

Quantitative and Volumetric and Diffusion Weighted MRI Analysis of Rodent Brains as a Function of Age and Cognition

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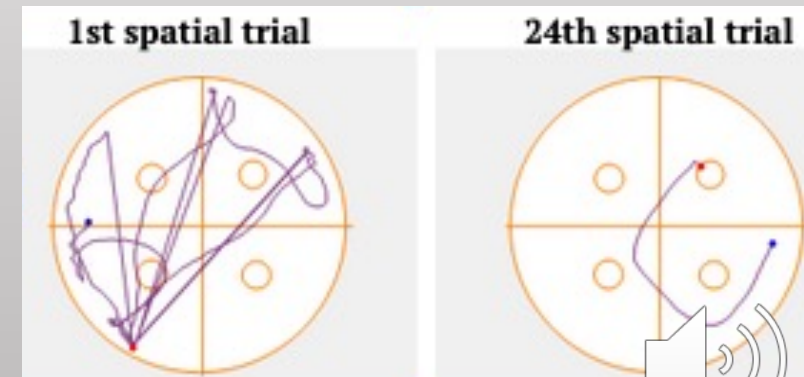
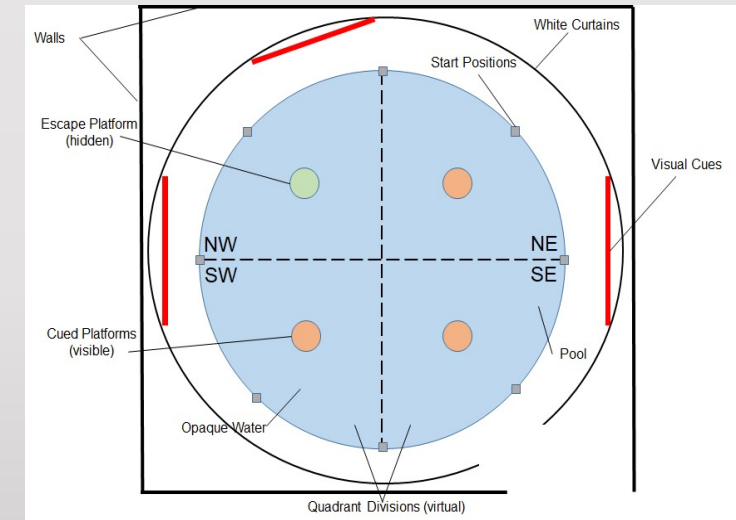
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Methods: Rodent Model of Cognitive Aging

- Rats have been used as a model of aging (1) and serve an important role in the study of neurological structure and function
- Background (n=110)
 - Male
 - Genetic backgrounds
 - Environmental Stimuli, Diets
- Three Age Groups
 - Young Adult (6 mos), Middle Aged Adult (15 mos) and Old Adult (23 mos)
- Three Levels of Cognition
 - 5 different cognitive tests over 6 weeks
 - Morris water maze was used for cognitive grouping



