DEFENSE CENTERS OF EXCELLENCE
For Psychological Health & Traumatic Brain Injury

Detrimental Effects of Blue Light from Electronics on Sleep

December 3, 2015; 1-2:30 p.m. (ET)

Presenter:
Mariana G. Figueiro, PhD, Fellow of the Engineering Society (FIES)
Professor, Lighting Research Center
Rensselaer Polytechnic Institute
Troy, NY

Moderator:
Cmdr. David S. Barry,
Psy.D., USPHS
Implementation Division Chief
Deployment Health Clinical Center, Silver Spring, Maryland

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Webinar Details

- Live closed captioning is available through Federal Relay Conference Captioning (see the “Closed Captioning” box)
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- Question-and-answer (Q&A) session
  - Submit questions via the Q&A box

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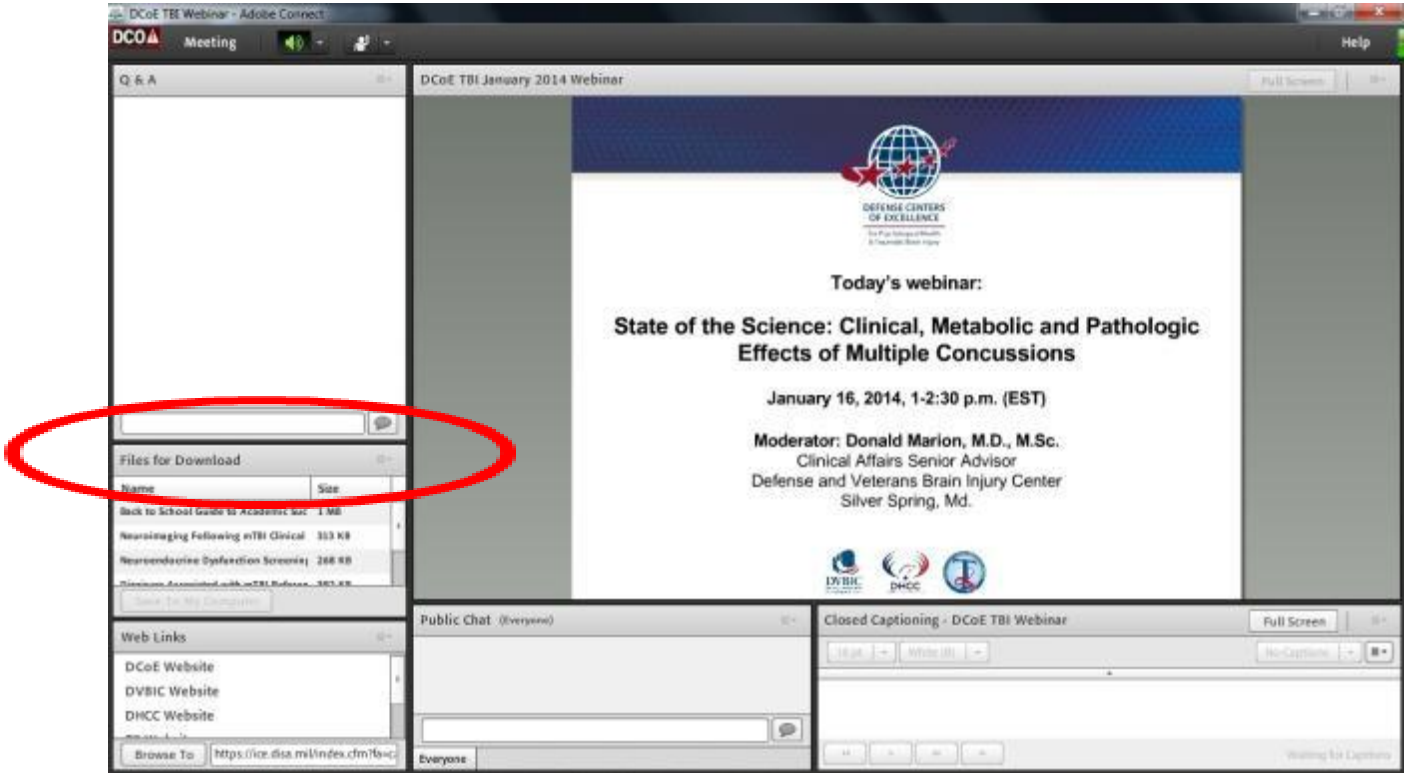

Continuing Education Details

- DCoE's awarding of continuing education (CE) credit is limited in scope to health care providers who actively provide psychological health and traumatic brain injury care to active-duty U.S. service members, reservists, National Guardsmen, military veterans and/or their families.

- The authority for training of contractors is at the discretion of the chief contracting official.
  - Currently, only those contractors with scope of work or with commensurate contract language are permitted in this training.

Continuing Education Accreditation

- This continuing education activity is provided through collaboration between DCoE and Professional Education Services Group (PESG).

- Credit Designations include:
  - 1.5 AMA PRA Category 1 credits
  - 1.5 ANCC nursing contact hours
  - 1.5 APA Division 22 contact hours
  - 1.5 NASW contact hours
  - 1.5 ACCME AMA PRA Category 1 credits
  - 1.5 CRCC continuing hours
  - 0.15 ASHA, Intermediate level continuing hours

Continuing Education Accreditation

Physicians
This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Professional Education Services Group and the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCOE). Professional Education Services Group is accredited by the ACCME to provide continuing medical education for physicians. This activity has been approved for a maximum of 1.5 hours of AMA PRA Category 1 Credits™. Physicians should only claim credit to the extent of their participation.

Psychologists
This activity is approved for up to 1.5 hours of continuing education. APA Division 22 (Rehabilitation Psychology) is approved by the American Psychological Association to sponsor continuing education for psychologists. APA Division 22 maintains responsibility for this program and its content.

Nurses
Nurse CE is provided for this program through collaboration between DCOE and Professional Education Services Group. Professional Education Services Group is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation. This activity provides a maximum of 1.5 contact hours of nurse CE credit.

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This program is approved by The National Association of Social Workers for 1.5 Social Work continuing education contact hours.

Continuing Education Accreditation

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This activity will provide 0.15 ASHA CEUs (Intermediate level, Professional area).

Occupational Therapists
(ACCME Non Physician CME Credit) For the purpose of recertification, The National Board for Certification in Occupational Therapy (NBCOT) accepts certificates of participation for educational activities certified for AMA PRA Category 1 Credit ™ from organizations accredited by ACCME. Occupational Therapists may receive a maximum of 1.5 hours for completing this live program.

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The Commission on Rehabilitation Counselor Certification (CRCC) has pre-approved this activity for 1.5 clock hours of continuing education credit.

Other Professionals
Other professionals participating in this activity may obtain a General Participation Certificate indicating participation and the number of hours of continuing education credit.

Continuing Education Details

- If you wish to obtain a CE certificate or a certificate of attendance, please visit http://dcoe.cds.pesgce.com after the webinar to complete the online CE evaluation.

- The online CE evaluation will be open through **Thursday, December 17, 2015**.

Questions and Chat

- Throughout the webinar, you are welcome to submit technical or content-related questions via the Q&A pod located on the screen. **Please do not submit technical or content-related questions via the chat pod**.
- The Q&A pod is monitored during the webinar; questions will be forwarded to presenters for response during the Q&A session.
- Participants may chat with one another during the webinar using the chat pod.
- The chat function will remain open 10 minutes after the conclusion of the webinar.

Summary and Learning Objectives

Light isn't just for vision. In addition to enabling us to see, light is the major synchronizer of our bodies' circadian rhythms to the local time on earth. Light can also induce an acute alerting effect on people. Lighting characteristics affecting vision are different than those affecting our biological rhythms and our acute alertness. Different types and levels of light can affect a person's ability to see clearly, identify people and objects, and drive safely.

Certain types of light applied at certain times of the day can increase sleep efficiency of older adults and reduce symptoms of seasonal affective disorder, or SAD, felt by many people during winter months. If applied at the wrong time, light can lead to circadian rhythm disruption, which has been linked to increased risk for diseases and disorders. How and when lighting can be used to promote health and well-being of those suffering from circadian disorders will also be discussed.

At the conclusion of this webinar, participants will be able to:

- Demonstrate understanding of the circadian rhythm by identifying at least three ways to measure it.
- Identify lighting characteristics that affect shift worker's circadian rhythm.
- Analyze symptomology of sleep and circadian rhythm disruption in military settings.

Dr. Mariana Figueiro, PhD, Fellow of Engineering Society (FIES)

- Dr. Figueiro is the Light and Health Program Director at the Lighting Research Center (LRC) and Professor at Rensselaer Polytechnic Institute. She conducts research on the effect of light on human health, circadian photobiology, and lighting for older adults.

- Dr. Figueiro holds a bachelor's in architectural engineering, a master's in lighting and a doctorate in multidisciplinary science. She is the recipient of the 2007 NYSTAR James D. Watson Award, the 2008 Office of Naval Research Young Investigator Award, and the 2010 Rensselaer James M. Tien '66 Early Career Award.

- In 2013 she was elected Fellow of the Illuminating Engineering Society. She is the author of more than 60 scientific articles in her field of research.

- Her research is regularly featured in national media including The New York Times, The Wall Street Journal, Scientific American, The Economist, and NPR.

- She was a speaker at TEDMED on September 12, 2014 at the Kennedy Center in Washington, DC.

Detrimental Effects of Blue Light from Electronics on Sleep

Overview of the health effects of light (not just blue light) on humans

Mariana G. Figueiro, PhD, FIES
Professor
Lighting Research Center
Rensselaer Polytechnic Institute
Troy, NY
December 3, 2015

Lighting Research Center

Rensselaer

General learning objectives

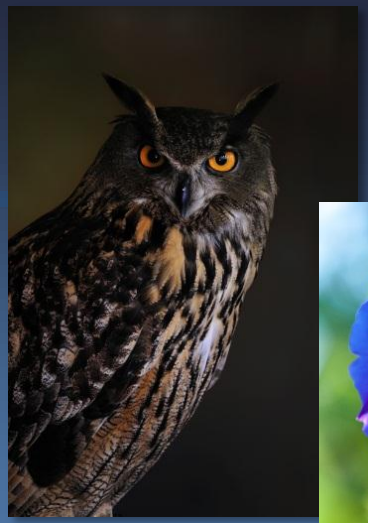
- Learn about the science
  - Basics of circadian rhythms
  - Circadian phototransduction
  - Lighting characteristics affecting circadian rhythms
  - Effects of self-luminous displays on acute melatonin suppression
- Learn about the applications
  - Seasonal Affective Disorder (SAD)
  - Submariners
  - Delayed sleep phase disorder
  - Shift workers
  - Older adults including Alzheimer's disease patients
- Learn about how to apply this knowledge

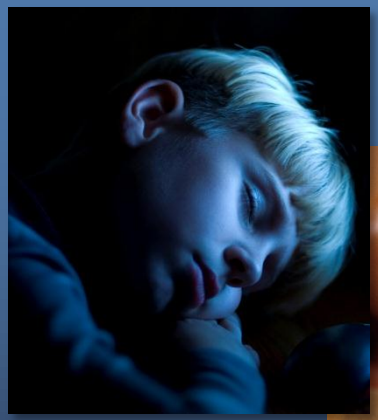
Specific learning objectives

- Demonstrate understanding of the circadian rhythm by identifying at least three ways to measure it
- Identify lighting characteristics that affect shift worker's circadian rhythm
- Analyze symptomology of sleep and circadian rhythm disruption in military settings

Circadian system

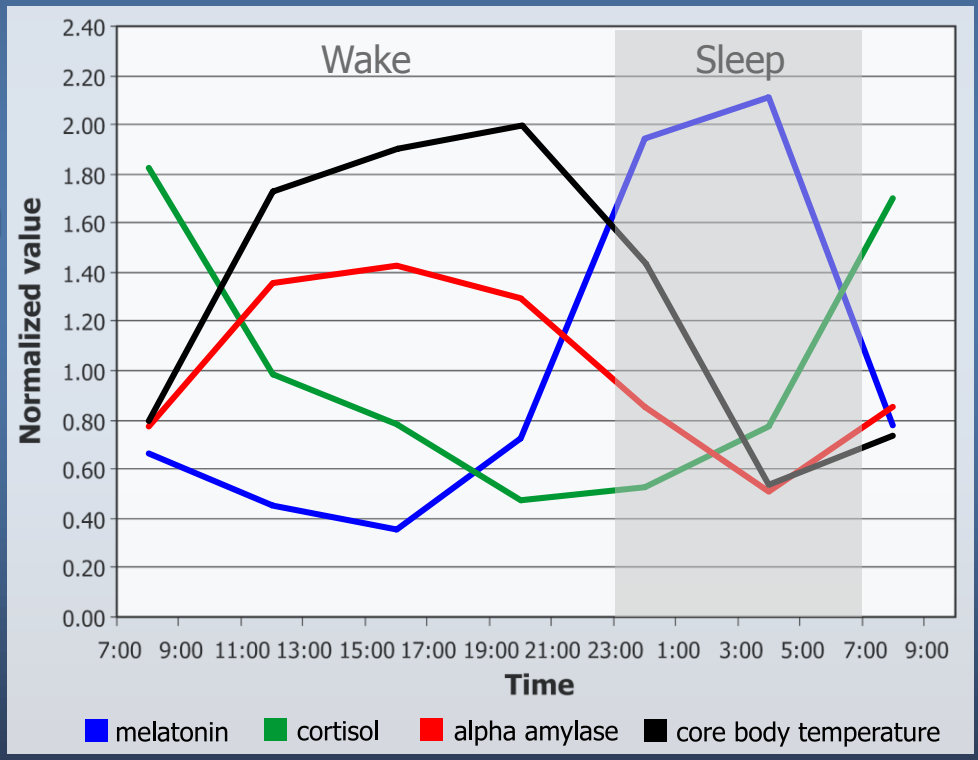
- Plants and animals exhibit patterns of behavioral and physiological changes over an approximately 24-hour cycle that repeat over successive days—these are circadian rhythms
- circa = about; dies = day
- Circadian rhythms are influenced by exogenous and endogenous rhythms





Circadian system

- Biological (circadian) rhythms in humans can be measured in several ways
  - Sleep/wake cycle
  - Core body temperature
  - Melatonin concentration
  - Cortisol concentration
  - Alpha amylase concentration



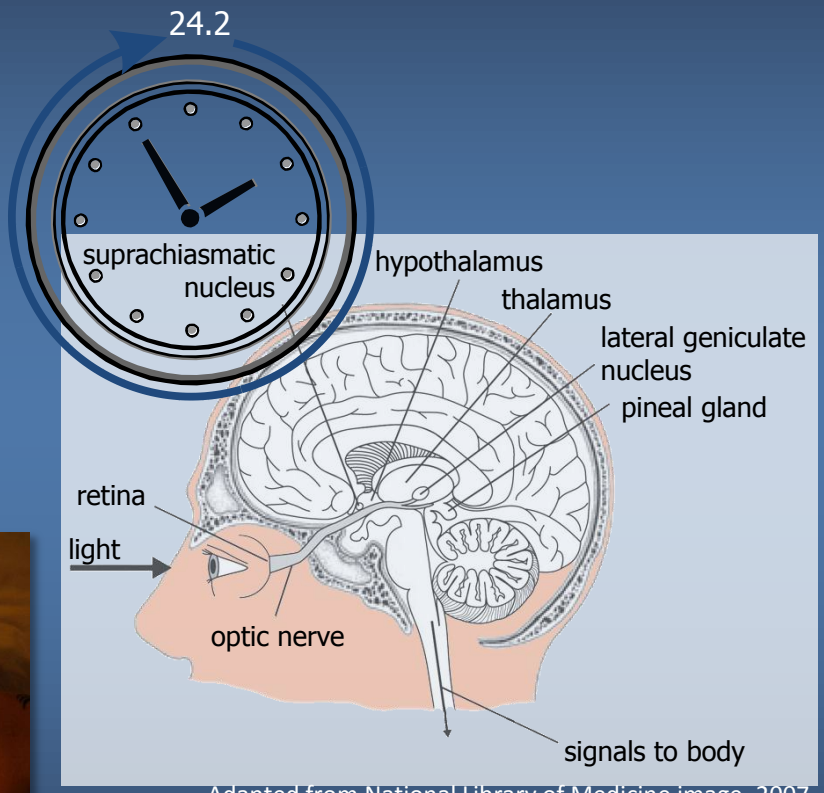
Figueiro, M. G., Bierman, A., Plitnick, B., & Rea, M. S. (2009). Preliminary evidence that both blue and red light can induce alertness at night. *BMC Neuroscience, 10*, 105.

