

Notes: Research Methods

PDF

Research Goals

_____ a single patient

identify damage in the brain, if detectible

differentiate a hearing problem versus a language problem versus a memory problem

identify a specific disease

characterize the _____ of a population

planning abilities continue to improve until ~20 years old, then plateau

do people with ADHD have better or worse working memory compared to non-ADHD controls

identify _____ relationships

the frontal cortex is activated by working memory tasks

London taxi drivers have enlarged hippocampus

schizophrenics have enlarged ventricles

Neuroimaging

creating a _____ of the brain

_____ - visualizing the stable shape/size of the brain

acute differences: detecting tumors, hemorrhaging, congenital abnormalities

subtle differences: contrast size of structures between different populations

differences tend to be nominal and unclear if cause/correlation

identify a group of patients that all have damage in a similar area (e.g. right frontal lobe)

damage might be due to different causes, lesion might be different sizes

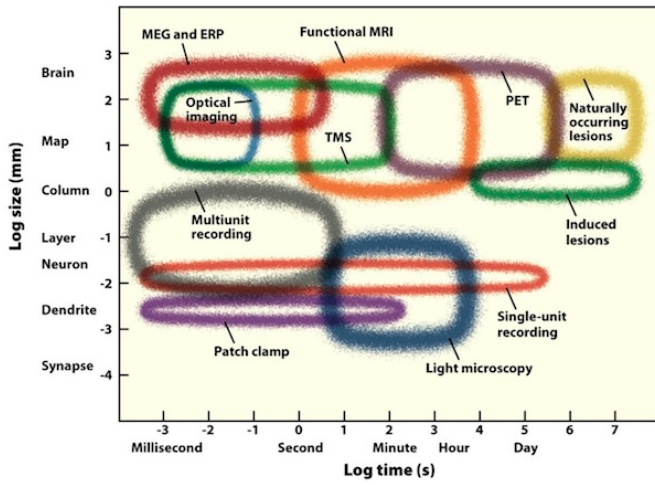
compare differences in behavior between lesion group and non-lesion group

_____ - visualizing changes in the brain related to activity

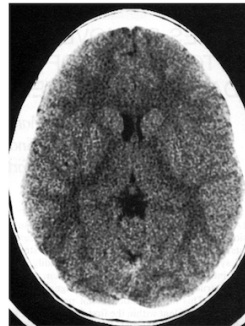
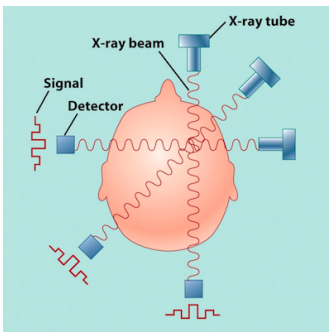
an active area doesn't mean a necessary area

an alien might observe that a car radio is typically active, but it isn't necessary for motion

