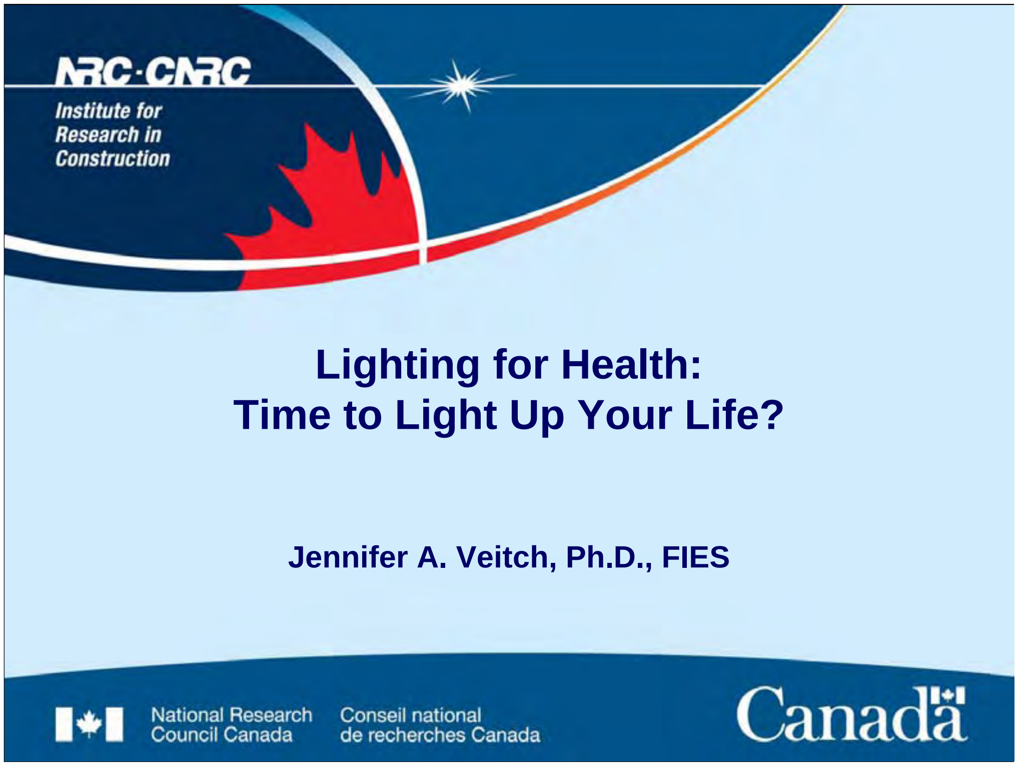
Lighting for health: time to light up your life?

IRC-ORAL-851

Veitch, J.A.

A version of this document is published in / Une version de ce document se trouve dans:
Montreal Section, Illuminating Engineering Society of North America, Montréal, QC., Feb. 19, 2008, pp. 1-28



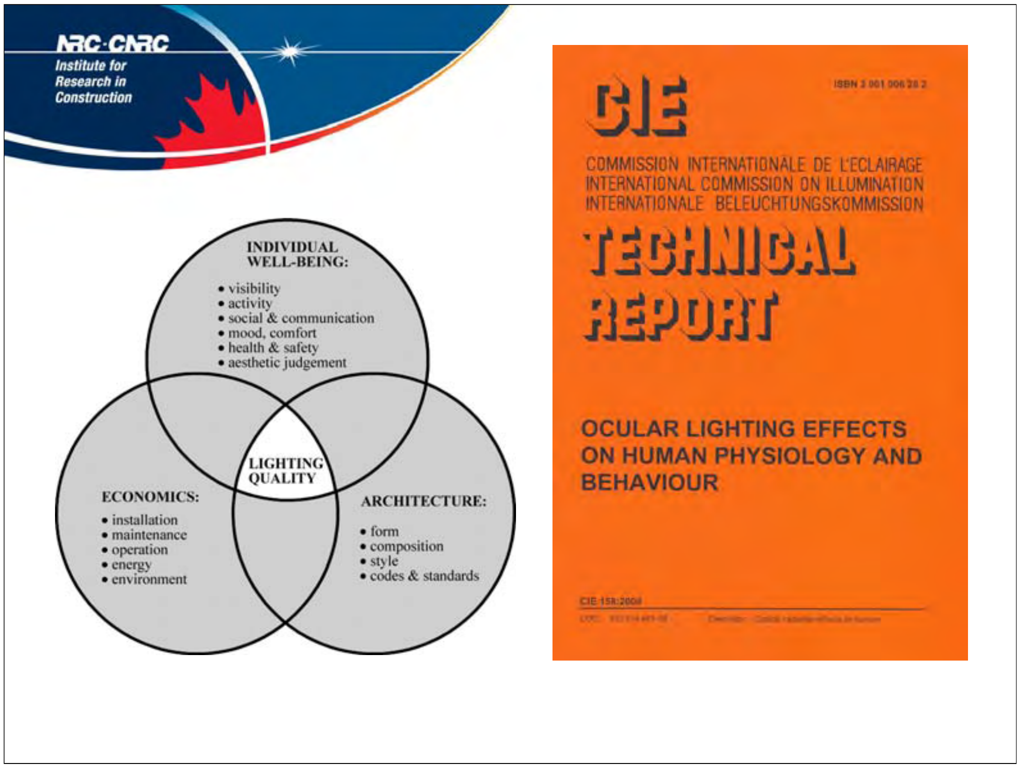
Lighting for Health: Time to light up your life?

