

Neuroanatomy

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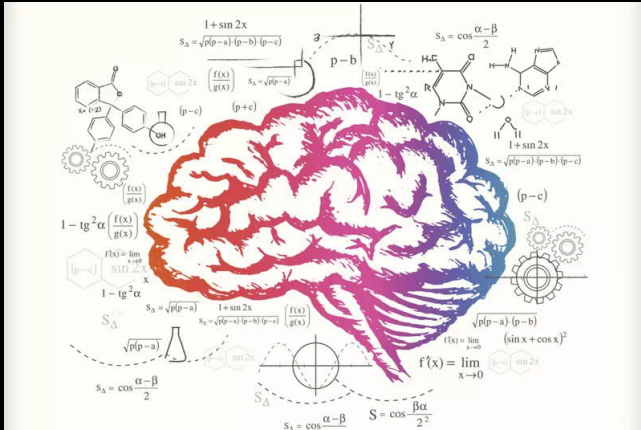
Kubiac
May 24, 2022

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THE BRAIN

Complex



Oversimplify

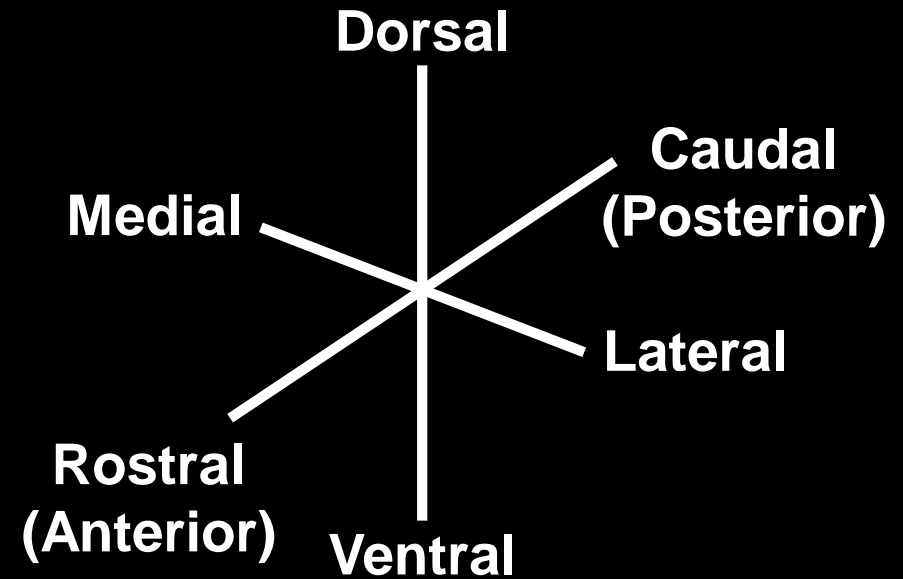
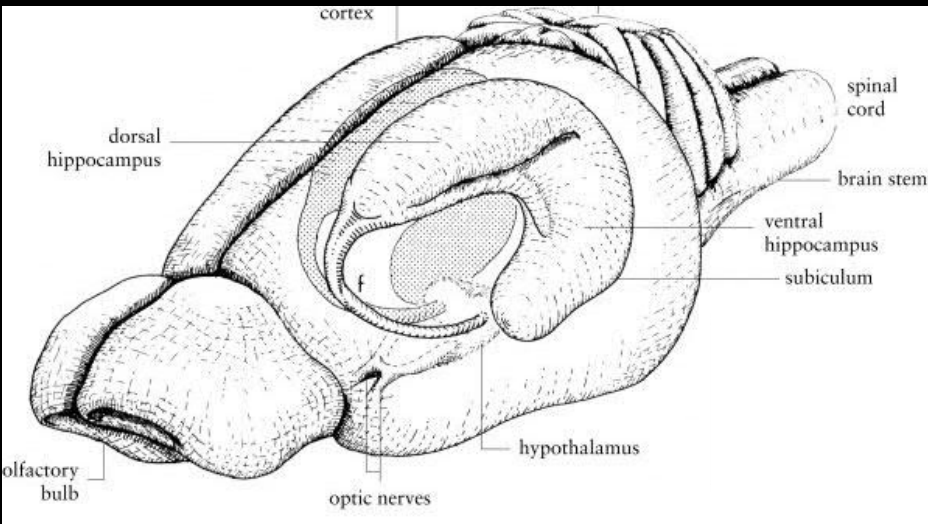


OUTLINE

- Basics of neuroanatomy
- What do we see in MRI?
- Guidelines to analyze MR images of the brain

BASICS OF NEUROANATOMY

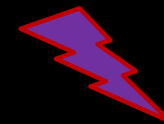
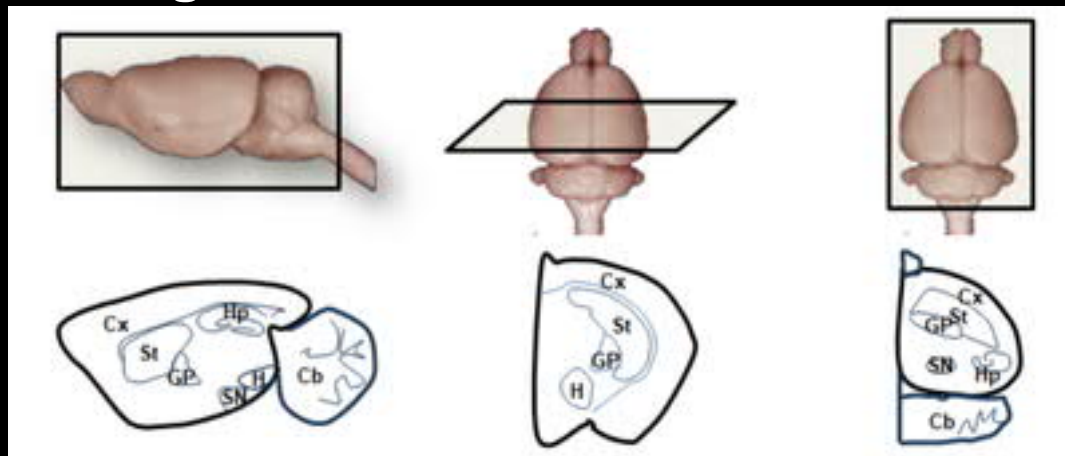
ANATOMICAL REFERENCES



Sagittal

Coronal

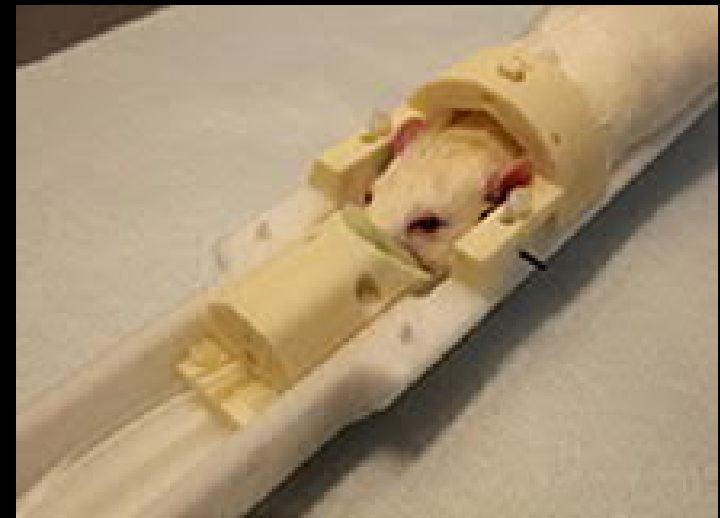
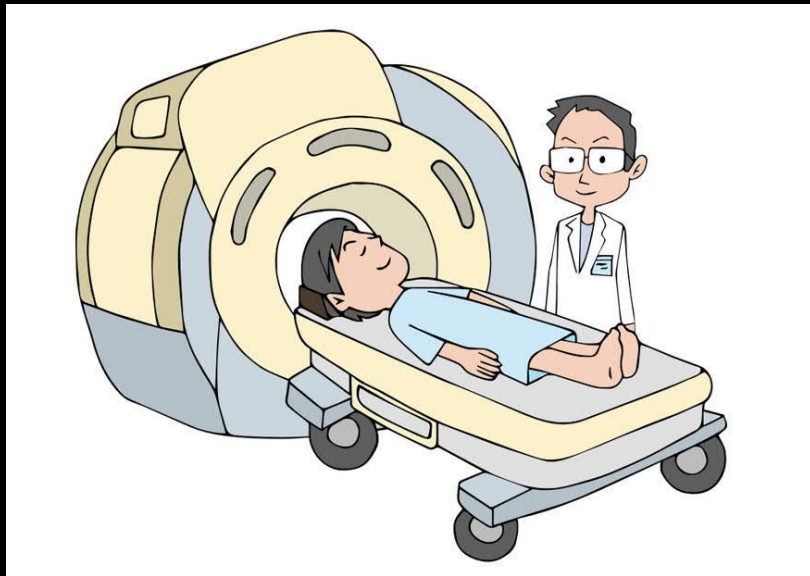
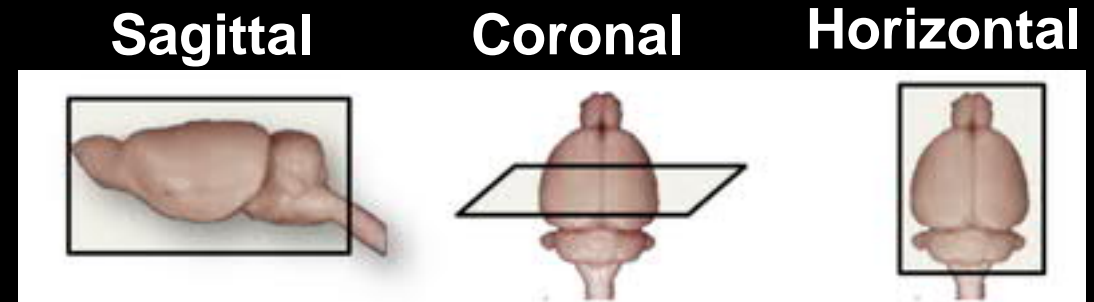
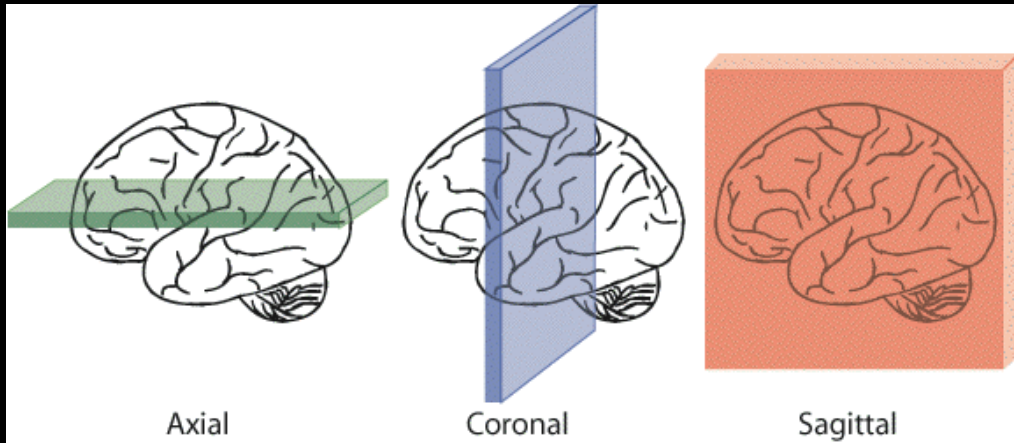
Horizontal (axial)



