

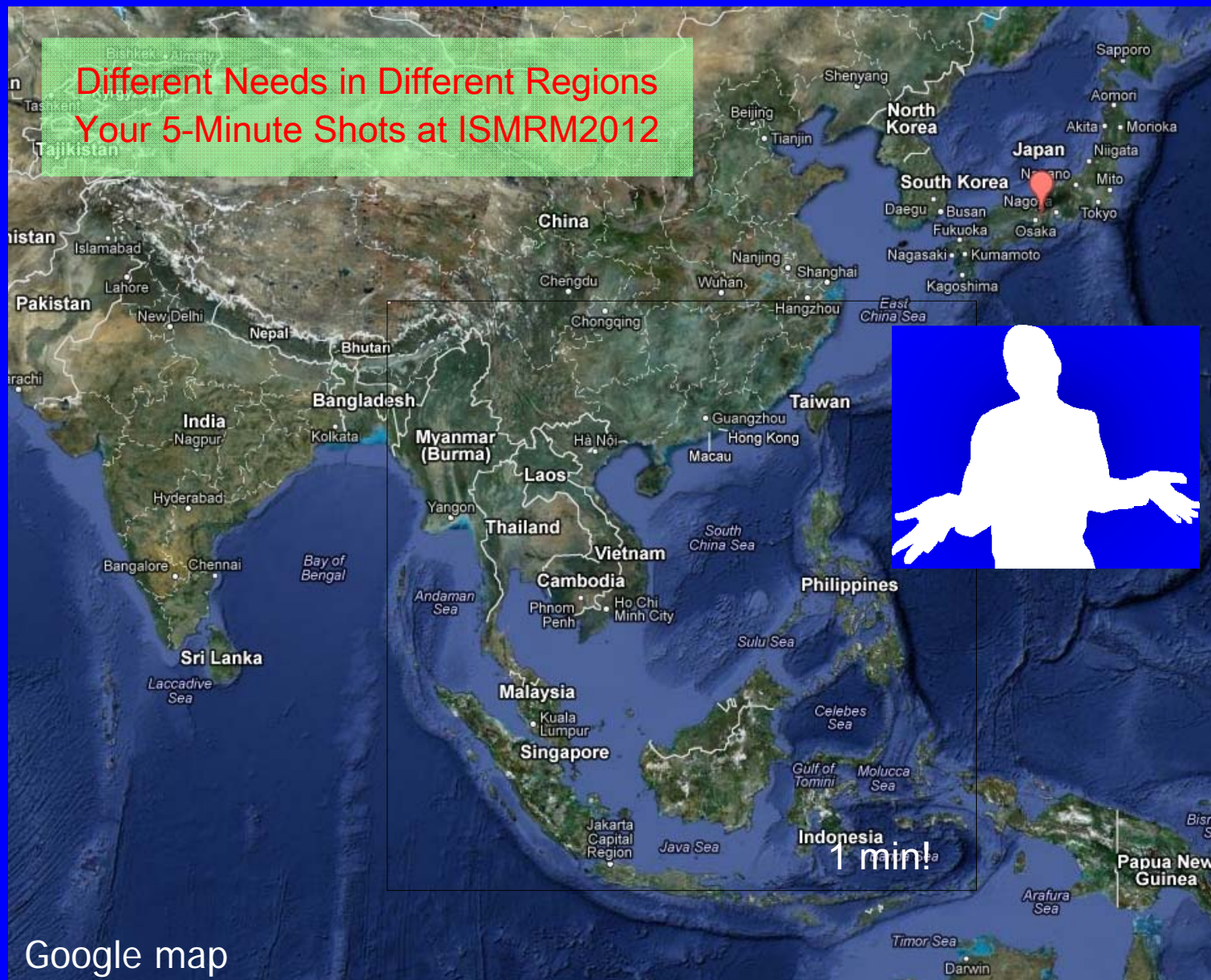
Clinical applications of medical image analyses

Tomohisa Okada, MD, PhD
Diagnostic Imaging and Nuclear Medicine
Kyoto University Hospital

Aim

facilitate you to find a way
in medial image analyses

Movements in Medical Imaging



The Machine Learning Summer School in Kyoto 2012 at 17:30 – 18:15 on August 31 at Clock Tower Hall, Kyoto Univ.

What clinicians need?



Diagnostic
HELP!

Kyoto Univ Hospital



Out patient clinic



Clinical MRIs



Research MRIs



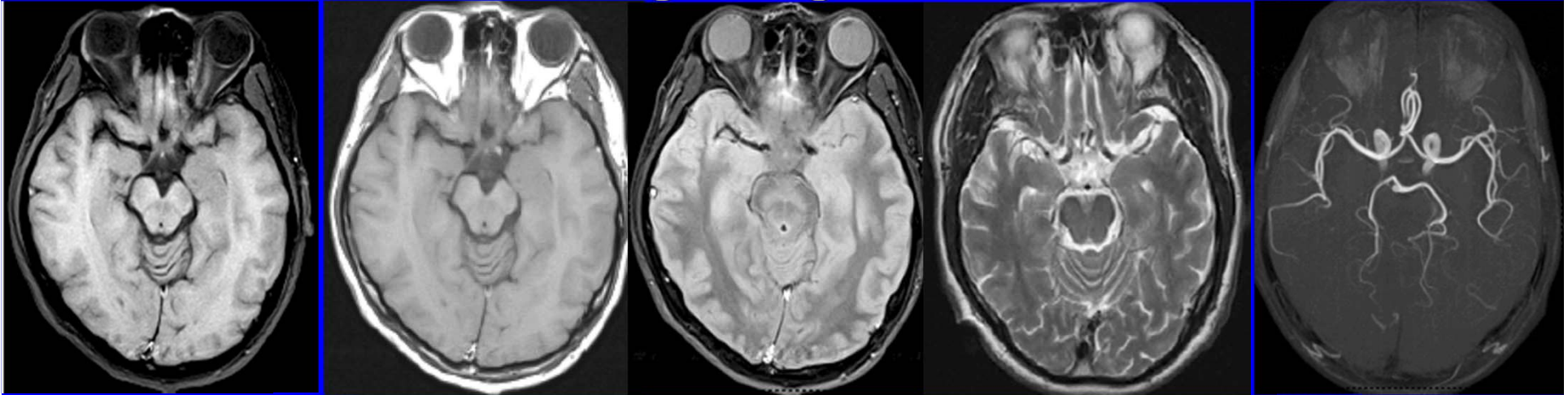
京大病院

Research
Bldgs

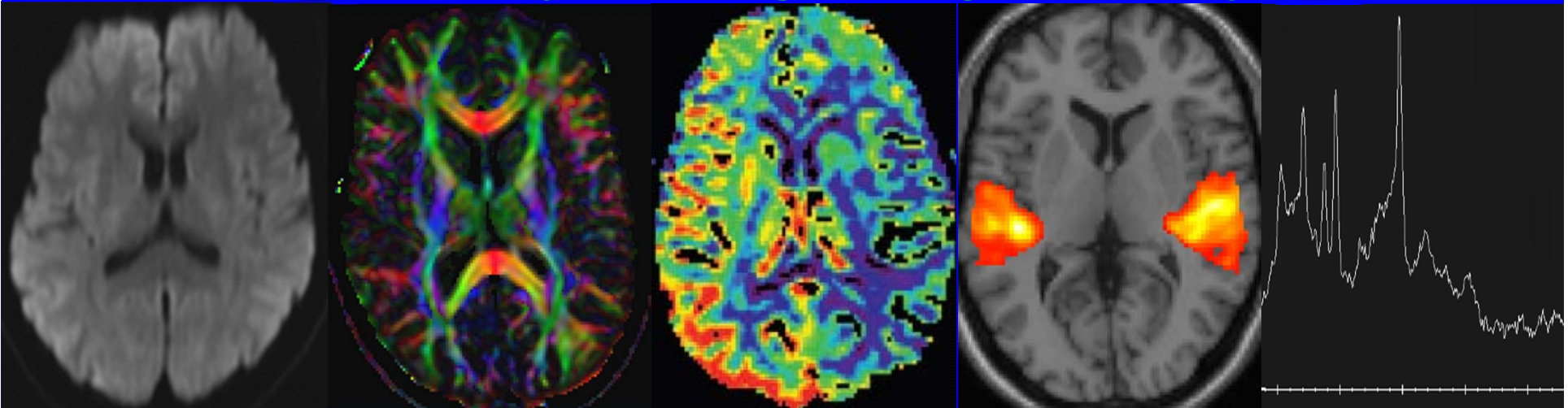
Wards

In Patinets

MRI imaging is flexible



😲 Up to your programming capability! 😲





Tetsugaku no Michi
(Philosopher's Walk)

CNN: Larry King special

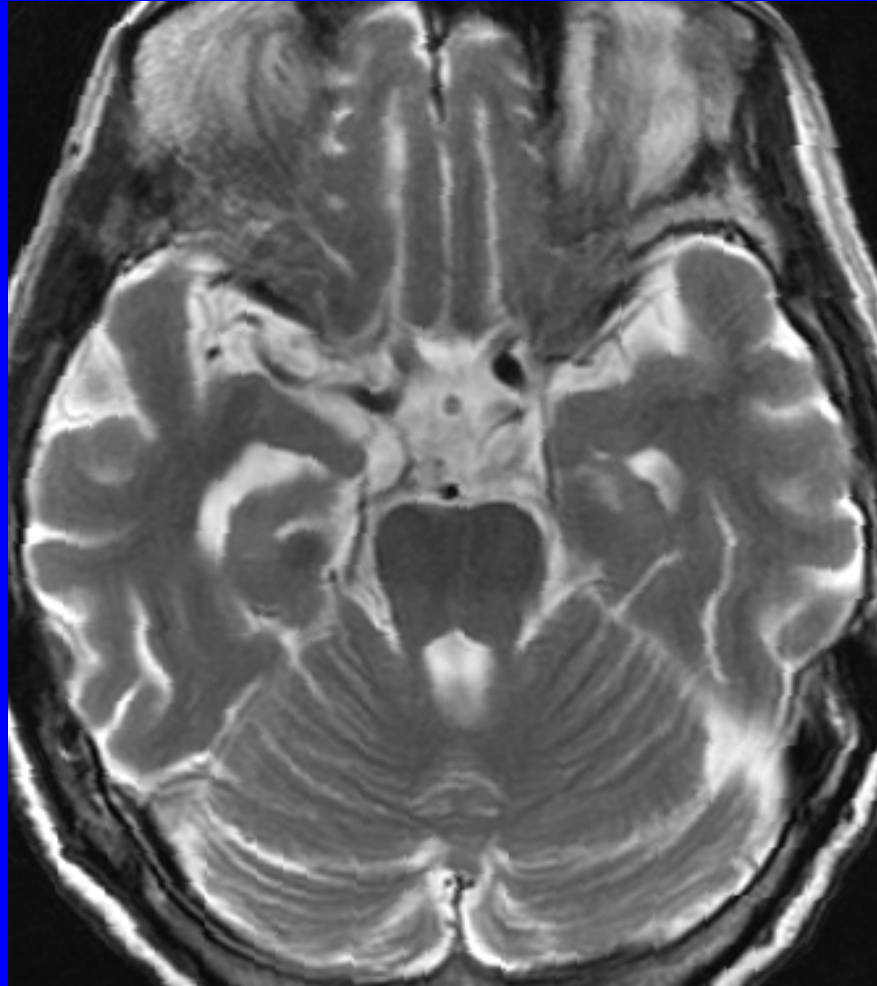
“Unthinkable: the Alzheimer’s Epidemic.”



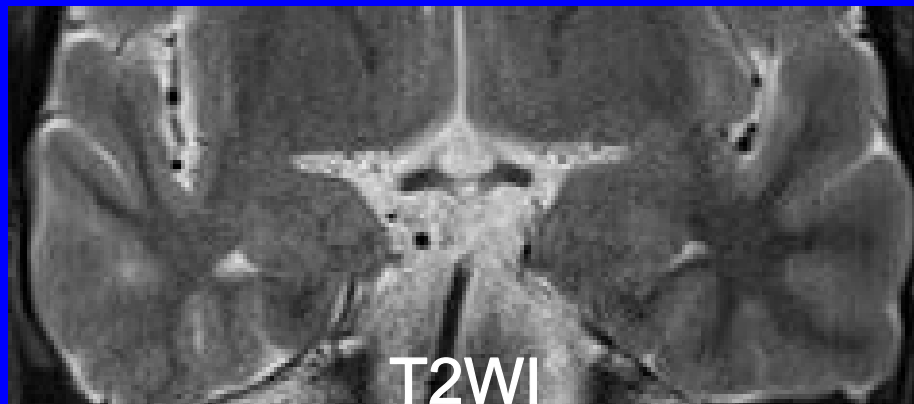
The disease of the 21st century as an estimated 5.4 million people have been diagnosed with Alzheimer’s. It is the sixth-leading cause of death across all ages in the United States, but many Americans still do not know much about this illness.

Source: <http://edition.cnn.com/SPECIALS/2011/larryking/>

70 year old male. Forgetful.

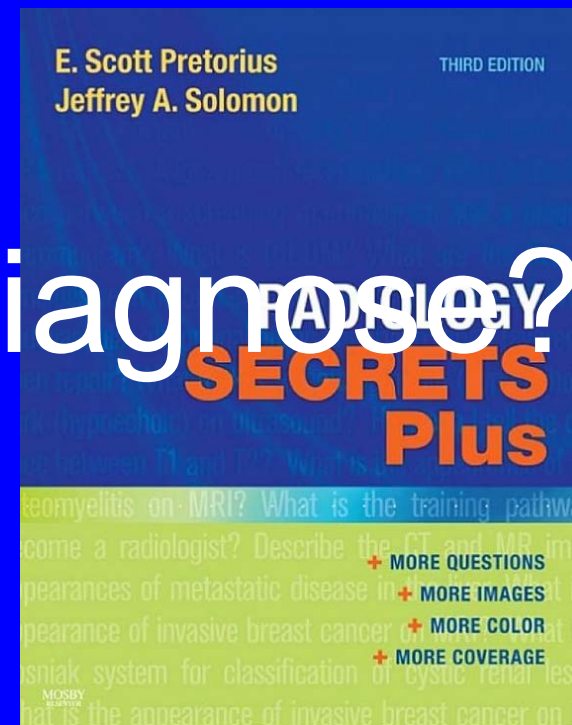
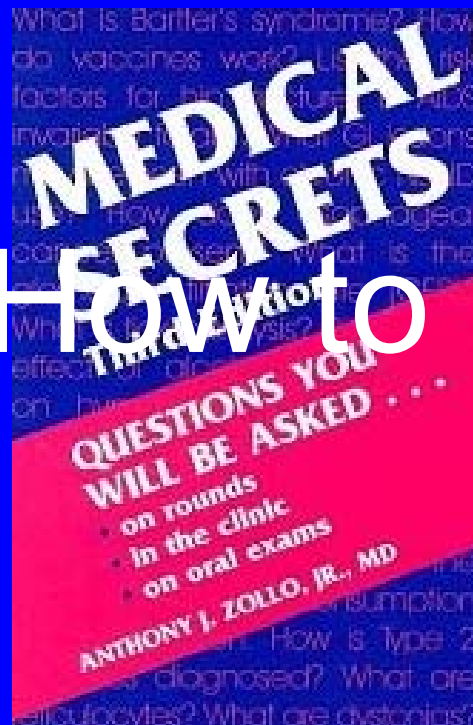


