A novel 11.7T ultra-high field dmri connectivity atlas of the japanese quail

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#Th749 : A novel 11.7T ultra-high field diffusion MRI structural connectivity atlas of the Japanese quail

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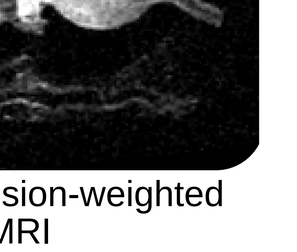
The Japanese quail (*Coturnix japonica*)

This little nidifugous bird presents a quantifiable response to fear : **tonic immobility**[1]. This behavioral characteristic leads to two breeding lines of quails :

- The short time immobility (STI)
- The long time immobility (LTI)



A Japanese quail showing tonic immobility

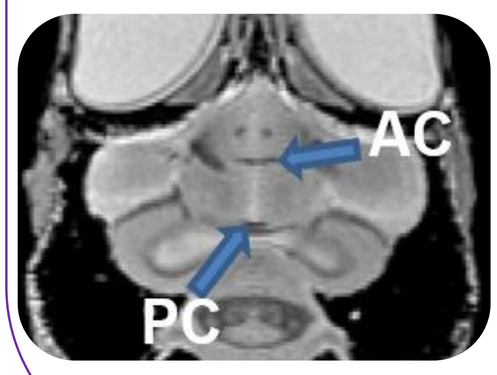
Research hypothesis: The two lines do not show the same cerebral organization, and more specifically for the emotional fear circuit.

Goal: Establishing a structural connectivity atlas of the Japanese quail using diffusion magnetic resonance imaging (dMRI) to compare lineages.

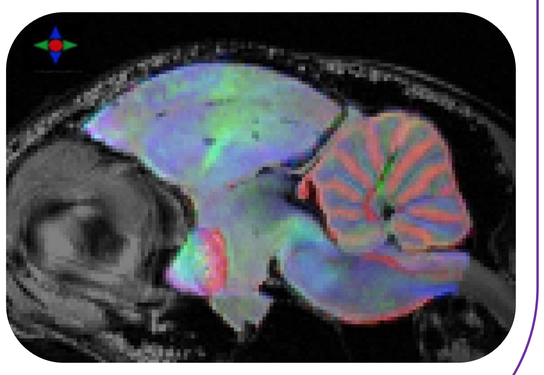
Sample before and after plucking for scanning

200µm diffusion-weighted MRI

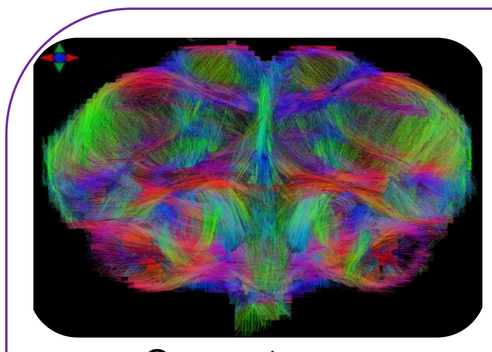
From sample preparation to anatomical and diffusion data at 11.7T



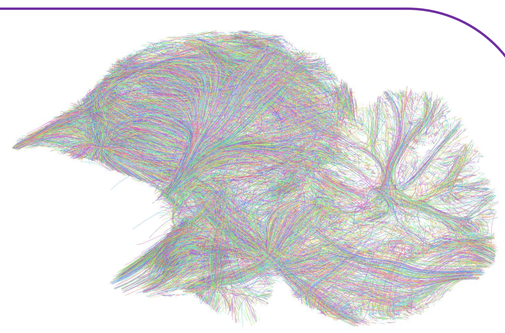
150µm anatomical MRI



RGB diffusion direction map

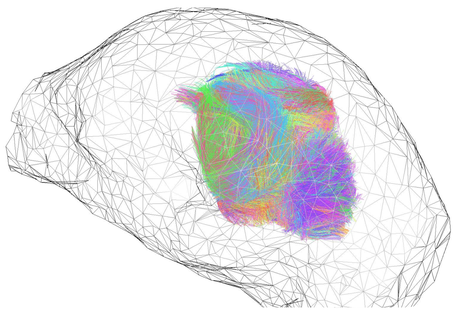


Connectogram



Intra-subject fiber clustering

From connectograms to inter-subject fiber clustering



Inter-subject fiber clustering

223 clusters found

Material and methods

The cohort : 21 male and sexually mature Japanese quails including 11 LTI and 10 STI scanned *post mortem*

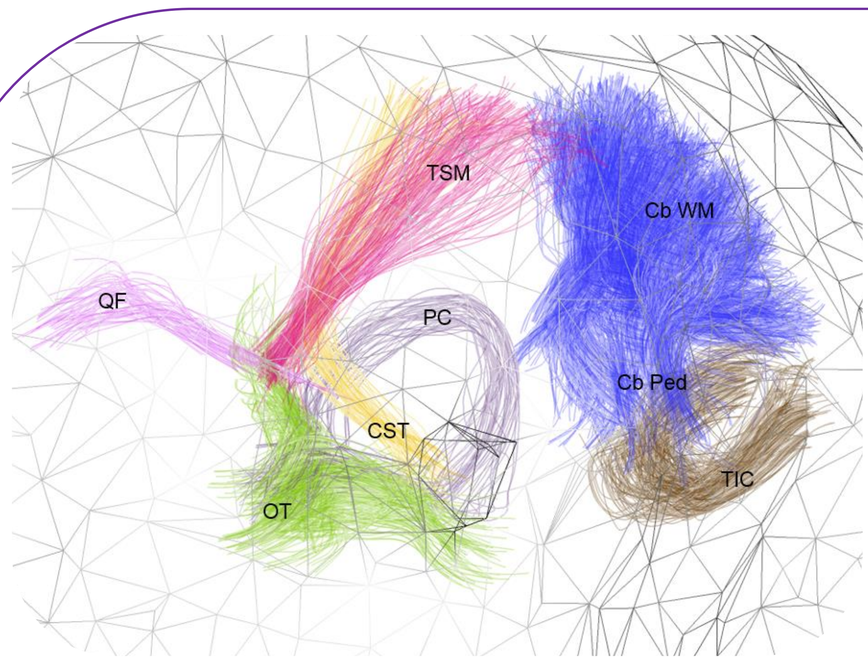
MRI system : Preclinical Bruker 11.7T MRI scanner (G_{max}=780mT/m)