Jennifer A. Veitch, Ph.D., FIES

NRC Institute for Research in Construction

Good lighting balances the needs of humans, economic and environmental issues, and architectural design. Good lighting provides for the needed level of visual performance, but also determines spatial appearance, provides for safety, and contributes to human health and well-being. Our daily exposure to light and darkness influences circadian cycles of hormone release, bodily functions, and activity. Among other applications, this new basic knowledge is leading to light treatments for sleep disorders and seasonal mood disorders, and to methods for alleviating problems related to shift work and jet lag. Some research suggests that increasing the total daily light exposure could improve well-being even for healthy people who are active by day. This lecture will summarize this research, explain its limitations, and identify the issues that practitioners should watch for in the coming years as this exciting new research augments our understanding.

Biographical note: Dr. Veitch is a Senior Research Officer in the National Research Council of Canada Institute for Research in Construction, where she leads research into lighting effects on health. She has been actively involved in environmental psychology and lighting research since 1985 and joined NRC in 1992, after completing her Ph.D. in psychology at the University of Victoria, British Columbia . She is best known for her research on lighting quality, and was actively involved in the development of the chapter on the Quality of the Visual Environment (chapter 10 of the Lighting Handbook, 2000). She is active in several professional associations, and is a Fellow of the Canadian Psychological Association, the American Psychological Association, and the Illuminating Engineering Society of North America. She is active in the International Commission on Illumination (CIE), and currently chairs TC 3-34 'Protocols for Describing Lighting'. She led TC 6-11 'Systemic Effects of Optical Radiation on Humans' to the first consensus report on the effects of ocular light on human physiology and behaviour, published in 2004.



This model (left) appeared in the 2000 edition of the IESNA lighting handbook, and it's consistent with what was discussed here in Ottawa in 1998 at the First CIE Symposium on Lighting Quality. It represents a major change in thinking about lighting design: although visual performance is still among the reasons for lighting, it's not the only consideration

I'd like to point out that it includes as a goal for lighting, the provision of individual well-being for the people in the space. That is to say, good lighting aims to provide for the many and various needs of all the different people who encounter it.

My argument today is that we already aim to provide well-being with lighting; going forward, the questions that face us concern how we might modify what we do in order to do that more effectively and thoroughly.

I chaired the committee that wrote CIE Report 158, which identified 5 principles of healthy lighting, which I will refer to throughout this presentation.

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Fundamentals: Photoreception

- Different retinal receptors process visual and non-visual information.
- For example, some blind people show hormone responses to bright light exposure.
- This system seems to use a small number of widely-distributed retinal ganglion cells.

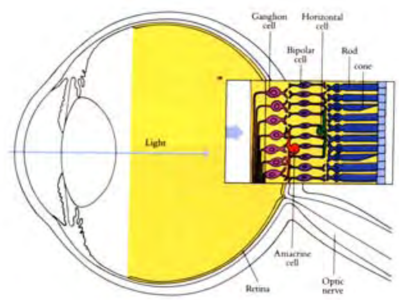

Image © IESNA, 2002

The discovery of these new photoreceptors set the photobiology world on its ear in 2001! We thought we knew everything there is to know about the retina: that rods and cones detect light and send signals to the brain that are decoded to produce visual perception.

However, it was found that some blind people (depending on the type of blindness) showed hormonal responses to bright light exposure. Scientists track the release of the hormone melatonin, which happens at night, in the dark; it can be suppressed by acute light exposure. Certain blind people can't detect the bright light - they can't tell you if they're sitting in light or dark - but yet, their melatonin could reliably be suppressed by light exposure at night, just like in sighted people.

Following anatomical research and other functional studies, we now know that there is a separate set of retinal receptors, a special subset of the ganglion cells, that detects light and sends signals to the brain. It seems to be a small number of the cells, spread all over the retina.

