

A high-resolution in vivo atlas of the human brain's serotonin system

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Vincent Beliveau

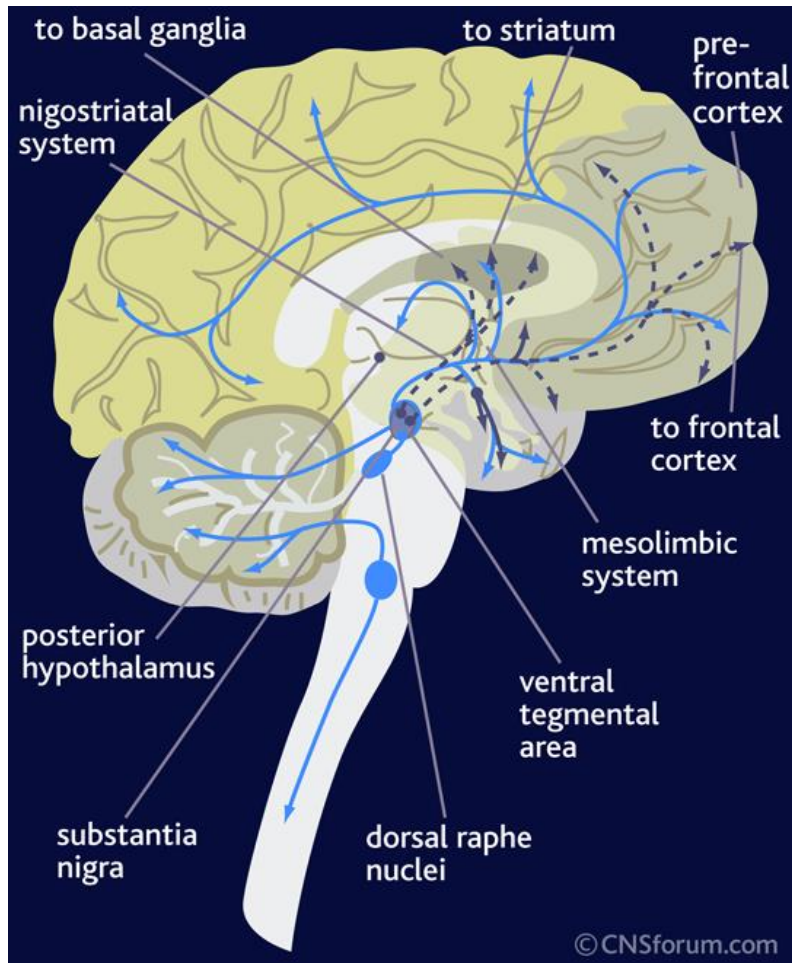
Neurobiology Research Unit
Rigshospitalet, Copenhagen



FreeSurfer Course, Copenhagen 2016



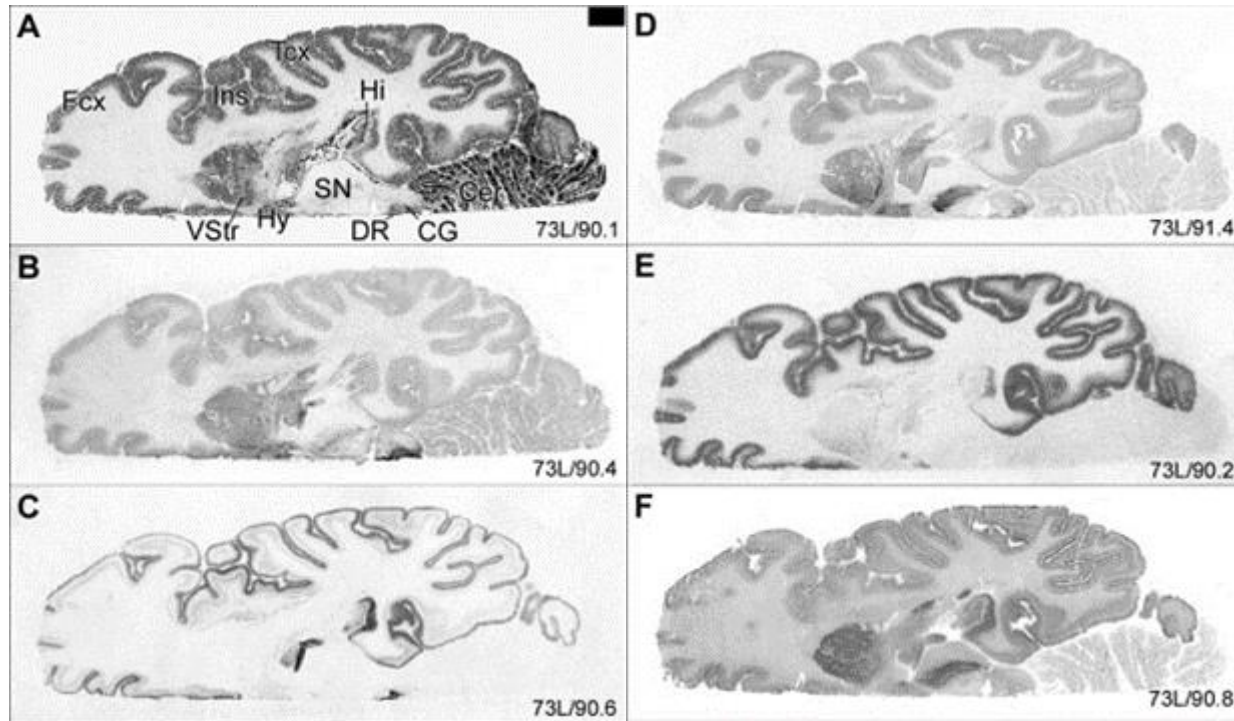
The serotonin (5-HT) system



- Involved in cognition, mood, social interaction, sexual behaviors, ...
- But also in disorders such as depression, anxiety, schizophrenia.
- The 5-HT system has 14 receptor subtypes and a transporter



