UF Department of Biochemistry and Molecular Biology
College of Medicine
UNIVERSITY of FLORIDA

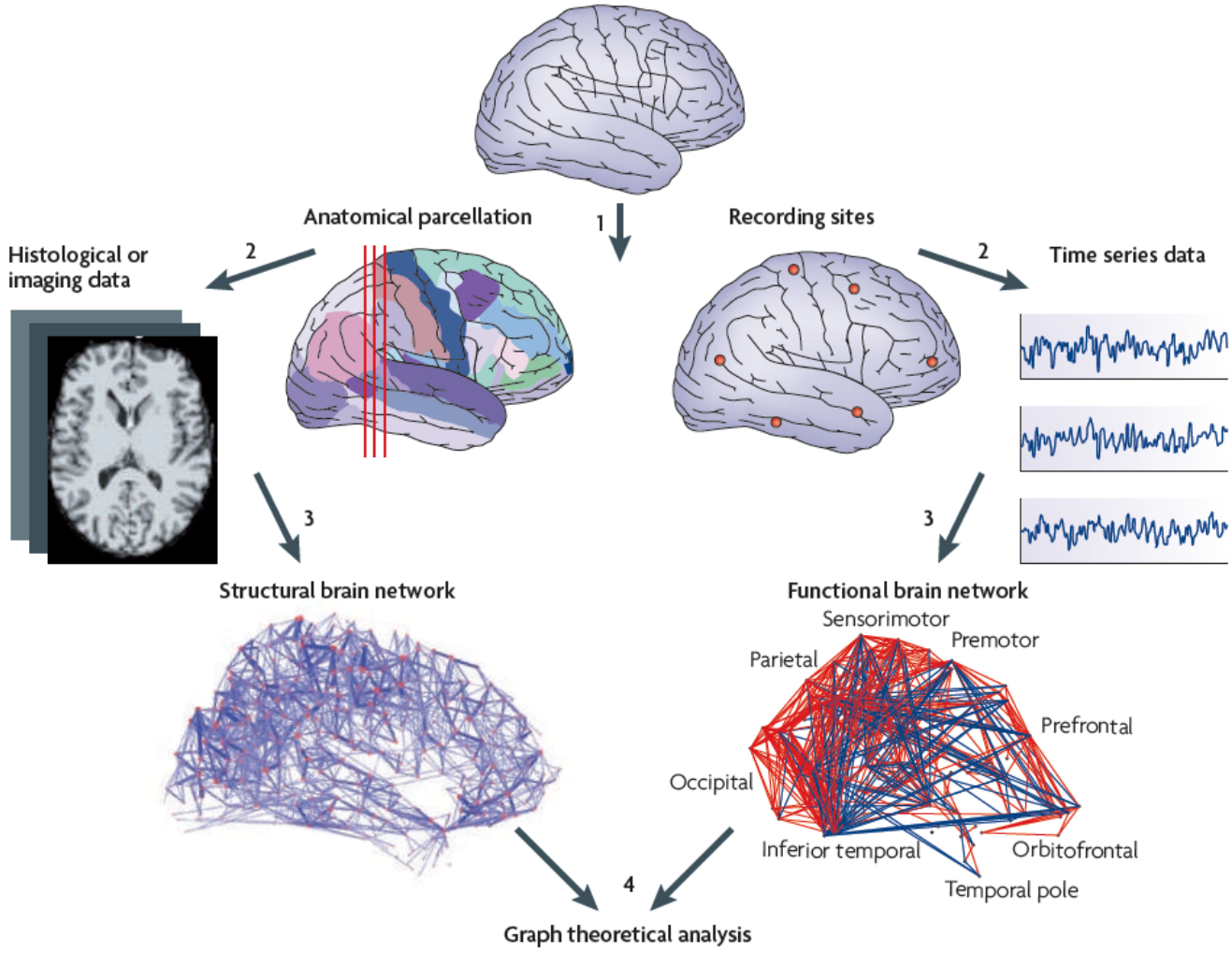
Imaging structure and function in biology with magnetic resonance and electroencephalography

Thomas H. Mareci
(thmareci@ufl.edu)