Figueiro, M. G., & Rea, M. S. (2010). The effects of red and blue lights on circadian variations in cortisol, alpha amylase, and melatonin. *International Journal of Endocrinology*, 2010.

Sponsor: Office of Naval Research

Light is the primary synchronizer of circadian rhythms to local position on Earth

The natural, 24-hour, light-dark cycle



Adapted from National Library of Medicine image, 2007 (public domain)

Light is the primary synchronizer of circadian rhythms to local position on Earth

…also the major disruptor

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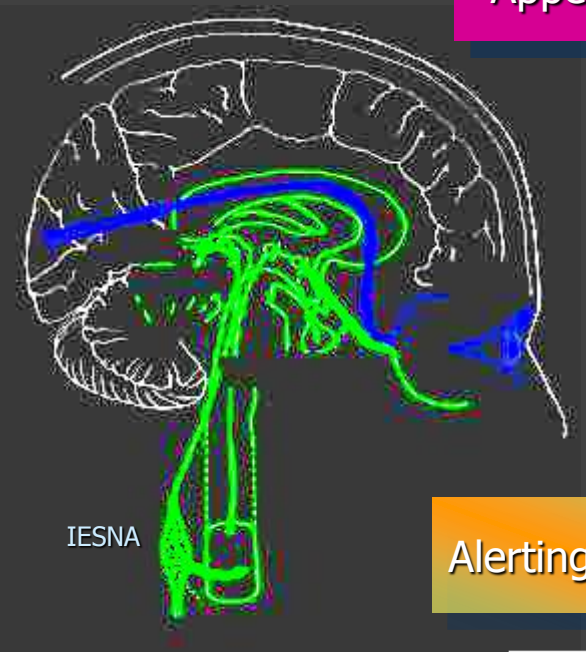
Circadian disruption

- Circadian disruption has been associated with:
  - Poor sleep and higher stress
    - Eismann et al., 2010
  - Increased anxiety and depression
    - Du-Quiton et al., 2010
  - Increased smoking
    - Kageyama et al., 2005
  - Cardiovascular disease
    - Young et al., 2007; Maemura et al., 2007
  - Type 2 diabetes
    - Kreier et al., 2007
  - Higher incidence of breast cancer
    - Schernhammer et al., 2001; Hansen, 2006

Lighting characteristics



Intensity
Spectrum
Distribution
Timing
Duration

Appearance
Visual System
Visual Performance

Performance, Well-being, Satisfaction, and Comfort

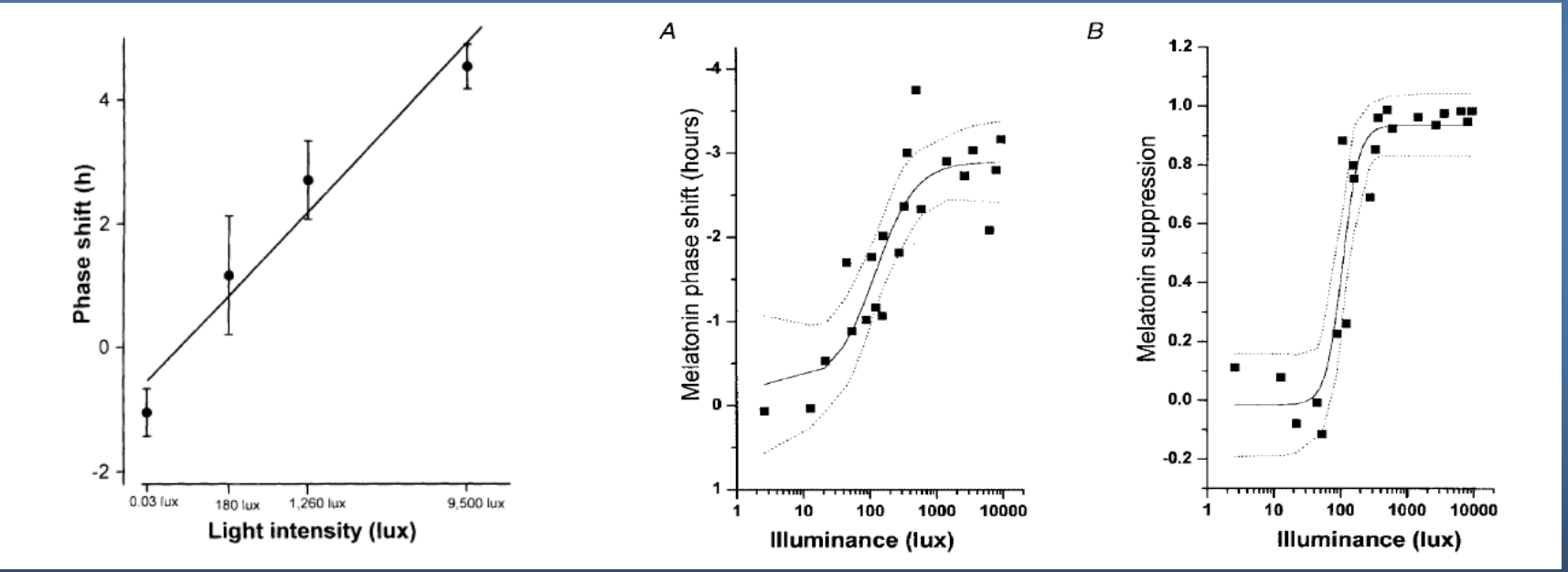
Culture, Experience, Expectations

Alerting Effects
Circadian System
Phase Shift

Intensity
Spectrum
Distribution
Timing
Duration

Lighting characteristics affecting the circadian system

- Quantity: absolute sensitivity
  - Dim white light (~100 lx [10 fc] at the eye) can be effective at suppressing melatonin and phase shifting the pacemaker



5 h exposure to 80 lux = 1 h advance

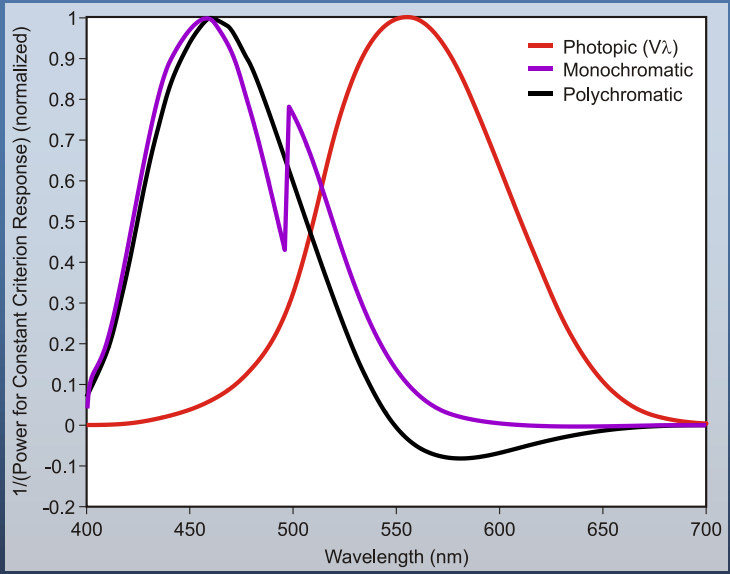
Boivin, D. B., Duffy, J. F., Kronauer, R. E., & Czeisler, C. A. (1996). Dose-response relationships for resetting of human circadian clock by light. *Nature*, *379*(6565), 540.

6.5 h exposure to 100 lux = 2 h delay and 45% suppression

Zeitzer, J. M., Dijk, D., Kronauer, R., Brown, E. N., & Czeisler, C. A. (2000). Sensitivity of the human circadian pacemaker to nocturnal light: melatonin phase resetting and suppression. *Journal of Physiology*, *526*(3), 695-702.

Lighting characteristics affecting the circadian system

- Spectral weighting functions that might be used to characterize light stimuli for a variety of non-visual responses have not been established
  - Need to develop spectral sensitivity functions for melatonin phase shifting, for alertness and for other biomarkers

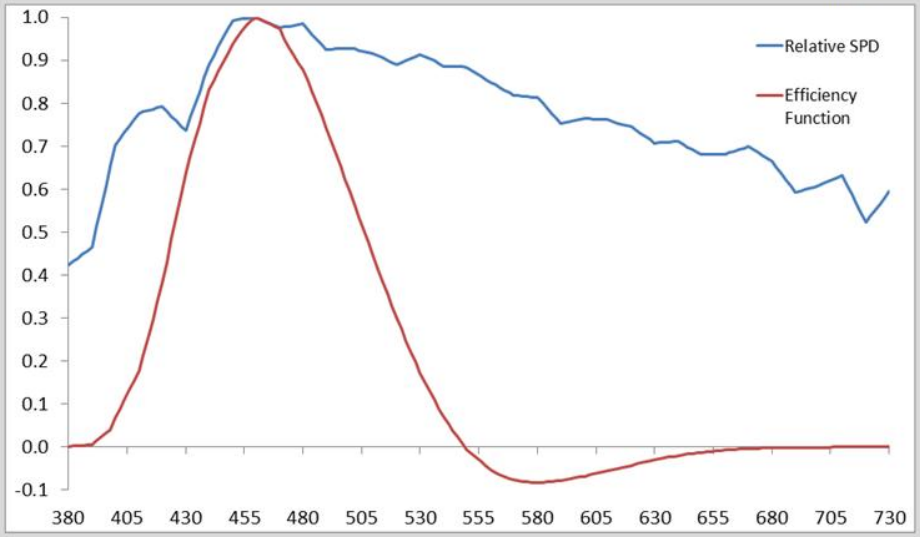


Rea, M. S., Figueiro, M. G., Bierman, A., & Hamner, R. (2012). Modelling the spectral sensitivity of the human circadian system. *Lighting Research and Technology, 44*(4), 386-396.

Rea, M. S., Figueiro, M. G., Bullough, J. D., & Bierman, A. (2005). A model of phototransduction by the human circadian system. *Brain Research Reviews, 50*(2), 213-228.

Circadian stimulus calculator

Select Source SPD	Universal Illuminance	User SPD	
		Wave-length	Value
CIE D65	**2016.0** lux (Using photometric convention 1 W @ 555 nm = 683 lm)	4.02E+02	0
(Click cell above for pull-down menu)	Irradiance (over spectral range given by available data)	4.56E+02	6
	2.221 W/m^2	5.11E+02	4
Illuminance (lux)	**Circadian Light (CLA)**	5.55E+02	7
1000	**1643** Circadian lux	6.02E+02	6
(Enter illuminance)	**Circadian Stimulus (CS)**	6.53E+02	5
	0.59		
Select action spectra weighting functior	**Action spectra-weighted irradiance**		
Circadian	1.160 W/m^2		
(Click cell above for pull-down menu)	**792.4** Benefit metric (action spectra-weighted irradiance*683)		



Sponsor: Light and Health Alliance

Acuity Brands, Ketra Inc., Philips Lighting, OSRAM Sylvania, Sharp Corporation, USAI Lighting

Lighting Research Center

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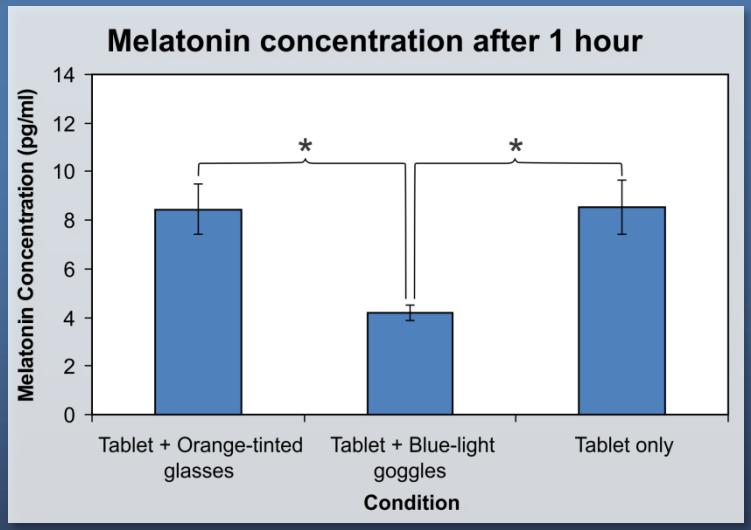
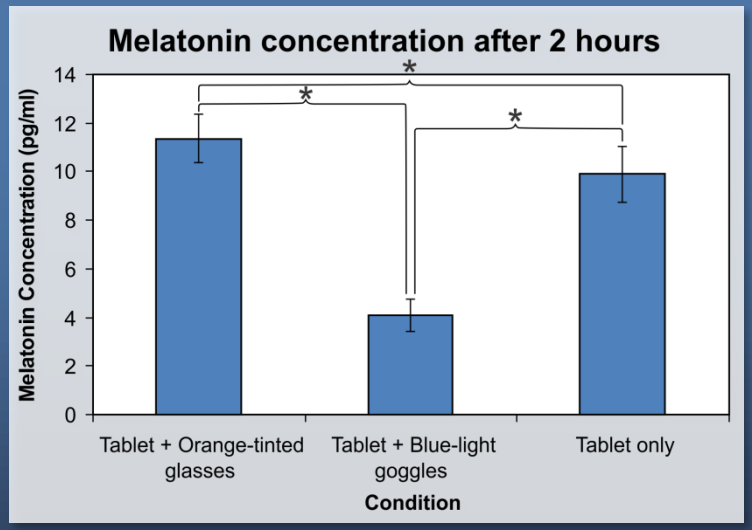
Using the calculator
Absolute and spectral responses

	30 lux		300 lux		3000 lux	
Source	**CL_A**	**CS**	**CL_A**	**CS**	**CL_A**	**CS**
Equal energy	41.9	0.06	428	0.39	5010	0.66
CIE D65	47.2	0.07	482	0.41	5673	0.67
Soft white 60W A lamp	29.9	0.04	299	0.32	2988	0.64
Enrich 60W A lamp	34.7	0.05	347	0.35	3467	0.65
Halogen 3277K	37.3	0.05	373	0.36	3734	0.65
CFL GE FLE15TBX L LLCD	21.7	0.03	217	0.26	2171	0.62
FO32 835 xp OCTRON 3500K	32.4	0.05	324	0.33	3242	0.64
F34T12 Cool White	15.6	0.02	159	0.2	1927	0.61
Design50 40W	28.2	0.04	288	0.31	3450	0.65
Xenon 1000W	40.8	0.06	417	0.38	4963	0.66
Pulse start MH 320W	17.2	0.02	177	0.22	2156	0.62
Mercury vapor 400W clear	10.2	0.01	105	0.14	1326	0.57
HPS 400W	12.9	0.02	129	0.17	1290	0.56
Philips Mastercolor CDM 100W	22.5	0.03	231	0.27	2787	0.63
LED 2700K Lumileds LXM3_PW81	25.6	0.04	256	0.29	2558	0.63
LED 6500 K Cree XPG cool white	37.7	0.05	385	0.37	4463	0.66
Blue LED 470 nm peak	486.4	0.41	5119	0.66	61666	0.7
Red LED 630 nm peak	0.6	0	6	0.01	56	0.08

Impact of light from iPads on melatonin levels

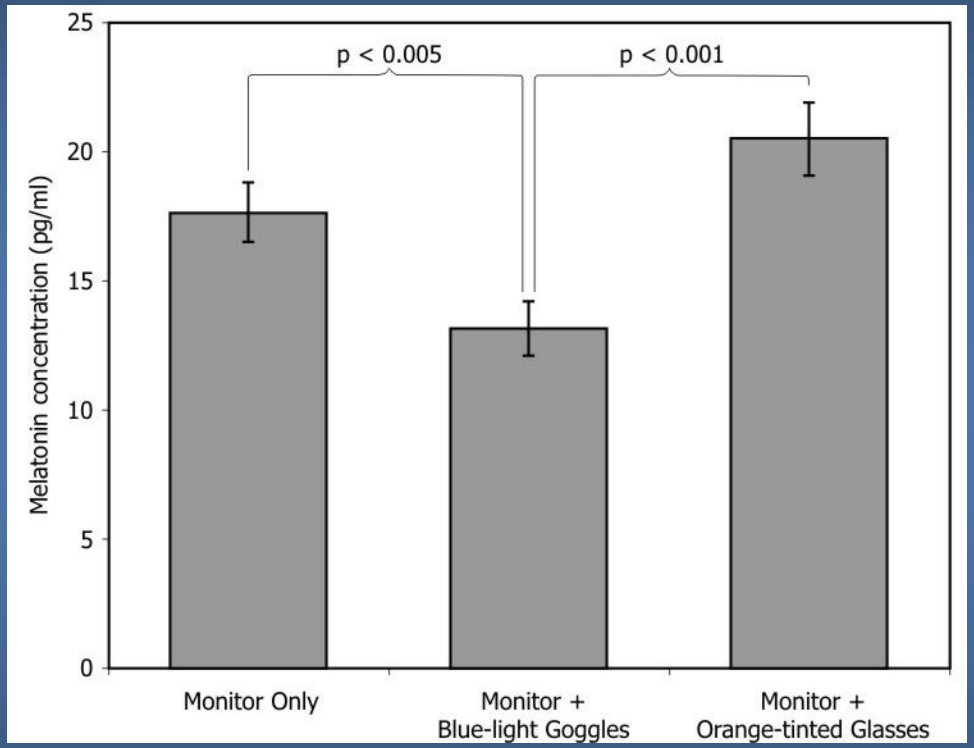




Sponsor: Sharp Labs of America

Wood, B., Rea, M. S., Plitnick, B., & Figueiro, M. G. (2013). Light level and duration of exposure determine the impact of self-luminous tablets on melatonin suppression. *Applied Ergonomics, 44*(2), 237-240.

