COGS17 * Technologies for Studying the Brain

Technique	Subject State	Technology	Costs	Temporal Resolution	Spatial Resolution	Functional	Example
ANATOMICAL EXAMS:							
Staining	Post-mortem, brain tissue slices.	Inject stains in live system. Process brain tissue.	Sacrifice subjects	None	**GOOD**, per stain type.	No.	Golgi, Nissl (somas), Weigert (axons)
Lesions	Alive or post-mortem. Brain damaged, naturally or experimentally.	Observe behavior before/after ablation surgery, or process brain tissue to examine (especially naturally occuring) damage.	Can include damaging subjects	None	**GOOD**, per damaged area.	**YES**, per deficits	Phineas Gage, H.M.
Electrical Stimulation	Alive. Electrical probe on surface or inserted in brain. Local (scalp) anesthetic.	Micro-electrode probe (stimulation) & map of (e.g. Brodmann) brain areas.	Invasive	None	**GOOD**, per stimulation site.	**YES**, per awake subject reactions, descriptions	Penfield Map
RECORDINGS OF ENDOGENOUS EM RADIATION:							
Single Cell Recording	Alive. Recording probe inserted in brain. Local (scalp) anesthetic. Engaged in task.	Micro-electrode probe (stimulation) & map of (e.g. Brodmann) brain areas.	Invasive	**GOOD,** for target cell, but highly localized	**GOOD**, per recording site.	**YES**, per associated activity, subject report	Face cells, Mirror cells
EEG (Electro-Encephalogram)	Alive. Record from external arrray of sensors, worn on scalp.	Wear cap of electrodes, record electric dipoles, perdendicular to brain surface (from Gyri), generated by changes of potential in thousands of cells. Trace oscilloscope output over time.	Relatively inexpensive technology	**GOOD,** per realtime (ongoing) brain activity	**POOR**, dipole an overall effect of activity in many cells	Weak, per associated activity	Stages of sleep
ERP (Event-Related Potential)	As above. Engaged in task.	Same equip as above. Examine average of the EEG responses that are time-locked to stimulus/task exposure, over repeated trials.	As above.	**GOOD,** for particular moment re: onset of task task	**POOR**, from mean differences across areas	**YES**, per associated activity	N400 in language processing. P200 in visual attention
MEG (Magneto-Encephalogram)	Alive. Head fixed in large apparatus.	Apparatus records magnetic fields, parallel to brain surface (from Sulci), generated by changes of potential in thousands of cells. Requires super-conducting materials to detect subtle fields.	More expensive magnetic detectors ("SQUIDs")	**GOOD,** per realtime (ongoing) brain activity	**GOOD**,tho field an overal effect of activity in many cells	Weak, per associated activity	Cortical activity
IMAGES PRODUCED BY PERTUBATION OF SYSTEM:							
MRI (Magnetic Resonance Imaging)	Alive. Lying in large, loud drum.	Magnetically align proton spin in hydrogen atoms (in water) using magnet & radio waves, then release. Use energy released by return to natural alignment to expose image. Differentiate structures, tumors, myelin, lesions, etc.	Expensive, loud	None	**BEST**, high resolution	No	Detailed brain images, cortical and sub; Detection of disease Multiple Sclerosis (MS)
fMRI (Functional MRI)	Alive. Lying in large, loud drum. Engage in sensory or cognitive task.	Like above, but BOLD records ratio between oxygenated- and deoxygenated hemoglobin in blood, at active sites. Images color-coded per differences during task relative to baseline.	Expensive, loud	**POOR**, few seconds	**VERY GOOD**, high resolution	**YES**, per associated activity	Listen to music, examine faces, imagine objects, etc.
PET (Positron Emission Tomography)	Alive. Head fixed in apparatus. Engage in sensory or cognitive task.	Gamma Rays from decay of injected radioactive fluid, absorbed w/glucose (at active sites). Images color-coded per differences during task relative to baseline.	Radioactive materials, expensive	**POOR**, ~ 30 seconds	**GOOD**	**YES**, per associated activity	Listen to music, examine faces, imagine objects, etc.
CAT (Computed Axial Tomography)	Alive or post-mortum. Head in apparatus.	X-Rays. Tissues vary in penetration /shade of image. Build up 3D from 2D images.	X-Ray exposure, less expnsv	None	**OK**, less resolution	No	Anatomy of brain and other structures