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Beyond Vision: Physiologic effects of visible light

Shadab A. Rahman Ph.D., M.P.H.

Instructor in Medicine - Harvard Medical School
Division of Sleep Medicine
Associate Neuroscientist - Brigham and Women's Hospital
Division of Sleep and Circadian Disorders

sarahman@partners.org

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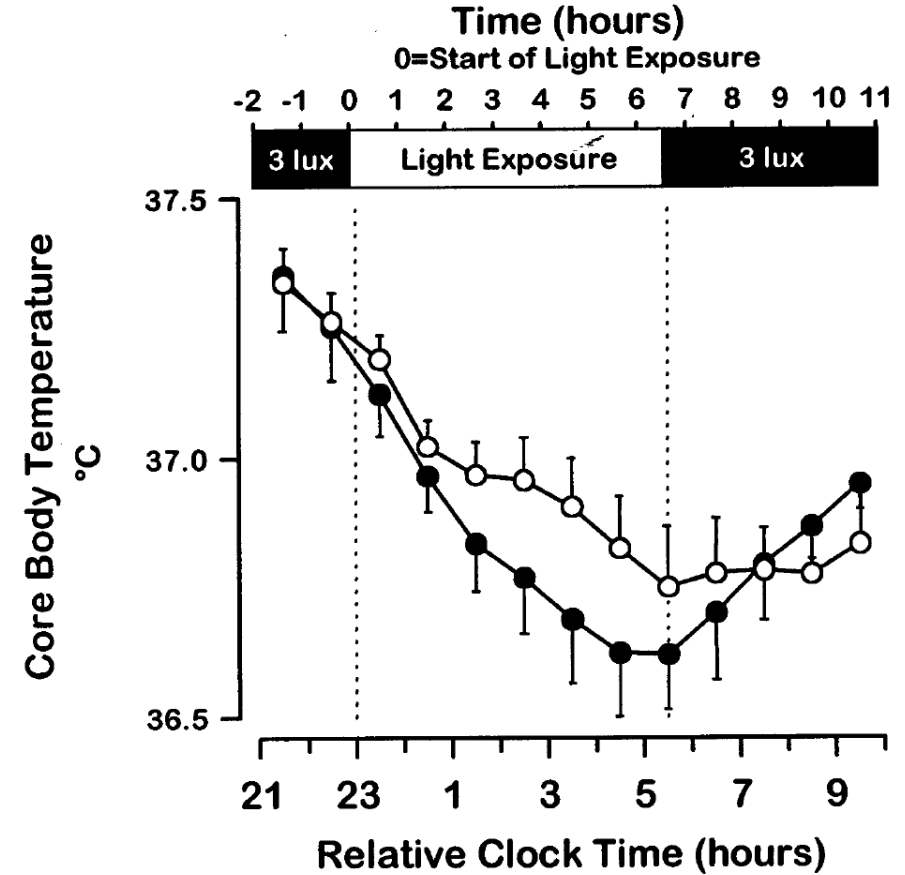
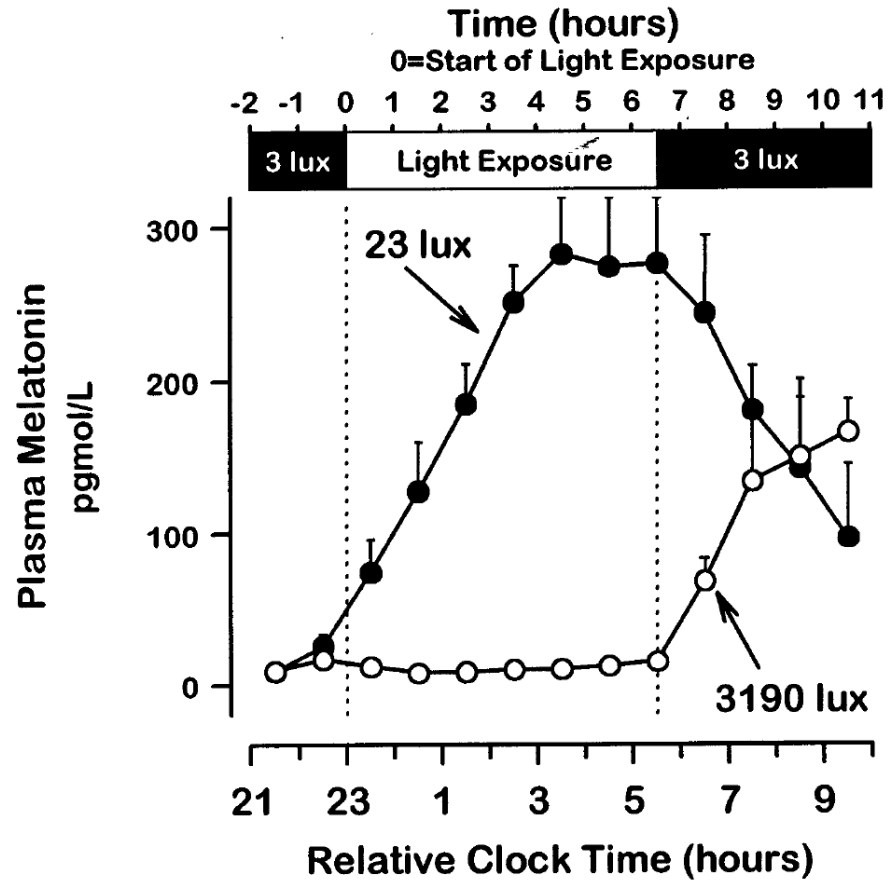


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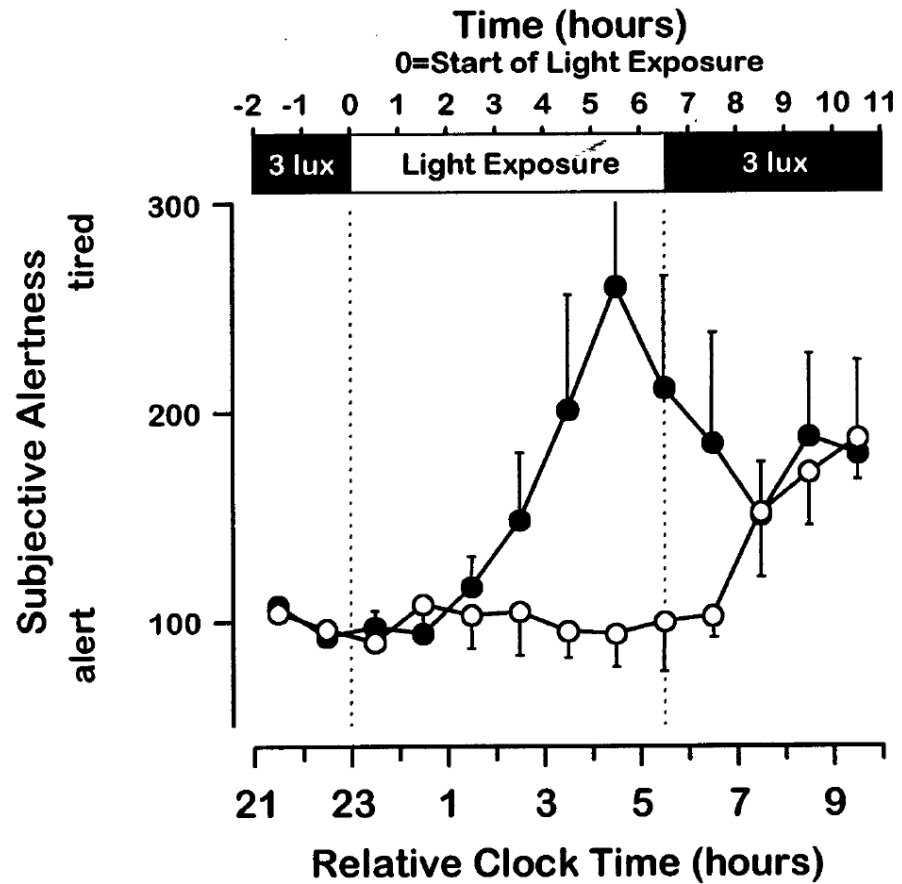
Outline