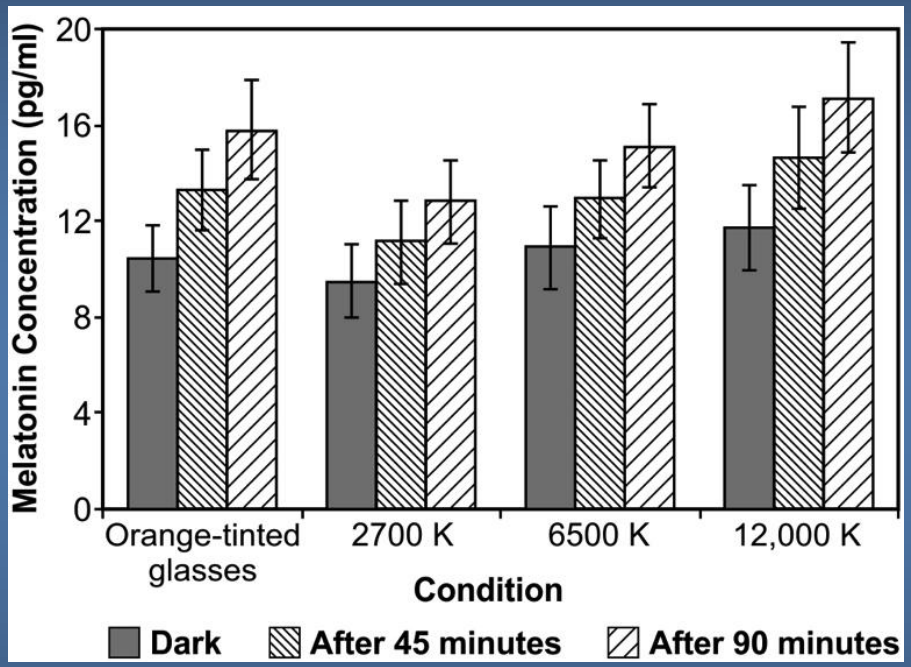
Impact of light from computer screens on melatonin levels



Sponsor: Sharp Labs of America

Figueiro, M. G., Wood, B., Plitnick, B., & Rea, M. S. (2011). The impact of light from computer monitors on melatonin levels in college students. *Neuroendocrinology Letters, 32*(2), 158-163.

Impact of light from televisions on melatonin levels



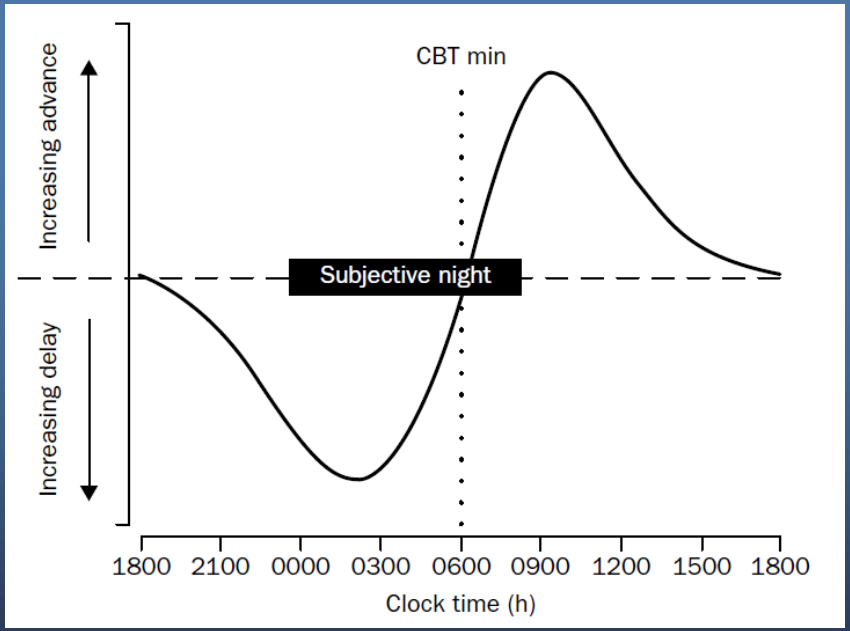
Sponsor: Sharp Labs of America

No significant melatonin suppression after 45 min and 90 min

Figueiro, M. G., Wood, B., Plitnick, B., & Rea, M. S. (2013). The impact of watching television on evening melatonin levels. *Journal of the Society for Information Display, 21*(10), 417-421.

Lighting characteristics affecting the circadian system

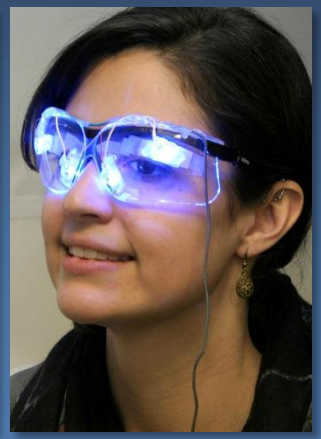
- Timing
  - Change in direction and magnitude of phase shift as a function of circadian time can be plotted as a phase response curve (PRC)

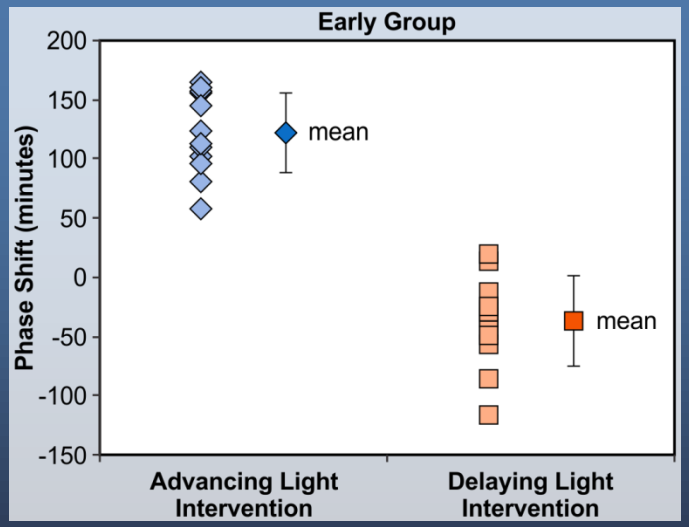


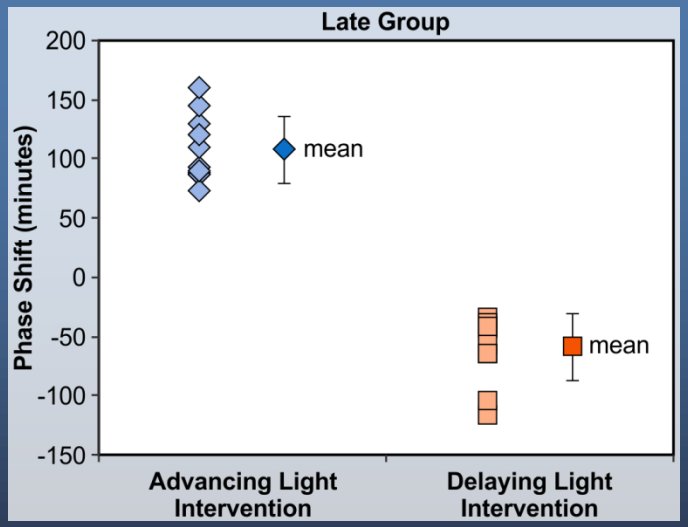
Rajaratnam, S. & Arendt, J. (2001). Health in a 24-h society. *The Lancet, 358*(9286), 999-1005.

Light-dark patterns and circadian phase in early and late chronotypes

- Collected data from 23 subjects (12 early and 11 late people) who experienced an advancing and a delaying lighting intervention
- Late people delayed by about 59 min in the delaying light and advanced by about 108 min in the advancing light; early people delayed by about 37 min in the delaying light and advanced by about 122 min in the advancing light





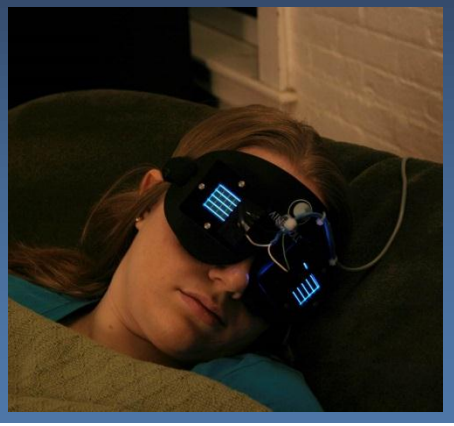


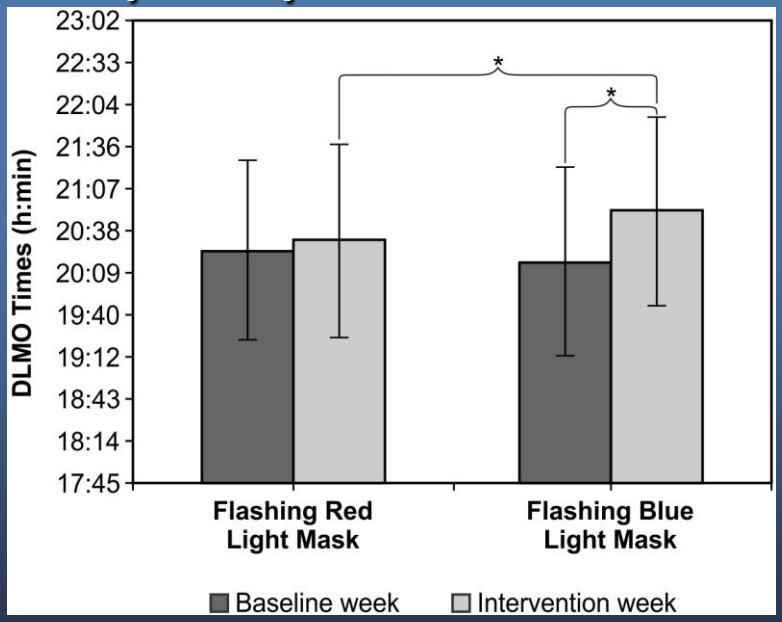
Sponsor: Office of Naval Research (N00014-11-1-0572)

Figueiro, M. G., Plitnick, B., & Rea, M. S. (2014). The effects of chronotype, sleep schedule and light/dark pattern exposures on circadian phase. *Sleep Medicine, 15* (12), 1554–1564.

Flashing-blue light mask delays circadian phase in older adults living at home

- 28 participants (9 with early sleep onset) living at home were exposed to flashing blue and flashing red lights starting one hour after bedtimes
- Results showed that DLMO was delayed by an average of 27 minutes after one week of flashing blue light
- Continue studies in NC





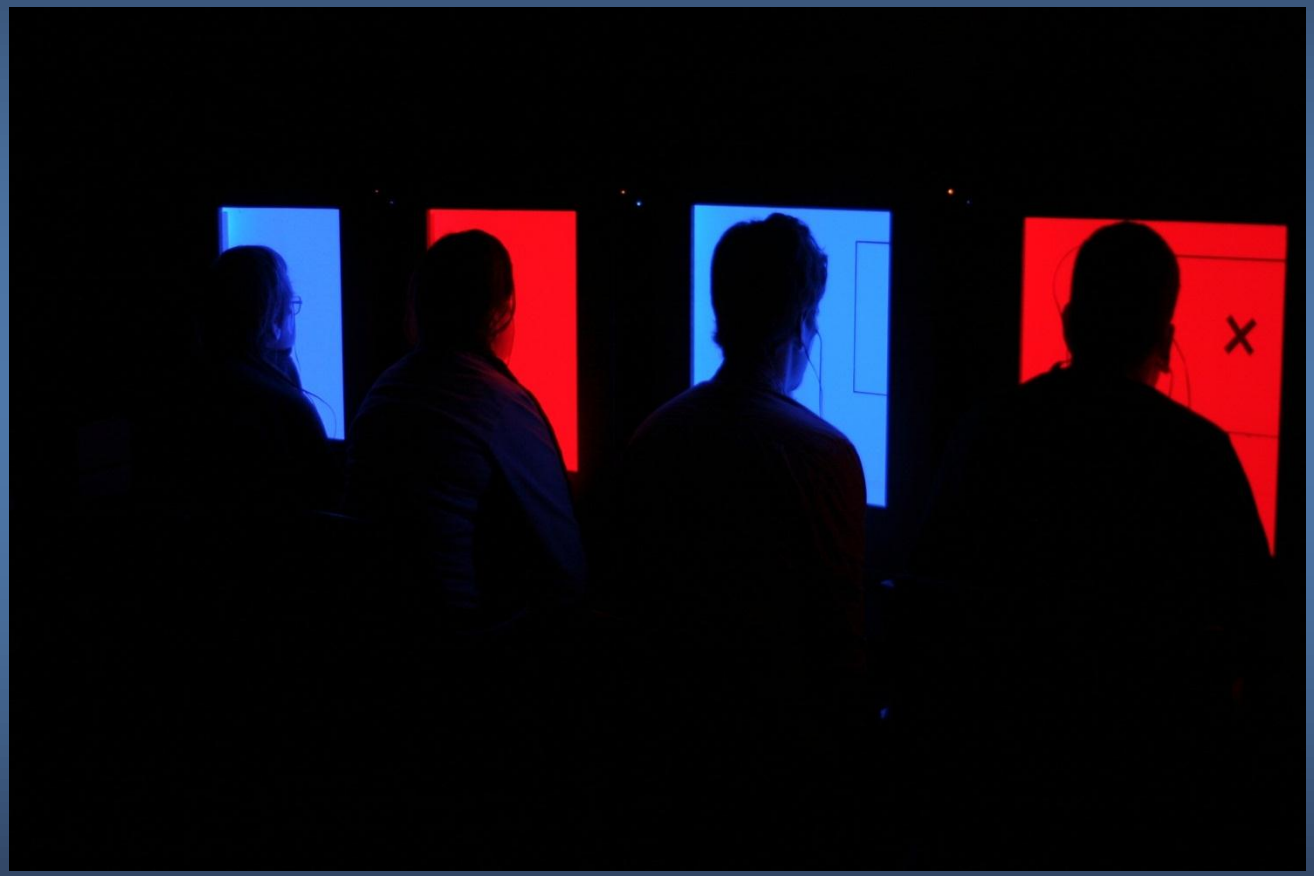
Figueiro, M. G. (2015). Individually tailored light intervention through closed eyelids to promote circadian alignment and sleep health. *Sleep Health: Journal of the National Sleep Foundation, 1*(1), 75-82.

