FIIND: Ferret Interactive Integrated Neurodevelopment Atlas

Main area: Neuroinformatics
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Abstract

The first days after birth in ferrets provide a privileged view of the development of a complex brain. Unlike mice, ferrets develop a rich pattern of deep neocortical folds and cortico-cortical connections. Unlike humans and other primates, whose brains are well differentiated and folded at birth, ferrets are born with a very immature and completely smooth neocortex: folds, neocortical regionalisation and cortico-cortical connectivity develop in ferrets during the first postnatal days. After a period of fast neocortical expansion, during which brain volume increases by up to a factor of 4 in 2 weeks, the ferret brain reaches its adult volume at about 6 weeks of age. Ferrets could thus become a major animal model to investigate the neurobiological correlates of the phenomena observed in human neuroimaging. Many of these phenomena, such as the relationship between brain folding, cortico-cortical connectivity and neocortical regionalisation cannot be investigated in mice, but could be investigated in ferrets.
Our aim is to provide the research community with a detailed description of the development of a complex brain, necessary to better understand the nature of human neuroimaging data, create models of brain development, or analyse the relationship between multiple spatial scales. We have already started a project to constitute an open, collaborative atlas of ferret brain development, integrating multi-modal and multi-scale data. We have acquired data for 28 ferrets (4 animals per time point from P0 to adults), using high-resolution MRI and diffusion tensor imaging (DTI). We have developed an open-source pipeline to segment and produce – online – 3D reconstructions of brain MRI data.
We propose to process the brains of 16 of our specimens (from P0 to P16) using high-throughput 3D histology, staining for cytoarchitectonic landmarks, neuronal progenitors and neurogenesis. This would allow us to relate the MRI data that we have already acquired with multi-dimensional cell-scale information. Brains will be sectioned at 25 µm and scanned at 0.25 µm of resolution, and processed for real-time multi-scale visualisation. We will extend our current web-platform to integrate an interactive multi-scale visualisation of the data. Using our combined expertise in computational neuroanatomy, multi-modal neuroimaging, neuroinformatics, and the development of inter-species atlases, we propose to build an open-source web platform to allow the collaborative, online, creation of atlases of the development of the ferret brain. The web platform will allow researchers to access and visualise interactively the MRI and histology data. It will also allow researchers to create collaborative, human curated, 3D segmentations of brain structures, as well as vectorial atlases. Our work should provide a first integrated atlas of ferret brain development, and the basis for an open platform for the creation of collaborative multi-modal, multi-scale, multi-species atlases.

Consortium

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