- Characteristic non-visual physiologic responses to light exposure
- Properties of light exposure that modulate non-visual responses
- Nuances & application considerations
- What do we know
- Future directions

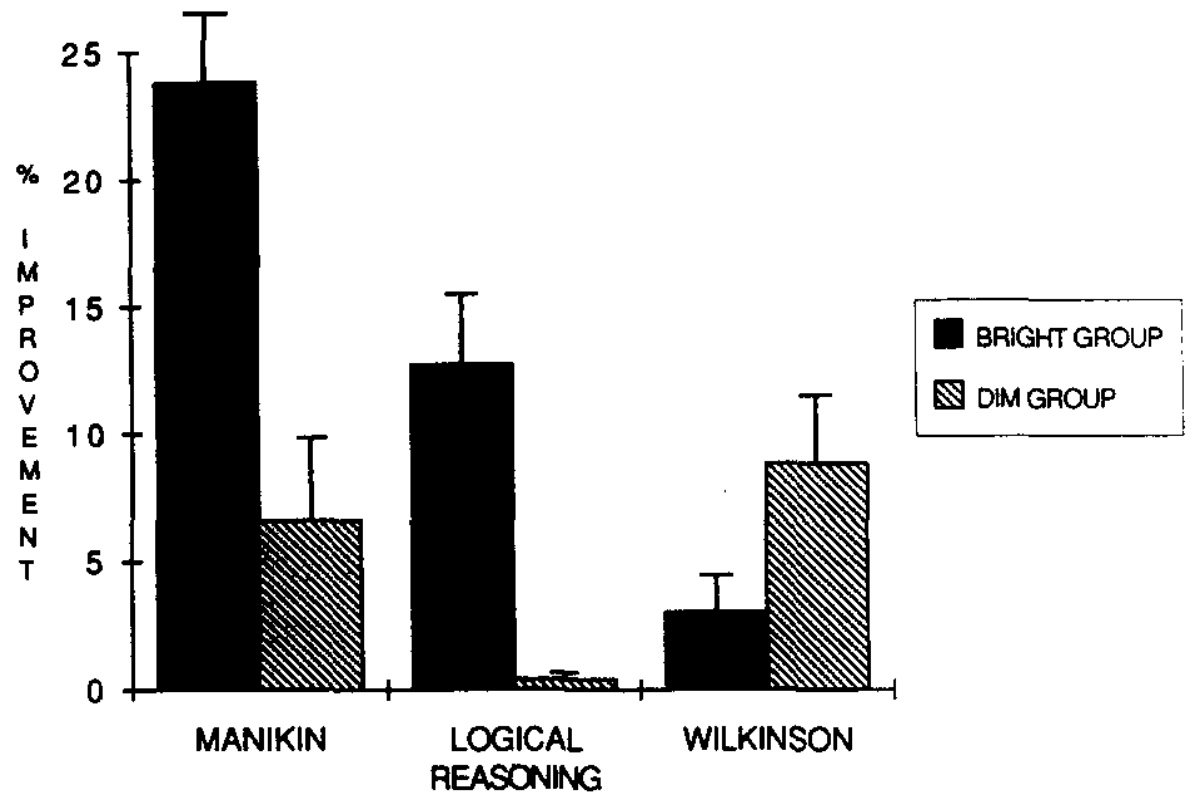
Non-visual effects of light



Non-visual effects of light



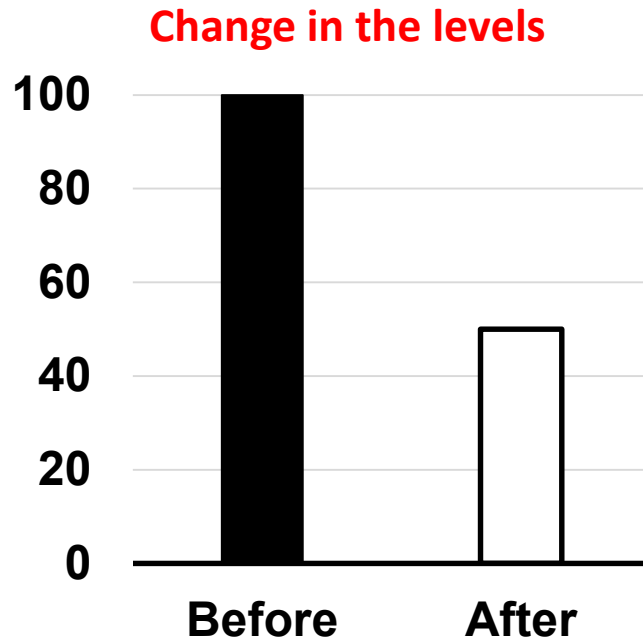
Cajochen *et al.*, *Behav Brain Res*, 2000



Campbell & Dawson *Physiol Behav*, 1990

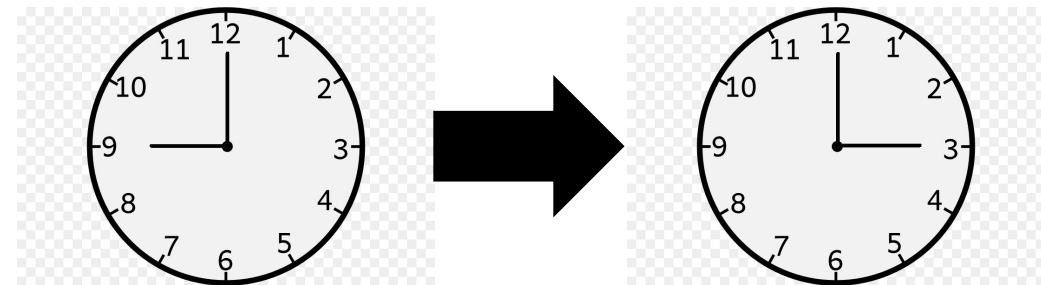
Classification of non-visual effects of light

