

The Rise of Human Centric Lighting

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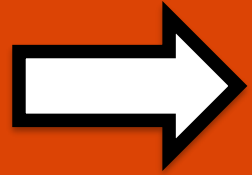
Editor in Chief | LEUKOS, the journal of the Illuminating Engineering Society
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Outline

- Context
- Defining *Human Centric Lighting*
- Opportunity for *Integrative Lighting*

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- Defining *Human Centric Lighting*
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**Light
Level**

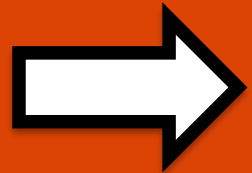
**Light
Spectrum**

**Spatial
Pattern**

**Temporal
Pattern**

Outline

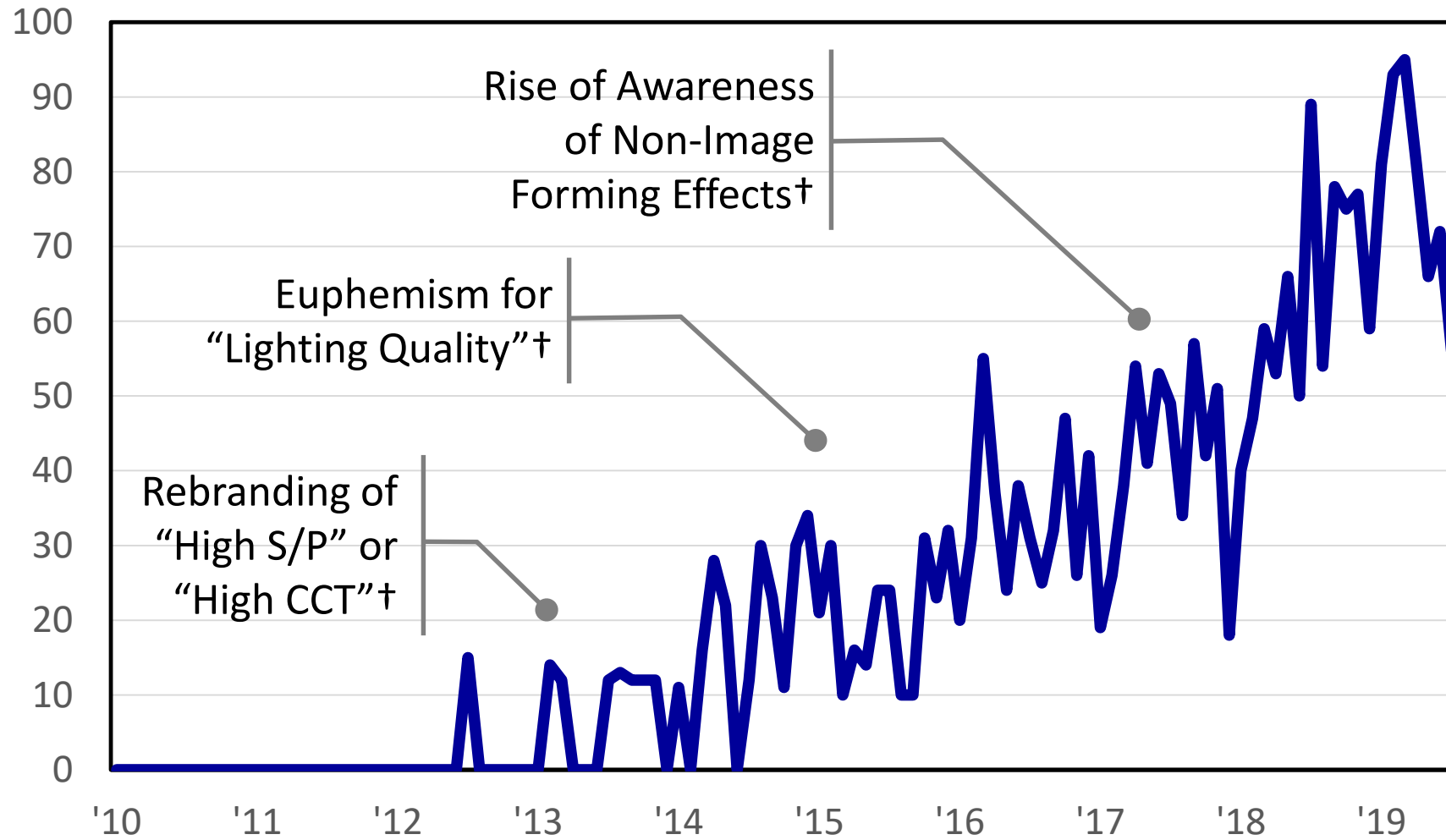
- Context



Defining *Human Centric Lighting*

- Opportunity for *Integrative Lighting*

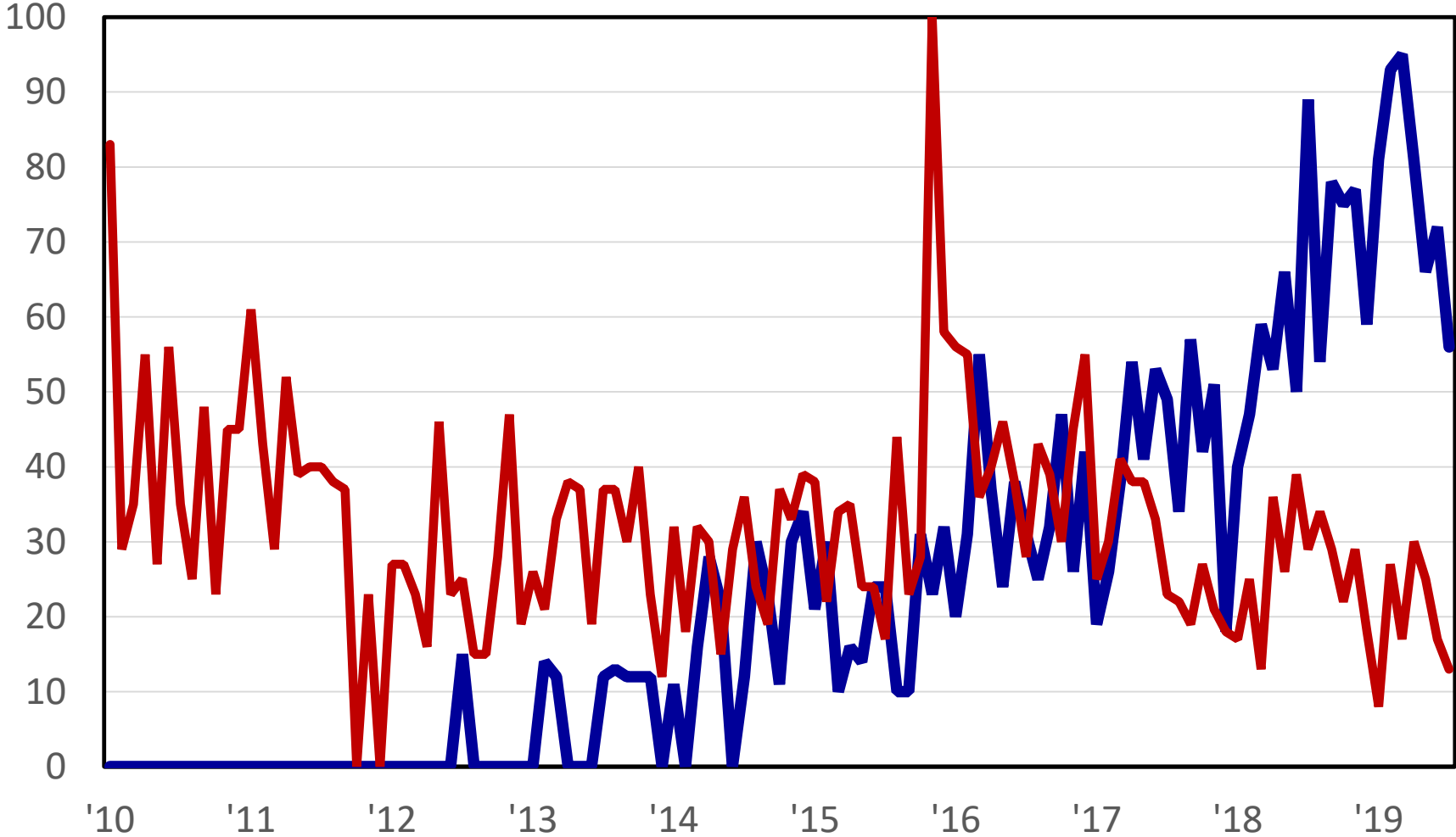
Google Trend* for *Human Centric Lighting*



