

# Bright Light

## A White Paper



Jacqueline Olds, M.D.  
Richard Schwartz, M.D.



# Contents

- 1 Light and the Circadian Rhythm
- 4 Light Therapy
- 6 Timing, Brightness, and Wavelength
- 8 Bright Light and SunSprite
- 10 References

## Authors

---

Jacqueline Olds, M.D. & Richard Schwartz, M.D.



Both Jacquie and Richard are psychiatrists, psychoanalysts, authors, and award-winning teachers. They are Associate Professors of Psychiatry, Part-Time, and on the Faculty of the Massachusetts General Hospital-McLean Hospital Psychiatry Residency program. They are also married to each other. They first conceived of the idea that would become SunSprite as a way to more simply and effectively bring the health benefits of bright light into the lives of their patients and many others.



# Light and Circadian Rhythm

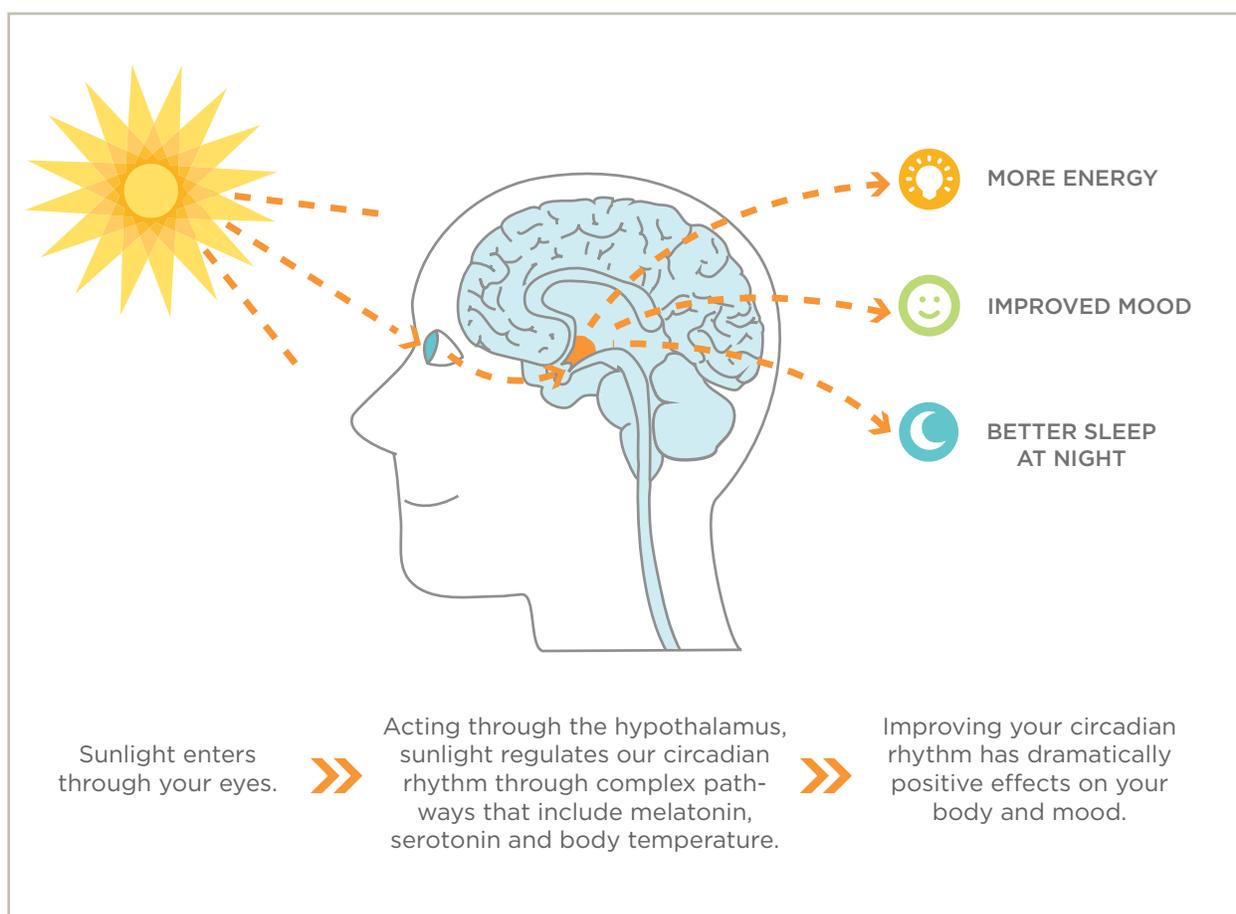
**Light sets the rhythms of our bodies and our minds.** It is the primary time-keeper that synchronizes all our biological processes with the 24 hour cycle of our days. When those rhythms are out of sync, we feel “off.” Jet lag is the most obvious example of what that asynchrony feels like. But it’s more than just a feeling. “Circadian synchronization” improves sleep, mood, alertness, cognitive performance, and wellbeing. And modern life regularly disrupts our circadian rhythms, even when we’re not crossing time zones. The regular cycle of sunlight and darkness that set the internal clocks of our ancestors throughout human history is at best a weak presence in most of our daily lives. The rhythms of light and dark today are often set instead by indoor lighting, computer screens and smartphones. Their timing and their brightness are not what we need to function at our best.

