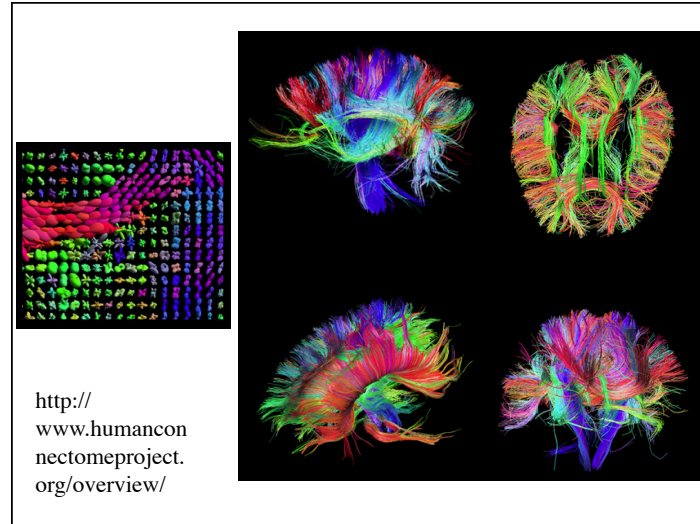


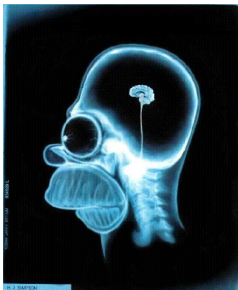
Bioengineering 280A
Principles of Biomedical Imaging

Fall Quarter 2010
MRI Lecture 7



fMRI

MRI studies brain anatomy.

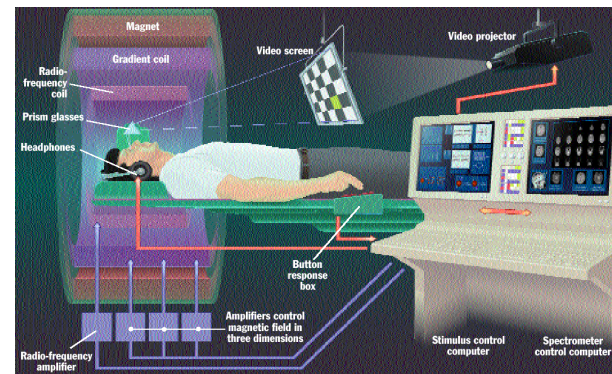


Functional MRI (fMRI)
studies brain function.



http://defiant.ssc.uwo.ca/Jody_web/fmr4dummies.htm

fMRI Setup

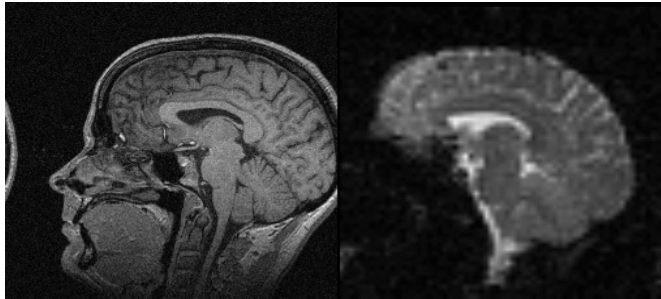


http://defiant.ssc.uwo.ca/Jody_web/fmr4dummies.htm

fMRI Acquisition

High spatial resolution

High temporal resolution



MP-RAGE
Voxel volume: 1 mm³
Imaging time: 6 min

EPI
Voxel volume: 45 mm³
Imaging time: 60 msec

Buxton 2002

History of Functional MRI

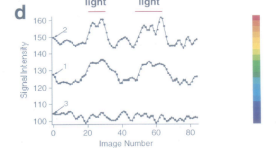
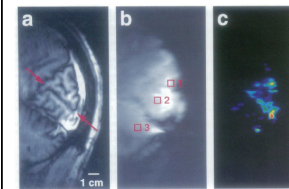


Fig. 1. Intrinsic signal changes in sagittal brain images produced by phos stimulation. (a) Sagittal slice image of the occipital pole taken with an inversion recovery pulse sequence. The reference line is oriented along the bank of the calcarine fissure. (b) Gradient echo image (EPI sequence; TE = 40 ms) at the same anatomical location. (c) Pseudocolor map of the difference in signal intensity between the average of eight images acquired during phos stimulation and eight images taken in the dark. (d) Time course of signal intensity changes in arbitrary units for regions indicated by the three boxes outlined in a.