Epilepsy



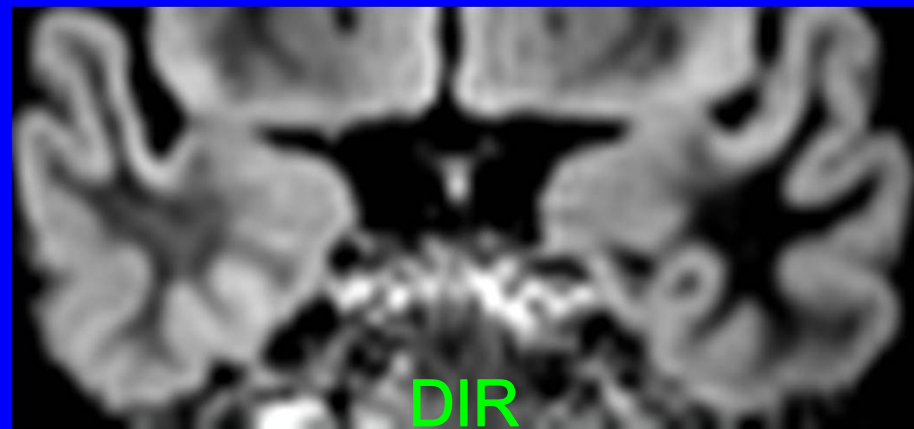
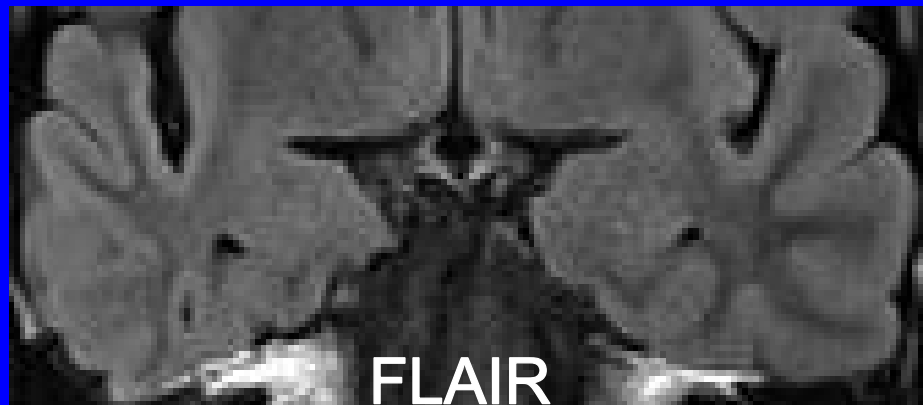
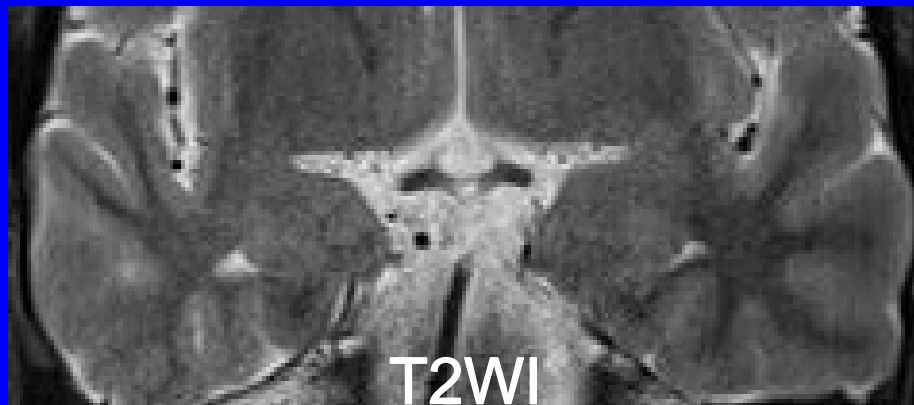
Evidence-based medicine was proposed in 1992!

How to diagnose?



Objective methods are required!!

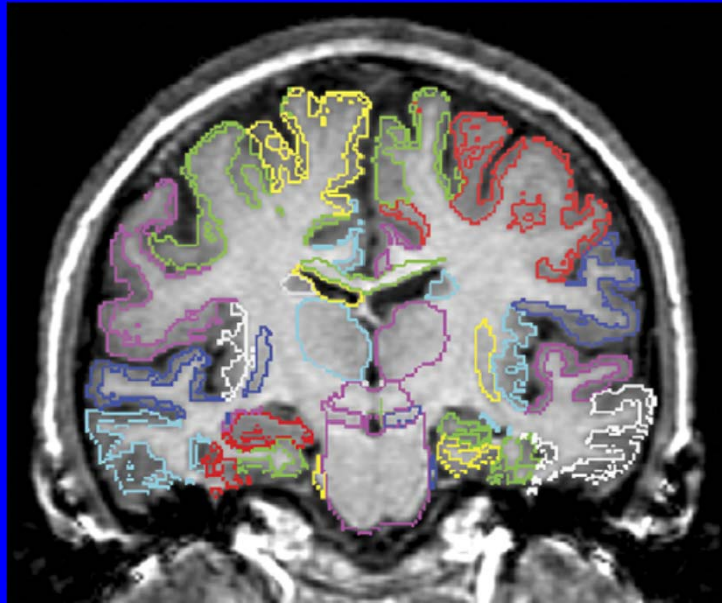
Temporal lobe epilepsy (TLE)



Morimoto et al., Eur Radiol, 2012

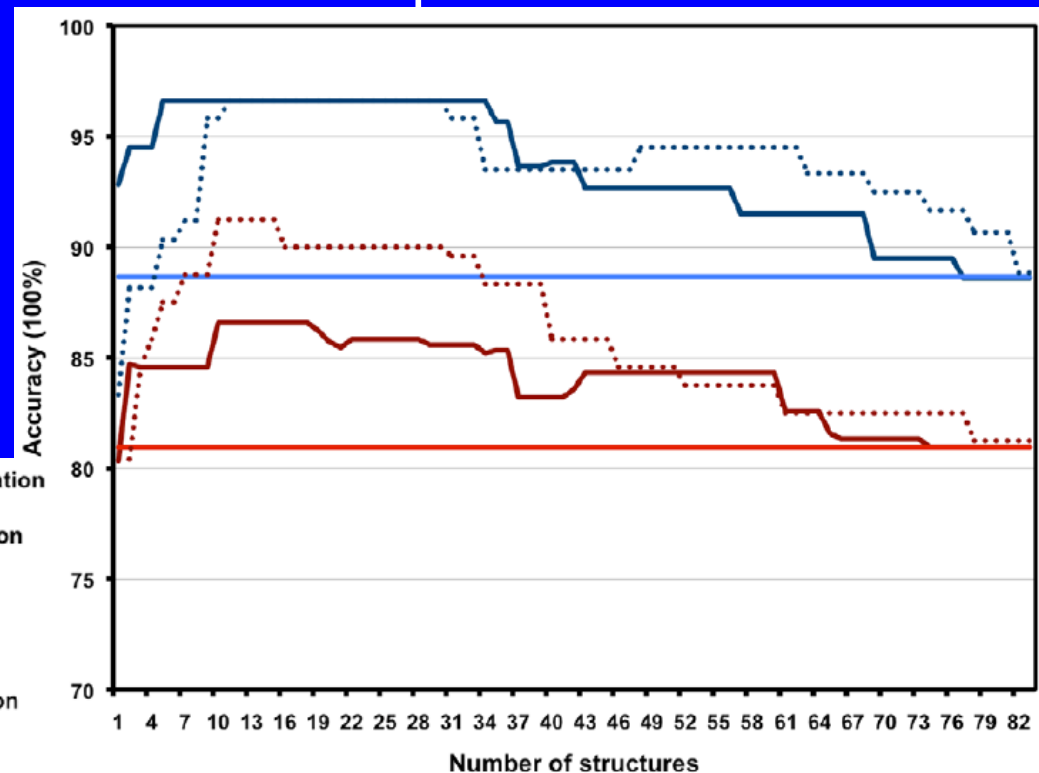


TL Epilepsy : Lt or Rt?



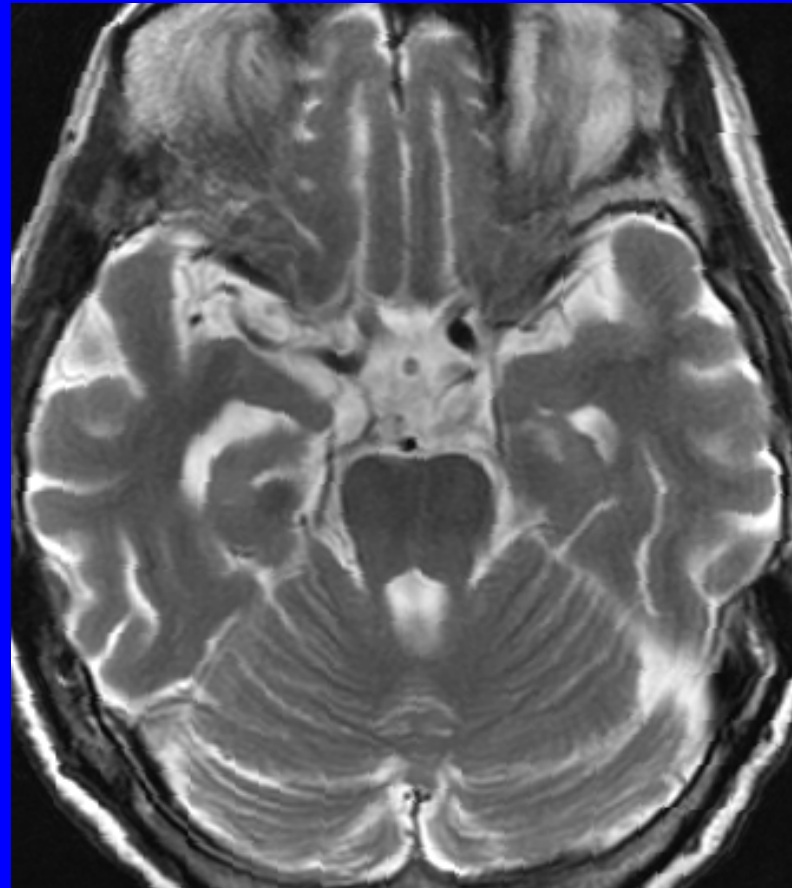
Some correlations in atrophy

SVM analysis for
1) volume & 2) shape (spectrum)
at 83 areas (structures)
in 28 TLE pts vs. 80 normals.



PLoS One
7:e33096

Demented !?



How to get hidden information?

Image Processing

Confounding differences in
each individual, image contrast,
distortion, artifact, etc.



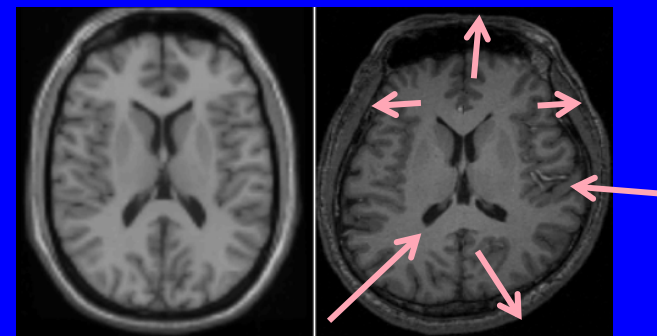
Brain Normalization: non-linear warping ex. DCT