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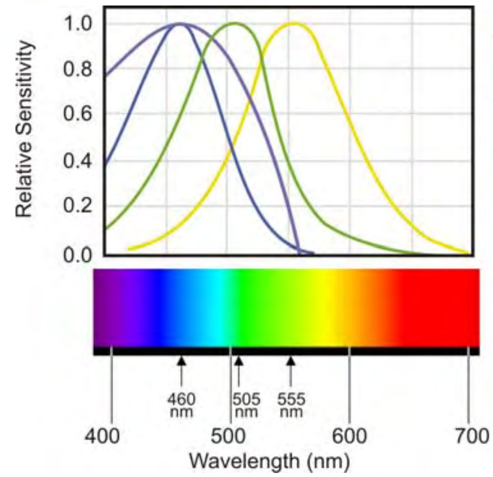
Fundamentals: Photoreception



- CIE Principle 3: Light for biological action should be rich in the regions of the spectrum to which the nonvisual system is most sensitive.

What do these photoreceptors do? They send signals about the presence of light to other brain structures. One of the keys to identifying these cells as being different from rods and cones has been to identify the action spectrum - that is, the response of these cells to different wavelengths of light. The response that has been chosen is the suppression of the hormone melatonin by light exposure at night. Two independent labs, using slightly different techniques, published the first curves at the same time in 2001. It's clear now that the peak response is around 460 nm - in the blue region of the spectrum - and that it's not the same as the response of the visual system (nor of any of its component photoreceptors, not shown). (The range 447 - 477 nm is the key area.)

Two proposed action spectra for melatonin suppression: Results from Brainard et al. (2001) and results from Thapan et al. (2001). Also shown: the scotopic and photopic visual efficiency functions, from Gregory (1977).

These findings are important because:

1. It further demonstrates that there's a separate sensory system for nonvisual effects.

2. It tells us that short-wavelength illumination is most potent for influencing the processes to which this signal extends.

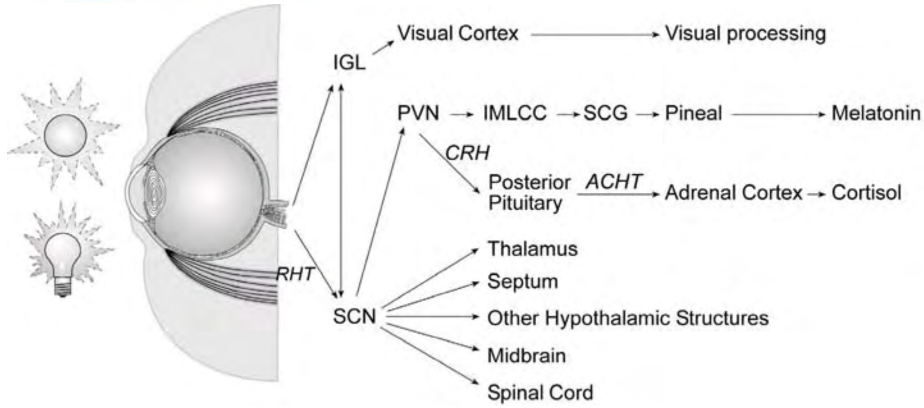
References

Brainard, G. C., Hanifin, J. P., Greeson, J. M., Byrne, B., Glickman, G., Gerner, E., et al. (2001). Action spectrum for melatonin regulation in humans Evidence for a novel circadian photoreceptor. *Journal of Neuroscience*, *21*(16), 6405-6412.

Gregory, R. L. (1977). *Eye and brain The psychology of seeing* (3rd ed.). Oxford, UK Oxford University Press.

Thapan, K., Arendt, J., & Skene, D. J. (2001). An action spectrum for melatonin suppression Evidence for a novel non-rod, non-cone photoreceptor system in humans. *Journal of Physiology*, *535*(Pt 1), 261-267.

Fundamentals: Brain Connections



- CIE Principle 4: The important consideration in determining light dose is the light received at the eye, both directly from the light source and reflected off surrounding surfaces

This is a figure from CIE 158:2004. Much of what is presented here will focus on the links from the SCN to the pineal gland and the effects of light exposures on melatonin.

When we talk about the effects of light or lighting on well-being, however, it's important to remember that there are these several other pathways still waiting for more thorough investigation. Despite all the important advances thus far, we're a long way from having all the answers about how light affects physiology and psychology.

The lighting influences on well-being that I will discuss are almost certainly not related to the pineal pathway.

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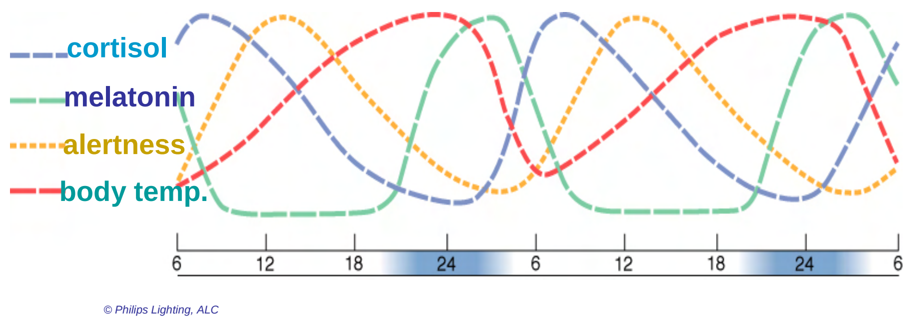
Fundamentals: Circadian Rhythms



This shows in a simplified way how various circadian rhythms vary. Note that the shapes as well as the timing of different events vary. We don't know everything about how these various cycles interact, nor are they they only ones we know of.