Sponsor: National Institute on Aging (R01AG042602)

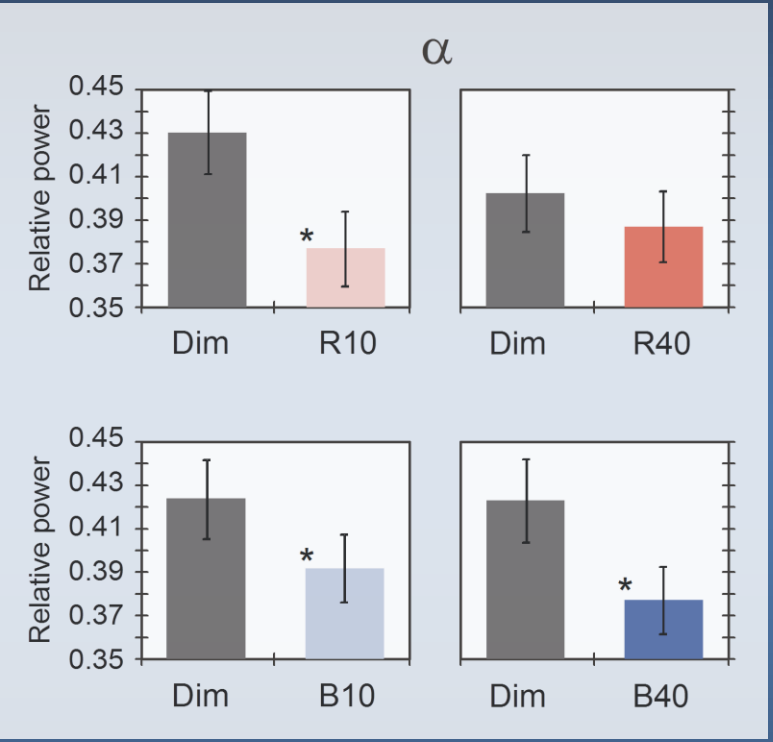
Summary

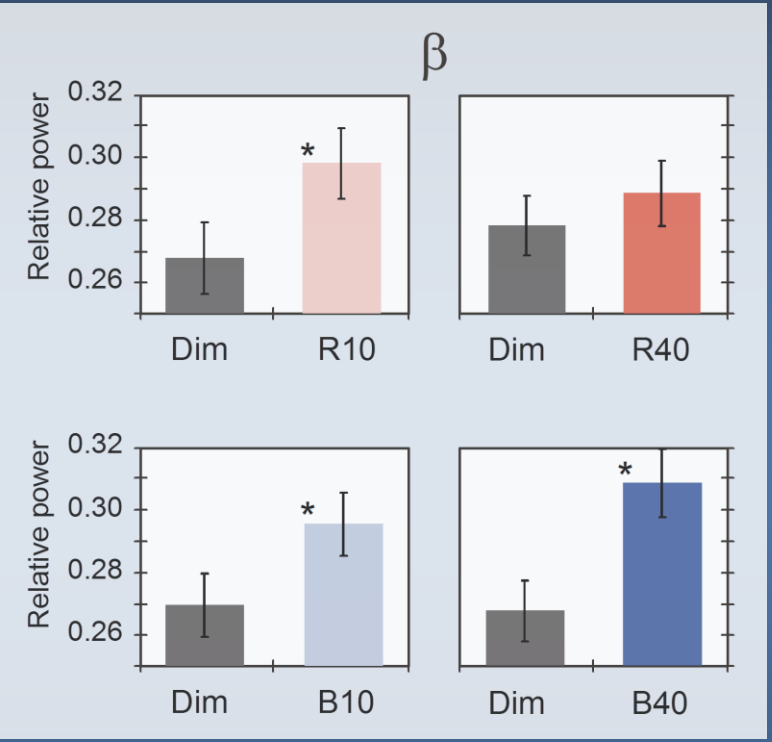
- Intensity and spectrum matters!
  - Light is the major synchronizer of circadian rhythms to the local time on Earth
  - Melatonin is used as a marker of the circadian clock
  - Short-wavelength (blue) light maximally affects melatonin profiles
  - But light levels are just as important
- Timing matters!
  - Light can also be a disruptor if applied at the wrong time
    - Circadian disruption has been linked to diabetes, obesity and cancer
- Photic history matters!
  - Total light exposure over the course of the day needs to be monitored

It is not just about "blue" light!



"Blue" and "red" lights as alerting stimuli
Nighttime Experiments





α ↓
β
} more alert

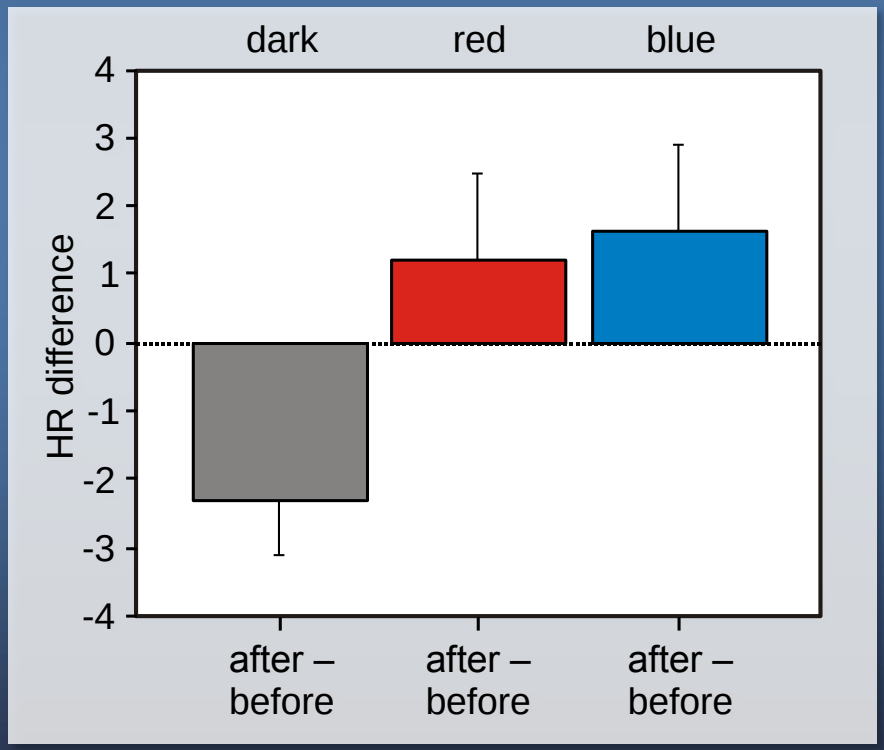
* - statistically significant

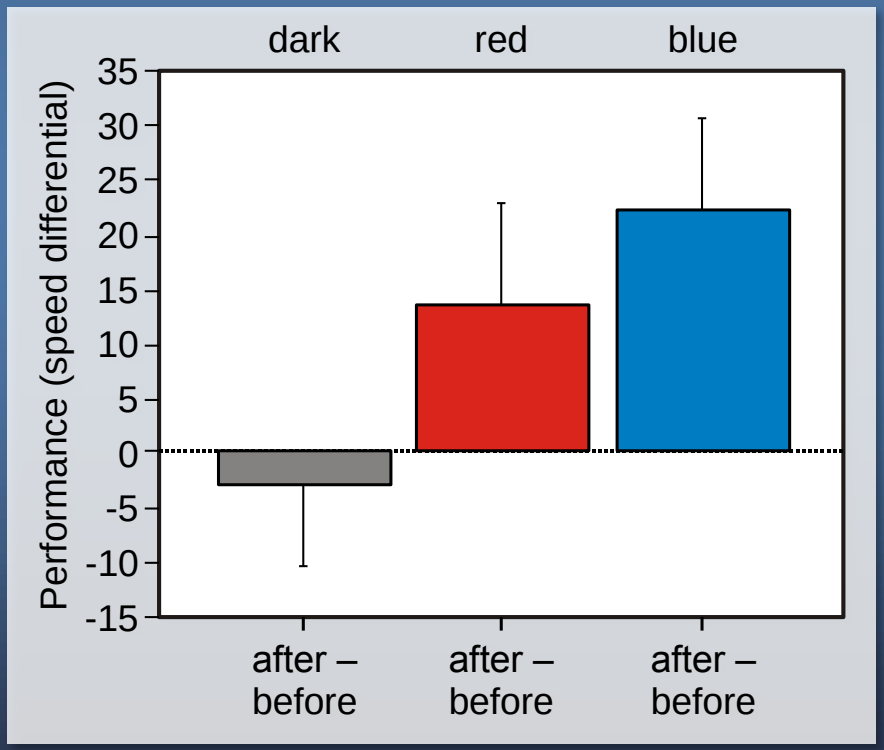
Figueiro, M. G., Bierman, A., Plitnick, B., & Rea, M. S. (2009). Preliminary evidence that both blue and red light can induce alertness at night. *BMC Neuroscience, 10*, 105.

Sponsor: Office of Naval Research

"Blue" and "red" lights as alerting stimuli
Nighttime Experiments

- 40 lux of blue (470-nm) and red (630-nm) lights increased performance and heart rate compared to dim light at night





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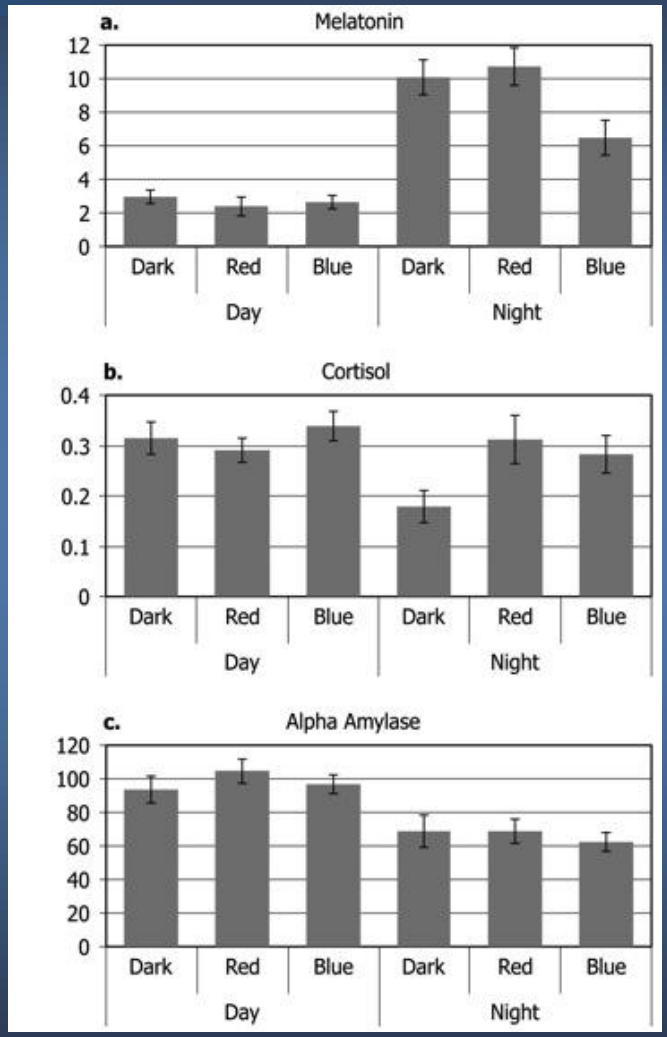
"Blue" and "red" light as alerting stimuli
Nighttime Experiments

- Only short-wavelength (blue) light affected melatonin levels at night
- Both short- (blue) and long-wavelength (red) lights affected cortisol and alpha amylase at night, but in opposite ways

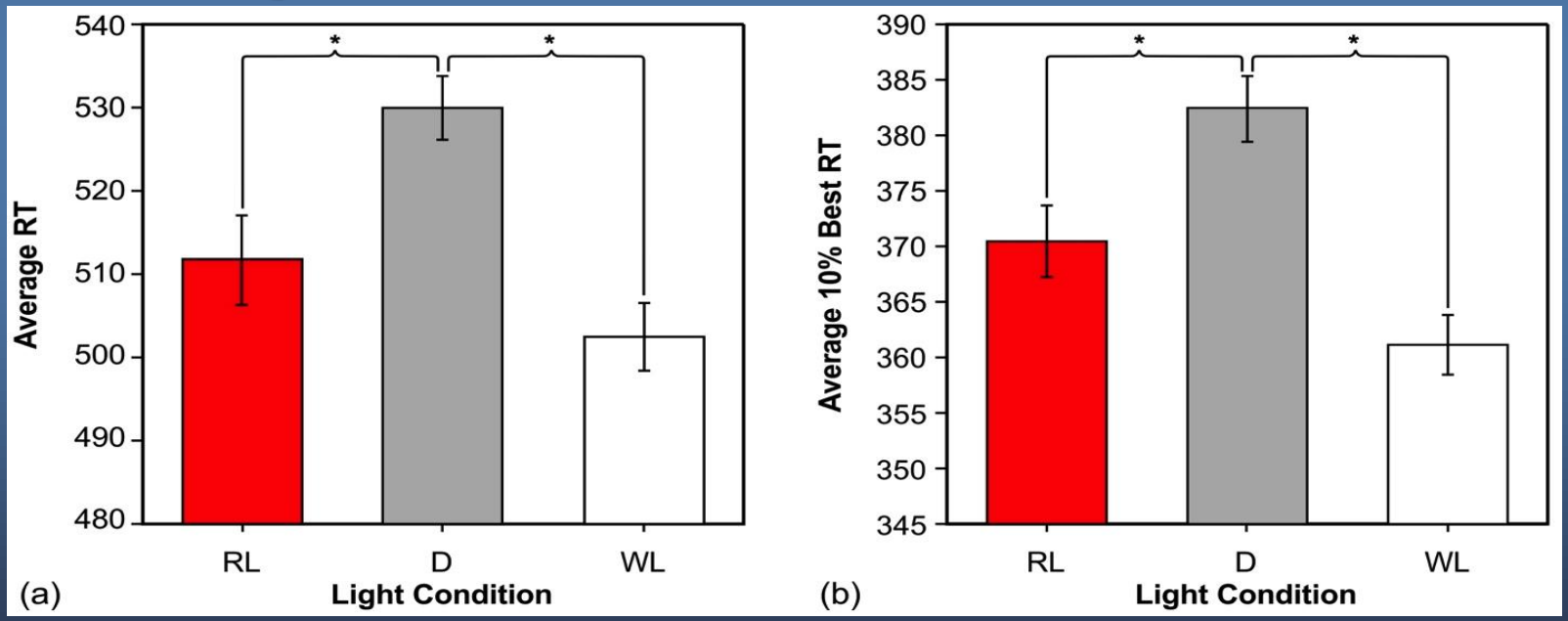


Figueiro, M. G., & Rea, M. S. (2010). The effects of red and blue lights on circadian variations in cortisol, alpha amylase, and melatonin. *International Journal of Endocrinology*, 829351.

Sponsor: Office of Naval Research

"Red" and "white" lights as alerting stimuli
Nighttime Experiments

- Studies showed that red light, which does not suppress nocturnal melatonin can:
  - Improve certain types of performance, similar to white light

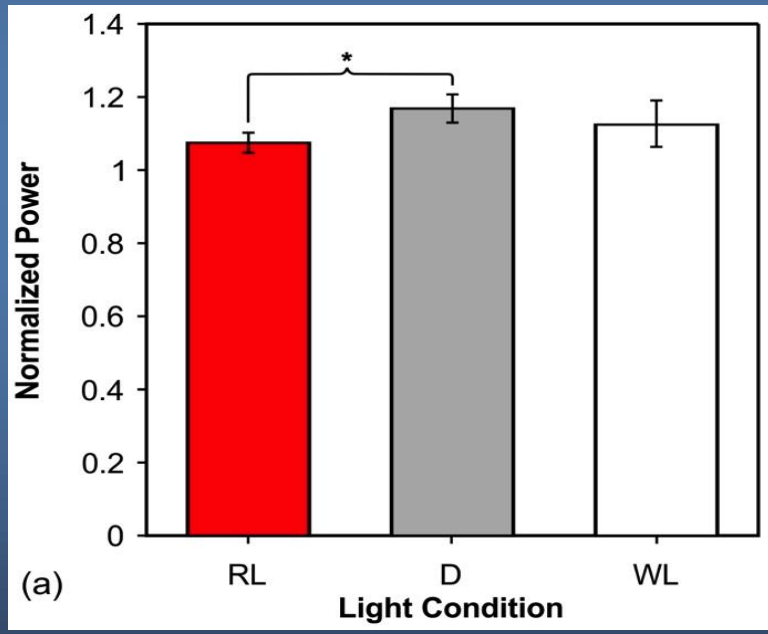


Figueiro, M. G., Sahin, L., Wood, B., & Plitnick, B. (2015). Light at night and measures of alertness and performance: Implications for shift workers. *Biological Research for Nursing, In Press*.