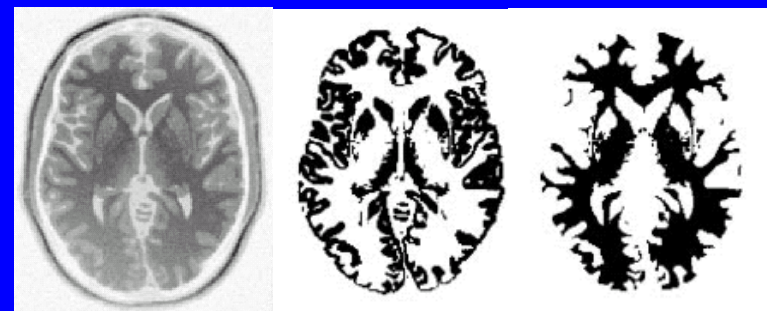
Extraction of information

Typical image processing

Anatomical Normalization
Talairach Atlas



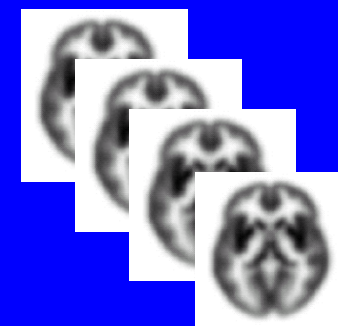
Segmentation



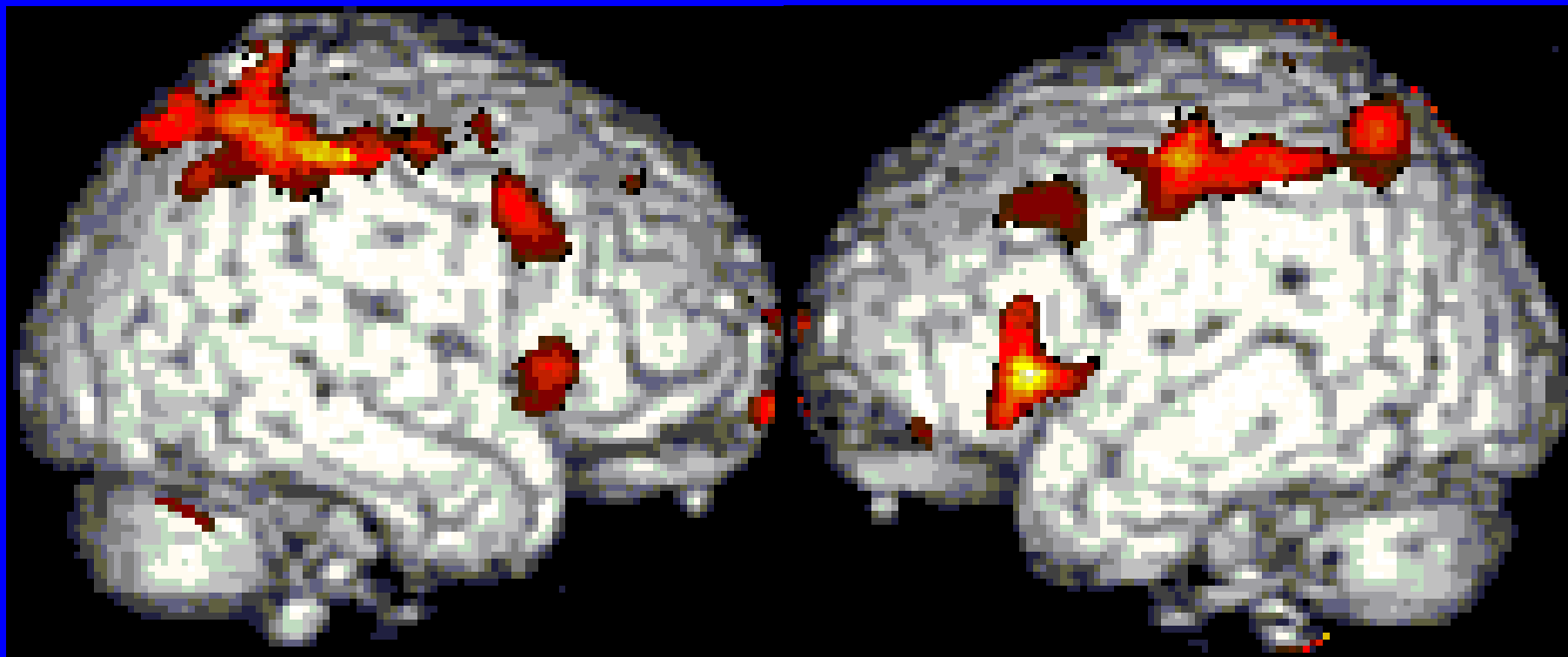
Smoothing



→ Statistics



Correlated brain areas to aging

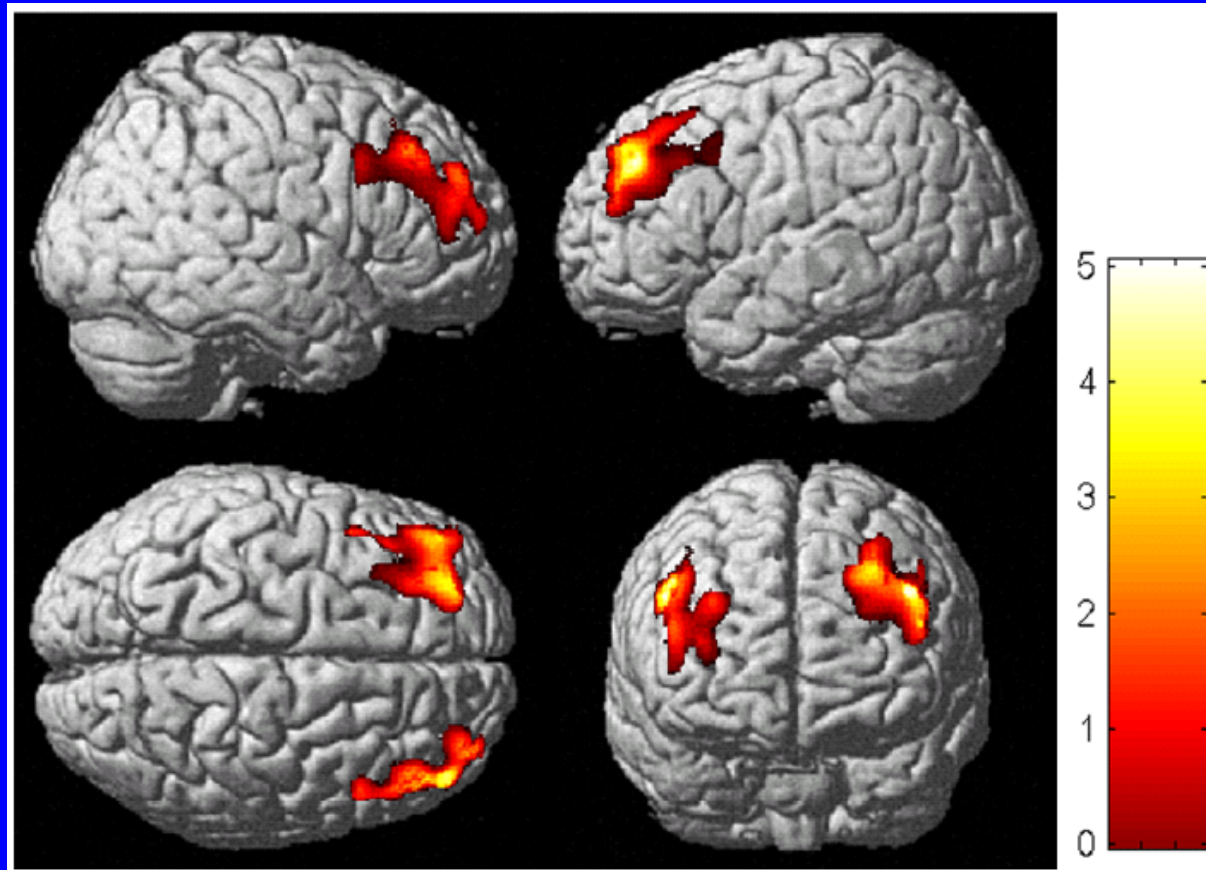


54 subjects (19 – 73 y.o.), $P < 0.005$



Chronic Fatigue Syndrome

Neural Correlates to Fatigue

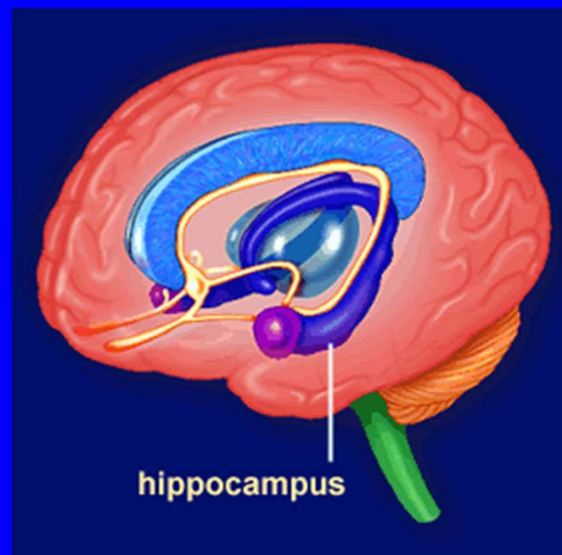


BMC Neurology 4:14

More sophisticated analyses

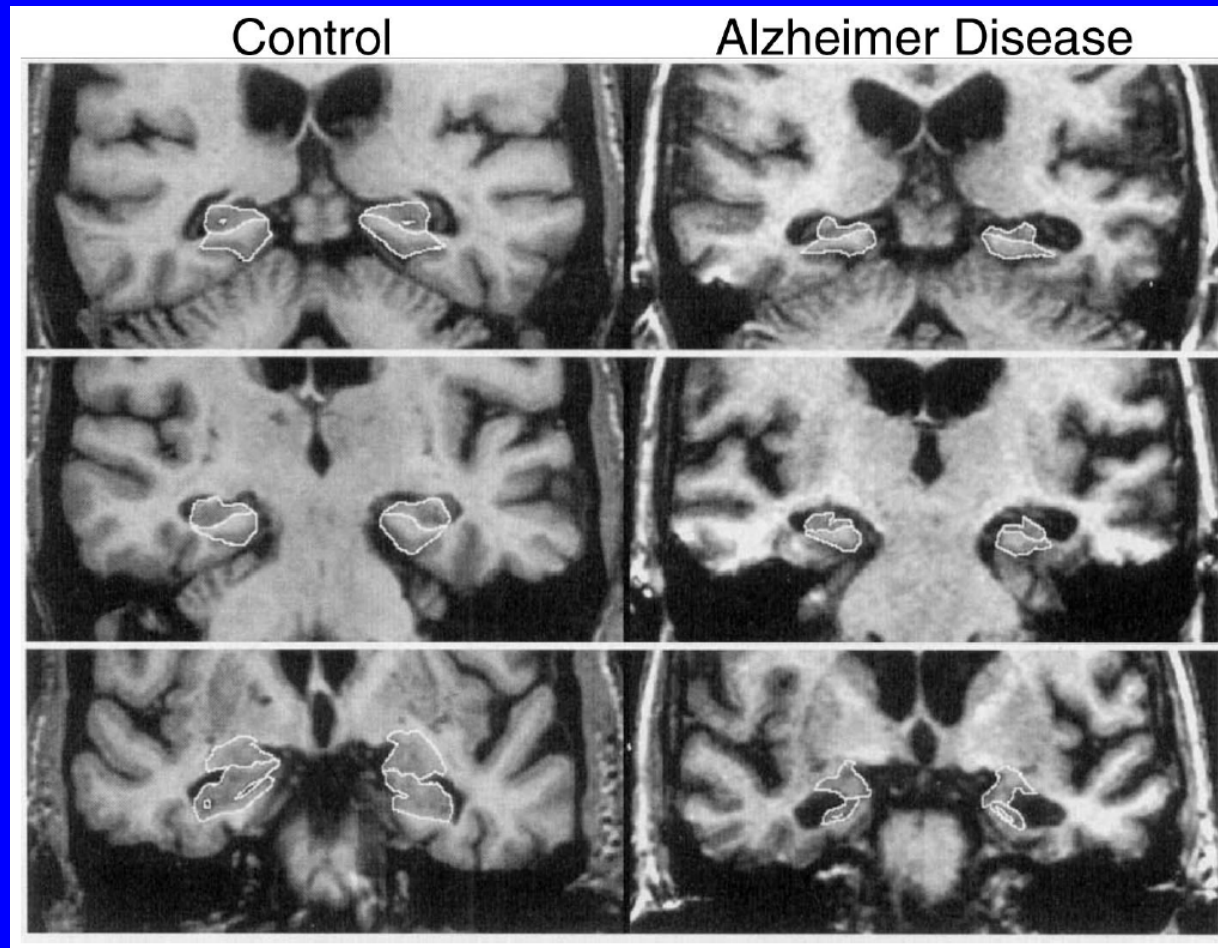


Better understanding of illness



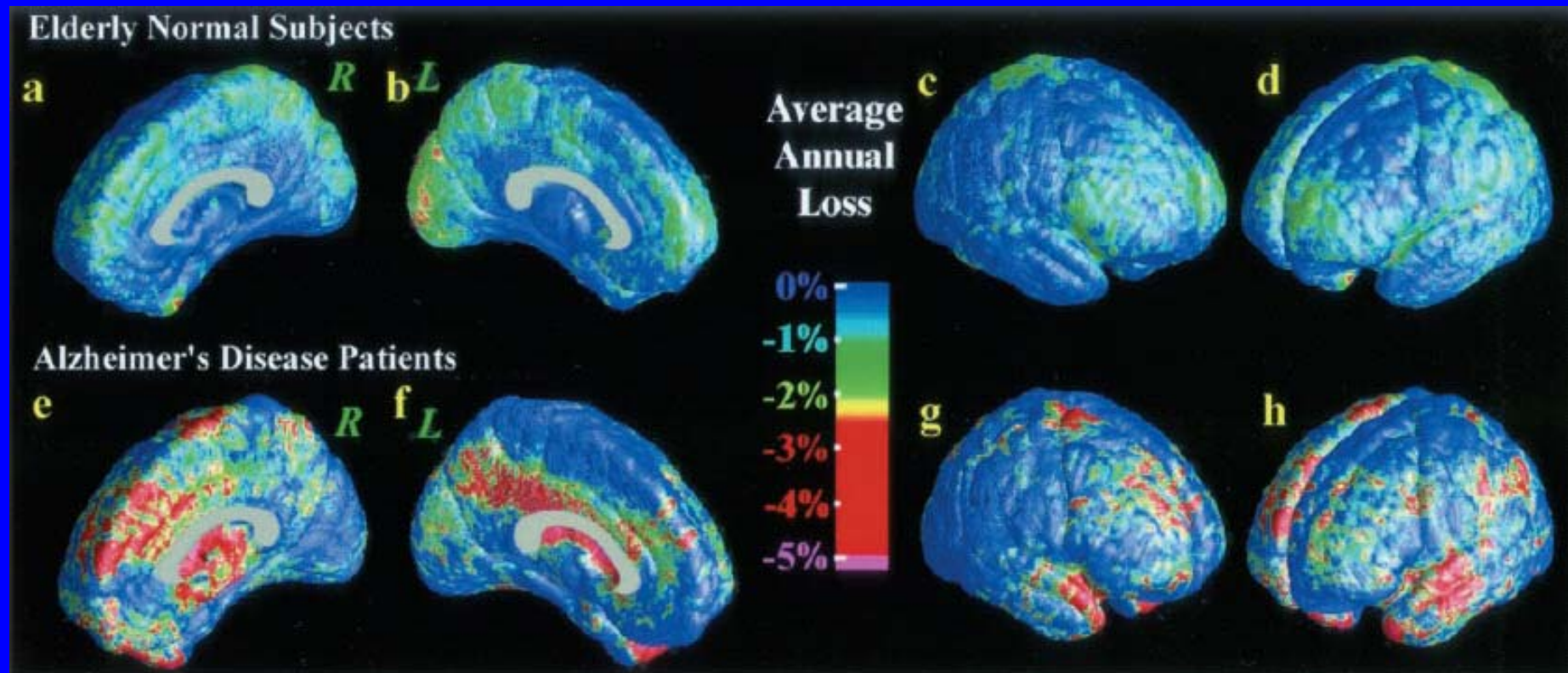
<http://editthis.info/psy3242/Hippocampus>

Hippocampal volume



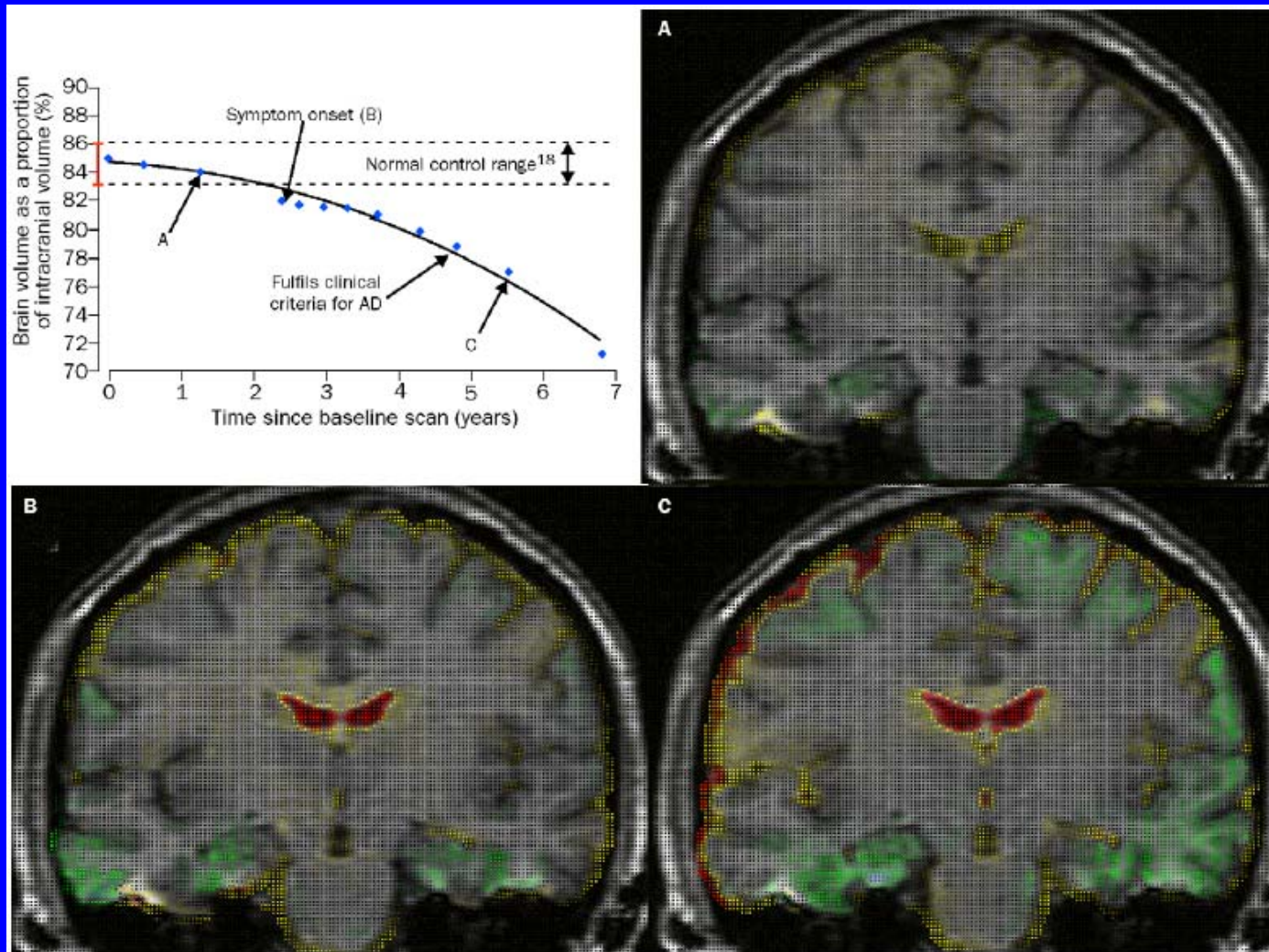
Sensitivity & specificity > 80% O'Brien et al., 1997