MRI Protocol

High resolution 3D Anatomical T2-weighted MRI

- 150 μm isotropic resolution
- time of acquisition=1hr 16min

Diffusion-Weighted MRI

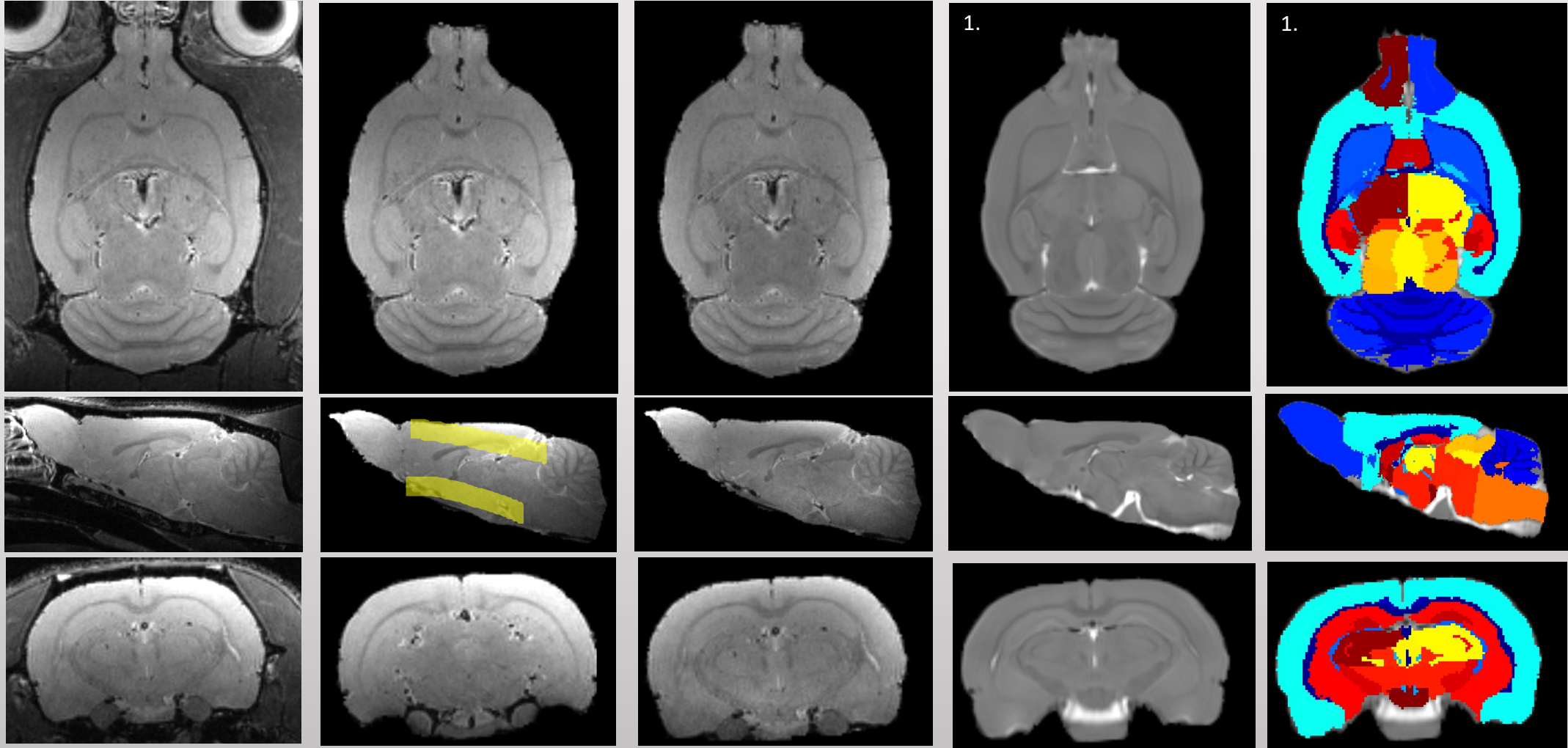
- 300 μm in plane resolution, 900 μm slice
- $b = 1000, 2000$ and 3000 s/mm^2
- 64 directions per shell
- 8 $b = 0$ images (no diffusion weighting)
- Single-shot echo planar imaging (EPI)
- Geometry-matched 2D Fast spin echo also collected to correct EPI distortions.