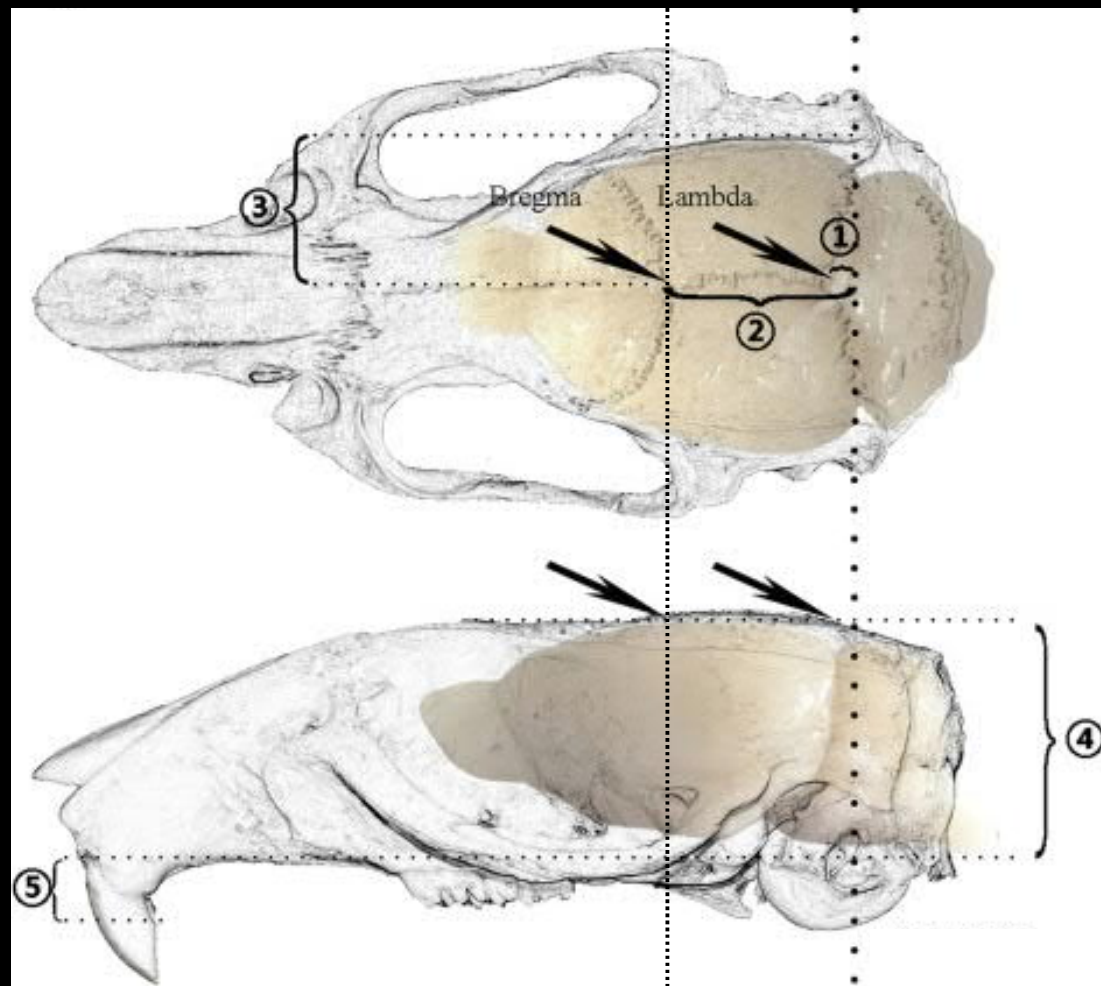
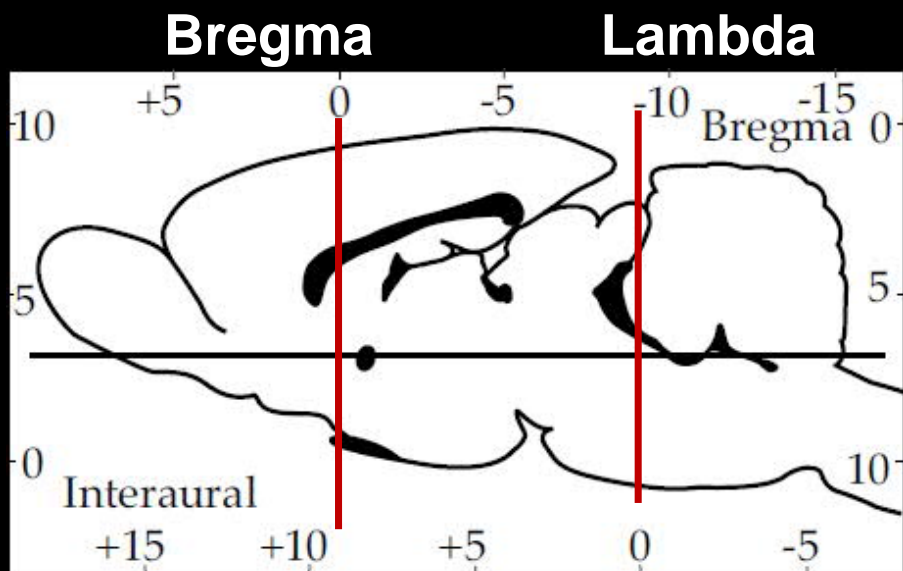
Warning:

Anatomical planes match in clinical scanners, but not in small animal scanners

ANATOMICAL PLANES



ANATOMICAL REFERENCES



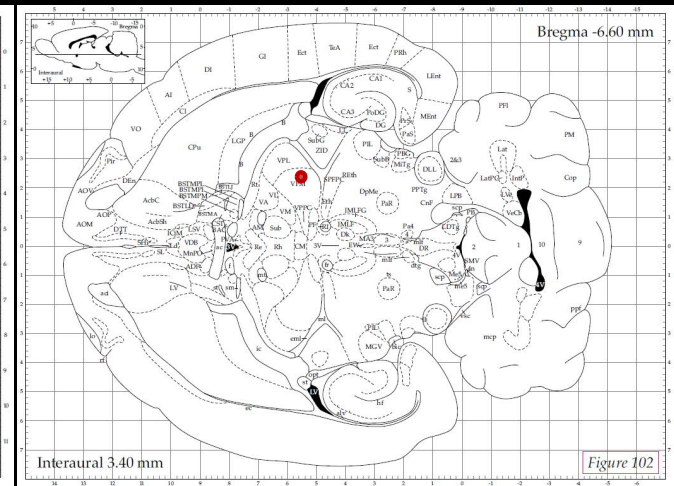
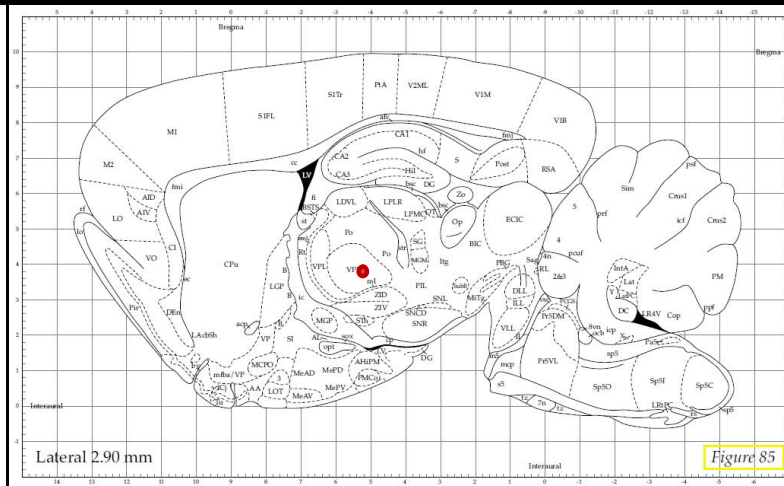
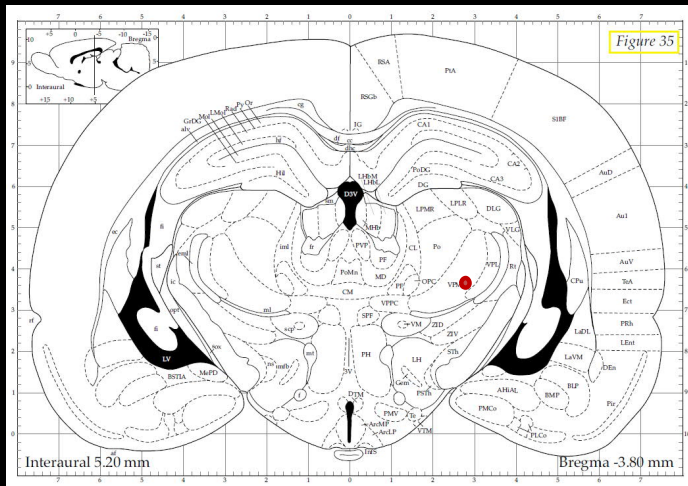
ANATOMICAL COORDINATES

Ventral posteromedial thalamic nucleus (VPM)

AP -3.80 mm from bregma

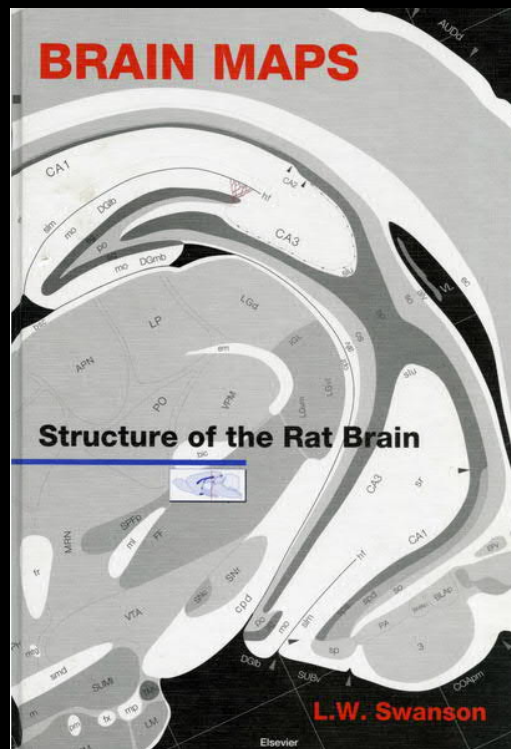
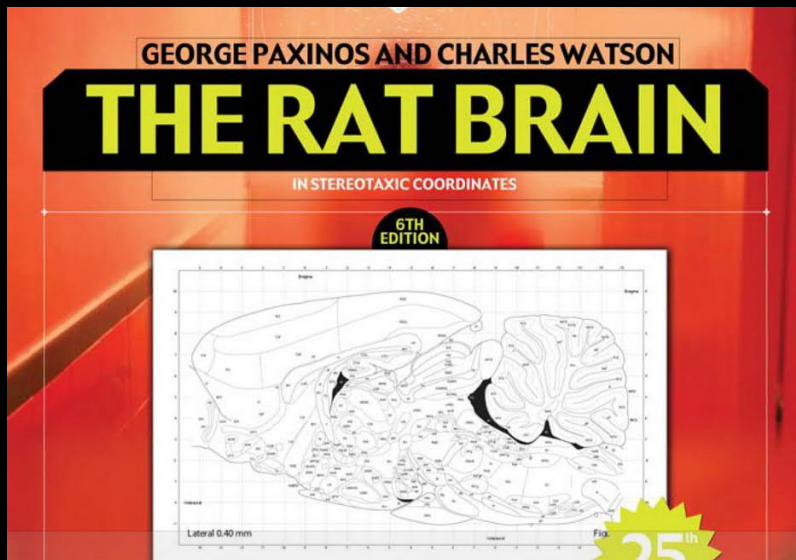
ML 2.90 mm from midline

DV - 6.60 mm from dura

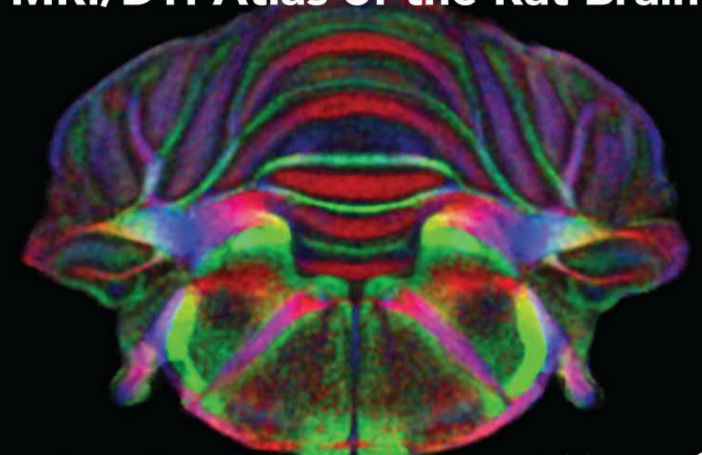


ATLASES

Brain atlases can help to navigate through the brain



MRI/DTI Atlas of the Rat Brain



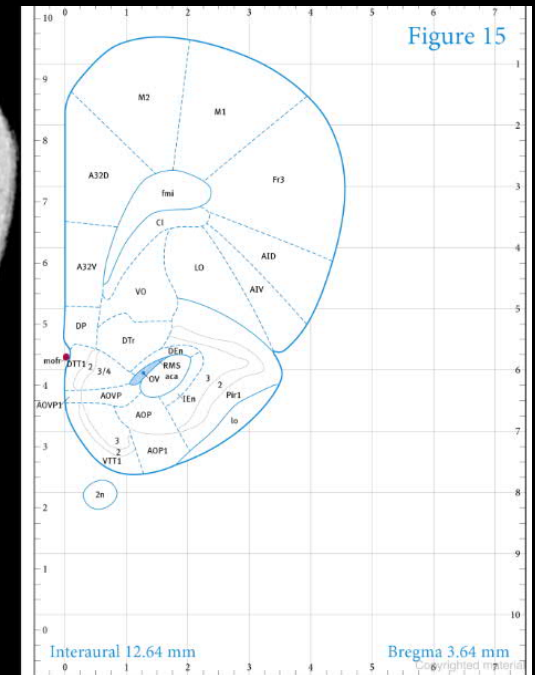
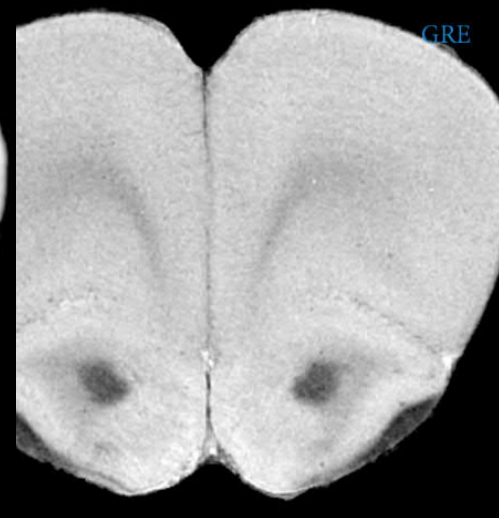
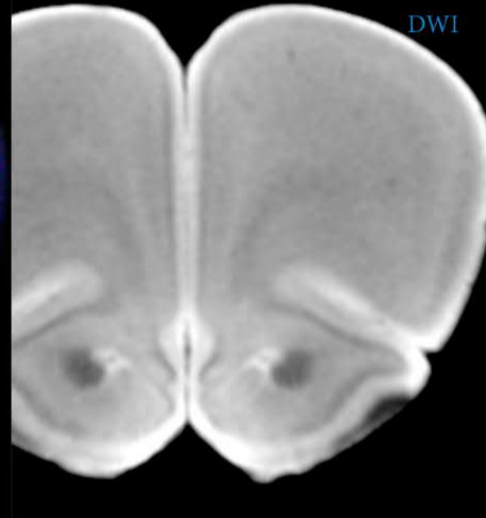
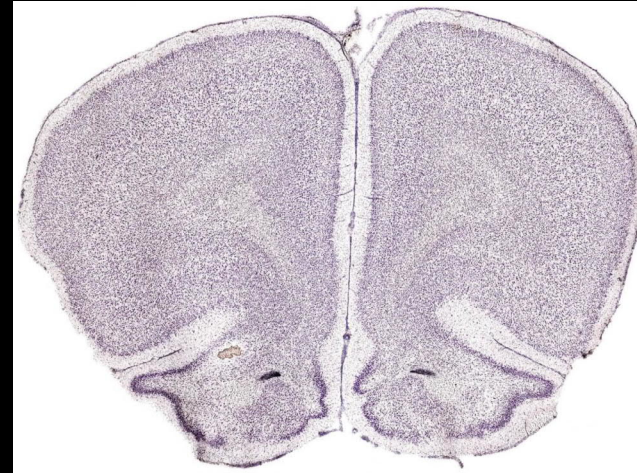
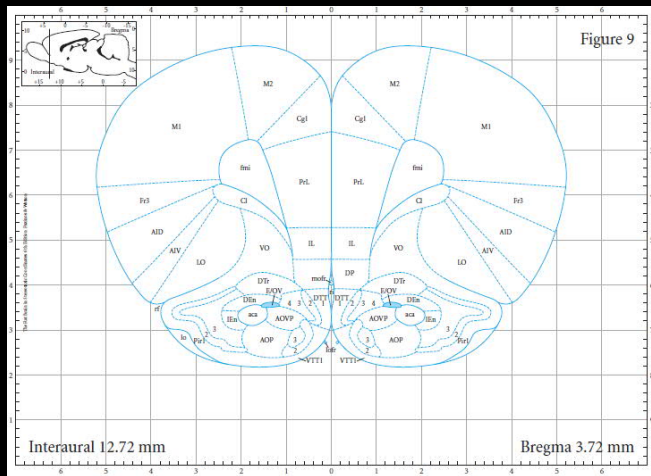
George Paxinos, Charles Watson, Evan Calabrese,
Alexandra Badea and G. Allan Johnson