Brain atrophy in AD vs. Normals



Thompson PM et al., 2003, JNS 23:994

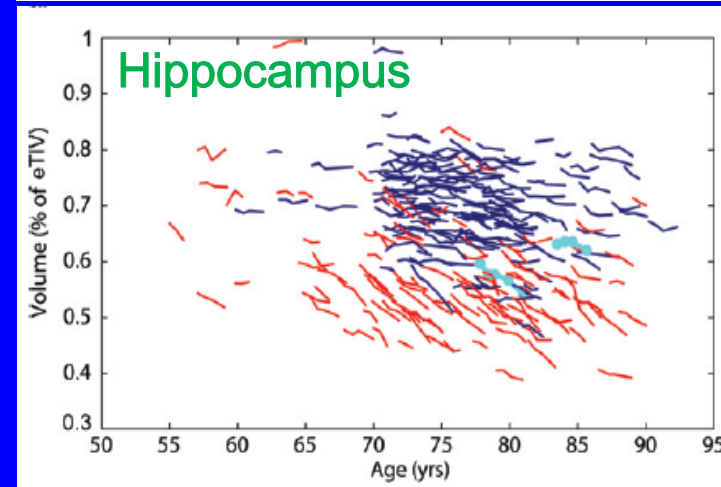
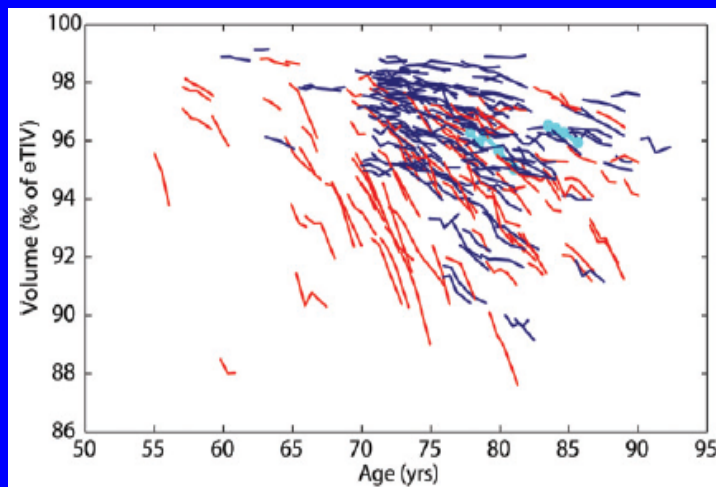
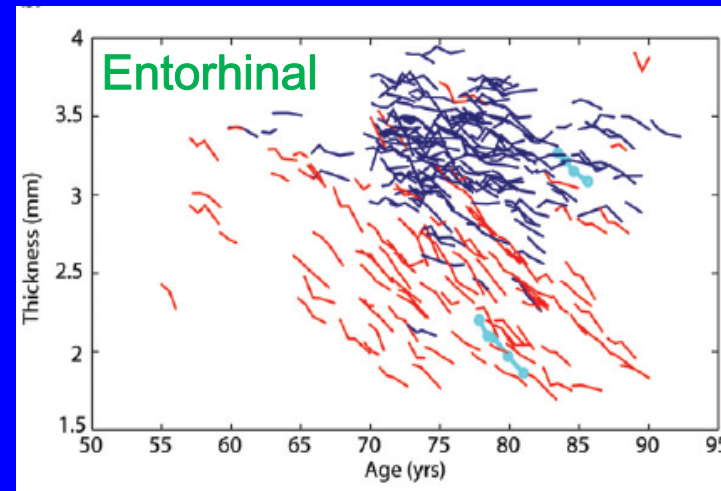
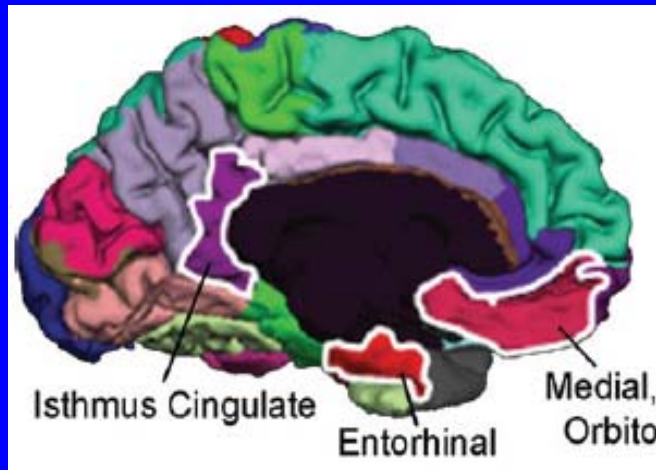
Annual change within a subject



A 36 y.o. female with family history of AD. Fox et al., 2001

ADNI: Alzheimer's Disease Neuroimaging Initiative

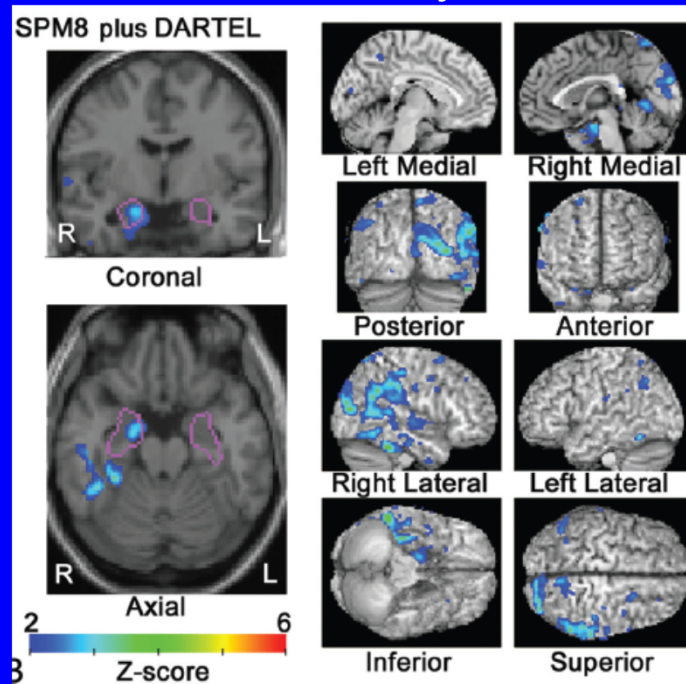
AD(red):164, Norm(blue):203, Norm->AD(Cyan):2. Radiology 2011, 259: 834



<http://i.nurukomonogetari.seesaa.net/category/4768766-1.html>

Volumetry in clinical practice!

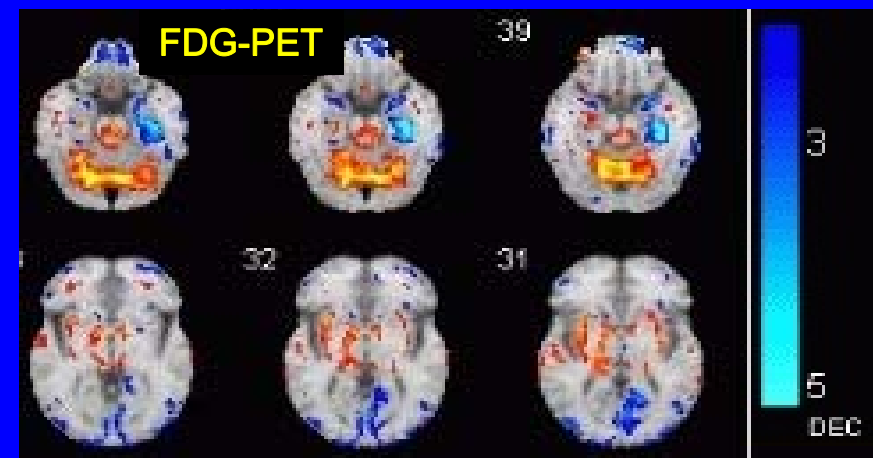
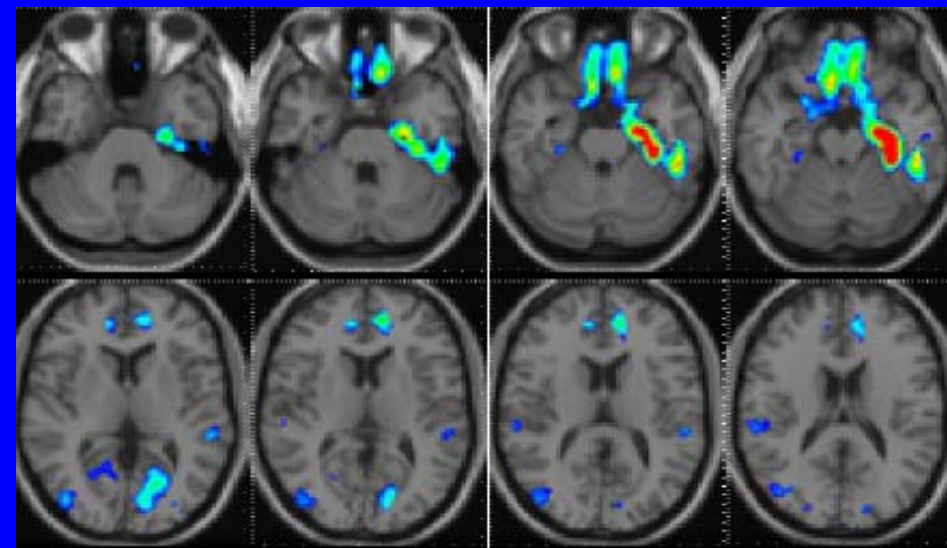
Stand alone PC analysis in 10 min



Matsuda et al., AJNR 2012

Sensitivity of AD
91.6 - 98.2%

Atrophic areas in epileptic pt.





Gion Shirakawa

Functional MRI (fMRI)

10:15 ~ 10:25
開会挨拶



脳 の 世 紀

13:30 ~ 14:15
脳を知る
記憶形成のダイナミクス
井ノ口 馨
富山大学大学院医学薬学研究部
14:15 ~ 15:00

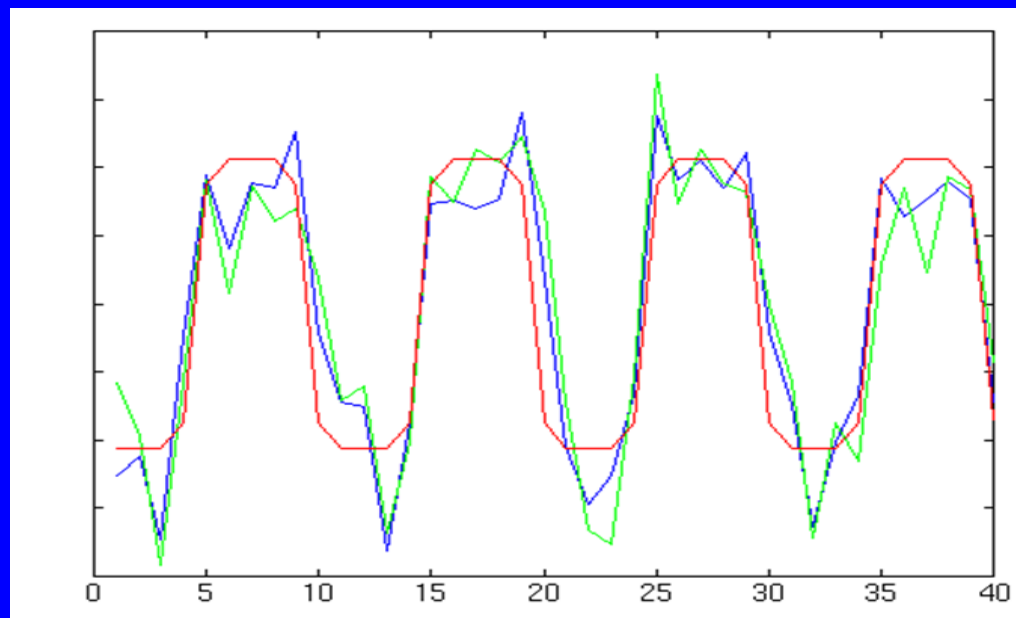
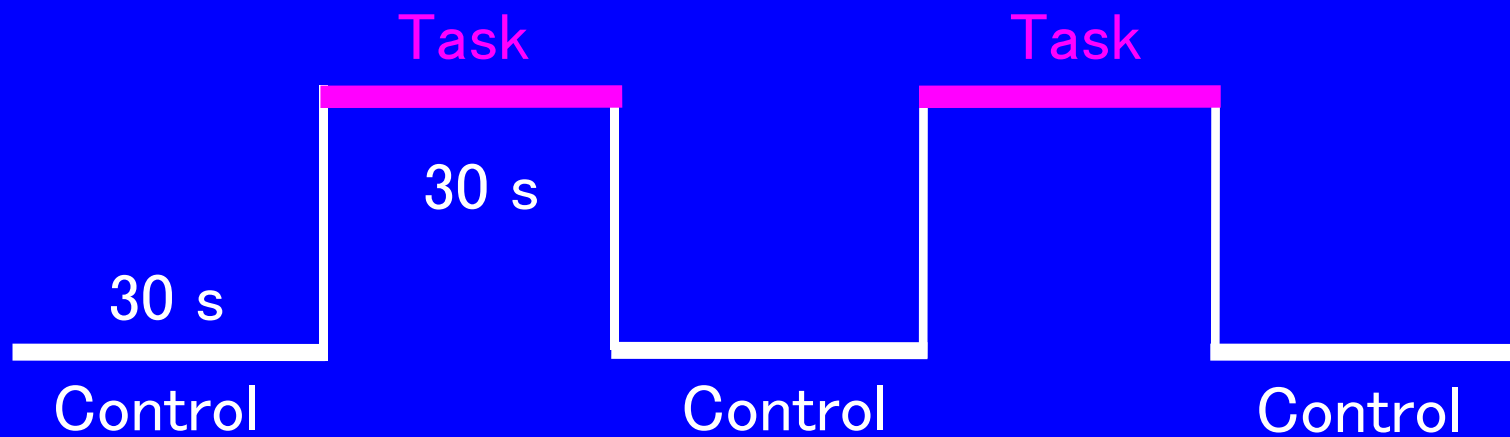