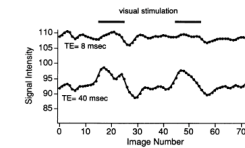
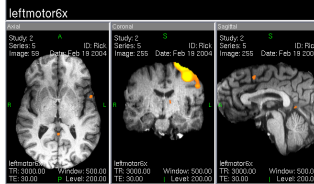
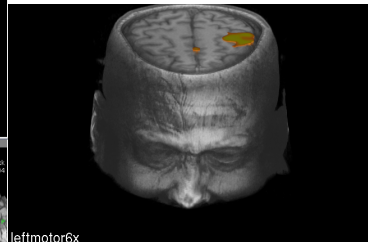
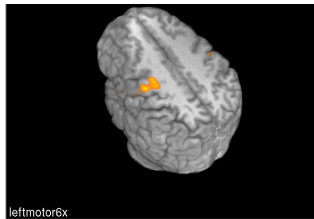


Fig. 3. Reducing TE reduces amplitude of the visual stimulation-induced intrinsic signal change. The time course of intrinsic signal changes observed at a fixed caudal position in primary visual cortex are shown for TE = 40 ms and TE = 8 ms. Other experimental conditions were as in Fig. 2, except that patterned-flash visual stimulation was provided between images 15–25 and 35–55.

Source: Ogawa et al., 1992

Finger Tapping Task



Functional MRI

Large-amplitude, spatially correlated fluctuations in BOLD fMRI signals during extended rest and early sleep stages

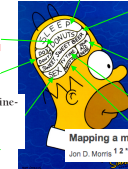
Masaki Fukunaga^{a,*}, Silvana G. Horowitz^a, Peter van Gelderen^a, Jacco A. de Zwart^a, J. Martijn Jansma^a, Vassiliki N. Ikonomidou^a, Renxin Chu^a, Roel H.R. Deckers^a, David A. Leopold^a, Jeff H. Duyn^a

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3: [Gull HI, Shulzke SP: Heavy MR. Imaging obesity: fMRI, food reward, and feeding. Cell Metab. 2007 Dec;6\(6\):423-5. PMID: 18054310 \[PubMed - indexed for MEDLINE\]](#)
[See also] no items found.
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Neural Activation Patterns of Mefhamphetamine-Dependent Subjects During Decision Making Predict Relapse

Moran P. Pauls, MD; David F. Tapscott, PhD; Mary A. Schenk, MD



Acute effects of alcohol on neural correlates of episodic memory encoding

Hedvig Söderlund^{a,*}, Cheryl L. Grady^{a,b,c}, Craig Easdon^a, and Endel Tulving^{a,b}

Marketing actions can modulate neural representations of experienced pleasantness

Hilke Plassmann^a, John O'Doherty^a, Baba Shiba^a, and Antonio Rangel^{a*}

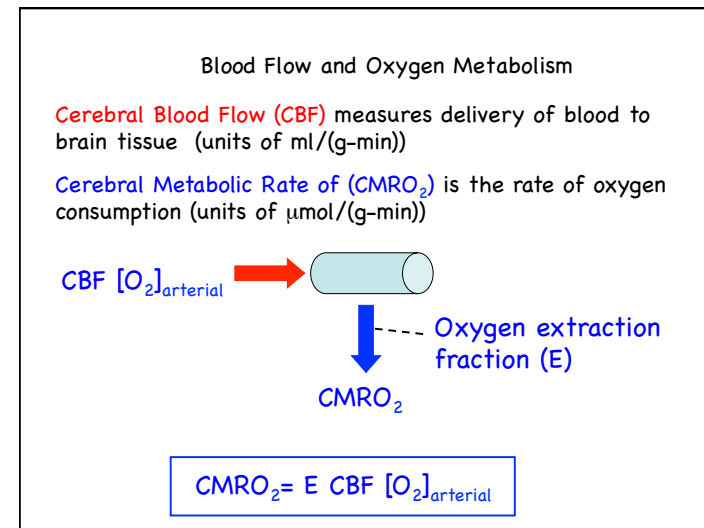
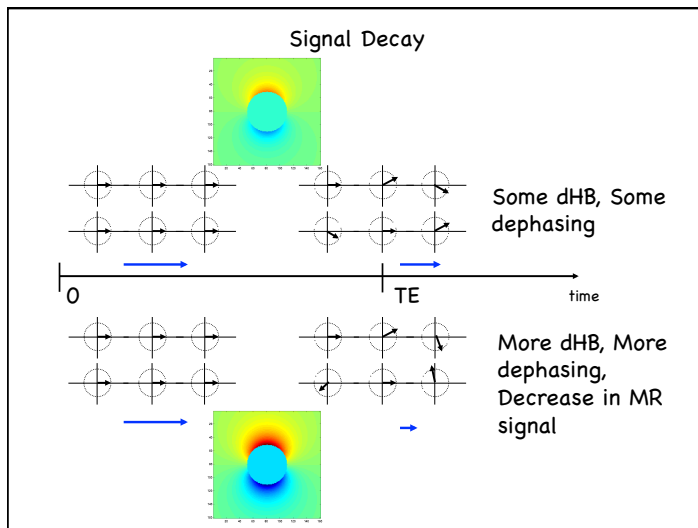
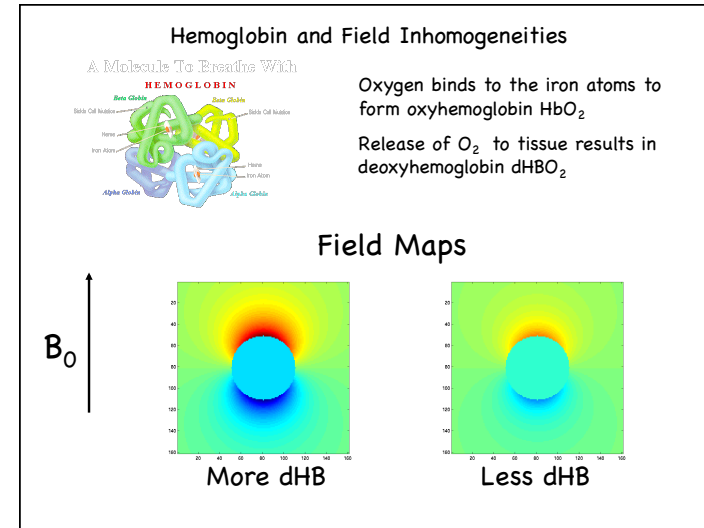
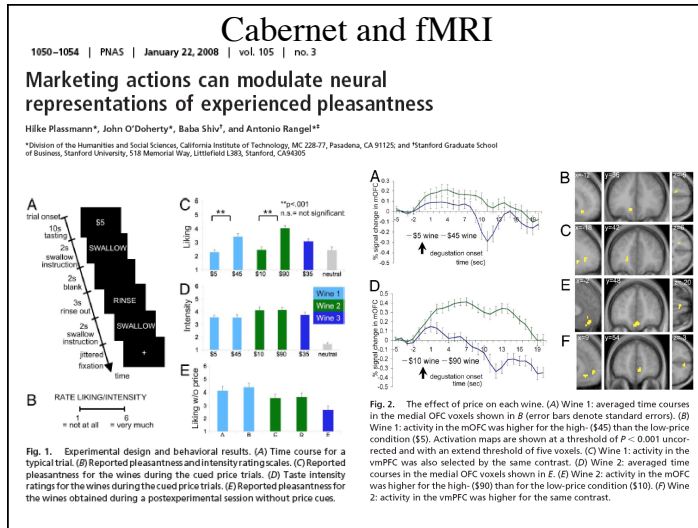
Mapping a multidimensional emotion in response to television commercials

