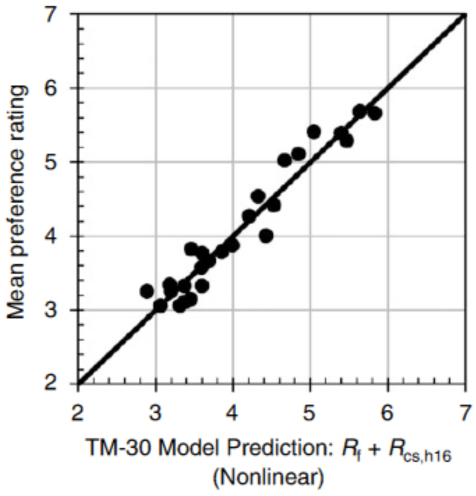
"Lighting designers continue to refer to it with reverence . . . " [Cuttle 2015], which suggests that there is something regarding the interaction of SPD and illuminance still to be teased out. Further work would be interesting if it explored SPD metrics beyond CCT.

# Colour rendering

CIE ($R_a$)

↓

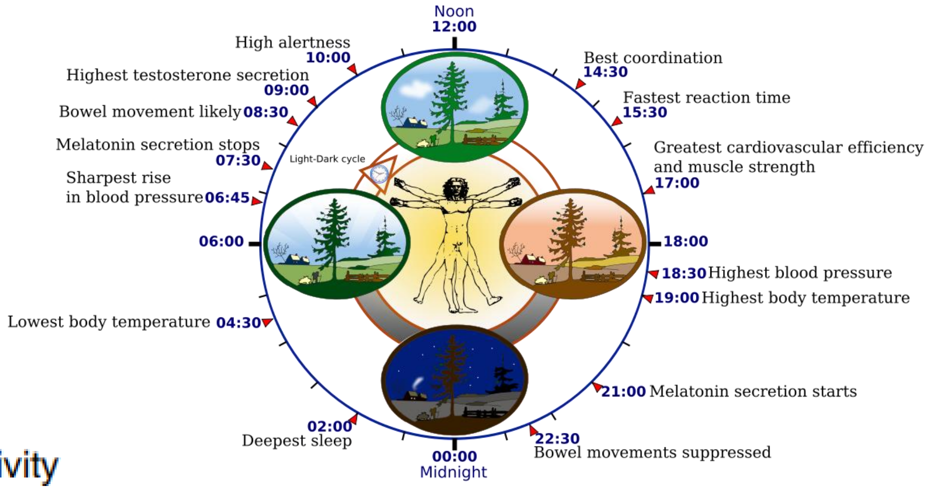
IES TM-30-15 ($R_f$ / $R_g$)

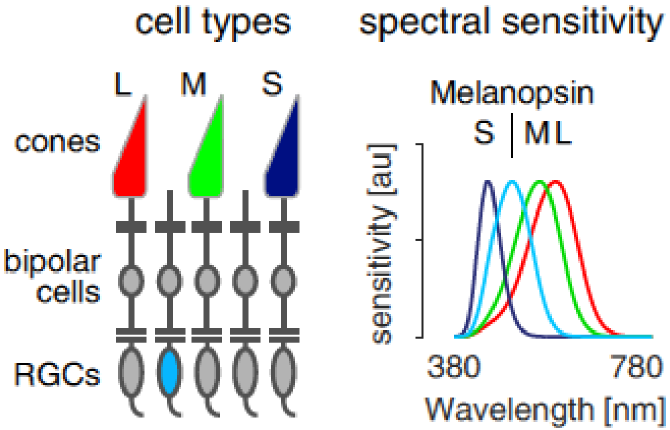



*Royer, M., Wilkerson, A., Wei, M., Houser, K., Davis, R., 2016.* ***Human perceptions of colour rendition vary with average fidelity, average gamut, and gamut shape.*** *Lighting Research & Technology 1–26.* *https://doi.org/10.1177/1477153516663615*

# Melanopsin

# Circadian rhythms



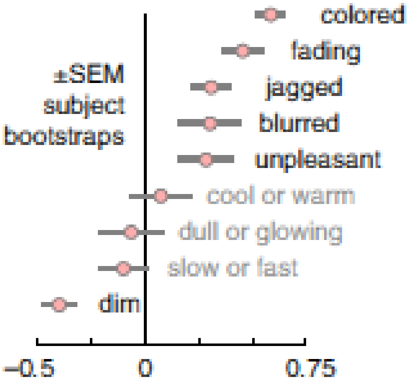




https://en.wikipedia.org/wiki/Circadian_rhythm#/media/File:Biological_clock_human.svg

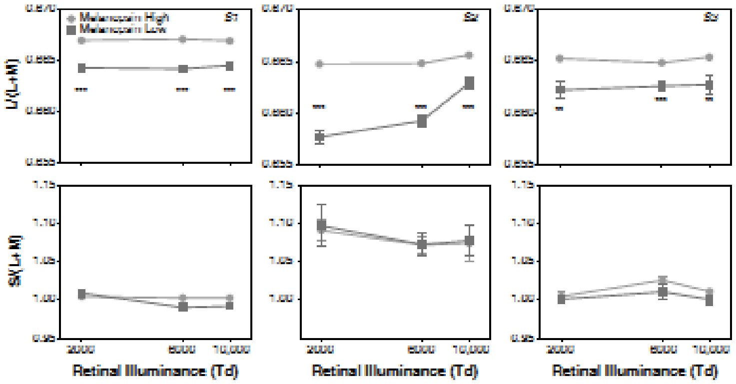
Spitschan et al., 2017. PNAS 114, 12291–12296. https://doi.org/10.1073/pnas.1711522114