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ATLASES

Paxinos atlas

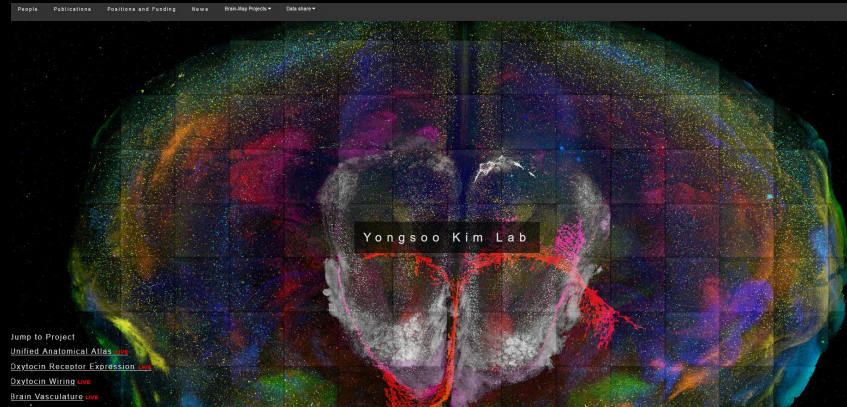


MRI/DTI atlas of the rat brain

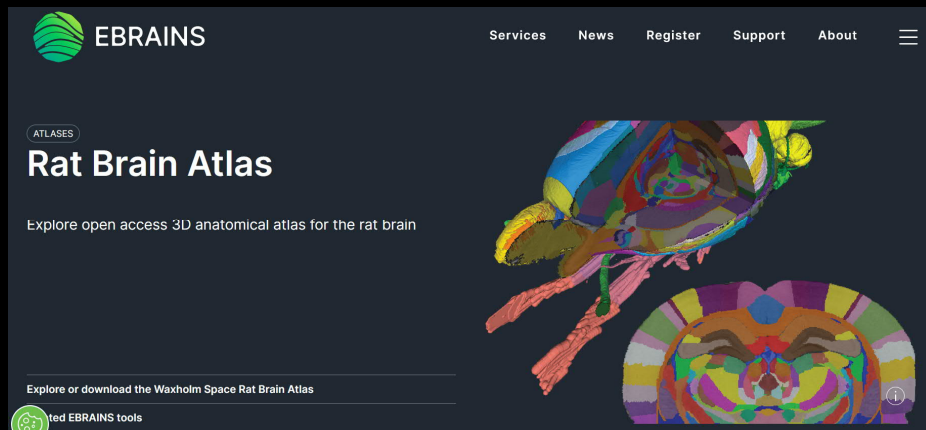
ATLASES

Online atlases for 3D navigation

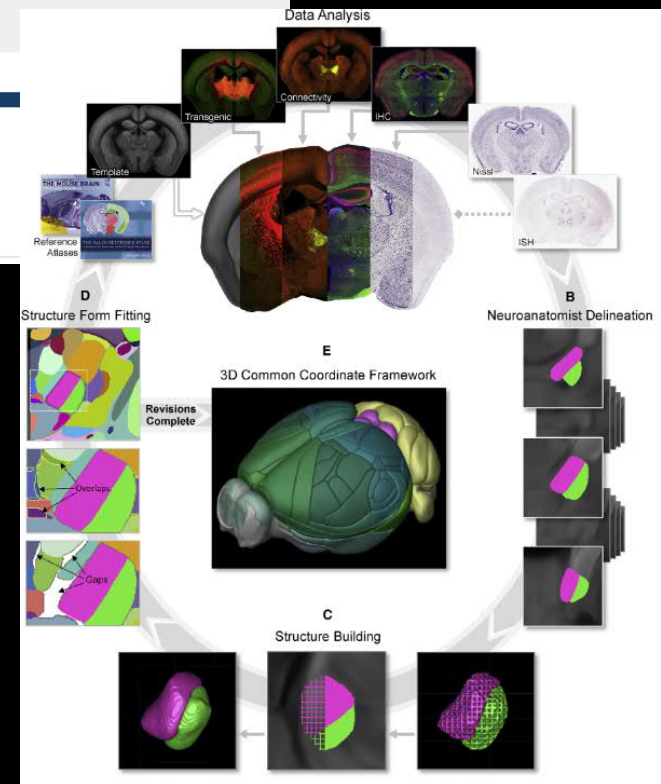
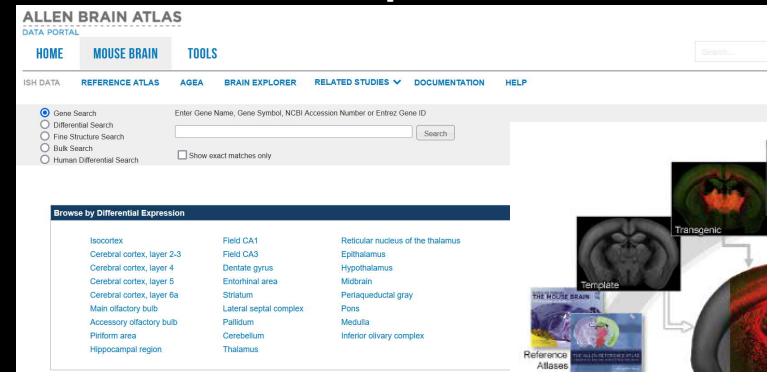
<https://kimlab.io/>

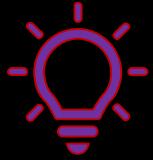


<https://ebrains.eu/service/rat-brain-atlas/>



<https://mouse.brain-map.org/>

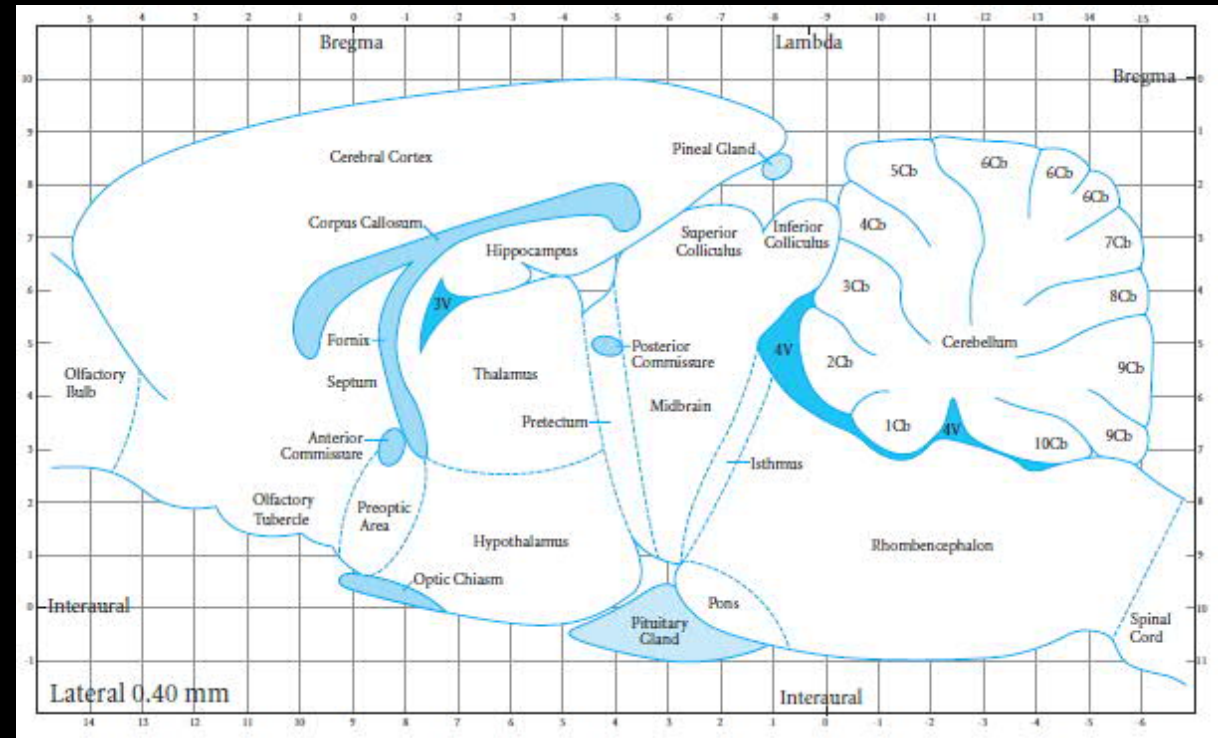
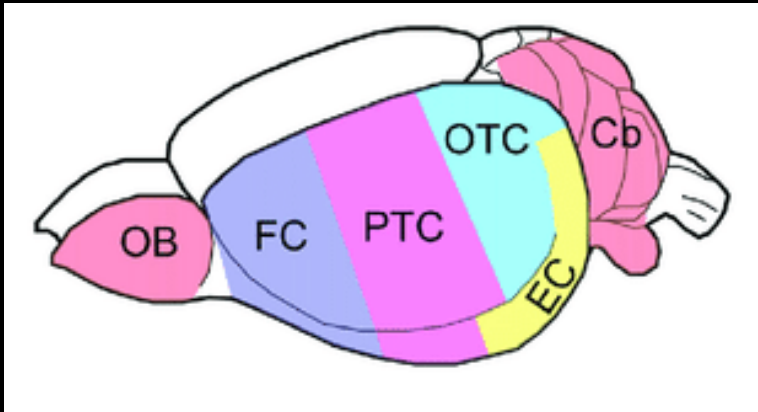