Jon D. Murns^{1,2}, Nelson J. Naranjo^{2,3}, Feng Shen¹, Jorge Villegas¹, Paul Wang^{2,3}, Guojun He^{2,3}, Yijun Li^{2,3}

Distinguishing specific sexual and general emotional effects in fMRI—Subcortical and cortical arousal during erotic picture viewing

Martin Walter^{1,*}, Felix Bermpohl², Harold Mouras², Kolja Schiltz^{2,4}, Claus Tempelmann⁴, Michael Rotte⁴, Hans Jochen Heinze², Bernhard Bogerts², and Georg Northoff²

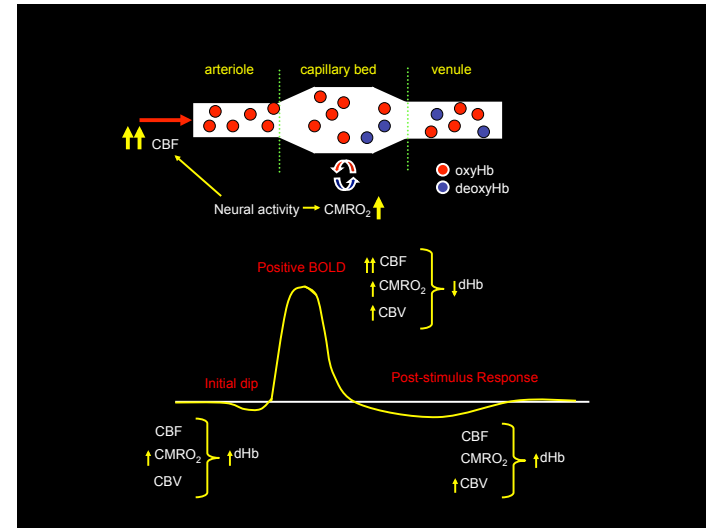
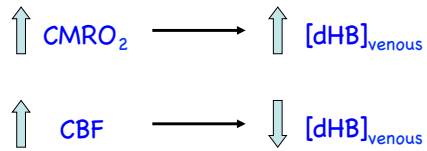
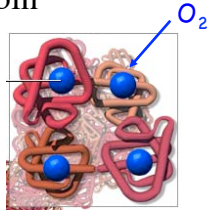
Hippocampal Activation for Autobiographical Memories over the Entire Lifetime in Healthy Aged Subjects: An fMRI Study