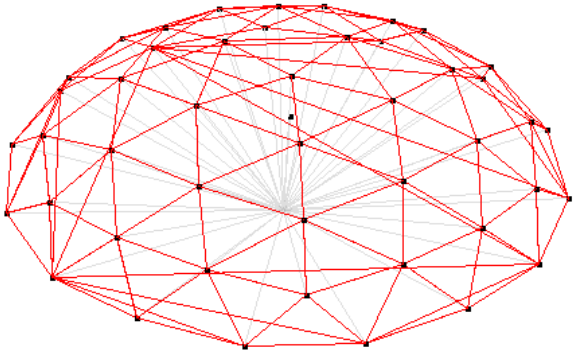
- **Problem**: Determine brain structure and function
- "Big Data" means rapid acquisition of large data and intense data processing
- Illustrate data generated, communicated, and/or computed
- Big Data limitations for brain studies involve data handling, processing and analysis.
- Big Data program can facilitate infrastructure and collaboration
- Current state of Big Data generation/analysis and growth over the next 5 years?
- Infrastructure and analysis challenges to successful research?

Brain Network Graphs: Relate Structure to Function

Bullmore and Sporns, Nature Rev Neuro 2009;10:186-198



Acquisition of Diffusion Weighted Images



Protocol for 3D imaging, ~ 30 min

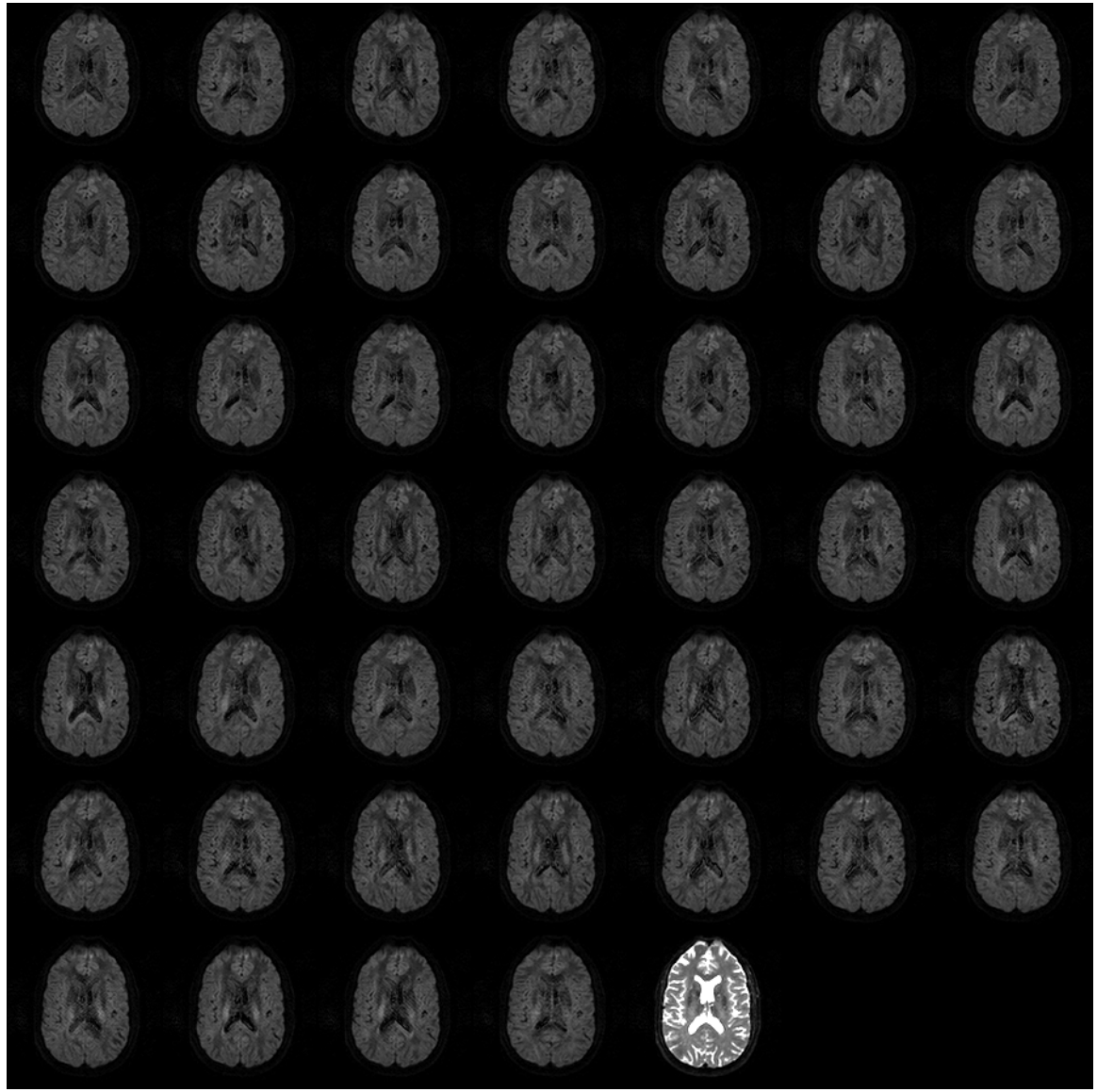
Diffusion weighted images resolution 2 mm x 2 mm x 2 mm