5-HT autoradiography

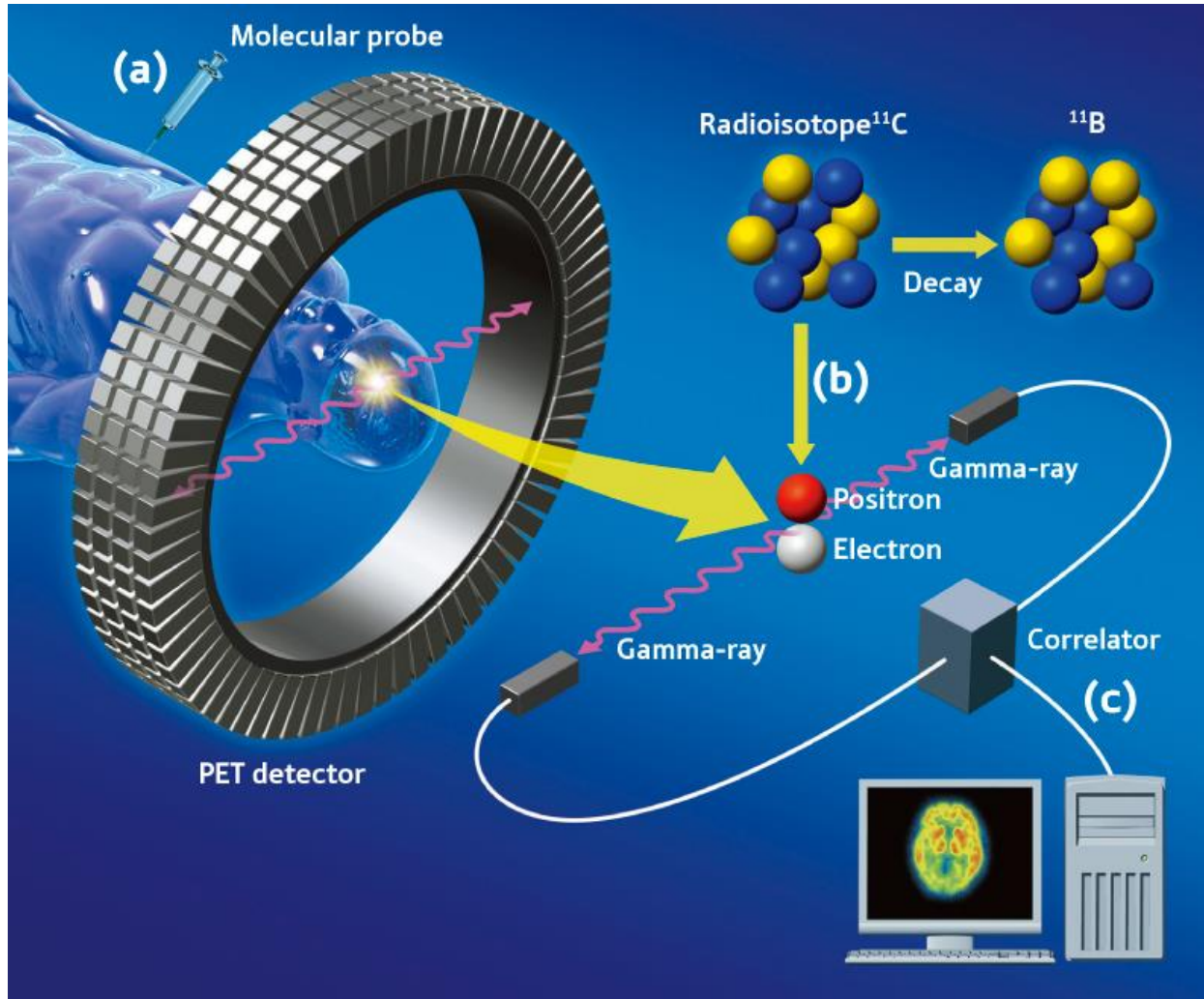


Whole hemisphere autoradiograms comparing the distribution of the 5-HT transporter and receptor binding sites in human brain cryosections. The following information and the abbreviation list apply to all images: Total binding is shown for the different radioligands. **A:** Cresyl violet-stained section. **B:** [^3H]Citalopram binding to the 5-HT transporter. **C:** [^3H]WAY-100635 binding to the 5-HT_{1A} receptor. **D:** [^3H]GR 125743 binding to the 5-HT_{1B} receptor in the presence of the 5-HT_{1D} antagonist PNU-142633 (800 nM). **E:** [^3H]M100907 binding to the 5-HT_{2A} receptor. **F:** [^{125}I]SB 207710 binding to the 5-HT₄ receptor.⁴

