Assessment of the window performance from the light provision and circadian light aspects

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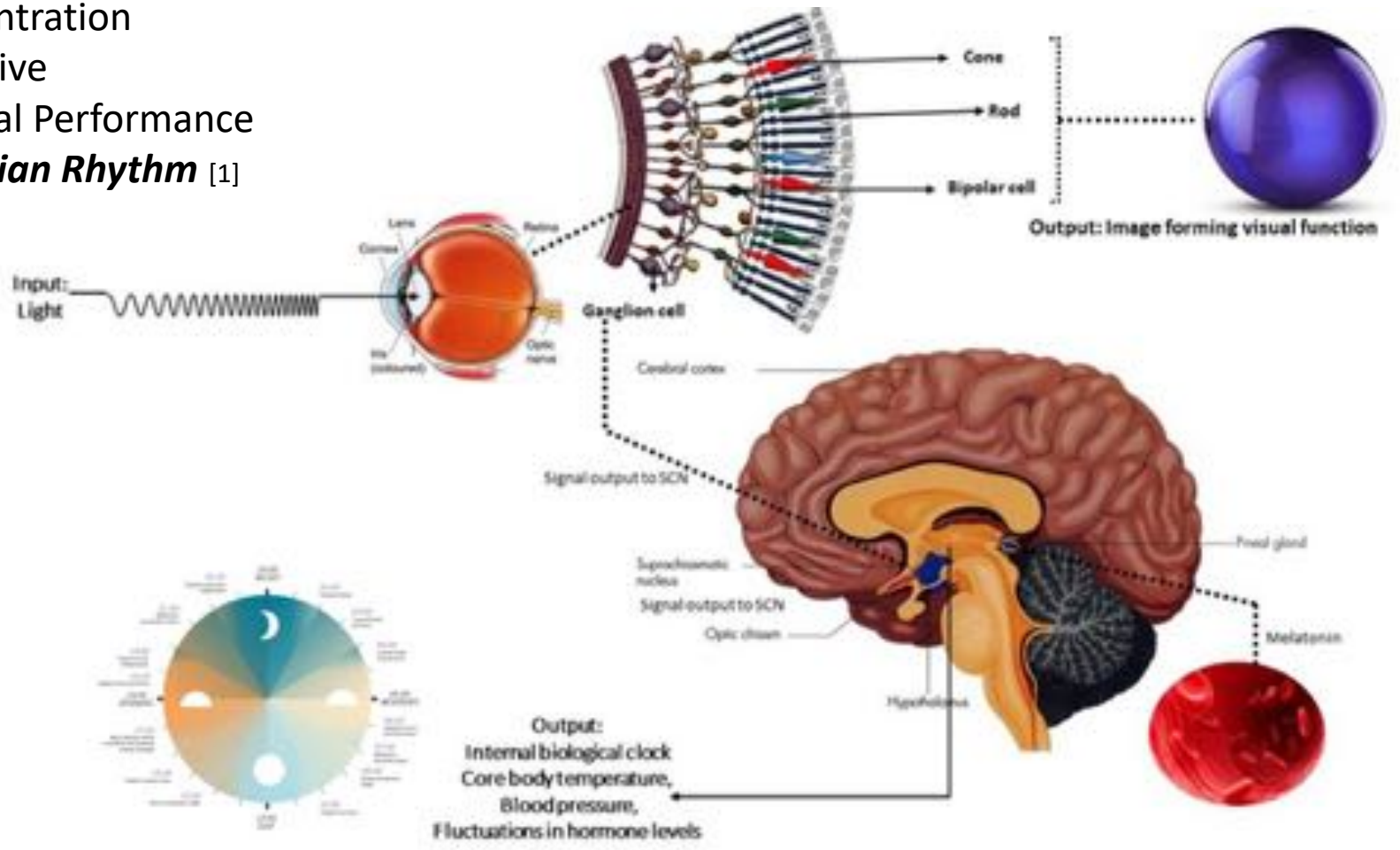
Introduction: Circadian light and well-being

