

# Early-life exposure to BPA affects adult learning

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In testing the effects of the controversial chemical bisphenol A (BPA) on zebrafish, UWM scientist Daniel Weber found himself in familiar territory.

The results he observed were similar to those he'd seen when exposing the fish to [mercury](#) during their early development – profound behavioral changes occurred not only immediately after hatching, but also in adulthood.

Like developmental exposure to mercury, adult fish that had been exposed to tiny amounts of [BPA](#) as embryos had learning and memory problems, compared to fish that had not been exposed.

Weber, a researcher with UWM's Children's Environmental Health Science Center, collaborated with Robert Tanguay at Oregon State University. Their study is the first to identify a neurobehavioral effect of BPA using a zebrafish model exposed to concentrations comparable to what humans might encounter in the environment.

"What was amazing is that exposure only happened at the embryonic stage," says Weber, "but somehow the wiring in the brain had been permanently altered by it. It's an example of why children are not just little adults when it comes to gauging the effects of contaminants."

## Zebrafish as sentinels

BPA is widely used in plastic food containers and container liners. Conflicting reports of its safety have made it the subject of vigorous public debate. Amid the debate, the Campbell's Soup Company recently announced it would be removing BPA from the linings of the company's soup cans as soon as a viable alternative is found.

At issue is the amount of exposure with some studies concluding BPA is a health risk only at concentrations that are higher than environmental levels. Results of this study, however, suggest that lower concentrations may be more potent during early-life exposures. This study tested three different small amounts considered environmentally relevant.

The compound, which mimics the hormone estrogen, was added to the aquatic environment of fish embryos in their first two days of life. Then they were returned to clean water for the ensuing 10 months while they grew into middle-age adulthood.

Since zebrafish mature in only a few months, they are a useful model to test effects of toxicity over a lifetime. Scientists also can control the conditions and timing of chemical exposure with zebrafish because the embryos can live outside the mother.

Tanguay says the low concentrations of BPA they used don't cause physical malformations or cardiac defects. But even without physical abnormalities, behavioral deficits can still occur, as this study indicates.

## **The exam**

Using a T-shaped maze, Weber freed adult fish that were exposed to BPA as embryos at the base of the T and conditioned them choose the left arm of the intersection. He then reversed the task, conditioning them to choose the right.

It took seven to ten trials for an unexposed fish to learn this. But the exposed fish took two to three times as many trials to learn it. Almost none of the [fish](#) exposed to the highest levels of BPA Weber used learned even the first part of the task.

For comparison, the team also exposed some of the zebrafish embryos to two other substances – one a natural estrogen and the other a synthetic version. Similar to equal amounts of BPA, the other two substances caused hyperactivity at the larval stage.

Weber says multiple behavioral outcomes are not only changed by BPA, but those behaviors – immediate hyperactivity and later-stage learning impairment – may be inter-related.

"Being hyperactive – or even hypersensitive to an environmental stimulus – makes it difficult to learn," he says. "We've seen that with children."

In the next step of the work, Tanguay's lab will investigate the molecular mechanism that links BPA exposure to interference in normal neurodevelopment.

More behavioral research also is needed, says Weber. He expected to see differences in the resulting behaviors of the sexes since BPA is a kind of estrogen. But he found no evidence of that. Social behaviors, however, may show a sex-based effect due to BPA exposure and that is the subject of his next experiments.

Provided by University of Wisconsin - Milwaukee

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