

Striking differences in brain morphology between wild and domestic rabbits

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Illustration of striking phenotypic differences between domestic and wild rabbits including changes in the size of the amygdala and the medial prefrontal cortex.
Credit: Fabian Sinzinger

The most characteristic feature of domestic animals is tame behaviour. An international team of scientists has now used high-resolution magnetic resonance imaging (MRI) to study how domestication affects brain morphology in domestic rabbits. The results show that domestication has a profound effect on brain morphology in particular regions of the brain involved in fear processing, the amygdala and medial prefrontal cortex. The study is published in *PNAS*.

In contrast to domestic rabbits, wild rabbits have a very strong flight response because they are hunted by eagles, hawks, foxes and humans, and therefore must be very alert and reactive to survive in the wild. In fact, Charles Darwin wrote in *On the Origin of Species* that "...no animal is more difficult to tame than the young of the wild rabbit; scarcely any animal is tamer than the young of the tame [rabbit](#)." There is no doubt that these differences in behaviour between wild and domestic animals to a large extent are genetically determined.

"In a previous study we reported that genetic differences between wild and domestic rabbits are particularly common in the vicinity of genes expressed during brain development," explains Miguel Carneiro, from CIBIO-InBIO, University of Porto, one of the leading authors on the paper. "In the present study, we decided to use high-resolution MRI to explore if these genetic changes are associated with changes in brain morphology," says Miguel Carneiro.

The scientists raised eight domestic and eight wild rabbits under very similar conditions to minimize changes due to environmental effects. Furthermore, the brain MRI data were interpreted with sophisticated image analysis in which the scientist carrying out the analysis was unaware of the status [animals](#) (wild or domestic).



Madonna of the rabbit, painted 1530 by Tiziano Vecellio, The Louvre, Paris. A painting illustrating a domestic rabbit from the 16th century with altered coat color and behavior compared with a wild rabbit. Credit: UM SEGUNDO FILMES/CIBIO, Porto, Portugal.

"We observed three profound differences between the brains of wild and domestic rabbits," says Irene Brusini, first author and Ph.D. student at KTH Royal Institute of Technology in Stockholm. "Firstly, wild rabbits have a larger brain-to-body size ratio than domestic rabbits. Secondly,

domestic rabbits have a reduced amygdala and an enlarged [medial prefrontal cortex](#). Thirdly, we noticed a generalized reduction in white matter structure in domestic rabbits."

"These differences in brain morphology make perfect sense in relation to the fact that domestic rabbits are less fearful and have an attenuated flight response compared with wild rabbits," explains Mats Fredrikson, Professor at Uppsala University and Karolinska Institutet, one of the senior authors on the paper. "Our results show that an area involved in sensing fear (the amygdala) is smaller in size while an area controlling the response to fear (the medial prefrontal cortex) is larger in domestic rabbits. The reduced amount of white matter suggests that domestic rabbits have a compromised information processing possibly explaining why they are more slow reacting and phlegmatic than their wild counterparts."

"No previous study on animal domestication has explored changes in brain morphology between wild and [domestic animals](#) in such depth as we have done in this study," says Leif Andersson, Uppsala University, Swedish University of Agricultural Sciences and Texas A&M University. "When we initiated the study the concern was that any changes may be too subtle to be noticeable with MRI but that was clearly not the case as we noticed distinct changes. This study is not only important for our understanding of animal domestication but also for the basic understanding how variation in [brain morphology](#) can impact a complex behaviour like fear response," says Leif Andersson.

More information: Irene Brusini et al., "Changes in brain architecture are consistent with altered fear processing in domestic rabbits," *PNAS* (2018). www.pnas.org/cgi/doi/10.1073/pnas.1801024115

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