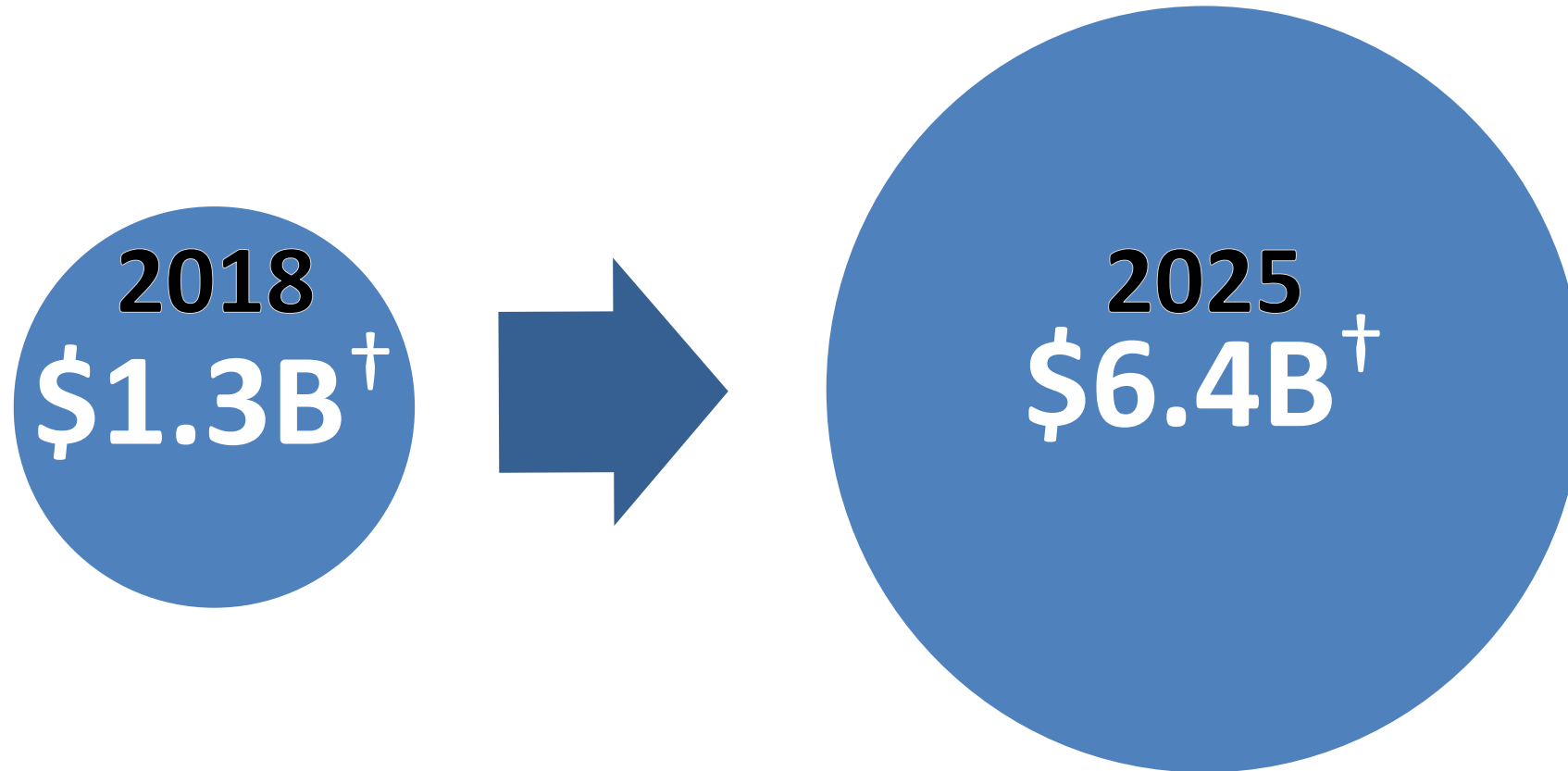
* <https://trends.google.com/>

† Houser KW. 2018. Editorial. Human Centric Lighting and Semantic Drift. LEUKOS. 14(4):213-214. <https://doi.org/10.1080/15502724.2018.1501234>

Google Trends for *Lighting Quality* and *Human Centric Lighting*



Human Centric Lighting is a **marketing term**



† Global Market Insights. 2019. Human Centric Lighting. <https://www.gminsights.com/toc/detail/human-centric-lighting-market>
See also: AT Kearney. 2013. Market Study. Human Centric Lighting Going Beyond Energy Efficiency. Lighting Europe / ZVEI. 19 pgs. [https://www.lightingeurope.org/images/publications/general/Market Study-Human Centric Lighting. Final July 2013.pdf](https://www.lightingeurope.org/images/publications/general/Market_Study-Human_Centric_Lighting_Final_July_2013.pdf)

Setting aside the marketing of *Human Centric Lighting*, what to people generally mean by the phrase?

Integrative Lighting [CIE DIS 017:2017, revised, in preparation]*

Lighting specifically integrating both visual and non-visual effects, and producing physiological and/or psychological benefits upon humans.

Note 1: The term “integrative lighting” applies only to humans.

Note 2: Lighting primarily for therapeutic purposes (light therapy) is not included.

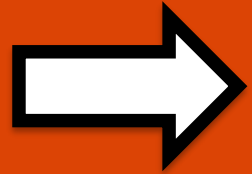
Note 3: The term “human centric lighting” is used with a similar meaning.

* See also: [CIE] 2019. CIE Position Statement on Non-Visual Effects of Light: Recommending Proper Light and the Proper Time. 2nd Edition. Vienna (Austria): CIE. 4 pgs.

