Robotic fish offer new avenue for understanding alcohol's effect on brain, behavior

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Rats and mice have long been a model for researchers aiming to understand the complex impact of alcohol and other substances of abuse on behavior and the brain's reward systems. But now, a team at the Polytechnic Institute of New York University (NYU-Poly) has demonstrated a new method for such experiments that promises to yield large amounts of data quickly and consistently, thereby potentially reducing the number of live animals needed in research. The secret? Robotic fish.

Maurizio Porfiri, associate professor of mechanical and aerospace engineering and director of the Dynamical Systems Lab at NYU-Poly, described his method and details the results of fish experiments in the current issue of the journal *Alcohol*.

Porfiri, along with visiting biology student Chiara Spinello from Sapienza University of Rome and research scientist Simone Macrì from the Italian Institute of Health, introduced a biomimetic robot designed to replicate the color pattern and tail beat motion of a fertile female zebrafish into shoals of live zebrafish. The species is highly social, and in prior experiments showed a consistently strong affinity for this robotic member. Porfiri and his colleagues aimed to test whether alcohol could impact this well-established preference.

Three groups of fish were treated with varying doses of ethanol in water—zero percent (control group), 0.25 percent and 1 percent by volume. These doses represent acute administration and cause neither lasting effect nor harm to the fish. The control group behaved as expected, showing a marked preference for the robotic member, assessed by the amount of time the fish spent in close proximity to the robot. The two ethanol-exposed groups deviated significantly from this pattern, spending more time in other regions of the tank.

This is the first study to demonstrate use of robotic stimuli to study reward-related behavior in zebrafish, and is an example of how the emerging field of ethorobotics—the interaction of biologically inspired robots with live animals—can transform longstanding research models.

"One of the major advantages of robotics is that we can provide a fully controllable, consistent stimulus for the zebrafish," Porfiri explained. "The traditional stimulus in these experiments is another animal, but individual variations can affect the results. Robotic fish don't feel fatigue. Their tail beat frequency never changes. Every time we introduce the stimulus, it's identical, making the results much cleaner."

"What we know right now is that robots can be a uniquely repetitive stimulus for those investigating the effects of alcohol on behavior," Porfiri said. "The innovation here is the method—we've taken one of the elements of experimentation that can vary, and standardized it."

Macrì added: "Such standardization was indeed mirrored by the live fish, which behaved more consistently when confronted with the robot than when confronted with a live companion. This aspect holds promise to reduce the number of live animals used in preclinical research".

Relatively little data exist to indicate how—or if—alcohol affects the cognitive abilities of zebrafish. Porfiri and his colleagues believe that the change in behavior under the influence of alcohol may be attributed to impaired shoaling instincts or a shift in the incentive value of the robot from the fishes' perspective.

In the next phase, the research team plans to deploy a robotic predator to test the impact of alcohol on the zebrafishes' sense of fear, as well as evaluating whether exposure impacts fishes' willingness to make efforts to shoal with a robotic member.

More information: www.sciencedirect.com/science/ … ii/S0741832913000669

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