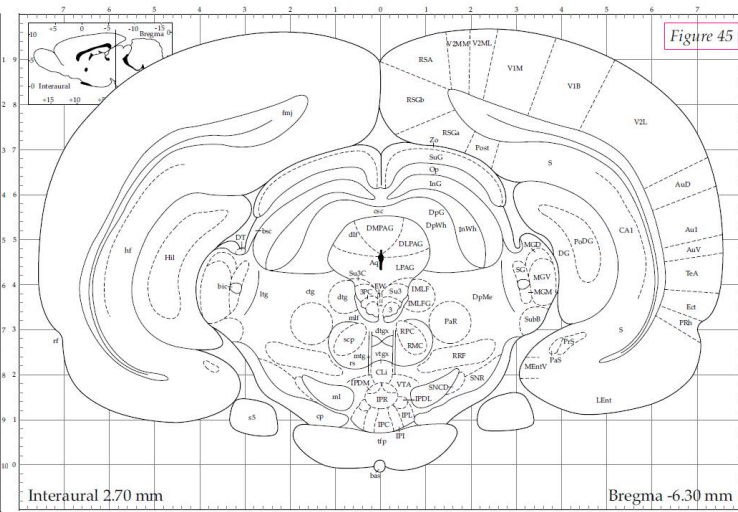
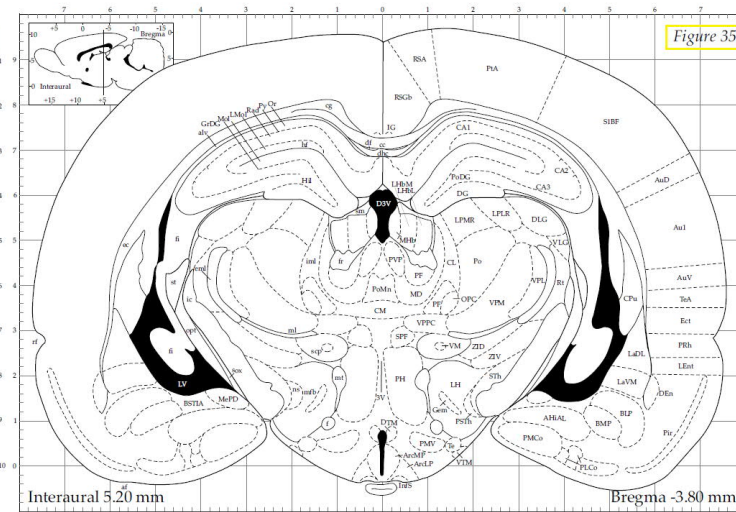
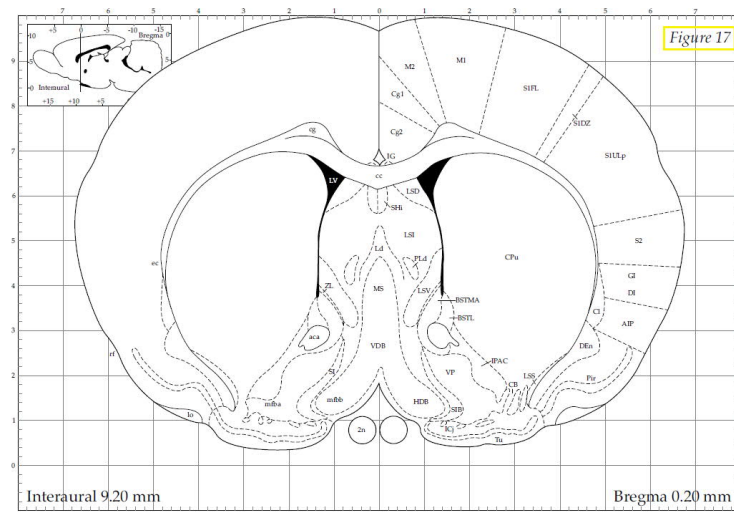
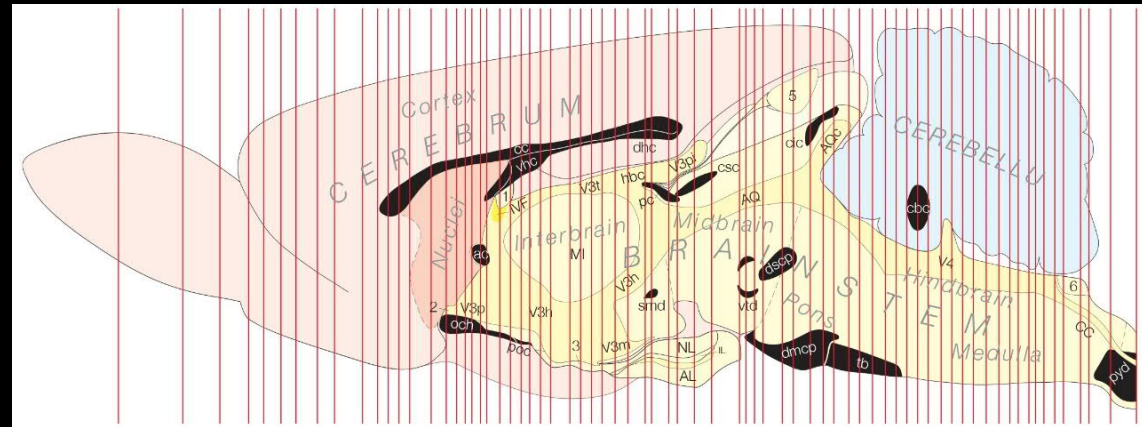
Tips:

- **Choose an atlas based on mouse/rat strain, age, or technique**
- **Use the atlas!**

