Guppies change their eye color to deter rivals

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Black and silver iris guppies feeding. Credit: Robert Heathcote, University of Exeter

Tiny fish called Trinidadian guppies turn their eyes black to warn other fish when they are feeling aggressive, new research shows.

A study led by the University of Exeter, in collaboration with the University of the West Indies, found that when facing a rival, guppies rapidly turn their irises from silver to black before attacking their

adversary.

This makes their eyes more conspicuous and is an "honest" signal of aggression—larger guppies do it to smaller ones whom they can beat in a fight, but smaller ones do not return the gesture.

As part of the study, the researchers made visually realistic robotic guppies to see what would happen if smaller fish displayed their aggressive motivation—and larger fish flocked in to compete with the small imposters for food.

Dr. Robert Heathcote, lead author of the study and from the University of Exeter, said: "Trinidadian guppies can change their iris colour within a few seconds, and our research shows they do this to honestly communicate their aggressive motivation to other guppies.

"Experimentally showing that animals use their eye colouration to communicate with each other can be very difficult, so we made realistic-looking robotic fish with differing eye colours and observed the reaction of real fish."

Professor Darren Croft, also from the University of Exeter and an author of the study, added: "Eyes are one of the most easily recognised structures in the natural world and many species go to great lengths to conceal and camouflage their eyes to avoid unwanted attention from predators or rivals.

"However, some species have noticeable or prominent eyes and, for the most part, it has remained a mystery as to why this would be. This research gives a new insight into the reasons behind why some animals have such 'conspicuous' eyes."

Professor Indar Ramnarine, from the University of the West Indies and

co-author of this study, indicated his amazement that guppies could have evolved this behaviour of changing their iris colour to warn guppies and other fish of their willingness to engage in aggressive behaviour.

To carry out the research, scientists developed the robotic guppies to help determine what would happen if smaller guppies tried to "cheat" by displaying aggression towards larger rivals.

They found that food patches defended by black-eyed robots attracted disproportionate competition from larger real guppies—and in particular those which displayed blacker-coloured eyes.

The research team believe that this behaviour explains why the guppies are "honest" and only display how angry they are if they can actually be dominant against rivals.

Dr. Jolyon Troscianko, also from University of Exeter and who helped invent the guppy robots, said: "Scientists used to spend hours laboriously painting model fish, eggs and other objects to see how their appearance affected how other animals interacted with the models.

"Here, we used carefully calibrated photography and printing techniques to create robotic models, and guppies responded to them as though they were real fish."

Dr. Safi Darden, co-author on the study, added: "It is well known that in humans the white sclera of the eye is used to signal gaze direction—it provides others with information on what we are looking at. Our work shows that just like humans these little fish pay attention to the eyes of their group members and that the eyes provide important information to other rival fish".

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