

Experiments that fast-tracked big brains questioned

At stake is theory on trade-offs in evolution of intelligence.

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Researchers disagree on whether developing larger brains would yield diminishing returns for guppies.

A high-profile study that showed an intelligence boost in big-brained guppies has been challenged by other scientists. The debate raises questions over the contentious idea that evolving a larger brain costs an animal with regard to other traits. It also highlights the difficulty of proving that one animal is smarter than another.

The expensive-tissue hypothesis contends that evolving a larger brain requires making trade-offs with other traits, because brains hog so much energy. The idea has been used to explain why humans have larger brains than other apes, and some have argued that larger brains mean smaller digestive tracts. Studies testing the expensive-tissue hypothesis in fish, birds, bats and mammals reported conflicting results.

In January, Niclas Kolm, an evolutionary biologist at the University of Stockholm, and his team tested the hypothesis on guppy fish (*Poecilia reticulata*)¹. They bred lines of big-brained guppies by mating pairs of large-brained fish. After just two generations, they had bred fish with brains that differed in size by as much as 9%.

Previous studies had compared different species to see whether animals with larger brains tended to have smaller guts (after accounting for overall body size). But Kolm saw his big-brained guppies as a more direct test, because they could be used to prove that the evolution of a bigger brain leads to other trade-offs.

The large-brained guppies had smaller guts than small-brained guppies — 20% smaller for males and 8% for females — and spawned fewer offspring. But larger brains were not all bad news, says Kolm. “Why spend energy on evolving a larger brain if it is only costly?” he says. Larger-brained female guppies were better than smaller-brained ones at learning to associate the number of symbols on their tank wall with a food reward.

Called into question

But now Candy Rowe, an animal behaviourist at the University of Newcastle, UK, says that the study's methodology may have been flawed. “The big disappointment for me is that the cognitive task that was used didn't really demonstrate differences in cognitive

ability,” says Rowe, who along with biologist Susan Healy of the University of St Andrews, UK, published a critique in the journal *Animal Behaviour* on 20 August².

Bigger-brained guppies could have performed well if they were more motivated by the food rewards than the smaller fish, or they could have been more attuned to the shapes on the tank because their brains were better at processing visual information. Until such confounding factors are ruled out, Kolm's team cannot prove that the performance differences were due to intelligence, Healy says.

Kolm says that his team noticed no major differences in the amount of food consumed by the guppies, which suggests they were equally motivated to do the task. “You try your best to make sure there are no obvious differences in motivation, and we couldn't measure any differences,” he says. His team's official response also appears in *Animal Behaviour*³.

In new experiments, Kolm's team found more proof that larger brains lead to cognitive gains. Big-brained males, which did not outperform other males on the earlier task, were quicker to solve a maze that led them to a female guppy, Kolm says; these results have not been published yet. Kolm is working on breeding large brains in other species to strengthen his case.

Christian Agrillo, a cognitive scientist at the University of Padua in Italy who studies numerical cognition in fish, believes that Kolm's team made a good case that evolving a larger brain made the fish smarter. But he says that personality might offer another explanation for the results. If larger-brained fish are bolder, they might be more likely to explore their tanks, he says.

It is possible to discount such factors with additional experiments — for instance, through testing personality by observing how fish behave in an open tank — but Agrillo says that it can be difficult to completely rule out alternatives. Rowe says that other studies that report differences in animal intelligence between individuals, such as those looking at mental decline with age, come up against the same problem. “It is a real challenge, and it's one we've got to really try and face,” she says.

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References

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