<http://www.cie.co.at/publications/position-statement-non-visual-effects-light-recommending-proper-light-proper-time-2nd>

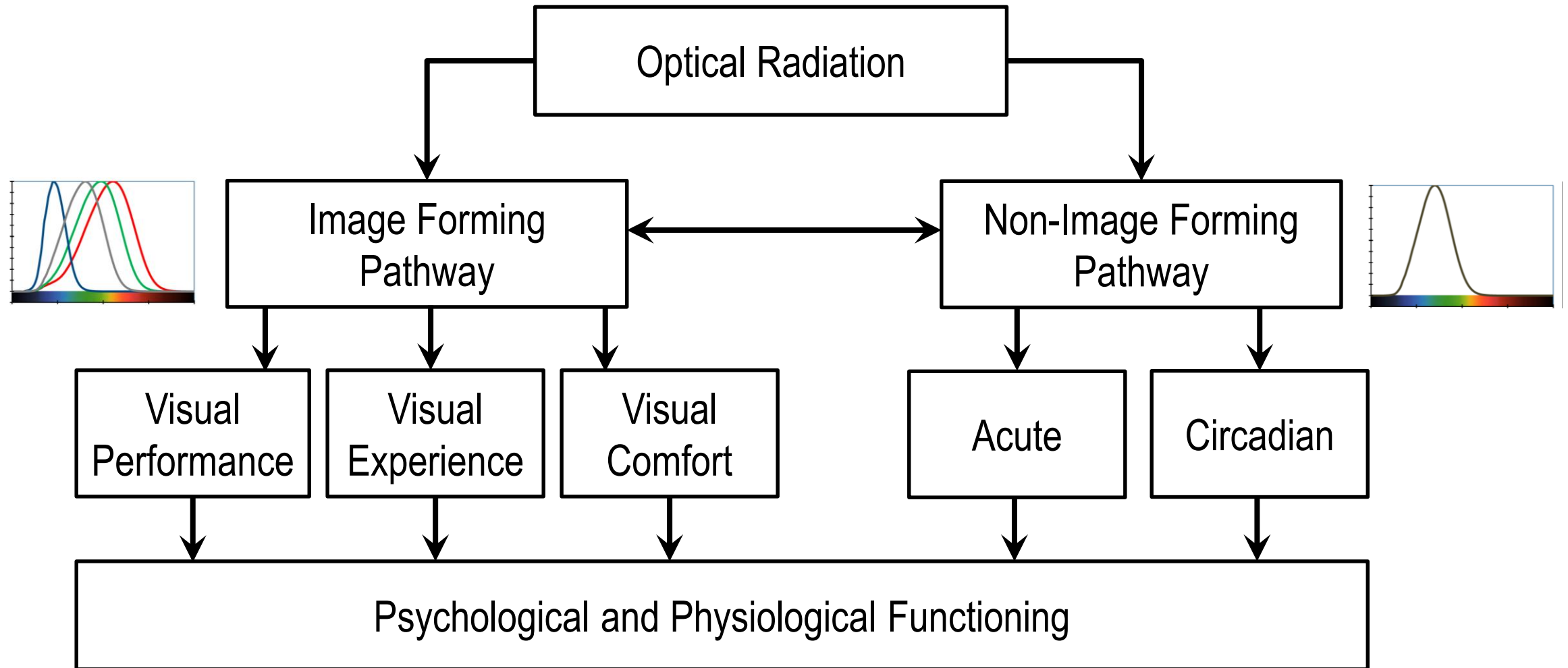
Outline

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Opportunity for *Integrative Lighting*

Optical radiation is a complex stimulus that can be manipulated to affect people.



Optical radiation affects human physiological functioning.

- Changes pupil size [1 – 3]
- Acutely suppresses melatonin [3 – 9]
- Modulates alertness, body temp, and heart rate [6, 10, 11]
- Shifts the timing of circadian rhythms [12]
- Extended periods in windowless spaces have detrimental effects on vitality, activity levels, and sleep quality [13]

1. Gooley JJ, Ho Mien I, St Hilaire MA, Yeo SC, Chua EC, van Reen E, Hanley CJ, Hull JT, Czeisler CA, Lockley SW. 2012. Melanopsin and rod-cone photoreceptors play different roles in mediating pupillary light responses during exposure to continuous light in humans. *J Neurosci.* 32:14242–14253. <https://doi.org/10.1523/JNEUROSCI.1321-12.2012>
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3. Spitschan M. 2019. Photoreceptor inputs to pupil control. *Journal of Vision.* 19(9):1-5. <https://doi.org/10.1167/19.9.5>
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5. Thapan K, Arendt J, Skene DJ. 2001. An action spectrum for melatonin suppression: evidence for a novel non-rod, non-cone photoreceptor system in humans. *J. Physiol.* 535:261–267. <https://doi.org/10.1111/j.1469-7793.2001.t01-1-00261.x>
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8. Prayag AS, Najjar RP, Gronfier C. 2019. Melatonin suppression is exquisitely sensitive to light and primarily driven by melanopsin in humans. *J Pineal Res.* 66:e12562. <https://doi.org/10.1111/jpi.12562>
9. Souman JL, Borra T, de Goijer I, Schlangen LJM, Vlaskamp BNS, Lucassen MP. 2018. Spectral Tuning of White Light Allows for Strong Reduction in Melatonin Suppression without Changing Illumination Level or Color Temperature. *Journal of Biological Rhythms* 33(4):420-431. <https://doi.org/10.1177%2F0748730418784041>
10. Cajochen C, Munch M, Koblalka S, Krauchi K, Steiner R, Oelhafen P, Orgul S, Wirz-Justice A. 2005. High sensitivity of human melatonin, alertness, thermoregulation, and heart rate to short wavelength light. *J. Clin. Endocrinol. Metab.* 90:1311–1316. <https://doi.org/10.1210/jc.2004-0957>
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12. Gooley JJ, Rajaratnam SM, Brainard GC, Kronauer RE, Czeisler CA, Lockley SW. 2010. Spectral responses of the human circadian system depend on the irradiance and duration of exposure to light. *Sci. Transl. Med.* 2:31ra33. <https://doi.org/10.1126/scitranslmed.3000741>
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On average, people spend 87% of the time indoors*



