Guppy study suggests larger brained animals have weaker immune systems

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Male and female guppies (Poecilia reticulata). Image: Wikipedia.

(Phys.org)—A trio of researchers, two with Stockholm University, the other with the Konrad Lorenz Institute of Ethology in Austria, has found via experiments they conducted with guppies, that larger brain size in an organism may lead to a weaker immune system. In their paper published in *Proceedings of the Royal Society B*, Alexander Kotrschal, Niclas Kolm and Dustin Penn describe their experiments and results and why they believe other similar studies may one day prove that larger brained animals tend to have weaker immune systems than do those with smaller brains.

Scientists have suspected for some time that larger brained animals pay for their larger brains by having to survive with reductions in other

organs—animals are capable of supporting only so many energy consuming organs based on how much they eat, their metabolism, etc.—thus, tradeoffs must be made. Prior research has shown, for example, that big brained primates, including humans, tend to have relatively small guts. In this new effort, the researchers wanted to know if a larger brain might also mean a less robust immune system compared to smaller brained animals.

To learn more, they conducted experiments with Trindadian guppies that had been artificially selected for large or small brain size. Each fish had scales from another guppy grafted onto its body—the degree of rejection response by the individual fish over a period of eight days would be a measure of an innate immune response. As expected, the researchers found that those fish that had larger brains tended to exert a less ardent rejection response than did those with smaller brains. Interestingly, the same fish were given a second set of scale grafts two weeks later, but this time around the response was identical for both groups, which suggested that the larger brain did not impact an adaptive immune response.

The researchers note that while the study indicates that larger brains do tend to mean weaker immune systems, nature has found a way to make up the difference—with humans for example, our large brain has meant more intelligence which has allowed us to modify our environment to make us less susceptible to infections and to use natural and artificial remedies to treat illnesses.

More information: Alexander Kotrschal et al. Selection for brain size impairs innate, but not adaptive immune responses, *Proceedings of the Royal Society B: Biological Sciences* (2016). DOI: 10.1098/rspb.2015.2857

Abstract

Both the brain and the immune system are energetically demanding organs, and when natural selection favours increased investment into one, then the size or performance of the other should be reduced. While comparative analyses have attempted to test this potential evolutionary trade-off, the results remain inconclusive. To test this hypothesis, we compared the tissue graft rejection (an assay for measuring innate and acquired immune responses) in guppies (Poecilia reticulata) artificially selected for large and small relative brain size. Individual scales were transplanted between pairs of fish, creating reciprocal allografts, and the rejection reaction was scored over 8 days (before acquired immunity develops). Acquired immune responses were tested two weeks later, when the same pairs of fish received a second set of allografts and were scored again. Compared with large-brained animals, small-brained animals of both sexes mounted a significantly stronger rejection response to the first allograft. The rejection response to the second set of allografts did not differ between large- and small-brained fish. Our results show that selection for large brain size reduced innate immune responses to an allograft, which supports the hypothesis that there is a selective trade-off between investing into brain size and innate immunity.