A 3D image for each of 46 directions plus 1 baseline 3D image

Two anatomical 3D images

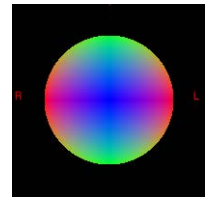
Total data ~ 1Gbytes/subject

Slice 24/60

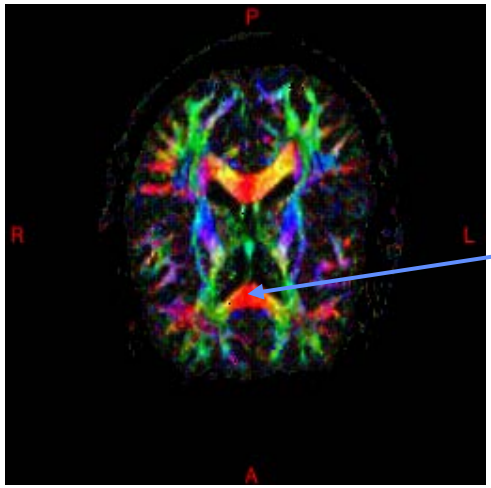


X:\a\Epilepsy\Humans\DTI_DATA\HARDI46_NO ANG_7_1

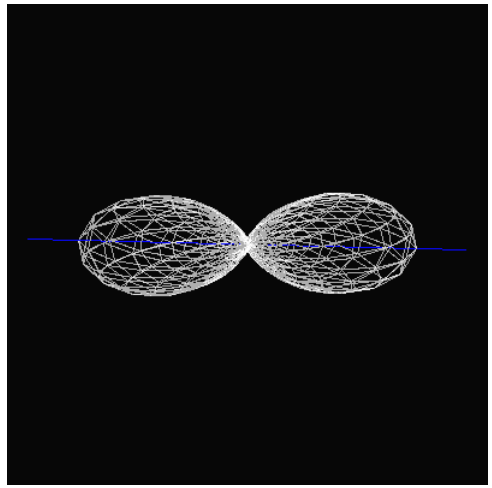
Calculated Water Diffusion Displacement Probability Function in Human Brain (within a voxel)



