SCIENTIFIC DISCOVERIES ABOUT THE HUMAN EYE SUGGEST "BLUE LIGHT" TO IMPROVE HEALTH, LEARNING, AND WORKPLACE PERFORMANCE.

By

Laurence D. Martel, Ph.D.
National Academy of Integrative Learning, Inc.

Researchers have identified a new class of undetected photoreceptors in the retina of the human eye. These new receptor cells function quite differently than helping us to see. There is a protein-like photo-pigment within the retina called "CRYs" or "Crypto-chromes." These CRYs use UV light for non-DNA repair and other important bodily functions.

Dr. Russell Foster of the Department of Integrative and Molecular Neuroscience at Imperial College in the United Kingdom claims that CRYs were originally named in plant research and "…appear to act as blue/UV photo-pigments and contribute to several physiological responses, including the link between interrupting "blue light" and shortening the circadian period and disturbing the regulation of "flowering" in plants. Dr. Foster claims that plant CRYs "…are involved in a number of "blue light" - regulated processes, and it has been argued that these proteins must act as photo-pigments." This has led to a general observation that "…plant and animal CRYs together are photo-pigments that mediate "blue light's" effects on the circadian system." It also suggests the potential to impact the regulation of other systems of the body, as well.

"Blue Light", according to Dr. Foster and his associates, influences "…varied aspects of mammalian physiology, endocrinology and behavior…" which are "…regulated by non-rod and non-cone ocular photoreceptors….For example, pineal melatonin production, pupil size, adrenal cortisol secretion, heart rate, and body temperature are all affected by irradiance (sending forth radiant "blue light"). Furthermore, in our own species, increasing environmental irradiance can result in marked improvements in alertness and performance…." This regulation also includes mood fluctuation, according to the researchers.

Yet the discovery of a different kind of photoreceptor in the human eye has been accompanied by a new shift in research according to Dr. Michael Simmonovitch who is Research Director at the California Lighting Technology Center at the University of California – Davis. Vision is made possible by 120 million rods which process light into shades of gray – the scotopic side of sight – and 6 to 7 million cones which convert light wavelengths into color – the photopic side of vision.

Most modern lighting products, as well as architectural building and room design have focused on the photopic side of lighting. In a recent interview, Dr. Simmonovitch said that "a new emphasis on the scotopic side, and particularly the "blue" wavelength holds

great promise in improving vision and other non-visual effects of "blue light"(400-475 nm) exposure."

In addition to the new emphasis on the scotopic cone side of the retina, with a focus on blue light, the newly discovered photo-receptors are also responsive to "blue" waves, "blue light", and blue "pigment".

As an example, consider the recent research results reported in the September, 2003 issue of the *Journal of Clinical Endocrinology and Metabolism* and conducted at Brigham and Woman's Hospital and Harvard Medical School. As stated in the Harvard University press release: "Researchers from Brigham and Women's Hospital (BWH) have found that short wavelength, or "blue light", has a greater impact on resetting the human circadian pacemaker – which controls daily rhythms such as sleep patterns, hormones and other physiological and behavioral functions – than the most visible kinds of light."

'These findings provide us with a more complete understanding of how different types of light impact sleep patterns and cause various sleep-wake disorders such as jet-lag and shift-work disorder,' said Steven Lockley, PhD, lead author of the study and a researcher in BWH's Division of Sleep Medicine. 'It is the first direct demonstration that photoreceptors other than rods and cones influence circadian rhythms that regulate sleep in humans.'

The researchers found that "blue light" was ***twice*** as effective as the same amount of green light at resetting the internal circadian clock. The fact that "blue light" was much better proves that a novel photoreceptor system exists in the human eye, different than what is used for sight. (See www.bluemaxlighting.com)

"These results have major implications for the design of light treatment or exposure regimes to treat or avoid circadian sleep disorders," said Lockley, who is also an instructor at Harvard Medical School (HMS). "They also have implications for sleep disorders that are associated with space travel, life in extreme photoperiods such as the Arctic and Antarctic, changes in light exposure associated with aging and blindness, as well as ensuring proper alignment of internal circadian rhythms with the ever-increasing pressure to live in a 24/7 society."

Previous studies at BWH showed that rods and cones were probably not required to perceive light or reset the body clock. This was determined by demonstrating that light exposure to the eyes could affect the circadian rhythms of totally blind people, even though they could not see any light. The current studies confirm this important observation.

'In simplest terms, we found that looking up at the blue sky has twice the resetting effect as looking down at the green grass,' said Charles Czeisler, PhD, MD, chief of the Division of Sleep Medicine at BWH, senior author of the study, and a professor at HMS. 'This discovery could lead to the development of new treatments and a new class of

lamps in light fixtures for greater control and regulation of the circadian clock.' BlueMax Lighting, designed and developed by Full Spectrum Solutions, Inc. of Jackson, Michigan, has produced an innovative, multi-phosphor lamp which has a spectrum that mimics daylight, but favors the blue wave length. These lamps hold great promise for enhancing the quality of life in home and work settings, as well as providing therapy and increased work performance. They also could be helpful in retarding the effects of a major problem in our society, especially among teenagers; namely, sleep disorders. (See www.bluemaxlighting.com)

Sleep disorders are extremely common, affecting as many as 40 million Americans, with around 25 percent of adults reporting having sleep problems a few nights a week or more. In addition, more than 40 percent of adults experience daytime sleepiness severe enough to interfere with their daily activities at least a few days each month, researchers said.

