Daylight in Office Buildings

Impact of Building Design on Circadian Light Exposures

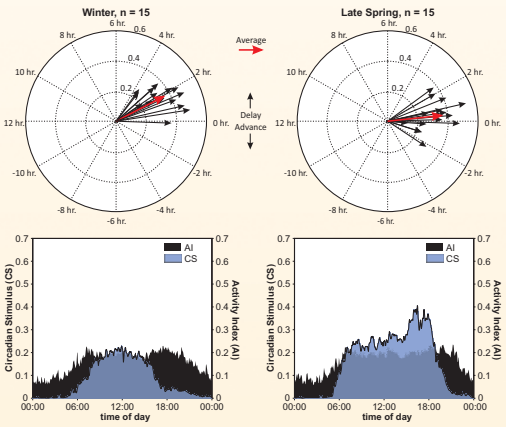
Lighting design for office buildings has focused largely on the amount of light for visibility and strategies to reduce energy use. Little attention has been given to understanding how light affects health. The present study is among the first to measure personal light exposures in an office building designed to maximize daylight availability in the space.

Table 1. Average personal CS values obtained from the Daysimeters

	Late Spring CS	Winter CS	Significance
Waking hours	0.26	0.15	p<0.001
Work hours	0.28	0.19	p<0.01
After work hours	0.22	0.06	p<0.001

Table 2. Average CS and photopic lux spot measurements

	Late Spring		Winter	
	CS	**lux**	**CS**	**lux**
Deskspace				
Window	0.45	865	0.39	678
Interior	0.29	344	0.32	335
Orientation				
East	0.36	675	0.36	456
North	0.49	1001	0.34	393
South	0.29	302	0.40	766
West	0.32	413	0.35	412
Floor				
4th	0.33	415	0.31	379
12th	0.34	487	0.41	571
17th	0.43	896	0.37	570



Phasor distributions (upper panels), and average activity (AI) and light exposures (CS) over 24 hours (lower panels) for winter (left panels) and late spring (right panels).

Citation

Figueiro MG, Steverson B, Heerwagen JH, Rea MS. Daylight in office buildings: impact of building design on personal light exposures, sleep and mood. *28th CIE SESSION*. Manchester, UK. June 28 – July 4, 2015

Methods

The study was conducted at the Edith Green-Wendell Wyatt Federal Building, an 18-story office building in Portland, Oregon, managed by the U.S. General Services Administration. LRC obtained photometric "spot" measurements using a spectroradiometer and personal light exposures from volunteers who agreed to wear the Daysimeter as a pendant for seven consecutive days in late spring and again in winter. Participants were also asked to fill out subjective questionnaires about sleep and mood.

Results

Table 1 shows the average individual circadian stimulus (CS) light exposures obtained from the Daysimeters and Table 2 shows the spot measurement results. Key findings include:

- Participants received significantly greater CS in late spring than in winter.
- Participants received the greatest circadian stimulation during work hours.
- No significant seasonal differences between sleep and mood parameters were observed.
- Building orientation, deskspace location and floor height influenced the amount of CS received by workers.
- Spot measurements may not be representative of actual light exposures experienced by workers.

The figure (left) shows the average activity (AI) and light exposure (CS) in late spring and winter for the 15 subjects who wore the Daysimeter. CS values were highest during the middle of the day, particularly in the winter.

Conclusions

The present results underscore the importance of measuring personal light exposures to determine the actual circadian stimulation received by an occupant in a building, rather than relying on spot measurements or software simulations. Occupant behavior and furniture placement can determine daylight availability; people may not receive circadian-effective light in what appears to be a building with daylight. Even though daylight is an ideal light source for the circadian system, architects and lighting designers should always consider how to effectively use electric lighting to supplement daylight and assure that every worker receives enough circadian-effective light, particularly in the morning.

Sponsor

U.S. General Services Administration

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