- Mood
- Concentration
- Cognitive
- Physical Performance
- ***Circadian Rhythm*** [1]



Introduction: Circadian light transmittance

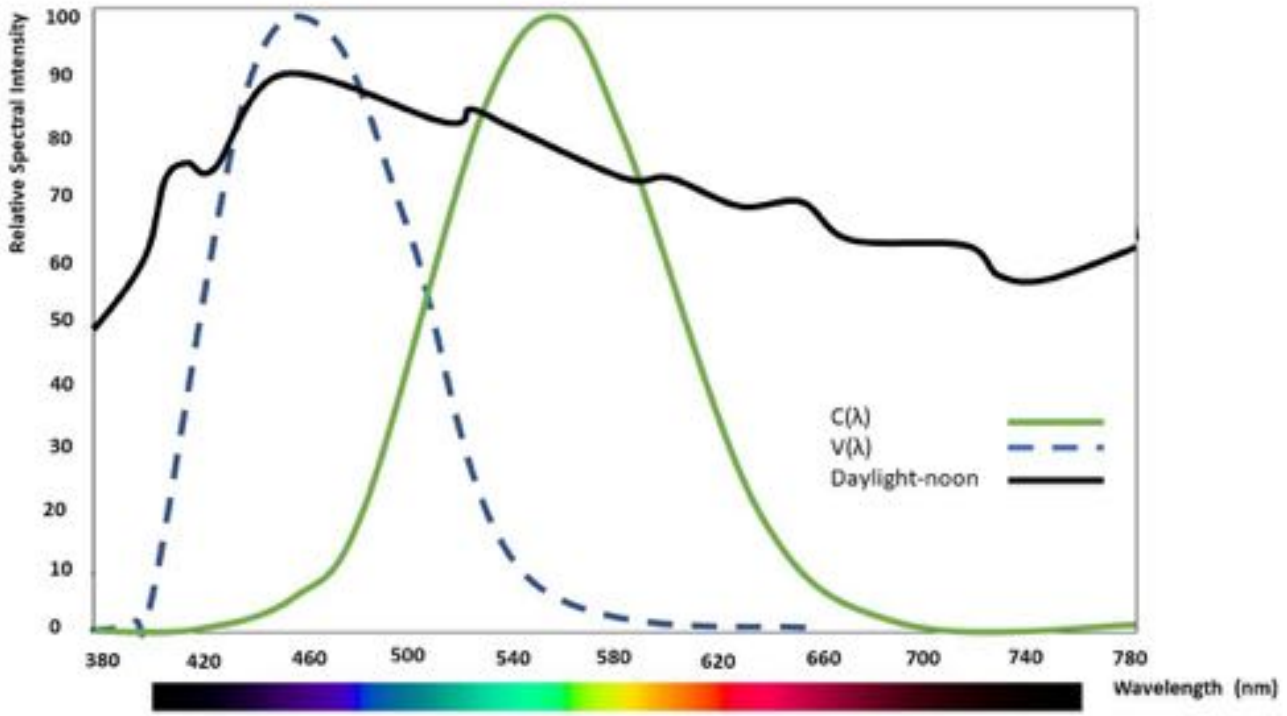


Figure1. Photopic and melanopic curve

$$T_c = \frac{\sum_{380}^{580} D_\lambda . T(\lambda) . C(\lambda) . \Delta\lambda}{\sum_{380}^{580} D_\lambda . C(\lambda) . \Delta\lambda} \quad [2]$$

Introduction: Window and Circadian light

Circadian light transmittance and window properties:

Tvis: High Tvis does not guarantee high circadian light inlet

Window Color : Blue tinted window inlets more circadian-weighted light [3]

Window to wall ratio : Up to a certain WWR, a higher WWR allows more circadian light to enter the room [4]

Window direction : South facing window provides more circadian light [5]

Focus of this research:

Tvis

Tc

Method: Simulation setup

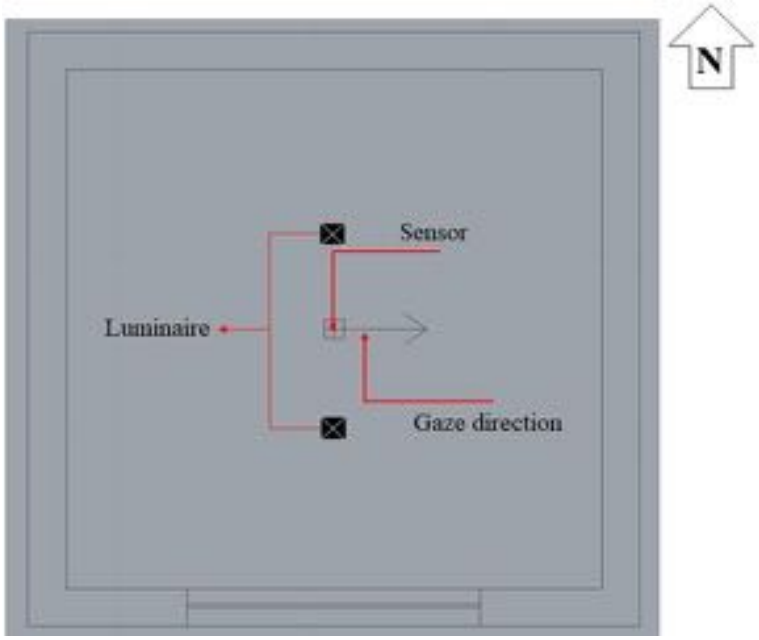


Figure2. Plan view of simulation setting

Location:

Denver, CO.

Software:

Rhino, Lark plugin

Window:

South facing window, with a 30% WWR

Occupant position:

With the 120 cm height in the middle of the room facing parallel to the window orientation

Simulation period & Metrics :