One important linkage that is very robust is the pattern of melatonin peak followed shortly by the nadir of core body temperature. This pairing is consistent even when the melatonin peak us shifted (e.g., by bright light exposure).

(This slide was given to me by Gerrit van den Beld of Philips Lighting.)

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Fundamentals: Circadian Rhythms

- Melatonin
  - Pineal
    - high levels secreted at night
    - hypnotic; regulates activity-sleep cycle, body temperature
  - Acute light exposure at night
    - suppresses secretion
    - increased alertness & arousal
  - Daytime light exposure
    - no immediate effect on melatonin, but influences circadian rhythm
- CIE Principle 5: The timing of light exposure influences the effects of the dose.

Acute light suppression of melatonin has been the principal mechanism studied thus far. It's a dose-dependent effect: brighter light, more suppression. And, as we've seen, it's spectrally sensitive.

Melatonin levels are almost zero during the day, so bright light exposure doesn't further suppress this hormone. However, the effect of light exposure differs depending on the **timing** in relation to the endogenous circadian phase.

Light exposure after the nadir of the body temperature cycle (i.e., in the morning) **advances** the phase of the body temperature cycle and the melatonin rhythm (so that the new cycles peak earlier);

light exposure in the evening **delays** both the body temperature and melatonin cycles (so that these cycles peak later than they would have).

Light exposure close to the core body temperature minimum may also directly suppress circadian amplitude.

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Fundamentals: Light at Night

- *In vitro* studies*:* Melatonin suppresses breast cancer and melanoma cell growth.
- *In vivo* studies: Dim light at night suppressed melatonin and increased liver tumour growth.
- Epidemiology: Four separate studies have found night-time light exposure increased breast cancer risk.
  - *One recent study did not find the effect.*

It also appears that melatonin shuts down certain metabolic activities, particularly in certain cell types. These cell types include some forms of cancer, including breast cancer.

Breast cancer rates are higher in the industrialized world than elsewhere, and 50% of cases have no known risk factor. Three lines of research suggest that light exposure at night could be a factor

4 epidemiologic studies:

Davis, S., Mirick, D. K., & Stevens, R. G. (2001). Night shift work, light at night, and risk of breast cancer. *Journal of the National Cancer Institute, 93*(20), 1557-62.

Hansen, J. (2001). Increased breast cancer risk among women who work predominantly at night. *Epidemiology, 12* (1), 74-7.

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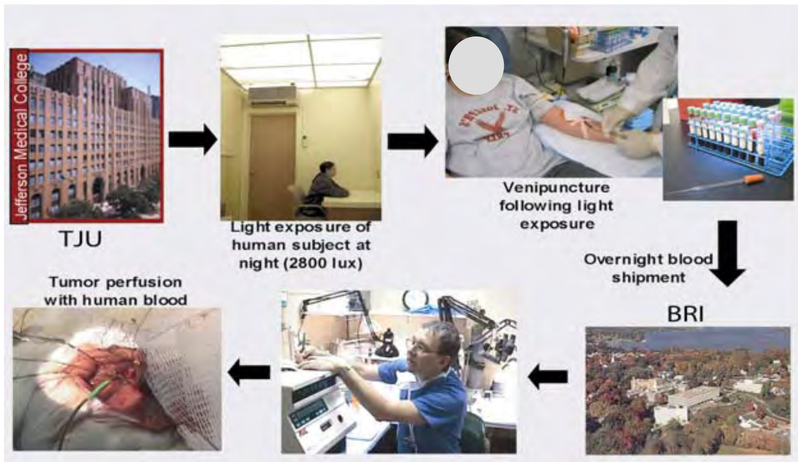
Schernhammer ES, Rosner B, Willett WC, Laden F, Colditz GA, Hankinson SE.
Epidemiology of urinary melatonin in women and its relation to other hormones and night work.
Cancer Epidemiol Biomarkers Prev. 2004 Jun;13(6):936-43.
PMID: 15184249 [PubMed - indexed for MEDLINE]

Fundamentals: Light at Night



Images courtesy Dr. David Blask

- CIE Principle 2: Healthy light is inextricably linked to healthy darkness.

Dr. David Blask and colleagues experimentally tested the hypothesis that light at night contributes to breast cancer cell growth through the suppression of melatonin.

Nude (hairless) rats had human breast cancer tumours xenografted

Blood was collected from women at midday (low in melatonin) and at night (high in melatonin), and at night after light exposure (low in melatonin)

The blood was perfused through the rat tumours.

Tumours with the melatonin-rich blood grew more slowly than those with the melatonin-poor blood.