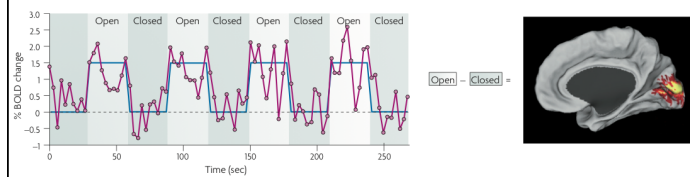
Deoxyhemoglobin

$$[dHb]_{\text{venous}} \approx E [O_2]_{\text{arterial}} / 4$$

$$= CMRO_2 / 4CBF$$

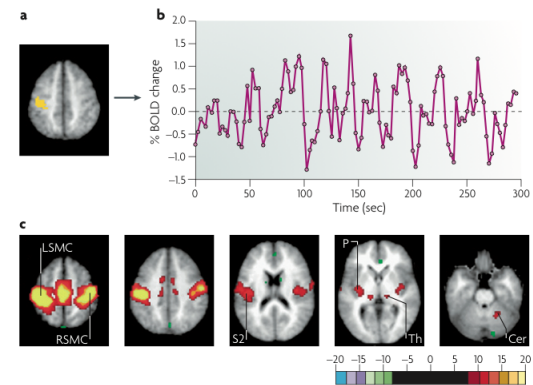


Task-Based fMRI

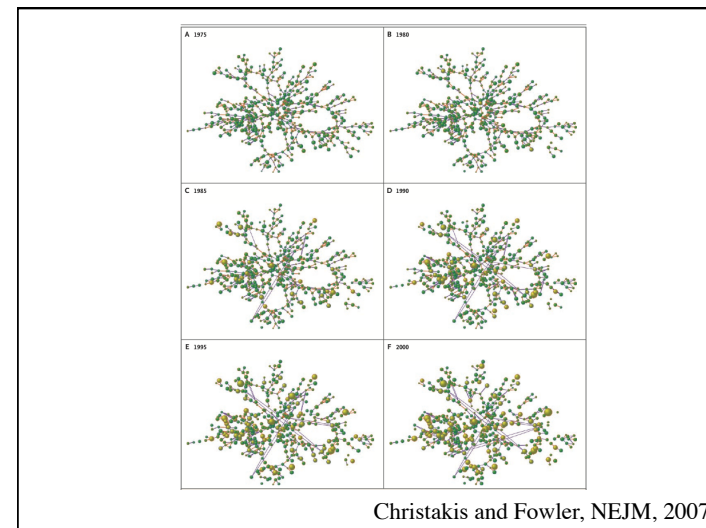
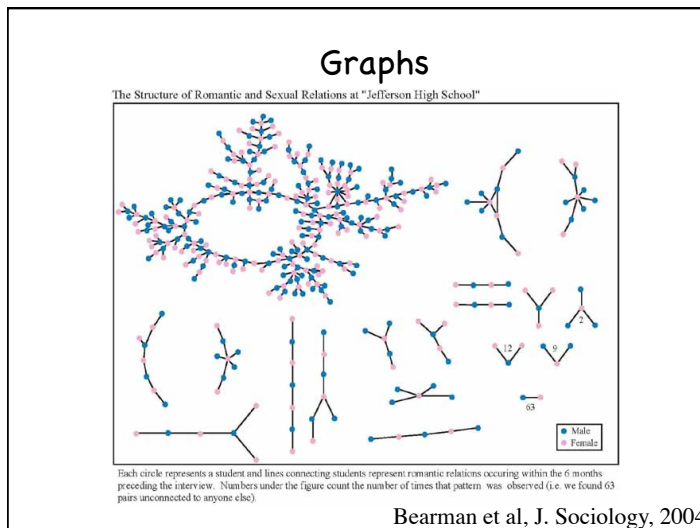
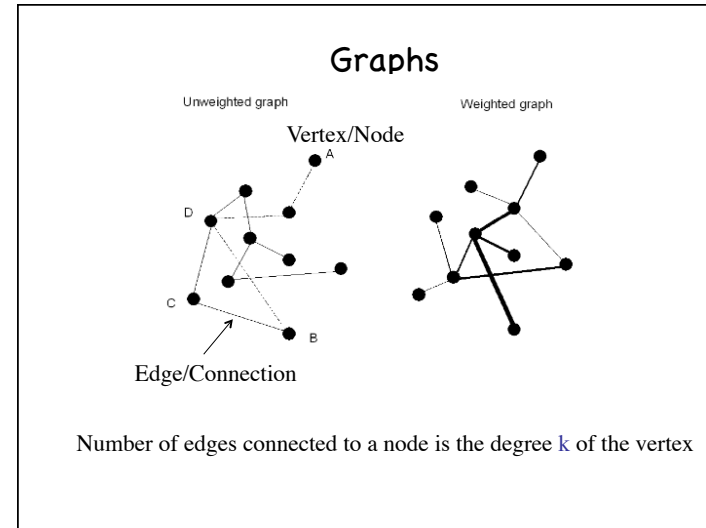
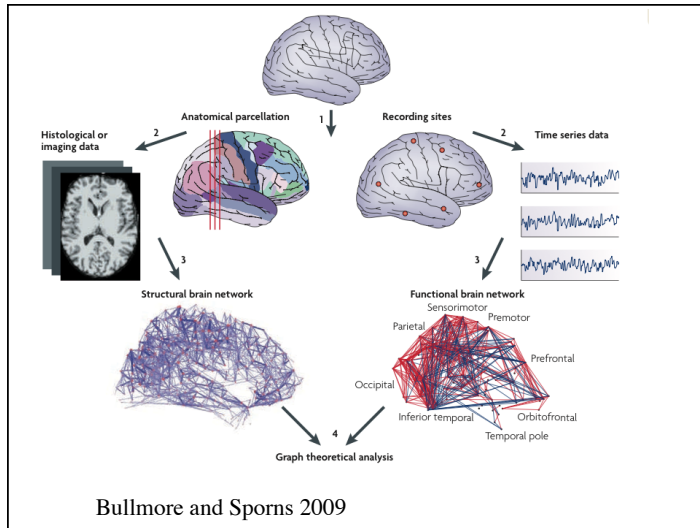