Century of the Brain

第19回
2011

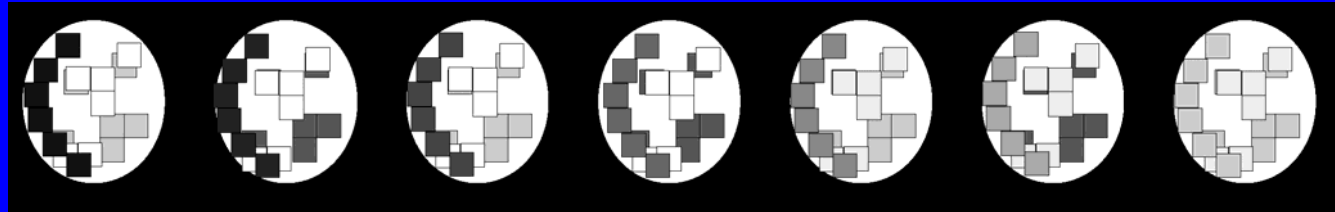


Modeling in functional MRI



Exploratory fMRI analysis: ICA

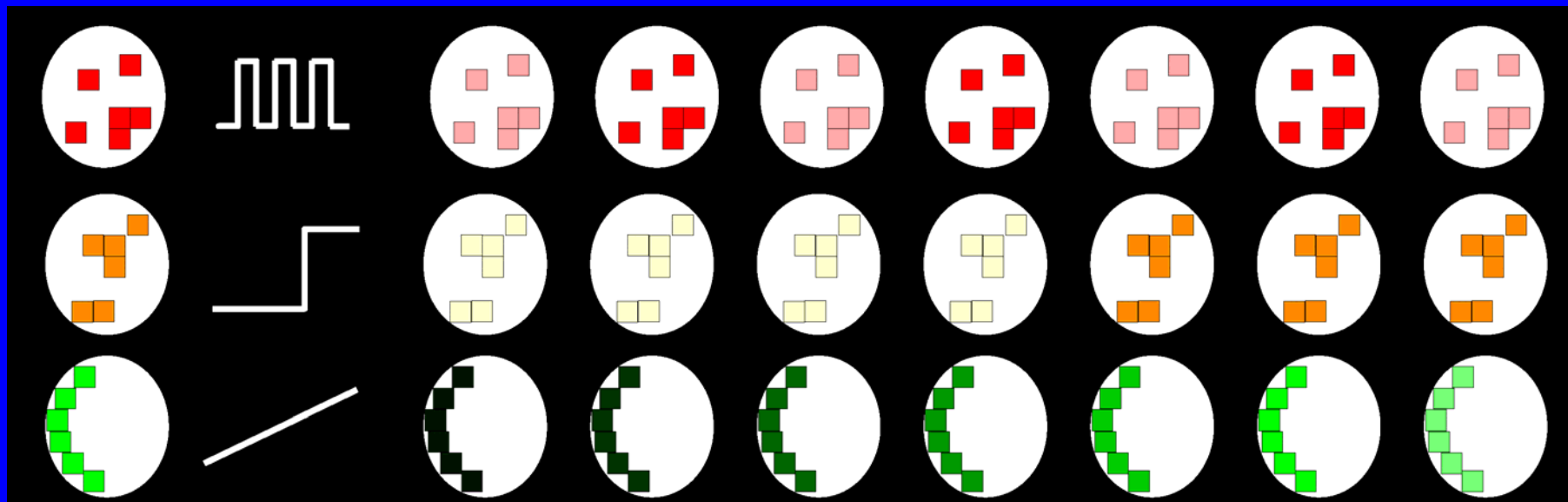
Observed
signals



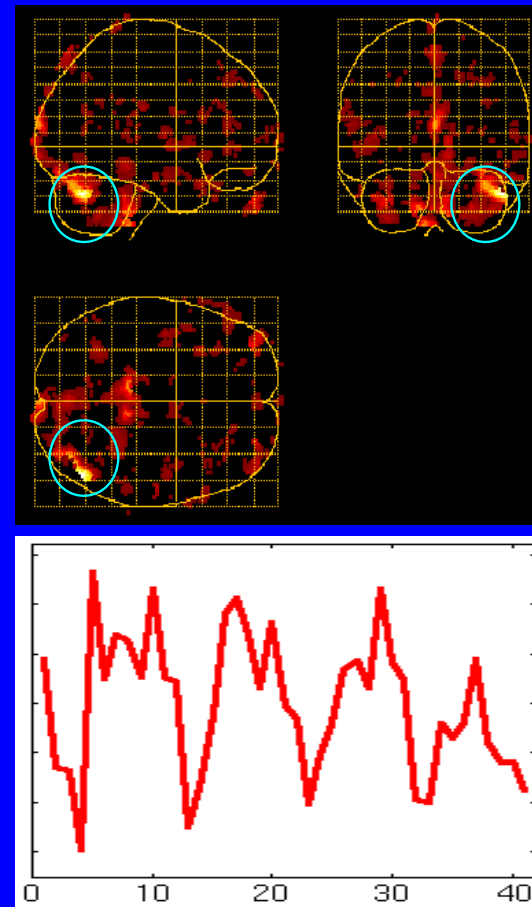
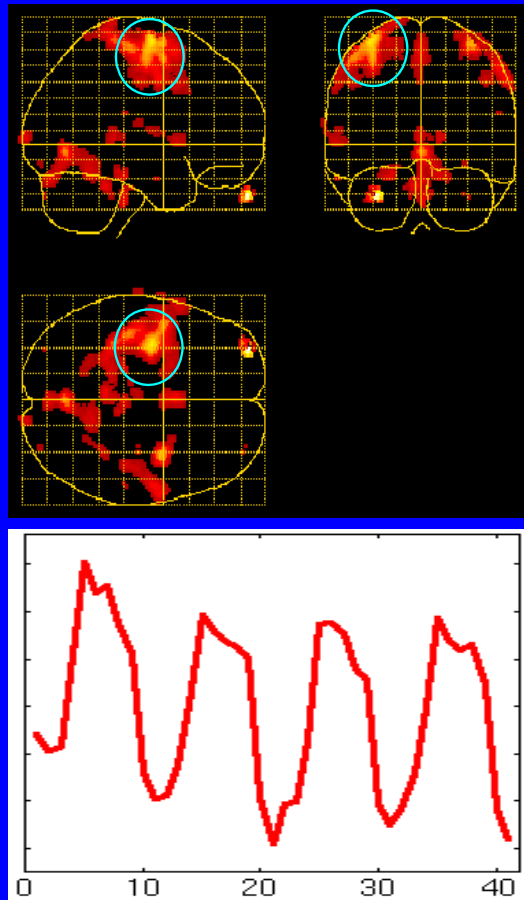
IC map

Activation

Time

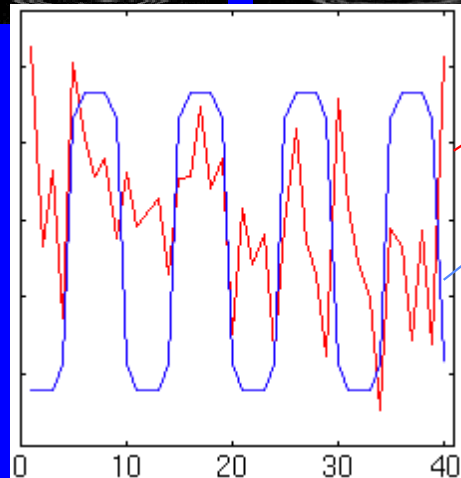
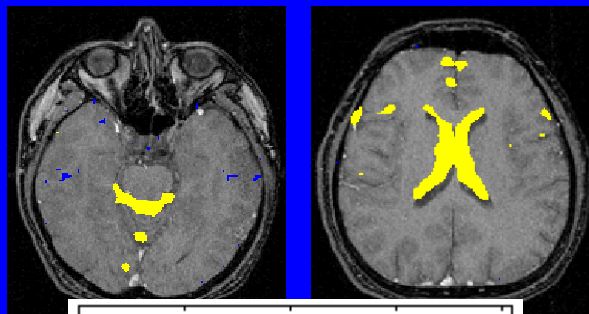


Learning complex finger movements



ICA as a noise filter

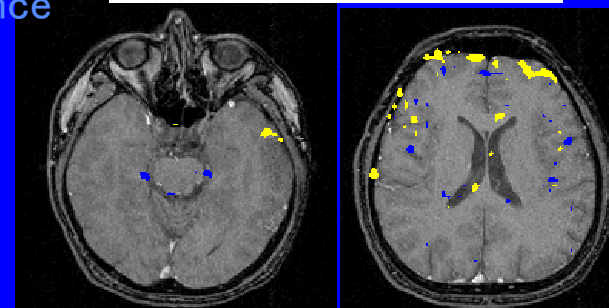
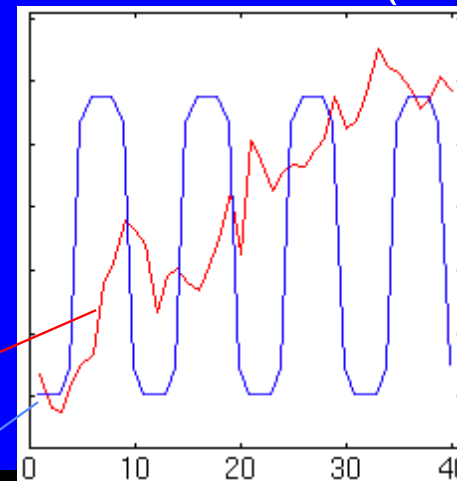
CSF (#1)



Time course

Reference

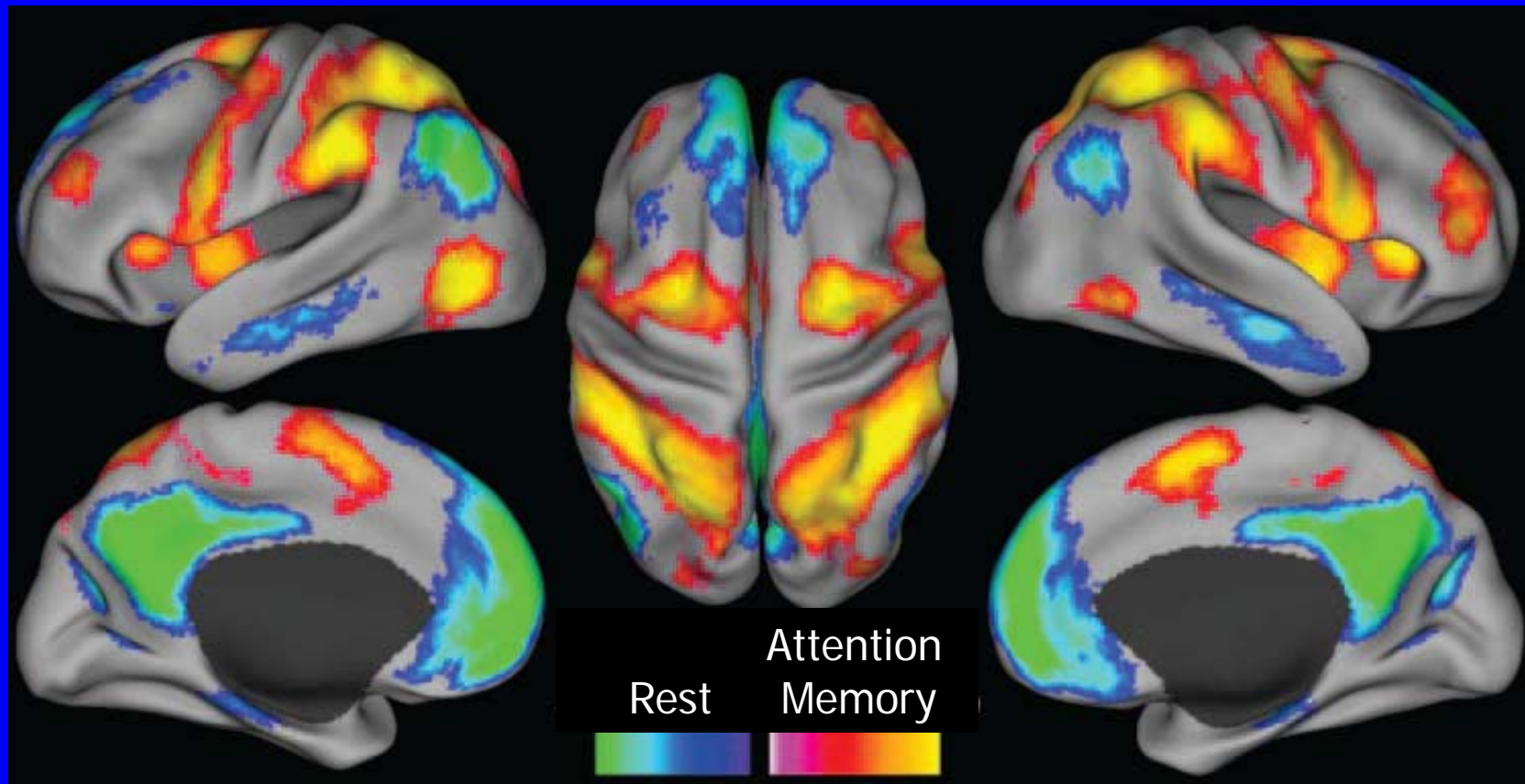
Slow movement (#14)





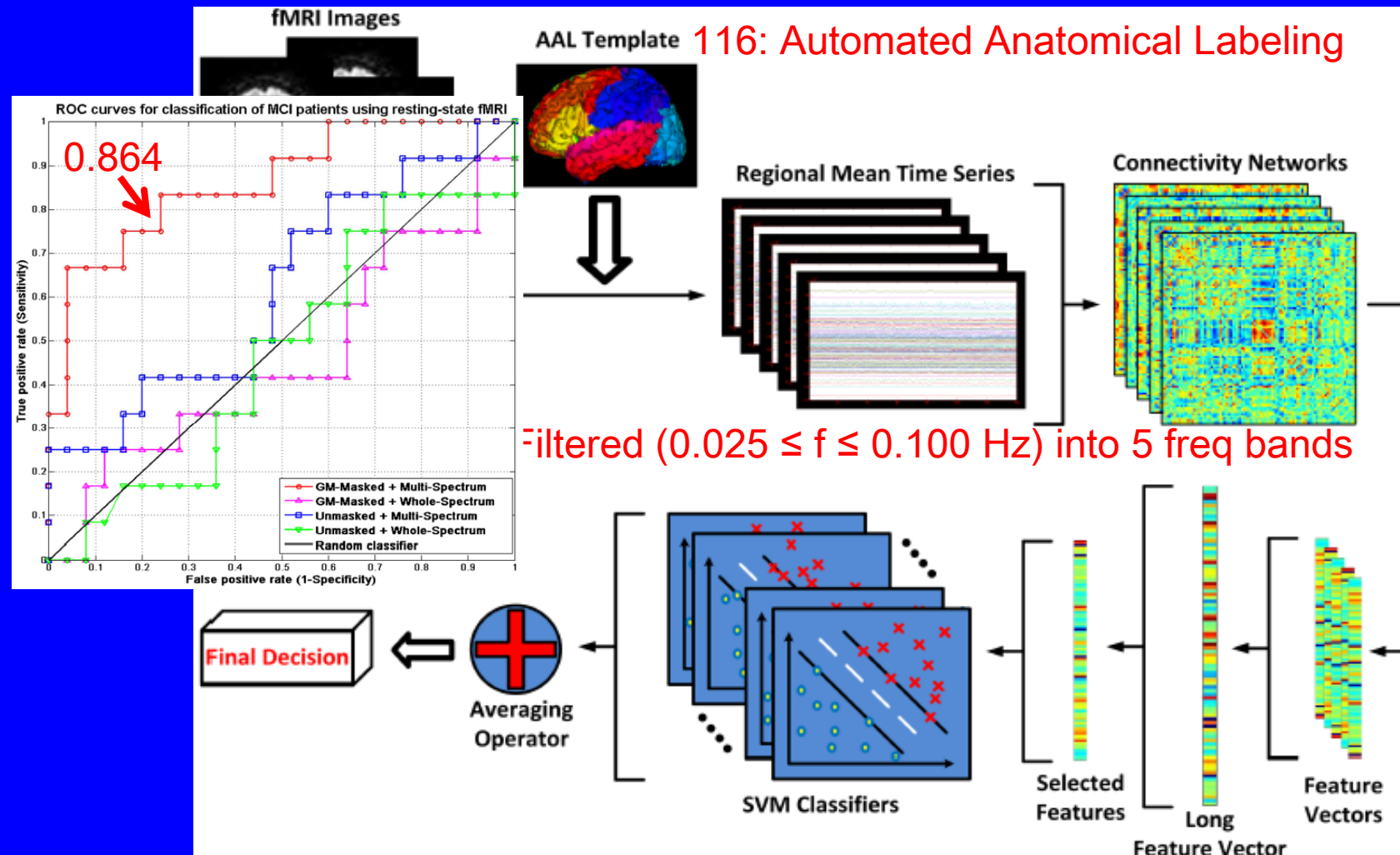
[http://flowingdata.com/2008/03/12/
17-ways-to-visualize-the-twitter-universe/](http://flowingdata.com/2008/03/12/17-ways-to-visualize-the-twitter-universe/)

Resting & Acting Brain Networks



Fox, ... & Raichle, PNAS 2005; 102: 9673.

