Researchers discover second light-sensing system in human eye

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New research on blind subjects has bolstered evidence that the human eye has two separate light-sensing systems — one that perceives the familiar visual signals that allow us to see and a second, separate system that tells our body when it is day or night.

Researchers have long known that the eye performed both functions but until recent years it had been thought that both vision and the management of the circadian rhythm that tells us when to be sleepy and when to be alert had been done all at once through the retina's rods and cones that enable us to see.

Beginning in the 1990s, however, research in animals and in healthy human subjects indicated that though vision was handled by the rods and cones, the signals that synchronize our body clock with the sun's rising and setting are handled through a second system of light-sensitive cells, located at the back of the retina. These cells extend from the back of the eye into the brain's hypothalamus region, which manages our body's clock.

In work on healthy subjects, researchers showed that these cells were most sensitive to blue light, unlike the visual system, which is most sensitive to light in the green wavelengths. Blue light exposure was shown to be much more effective than green at resetting subjects' body clocks.

The new work, published in the journal *Current Biology*, examines two

blind subjects, a 56-year-old man and an 87-year-old woman. Though they cannot see at all, they show none of the circadian imbalance that often accompanies blindness. Senior author Steven W. Lockley, an assistant professor at Harvard Medical School and Brigham and Women's Hospital Division of Sleep Medicine, said that most totally blind people have problems with their circadian clocks, feeling sleepy and awake at times out of sync with the rest of society. It is very rare — fewer than 10 cases have been confirmed — to find subjects like those in the study whose visual system is not working but whose circadian rhythm is unaffected.

The work was conducted by researchers from Harvard Medical School, Brigham and Women's Hospital, Massachusetts Eye and Ear Infirmary, Imperial College London, University of Oxford, Thomas Jefferson University, and City University in London. They exposed one subject to two separate light sources, one blue and one green — the peak wavelength for normal vision. They found that the green light had no effect on the presence of melatonin — the hormone that signals night time and makes us sleepy — while exposure to blue light led to a 57 percent decline in melatonin. Exposure to blue light also resulted in a shifting of the subject's body clock by 1.2 hours and increased alertness (measured by brain alpha wave activity), hearing performance, and the subject's reported sleepiness.

Researchers said that the work also indicates at least some visual sensitivity through the second system. The female subject was able to tell when a blue light was shined on her, reporting to researchers a sense of "brightness," though she was unable to detect light at other wavelengths.

A third finding shows that the pupil's contraction and dilation response to light is controlled primarily by the eye's second system. Though the woman subject's eyes were unresponsive to a short exposure to a pen

light — similar to what a doctor might use in his or her office — her pupils did contract most to prolonged exposure to blue light compared to other colors.

Lockley said the new research provides the final confirmation of the earlier work conducted on sighted subjects. The enhanced understanding of the function of human circadian rhythms is potentially useful. Blue light could be used to help people recover from jet lag or to help people working night shifts experience increased alertness

“Our society’s massive use of caffeine tells us that we’re sleep-deprived,” Lockley said. “Poor sleep affects our ability to perform, to learn and, long-term, may affect our health. If we can’t get enough sleep, our work suggests that light could be developed as an effective nonpharmacological fatigue countermeasure.”

Source: Harvard Medical School