Fox and Raichle; Nature Rev. Neuro, 2007

Resting-State fMRI

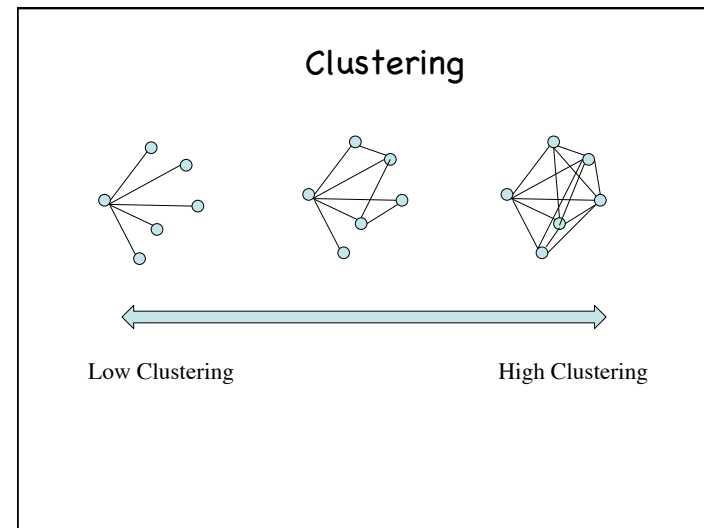
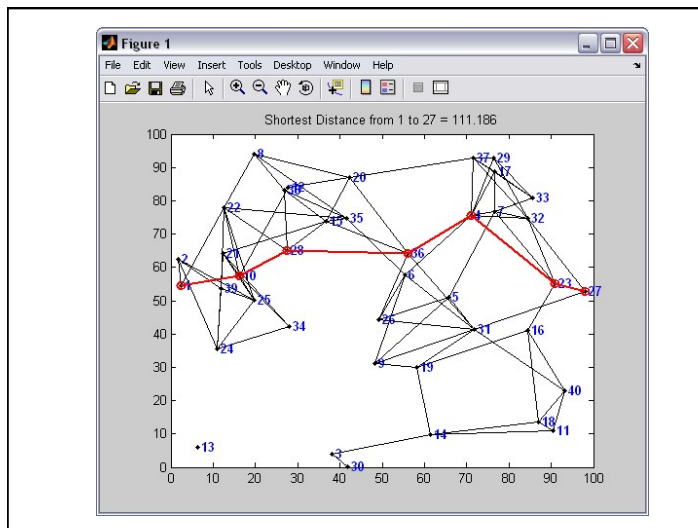
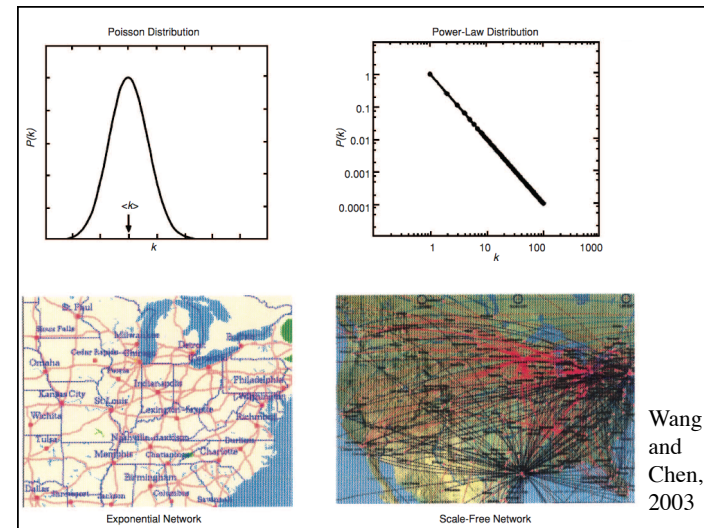