9a.m. to 1 p.m., m_EDI

Method: Window Selection Strategies

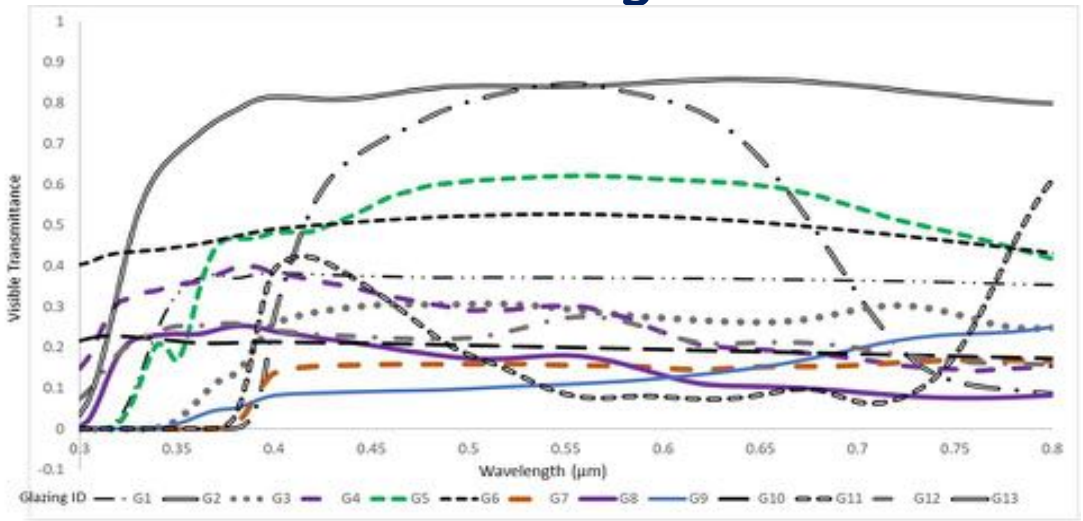


Figure3. SPD of chosen window

Table1. Properties of chosen window

ID	Color appearance	Tvis	Tc	SHGC	U-factor	Peak Tvis
G1	Silver	0.361	0.37	0.476	5.538	400
G2	Clear	0.361	0.75	0.68	5.813	475
G3	Grey	0.272	0.28	0.281	3.222	510
G4	NA****	0.272	0.35	0.38	5.698	470
G5	Green	0.514	0.6	0.475	5.809	560
G6	Silver Grey	0.514	0.52	0.58	3.454	555
G7	Bronze	0.159	0.15	0.374	5.757	750
G8	NA	0.159	0.22	0.348	5.404	470
G9	Dark blue	0.2	0.12	0.503	5.834	780
G10	Silver	0.2	0.21	0.334	5.685	395
G11	Clear	0.234	0.11	0.703	5.818	780
G12	Grey	0.234	0.24	0.227	3.178	560
G13	Clear Low_E	0.844	0.83	0.794	5.821	630

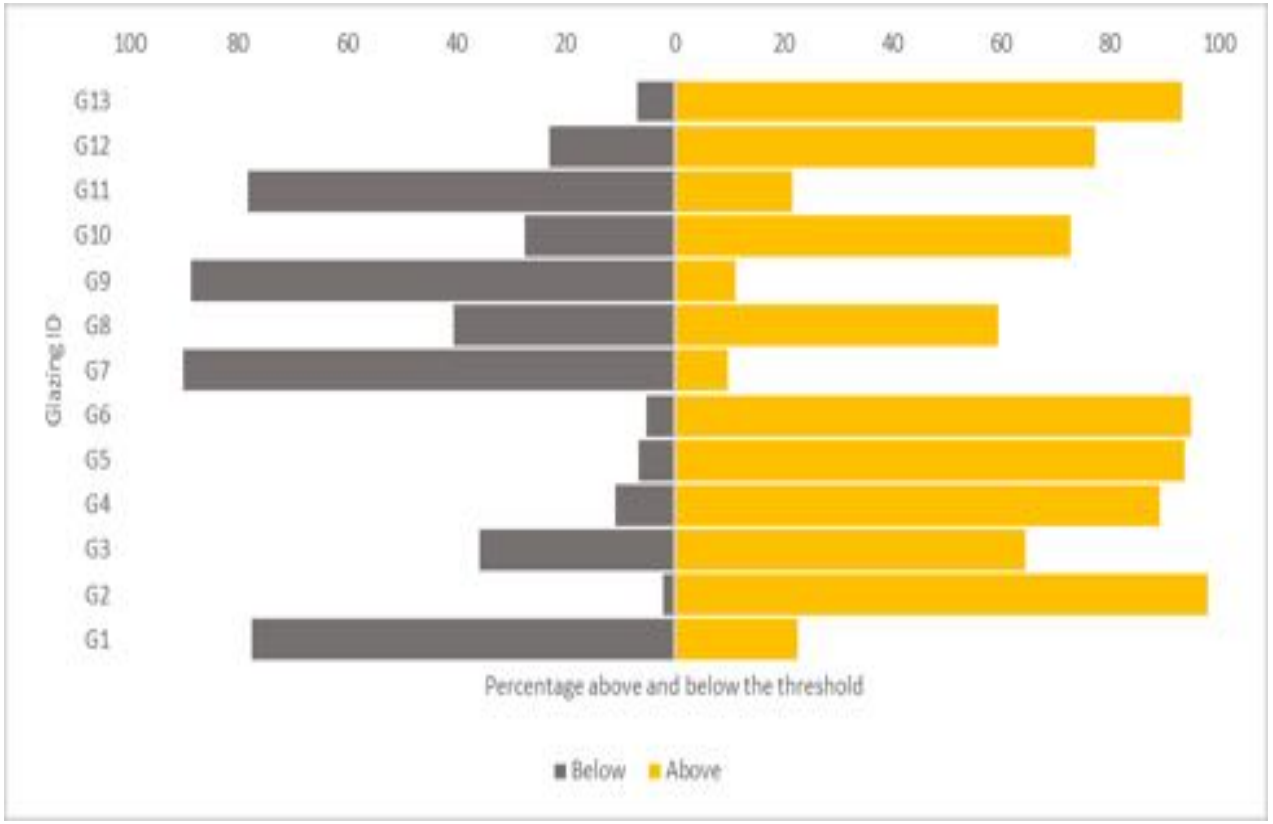
Source: LBNL Optics

Tvis and Tc are the selection indicators

Finding: Circadian performance of windows

As per WELL Standard_250 lux m-EDI from 9 a.m. until 1 p.m. [4]