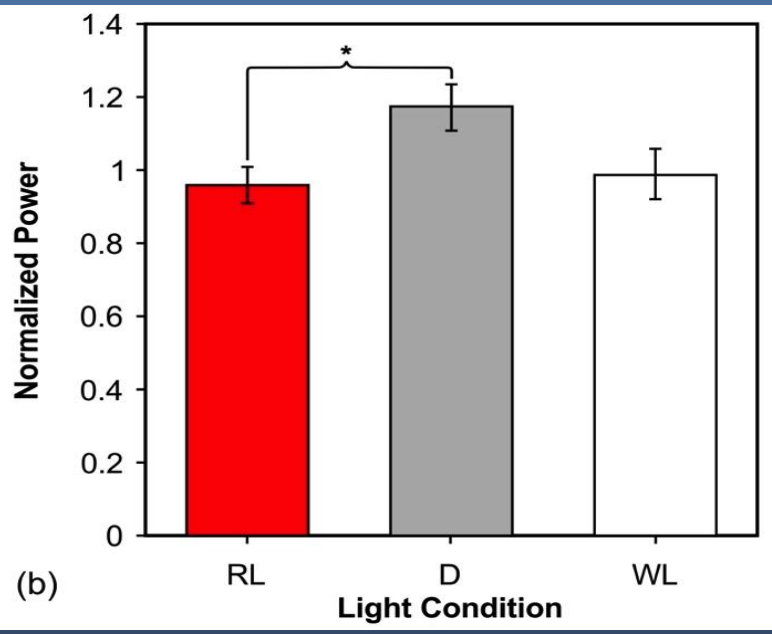
Sponsor: Office of Naval Research

"Red" and "white" lights as alerting stimuli
Nighttime Experiments

- Studies showed that red light, which does not suppress nocturnal melatonin can:
  - Improve subjective and objective measures of alertness



Alpha theta power

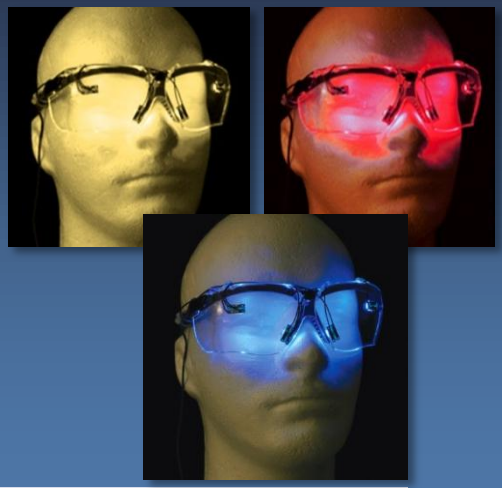


Alpha power

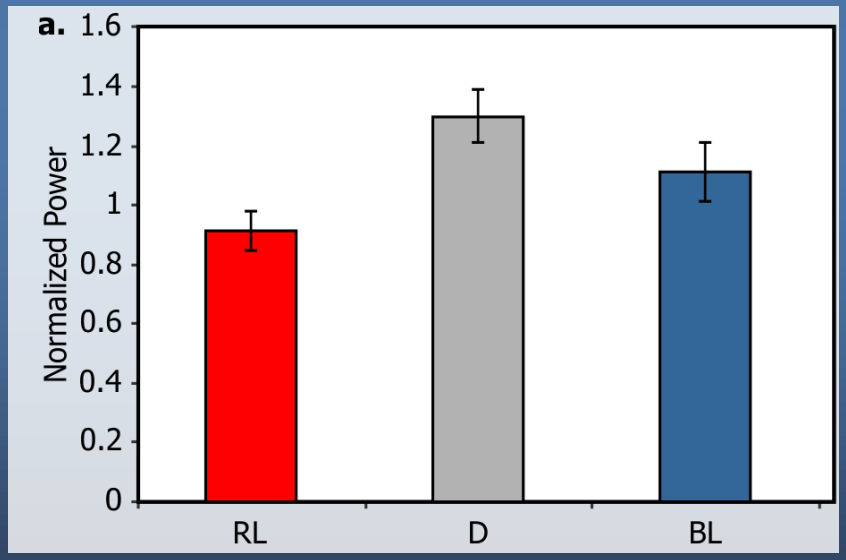
Figueiro, M. G., Sahin, L., Wood, B., & Plitnick, B. (2015). Light at night and measures of alertness and performance: Implications for shift workers. *Biological Research for Nursing, In Press*.

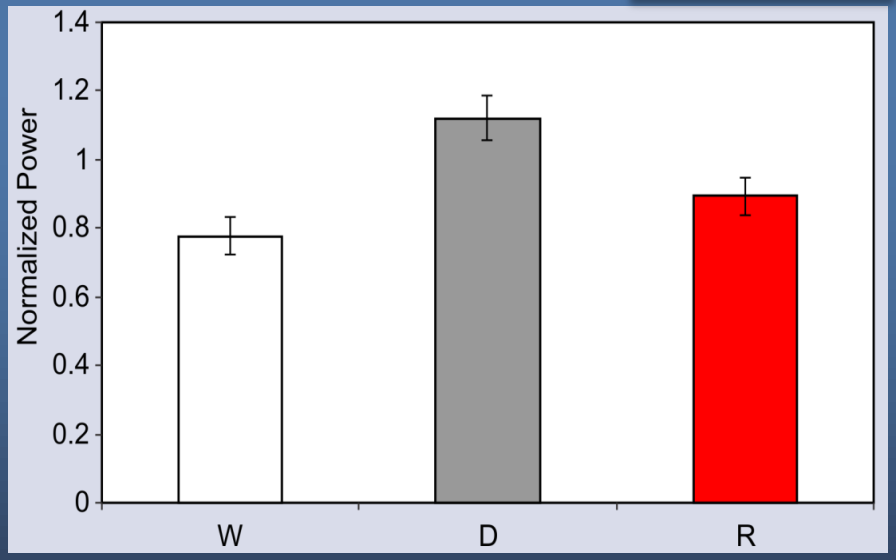
Sponsor: Office of Naval Research

"Red" "blue" and "white" lights as alerting stimuli
Daytime Experiments



- Exposure to 40 lux of long-wavelength light increased alertness in the afternoon
- Exposure to 200 lux of long-wavelength (red) light and 360 lux of 2650 K lights in the afternoon also increased alertness in the afternoon



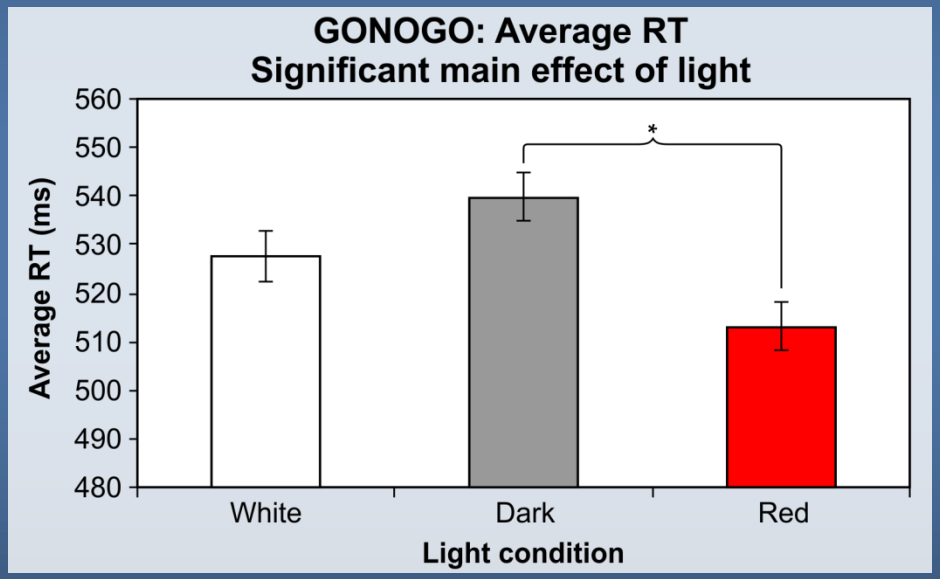


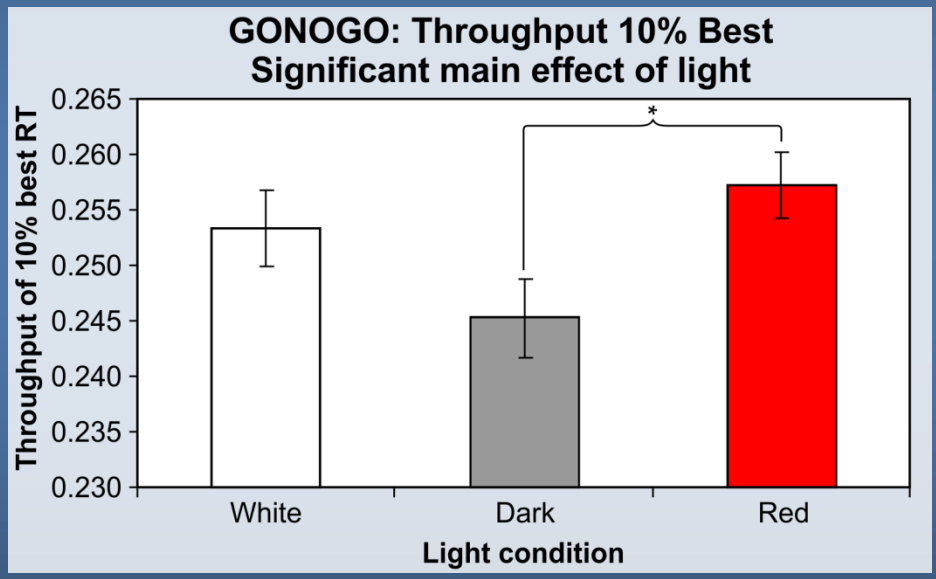
Sponsor: Office of Naval Research (N00014-11-1-0572)

Sahin, L., & Figueiro, M. G. (2013). Alerting effects of short-wavelength (blue) and long-wavelength (red) lights in the afternoon. *Physiology and Behavior, 116-117*, 1-7.
Sahin, L., Wood, B., Plitnick, B., & Figueiro, M. G. (2014). Daytime light exposure: Effects on biomarkers, measures of alertness, and performance. *Behavioural Brain Research, 274*, 176.

"Red" and "white" lights as alerting stimuli
Daytime Experiments

200 lux of long-wavelength (red) and 2650 K lights increase performance in short-term tasks





Sponsor: Office of Naval Research (N00014-11-1-0572)

Sahin, L., Wood, B., Plitnick, B., & Figueiro, M. G. (2014). Daytime light exposure: Effects on biomarkers, measures of alertness, and performance. *Behavioural Brain Research, 274*, 176-185.

It is not just about blue light

- Low to moderate levels of red light (between 40-300 lux at eye level), which does not affect melatonin levels or phase shift the circadian clock was shown to:
  - Improve objective and subjective measures of alertness at night and during the day
  - Improve certain times of performance (reaction times) at night and during the day
  - Increase cortisol levels at night

Applications

- Treatment of mood disorders: Seasonal Affective Disorder (SAD) and non-SAD disorders
  - Mood disorders are associated with alterations in hormone cycles and disturbance of sleep/wake cycles.
  - SAD is distinguished by seasonal depressive episodes.
  - Light treatment is typically given in the morning. Afternoon or evening light therapy may also be considered if morning is inconvenient.

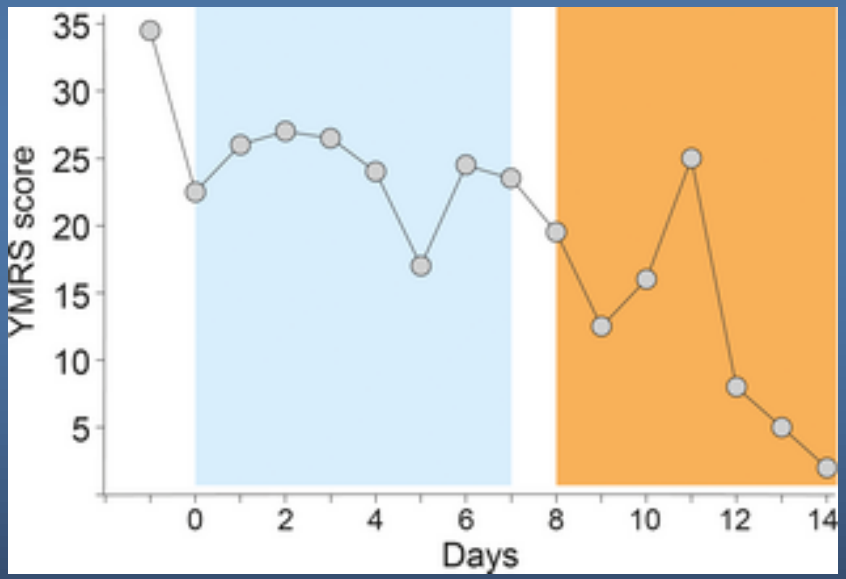
Lam, R. W., Levitt, A. J., Levitan, R. D., Enns, M. W., Morehouse, R., Michalak, E. E., & Tam, E. M. (2006). The Can-SAD study: a randomized controlled trial of the effectiveness of light therapy and fluoxetine in patients with winter seasonal affective disorder. *American Journal of Psychiatry, 163*(5), 805-812.

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, et al. (1984). Seasonal affective disorder: a description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry, 41*(1), 72-80.

Terman, J. S., Terman, M., Lo, E. S., Cooper, T. B. (2001). Circadian time of morning light administration and therapeutic response in winter depression. *Archives of General Psychiatry, 58,* 69–75.

Applications

- Bipolar disorder
  - Use of evening blue blockers increased regularity of sleep and reduced mania symptoms

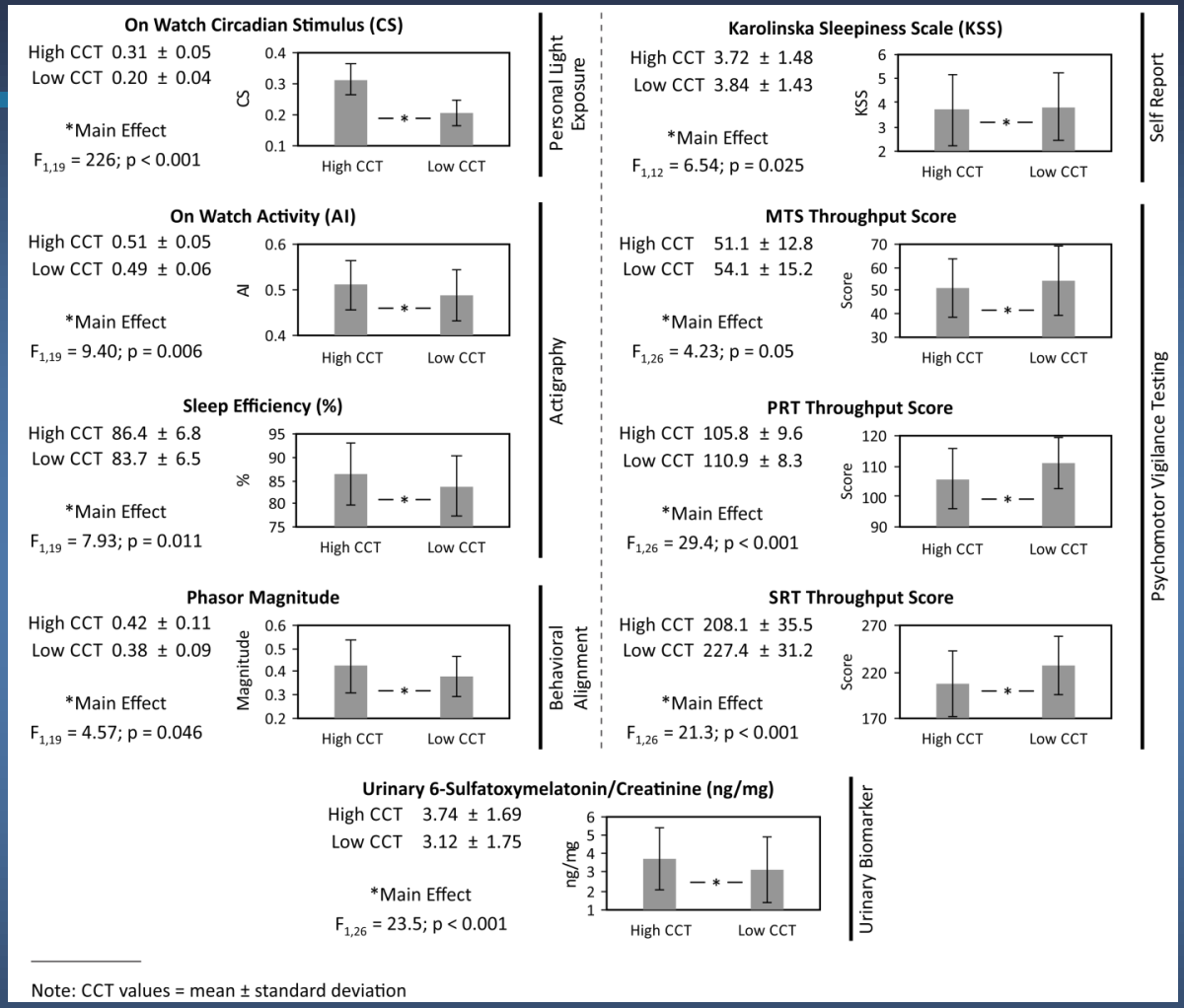


Young Mania Rating Scale (YMRS) scores during the 15 days of hospitalization. The white background represents no glasses used, the blue background represents clear-lensed glasses, and the orange background represents blue-blocking glasses.