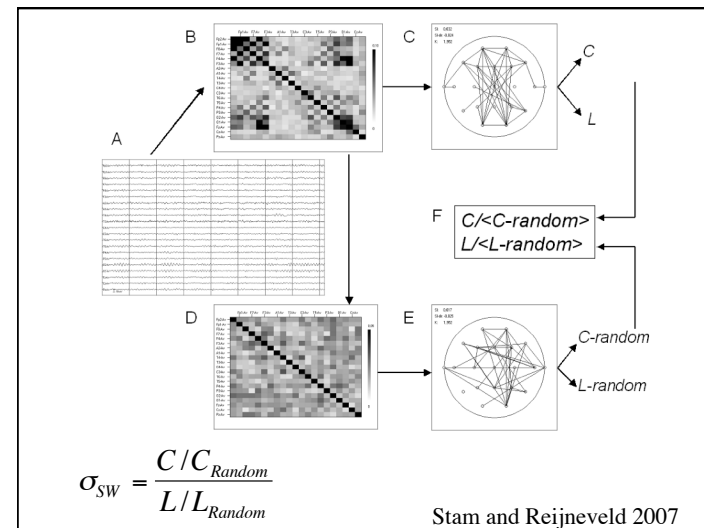
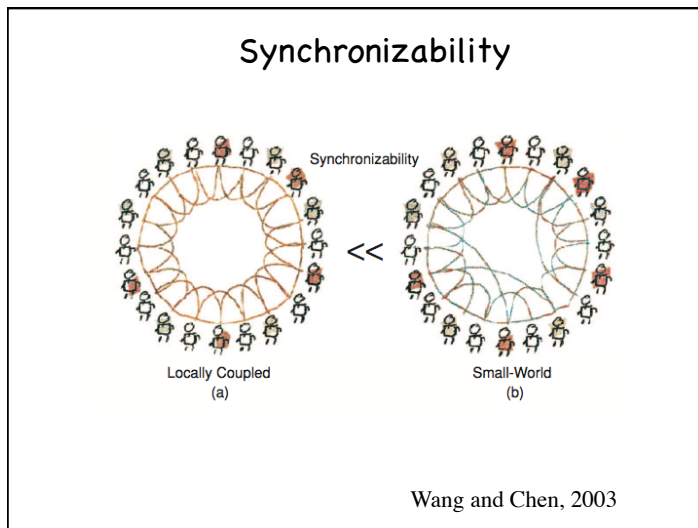
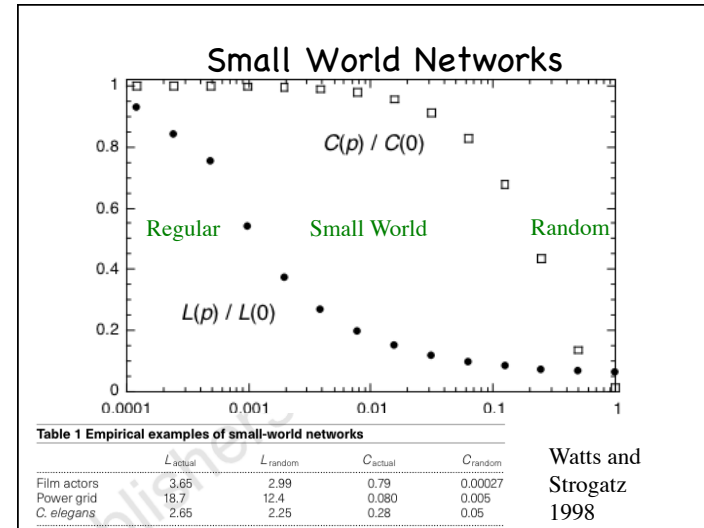
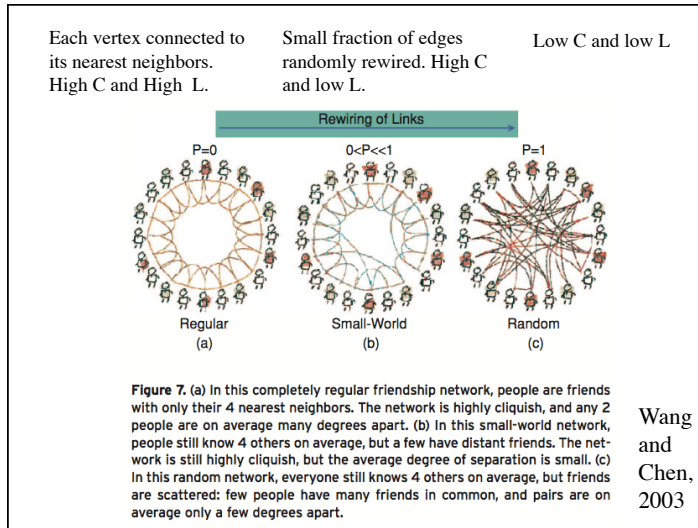
Fox and Raichle; Nature Rev. Neuro, 2007