Effective design, construction, and maintenance of buildings can have a big impact on **quality of life**

(and on productivity, absenteeism, recruitment, retention, and profitability)

* Klepeis NE, Nelson WC, Ott WR, Robinson JP, Tsang AM, Switzer P, Behar JV, Hern SC, Engelmann WH. 2001. The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Science & Environmental Epidemiology*. 11(3):231-52.



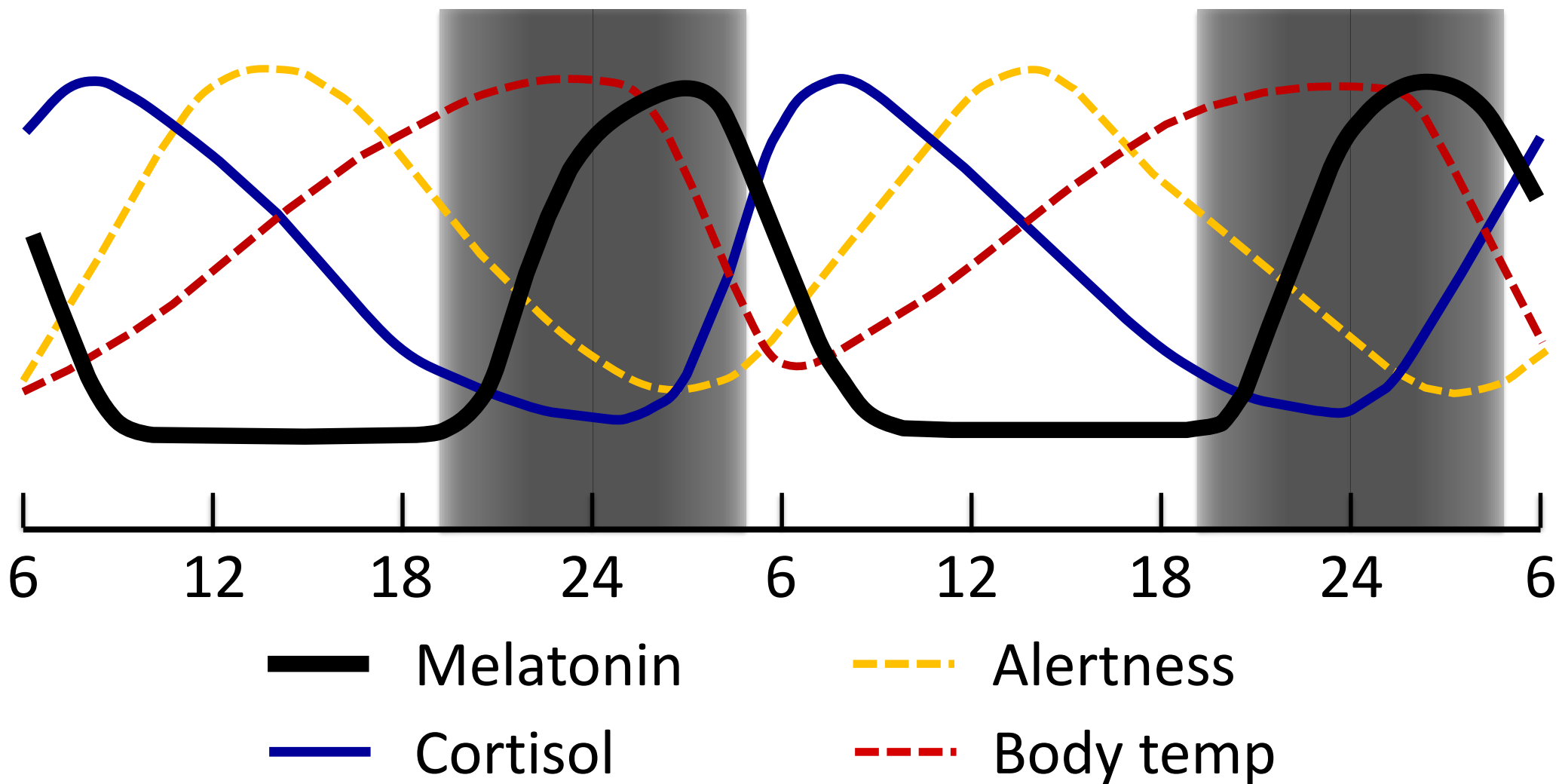
**Light
Level**