Henriksen, T. E. G., Skrede, S., Fasmer, O. B., Hamre, B., Grønli, J., & Lund, A. (2014). Blocking blue light during mania – markedly increased regularity of sleep and rapid improvement of symptoms: a case report. *Bipolar Disorders, 16* (8), 894-898.

Applications

- Lighting in Submarines
  - Combining a 24-hour shift with enhanced circadian light during work resulted in:
    - Better sleep
    - Better alignment of melatonin with sleep
    - Feeling more awake during the work shift
    - Better entrainment of activity-rest with light-dark patterns



Funding: Commander of Submarine Forces, Navy Bureau of Medicine and Surgery, and Office of Naval Research.

Young, C. R., Jones, G. E., Figueiro, M. G., et al. (2015). At-Sea Trial of 24-h-Based Submarine Watchstanding Schedules with High and Low Correlated Color Temperature Light Sources. *Journal of Biological Rhythms, 30*(2), 144-154.

Applications

- Delayed sleep phase disorder (DSPD)
  - Common in adolescents and young adults
  - Delayed bedtime, inability to entrain to daytime schedule
  - Light treatment in morning (after MCBT), light restriction in evening

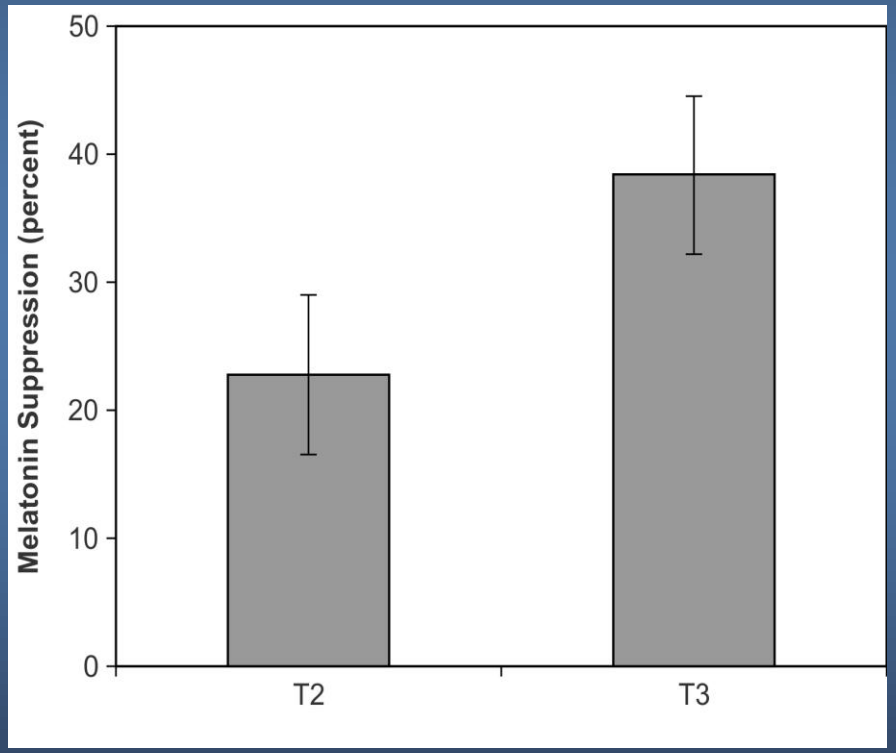
Cole, R. J., Smith, J. S., Alcala, Y. C., Elliott, J. A., & Kripke, D. F. (2002). Bright-light mask treatment of delayed sleep phase syndrome. *Journal of Biological Rhythms, 17*(1), 89-101.

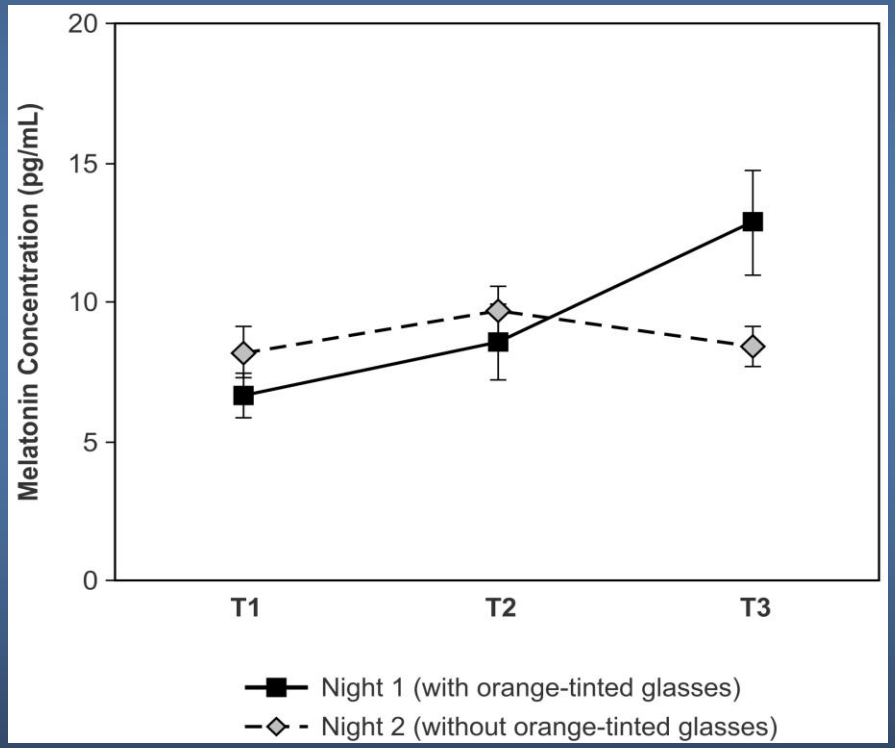
Lack, L., Bramwell, T., Wright, H., & Kemp, K. (2007). Morning blue light can advance the melatonin rhythm in mild delayed sleep phase syndrome. *Sleep and Biological Rhythms, 5*(1), 78-80.

Rosenthal, N. E., Joseph-Vanderpool, J. R., Levendosky, A. A., Johnston, S. H., Allen, R., Kelly, K. A., et al. (1990). Phase-shifting effects of bright morning light as treatment for delayed sleep phase syndrome. *Sleep, 13*(4), 354-361.

Evening light and melatonin suppression

Delayed sleep phase disorder (DSPD)





Applications

Applications

- Circadian rhythm sleep disorder: Shift work type
  - Light therapy may align circadian rhythm with work schedule
  - Light therapy can provide alerting effect at night
  - Suppression of melatonin by light at night (LAN) is correlated with increased breast cancer risk

Boivin, D. B., & James, F. O. (2005). Light treatment and circadian adaptation to shift work. *Industrial Health, 43*(1), 34-48.

Czeisler, C. A., Johnson, M. P., Duffy, J. F., Brown, E. N., Ronda, J. M., & Kronauer, R. E. (1990). Exposure to bright light and darkness to treat physiologic maladaptation to night work. *New England Journal of Medicine, 322*(18), 1253-1259.

Lee, C., Smith, M. R., & Eastman, C. I. (2006). A compromise phase position for permanent night shift workers: circadian phase after two night shifts with scheduled sleep and light/dark exposure. *Chronobiology International, 23*(4), 859-875.

Smith, M., Cullnan, E., & Eastman, C. (2008). Shaping the light/dark pattern for circadian adaptation to night shift work. *Physiology & Behavior*, *95*(3), 449–456.

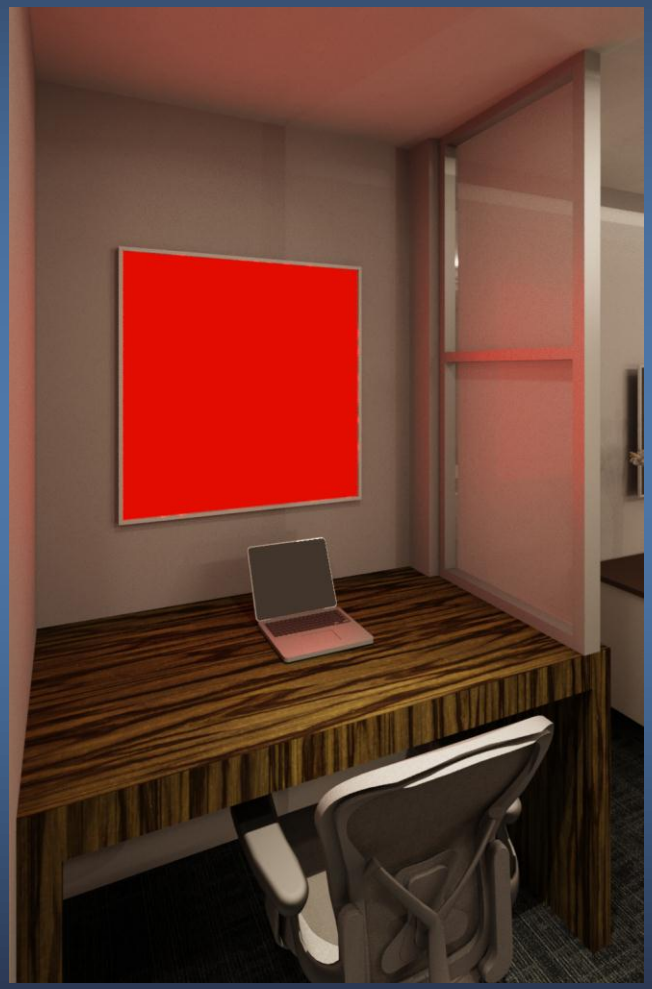
Smith, M. R., Fogg, L. F., & Eastman, C. I. (2009). A compromise circadian phase position for permanent night work improves mood, fatigue, and performance. *Sleep, 32*(11), 1481-1489.

Yoon, I. Y., Jeong, D. U., Kwon, K. B., Kang, S. B., & Song, B. G. (2002). Bright light exposure at night and light attenuation in the morning improve adaptation of night shift workers. *Sleep, 25*(3), 351-356.

Applications

- Promote entrainment or increase acute alertness in dayshift workers
  - Morning light can promote entrainment
  - Morning light can increase cortisol awakening response
  - Light can provide alerting effect during the day, especially during the post-lunch dip hours
  - High levels of circadian light during the daytime may reduce impact of light at night on acute melatonin suppression

Lighting to promote alertness in daytime and rotating shift workers



Applications

- Older adults, including those with Alzheimer's disease or other dementia (ADRD)
  - Disturbance in circadian rhythms due to deteriorating SCN function, reduced exposure to light and impaired visual perception
  - Prolonged wakefulness at night, compensated by daytime sleep
  - Robust light/dark pattern may minimize depression and make circadian rhythms more robust

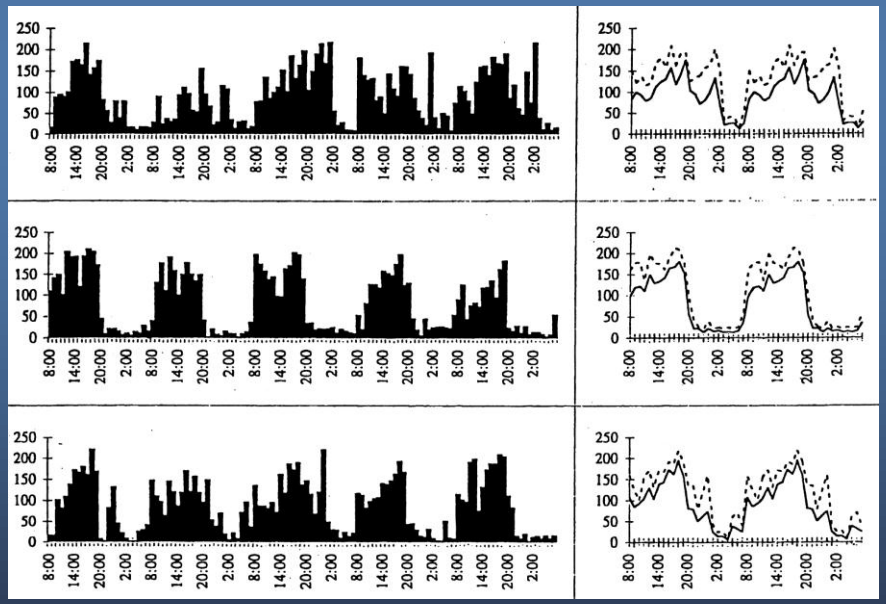
Ancoli-Israel, S., Martin, J. L., Gehrman, P., Shochat, T., Corey-Bloom, J., Marler, M., et al. (2003). Effect of light on agitation in institutionalized patients with severe Alzheimer disease. *American Journal of Geriatric Psychiatry, 11*(2), 194-203.

Riemersma-van der Lek, R. F., Swaab, D. F., Twisk, J., Hol, E. M., Hoogendijk, W. J., & Van Someren, E. J. (2008). Effect of bright light and melatonin on cognitive and noncognitive function in elderly residents of group care facilities: a randomized controlled trial. *JAMA, 299*(22), 2642-2655.

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

Light therapy for persons with dementia

- Alzheimer's patients exposed to 1136 ±89 lux at the eye during the entire day showed an improvement in the circadian rest-activity rhythms disturbances
- Riemersma-van der Lek et al. 2008 showed that long term (up to 3.5 years) light therapy delivered to patients with dementia
  - Attenuated cognitive deterioration by 5%
  - Ameliorated depressive symptoms by 19%
  - Attenuated the increase in functional limitations over time by 53%

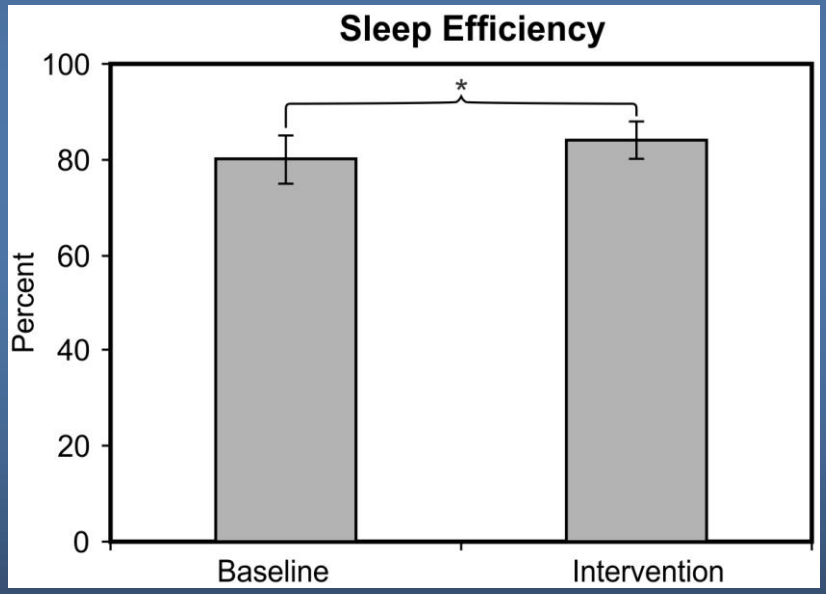


Riemersma-van der Lek, R. F., Swaab, D. F., Twisk, J., Hol, E. M., Hoogendijk, W. J., & Van Someren, E. J. (2008). Effect of bright light and melatonin on cognitive and noncognitive function in elderly residents of group care facilities: a randomized controlled trial. *JAMA, 299*(22), 2642-2655.