Sleep researcher Mary Carskadon of Brown University claims that teenagers require nine and a half hours of sleep, yet get much less(about seven and a half). This leads to fatigue, lack of alertness, and deprivation in the stress hormone, cortisol. Lack of sleep is also linked to the inability to process glucose which is critical to brain function.

Mood disorders are another sign of sleep deprivation. Some school districts have started high school later in the morning and have realized improved grades, reduced absenteeism, and overall positive increase in behavior. In one district, college entrance exams rose significantly after starting school an hour later for high school teens. We wonder what effect the intervention of lighting with "blue light" would have by equipping schools from the dreaded traditional "cool white" fluorescent bulbs to the full spectrum lights.

Renowned Pediatrician Doris Rapp, M.D. states in her best selling book***, Is This Your Child's World?, "***The best lighting for schools (and elsewhere) is natural light. But in many classrooms, students spend about six hours a day beneath (cool white) fluorescent lights. These ordinary fluorescent lights can emit X-rays, radiation and radio waves – emissions that can decrease productivity and cause fatigue, confusion, eyestrain, irritability, depression and hyperactivity in some sensitive children (and adults)…. A study of one classroom concluded that hyperactivity declined by Thirty-three percent when full-spectrum lighting (www.fullspectrumsolutions.com) replaced fluorescent lights. So why do we not use full-spectrum lighting all the time, but instead encourage drug therapy with Ritalin? Germany banned (cool white) fluorescent lighting in both schools and hospitals years ago: maybe German health officials know something we don't." Dr. Rapp recommends that "If fluorescent lighting must be used, it should be full spectrum lighting…."

Michigan Psychiatrist, Dr. Daniel Field, stated in a recent interview with me that when he and his staff use light therapy with "blue light" fluorescent light and task lamps(from Full Spectrum Solutions, Inc.), his patients improve much faster with sustained levels of improvement. And this applies not only to patients with Seasonal Affective Disorder, but for patients with many other psychological problems as well. Even Dr. Field's office

staff have reported noticeable improvements in their own work performance and personal levels of reduced fatigue with full spectrum lights.

Jack Stull recently reported that "In 1980 Dr. Fritz Hollwich did a study comparing cool-white light with full spectrum light. A person sitting under the non-full spectrum experienced stress-like levels of ACTH and cortisol (*chemicals in the brain and body which induce stress*). A person sitting under full spectrum light ***showed none*** of these symptoms. To further appreciate the differences between full spectrum and non-full spectrum and how they affect our health, we can turn our attention to the study John Ott and the Environmental Health and Light Institute conducted in 1973 involving fourth graders. Full spectrum lights were installed into two identical classrooms, while two other identical class rooms received standard, fluorescent lights. The students were not informed of the experiment, while the teachers, although they knew of the experiment, did not know which classrooms had which lights. In the classrooms with full spectrum lights, behavior, classroom activity, and academic achievement all improved markedly by the end of the first month. I wonder, after so much scientific research has shown how damaging non-full spectrum lights can be, and how beneficial full spectrum can be, why we continue to use the lowest grade fluorescents in our children's classrooms and in the business setting. It may appear as though money is being saved, since full spectrum lights are more expensive, but will we not gain more than we spend in health, reduced stress, reduced learning deficiencies, and in an overall increase in productivity?"

Workplace productivity can improve with full spectrum lighting. According to the Pennsylvania Power and Lighting Company's report, the N3 Drafting Department had a high error rate and it was believed the employees were not working to their potential because of the inadequate cool-white fluorescent light. "Light from the overhead fixtures was bouncing off the surface of the task and into their eyes, creating a form of indirect glare known as a *veiling reflection.* PP & L management determined that a change was in order and that new lighting selected (full spectrum fluorescent bulbs) could also be more energy-efficient than that which comprised the existing system. (Full spectrum bulbs use less energy and last far longer.) After the modernization, it was projected these costs would be minor by virtue of productivity improvements. Actual measurement showed that the new lighting, which virtually eliminated veiling reflections, permitted workers to perform their tasks more than 13 percent faster. The productivity benefit was projected to be worth $235,290 per year. It was known that a number of errors were avoided as a result of the new lighting, but the value of these could not be quantified. Even a relatively minor error could have major dollar implications. It was noted, too, that absenteeism seemed to decline after the new lighting was installed, a result, some said, of less eyestrain and fewer headaches. All told, the bottom line benefits of better lighting were projected to save PP & L $255,929 per year."

In conclusion, there is good news and bad news. The bad news is that people are often skeptical, even when presented with research, and are hesitant to change from the limited cool-white florescent lights to the new scotopically enhanced fluorescent lights. (See www.bluemaxlighting.com)

The good news is that recent scientific research proves that there are previously undiscovered photoreceptors which can significantly affect our health, our daily lives and our workplace performance by responding to "blue light" and full spectrum light. Also, the scotopic side of lighting shows promise for "blue light" to improve vision, clarity, focus and performance, while reducing headaches, attention deficits and other physical and psychological problems.

For further information contact Dr. Laurence D. Martel at The National Academy of Integrative Learning, Inc.; PO Box 5784; Hilton Head Island, SC 29938. Phone: 843-686-4050. e-mail: martel@intellilearn.org