Other risk factors for people:

consumption of fats (e.g., people on shifts have a harder time eating a healthy diet)

disruption of cortisol rhythm by light at night

socio-economic status and likelihood of night-shift work

unknown factors that influence work choices

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Application: Circadian Phase Shifting

- Circadian rhythm disruptions commonly occur when travelling across time zones, and in shift work.
- Adjusting to a new clock time can cause daytime sleepiness, insomnia, stomach upset, irritability, mild depression.

- Timed bright light exposure can reset the clock.
  - Sensitivity varies depending on system state, and on age
- Bright light in morning advances the clock.
- Bright light in the late evening delays the clock.
  - Delays are easier than advances

In this next set of slides, I'll talk about how these mechanisms might affect people who are basically healthy.

Many people experience uncomfortable symptoms such as daytime sleepiness, night-time insomnia, gastro-intestinal distress, irritability, mild depression and confusion, when their circadian rhythms are disrupted by travel, shift work, or sleep disorders.

For people working shifts that rotate rapidly, these can be chronic problems.

Other consequences are an increased error rate, memory disruptions, and cognitive confusion. The accident rate for people driving home from night shifts is higher than for other drivers.

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Application: Circadian Phase Shifting

- Good news for designers: the night-time bright light for phase shifting doesn't have to be constant.
  - Intermittent bright light can reset the clock.
    - 4-5 20-minute pulses per night shift, ~1200 lx
    - timing of the pulses in relation to the individual's circadian state is critical to the success
    - light should be rich in short-wavelength light
  - Daytime light avoidance:
    - blue-blocking sunglasses for the drive home
    - dark shades, curtains while sleeping

Charmane Eastman and colleagues have presented a compromise schedule for permanent night shift workers. The bright light at work starts relatively early in the shift at the start of the week, then gradually pushes later and later. Behavioural compliance by the worker is part of the scheme; if they don't avoid light when the shift ends, it won't work.

Eastman, C. I., & Martin, S. K. (1999). How to use light and dark to produce circadian adaptation to night shift work. *Annals of Medicine, 31*, 87-98.

The authors, who are not alone in this recommendation, say that from a phase-shifting perspective, a permanent night shift is best (even more so if you can keep the schedule during days off and vacation, but few do). They are especially critical of rapidly-rotating shifts because the worker is never appropriately phase-shifted. This is especially dangerous for critical positions such as nuclear control rooms, or critical-care nursing, where errors are potentially fatal.

<u>Note: this phenomenon is the same as the experience of jet lag, for which there are also solutions based on timed light exposure and light avoidance.</u>

Success at phase shifting isn't a matter of technology alone, but of the behaviour of the individual, too.

In designing spaces for night-shift work, it would make sense to build in a way to deliver high-intensity light for short periods. Don't rely on the occupants to use a light box on their breaks; they are unlikely to persist in it. How about a brighter area in the lunchroom?

Remember, that does is **light at the eye**, not on the table.

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Application: Circadian Phase Shifting

- Permanent night shift is best - one can reset the clock
  - Rotating shift schedules prevent phase-shifting, leave workers with disrupted rhythms
- Long-wavelength light appears to increase alertness without affecting melatonin rhythm
  - Hypothesis: bright long-wavelength light might help to maintain performance in rapidly-rotating night shift schedules.
  - *Still under test.*

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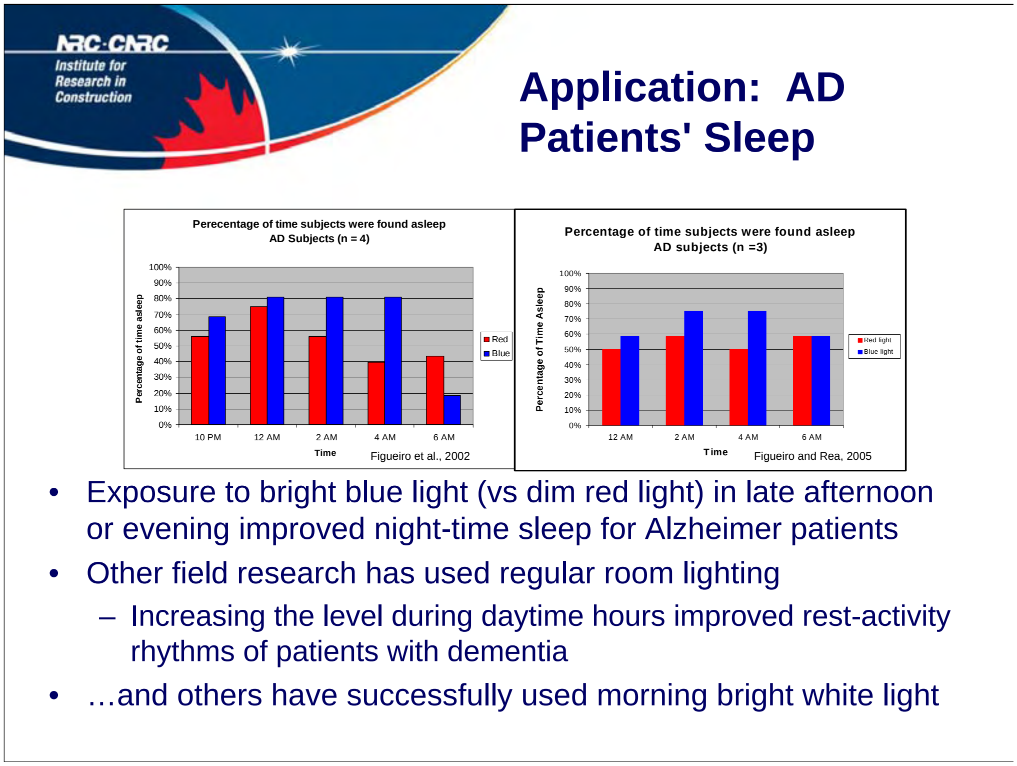
Application: AD Patients' Sleep

