

Fixated on food?

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African Clawed Frog (*Xenopus laevis*). Credit: AG Straka

Contrast has an impact on the optokinetic reflex, which enables us to clearly perceive the landscape from a moving train. Researchers from Ludwig-Maximilians-Universitaet (LMU) in Munich have now shown that visual features that modulate this ability are encoded in the retina.

When we gaze out the window of a moving train, our [eye muscles](#) are constantly at work, stabilizing the gaze in order to keep the passing landscape in focus. This so-called optokinetic reflex allows us to gauge the relative velocity of the passing scene, and thus helps us to stabilize the rapidly changing images on the retina - otherwise we would perceive what moves past us beyond the carriage window as a diffuse blur. Researchers led by LMU neurobiologist Professor Hans Straka have now shown experimentally that visual image features of the environment play

an important role in the analysis and assessment of relative motion. In particular, they find that the levels of contrast determine the efficiency with which the passing parade is perceived by a moving observer. The results of the new study appear in the *Journal of Experimental Biology*.

All vertebrates display optokinetic reflexes, which are responsible for fine-tuning the involuntary movements of the eye muscles, which in turn permit us to faithfully stabilize objects when we move. The operation of this optokinetic system depends on rapid processing of visual information, and on the ability to realistically estimate the relative velocity of the objects in the passing scene - under widely varying levels of illumination. To investigate how visual parameters such as image patterns, lighting conditions and brightness contrasts modify this capacity, Straka and his colleagues turned to the African clawed frog *Xenopus laevis*, a popular model system in the field of neurobiology, and used a high-resolution video camera to follow eye movements in tadpoles. They revealed that, when confronted with a large field pattern of dots that moved back and forth, the eyes of the tadpole executed movements of larger amplitude when the pattern consisted of white dots on a black background than when the "color scheme" was reversed. In other words, the polarity of the contrast had a marked influence on the efficiency of perception of the moving pattern. The structure of the pattern itself, on the other hand, was irrelevant in this context.

"We then measured the activity of the optic nerve, which transmits the visual signal from the retina to the visual centers in the brain," Straka says. "The results revealed that the difference in the efficiency of motion perception is encoded at the level of the retina: White dots on a black background generate nerve impulse rates of higher amplitude than do black dots on a white ground." Strikingly, the brain is not involved in making this distinction. It simply picks up the impulse patterns from the retina and passes them on to the nerves that control the eye muscles.

"This implies that the quality of the environmental motion characterized

by brightly lit structures against a darker background - and hence the ability to track objects of interest - is greater than it is in the converse situation, where dark structures are viewed in a bright setting," as Straka explains. "We were very surprised to discover this difference. It may be a reflection of the fact that tadpoles spend their lives in a relatively turbid medium, and feed on items that are brighter than pond water. It could therefore be an adaptation to their lifestyle."

Mature frogs, on the other hand, tend to swim nearer the surface and obtain their food at or above it. Hence, the LMU team now believes that a pattern of black dots against a white background is likely to evoke larger [eye movements](#) in adult *Xenopus*. They are now engaged on testing whether the relative efficiency of pattern recognition - mediated by the connectivity of the photoreceptors in the [retina](#) - is reversed during metamorphosis when the tadpole is transformed into the mature frog. "If the adult frog is in fact better equipped to perceive dark patterns against a bright background, that would prove that the relative efficiencies of different modes of [pattern](#) recognition are defined by the animal's mode of life", Straka concludes.

More information: Céline M. Gravot et al, It's not all black and white: visual scene parameters influence optokinetic reflex performance in *Xenopus laevis* tadpoles, *The Journal of Experimental Biology* (2017). [DOI: 10.1242/jeb.167700](https://doi.org/10.1242/jeb.167700)

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