Direct effect

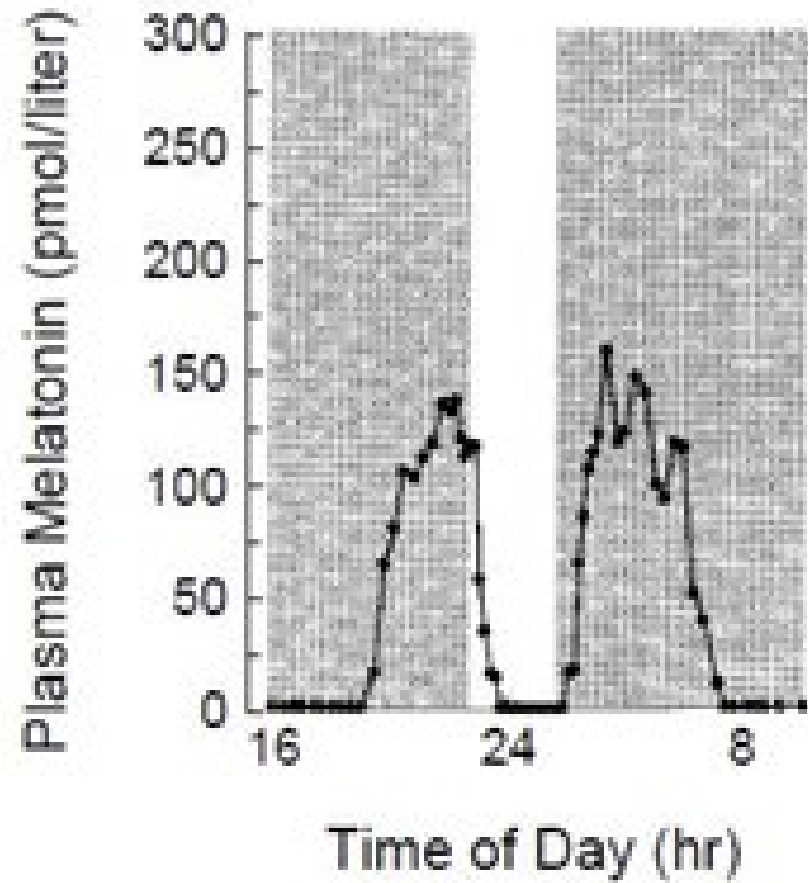


Pacemaker mediated phase-shift effect

Change in the timing

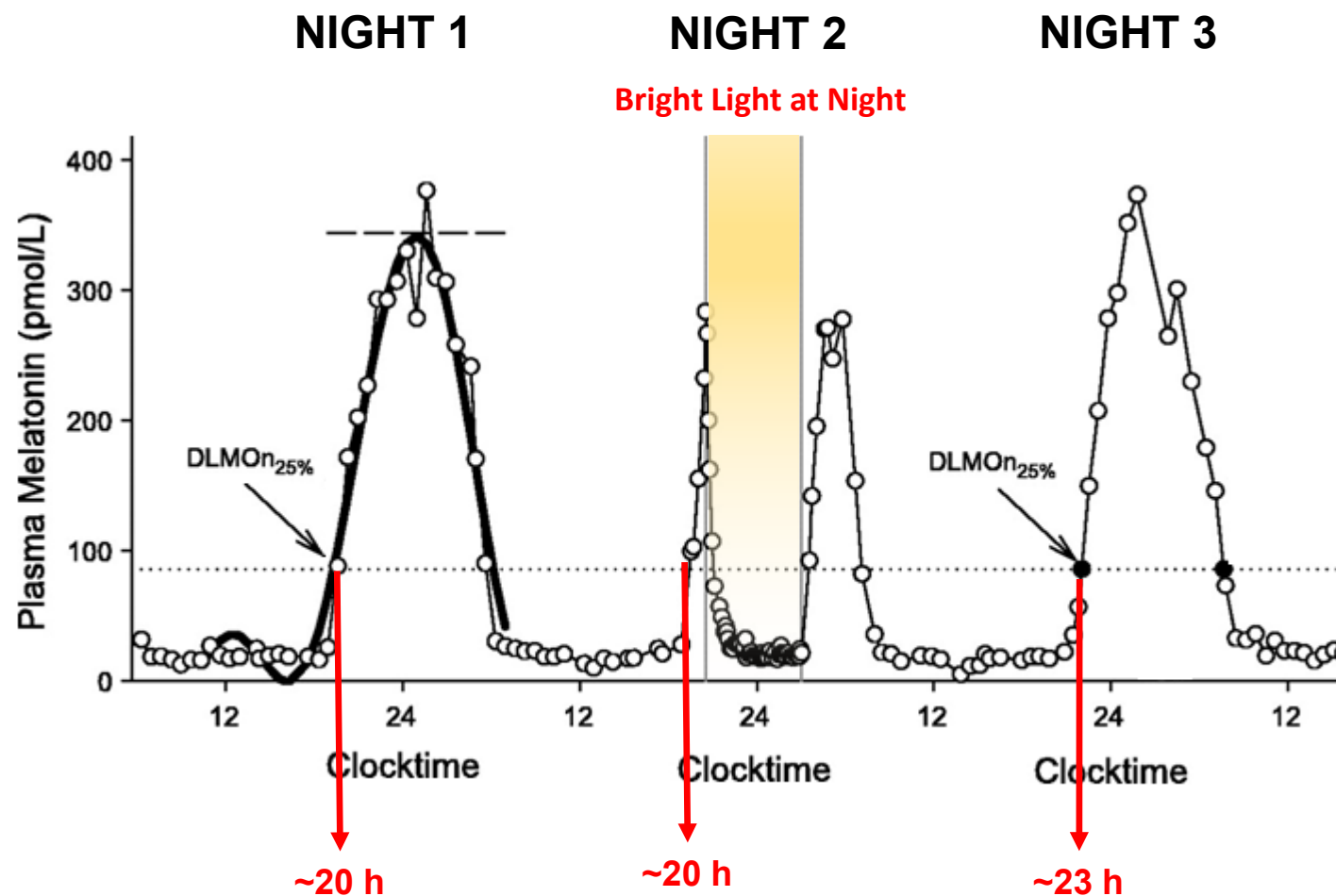


Direct effect

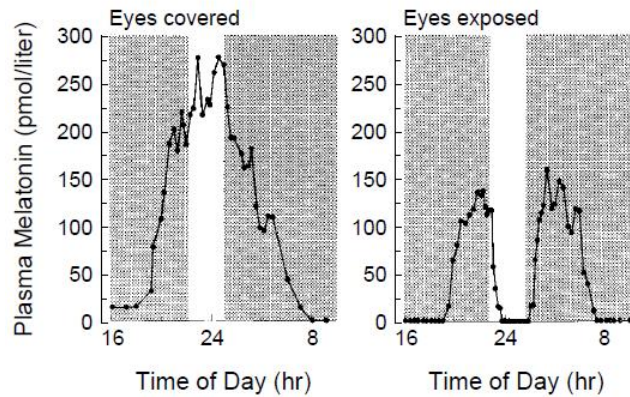


Czeisler *et al.*, *N Eng J Med*, 1995

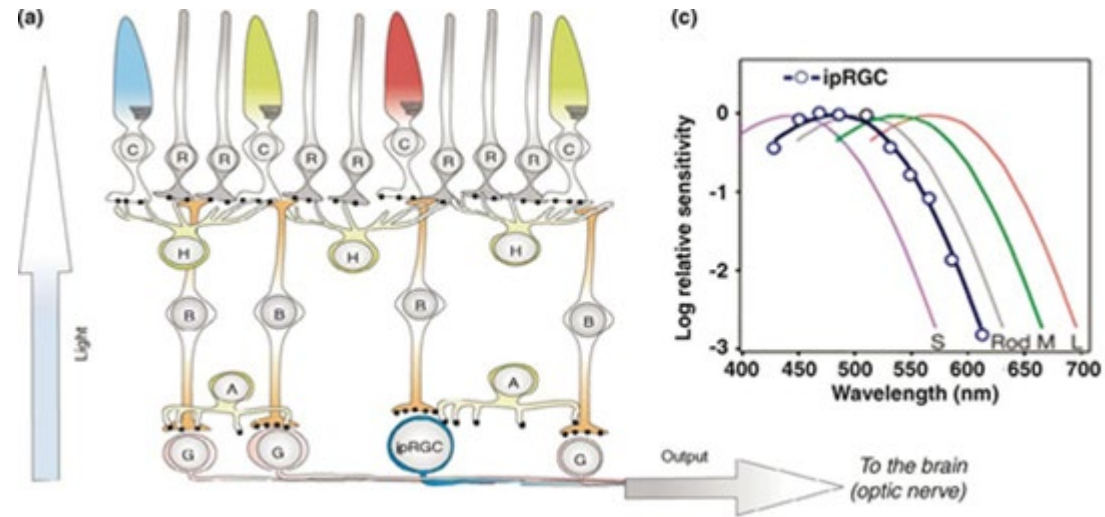
Pacemaker mediated (phase-shift) effect



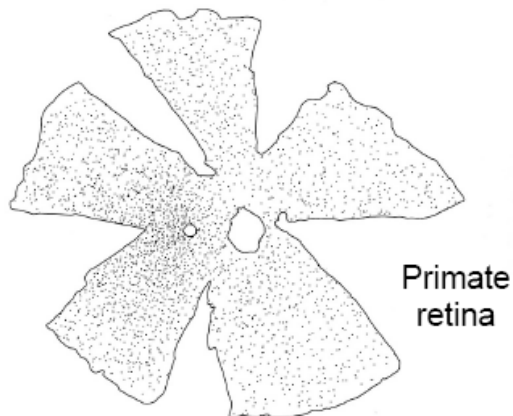
Pathway for non-visual effects of light