Photos courtesy Lighting Research Center

- Two studies by the Lighting Research Center tested use of blue LEDs to increase light dose of Alzheimer patients in a nursing home.
- Compared bright blue to dim red LEDs, both with afternoon/evening exposure

Alzheimer patients often suffer from disrupted sleep and night-time restlessness. This is a big problem for caregivers. At the symposium, Mariana Figeuiro of LRC presented a summary of two studies they have done to test whether blue LED lights supplementing room lighting could help AD patients with this problem.

It's likely the case that institutionalized AD patients have very very low light exposure - so the problem may not entirely be the disease.



In both cases, night-time waking was lower for the blue-light condition than the red. The sample size is small, but that makes the demonstration more convincing as it's hard to get statistical significance for a small sample.

Note that for the regular room lighting studies, I can't tell you what the old or new light levels were for the daytime-field-experiment study, because it wasn't reported and can't be calculated from the information in the paper (Someren et al., 1997).

Reference

Figueiro, M. G. (2006). Lighting for Alzheimer's care. In *Proceedings of the 2nd CIE Expert Symposium on Lighting and Health* (CIE x0312006), pp. 69-72). Vienna, Austria CIE.

Someren, E. J. v., Kessler, A., Mirmiran, M., & Swaab, D. F. (1997). Indirect bright light improves circadian rest-activity rhythm disturbances in demented patients. *Biological Psychiatry*, *41*(9), 955-963.

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Fundamentals: Daily Light Dose

- Survey: monitored daily light exposure and administered questionnaires
  - Everyone had low overall exposure
  - Evidence that depressive people spent least time in bright light
- Other studies replicated the light exposure measurements:

Daily time > 1000 lx	Summer	Winter
Montreal, QC (45°N)	2 h 36 m	24 m
Rochester, MN (44°N)	2 h 23 m	23 m
San Diego, CA (33°N)	2 h 10 m	1 h 20 m

Sources: Cole et al., 1995; Hebert et al., 1998.

I'll turn now to an area that is more controversial: the suggestion that we don't generally have sufficient daily light exposure.

In the industrialized world, total daily light exposure (from all sources) is low . A study of106 people in San Diego, ages 40-64, found that the median person spent 4% of each 24 hr in illumination greater than 1000 lx, and more than 50% of the time in illuminance levels from 0.1 to 100 lx (an additional 38.6% of the time was below 0.1 lx, consistent with sleeping, driving at night, etc.). The data were collected in August and September, so this isn't a winter effect. This is remarkable given that of all places in North America you would expect southern California to be a place where people spend lots of time outdoors, and have lots of sunlight to experience! San Diego is the 81st percentile in US hours of sunshine. Other places probably show even lower light exposure.

The questionnaire results showed a moderate correlation between atypical SAD mood symptoms and time in bright light (r=-.27). This suggests that inadequate light exposure is associated with depressed mood, but doesn't establish a causal link.

References

Cole, R. J., Kripke, D. F., Wisbey, J., Mason, W. J., Gruen, W., Hauri, P. J., et al. (1995). Seasonal variation in human illumination exposure at two different latitudes. *Journal of Biological Rhythms*, *10*(4), 324-334.

Espiritu, R. C., Kripke, D. F., Ancoli-Israel, S., Mowen, M. A., Mason, W. J., Fell, R. L., Klauber, M. R., & Kaplan, O. J. (1994). Low illumination experienced by San Diego adults: Association with atypical depressive symptoms. *Biological Psychiatry, 35*(6), 403-407.

Hébert, M., Dumont, M., & Paquet, J. (1998). Seasonal and diurnal patterns of human illumination under natural conditions. *Chronobiology International*, *15*(1), 59-70.