Bruker 7 Tesla Small Animal Scanner



MRI Processing Pipeline



Original Image

Masked Image

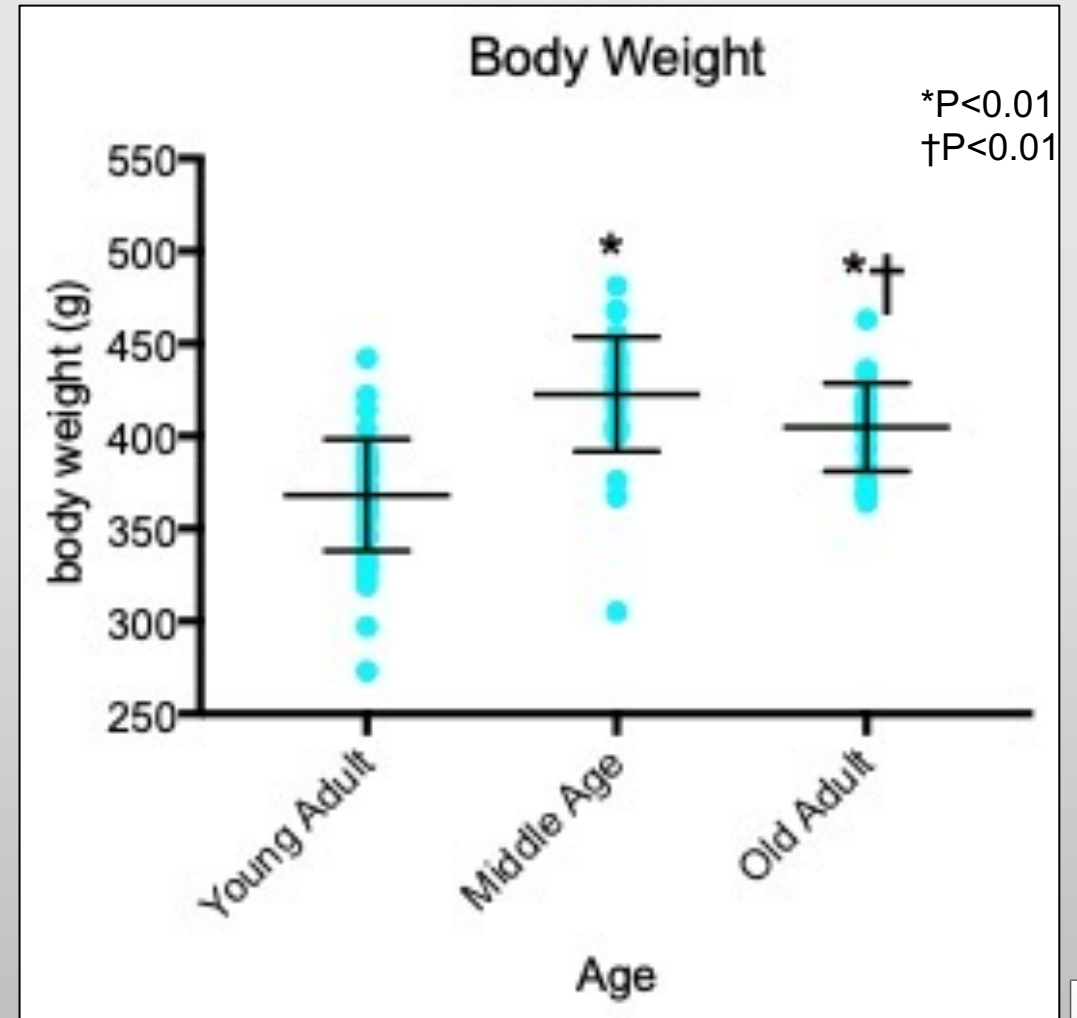
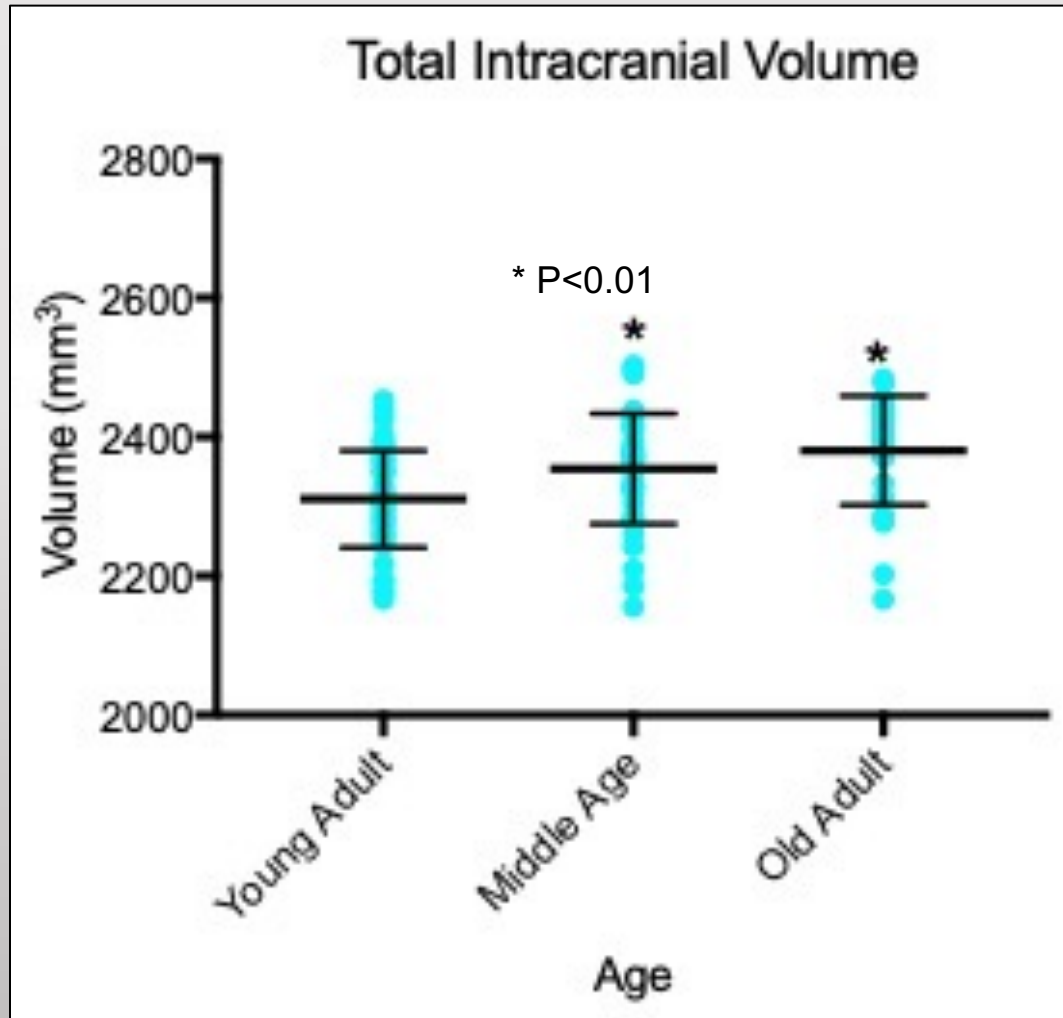
Bias Field Corrected

