# Mouse vision has a rhythm all its own

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In the eyes of mammals, visual information is processed on a daily schedule set within the eyes themselves—not one dictated by the brain, according to a new report in the August 24 issue of the journal *Cell*, a publication of Cell Press. The researchers found in mice that the eyes' normal rhythmic response to light requires only that a molecular "clock" inside the retina go on ticking. The retina is a layer of nerve tissue covering the back of the eyeball, which is often likened to the film in a camera; without it, images can't be captured.

The results offer the first glimpse into the physiological importance of circadian clocks found in organs throughout the body, said Charles Weitz of Harvard Medical School. The retina's apparent independence when it comes to keeping itself on time further challenges the notion that the circadian rhythms of the body—which drive regular patterns of physiology and behavior—strictly follow orders handed down from a "master clock" in the brain, the researchers said.

"We're moving from a dictatorial model of the circadian system to a federal model," Weitz said. He added, however, that the brain's master clock isn't "completely off its pedestal" yet as it might still play a lead role in synchronizing the clocks found in other organs.

It has long been known that the roughly 24 hour circadian clock controlling behavior in mammals is located in the brain's suprachiasmatic nucleus (SCN), Weitz explained. Even when animals are placed under conditions of constant darkness, that daily rhythm marches on.

More recently, researchers have discovered that circadian clocks are also distributed in other mammalian tissues, including the retina, multiple brain regions, and many peripheral tissues such as the liver and kidneys. But while scientists had suspected physiological functions for those many timepieces, few studies had addressed the issue.

In the new study, the researchers found that retinas of mice that completely lack a critical component of the clock—a gene known as Bmal1—showed abnormal gene activity in hundreds of retinal genes and defective electrical responses in inner retinal cells critical for image processing. The animals' photoreceptors still sensed light normally and, upon close examination, their eyes appeared normal.

Mice deficient for the Bmal1clock gene only in their retinas had defects of vision essentially identical to those of mice lacking the gene in all tissues, evidence that the clock's function in the eye itself is the key. By contrast, the retinas of mice with brain lesions that disabled the SCN maintained normal visual responses and the regular ebb and flow of retinal gene activity.

"Circadian clocks in mammals are widely distributed, but except for the SCN clock known to regulate behavior, their physiological functions in vivo have largely been mysterious," Weitz concluded. "The studies described here indicate that an intrinsic retinal circadian clock regulates visual processing in vivo and that it does so autonomously, with no detectable contribution from the SCN or other clocks."

Whether the retina's ability to keep time on its own is the exception, "we don't know," Weitz said. Unlike other tissues, the eye's role as a light sensor does provide its component structures a unique ability to track the environment on their own authority, he noted.

Nonetheless, he said, "our work provides evidence that circadian clocks

outside the SCN contribute important physiological functions in mammals. Over evolutionary time, different cell types have likely recruited the circadian clock mechanism inherited from a single-celled ancestor for control of specialized tissue-specific processes," he suggested.

Source: Cell Press