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Retinal neurons do double duty

Scientists at the Friedrich Miescher Institute for Biomedical Research (part of the Novartis Research Foundation) have identified a new neural circuit in the retina responsible for the detection of approaching objects. Surprisingly, however, this is not the only function the circuit fulfills. The same nerve cells are also responsible for night-time vision. This is the first time such a dual function has been demonstrated, shedding new light on the nervous system's information-processing capacity.

In animals and humans, a looming threat triggers the same kind of behavior – freezing followed by flight. The uniform nature of this response suggests that the perception and processing of approaching motion is clearly defined and embedded in the brain.

Scientists working with group leader Botond Roska at the FMI in Basel and at the École Normale Supérieure in Paris have now managed to identify a neural circuit in the retina that responds specifically to approaching objects and conveys this information immediately to the brain.

Nerve cells for detection of approaching objects

As the researchers report in the latest issue of *Nature Neuroscience*, various types of retinal cells are involved in this perceptual process. An important role is played by the bipolar cells which lie just below the photoreceptors. Two types of bipolar cells are distinguished: those that become active in brighter light (known as ON cells) and those that respond to dimmer light (OFF cells).

For the eye, the image of an approaching object consists of a constantly expanding area of darkness. Therefore, as an object approaches, increasing numbers of OFF bipolar cells respond to this stimulus and transmit this signal to the next layer of retinal cells – the ganglion cells. These integrate the signal and transmit it to the brain. The same system is shut off when faced with laterally moving objects: here the lateral motion activates amacrine cells, another cell type in the retina, which shut down the information flow. Rapid processing of this information is often a matter of life or death – especially in the natural world, when an animal is suddenly confronted with a predator.

Different daytime and night-time functions

But this was not the only new finding. To date, given the vast numbers of nerve cells and the profusion of neural circuits, it has seemed perfectly reasonable to seek to ascribe a single function to a particular type of nerve cell. However, Roska's experiments showed that the nerve cells that detect approaching objects during the day serve a different function during the night: they are then responsible, via other photoreceptors, for night-time vision. Precisely how amacrine cells process these two different kinds of stimuli remains to be fully elucidated. Also unresolved is the question of what happens in the retina when the two different types of perception coincide – for example, when an owl swoops on a mouse at night-time. The results do, however, demonstrate that the capacity of the nervous system to process information is increased many times over when different types of nerve cells are involved in multiple perceptions.



Original publication

MüncH TA et al. (2009) Approach sensitivity in the retina processed by a multifunctional neural circuit. *Nature Neuroscience*, 12, 1308–1316.

-> Online publication (<http://www.nature.com/neuro/journal/v12/n10/full/nn.2389.html>)

Press photos

Available for download at: www.fmi.ch

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Legend

Mouse retina with labeled ganglion cells.

Further information

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About the FMI

The Friedrich Miescher Institute for Biomedical Research (FMI), based in Basel, Switzerland, is a world-class center for basic research in life sciences. It was founded in 1970 as a joint effort of two Basel-based pharmaceutical companies and is now part of the **Novartis Research Foundation**. The FMI is devoted to the pursuit of fundamental biomedical research. Areas of expertise are neurobiology, growth control, which includes signaling pathways, and the epigenetics of stem cell development and cell differentiation. The institute counts 320 collaborators. The FMI also offers training in biomedical research to PhD students and postdoctoral fellows from around the world. In addition the FMI is affiliated with the University of Basel. The Director of the FMI since 2004 is Prof. Susan Gasser.