About 25 million Americans suffer from Seasonal Affective Disorder

About 25 million Americans suffer from seasonal affective disorder (SAD). 75 million more experience milder dips in mood during the dark days of winter (1). But the problem of “circadian light deficiency” affects almost all of us. It is a condition of modern life. It is also an economic as well as a personal burden. In the United States, workplace costs of depression (from absenteeism and decreased productivity) are estimated at \$51.5 billion dollars annually (2).



**Light as a biological timekeeper works through the eyes.** (By contrast, the synthesis of vitamin D is a response to ultraviolet radiation reaching the skin.) When bright light enters the eyes, it stimulates specialized receptor cells in the retina that connect to our “master pacemaker” – the paired suprachiasmatic nuclei (SCN) in the hypothalamus. From there, the effects spread – much more widely than we once thought – controlling not only our sleep-wake cycle by regulating secretion and suppression of the hormone melatonin, but the ebbs and flows of biological processes throughout the body.





Here is a brief overview from an article in *Sleep Medicine Reviews*:

**Proper SCN functioning is critical to good health** due to its vital roles including control of sleep-wake cycles, hormonal and metabolic rhythms, and synchronization of internal biological with external geophysical time thereby assuring temporal alignment within and between organs. Without unambiguous SCN signals peripheral organs can become temporally uncoupled resulting in metabolic and biochemical disarray, flattening otherwise robust rhythm amplitudes. (3)

**Internal “chronodisruption” has major impacts on our health and well-being.** Some are well known and some are just beginning to be understood.



# Light Therapy

The therapeutic use of bright light in psychiatry began in 1984 with a groundbreaking study published by a group headed by Norman Rosenthal at the NIMH that first described “seasonal depression” and the use of bright light as an effective antidepressant in 11 patients (4). In 2005, the American Psychiatric Association Council on Research convened a work group to review the subsequent 20 years of research on light therapy for the treatment of mood disorders. Their conclusion was that light therapy was just as effective as antidepressant medication not only for seasonal depression (SAD) but for nonseasonal depression as well (5). Since 2005, further research has found that bright light may also benefit a wide range of medical conditions including insomnia (6), ADHD (7), Parkinson’s disease (8), and dementia (9).