techniques differ in their spatial/temporal resolution



Structural: CT



stacks of _____ images to create a 3D image of the brain

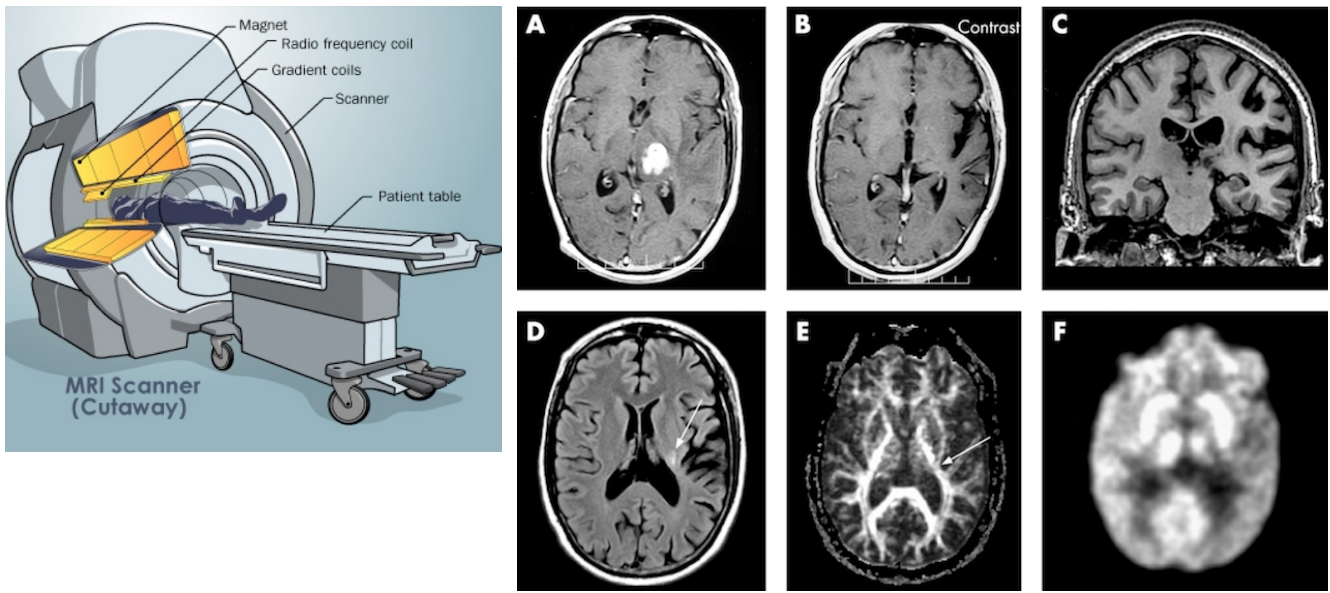
more common for clinical setting than research lab

cannot distinguish gray and white matter

brightness of image is determined by _____

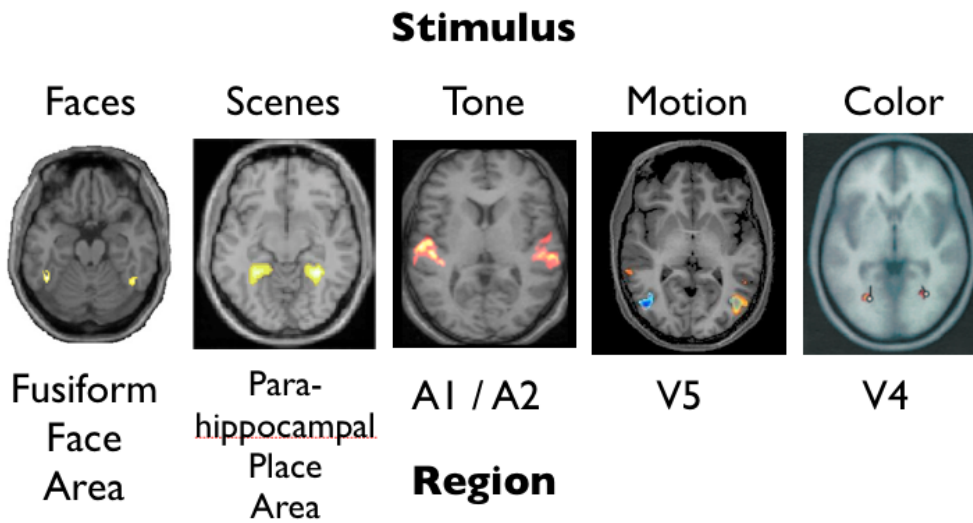
developed in 1960s

Structural: MRI



uses powerful magnets to manipulate the atomic spin of hydrogen atoms
 used in both clinical and research settings
 brightness of image is determined by _____
 differences across tissue: bone, white matter (myelin), gray matter, ventricles
 used for analyzing tissue since 1970s

Functional: fMRI



uses MRI to detect rate of deoxygenation of blood
 _____ contrast - blood-oxygen-level dependent

assumes that areas of high blood deoxygenation are areas of high neuronal activity