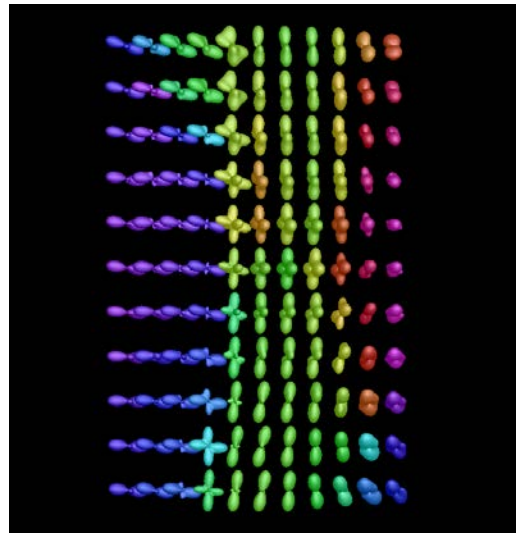
Voxel in Corpus Callosum



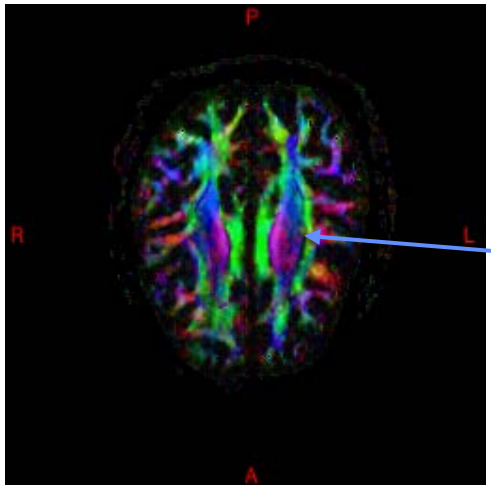
DPF for R = 10 μm



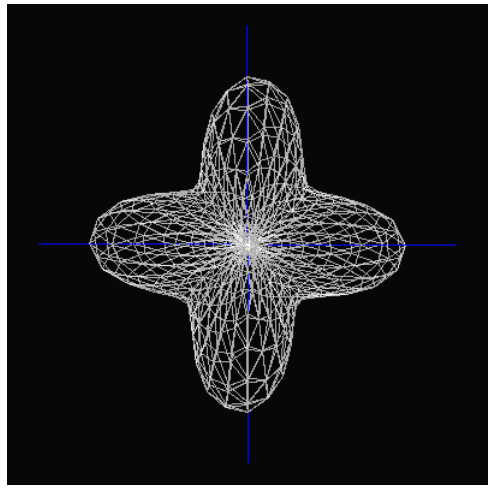
Expansion of colored DPF glyphs

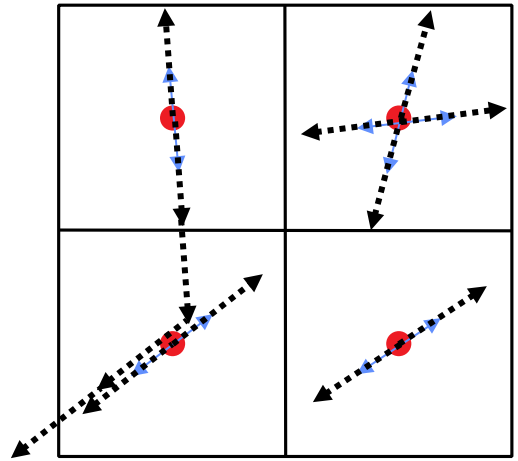


Voxel in Internal Capsule

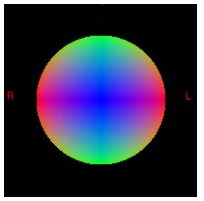