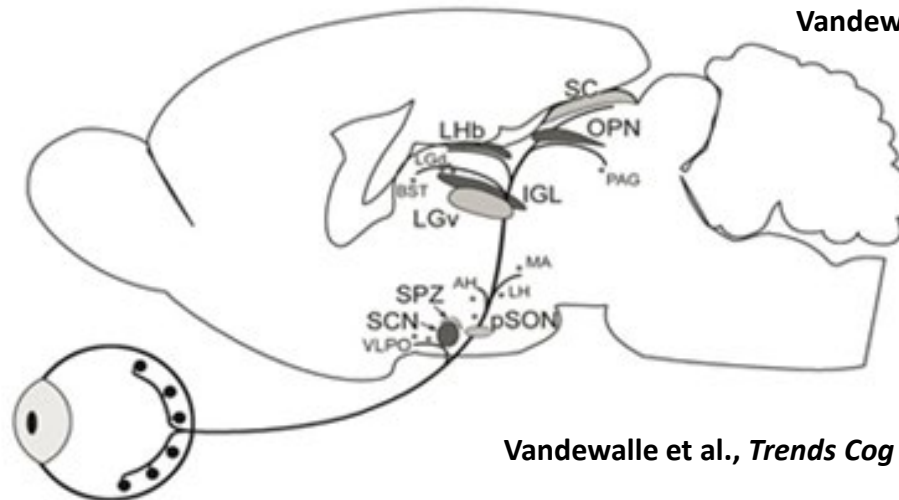
Czeisler et al., *N Eng J Med*, 1995



Vandewalle et al., *Trends Cog. Sci.* 2009

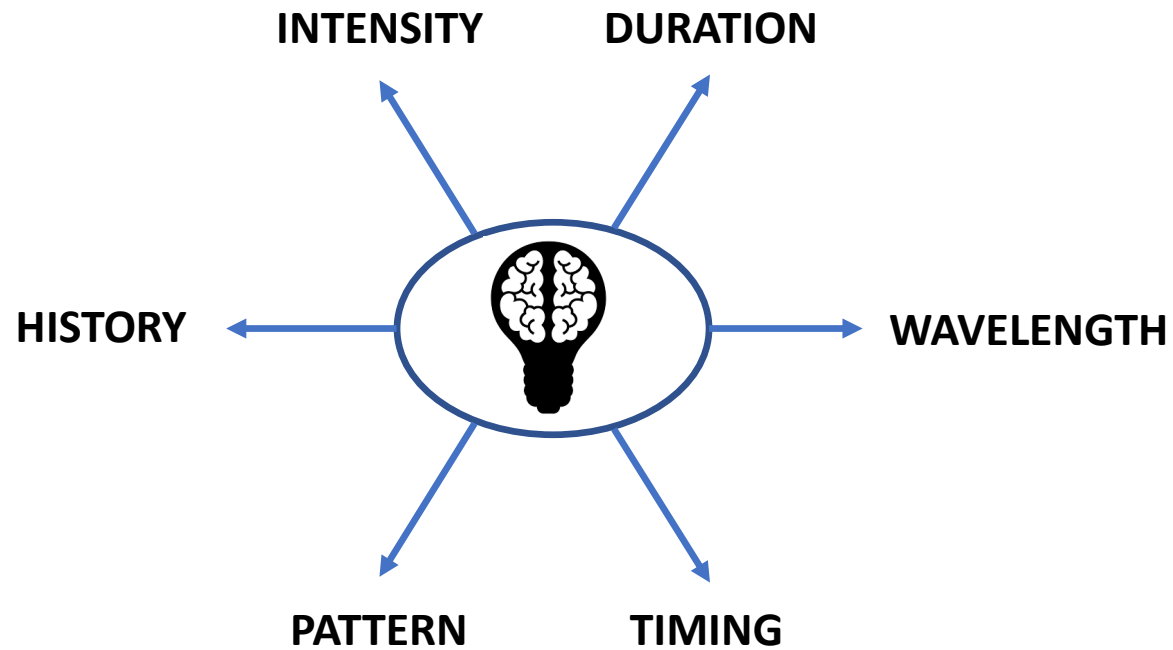


Dacey et al., *Nature* 2005

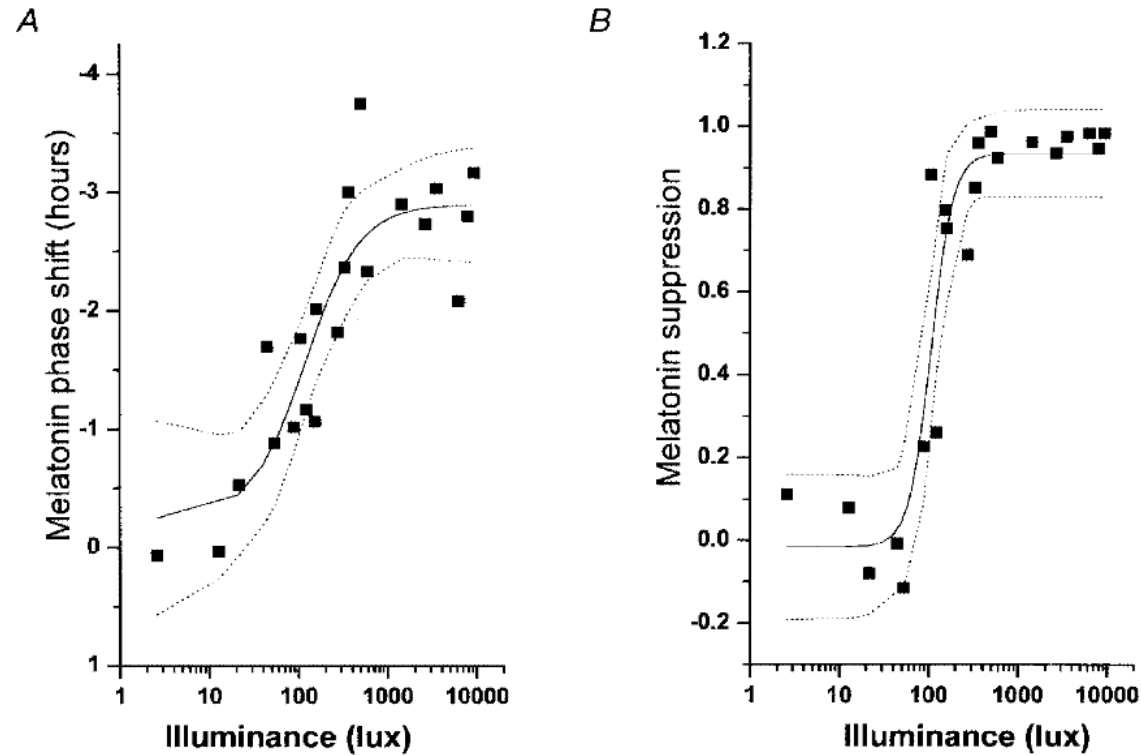


Vandewalle et al., *Trends Cog Sci*, 2009

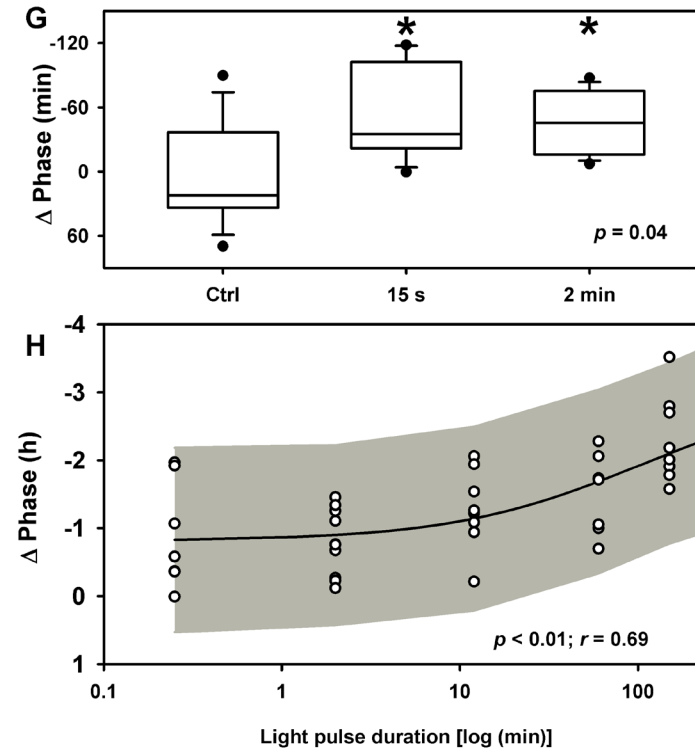
Lighting characteristics that modulate non-visual effects of light