**Light therapy has been found to be just as effective as antidepressant medication.**



**Bright light also improves the health and function of otherwise healthy individuals** who have been “light-deprived,” whether by the dark days of winter or simply too much time indoors. Light is linked to states of alertness and wakefulness (10). Bright light treatment improves vitality and decreases distress in light-deprived office workers (11). A recent study found that adding morning bright light to a weight control program helps reduce body fat and appetite (12). Bright light can lower plasma cortisol levels – a primary marker of physiological stress (13).

**Bright light is linked to states of alertness & wakefulness.**



**New research suggests that an “epidemic” of myopia is the result of children spending too little time outdoors in bright sunlight.** Elementary school children who were assigned to a special program that encouraged them to go outside during recess over the course of a school year were much less likely to become nearsighted (14).



# Timing, Brightness, & Wavelength

**Early morning light is most effective in improving alertness and energy.**

**Both timing and brightness are important.**

Morning light is most effective for a majority of patients with depression and more generally helps us to be awake, alert and energetic during the day. It is particularly helpful for individuals whose sleep-wake cycles are “phase-delayed,” meaning that they wake up too late and go to sleep too late. Early morning light resets their internal clocks to the world they are required to live in. Other

individuals are phase-advanced – they wake up too early and get sleepy too early. That problem becomes more common as we get older. Bright light in the late afternoon can then delay the onset of sleep and sleepiness.

## » How bright does the light need to be?

Our bodies evolved with the sun as our light source and timekeeper. Quoting Turner et al. (3), “Optimal neurobiologic function depends on exposures to sunlight.” Artificial lights are nowhere near as bright as sunlight and most of them simply do not do the job (Fig. 1). The level of brightness needed to treat mood disorders is 2500 lux or higher. (Lux is a measure of the brightness of the light as perceived by the eye.) At that level, a daily therapeutic “dose” of light takes approximately 2 hours. As brightness increases to 10,000 lux, the time required drops to about 30 minutes (15). That’s as short



as it gets, even though light can be much brighter. A similar threshold of 2500 lux seems to apply to other circadian functions, although much lower levels of light at night can still decrease melatonin levels, interfering with the onset and quality of sleep (16).



The benefits we have described come from visible light, not ultraviolet light (UV). Window glass and the clear lenses of prescription glasses are transparent to visible light, therefore **wearing glasses and getting bright light through a window are both effective and do not interfere with the accuracy of SunSprite.** And since the effects are through the eyes, they are not diminished by the use of sunscreen. Sunglasses, on the other hand, block the desired effects and keep SunSprite from measuring the light that a user's eyes actually see.



# Bright Light and SunSprite



**The benefits of bright light are clear.** The bright light “deficit” of contemporary life is also clear. SunSprite uses an elegant wearable technology to remind people to take **simple actions** that significantly improve their health and well-being and, by measuring their progress toward a scientifically-based goal, increase their motivation and success.

The world has wearables for fitness, sleep, and nutrition. And now there is one for sunlight.

The effect of measurement and quantification on behavior change is well known: the effectiveness of activity trackers in increasing the amount and regularity of exercise is a technology success story. SunSprite offers the same benefit in an equally important area of health.



**SunSprite increases users' awareness and control over the amount and timing of bright light in their day.**

It allows users of therapeutic light boxes the freedom to move around while still accurately tracking their dose. It lets people mix sources of bright light (a little time at the kitchen table with a light box, a walk to the bus-stop on the way to work) without needing to guess at how much is enough. And the SunSprite mobile app provides a clear record of light exposure that helps users stay on track and know that they are getting the benefits of enough light in their lives.