Registered T2 weighted
Template

Labeled Atlas

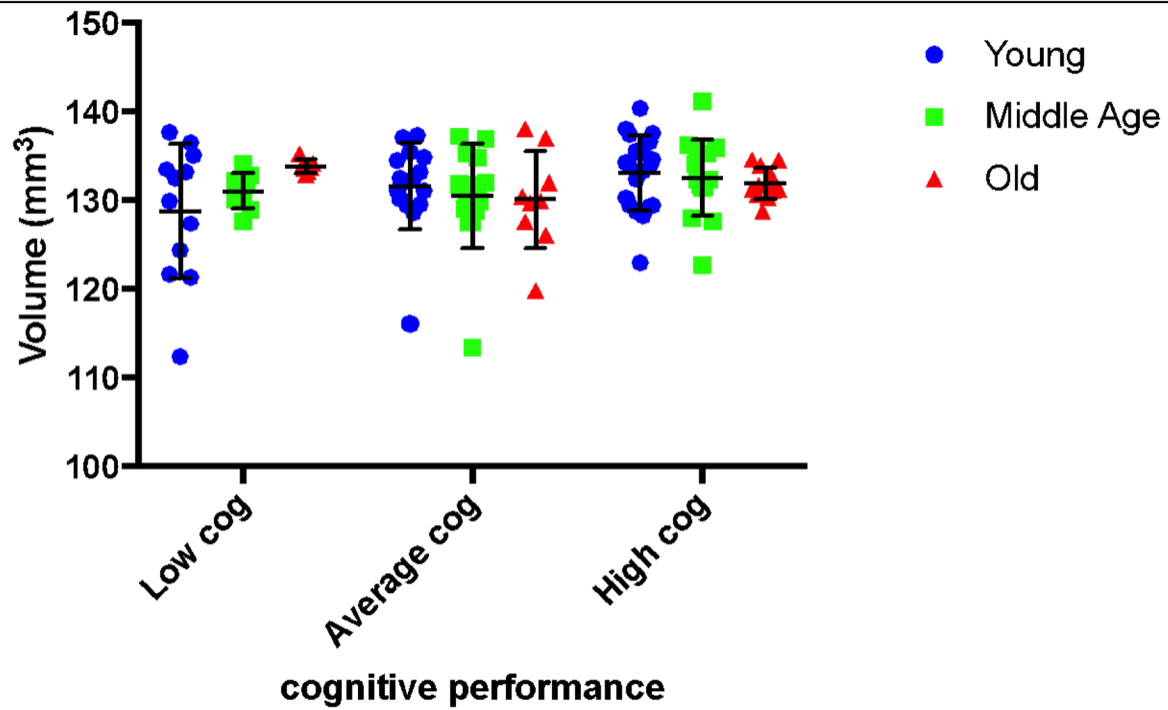


Brain Volume and Weight vs Age

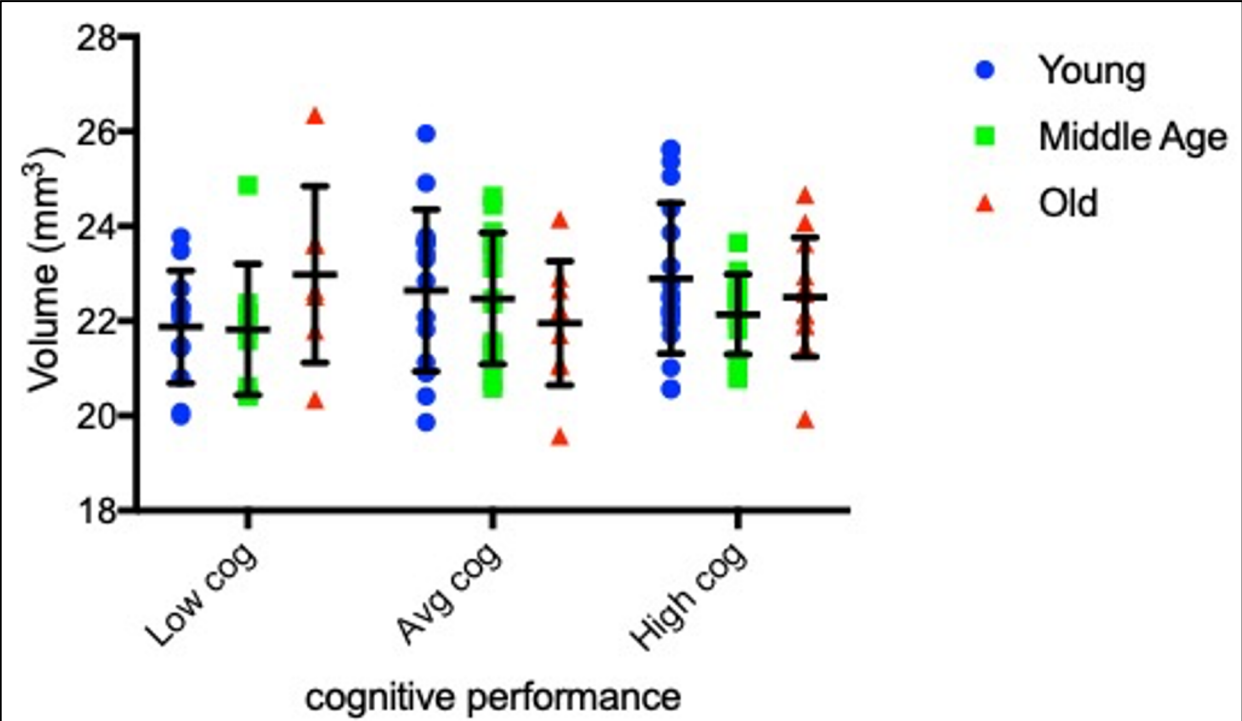


Regional Volumetric Results

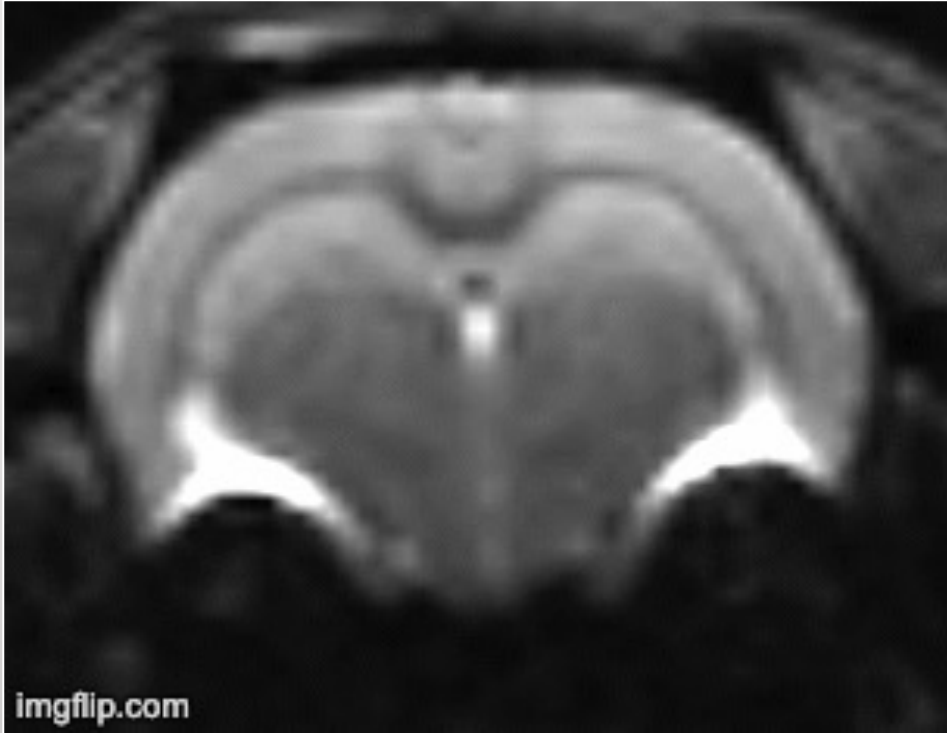
Hippocampus



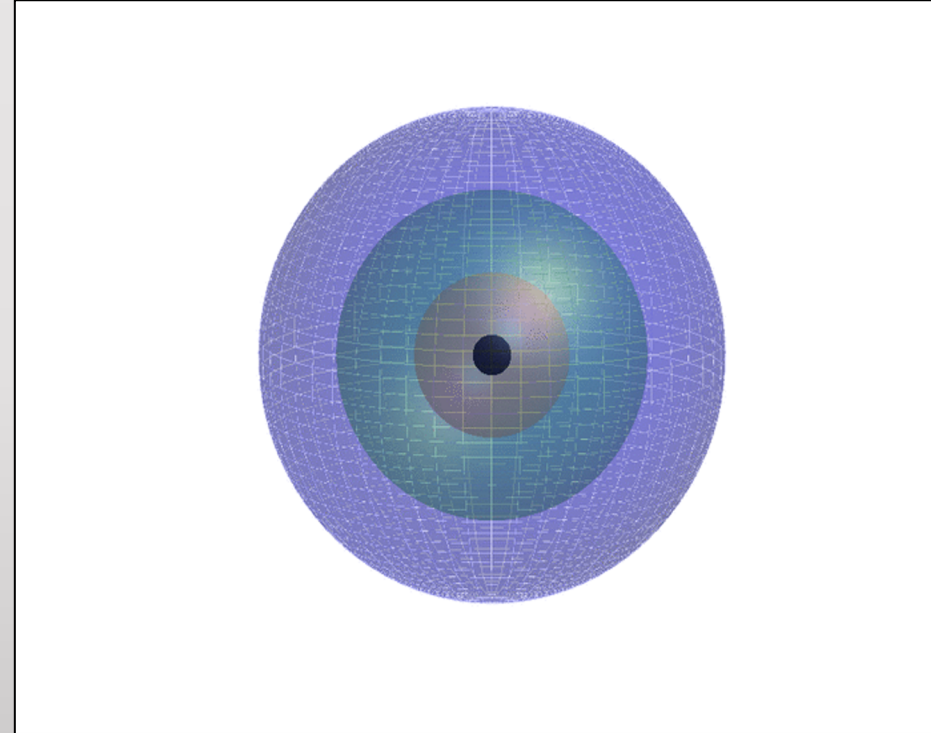