Intensity and duration response

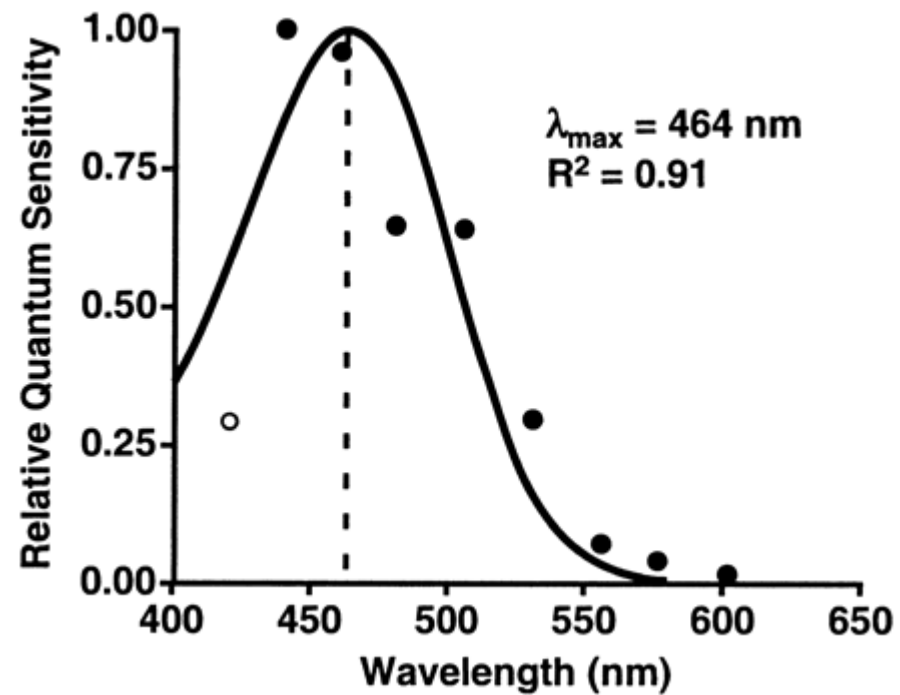


Zeitzer et al., *J. Physiol.* 2000

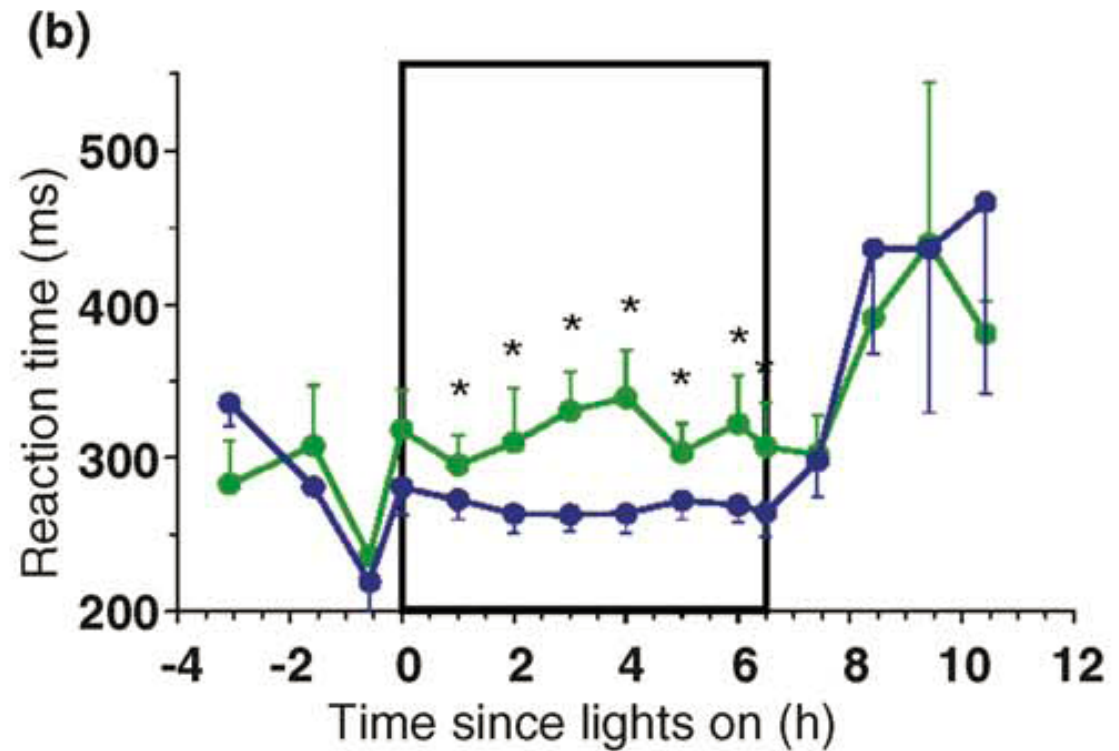


Rahman et al., *JCI Insight*, 2017

Spectral response