[1] K. Varnäs, C. Halldin, and H. Hall, *Hum. Brain Mapp.*, 2004

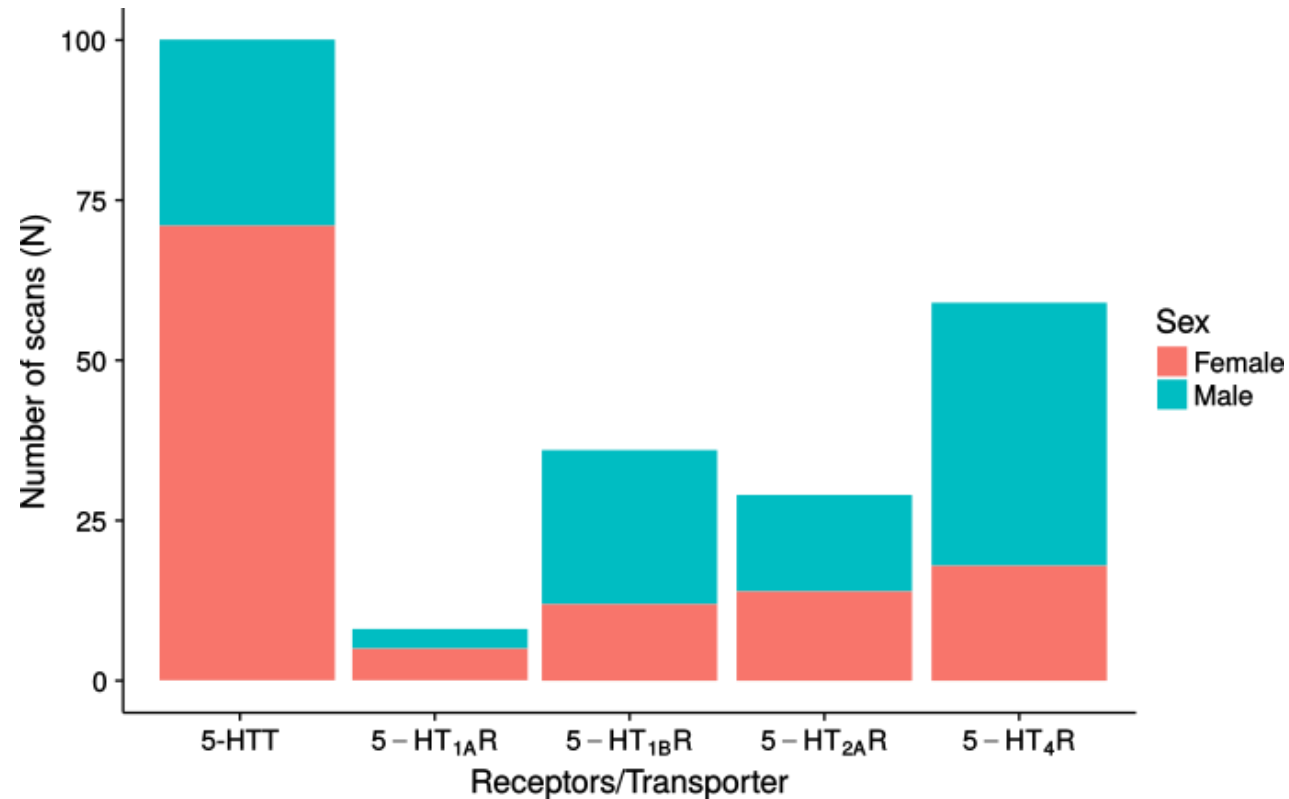


Positron Emission Tomography



Cimbi Database Demographics

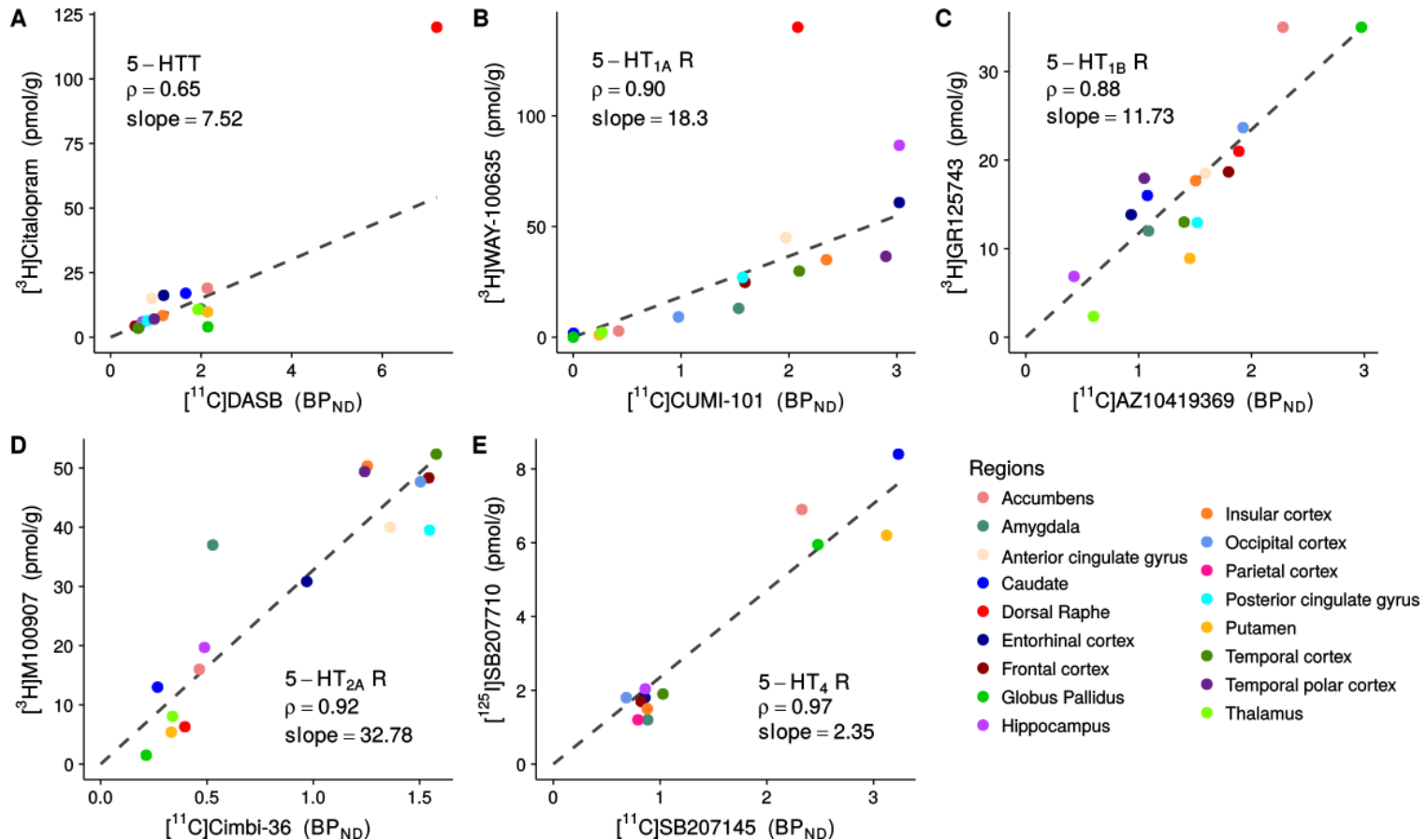
Healthy controls from the Cimbi database aged between 18 and 45



[1] G. M. Knudsen et al., *Neuroimage*, 2015



Binding potential and autoradiography

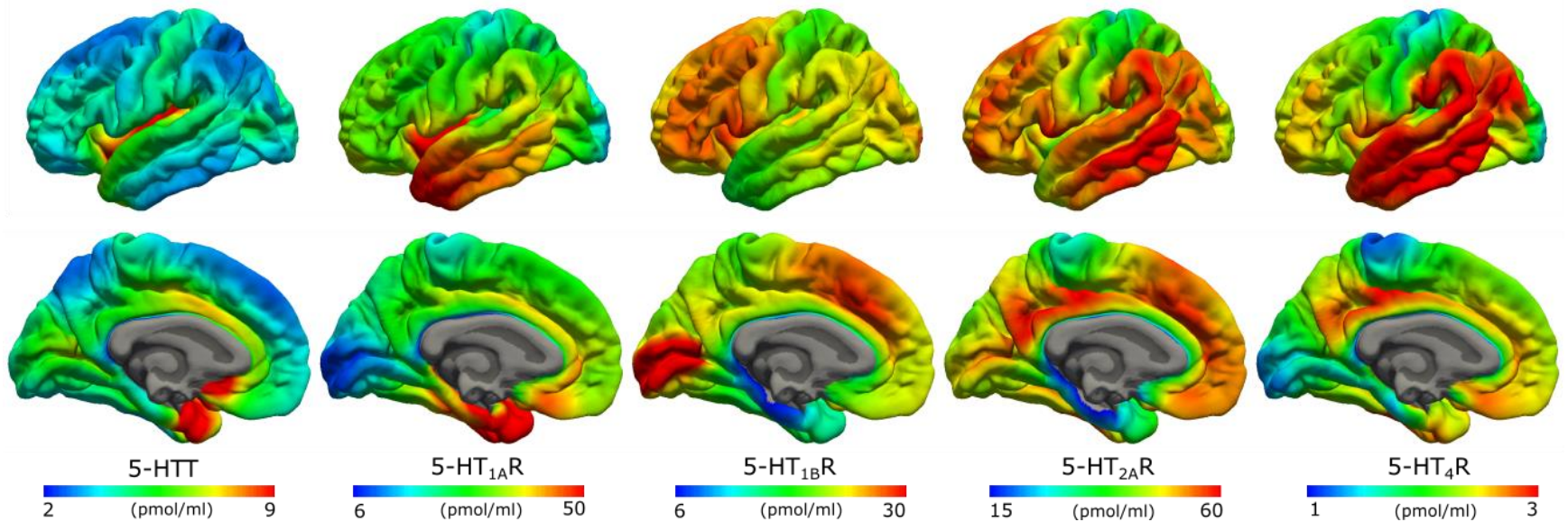


[1] K. Varnäs, C. Halldin, and H. Hall, *Hum. Brain Mapp.*, 2004.