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

Light therapy for persons with dementia
High correlated color temperature light

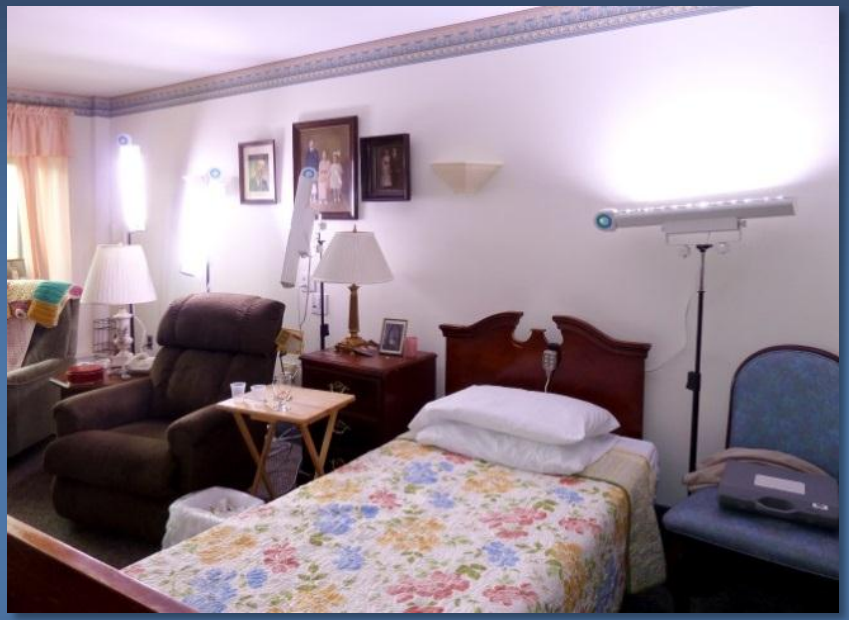
- Sleep efficiency increased from 80% to 84%
- For comparison, in another study, amyloid deposition, as assessed by Aβ42 levels, was present in those who had worse sleep quality, as measured by sleep efficiency (80.4% vs 83.7%)
- Light significantly reduced depression and agitation



Figueiro, M. G., Plitnick, B., Lok, A., Jones, G., Higgins, P., Hornick, T., & Rea, M. S. (2014). Tailored lighting intervention improves measures of sleep, depression and agitation in persons with Alzheimer's disease and related dementia living in long-term care facilities. *Clinical Interventions in Aging, 9*, 1527-1537.

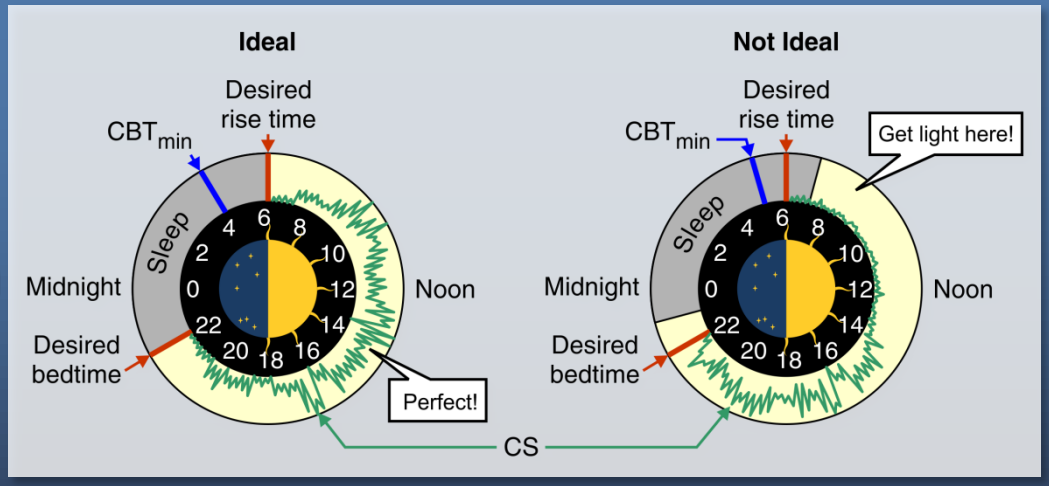
Sponsor: NIH# R01AG034157

Applications



A Model of the Human Circadian Timing Mechanism

- Development of the Daysimeter and a model of the SCN's limit cycle oscillator helps the LRC to "write a prescription" so that a person can receive a light-dark pattern that matches their desired rise and sleep times
  - A biological watch may track a person's circadian time and provide a recommendation for when to receive or avoid light

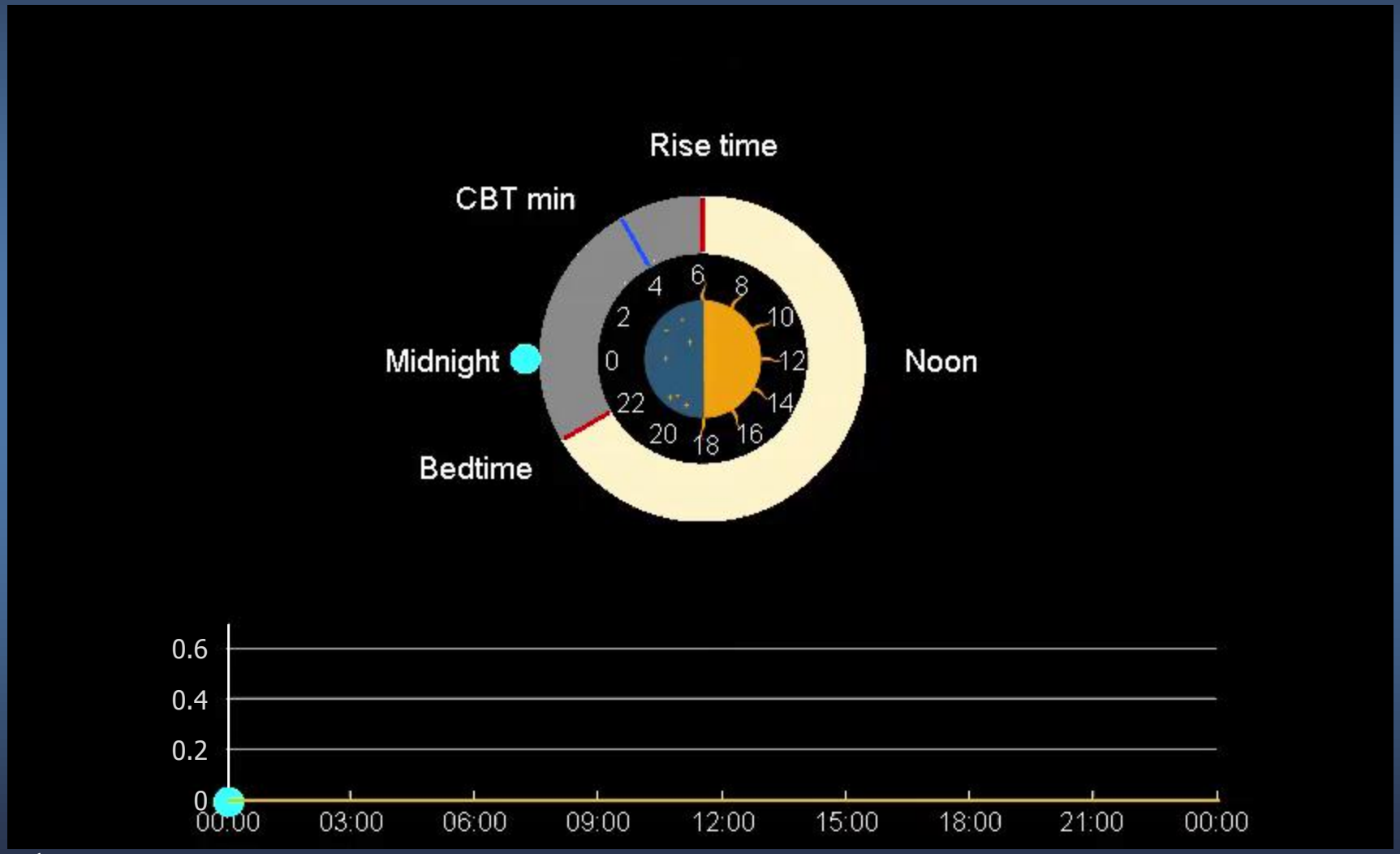


Sponsors:
National Institute on Aging (R01AG034157)
National Institute on Drug Abuse (U01DA023822)
Office of Naval Research (N00014-11-1-0572)
Army Research Office through IAI

Rea, M. S., Bierman, A., Ward, G., & Figueiro, M. G. (2014). Field tests of a model of the human circadian oscillator. Paper presented at the SLEEP 2014 Conference, Minneapolis, MN.

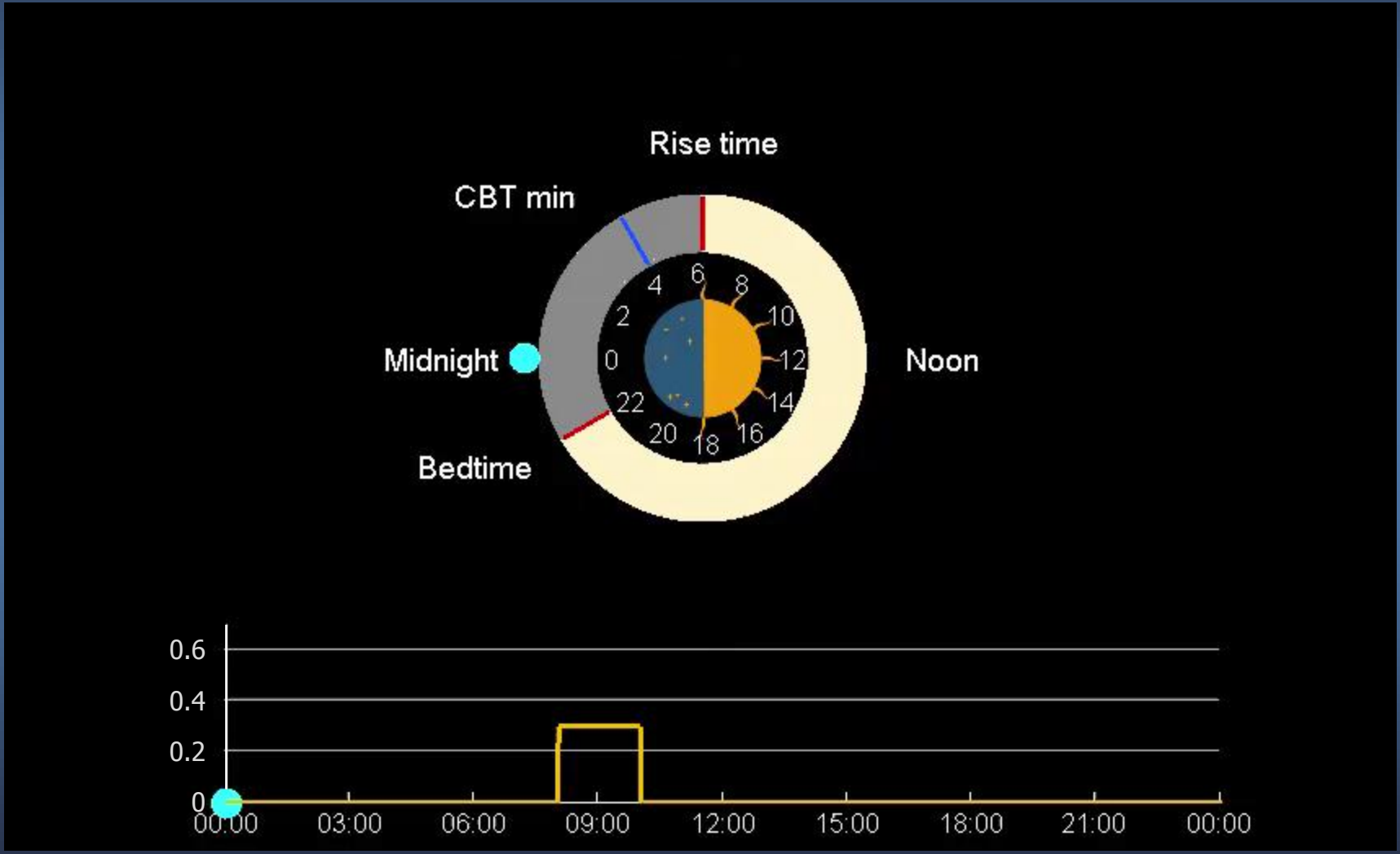
Earth dark

- [x] Earth dark
- [ ] Earth morning pulse
- [ ] Earth evening pulse
- [ ] Typical light profile
- [ ] Earth Swedish summer
- [ ] Earth Swedish winter



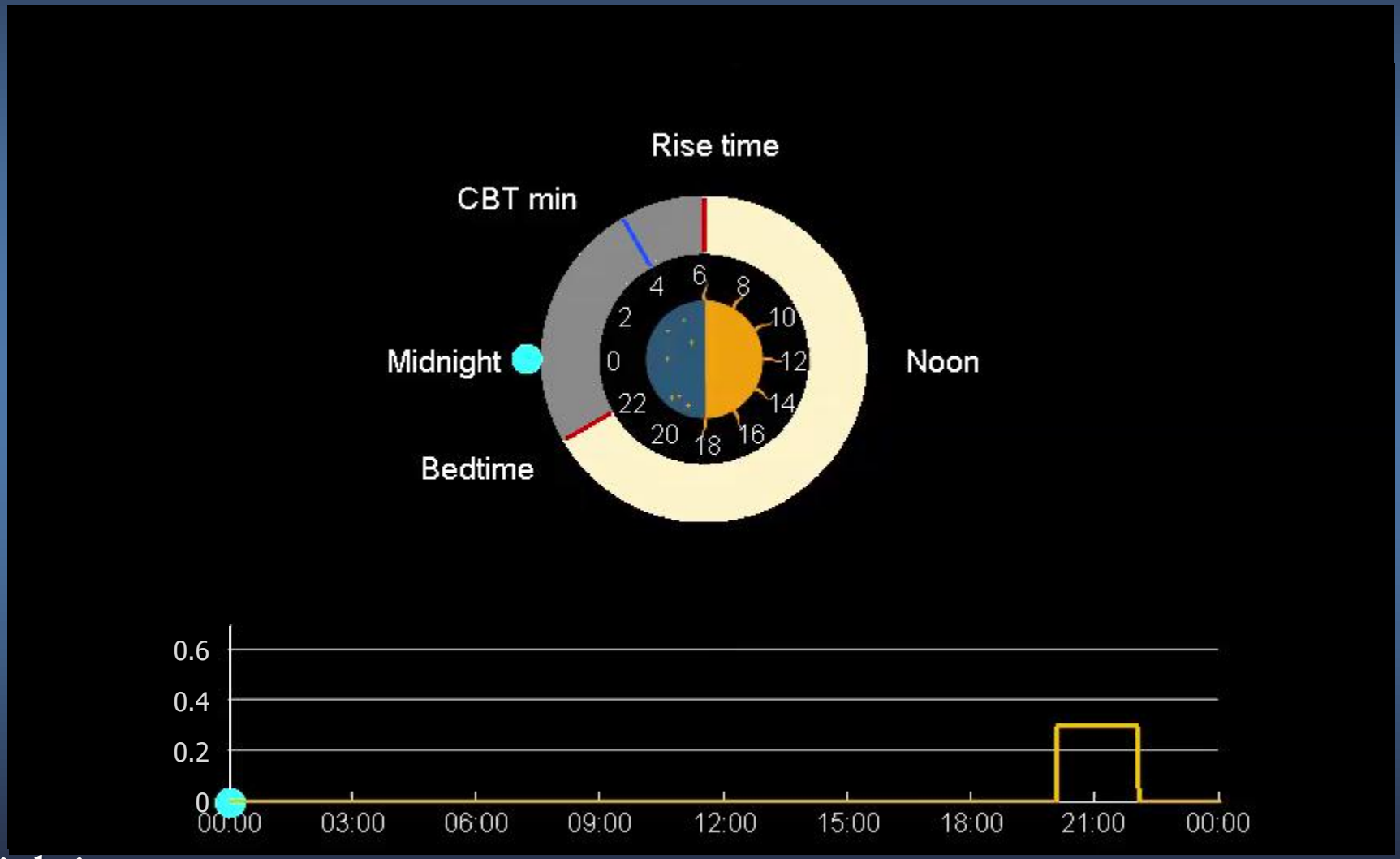
Earth morning pulse

- Earth dark
- Earth morning pulse
- Earth evening pulse
- Typical light profile
- Earth Swedish summer
- Earth Swedish winter