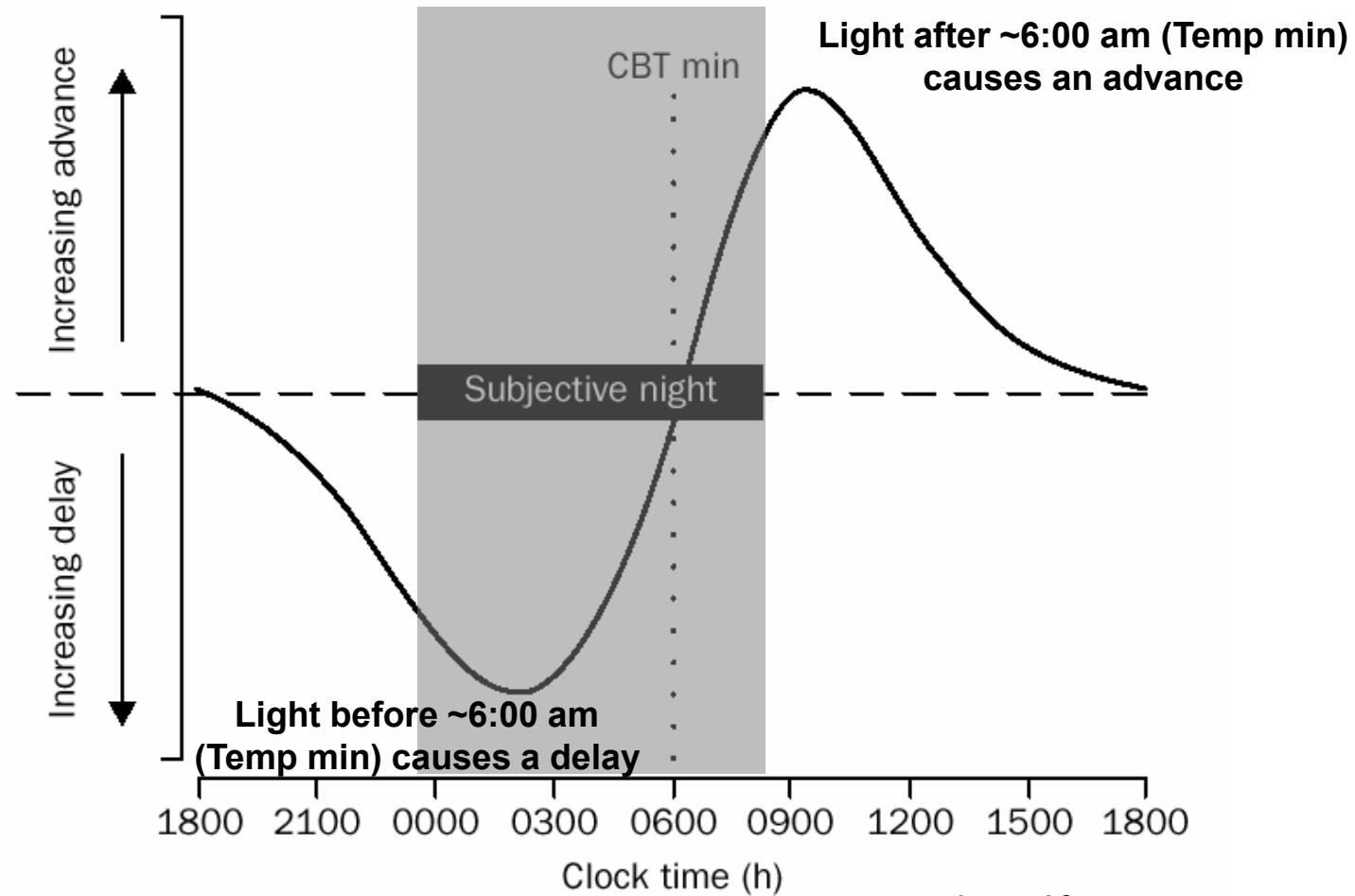


Brainard *et al.*, *J Neurosci*, 2001



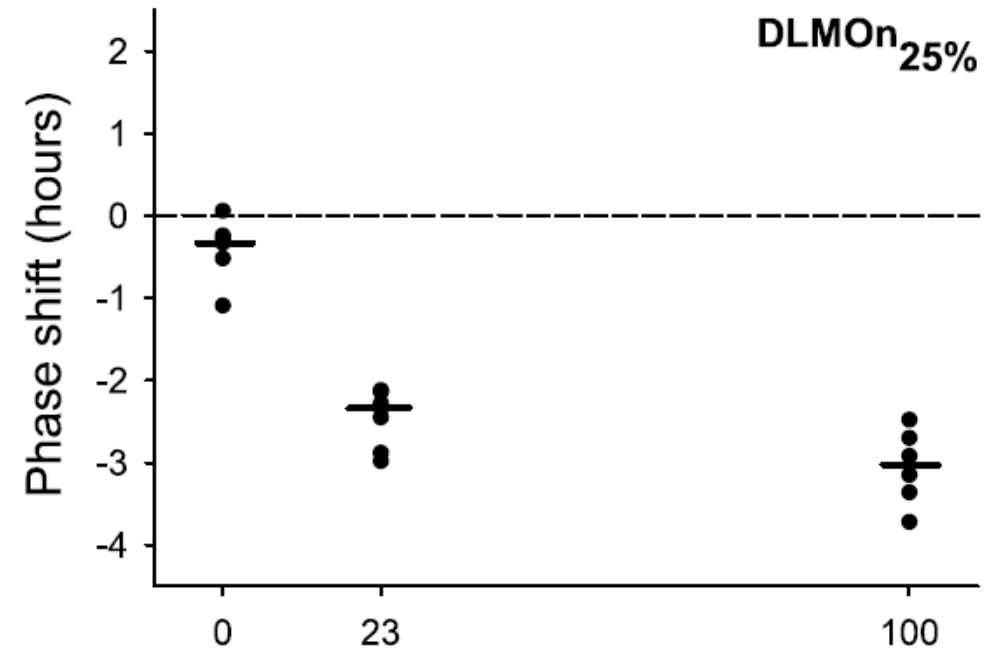
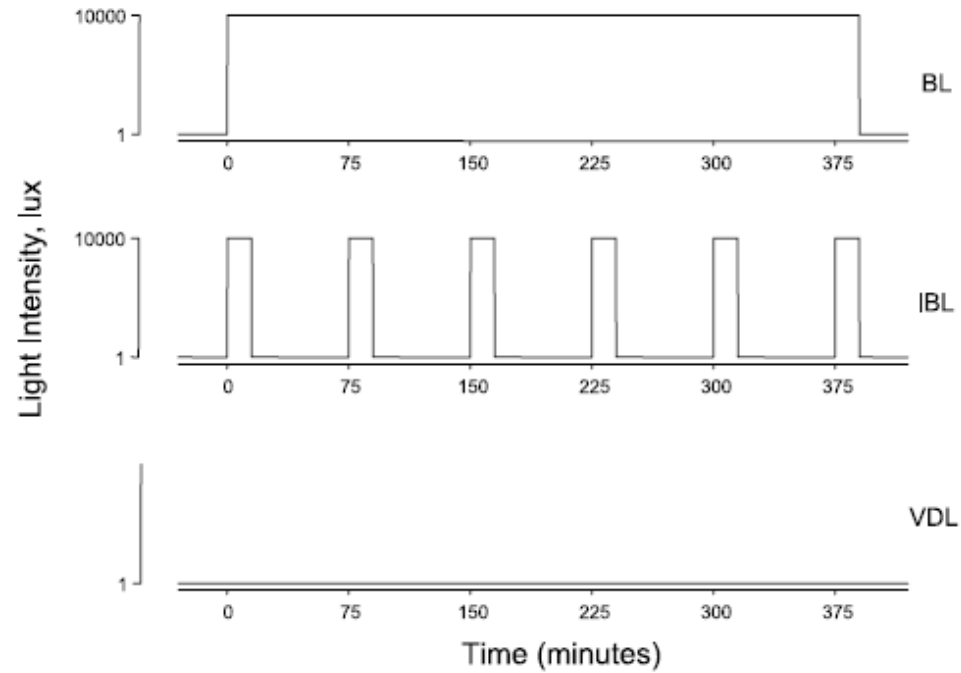
Lockley *et al.*, *SLEEP*, 2006