DPF for R = 10 μm





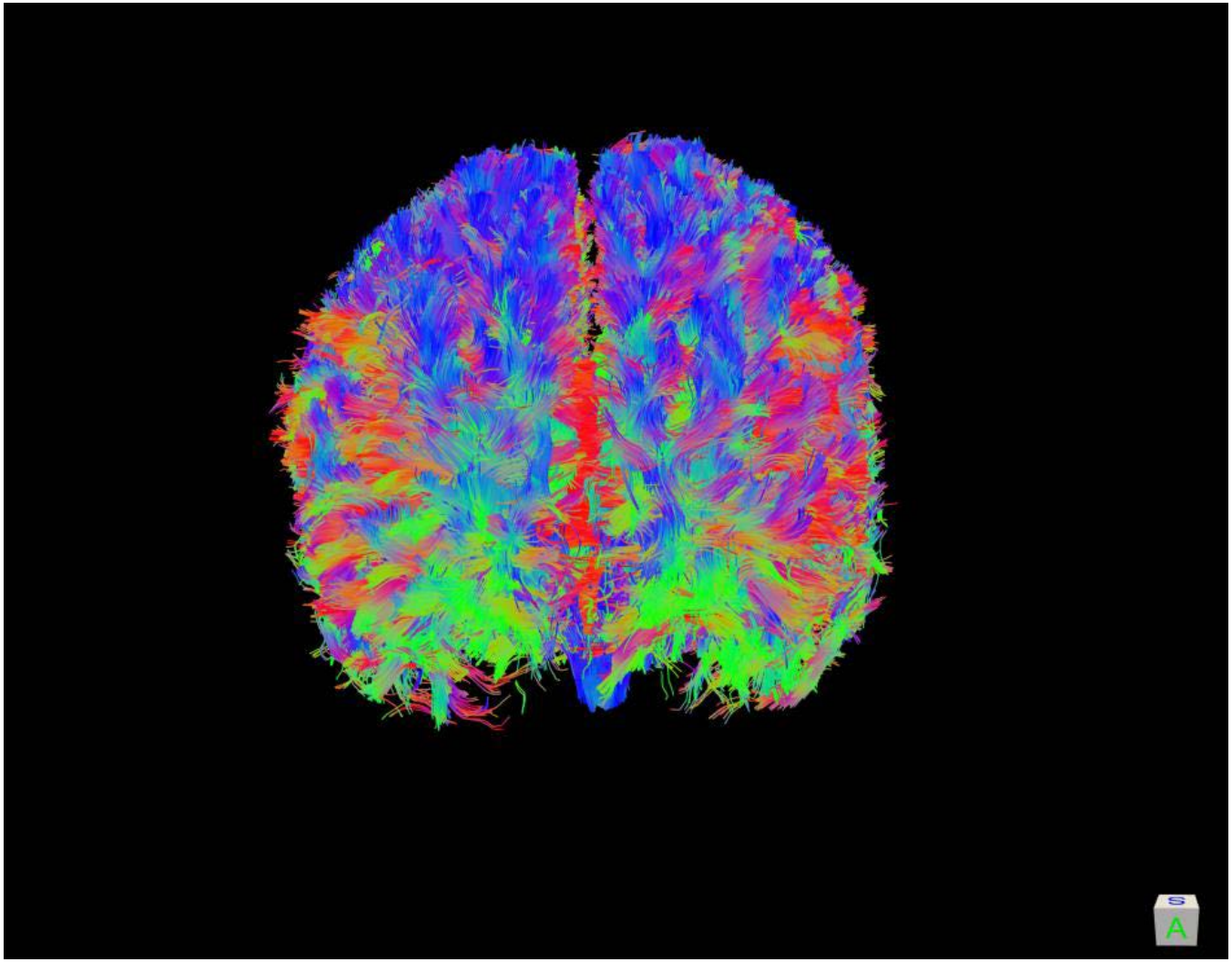
Calculated White Matter Fibers of the Entire Brain (skip 95% of fibers)



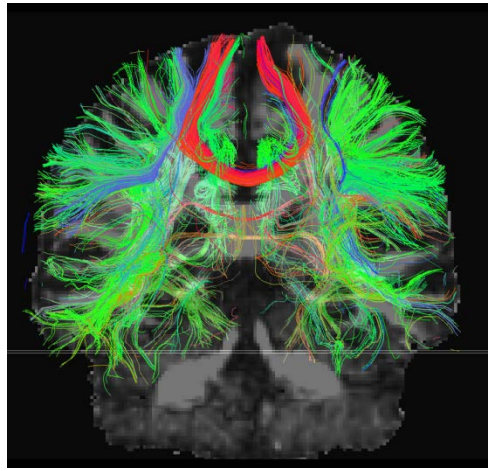
Processed image data

NIFTI images ~ 1.5 Gbytes
PDF ~ 600 Mbytes
Diffusion ~ 80 Mbytes
Tracks ~ 250 Gbytes