RS-fMRI Connectivity Networks for MCI



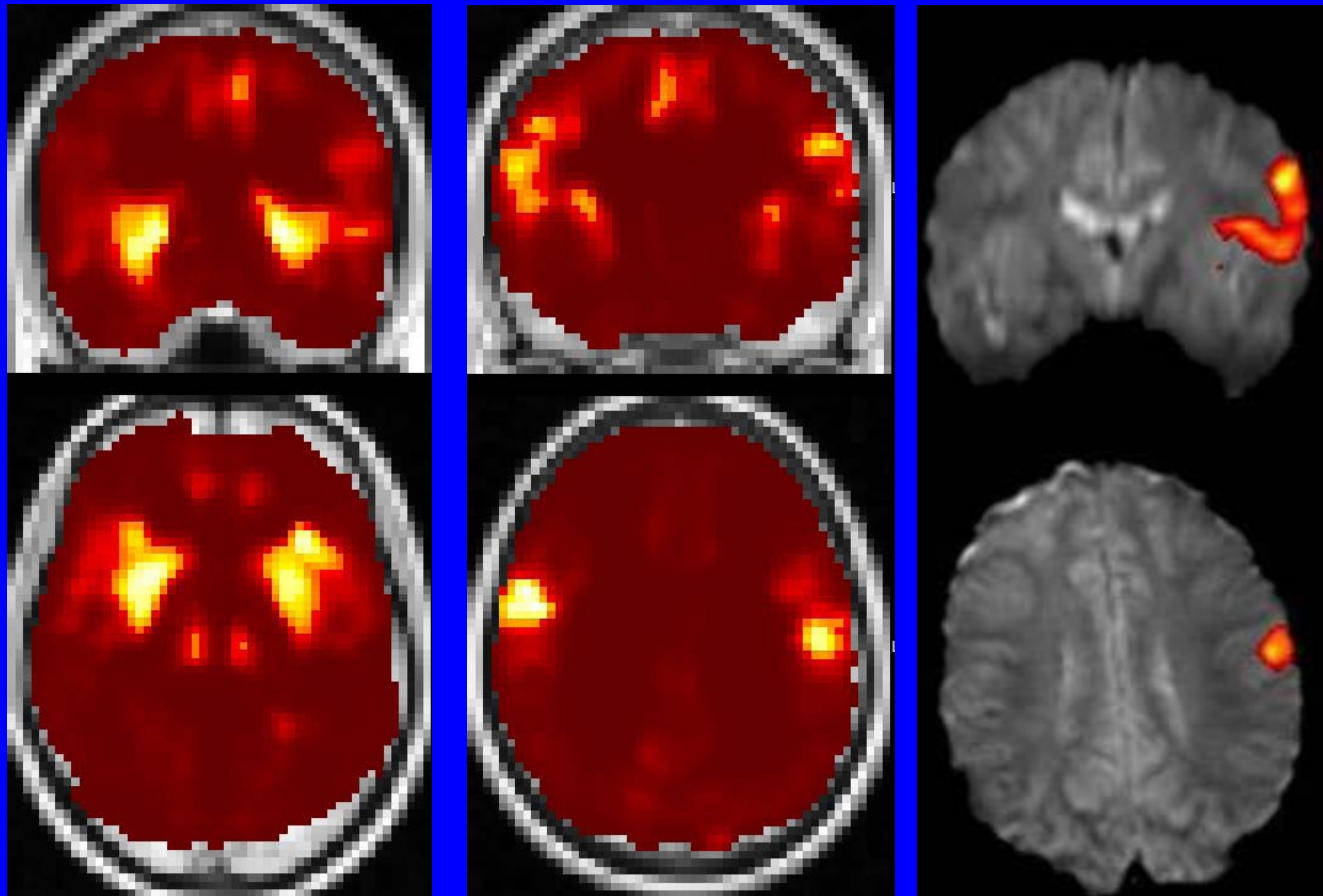
Univ NC, Duke: 3T, 4*4*4 mm, TR 2s, TE 32ms, 34 slices

Network analysis of resting-state fMRI

26 benign Rolandic epilepsy pts
& 16 controls: EEG-fMRI

RS-fMRI: 5min.

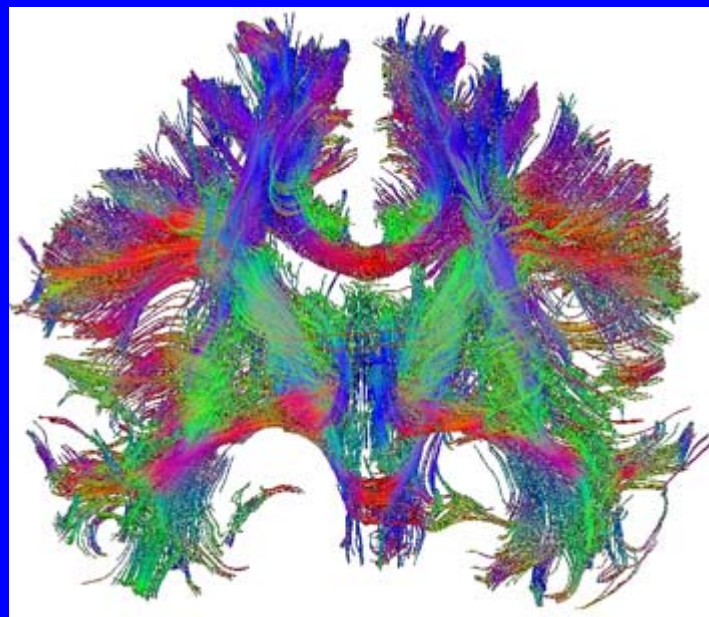
PageRank algorithm for node centrality



ISMRM2012:0372

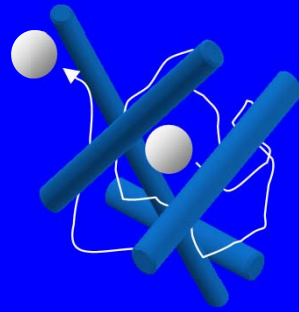


http://www.graphicshunt.com/images/bouquet_of_flowers-3271.htm

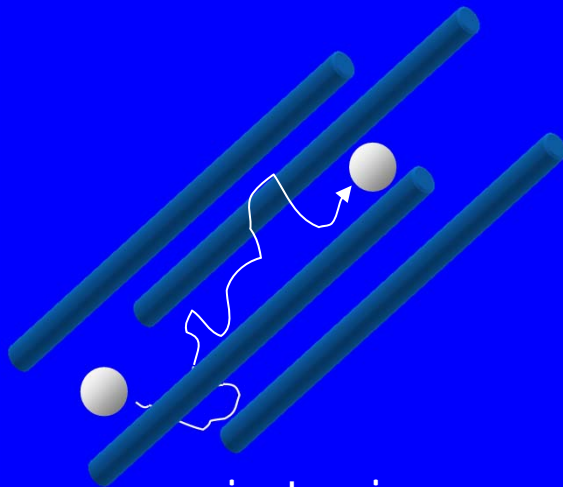


http://www.biomed.ee.ethz.ch/research/bioimaging/brain/diffusion_fiber_tracking

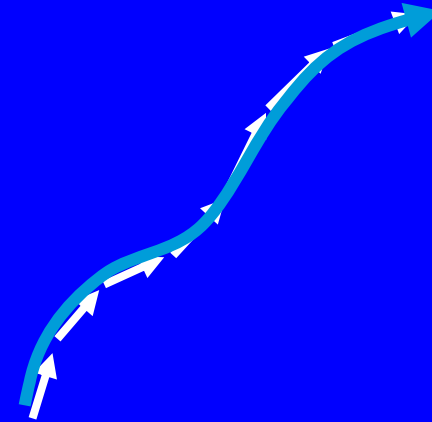
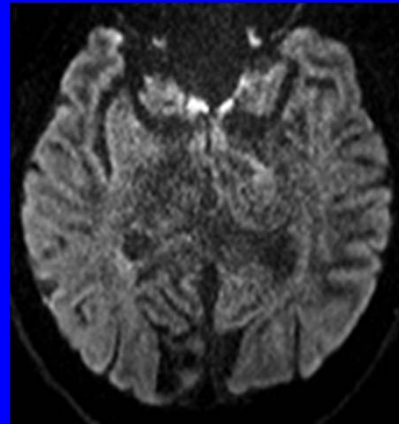
Water diffusion is restricted in the brain



isotropic



anisotropic

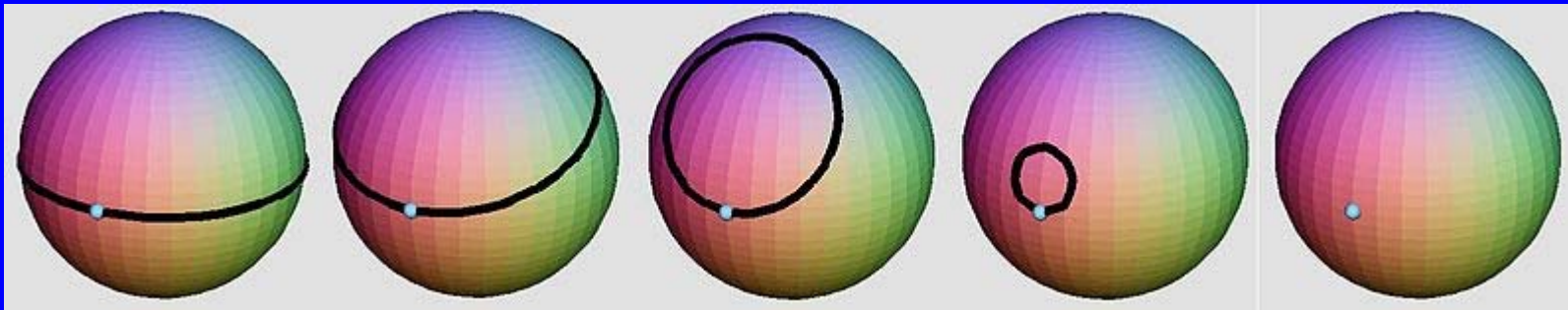


<http://www.cse.msstate.edu/~szhang/brain.htm>

Tractography

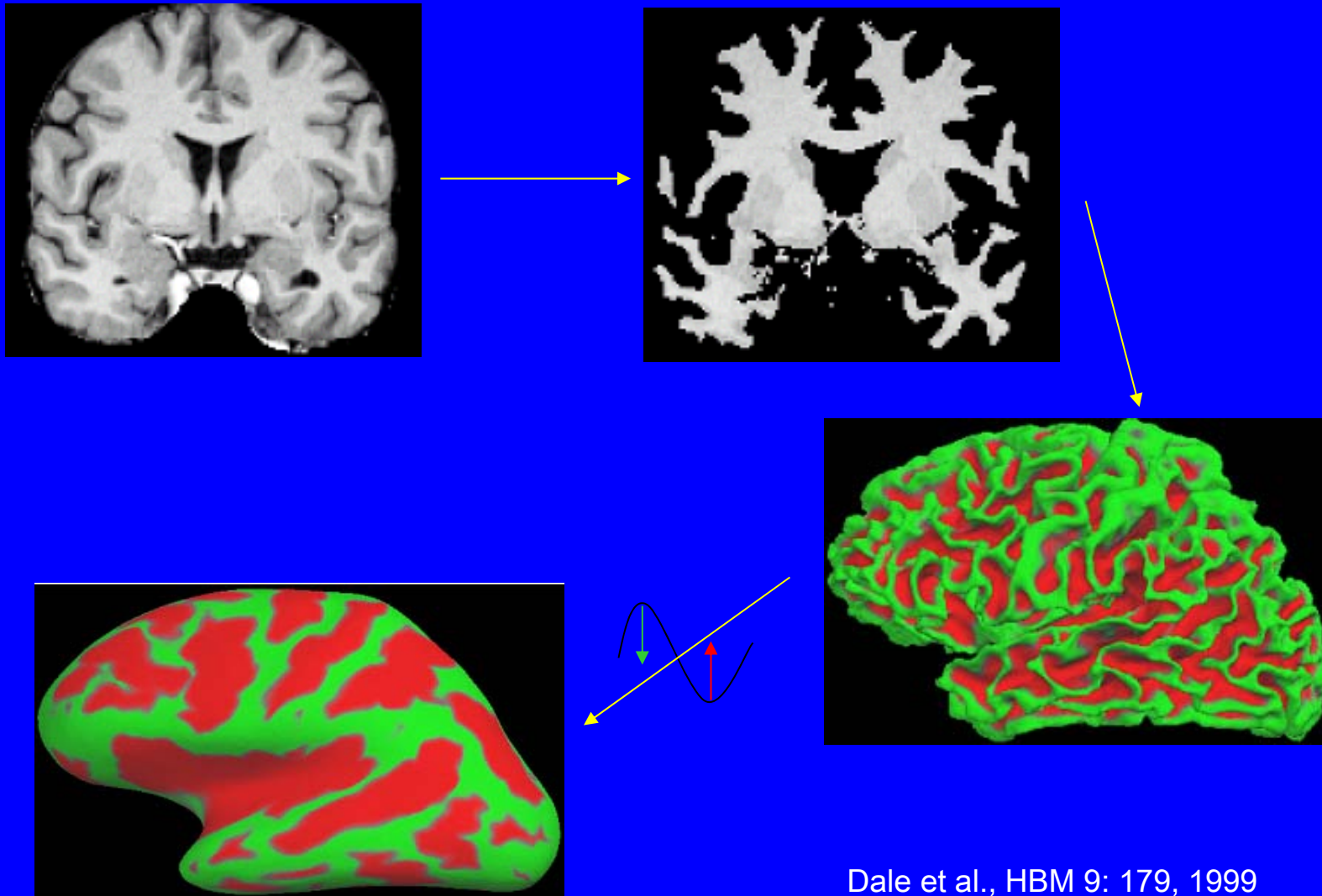
Still under development!

Make it simple!