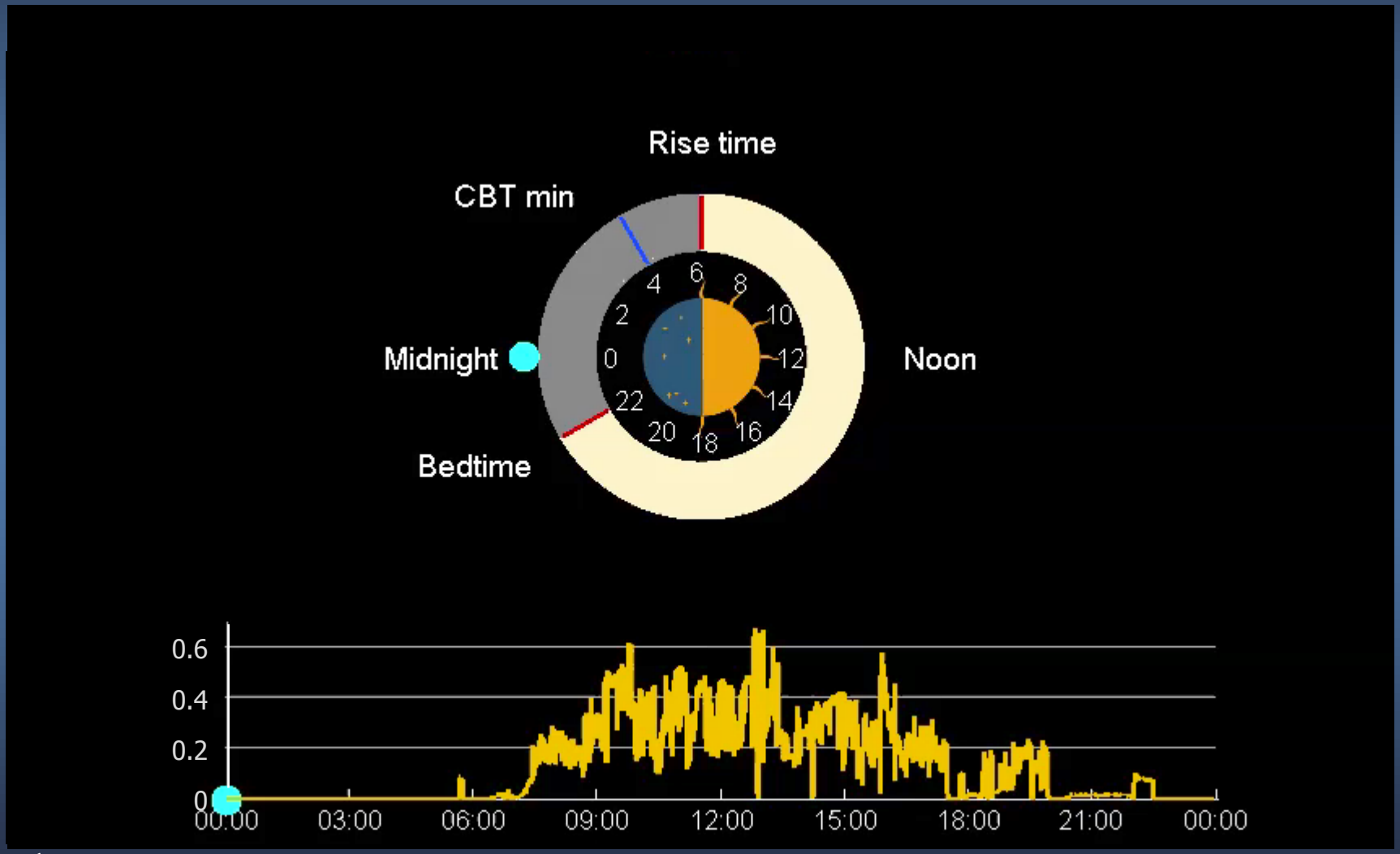
Earth evening pulse

- Earth dark
- Earth morning pulse
- Earth evening pulse
- Typical light profile
- Earth Swedish summer
- Earth Swedish winter



Typical light profile

- Earth dark
- Earth morning pulse
- Earth evening pulse
- Typical light profile
- Earth Swedish summer
- Earth Swedish winter



The Swedish Healthy Home

Light Logger

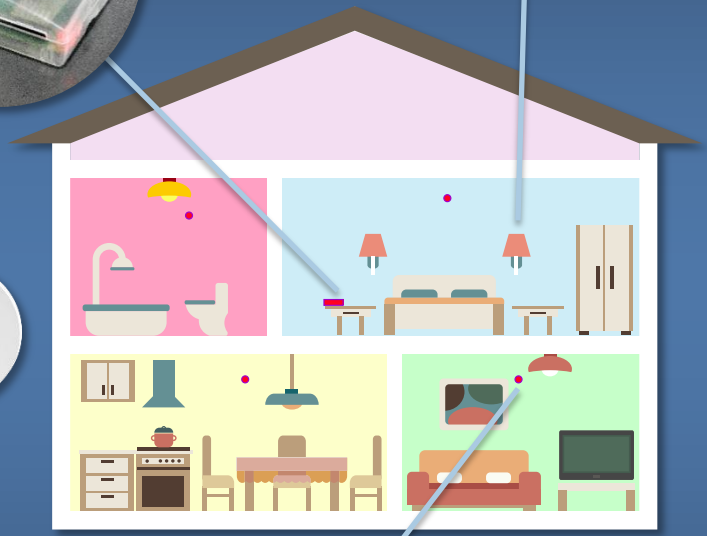
Activity Logger

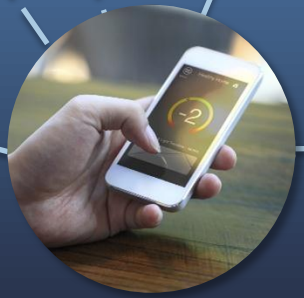
Scene Composer and ZigBee Coordinator

Hub Server

ZigBee-Enabled LED Lamps

Internet





Location Sensing App

Treatment Scheduling App

iBeacons

Sponsor: The Swedish Energy Agency
Collaborator: Lund University and IAI, Inc.

Lighting Research Center

Rensselaer

Summary

- Therapeutic light treatments have been shown to be effective at treating circadian related disorders
  - Light is a recognized treatment for Seasonal Affective Disorder
  - Lighting for older adults/dementia patients: ready for applications
  - Lighting for shift work: laboratory data are available, but they need to be tested in the field
  - Lighting for the general population: no claims can be made yet on how light affects performance, but light has a strong acute alerting effect on objective and subjective measures of alertness during the day
    - We are moving to a more "individualized" lighting solution

Take home messages

- Morning light will help you maintain entrainment and will help you go to sleep earlier while evening light will delay the timing of your sleep
- Light can also serve as a "cup of coffee" and increase alertness during the day and at night
  - But it is not just blue light!
- Self-luminous displays should have the potential to suppress melatonin in the evening and delay sleep
  - Turn them off 2 h prior to desired bedtimes
  - Reduce brightness of screen
  - Reverse polarity (black background and white fonts)
  - Get a lot of light during the day – go outdoors

Take home messages

- Disruption of circadian rhythms by exposure to too much light at night and/or too little light during the day can disrupt sleep and circadian rhythms
  - Circadian disruption has been associated with health risks, including diabetes, obesity, cancer and cardiovascular disease
- Indoor light, especially home lighting, may be too dim during the day and too bright at night
- Keep a regular schedule; go for a walk in the morning at the same time every day
- A "boring life" may be a "healthy life"

Thank you!

www.lrc.rpi.edu

http://www.lrc.rpi.edu/programs/lighthealth/

http://www.lrc.rpi.edu/resources/CircadianStimulusCalculator_May2015.xlsx

Lighting Research Center

Rensselaer

References

Ancoli-Israel, S., Martin, J. L., Gehrman, P., Shochat, T., Corey-Bloom, J., Marler, M., . . . Levi, L. (2003). Effect of light on agitation in institutionalized patients with severe Alzheimer disease. *American Journal of Geriatric Psychiatry, 11*(2), 194-203.

Boivin, D. B., Duffy, J. F., Kronauer, R. E., & Czeisler, C. A. (1996). Dose-response relationships for resetting of human circadian clock by light. *Nature, 379*(6565), 540.

Boivin, D. B., & James, F. O. (2005). Light treatment and circadian adaptation to shift work. *Industrial Health, 43*(1), 34-48.

Cole, R. J., Smith, J. S., Alcala, Y. C., Elliott, J. A., & Kripke, D. F. (2002). Bright-light mask treatment of delayed sleep phase syndrome. *Journal of Biological Rhythms, 17*(1), 89-101.

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Du-Quiton, J., Wood, P. A., Burch, J. B., Grutsch, J. F., Gupta, D., Tyer, K., . . . Reynolds, J. L. (2010). Actigraphic assessment of daily sleep–activity pattern abnormalities reflects self-assessed depression and anxiety in outpatients with advanced non-small cell lung cancer. *Psycho-Oncology, 19*(2), 180-189.

Eismann, E. A., Lush, E., & Sephton, S. E. (2010). Circadian effects in cancer-relevant psychoneuroendocrine and immune pathways. *Psychoneuroendocrinology, 35*(7), 963-976.

Figueiro, M. G. (2015). Individually tailored light intervention through closed eyelids to promote circadian alignment and sleep health. *Sleep Health: Journal of the National Sleep Foundation, 1*(1), 75-82.

Figueiro, M. G., Bierman, A., Plitnick, B., & Rea, M. S. (2009). Preliminary evidence that both blue and red light can induce alertness at night. *BMC Neuroscience, 10*, 105.

Figueiro, M. G., Plitnick, B., Lok, A., Jones, G., Higgins, P., Hornick, T., & Rea, M. S. (2014). Tailored lighting intervention improves measures of sleep, depression and agitation in persons with Alzheimer's disease and related dementia living in long-term care facilities. *Clinical Interventions in Aging, 9*, 1527-1537.

References

Figueiro, M. G., Plitnick, B., & Rea, M. S. (2014). The effects of chronotype, sleep schedule and light/dark pattern exposures on circadian phase. *Sleep Medicine, 15*(12), 1554–1564.

Figueiro, M. G., & Rea, M. S. (2010). The effects of red and blue lights on circadian variations in cortisol, alpha amylase, and melatonin. *International Journal of Endocrinology, 2010*, 829351.

Figueiro, M. G., Sahin, L., Wood, B., & Plitnick, B. (2015). Light at night and measures of alertness and performance: Implications for shift workers. *Biological Research for Nursing, In Press*.

Figueiro, M. G., Wood, B., Plitnick, B., & Rea, M. S. (2011). The impact of light from computer monitors on melatonin levels in college students. *Neuroendocrinology Letters, 32*(2), 158-163.

Figueiro, M. G., Wood, B., Plitnick, B., & Rea, M. S. (2013). The impact of watching television on evening melatonin levels. *Journal of the Society for Information Display, 21*(10), 417-421.

Hansen, J. (2006). Risk of breast cancer after night-and shift work: current evidence and ongoing studies in Denmark. *Cancer Causes & Control, 17*(4), 531-537.

Henriksen, T. E. G., Skrede, S., Fasmer, O. B., Hamre, B., Grønli, J., & Lund, A. (2014). Blocking blue light during mania – markedly increased regularity of sleep and rapid improvement of symptoms: a case report. *Bipolar Disorders, 16*(8), 894-898.

Kageyama, T., Kobayashi, T., Nishikido, N., Oga, J., & Kawashima, M. (2005). Associations of sleep problems and recent life events with smoking behaviors among female staff nurses in Japanese hospitals. *Industrial Health, 43*(1), 133-141.

Kreier, F., Kalsbeek, A., Sauerwein, H. P., Fliers, E., Romijn, J. A., & Buijs, R. M. (2007). "Diabetes of the elderly" and type 2 diabetes in younger patients: Possible role of the biological clock. *Experimental Gerontology, 42*(1), 22-27.

Lack, L., Bramwell, T., Wright, H., & Kemp, K. (2007). Morning blue light can advance the melatonin rhythm in mild delayed sleep phase syndrome. *Sleep and Biological Rhythms, 5*(1), 78-80.

Lam, R. W., Levitt, A. J., Levitan, R. D., Enns, M. W., Morehouse, R., Michalak, E. E., & Tam, E. M. (2006). The Can-SAD study: a randomized controlled trial of the effectiveness of light therapy and fluoxetine in patients with winter seasonal affective disorder. *American Journal of Psychiatry, 163*(5), 805-812.

References

Lee, C., Smith, M. R., & Eastman, C. I. (2006). A compromise phase position for permanent night shift workers: circadian phase after two night shifts with scheduled sleep and light/dark exposure. *Chronobiology International, 23*(4), 859-875.

Maemura, K., Takeda, N., & Nagai, R. (2007). Circadian rhythms in the CNS and peripheral clock disorders: role of the biological clock in cardiovascular diseases. *Journal of Pharmacological Sciences, 103*(2), 134-138.

Rajaratnam, S. M. W., & Arendt, J. (2001). Health in a 24-h society. *The Lancet, 358*(9286), 999-1005.

Rea, M. S., Bierman, A., Ward, G., & Figueiro, M. G. (2014). *Field tests of a model of the human circadian oscillator*. Paper presented at the SLEEP 2014 Conference, Minneapolis, MN.

Rea, M. S., Figueiro, M. G., Bierman, A., & Hamner, R. (2012). Modelling the spectral sensitivity of the human circadian system. *Lighting Research and Technology, 44*(4), 386-396.

Rea, M. S., Figueiro, M. G., Bullough, J. D., & Bierman, A. (2005). A model of phototransduction by the human circadian system. *Brain Research Reviews, 50*(2), 213-228.

Riemersma-van der Lek, R. F., Swaab, D. F., Twisk, J., Hol, E. M., Hoogendijk, W. J., & Van Someren, E. J. (2008). Effect of bright light and melatonin on cognitive and noncognitive function in elderly residents of group care facilities: a randomized controlled trial. *JAMA, 299*(22), 2642-2655.

Rosenthal, N. E., Joseph-Vanderpool, J. R., Levendosky, A. A., Johnston, S. H., Allen, R., Kelly, K. A., . . . Starz, K. E. (1990). Phase-shifting effects of bright morning light as treatment for delayed sleep phase syndrome. *Sleep, 13*(4), 354-361.

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, Y., . . . Wehr, T. A. (1984). Seasonal affective disorder: a description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry, 41*(1), 72-80.

Sahin, L., & Figueiro, M. G. (2013). Alerting effects of short-wavelength (blue) and long-wavelength (red) lights in the afternoon. *Physiology and Behavior, 116-117*, 1-7.

Sahin, L., Wood, B., Plitnick, B., & Figueiro, M. G. (2014). Daytime light exposure: Effects on biomarkers, measures of alertness, and performance. *Behavioural Brain Research, 274*, 176-185.

References

Schernhammer, E. S., Laden, F., Speizer, F. E., Willett, W. C., Hunter, D. J., Kawachi, I., & Colditz, G. A. (2001). Rotating night shifts and risk of breast cancer in women participating in the Nurses' Health Study. *Journal of the National Cancer Institute, 93*(20), 1563-1568.

Smith, M. R., Cullnan, E. E., & Eastman, C. I. (2008). Shaping the light/dark pattern for circadian adaptation to night shift work. *Physiology and Behavior, 95*(3), 449-456.

Smith, M. R., Fogg, L. F., & Eastman, C. I. (2009). A compromise circadian phase position for permanent night work improves mood, fatigue, and performance. *Sleep, 32*(11), 1481-1489.

Terman, J. S., Terman, M., Lo, E. S., Cooper, T. B. (2001). Circadian time of morning light administration and therapeutic response in winter depression. *Archives of General Psychiatry, 58*, 69-75.

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

Wood, B., Rea, M. S., Plitnick, B., & Figueiro, M. G. (2013). Light level and duration of exposure determine the impact of self-luminous tablets on melatonin suppression. *Applied Ergonomics, 44*(2), 237-240.

Yoon, I. Y., Jeong, D. U., Kwon, K. B., Kang, S. B., & Song, B. G. (2002). Bright light exposure at night and light attenuation in the morning improve adaptation of night shift workers. *Sleep, 25*(3), 351-356.

Young, C. R., Jones, G. E., Figueiro, M. G., Soutière, S. E., Keller, M. W., Richardson, A. M., . . . Rea, M. S. (2015). At-Sea Trial of 24-h-Based Submarine Watchstanding Schedules with High and Low Correlated Color Temperature Light Sources. *Journal of Biological Rhythms, 30*(2), 144-154.

Young, M. E., & Bray, M. S. (2007). Potential role for peripheral circadian clock dyssynchrony in the pathogenesis of cardiovascular dysfunction. *Sleep Medicine, 8*(6), 656-667.

Zeitzer, J. M., Dijk, D.-J., Kronauer, R., Brown, E. N., & Czeisler, C. A. (2000). Sensitivity of the human circadian pacemaker to nocturnal light: melatonin phase resetting and suppression. *Journal of Physiology, 526*(3), 695-702.

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