PSYC2020 notes
Neuroscience for psychologist

Week 1 Research methods

Non-Invasive visualizing brain structure

X-rays

· Pass radiation through the body and tissues absorb that radiation at differing rates based on density.

· It allows for study of brain structure

· Contrast x-rays can be used to look at blood flow through the brain by injecting a substance into the bloodstream that the x-ray can pick up.

Positive

Negative

CAT scan (CT scan)

· Computerized axial tomography scan

· A computer uses x-rays to scan individual slices of the brain and reconstruct them into a 3D picture.

Positive

+ Cheap

+ Readily available

+ Relatively quick

Negative

- Exposing people to x-rays is not ideal

- Not as detailed as an MRI

Magnetic Resonance Imaging (MRI)

· Uses an extremely powerful magnet.

· A structural scan detects waves emitted from hydrogen atoms when in a magnetic field

Positive

+ Very detailed structural images

+ Not exposing people to radiation

+ Can be done without contrast injection

Negative

- Expensive

- Not as readily available as x-rays

- Need to be really careful about metals in body (including some tattoo ink)

Diffusion Tensor Imaging (DTI)

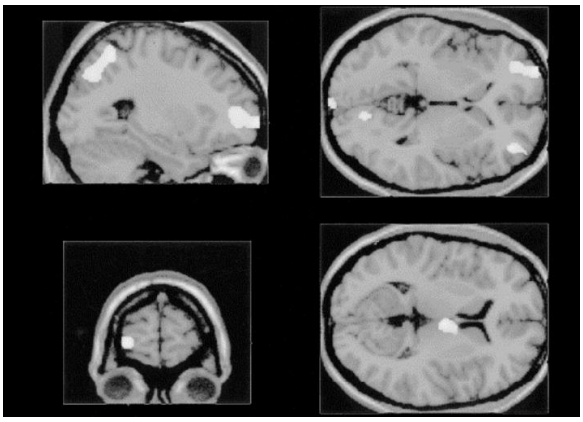
· Using an MRI to measure the water flow along axonal pathways.

It can be used to track connections in the brain

(Non-Invasive) Recording Brain Activity

Positron Emission Tomography (PET)

- Inject radioactive, positron-emitting isotope of glucose, oxygen, water, etc.
- When subject performs task radioisotope in blood will accumulate more in more active brain areas
- Machine measures gamma radiation produced by radioisotope



Positives

+ subjects can move their head and Jaw (e.g. read words/talk)

Negative

- expensive: requires cyclotron for on-site production of radioisotope

- Gamma radiation not healthy for repeated exposure

- Spatial resolution and temporal resolution not great

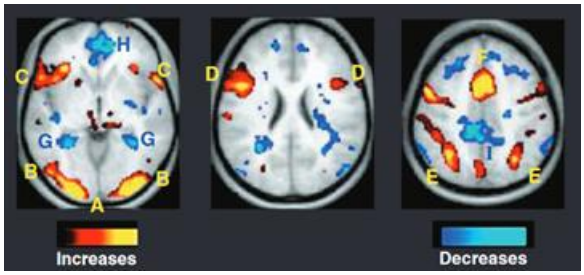
- Indirect measure of neural activity

Functional Magnetic Resonance Imaging (fMRI)

- Different type of MRI scan measuring concentration of oxygenated blood

- More active brain areas need more oxygen, so more fresh blood flow to more active area
- BOLD – Blood Oxygen Level Dependent signal
- The fMRI scans for areas of higher oxygen use which indicates activity

When using this method you have to use a



second thing as a control to cancel out noise.

Positives

+ no injection needed

+ **good spatial resolution** (normally ~3 mm^3 but can get 1 mm^3)

+ structural image in same scan session

+ 3D data across whole brain

Negatives

-Expensive

-Head movement a problem

-Blood flow is **indirect measure** of brain activity

-**Low temporal resolution**: BOLD response slow and laggy

-Metal in body a problem

-Cramped and REALLY noisy (can distract people or put them to sleep)

-Difficult: children; claustrophobics; clinical populations in general

The media misinterprets fMRI findings and there are a lot of flawed fMRI studies published

Electroencephalography (EEG)

- Attach a set of electrodes to the scalp
- Records electrical signals originating from the brain
- Measures different states of awareness
- Takes many reading and averages them out to get less noise
- Error related negativity - the larger the negativity the faster you learn. Learn faster if you make a mistake