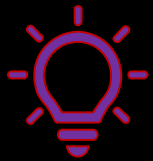
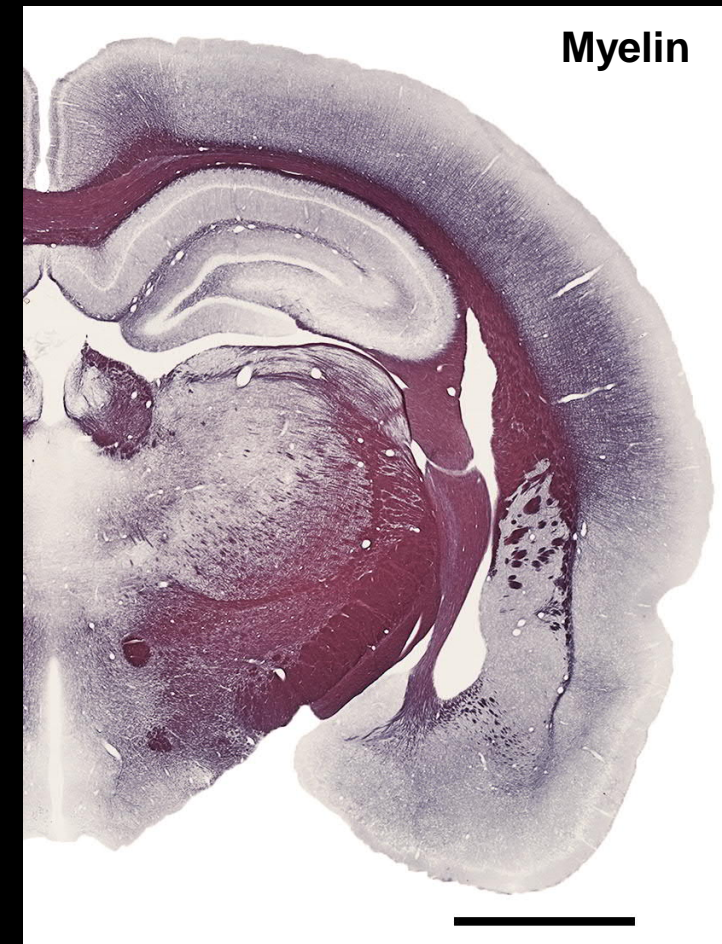
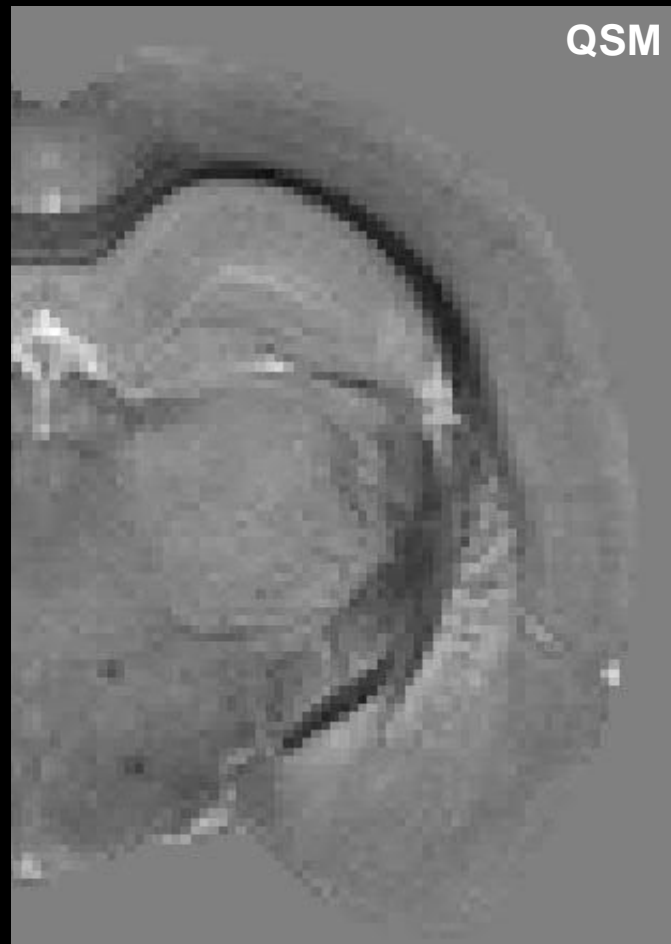
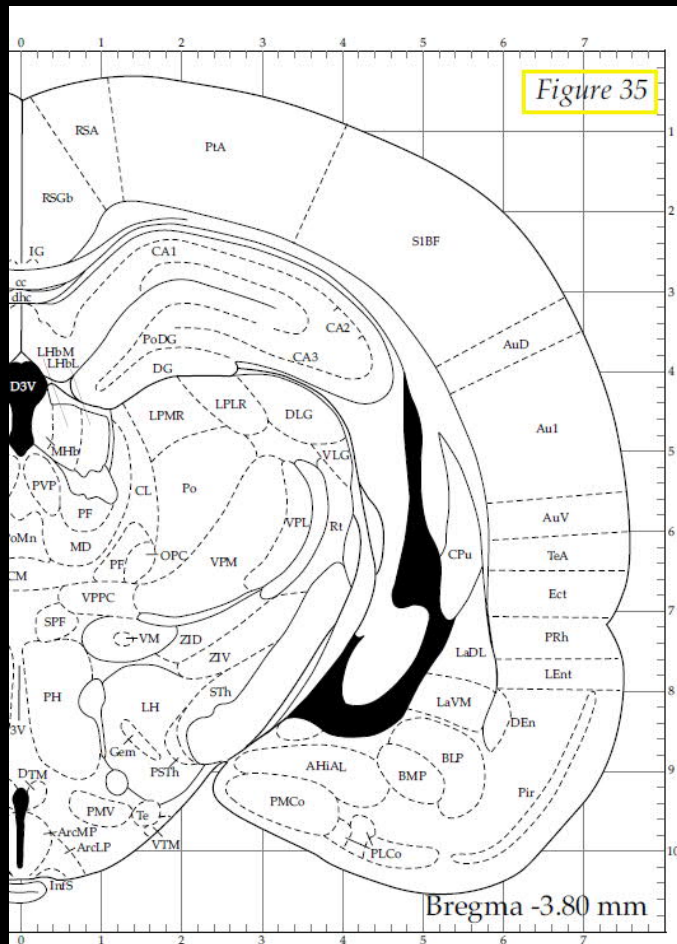
GROSS ANATOMY OF THE BRAIN



INTO THE ANATOMY OF THE BRAIN



WHITE AND GREY MATTER

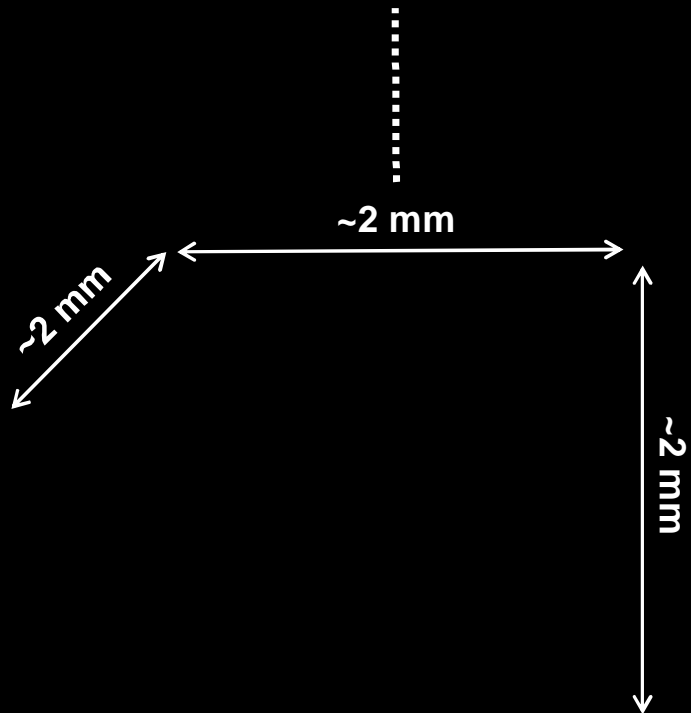


Tip: Use the white/grey matter contrast and other anatomical landmarks to navigate in the brain

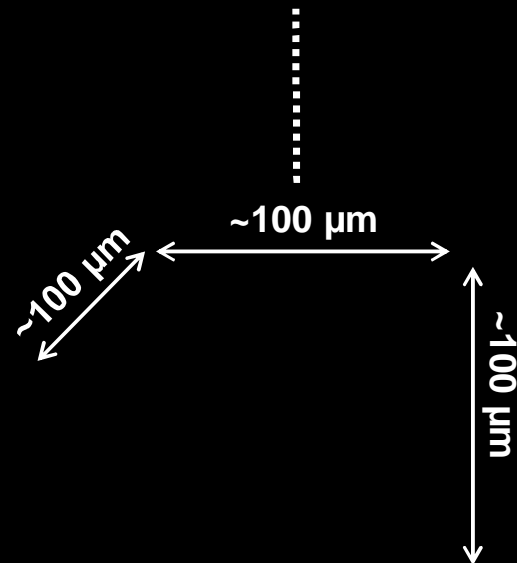
WHAT DO WE SEE IN MRI?

