

The MRI of Darwin: The Brain Catalogue

Mathieu David Santin¹, Marc Herbin², Florencia Grisanti², and Roberto Toro^{3,4}

¹CENIR, ICM, Paris, France, ²UMR 7179, Museum National d'Histoire Naturelle, Paris, France, ³Human Genetics and Cognitive Functions, Institut Pasteur, Paris, France, ⁴CNRS URA 2182, Genes, synapses and cognition, Paris, France

Purpose

Our aim is to create an open-access library of more than 1800 brain MRI datasets, covering the whole range of vertebrate species. These brains come from the Vertebrate Brain Collection of the National Museum of Natural History (Jardin des Plantes, MNHM, Paris, France, and have been conserved since the late 19th century. We intend to create a web portal in the spirit of Citizen Science, providing access to high quality data and tools that should allow everyone to discover both the incredible diversity but also the remarkable similarities of the vertebrate brain. Similar to the GalaxyZoo¹ portal in astronomy, the Brain Catalogue should connect professional scientists with a large community of citizen science, allowing us to tackle studies that would be otherwise impossible for any single laboratory. Finally, the Brain Catalogue should help reinvigorate the research in comparative neuroanatomy, and provide a new evolutionary, phylogenetic context to the study of human neuroanatomical variability.

Methods

MRI was performed using a 3T Siemens Tim Trio system (Siemens, Germany) with a 3D gradient-echo sequence (FLASH) with various parameters (Field of View, Matrix size, TR, TE), depending on the size of the object. Due to the age of the collection (end of 19th - early 20th century) and the lack of information about the methods used to fixate and preserve brains, we kept them in their own jar to prevent degradation by manipulation or air contamination. We fixed parameters to obtain the highest resolution achievable with our scanner (from 250 to 330 μm^3). TR and TE were always chosen as minimum (around 25 ms for TR, 6 ms for TE). Flip angle was fixed to 20°. The number of averages was chosen to maintain a scanning time length below 12 hours. After acquisition, data sets were bias corrected using N4, the cerebrum was interactively segmented using in house software. We computed surface reconstructions of the complete cerebrum, and used in house interactive software to ensure that the reconstructions were topologically spherical. We used different methods to estimate apparent cortical thickness, pattern and degree of folding, and used diffusion-based 2-D parameterizations of the cortical surface to produce different flat representations (Mercator, Polar stereographic, etc...)

Results

A first pilot was conducted with 8 specimens: Slow loris, Red squirrel, Bottlenose dolphin, Black rhinoceros, Sloth bear, Blackbuck, Leopard and Crocodile, which were scanned, processed and are available online at <http://siphonophore.org/braincatalogue>. An example shown in Figure 1, which shows a Sloth bear brain (330 μm isotropic resolution) and the processing done.

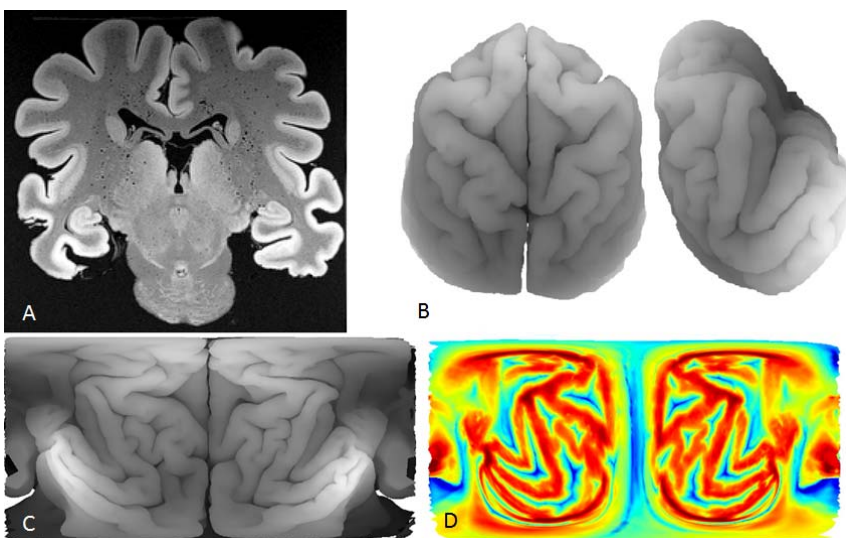


Figure 1: A. MRI of the Sloth bear brain (330 μm isotropic resolution). B. Reconstruction of the surface of the brain. C. Mercator projection of the brain color coded for sulcal depth. D. Mercator projection a flattened cortical surface, color coded for mean curvature.

Discussion

Our objective is to scan over 1800 specimens. Our aim is to develop a Citizen Science platform to provide access to this unique dataset of high-quality data to collaboratively process, segment, reconstruct, label and in general study the evolution and phylogeny of the vertebrate brain. We are currently exploring different methods to enrich the number of acquisition modalities, in particular, the possibility to add diffusion data to the catalogue.

References

1. GalaxyZoo <http://galaxyzoo.org/>