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Fundamentals: Daily Light Dose

- Effect of exercise and light on mood and quality of life
  - Exercise groups got more fit than relaxation
  - Bright-light group showed bigger mood and mental health score improvement than the moderate-light group

- CIE Principle 1: The daily light dose received by people in Western countries might be too low.

The experimental report (which was published in a top-notch journal) details the IV and DVs, experimental design and statistical tests in detail.

dim-light relaxation training – no illuminance value given (one small flaw)

moderate-light fitness training 400-600 lx

bright light fitness training 2500-4000 lx

What did they find? Participants who worked out all got fit, but the ones in the gym with bright light also showed improvements in standardised mood and mental health measurements, over the 8 weeks of training. However, 4 months later in follow-up the people who had received the bright light showed the biggest declines: the effect seems to rely on continued exposure.

Reference

Partonen, T., Leppämäki, S., Hurme, J., & Lönnqvist, J. (1998). Randomised trial of physical exercise alone or combined with bright light on mood and health-related quality of life. *Psychological Medicine*, *28*, 1359-1364.

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Therapeutic Lighting - SAD

- Seasonal affective disorder is a **recurring seasonal pattern** of clinical symptoms
  - Emotional depression, a desire to withdraw socially, and a drop in physical energy, **and**:
  - Atypical symptoms of nonseasonal depression: an increased need for sleep, increased appetite, unacceptable weight gain, and cravings for carbohydrates and sweets
- Population estimates are that ~2.6% of Ontarians might have winter SAD; this is 10% of all depression cases.

We hear a lot about SAD and light treatment. I want to emphasize that this is not a very frequently occurring disease.

When I say we might need more light exposure, I don't mean we all should use the light treatment I'm going to discuss here.

N.B. The evidence for increasing incidence with latitude is very weak. Going up north is not a sure-fire way to get this disorder.

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Therapeutic Lighting - SAD

- Light therapy for SAD uses bright white light (10,000 lx for 30 min), delivered to the eye, in the morning
- Benefit stops when treatment stops
- ~66 % of patients respond to light therapy
- Few side effects
  - except with photosensitizing medication (including St. John's Wort)

Photo: http://www.day-lights.com/

Michalak, Lam, & Levitt, 2002: "Light therapy has been shown to produce relatively limited or mild side effects, with the most common being headache, eye strain, nausea or agitation. Rare reports of hypomania or mania as a result of light therapy have occurred. Consequently, patients with bipolar disorder should be monitored closely during treatment. There are no absolute contraindications to light therapy, and no evidence exists that it associates with ocular or retinal damage. Nevertheless, patients with ocular risk factors (for example, retinal disease, diabetes, macular degeneration, photosensitizing medications, such as lithium, St. John's Wort, and phenothiazine antipsychotics) should have a baseline ophthalmological consultation prior to starting light therapy and should undergo periodic monitoring."

The cause of SAD is **not known.** It's not necessarily a lack of light. After all, pneumonia is cured by penicillin, but the cause of pneumonia is not a lack of penicillin!

Reference

Michalak, E. E., Lam, R. W., & Levitt, A. J. (2002). Current treatment recommendations for seasonal affective disorder. *Canadian Psychiatric Association Bulletin*, *34*(3), 47-50.

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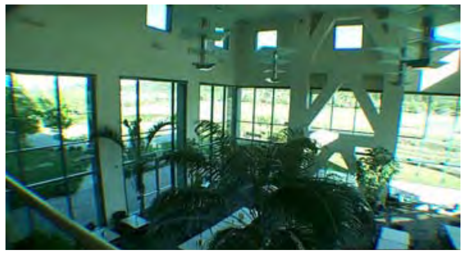
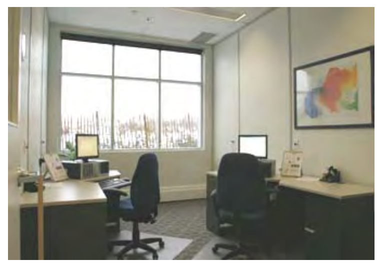
Implications: Daytime Lighting



Images © NRCC 2002, 1988

- Substantially more light …
- … in the blue-green region …
- … at the eye

- Daylighting, but ...
- Glare control ...



I'm going to focus on daytime in offices, because that's where I've done most of my research work. This are the things that the CIE principles tell me we might have to design for:

-More light (at least at some times of the day)

-Rich in the blue-green

-And more delivery in the vertical rather than horizontal plane

In the study I discussed earlier, Finnish researchers gave people higher doses of light using 3 1-hr visits a week to a specially lit gym. Perhaps we don't need more light all the time, but just some of the time - and perhaps not everywhere. This would be a good thing in terms of energy consumption, because to increase illuminance everywhere is unsupportable. The carbon dioxide emissions alone would be prohibitive!

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Do we need more light?

- We need more detail concerning the necessary…
  - Timing
  - Intensity
  - Spectrum
  - Duration
  - Pattern
- What about light dose needs for special populations?
  - Chronotype
  - Environmental sensitivity
  - Visual impairments
  - Light dose for infants, children, adults, elders

What does all this mean for lighting practice?