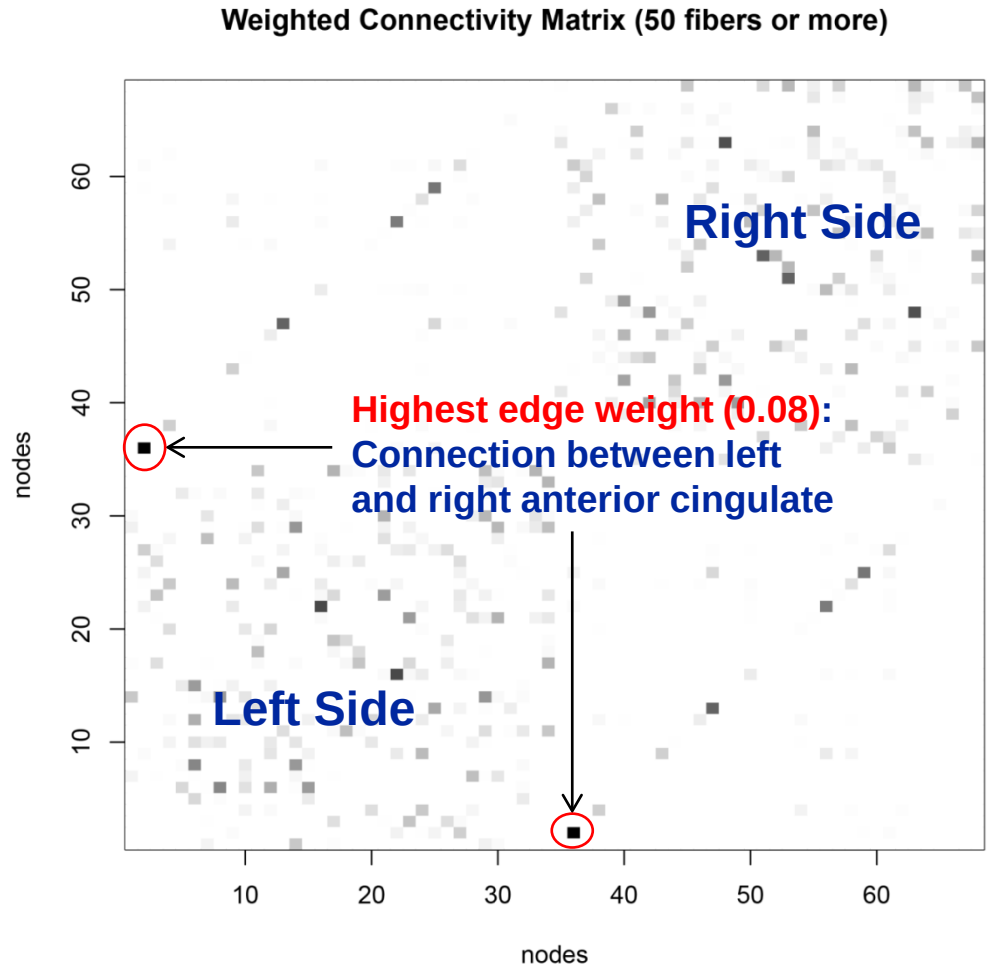
Total data ~ 260 Gbytes/subject



Edge Connectivity between Cortical Surface Node in the Brain



Anterior cingulate gyrus of left cerebral hemisphere. Shown in red.