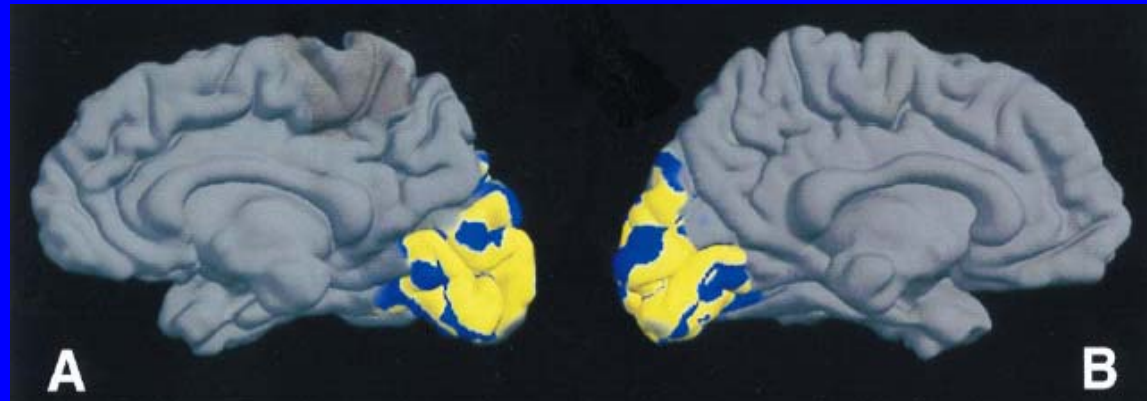
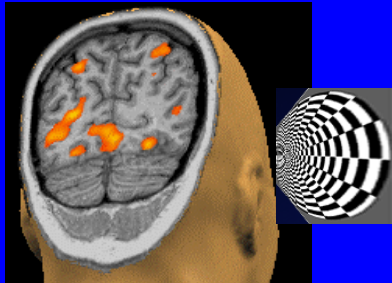
Poincaré conjecture, Wikipedia

Open the brain!



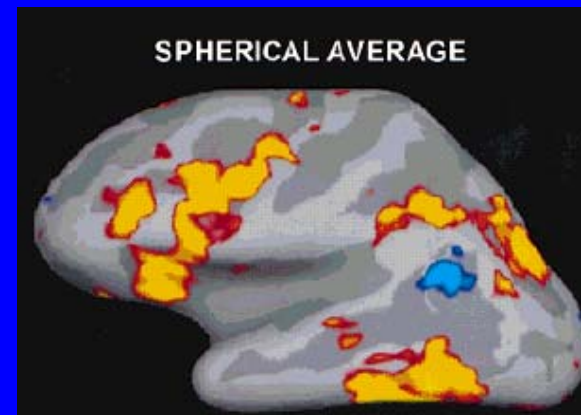
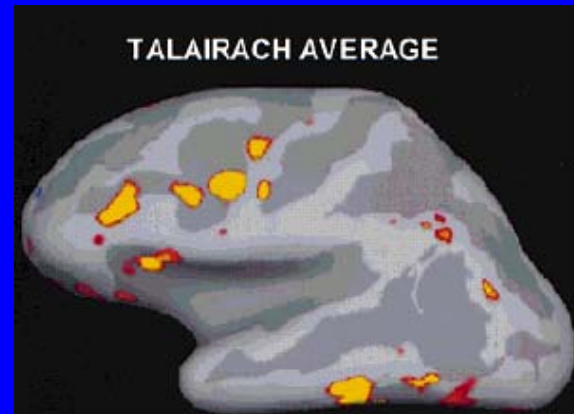
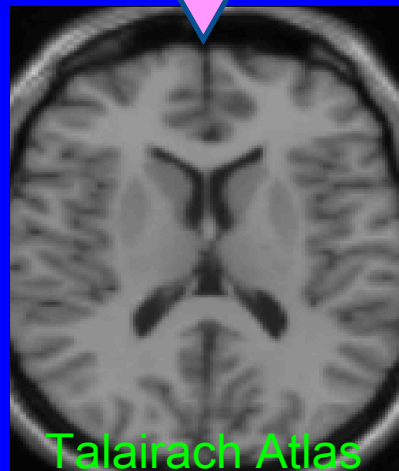
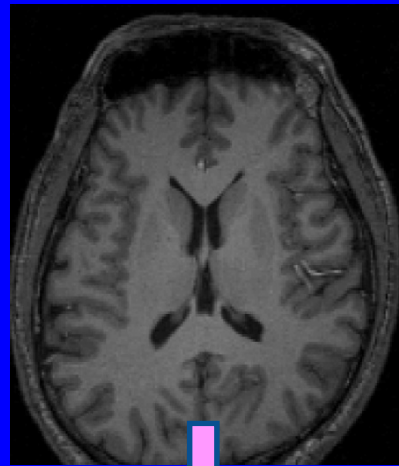
Dale et al., HBM 9: 179, 1999