A VOXEL IN MRI

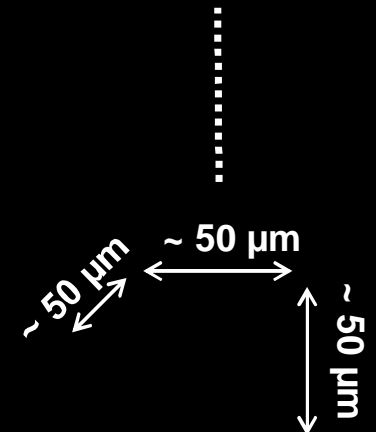
Clinical settings
1.5, 3 and 7 T



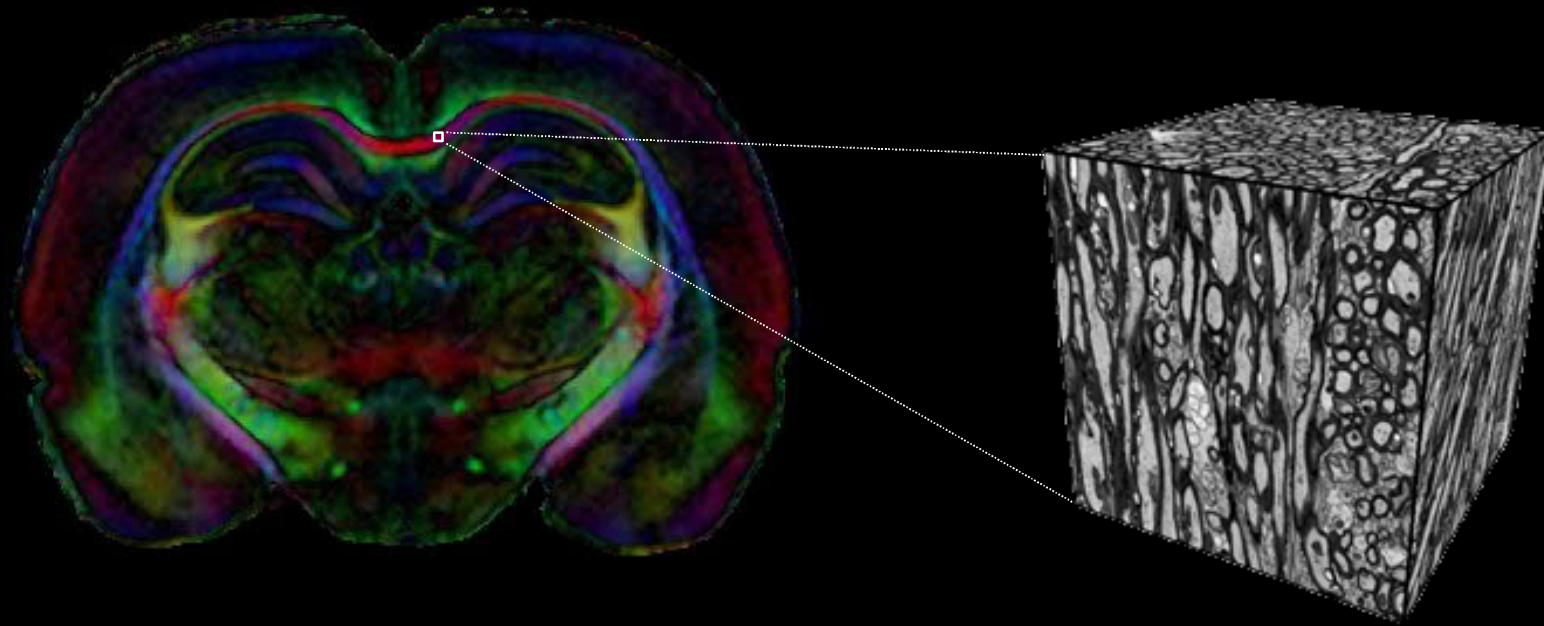
Research settings
7 and 9.4 T



Research settings
11.7 T



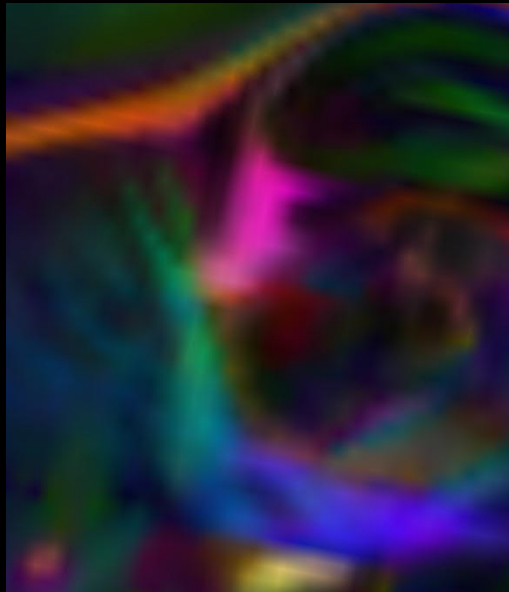
THE COMPLEXITY OF THE MRI VOXEL



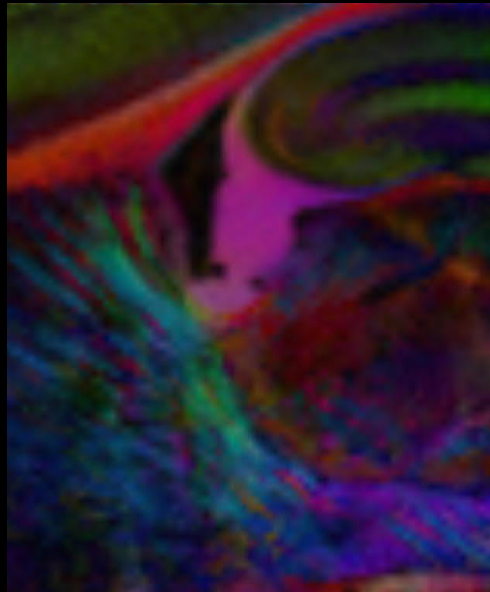
Each imaging voxel provides information of highly complex microstructural environment

SPATIAL RESOLUTION IN MRI

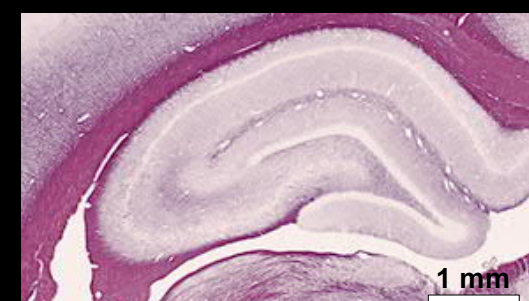
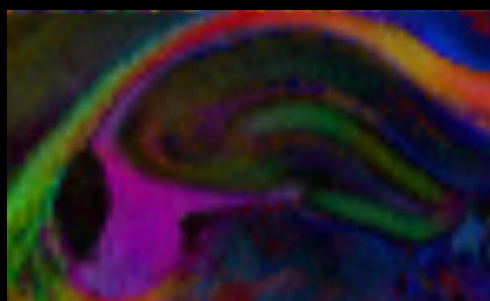
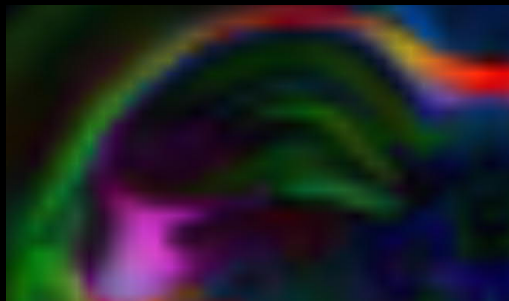
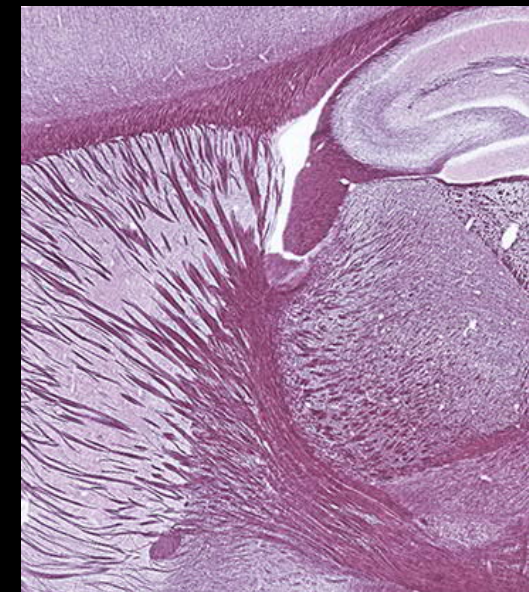
9.4-T scanner
150 x 150 x 150 μm^3



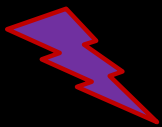
11.7-T scanner
60 x 60 x 60 μm^3



Histology
Myelin staining



DV
RC LR



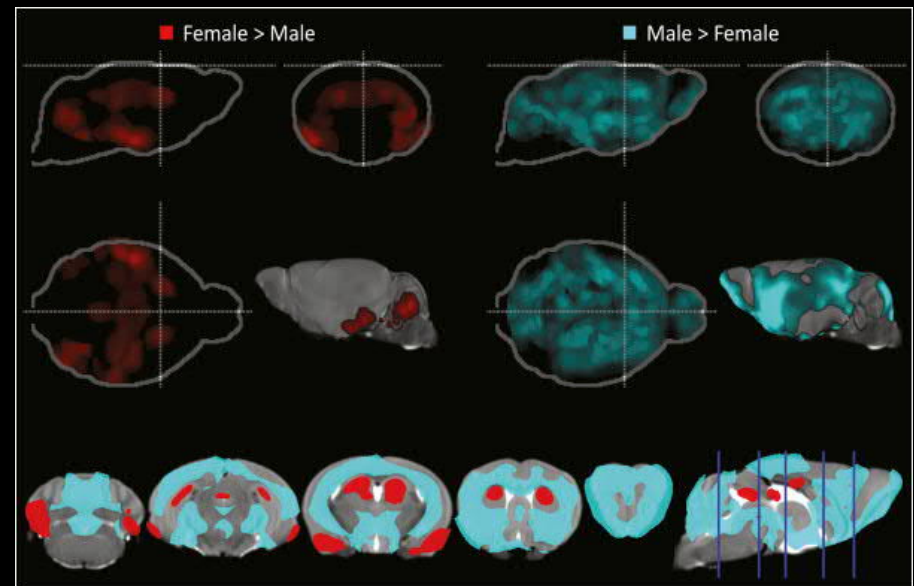
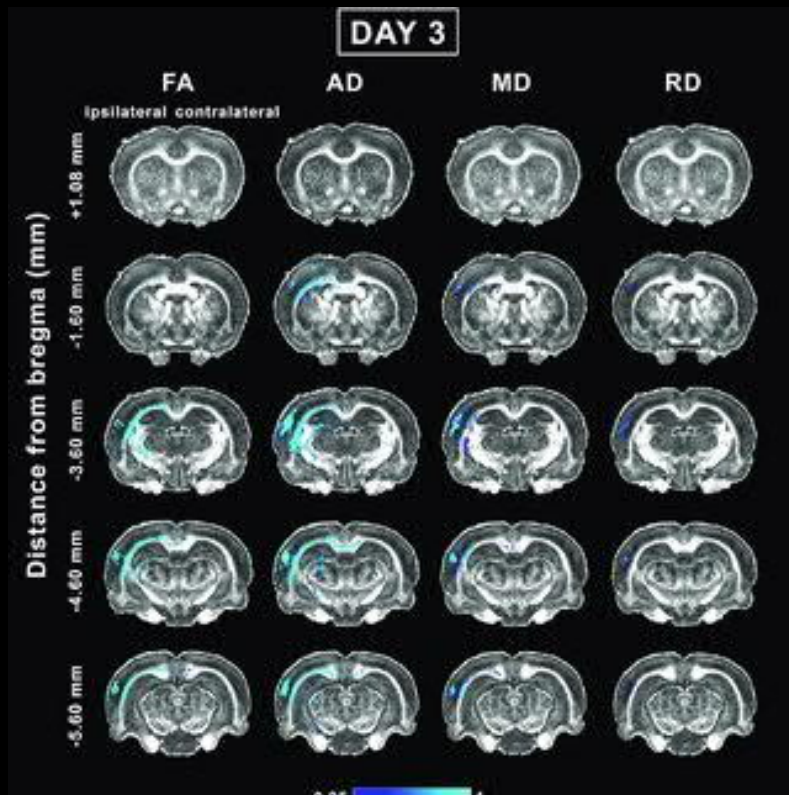
Warning: Take into account the resolution and partial volume effect