**Light
Spectrum**

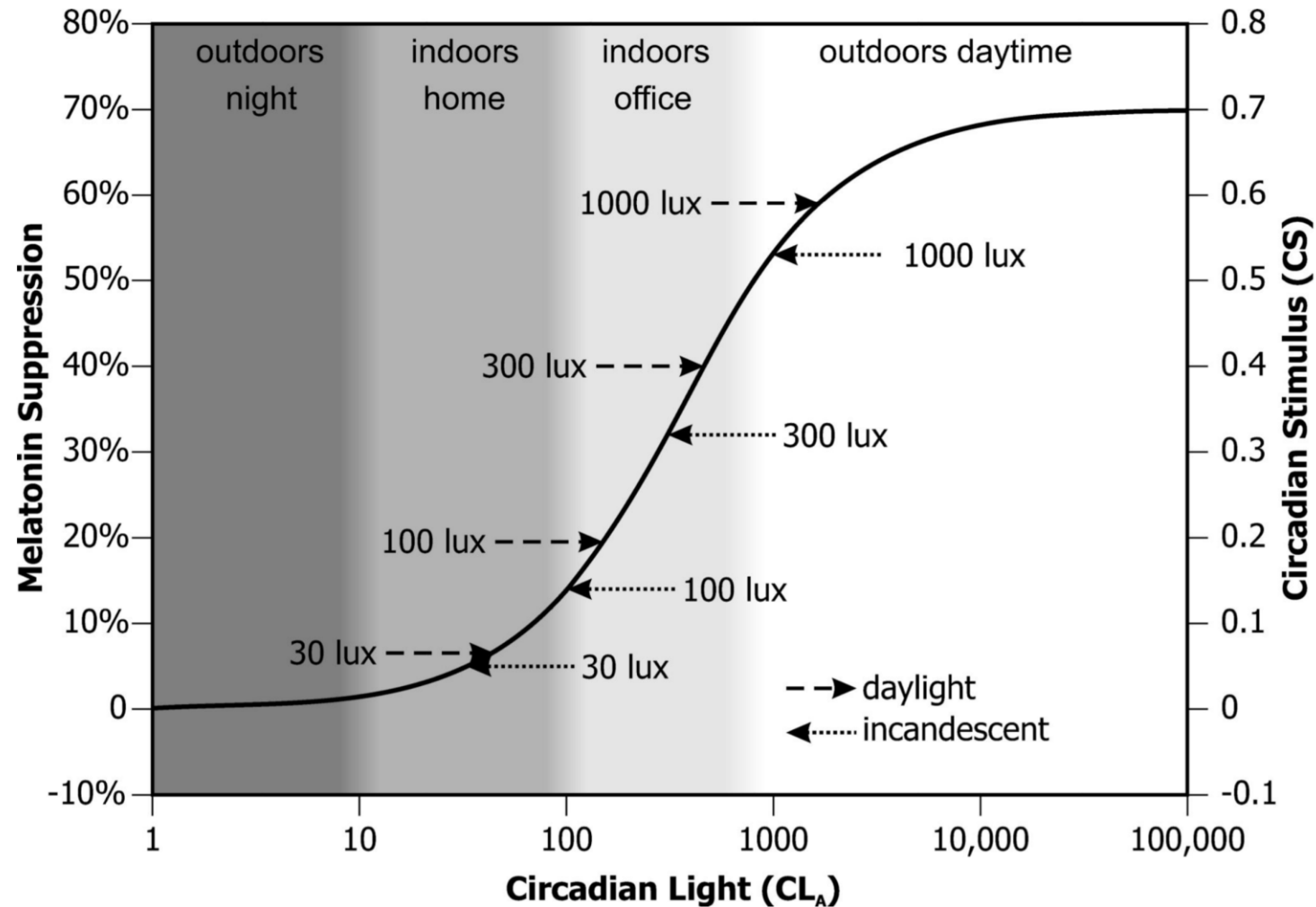
**Spatial
Pattern**

**Temporal
Pattern**

Temporal Pattern is the #1 influence on health related aspects of light.



Quantity is the #2 influence. Spectrum is #3.



Figueiro MG. 2017. Disruption of Circadian Rhythms by Light During Day and Night. *Current Sleep Medicine Reports*. 3(2):76-84.

<https://doi.org/10.1007/s40675-017-0069-0>

Spatial Pattern
should be
considered with
Quantity and
Spectrum.