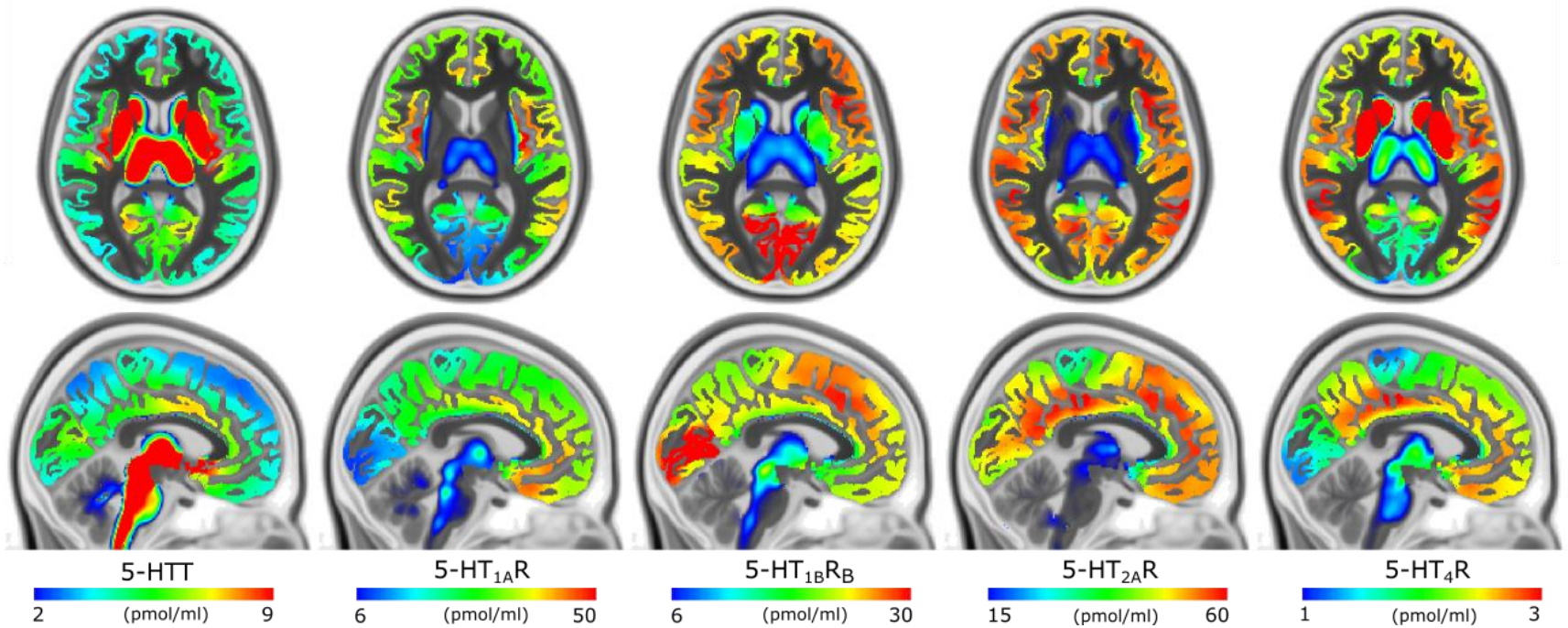
[2] G. P. Reynolds et al., *Br. J. Pharmacol.*, 1995.



