

Class #7 Methods in Research

Announcements:

Reading next Tuesday Chapt 6 up to page 138

Dr, Fellous will not hold office hours next Tuesday (9/20)

Midterm 1: Thursday Sept 29th Review session Tuesday Sept 27th 6:30-7:50 ILC 130
(HERE)

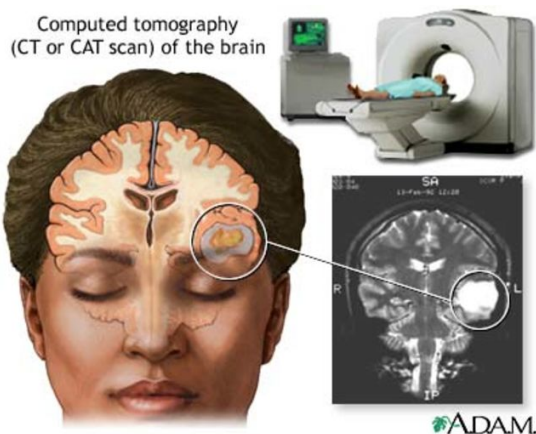
Methods in Brain Research (Imaging)

- Computerized (axial) Tomography (x-rays) static pictures and high spatial resolution. Horizontal plane only.
- Magnetic Resonance imaging. Hydrogen atoms in a magnetic field. Detailed static 2-D PICTURES of the brain. All planes. More sensitive then CT.
- Position Emission Tomography (need tracer 2-DeoxyGlucoseradioactivity. Measure the metabolic activity. Dynamics pictures of the brain in action. Variant: Autoradiography (brain slices)
- Functional MRI. (fMRI) Modified MRI. Higher temporal resolution (6-8 secs), low spatial resolution.
- Diffusion Tensor Imaging (DTI) Modified MRI. Image bundle of axons and projections pathways. (MODIFIED VERSION OF MRI)

CT SCAN 5.15, 5.16

Where are the eyes?

Where is the brain tumor?



MRI 5.17

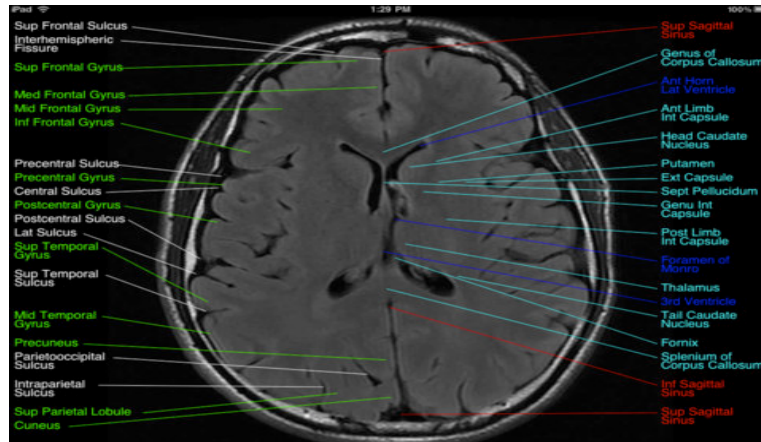
Where are the gyri? Sulci? Cerebellum? Pons? Corpus Callosum? Cortex

MRI (fMRI)

Imaging the brain in action

Normal (research) and abnormal (clinical) functions

NORMAL MRI



2-DG 5.20

Autoradiogram- (invasive brains laced after 2dg absorption image contained after photographic development)

PET SCAN (.24. 5.33)

Brain in action e.g. movement

Brain areas that function differently e.g. Depression

Brain areas that absorb a particular drug e.g. I DOPA IN PARKINSONS)

Diffusion TENSOR IMAGING (5.18)

Use of MRI data to complete the movement of water molecules along the axon efferent projections

NON INVASIVE ELECTRICAL

Electroencephalography-Recording SURFACE ELECTRICAL SIGNALS WITH MACRO ELECTRODES. HIGH temporal resolution low spatial resolution. Sleep studies and seizure detection

Note: Electrical imaging

- Optical Recordings (Invasive) Open skull imaging electrical activity used for research.

EEG Signals: Sleep Studies

NON INVASIVE (HUMAN) 5.21, 5.28

- Magnetic-Magneto Encephalography: Detect small magnetic fields generated by neurons. More temporally precise than fMRI. Need special equipment/room. Patients are seated seizure foci.
- Transcranial magnetic Stimulation- creates a magnetic field to induce an electrical current stimulation. Mostly superficial brain (cortex)

Motor Cortex- Motor Evoked Potentials

Occipital cortex->phosphenes

Variant Repetitive TMS. Effects outlast the period of stimulation

Research tool. Clinical tool (treat depression, mania, PTSD)

Non Invasive (Genetic)

In humans- Twin and adoptive studies Nature Vs Nurture

Monozygotic (identical twins) same chromosomes same genes

Dizygotic- (fraternal twins) Different chromosomes

Concordance for traits (e.g. Schizophrenia, obesity, alcoholism assess the influence of the environment.



In animals: targeted gene mutation: Changing or deleting a specific gene. Antisense oligonucleotides: Transient block of protein production of a gene.

Invasive IN VIVO Behaving (5.1) (5.2)

- Ablation/Lesion: Mapping brain area to functions and functions to behaviors
- Suction (mechanical) Radio frequency (heat) excitotoxic lesions (spare axons)
- Require surgery. Small damage due to insertion of electrode. Use of sham lesions for controls.

Variant: reversible lesions (use of specific chemical or cooling)

Lesion: Targeted lesions 5.3

IN VIVO Behaving continued (5.19)

Goal: recording/ stimulation. Microelectrodes. Single unit recordings. Extracellular recording . Mapping the brain.

IN VIVO behaving continued (5.26)

Cannula implantation (Injecting a chemical substance) Target a particular receptor in a specific brain area.

Microdialysis- measuring the concentration of a specific chemical substance e.g. Neurotransmitter.

(5.27) IN VIVO BEHAVING CONTINUED

Optogenetics

-Inject a virus in a brain area. The virus carries genes that will produce light sensitive proteins.

- ChR2- sensitive to blue, depolarizes the cell
- NpHR: sensitive to yellow, hyperpolarize the cell

Implant an optical fiber that shines blue and/ or yellow light with laser. Manipulate the activity of specific brain area.

High Temporal Resolution

High Spatial Resolution

Cell Specifics

IN VIVO BEHAVING CONTINUED

Single- unit recordings- Behavior, conditioning, learning and memory (maze)
E.g. Learning, memory, drug addiction, decision making and perception.

In VIVO Anesthetized

-Stereotaxic surgery. Use of an atlas and skull landmarks (e.g. Bregma)

Recording stimulation: Also done in human (Local Anesthesia)

-Microdialysis)

-E.g. Study brain connectivity, single cell activity (intracellular, single unit) sleep.

Stereotaxic Apparatus (5.5)

Using skull landmarks to target a brain area

In Vitro (Invasive Animal)

Study of brain tissue (Extracted from the animal)

Acute: Brain slices. Study of live single cells and small network properties. Calcium

Imaging

Culture: Study of live single cells and intracellular mechanisms.