Figure4. Performance of Windows in relation to circadian daylighting



Windows with effective performance:
G2, G4, G5, G12, G13

Windows that performances ineffectively:
G7, G9

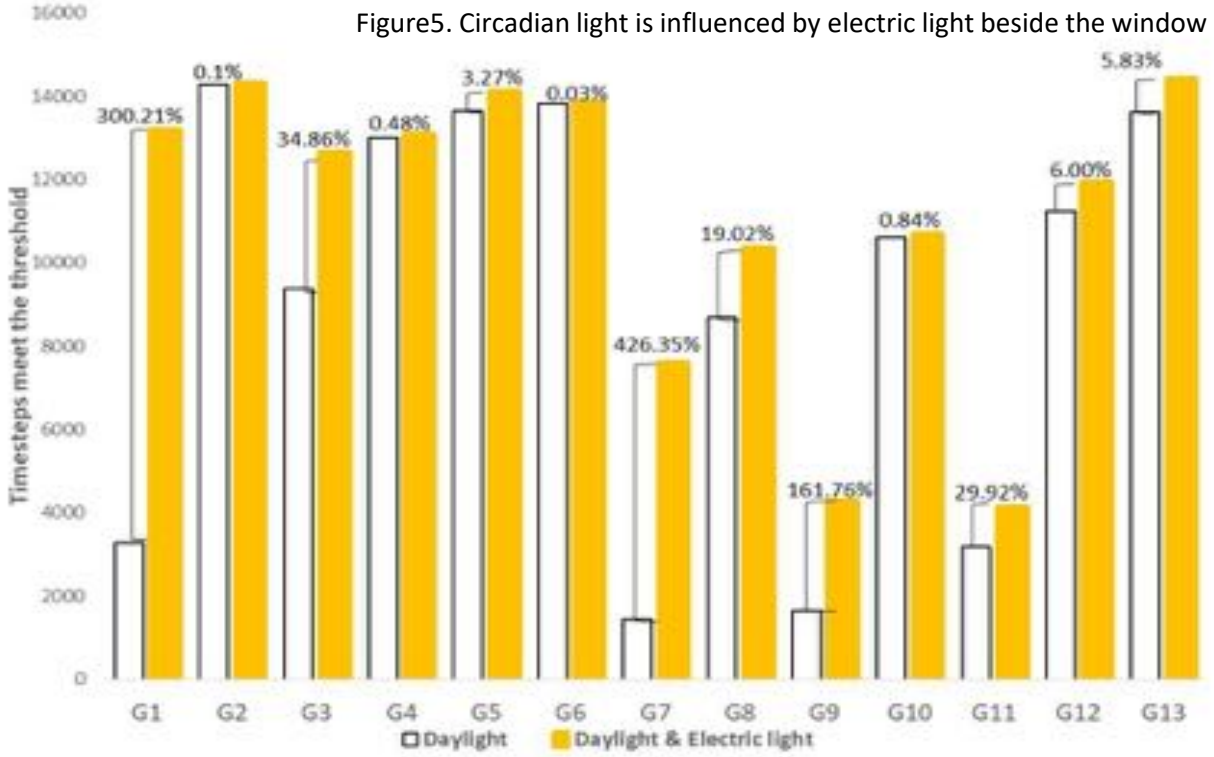
Finding: Circadian performance of windows besides artificial lighting