+ Excellent temporal resolution
+ Very well studied
+ Recent improvements in portability
-Very limited spatial resolution
-ERPs need a LOT of trials, which makes for VERY long sessions
-Some setups uncomfortable and cold for participants
-Can get interference from magnetic/electrical devices
-Interference from muscles in face/jaw – e.g. moving eyes, blinking, talking
-Not fully clear how it maps onto neuronal physiological events

Megnetoencephalography

- Measures changes in magnetic fields caused by neuronal activity
- Similar principles to the EEG but with a greater spatial resolution (still not great though)
- Very expensive and uncommon

Electromyography (EMG)

Attach electrodes to muscles to record their activity

Can be used on wide range of muscles – face, limbs, etc.

- Face – muscles associated with emotion/affect
- Hands – muscles associated with particular movements

Electrooculography (EOG)

- Electrodes placed on muscles around the eyes can measure eye movements
- Low spatial resolution for tracking eye movement
- Can use EEG to find when eye movement artefacts will be problems
- Other recordings are better (optical eye tracking)

Skin Conductance (Galvanic skin response)

- Conductivity of the skin changes as physiological arousal changes
- Emotions cause changes in conductivity (e.g. fear responses)

Skin conductance level (SCL) = baseline
Skin conductance response (SCR) = change in response to stimulus

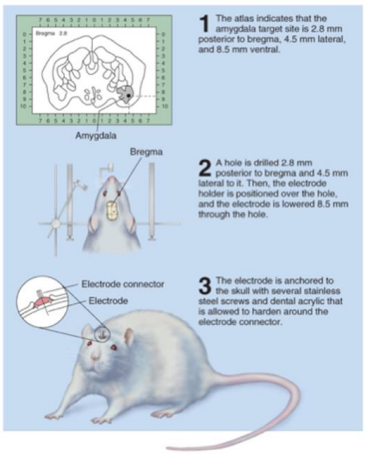
Cardiovascular activity

- Various cardiovascular markers can be measured (e.g. blood pressure electrocardiogram (ECG))

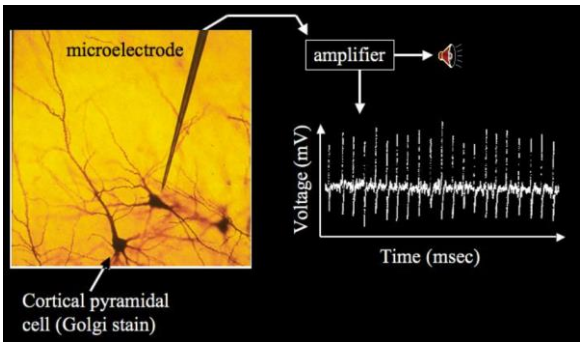
Invasive Brain Recording Methods

Stereotactic surgery

- Place recording or stimulation device in specific brain regions
- Need stereotactic atlas and surgery equipment
- Rat brains are well studied and well mapped



Invasive Electrophysiological recording



Can be:

- Intracellular - inside a single neuron
- Extracellular - records from just outside the neuron
- Multiple-unit recording - records many nearby neurons

positives:

+ can achieve best spatial resolution (down to single neuron)

+ best temporal resolution

negatives:

-Very rarely available with humans (only when people are being prepped for neurosurgery)

-Ethical issues using with animals – suffering, death

-Time-consuming

-Expensive

Brain Damage and Pharmacology

Acquired lesion methods

1. Remove or disable portion of the brain
2. Observe resulting changes in behaviour

Aspiration lesion (suck out tissue)
Radio frequency lesion
Knife cut
Cryogenic blockade (reversible)

Chemical lesions

1. Inject chemicals to destroy parts of the brain
2. See changes in behaviour
    - Neurotoxins can target different types of tissue and destroy cells but leave axons

Natural lesion

1. Find someone with naturally occurring brain lesions
2. Find controls matched on other characteristics
3. Compare behaviour or patient vs. control

Pharmacological methods
Alter neurotransmitters

1. inject/feed drugs that increase or decrease effects of neurotransmitters
2. Observe effects on behaviour

Due to the blood brain barrier it is hard to get drugs into the brain via food or normal injections
Cannula can deliver drugs straight to target tissue.