The implications are not at all clear for daytime lighting, because we don't know the necessary light dose. Remember all those brain structures the light signals go to - we don't know much about most of them.

The information we have now tells us that there are effects of light during the day that could be important for health and well-being, but we lack sufficient information to be specific in our recommendations. There is also some evidence that the requirements are different for various groups of people, but we need to know a lot more before we can make specific recommendations for them.

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Implications: Night Lighting

- Healthy, night shift workers
  - Need to shift circadian phase
  - Need light exposure at night
  - Need light avoidance by day
- Sleeping rooms for all
  - Get some darkness as well as light each day
  - Light avoidance - direct outdoor lights away from windows, etc.
  - Red/amber, not blue/green, nightlights

We do have some clear guidance for night-shift workers. Happily, we know we don't need to increase their light exposure hugely, all the time.

For all of us, at night we should try to avoid light for at least part of the time.

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Do we need more dark?

- How much darkness do we need daily?
  - How dark need it be?
  - Do we need recommendations for room darkness at night?
  - Should some light-emitting products be off the market (e.g., green LED clock radios)?

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Implications: Habits

- Daily outdoor exposure & exercise
- Light avoidance while sleeping
- “Light hygiene”

It's important to recognise that not all of the applications of this knowledge involve electricity or technology. There is also an element of individual responsibility to the application of this information. Light exposure and dark time could be considered part of personal hygiene, like brushing and flossing and eating from all the food groups. This applies to everyone.

It could be that your grade-school teacher was right: *"Go outside for recess!"*

Isn't it ironic that the only office workers who go outside regularly during the day are smokers!

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Implications: Energy

- Not increased light levels
- But, special equipment for specific purposes and times
- Potential conflict with codes based on limits to installed power density
- Exceptions needed for special populations - e.g., seniors, northern communities

In 1994 I attended a session with photobiologists and lighting designers where the former recommended higher illuminance and the latter protested that energy-efficiency concerns conflicted. If anything, the energy issues are more important now. Happily we now know that we don't need to increase general illuminance levels all the time.

We need to know more, and we need to be able to be specific about the light needs for special populations - and then we need to make sure that codes, standards, and regulations allow for the provision of those conditions (and maybe even require it).

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Implications: Technology

- New technologies under development
  - High-CCT (~17000 K) fluorescent lamps to increase short-wavelength contribution
  - Dynamic lighting systems (change CCT and intensity over the day)
  - LED sources for therapeutic and general lighting
  - Potential role for computer monitors and TVs to deliver light dose (especially for housebound populations)
  - Daylighting - shading & controls

Although the lighting community isn't in total agreement about how to apply this new knowledge, there are technological developments under way…

We need to keep in mind that any changes need to be energy-efficient and simple. Ordinary folks aren't going to want to stare at a light box for 30 min a day. And none of us wants to increase CO_2 emissions, with all the attendant air quality and climate-change problems that would bring.

International Initiatives

- Lighting Research Office symposium 2002
- CIE Expert Symposia, 2004 and 2006
- Dual-published papers in Leukos and Light and Engineering
  - Pro and con
- Workshop at CIE 26th Session, Beijing, July 2007
- New technical committees of CIE Division 3 and 6
  - D6 summarizes fundamentals; D3 seeks application guidance
- IESNA "Light and Human Health" committee

D3:

TC 3-46: "Research roadmap for healthful interior lighting applications" (Chair: J. A. Veitch, Canada)

TC 3-44: "Lighting for older people and people with visual impairment in buildings" (Chair: G. Cook, UK)

- also a D3 reportership on lighting for night shift work (M. Knoop, NL)

D6:

TC 6-61: Action Spectra and Dosimetric Quantities for Circadian and Related Neurobiological Effects. (H. Cooper, US)

TC6-62 Photobiological Strategies for Adjusting Circadian Phase to Minimize the Impact of Shift Work and Jet Lag. (S. Lockley, US)

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Design Guidance

- Associations' task is to take the information from scientists and distil it into design wisdom
- Find contradictions between design goals
- Find balance
  - codes
  - standards
  - recommendations

The Waveny Center, New Canaan, Connecticut, USA.
Architect: Reese Lower Patrick and Scott, Architects.
Photographer: Larry Lefever

Image courtesy Ms Naomi Miller

To combine the two tracks - lighting for visual effect and lighting for circadian regulation - requires a delicate touch. This is one example where it's been done well.

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Conclusions

- Scientific discoveries show us that light has previously unknown roles on physical and mental health.
  - There's lots more we don't know.
  - As Dr. Peter Boyce said, "be vigilant [for new information], skeptical, specific, and careful."

Contact: jennifer.veitch@nrc-cnrc.gc.ca

This isn't the end of the story, just the beginning.