Protocol scan : 16 hours of acquisition per sample including:

- Anatomical MRI: 2D T_2-weighted spin echo,150µm, TE/TR=16ms/9s
- Diffusion MRI: 3D segmented EPI using PGSE, 75 directions, 200µm, TE/TR=23.88ms/250ms, 18 segments, *b*=4500s/mm²

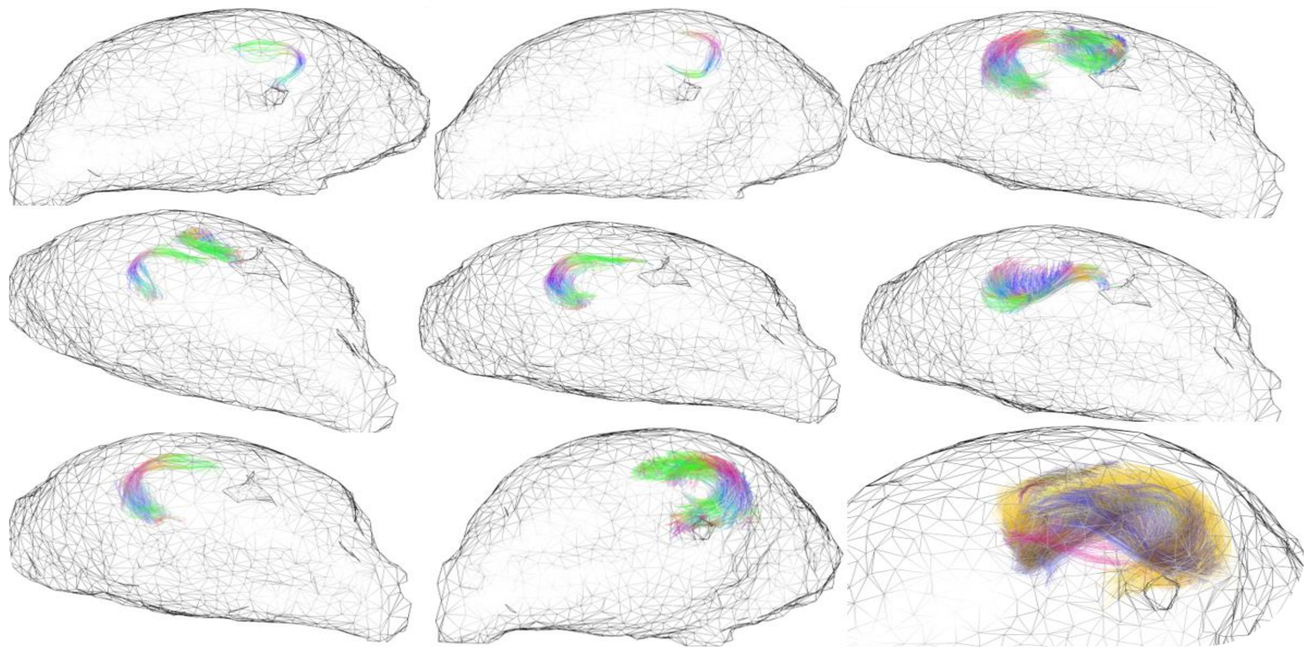
Post-processing :

- No preprocessing required (high SNR level and very few artifacts)
- Definition of a template space using the subject that is the closest to the others as the reference (affine registrations and a scaling criterion)
- Reorientation of the scans in AC-PC frame (anterior and posterior commissures)
- Manual segmentation of the brain masks
- Local modeling of the diffusion process with DTI and analytical QBI[2] (SH=8; λ=0.006)
- Streamline regularized deterministic tractography in Connectomist[3]
- Fiber clustering at the individual and population scales[4]
- Labeling of the inter-subject centroids to create an atlas



The structural connectivity atlas of the Japanese quail showing 8 major white matter bundles:
The posterior commissure (PC), the corticospinal tract (CST), the cerebellar peduncles (Cb Ped), the optic tract (OT), the septopallio-mesenphalic tract (TSM), the isthmocerebellaris tract (TIC), the cerebellum white matter (Cb WM), and the quintofrontal tract (QF).

The structural connectivity atlas of the Japanese quail and the connections of its emotional fear circuit



The connections of the emotional fear circuit of the Japanese quail.

Two structures specifically involved: the arcopallium and the nucleus taenia of amygdala (TnA).[5]

Prospects

- Methodological optimization (diffeomorphic registration)
- Combining this atlas with a 3D anatomical atlas of the Japanese quail to understand how its neuroanatomical structures communicate

References

[1] Mills and Faure, 1991
[2] Tuch, 2004
[3] Perrin et al., 2005
[4] Guevara et al., 2011
[5] Saint-Dizier, 2008

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