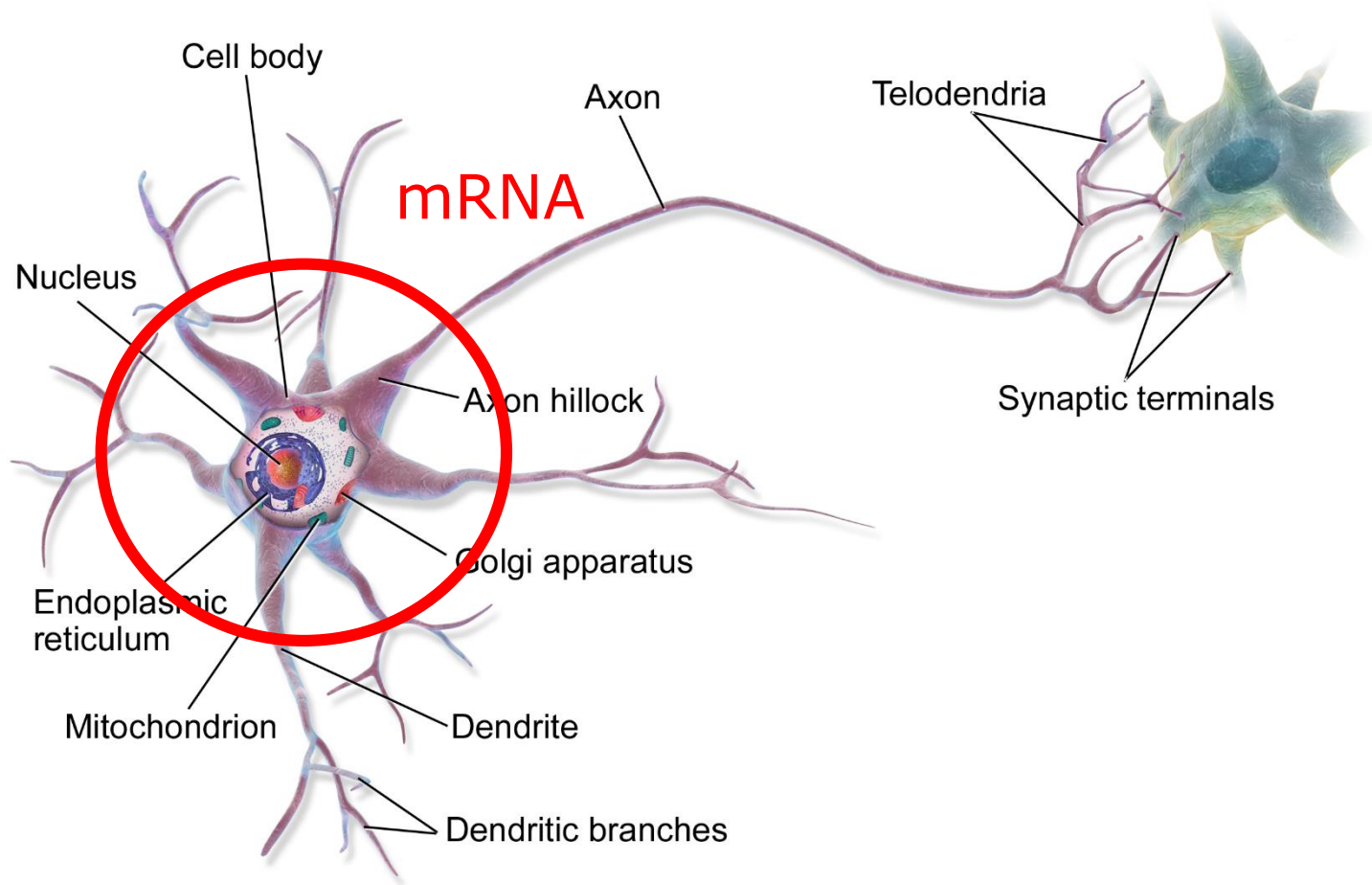
Cortical density maps



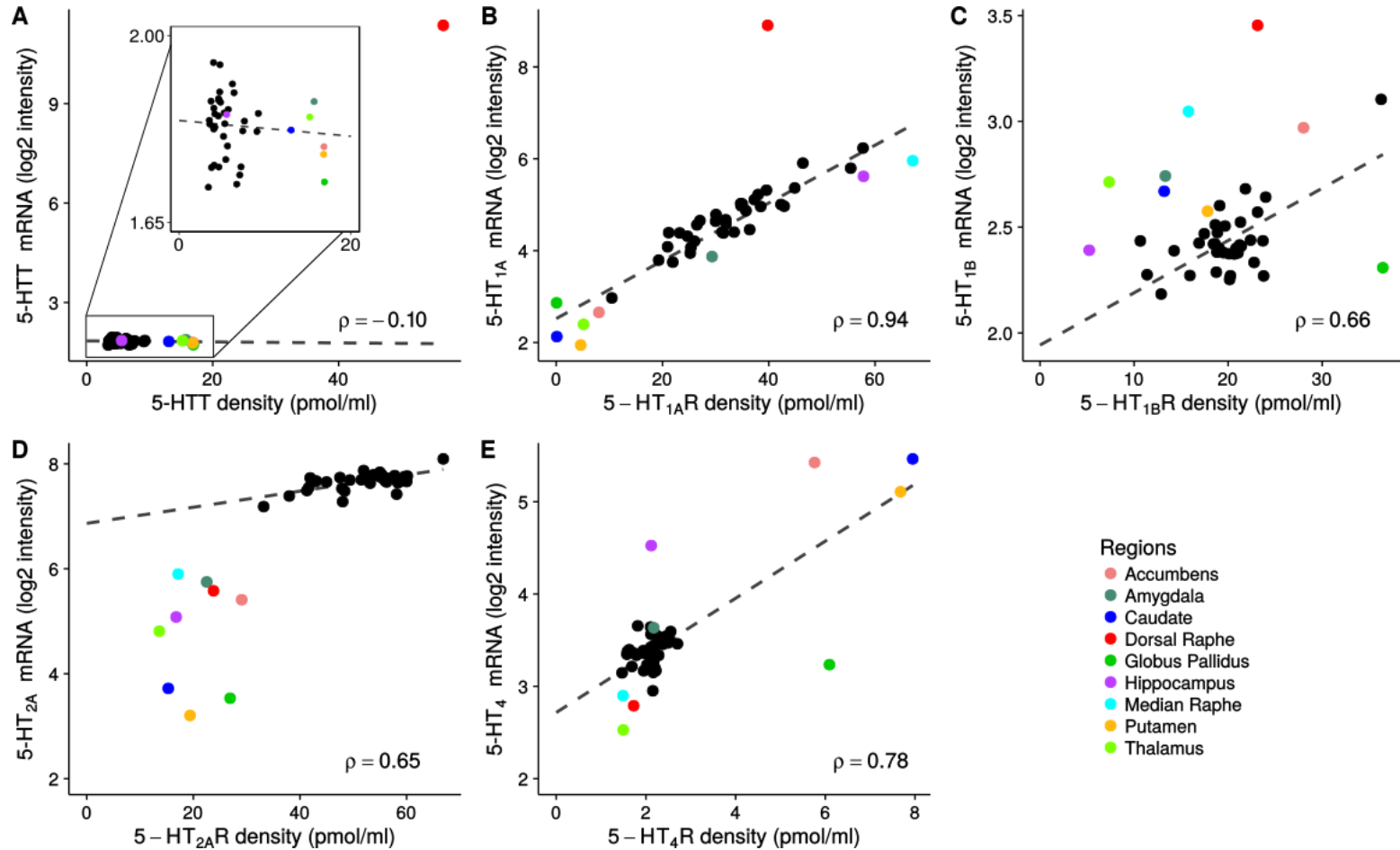
Subcortical density maps



Protein localization and mRNA



Density and mRNA



[1] L. French and T. Paus, *Front. Neurosci.*, 2015.





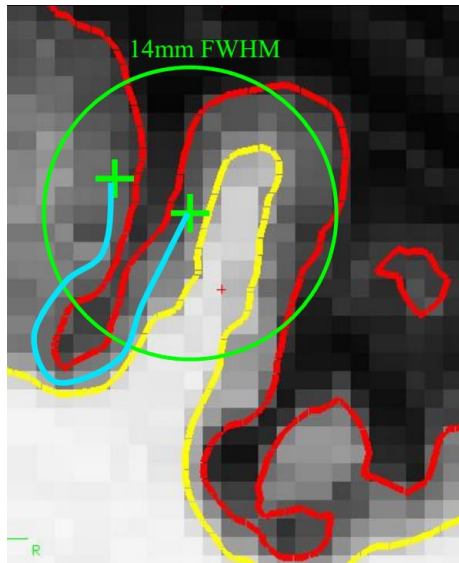
<https://surfer.nmr.mgh.harvard.edu/fswiki/PetSurfer>

(image inspired by Melanie Ganz)

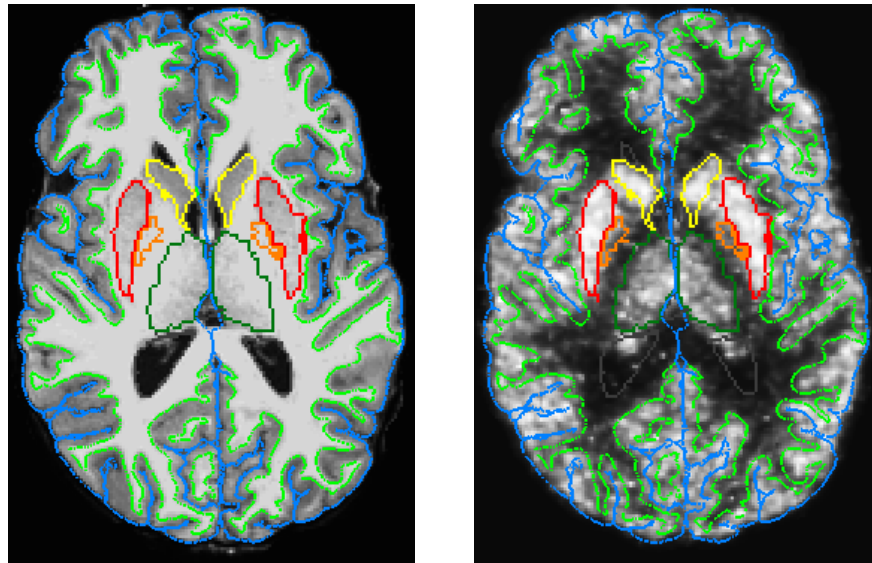


FreeSurfer provides...