Hierarchy in the visual cortex



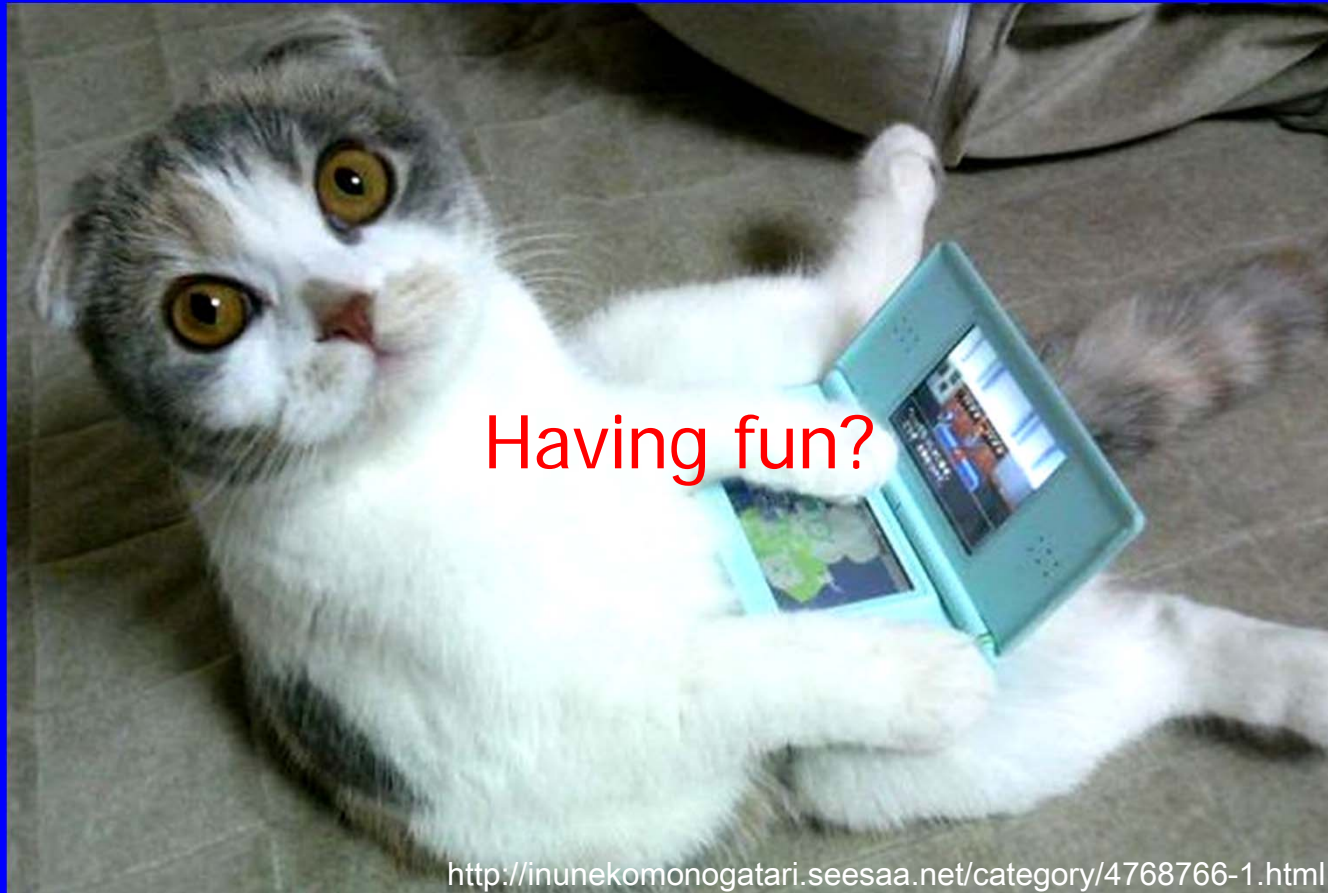
Tootell et al., PNAS95:811, 1998

Accuracy of anatomical normalization

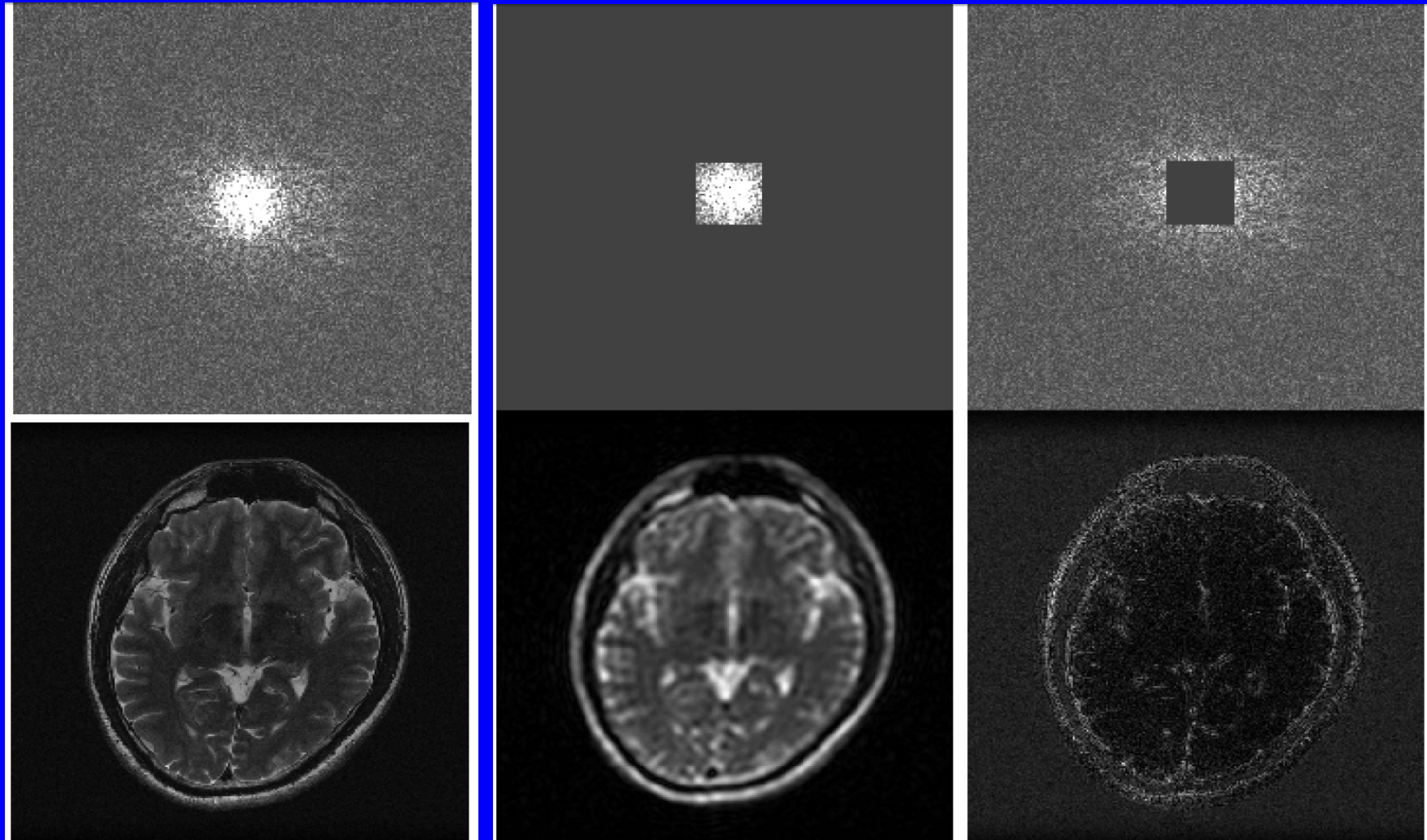


Words: new vs. old

Fischl et al., HBM 8:272, 1999

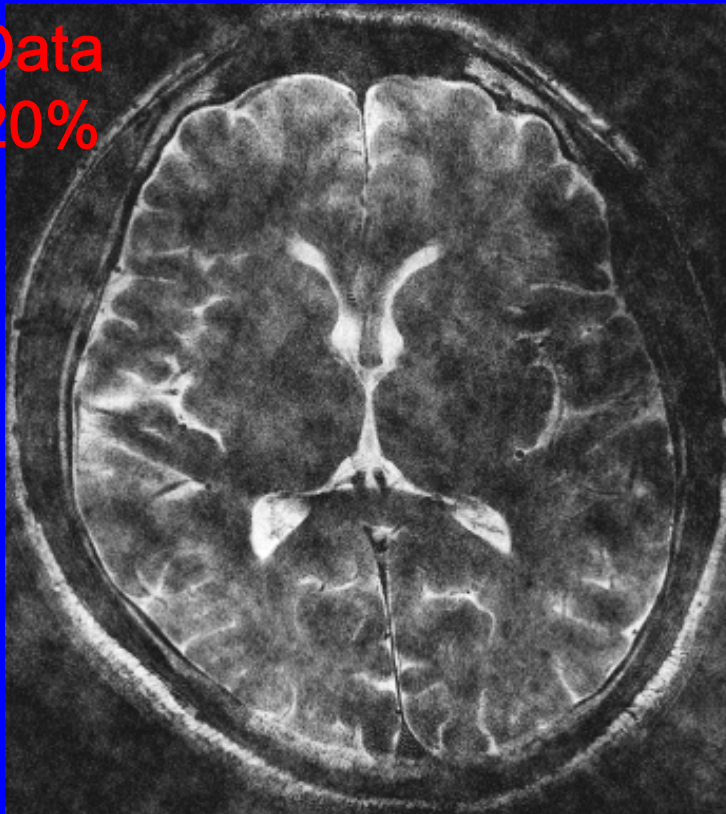


Fourier transform in MRI

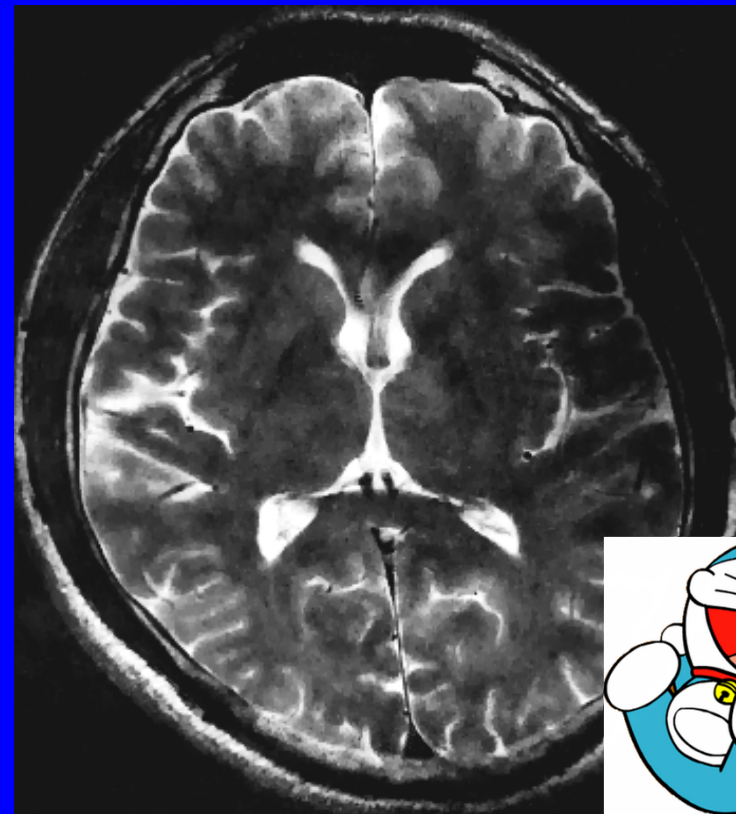


MR image reconstruction

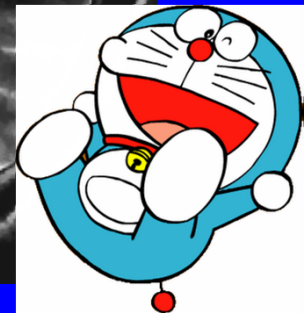
Data
20%



zero filling

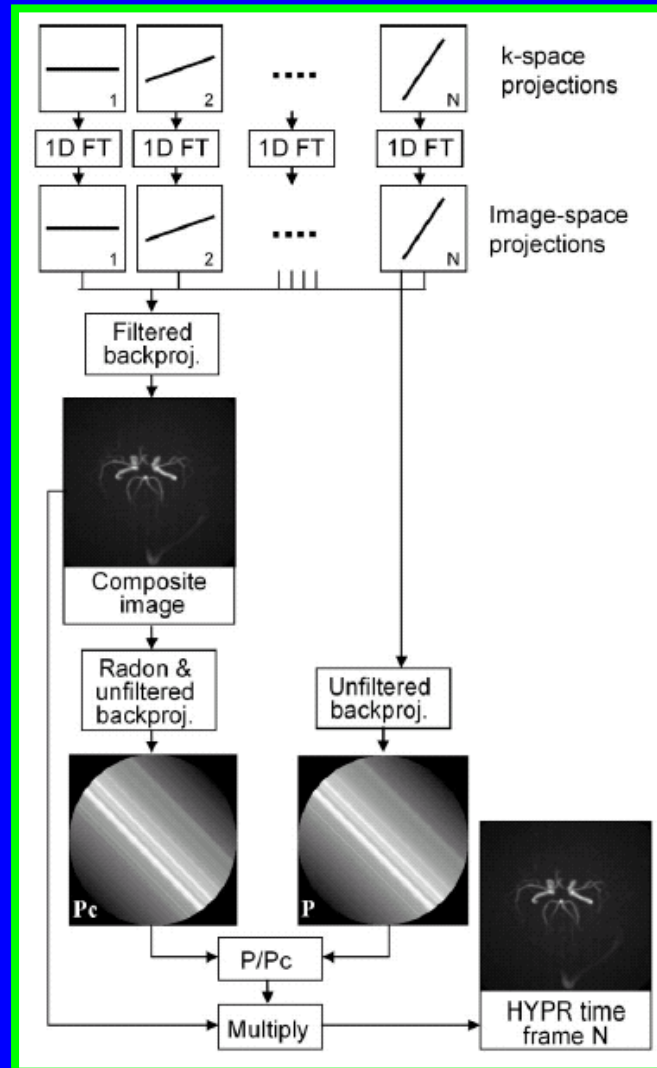


Compressed
Sensing (Matlab)

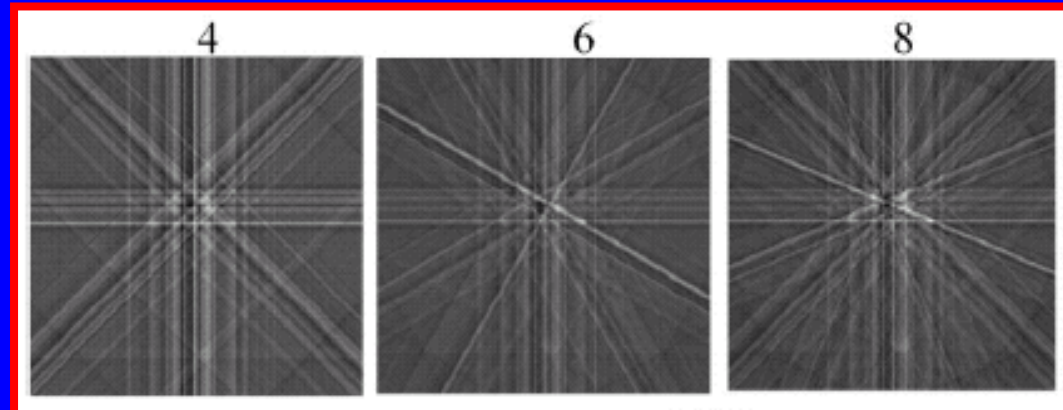


MRI reconstruction with HYPR

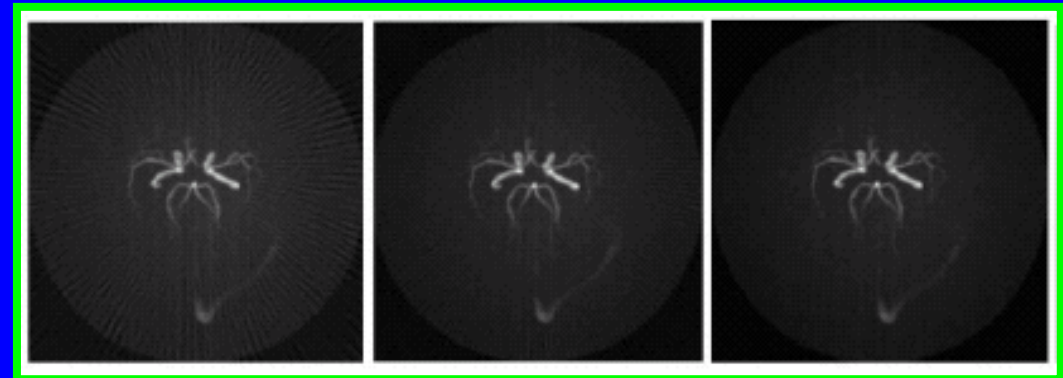
Highly constrained back Projection



FBP



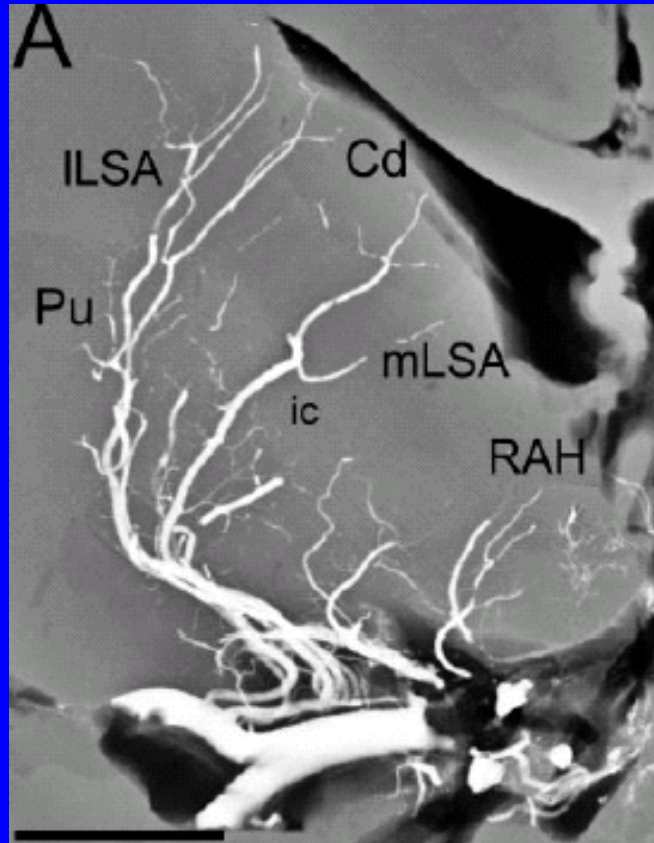
HYPR



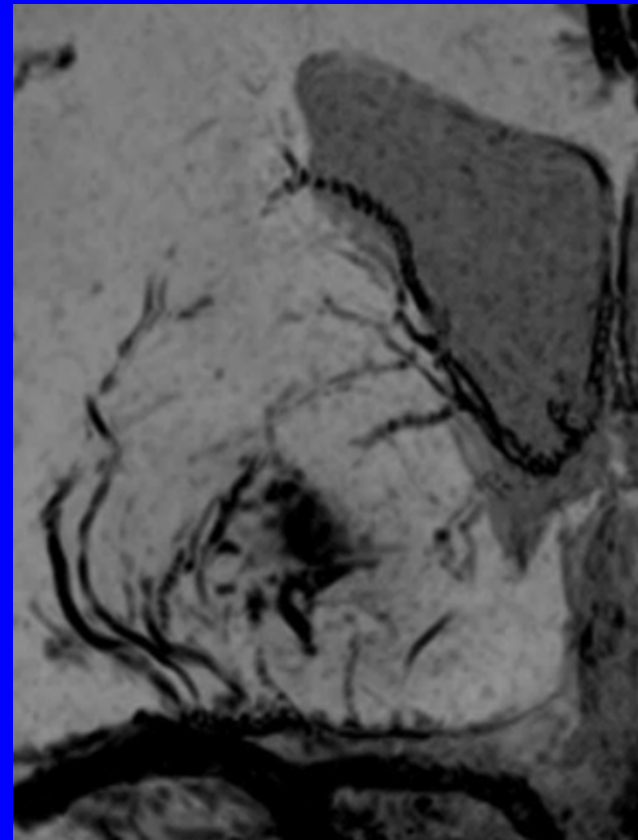
Expectation Maximization

MRM 55:30

Small artery, big impact!



Excised Brain
BRAIN 129:2189

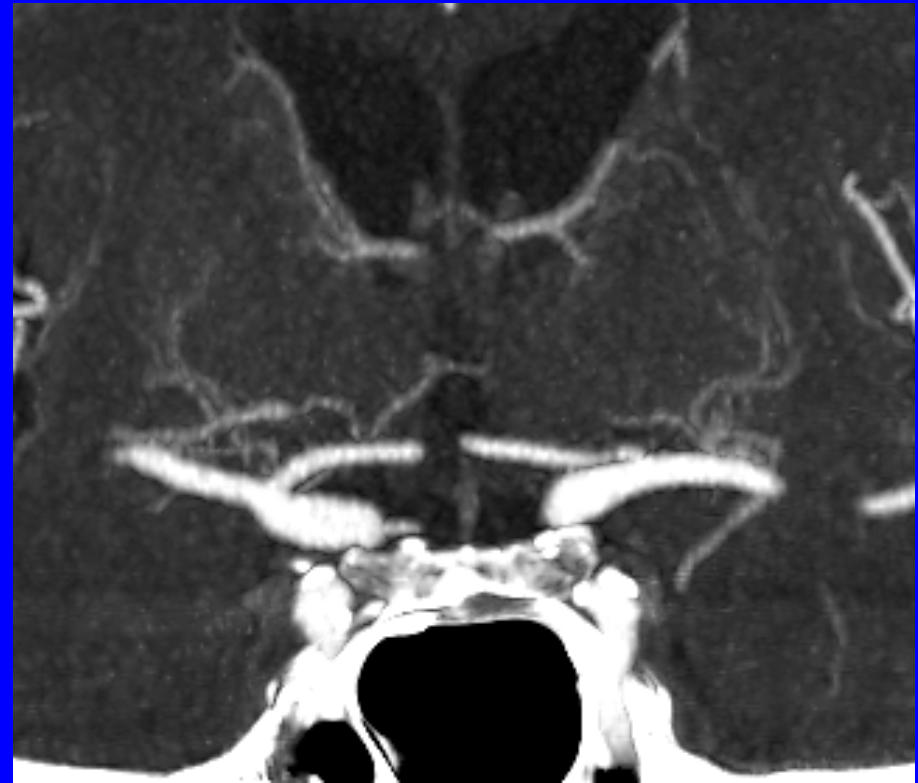


Lenticulostriate artery
Gotoh et al., JMRI 2009

Changes by hypertension



Normal



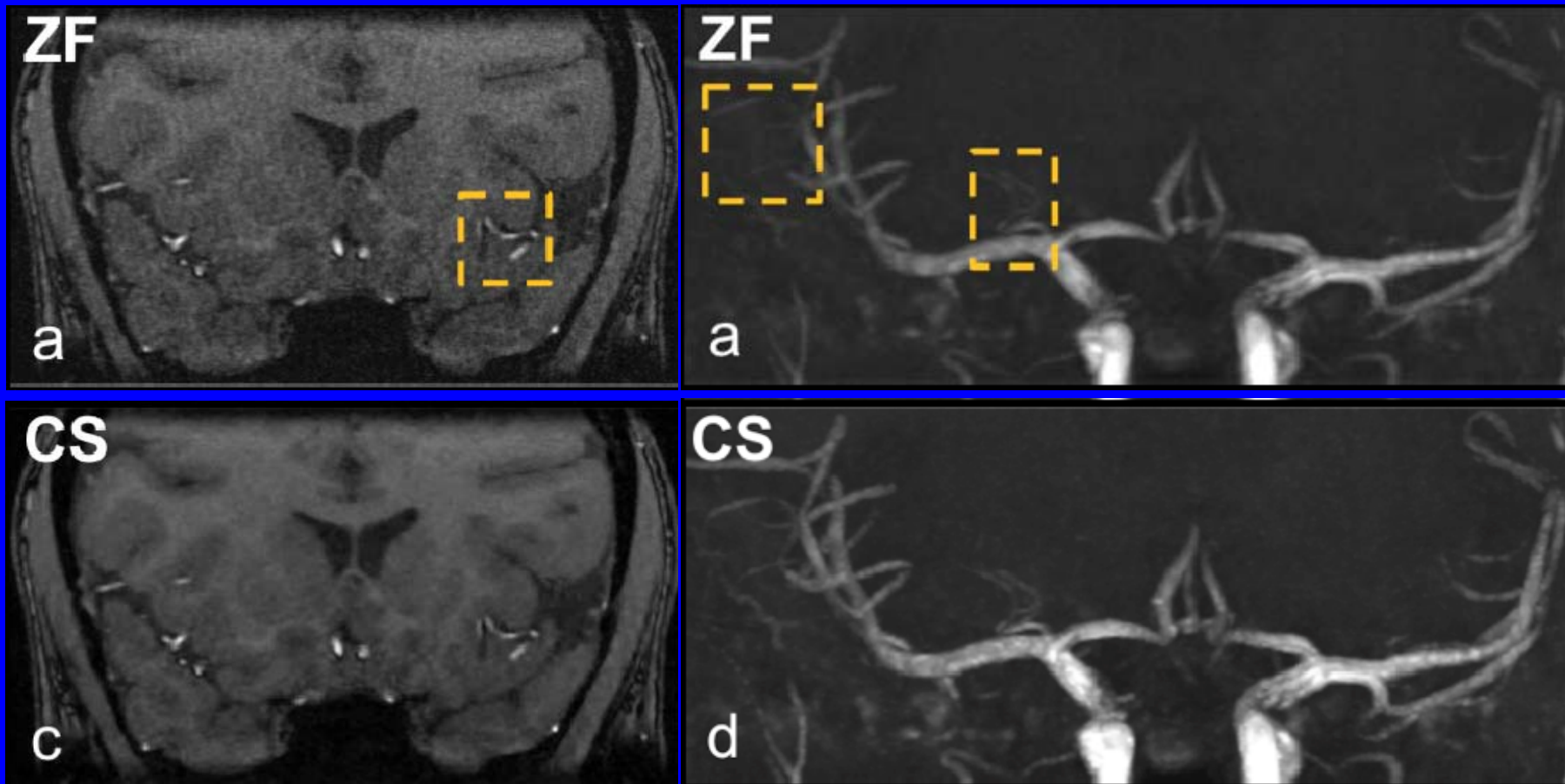
Hypertensive

Gotoh et al., BJR 2012

Reconstructions : CS vs. ZF

Very high resolution : $0.2 \times 0.2 \times 0.5$ mm

CS: compressed sensing vs. ZF: central sampling with zero-filling



Abstract 362, ISMRM2011

Roles in Medical Image Analyses



will expand HUGE!