Total Ventricular Volume



Multi-shell Multi-directional



Diffusion-weighted image



Direction/b-value

$b = 0$ (s/mm²) eight acquisitions

$b = 1000$ - 64 directions

$b = 2000$ - 64 directions

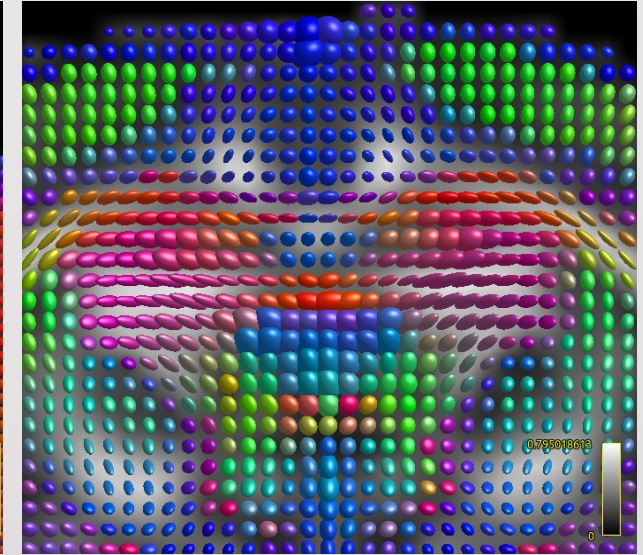
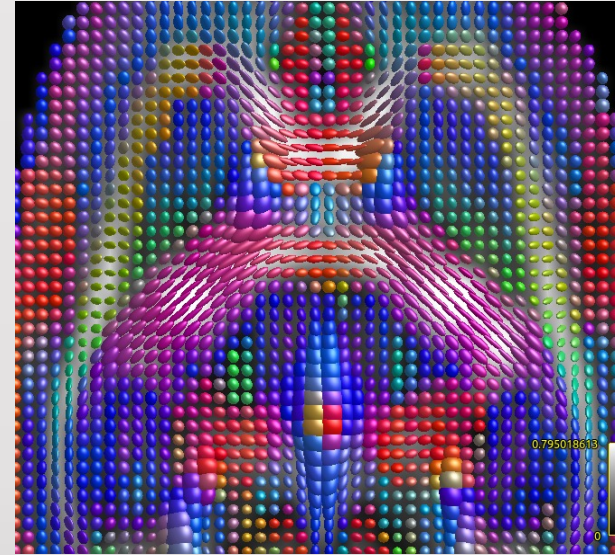