# Interactions between visual and non-visual systems?

*Spitschan, M., Bock, A.S., Ryan, J., Frazzetta, G., Brainard, D.H., Aguirre, G.K., 2017.*
***The human visual cortex response to melanopsin-directed stimulation is accompanied by a distinct perceptual experience.***
*PNAS 114, 12291–12296.*
*https://doi.org/10.1073/pnas.1711522114*




*Cao, D., Chang, A., Gai, S., 2018.*
***Evidence for an impact of melanopsin activation on unique white perception.***
*J. Opt. Soc. Am. A, JOSAA 35, B287–B291.*
*https://doi.org/10.1364/JOSAA.35.00B287*



# Chromatic Adaptation and melanopsin – why?

- Spatial
- Temporal
- Absolute
- Downstream

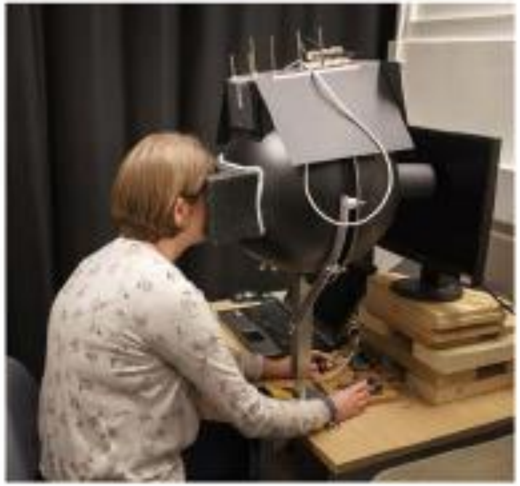
And why do we ***care***?

We think that colour constancy uses **multiple cues*.**
If one of them uses a melanopic signal and this conflicts with other cues, this would probably result in a percept of '**unnatural**', and quite possibly '**unpleasant**'.

* *Kraft, J.M., Brainard, D.H., 1999.* ***Mechanisms of color constancy under nearly natural viewing.*** *Proceedings of the National Academy of Sciences 96, 307–312.*

# Experimental work:

1. Computational (VSS 2018): doi.org/10.6084/m9.figshare.6280865.v1
2. Psychophysics in lab (ICVS 2017): icvs2017.fau.de/wp-content/uploads/2016/05/ICVS2017-Abstract-Book-1.pdf
3. Psychophysics in real world (AIC 2016): doi.org/10.6084/m9.figshare.4269680.v1

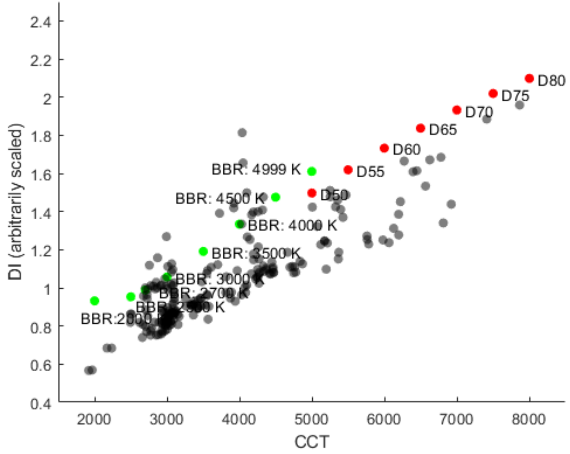


*Conclusion:*

If we can work out exactly what we do and don’t like about lighting,

that gives us much improved tools to decide on lighting which is

both minimally **damaging** and maximally **pleasing.**



*Supervisors:*

Lindsay MacDonald – CEGE, UCL
Kees Teunissen – Philips Lighting Research
Stuart Robson – CEGE, UCL
Katherine Curran – ISH, UCL
Capucine Korenberg – British Museum

*Funders:*
EPSRC
Philips Lighting Research

Engineering and Physical Sciences Research Council

# Hidden slides

# Studies have found 'preference' for:

- 3700K (Scuello et al., 2003)
- 5100K (Pinto, Linhares, Nascimento, 2008)
- 2900-5950K (Liu et al. 2013)
- 5500/5700K (Nascimento and Masuda, 2014)

Although there are some studies suggesting that for occidental viewers a correlated colour temperature (CCT) of about 5000K is optimal for visual appreciation there is not yet general agreement in the museum community about this issue.

*S. Nascimento, J. Linhares, C. Herdeiro, T. Kondo, Y. Misaki, and S. Nakauchi, 2017*
***"Influence of cultural factors in preferred illumination for paintings"***
*in "Book of Abstracts, Museum Lighting Symposium and Workshops", 49,*
*https://doi.org/10.14324/000.bk.10048078, also: https://youtu.be/_LD-XvBMfW0*