Luminaires: TBS600 1x49W D7 TL5/840 HFP

Luminaire effectiveness to meet 75% of threshold: ***G1, G3***

Luminaire inefficiency in enhancing window circadian performance: ***G7, G9***

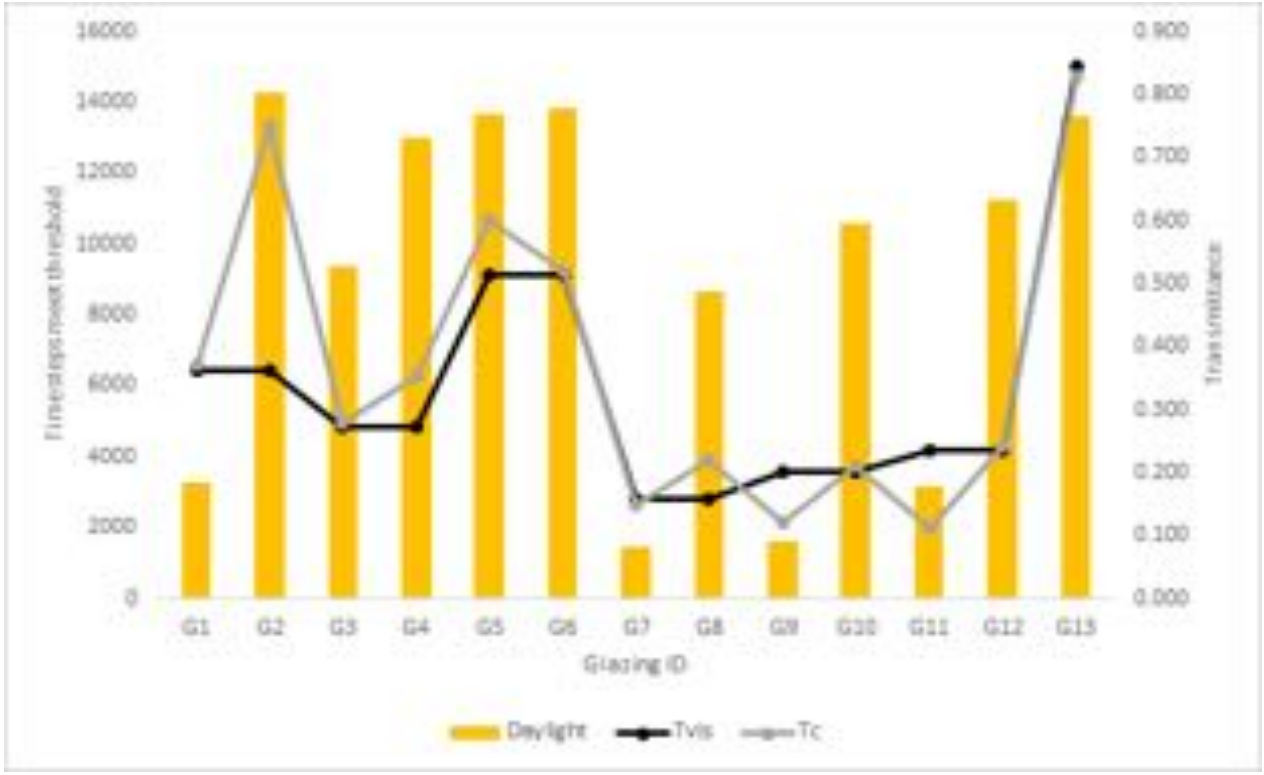
Figure5. Circadian light is influenced by electric light beside the window



Finding: Window properties as Circadian performance indicators

- *Tvis > 0.5 meets thresholds*
- *Tvis<0.5, Tc represents the effectiveness*
- *Nonlinear correlation between Tc and window circadian performance*

Figure6. Window's circadian performance regarding their Tvis and Tc



Conclusion

Circadian light is a new topic that needs further investigation and attention. This paper presents an analysis of the impact of the window on the circadian light entering the building. This research illustrates how various types of windows, even if they have a satisfactory Tvis level, might result in the use of artificial light to meet the shortage of windows for maintaining circadian health.

The Tvis or Tc values do not represent the accurate value for circadian light transmittance, and precise metrics for evaluating this value are required.

References

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