Graph Metrics

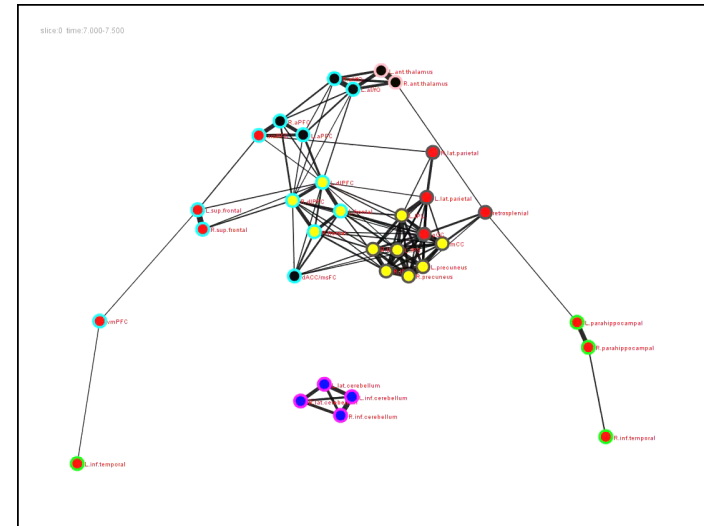
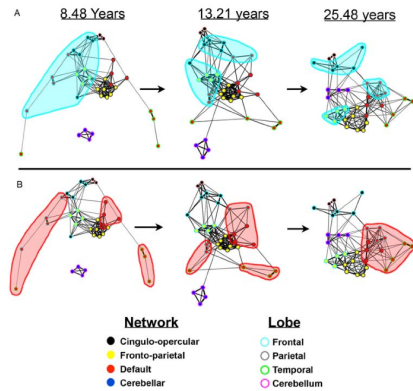
- **Degree:** Number of edges connected to a vertex.
- **Characteristic Length (L):** Number of edges in shortest path between two vertices, averaged over all vertices.
- **Clustering Coefficient (C):** A measure of the extent to which neighboring nodes are also directly connected. (i.e. a measure of how many of your friends are also friends of each other; cliquishness). Measure of resilience to random error – if vertex is lost, its neighbors still stay connected.





Functional Brain Networks Develop from a “Local to Distributed” Organization

Damien A. Fair^{1,2*}, Alexander L. Cohen^{2,3}, Jonathan D. Power², Nico U. F. Dosenbach², Jessica A. Church², Francis M. Miezin^{2,3}, Bradley L. Schlaggar², Steven E. Petersen^{2*}