BodyPart3D, The Database Center for Life Science

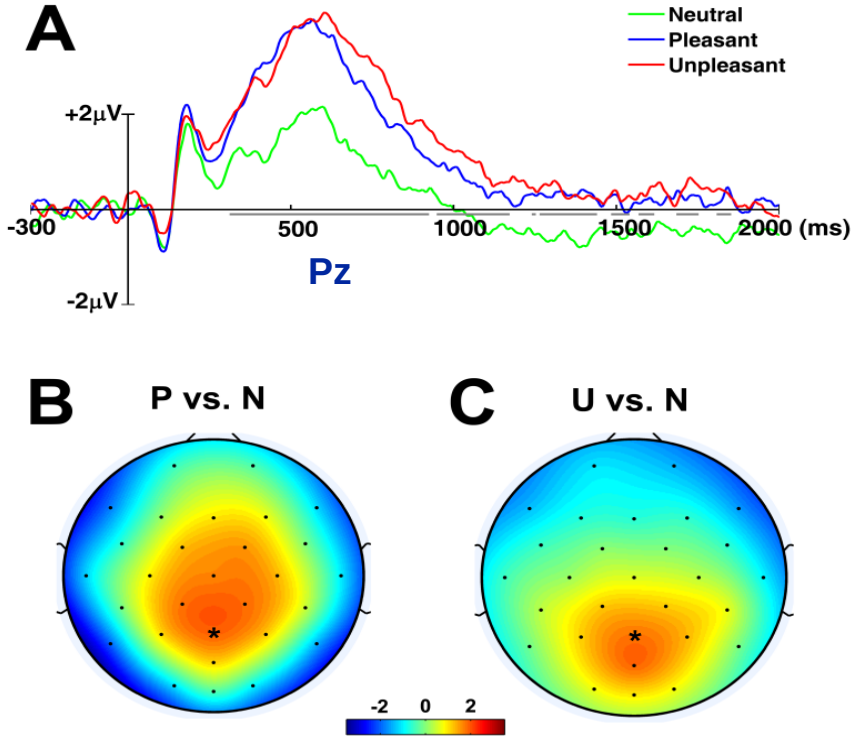
Simultaneous Acquisition of EEG-fMRI

Mingzhou Ding, Biomedical Engineering

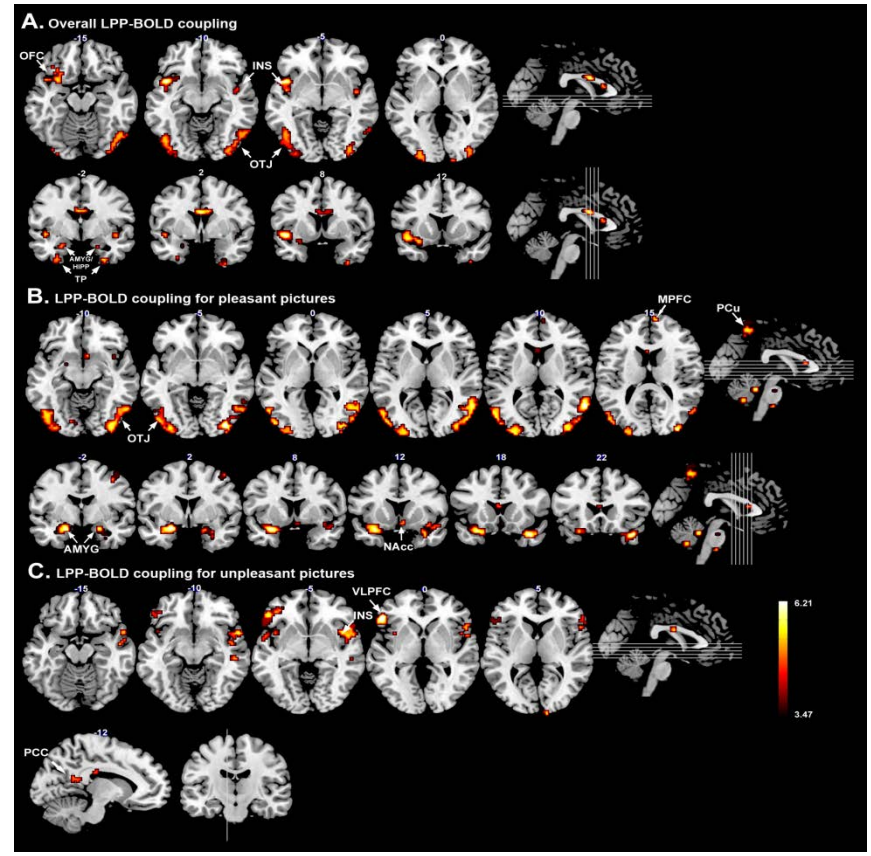
Acquired EEG/subject ~ 1 Gbytes (1-3 hrs)
Acquired fMRI/subject ~ 1.5 Gbytes
Processed EEG/subject ~ 2 Gbytes
Processed fMRI/subject ~ 4 Gbytes

Total data ~ 10 GB/subject

Event-related potential response to emotional pictures measured with 128-channel EEG



ERP-BOLD correlation



Big Data for Biological Imaging

- **Illustrative Problem**: Determine brain structure and function
- **"Big Data" size**

  Diffusion MRI; acquire 1 Gbytes/subject, 260 Gbytes/subject processed data

  EEG and fMRI; acquire 2.5 Gbytes/subject, 6 Gbytes/subject processed data

  50-100 subjects per year; 269.5 Gbytes/subject so 13.5 – 27 Tbytes per year
- **Big Data program can facilitate infrastructure and collaboration**

  Fast data communications (fast intranet to move data between labs)

  Adequate data storage (systems with Tbyte RAID storage)

  Capability for data sharing (database management)
- **Current state of Big Data generation/analysis and growth over the next 5 years?**

  Methods are underdevelopment but as these mature, more investigators will use the methods and each will require the same level of capability
- **Infrastructure and analysis challenges to successful research?**

  Computational hardware with large RAM (100's Gbytes and parallel processing)

  Algorithm development to use advanced hardware (memory and parallel processing)