2-21-94

4:30-4:56 pm

2-22-94

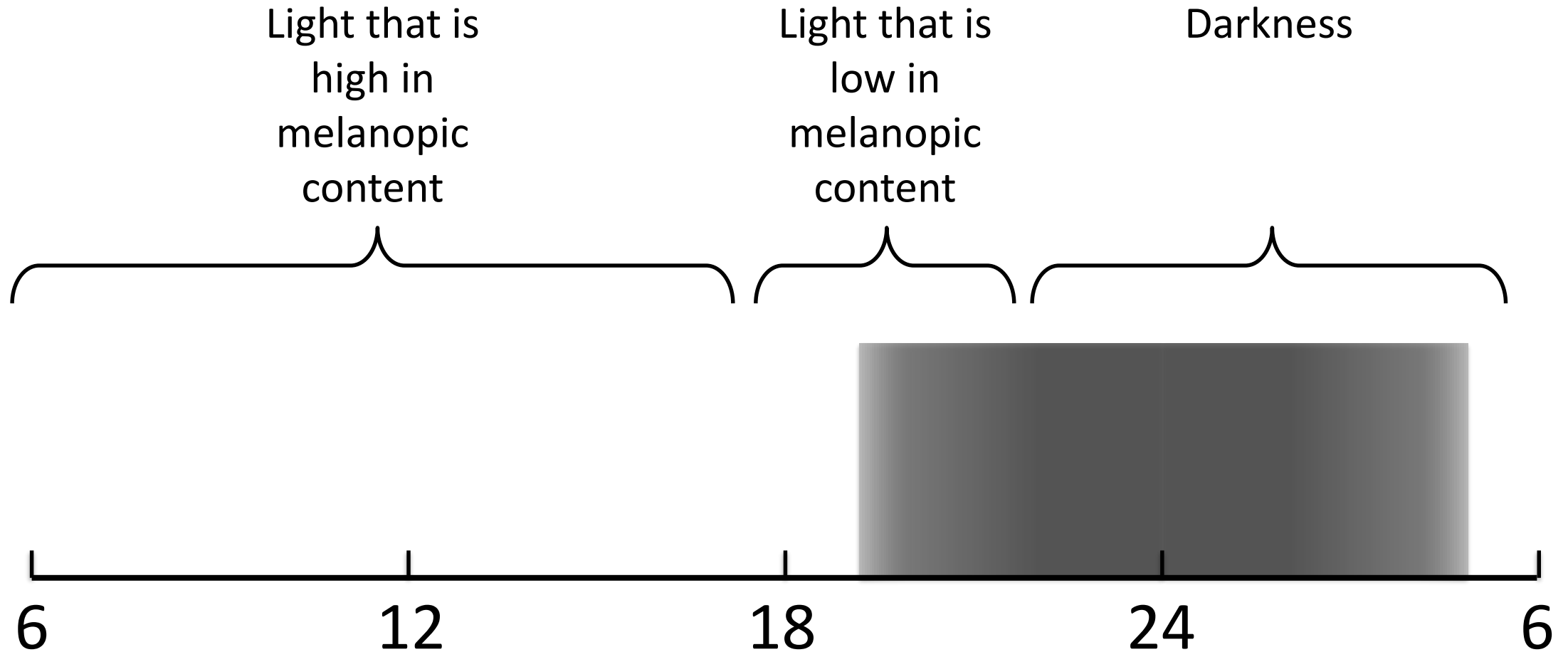
3:15-4 pm

2-23-94

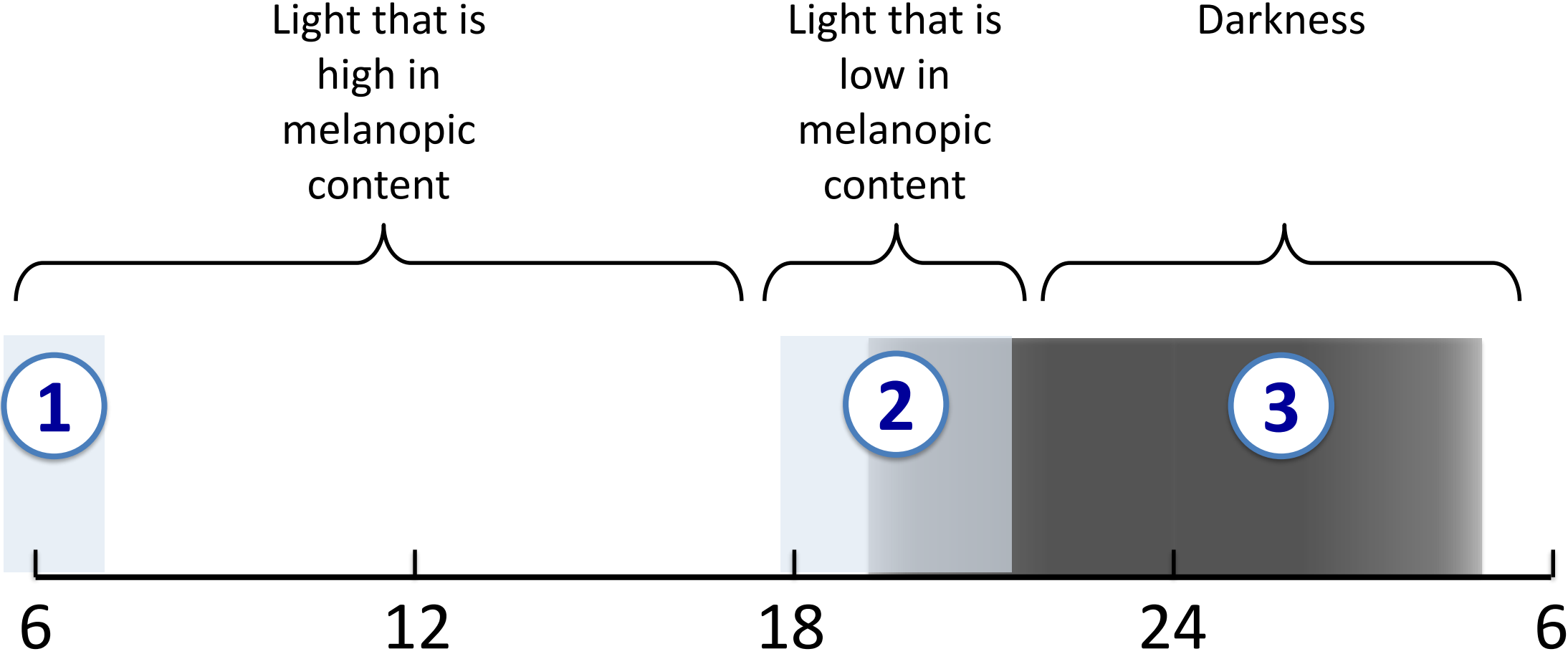
3:45-4:45 pm

ALF 1994

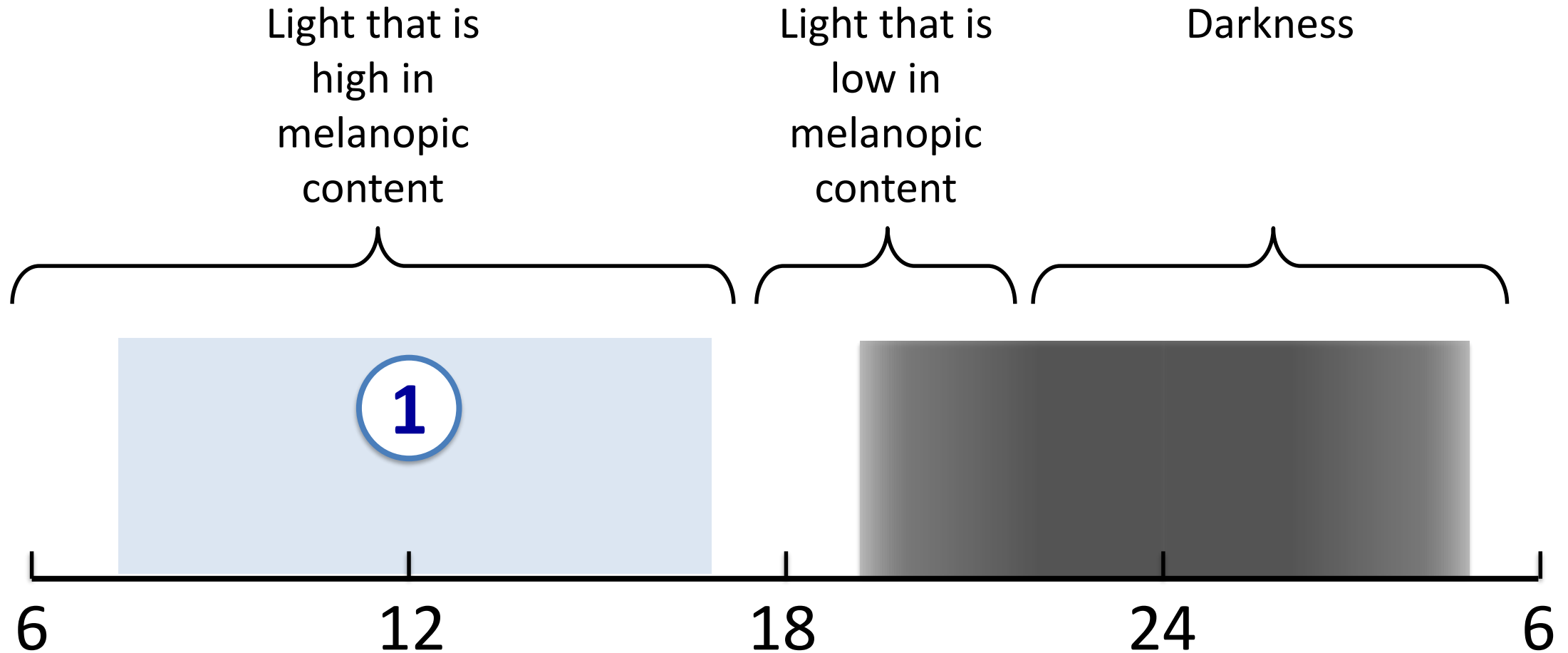
What then, is “human centric lighting”?



Buildings where people **sleep** require **three** lighting conditions (for physiological health).



Building where people **work/learn** require **one** static lighting condition (for physiological health).







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