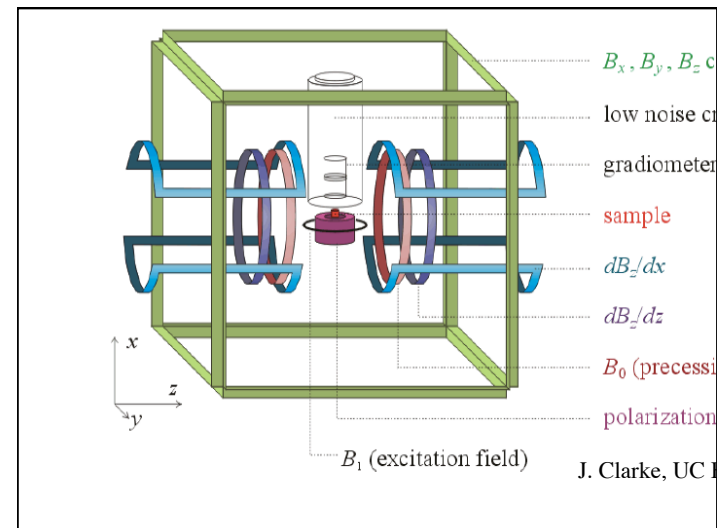


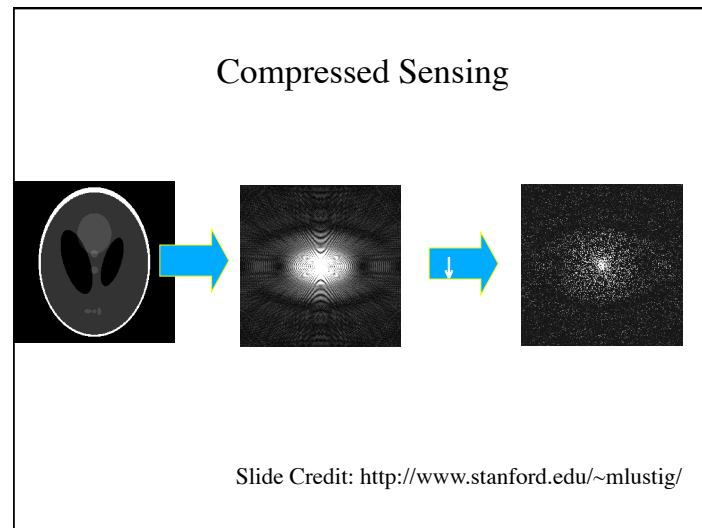
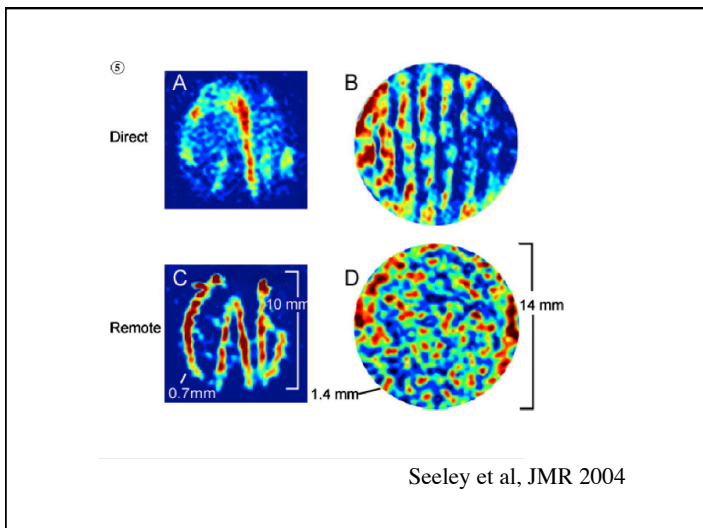
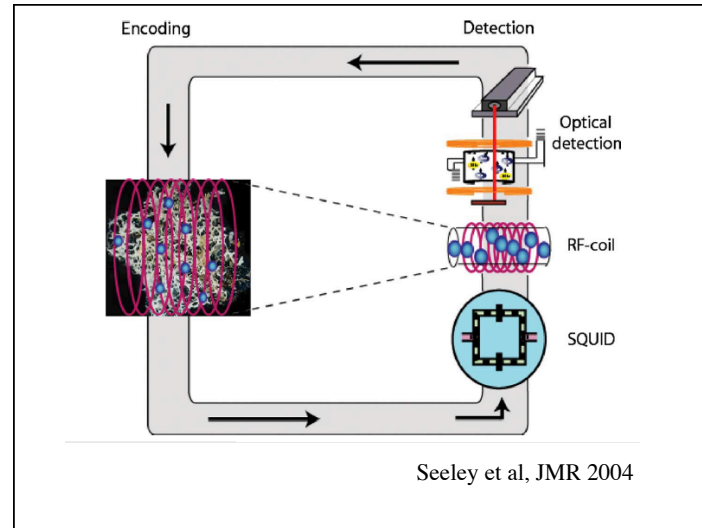
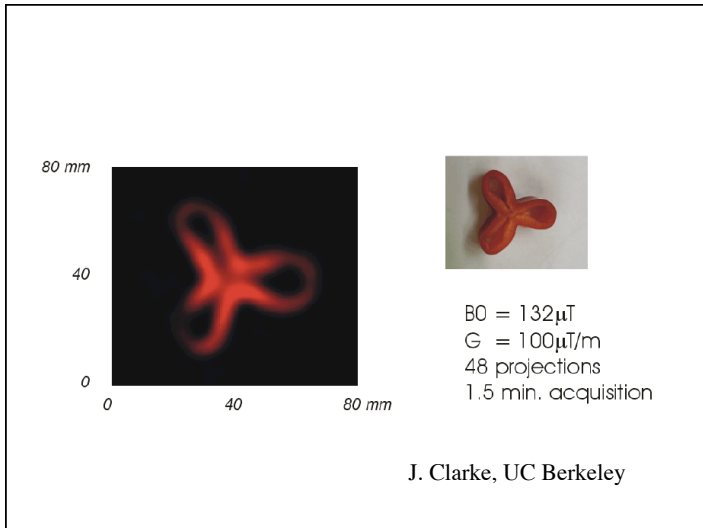
Timeline

Michael Crichton, 1999

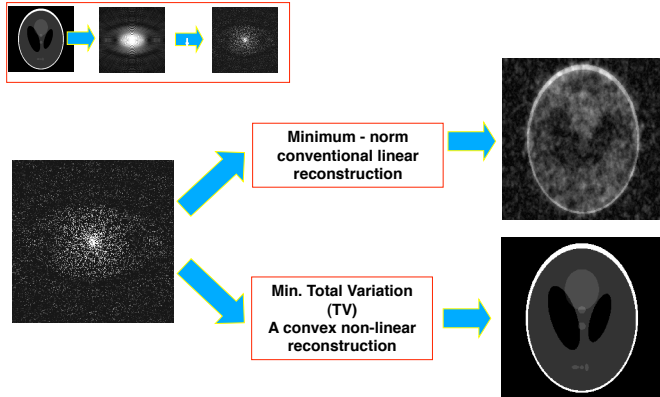
“Most people”, Gordon said, “don’t realize that the ordinary hospital MRI works by changing the quantum state of atoms in your body ... But the ordinary MRI does this with a very powerful magnetic field - say 1.5 tesla, about twenty-five thousand times as strong as the earth’s magnetic field. We don’t need that. We use Superconducting QUantum Interference Devices, or SQUIDS, that are so sensitive they can measure resonance just from the earth’s magnetic field. We don’t have any magnets in there”.

J. Clarke, UC Berkeley





Compressed Sensing



Slide Credit: <http://www.stanford.edu/~mlustig/>