# References

1. Chronotherapy: Resetting Your Inner Clock to Boost Mood, Alertness, and Quality Sleep. Michael Terman, Ian McMahan. New York: Avery, 2012, p. 74.
2. Greenberg PE, Kessler RC, Birthbaum HG. The Economic Burden of Depression in the United States: How Did It Change Between 1990 and 2000? *J Clin Psychiatry* 2003; 64:1465-1475
3. Turner PL, Van Someren EJW, Mainster MA. The Role of Environmental Light in Sleep and Health: Effects of Ocular Aging and Cataract Surgery. *Sleep Medicine Reviews* 2010; 14:269-280.
4. Rosenthal NE, Sack DA, Gillin C, et al. Seasonal Affective Disorder: A Description of the Syndrome and Preliminary Findings with Light Therapy. *Arch Gen Psychiatry*, 1984; 41:72-80.
5. Golden, Gaynes, Ekstrom, et al. The Efficacy of Light Therapy in the Treatment of Mood Disorders: A Review and Meta-Analysis of the Evidence. *Am J Psychiatry* 2005; 162:656-662.
6. Gooley JJ. Treatment of Circadian Rhythm Sleep Disorders with Light. *Annals Academy Medicine Singapore* 2008; 37:669-676.
7. Arns, van der Heijden, Arnold, Kenemans. Geographic Variation in the Prevalence of Attention-Deficit/Hyperactivity Disorder: The Sunny Perspective. *Biol Psychiatry* 2013 Oct 15; 74(8):585-90.
8. Rutten S, Vriend C, van den Heuvel OA, et al. Bright Light Therapy in Parkinson's Disease: An Overview of the Background and Evidence. *Parkinsons Dis.* 2012;2012:767105. doi: 10.1155/2012/767105. Epub 2012 Dec 23.
9. Terman M. Evolving Applications of Light Therapy. *Sleep Medicine Reviews* 2007; 11:497-507.
10. Cajochen C. Alerting Effects of Light. *Sleep Medicine Reviews* 2007; 11:453-464.



11. Partonen T, Lonnqvist J. Bright Light Improves Vitality and Alleviated Distress in Healthy People. *J Affective Disorders* 200; 57:55-61.
12. Danilenko, Mustafina, Pechenkina. Bright Light for Weight Loss: Results of a Controlled Crossover Trial. *Obesity Facts* 2013; 6:23-28.
13. Jung CM, Khalsa SBS, Scheer FAJL, et al. Acute effects of Bright Light Exposure on Cortisol Levels. *J Biol Rhythms* 2010; 25(3):208-216.
14. Wu, Tsai, Wu, et al. Outdoor Activity during Class Recess Reduces Myopia Onset and Progression in School Children. *Am Academy Ophthalmology* 2013; 120:1080-1085.
15. Terman M, Terman JS. Light Therapy for Seasonal and Nonseasonal Depression: Efficacy, Protocol, Safety, and Side Effects. *CNS Spectrum* 2005; 10(8):647-663.
16. Gooley JJ, Chamberlain K, Smith KA et al. Exposure to Room Light before Bedtime Suppresses Melatonin Onset and Shortens Melatonin Duration in Humans. *J Clin Endocrinol Metab* 2011; 96(3):E463-E472.



<b>Illuminance (lux)</b>	
<b>Photopic (cone) vision</b>	
Sunlight, reflective surfaces	150 000
Bright sunlight, noon	100 000
Hazy sunny day	50 000
Cloudy bright day	25 000
Overcast day, SAD Rx	10 000
Operating Room	5-10 000
Retail shop windows	1-5000
SAD Rx	2500
Very Overcast day	2000
Bright industrial	1500
	1000
Offices, kitchens	200-500
Living rooms	50-200
Corridors, bathrooms	50-100
Sunset	100
<b>Mesopic (cone and rod) vision</b>	
Average nursing home	50
Good street lighting	20
Candle at 30 cm	10
Full moon	1
Poor street lighting	.1
<b>Scotopic (rod) vision</b>	
Quarter moon	0.01
Moonless night, clear	0.001
Moonless night, overcast	0.0001
Star light	0.00001
	0.000001
<b>Human Visual Limit</b>	

From Turner PL, Mainster MA. Circadian photoreception: ageing and the eye's important role in systemic health. Br J Ophthalmol 2008; 92:1439-1444