$b = 3000$ - 64 directions



Diffusion Weighted MRI Analysis

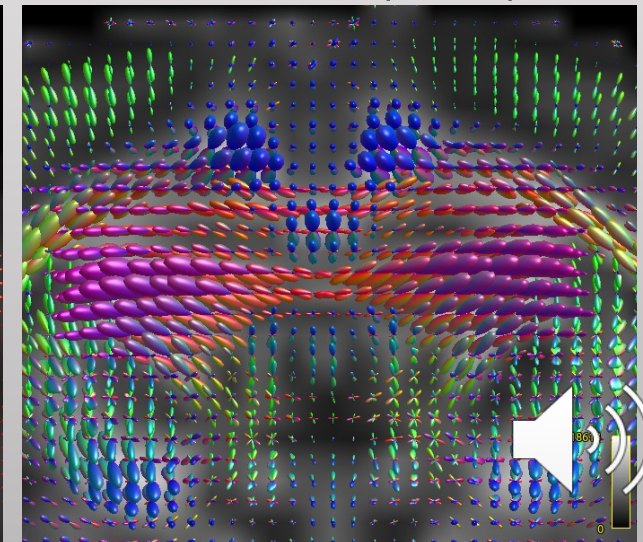
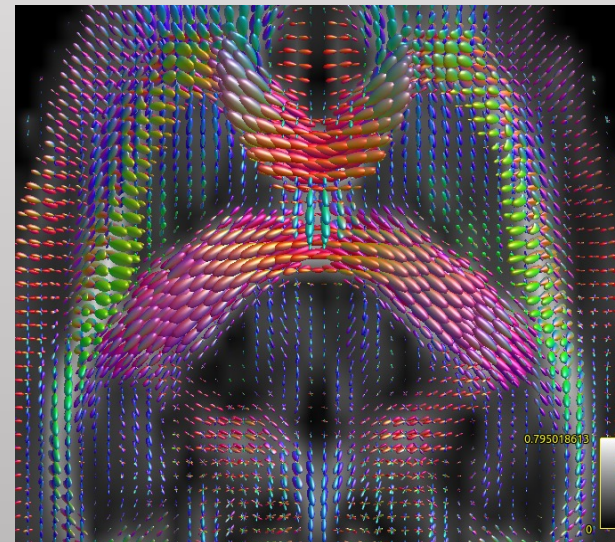
Diffusion Tensor Imaging (DTI)

- Diffusion Tensor Imaging (DTI)
 - Glyphs represent diffusion tensor
 - Color indicates primary direction