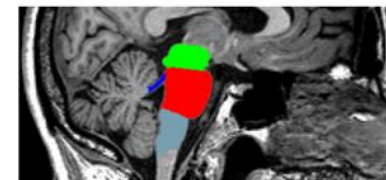
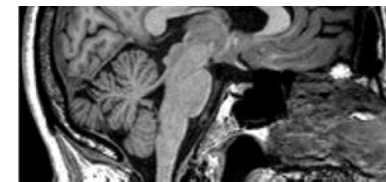
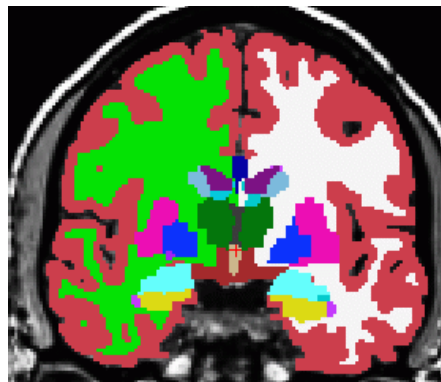
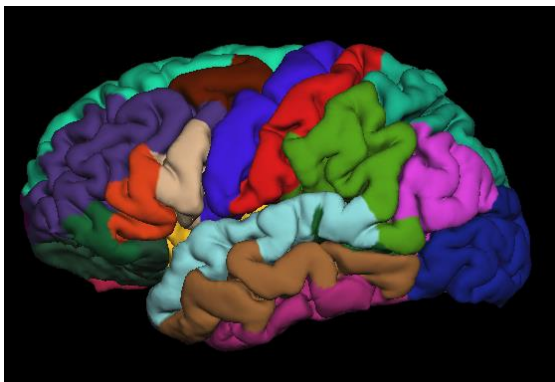
Surface smoothing



Multimodel registration



Individualized Automated Segmentations



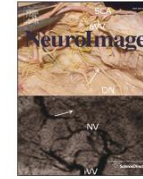
Volume vs. surface-based analysis for PET data



Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/ynimg



Cortical surface-based analysis reduces bias and variance in kinetic modeling of brain PET data

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^a Athinoula A. Martinos Center for Biomedical Imaging, Department of Radiology, Massachusetts General Hospital, Boston, MA, USA

^b Harvard Medical School, Boston, MA, USA

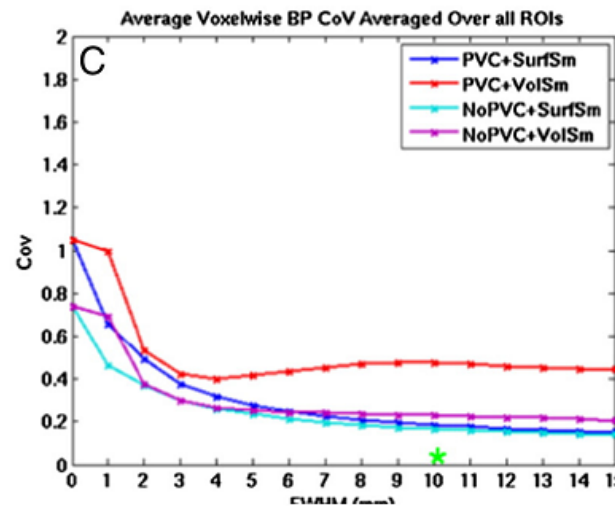
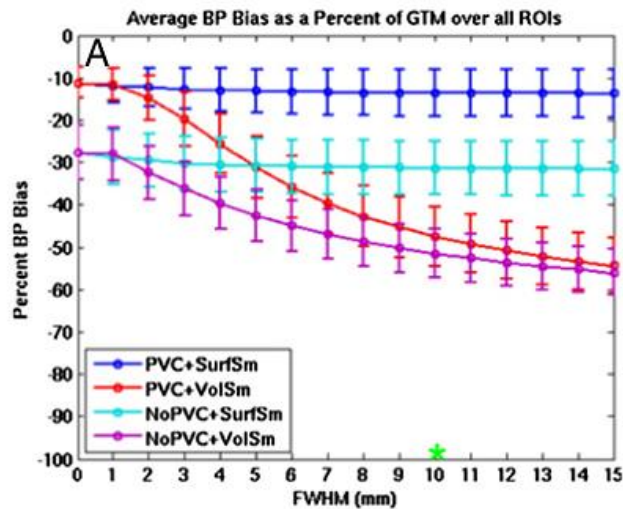
^c Center for Integrated Molecular Brain Imaging, Rigshospitalet, Copenhagen, Denmark