Phase response



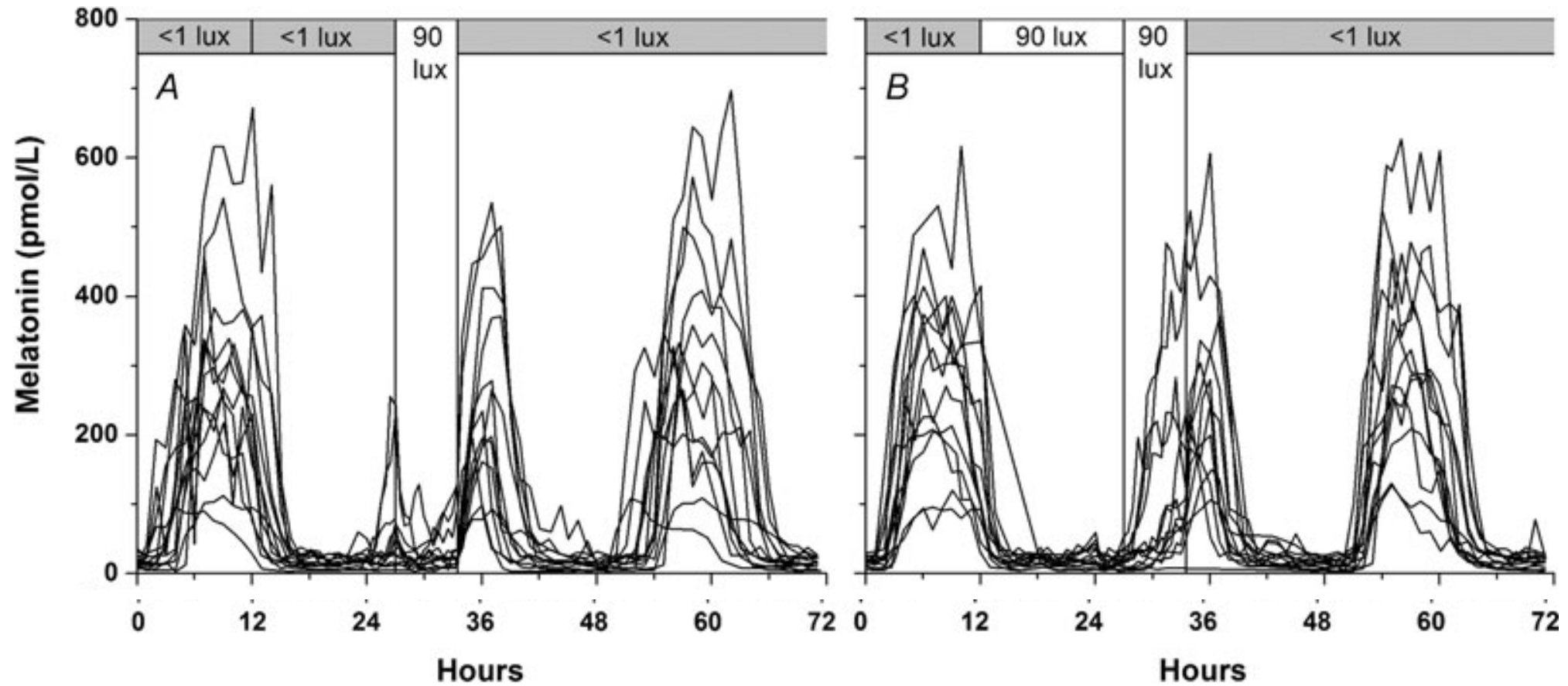
Adapted from Rajaratnam & Arendt, 2001

Exposure pattern

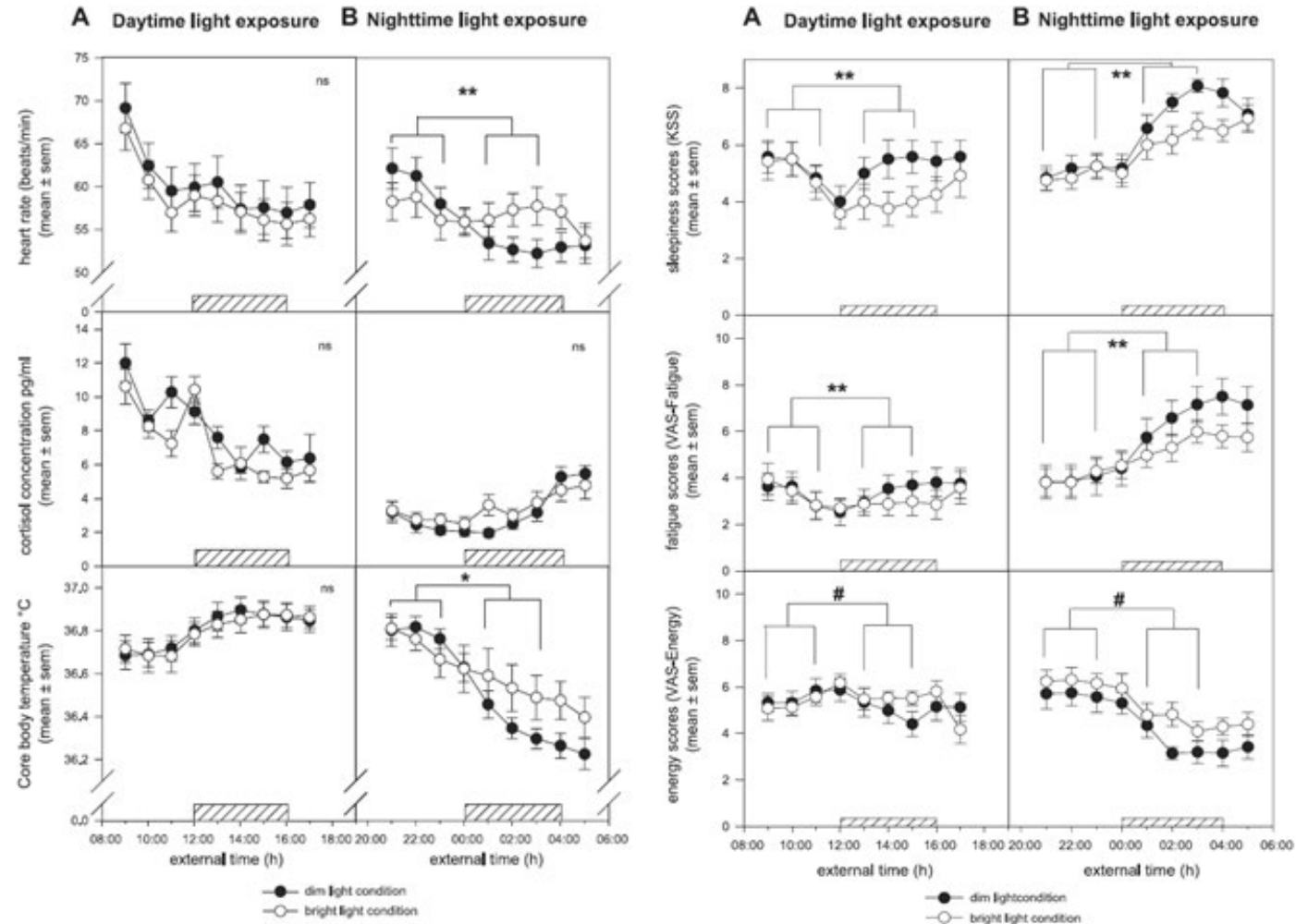


Gronfier et al., *Am. J. Physiol. Endocrinol. Metab.* 2004

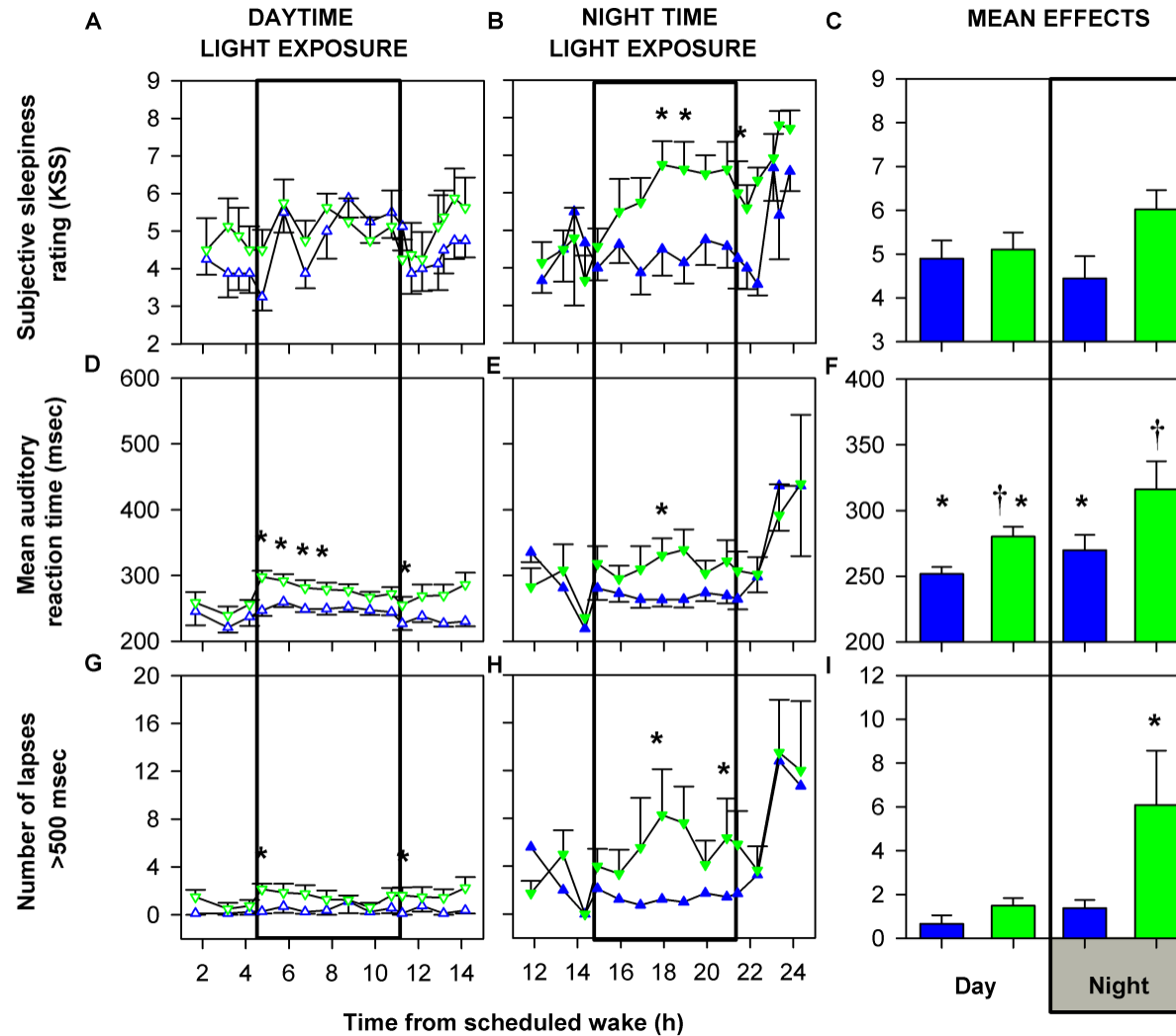
Photic history



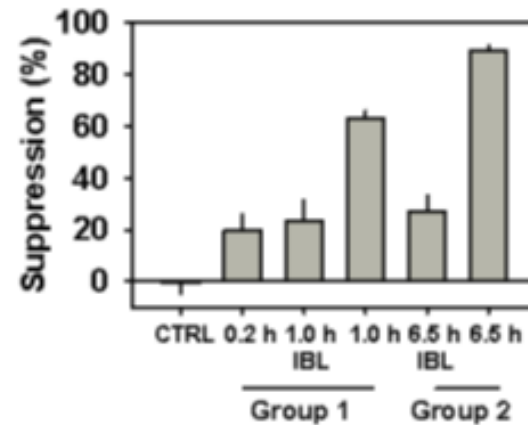
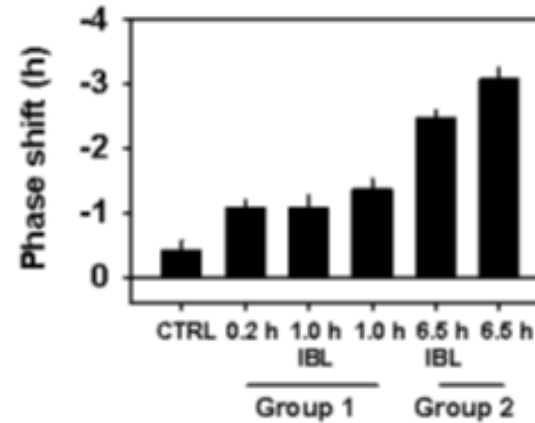
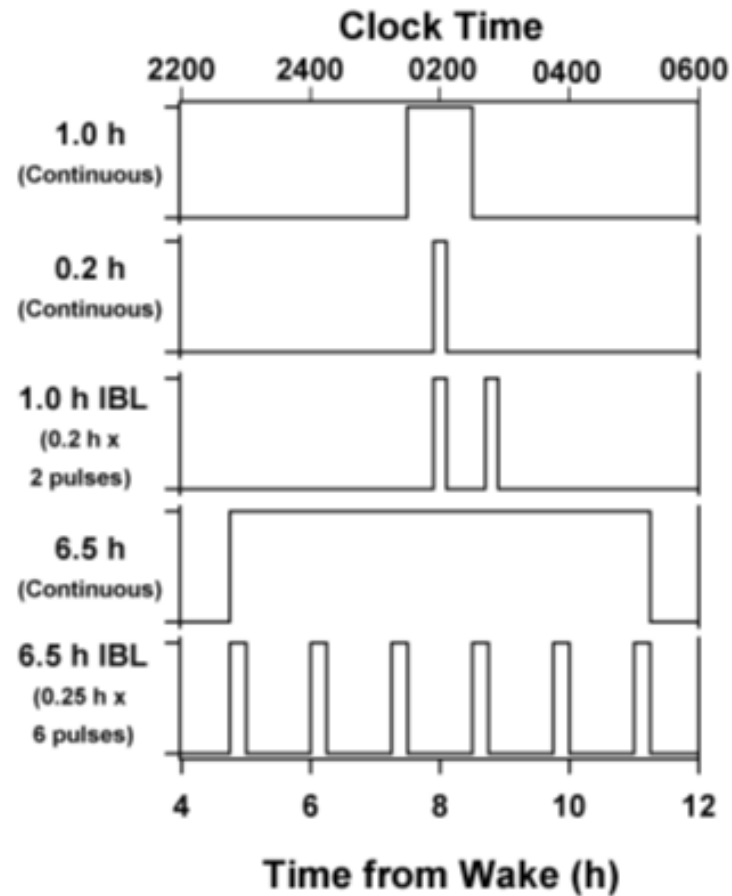
Responses differ based on the time of day



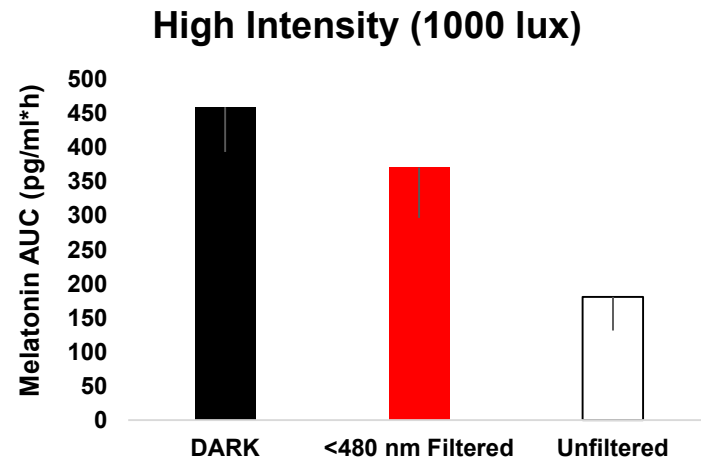
Responses differ based on the time of day



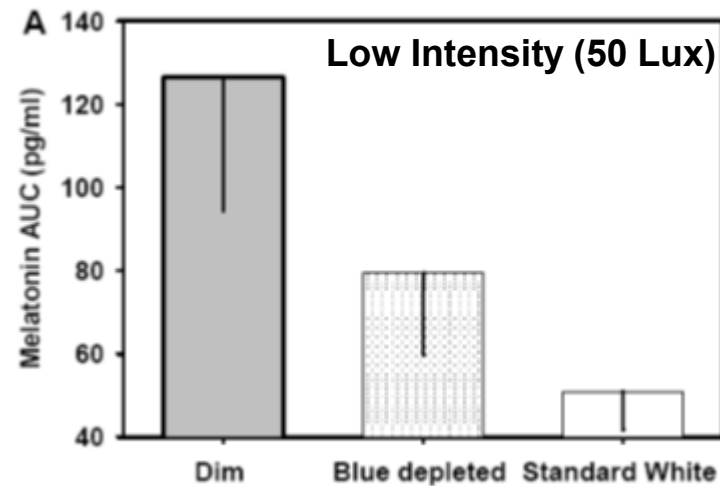
Direct effect is not a proxy measure of pacemaker mediated phase shift effect



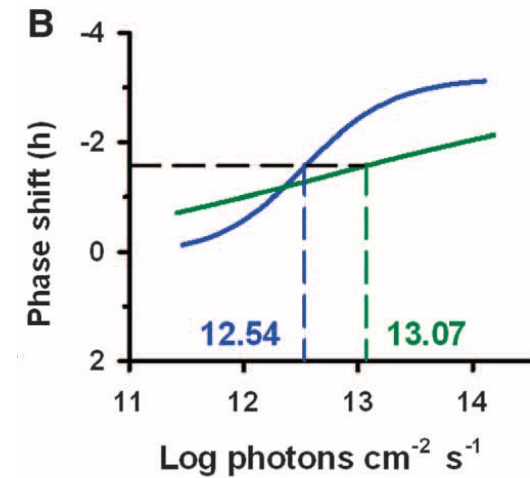
Are we ready to apply what we know?



Rahman et al., *Am J Physiol Endocrinol Metab* 2011



Rahman et al., *Physiol & Behav* 2017



Gooley et al., *Sci Transl Med* 2010

What do we know?

- Diverse range of physiologic responses to light
- Physiologic effects of light follow a dose response
- Short-wavelength sensitive ipRGC (melanopsin) response dominates in long-duration, bright-light conditions
- Visual photoreceptors modulate physiologic response to light
- Significant inter-individual variability
- **COMPLEX AND DYNAMIC SYSTEM**

Future directions

- Interactions between neural and receptor pathways
- Interactions between response modulators
- ***Lab to field applications***
- ***Evidence based claims***
- Definitions
- ***Standard(s) – for application & research***

Thank you