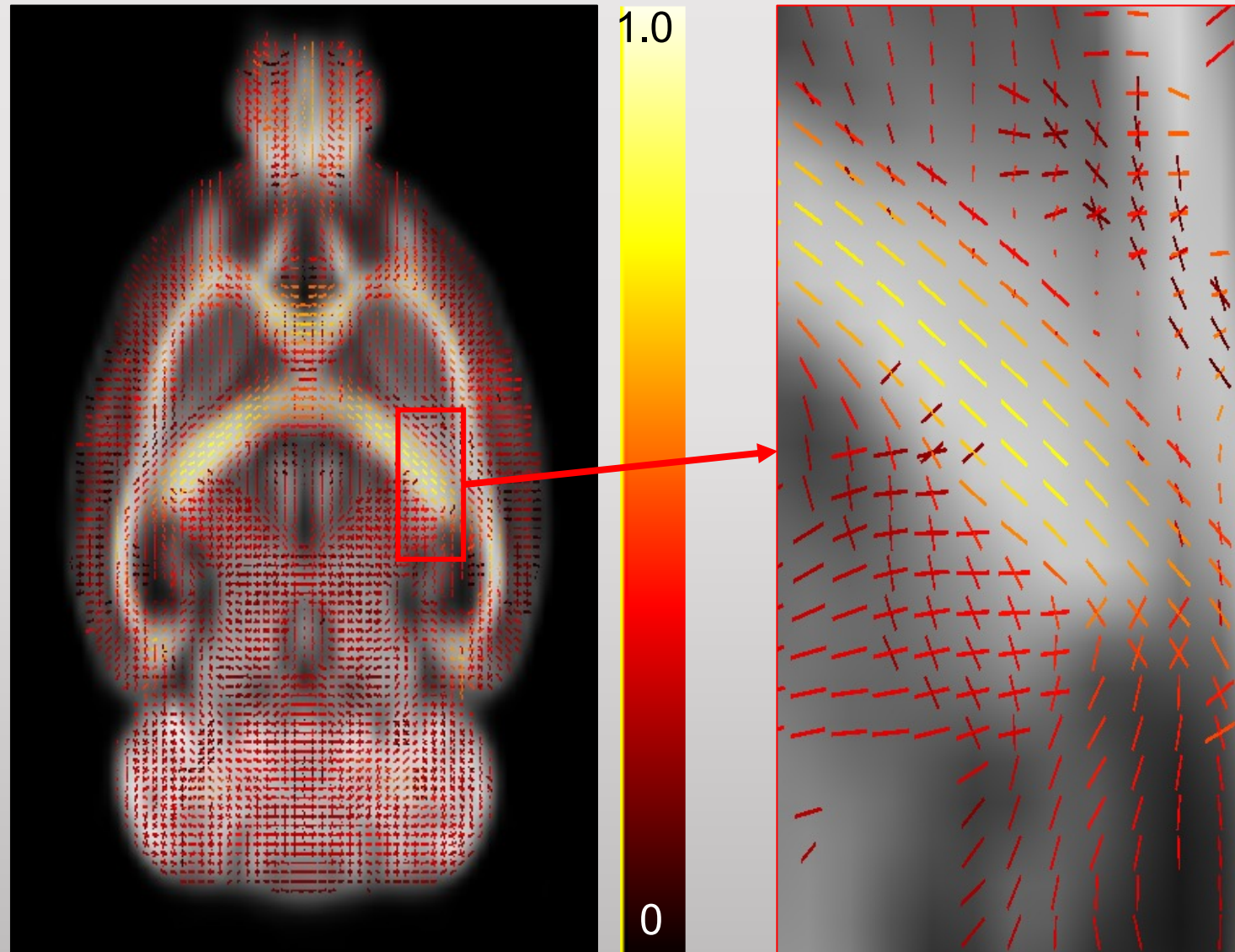


- Constrained Spherical Deconvolution (CSD)
 - Glyphs represent fiber orientation distribution function (FOD)
 - FOD describe direction density of multiple fiber population voxels

Constrained Spherical Deconvolution (CSD)



Fixel Based Analysis



Conclusion

- MRI showed significant difference in total intracranial volume for young adult animals compared with both middle aged and old adult animals
- MRI showed no significant difference in hippocampal volume nor total ventricular volume across age or cognition. Analysis of other regions is forthcoming
- Fixel based analysis will enable evaluation of microstructural changes across age and/or cognition

