

# Before colour, there was 'white': how fish vision shaped the way we see

*The first colour circuits in animal eyes were probably not built to see rainbow hues, but to judge underwater distance*

BRIGHTON, UNITED KINGDOM, November 4, 2025 /EINPresswire.com/ -- Key points

- Fish vision runs on rivalry: Zebrafish eyes pit colour channels against each other, not in harmony — challenging long-held ideas of how retinas process light.
- Red and ultraviolet drive, green and blue suppress: These cone types work in opposition, helping filter out the distant underwater haze.
- Seeing “white” to gauge distance: This wiring make the aquatic foreground objects “pop”, hinting that early colour circuits evolved to measure distance before they were used to see colour.

A new study from the University of Sussex reveals that the way fish see the world underwater is very different from how humans see it on land. Using advanced brain imaging, behavioural analysis and genetic tools, researchers found that zebrafish don't primarily use colour to build a richer picture of their surroundings.

Instead, their eyes are wired to pick out spectrally broad, “white” light reflected from nearby objects, while filtering out the hazy blue-green aquatic background.

This discovery sheds light on how the first visual systems evolved hundreds of millions of years ago — and suggests that colour vision originally developed as a way to “see distance”, not colour itself.

“For fish, colour isn't just about seeing the rainbow — first and foremost, it's probably about knowing what's close,” said Professor Tom Baden, who led the research. “Underwater, light becomes increasingly green or blue with distance. By tuning their eyes to ‘whiteness’, zebrafish can tell what's nearby and worth paying attention to.

“The same thing happens in air, only over much longer distances,” Baden added. “It's the reason distant mountains look pale and bluish — a trick artists have used for centuries.”

How they found it

The team used two-photon brain imaging to monitor zebrafish neurons as the fish viewed visual patterns in different colours of light. They also used genetic tools to switch off individual types of light-sensitive cells — called cones — to test how each contributed to vision and behaviour.

They discovered that:

- The brain responds strongly to broad-spectrum (“white”) light, but much more weakly to any form of “coloured” light.
- Red and ultraviolet cones are essential for normal “white” vision, driving the signals that detect movement and shapes.
- Green and blue cones act in opposition, suppressing visual signals when the stimulus is not white.
- Removing red and UV cones caused near-blindness, while removing green and blue cones increased visual responses in the brain.

Why it matters

The findings support a new evolutionary theory — proposed in two recent papers from the same team — that colour circuits in early vertebrates did not first evolve “to see colour”, but to help animals navigate underwater, where light quickly loses both brightness and spectral range with distance.

Understanding this also helps place our own vision in context. Human red, green, and blue cones — the basis of our colour vision — do not directly match the fish red, green, and blue types. Instead, human red and green cones both trace their ancestry to fish red cones, and human blue corresponds to fish ultraviolet.

This means the human visual system stems entirely from the core, light-detecting channels of that ancient design. The suppressive “auxiliary” circuits that fish still use to filter the underwater background were lost in mammals, simplifying the system but preserving its basic wiring logic.

“Our results show how the roots of human colour vision lie in a very different ecological world,” Baden said. “We’ve kept the part of the system built for detecting what’s nearby — the active, ‘white-seeking’ part — while the filtering components that once handled the watery background disappeared as our ancestors moved onto land.”

Yet mammals are the exception, not the rule. Most other tetrapods (amphibians, reptiles including birds) did not reduce but instead expanded upon the ancestral cone system, adding new photoreceptor types, and colour-processing circuits that appear to be far more complex. However, how those expanded systems work, and whether they retain traces of the ancient ‘white-seeking’ logic seen in fish, remains largely unknown.

For more information: [https://www.cell.com/cell/fulltext/S0092-8674\(25\)01138-9](https://www.cell.com/cell/fulltext/S0092-8674(25)01138-9)

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Background:

This work builds on two conceptual papers: PMIDs 38253752, 38537627

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