GUIDELINES FOR ANALYSIS

ANALYSIS OF MR IMAGES

The goal of MR image analyses is to extract quantitative information of the healthy and diseased brain

- Whole-brain analysis: voxel-wise or voxel-based morphometry



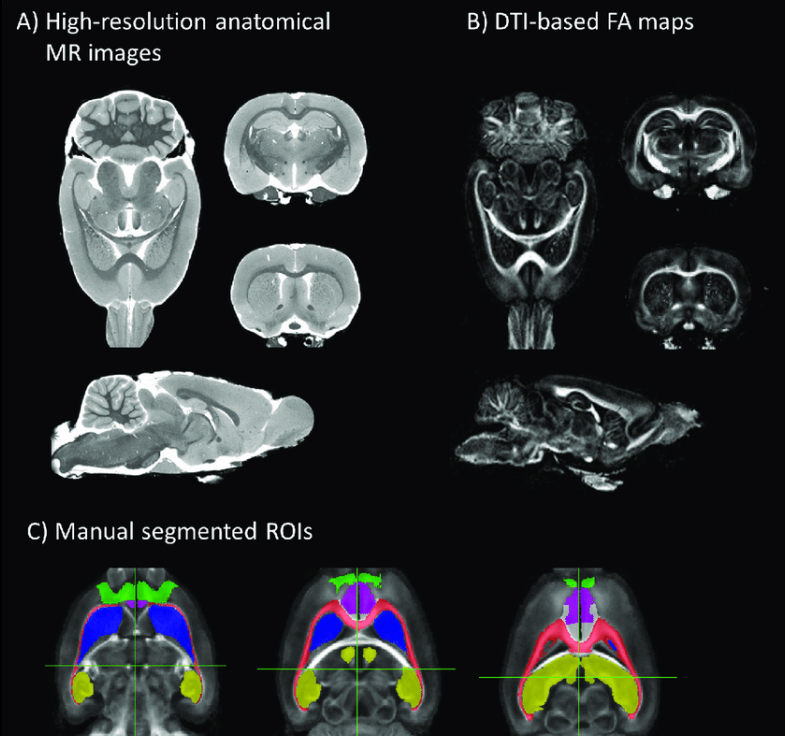
Meyer et al (2017) *NeuroImage* 163, 197-205

San Martin Molina et al (2020) *ENEURO*.0476-19.2020

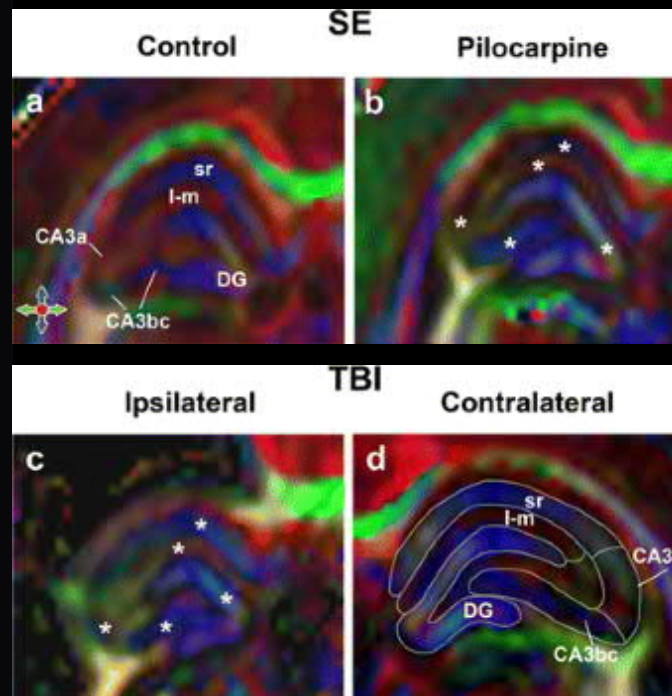
ANALYSIS OF MR IMAGES

- Region-of-interest (ROI)-based analysis:

Anatomical

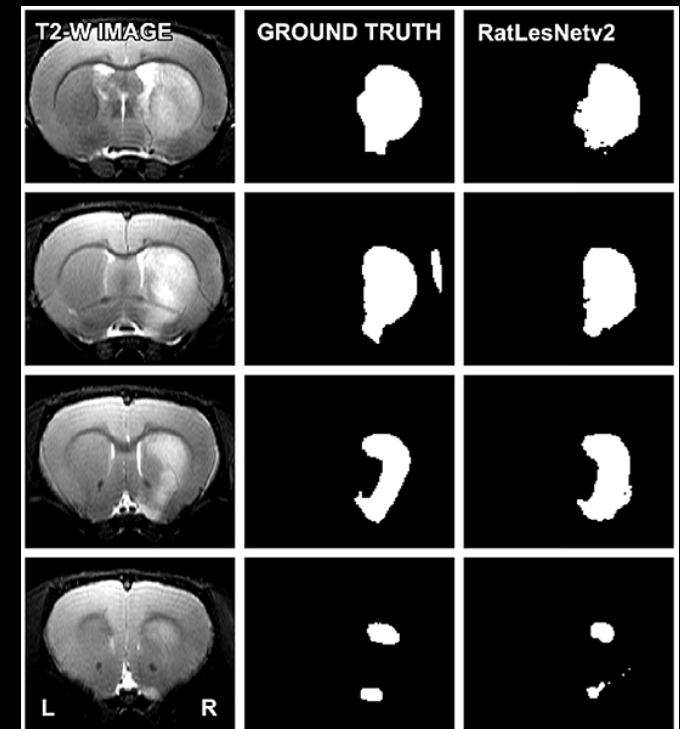


Sarabdjitsingh et al (2017) *PLoS One* 25;12(9):e0185061

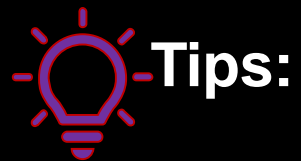


Sierra et al (2015) *Brain Structure and Function* 220:781–801

Regional



Valverde et al (2020) *Front Neurosci* 22;14:610239



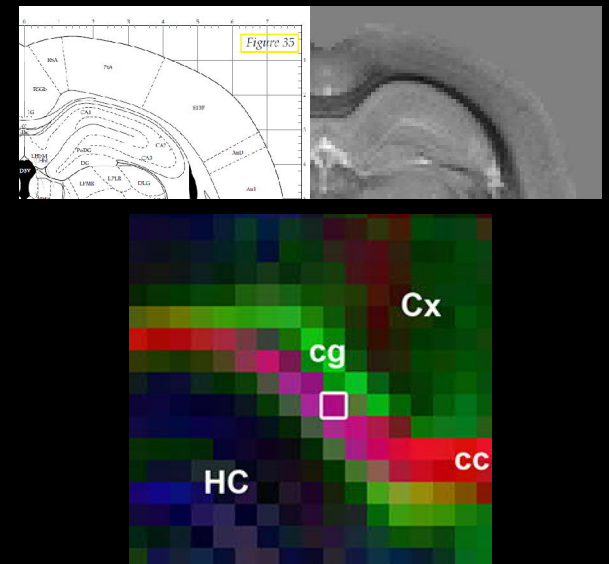
Tips:

- Plan your analysis based on the scientific question
- Consult an atlas (or expert) to outline ROIs or name highlighted areas
- Be consistent!



Warnings:

- Be careful when outlining what is not visible
- Not two people outline ROIs in the same way
- Partial volume effect can introduce errors in the analysis



SUMMARY

Basic knowledge in brain anatomy can guide an MRI analysis

The atlas is a useful tool to navigate throughout the brain

There is multiple ways to perform analysis on MR images:

design the analysis based on the scientific question, but....

....keep in mind the complexity of the brain

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