^d PET and Cyclotron Unit, Rigshospitalet, Copenhagen, Denmark

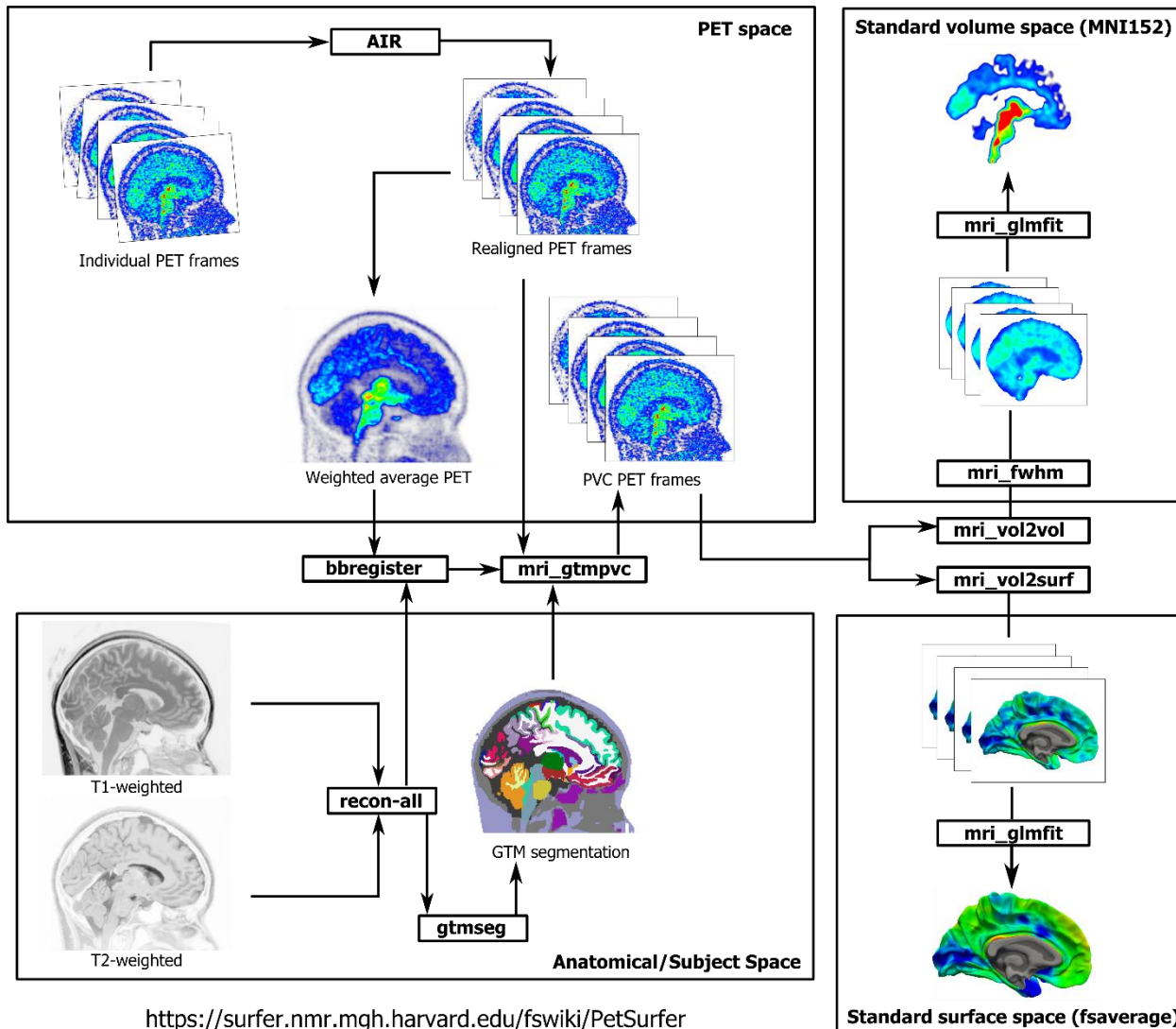
^e University of Copenhagen, Copenhagen, Denmark

^f Computer Science and Artificial Intelligence Laboratory, MIT, USA

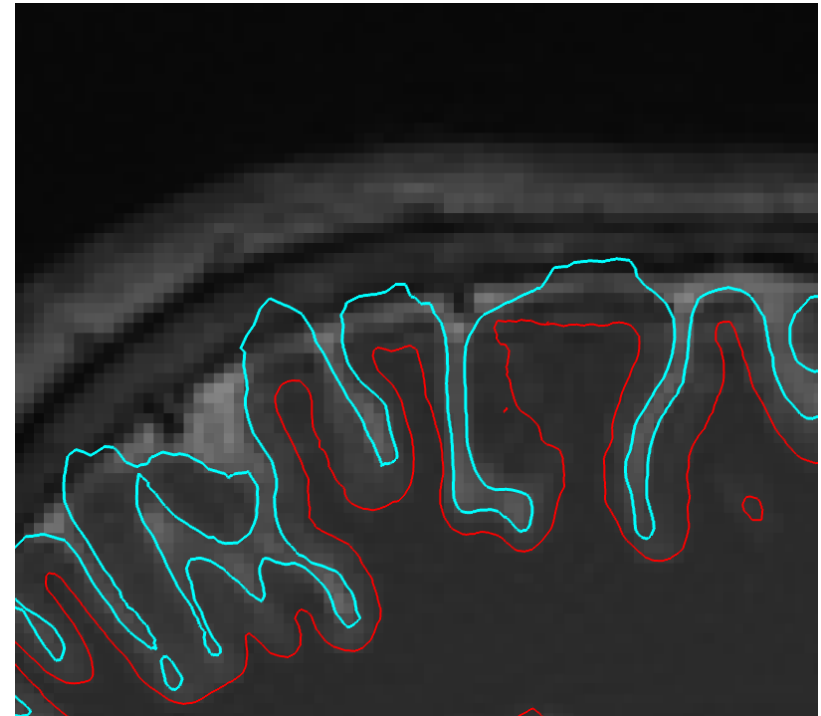
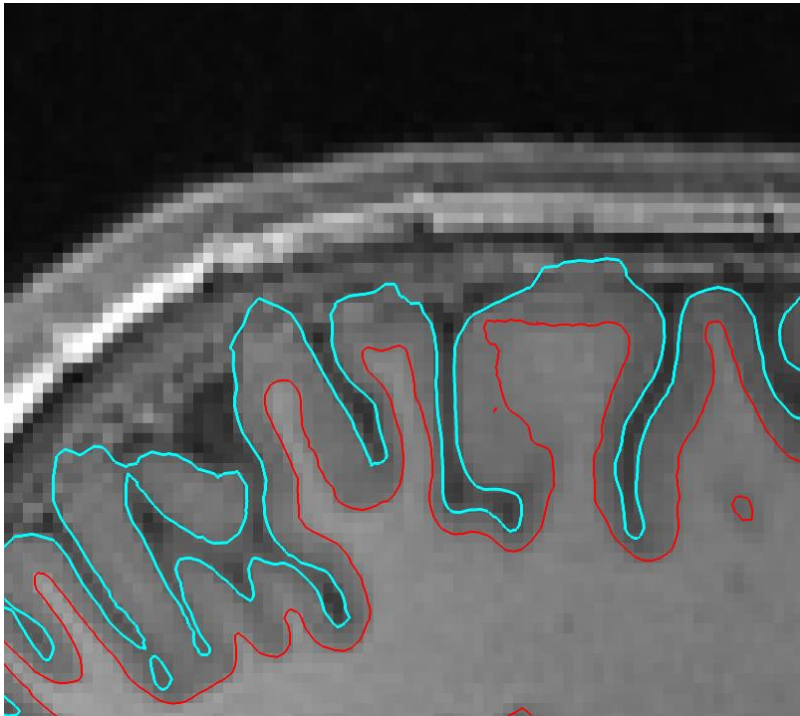
^g Danish Research Center for Magnetic Resonance, Hvidovre Hospital, Copenhagen, Denmark



The PET pipeline



Pial surface refinement with T2 images



New recon:

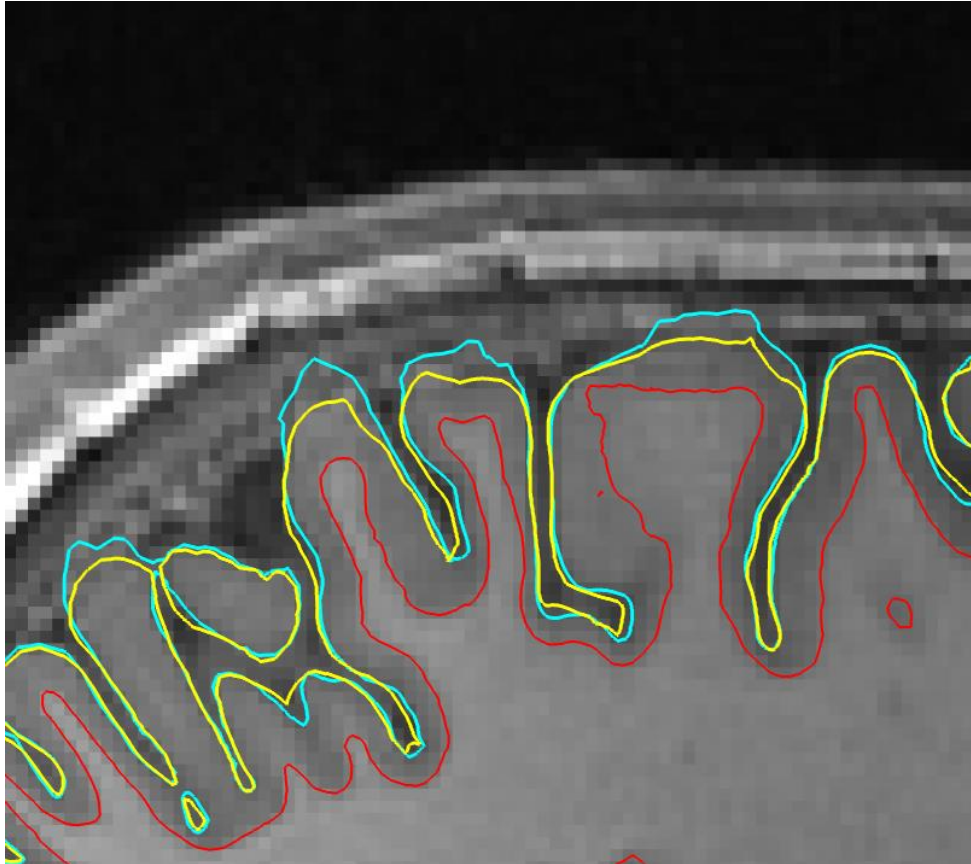
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recon-all -all -s <subj> -i <img> -T2pial -T2 <T2img>
```

Old recon:

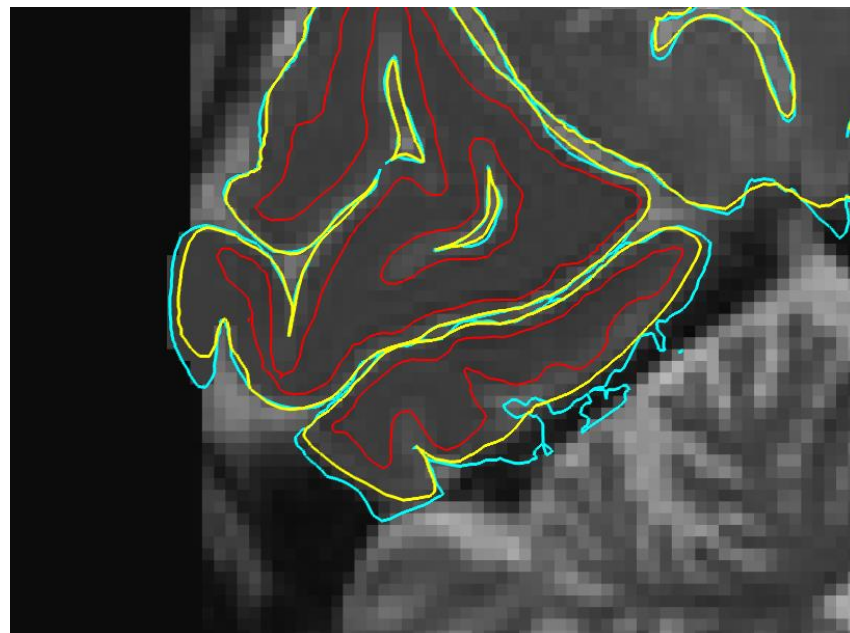
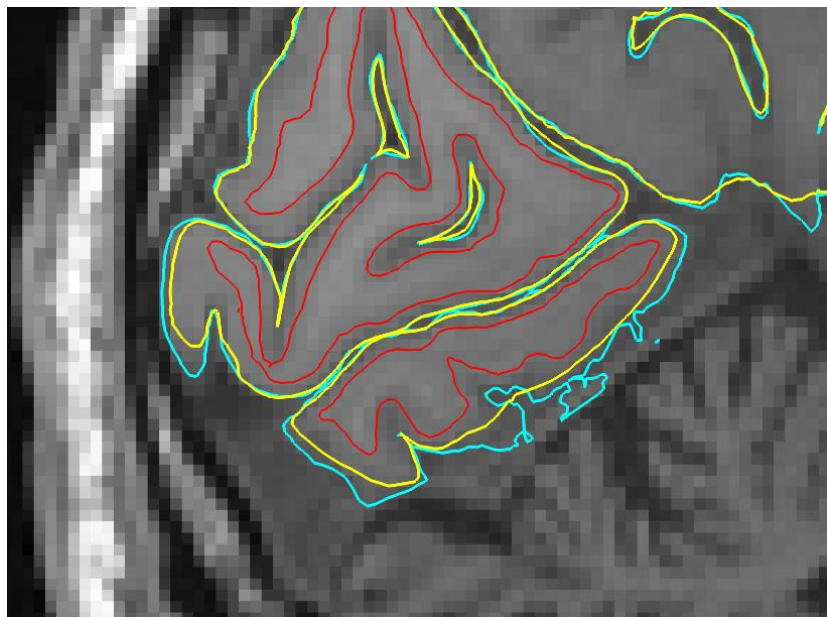
```
recon-all -all -s <subj> -T2pial -T2 <T2img> -autorecon3
```



Pial surface refinement with T2 images



T2 edit trick



- Parts of the T2 can be ignored if voxels are set to 110
- If the `-T2` flag is reused in `recon-all`, changes will be overwritten



Thank you for your attention!

Collaborators

Melanie Ganz-Benjaminson

Ling Feng

Patrick Fisher

Claus Svarer

Douglas N. Greve

Gitte Moos Knudsen