_____ response - how low it takes for blood flow to change in an area

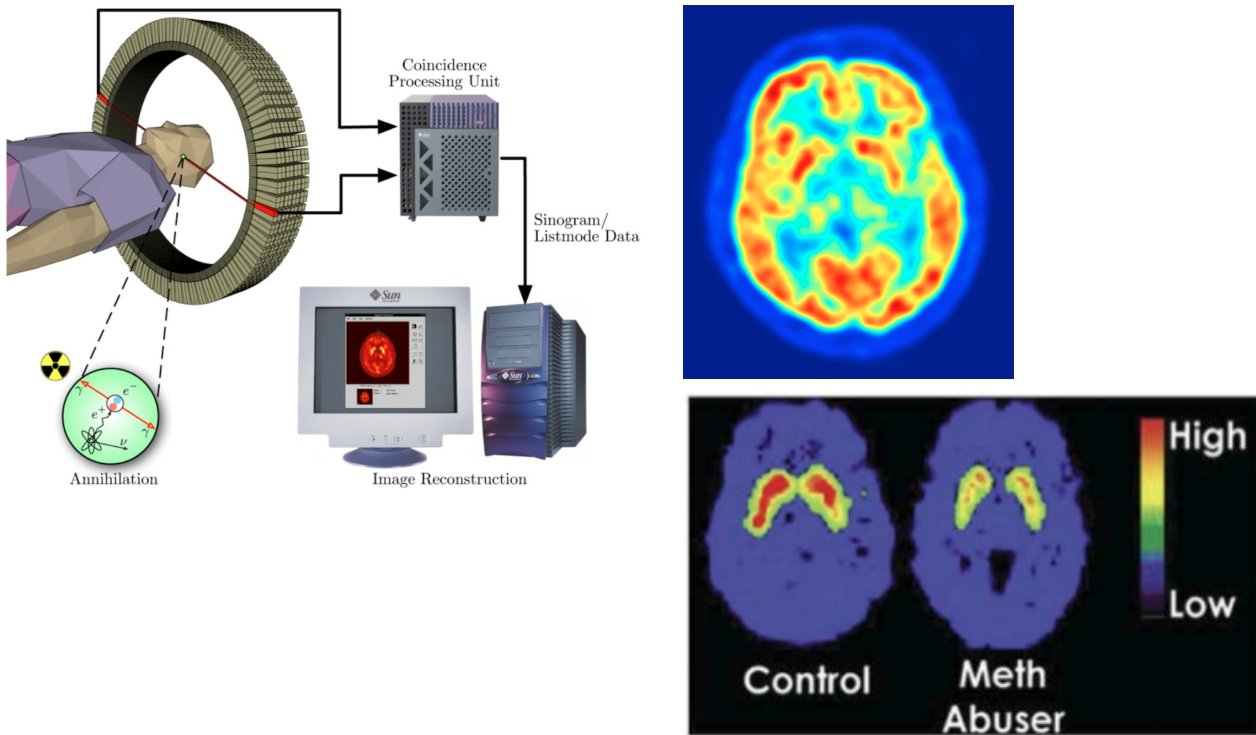
takes about 2 seconds to reach peak response, can return to baseline in ~7 seconds or stay sustained

orders of magnitude slower than the time scale of action potentials

a typical experiment contrasts blood flow for two different conditions

e.g. viewing pictures and laying still in the dark

Functional: PET



subject has a radioactive agent administered through IV

lays in an array of radioactive detectors

when the radioactive agent interacts in the brain, it releases a radioactive particle

the array of detectors can triangulate where in the brain the particle came from

able to localize molecular events in the brain

which molecular event depends on what radioactive agent was used

examples: using glucose, dopamine binding

Functional: EEG



covers the scalp in electrodes that amplify electrical fields produced by action potentials typically between 10 and 256 different electrodes or channels sampling > 1000 Hz, so at the timescale of action potentials rhythms

depending on states of consciousness,

there is synchronized activity at different frequencies

examples: beta (awake), alpha (meditative), delta (deep sleep)

excellent for detecting epilepsy

the scalp "smears" the signal, so not exact about location

can't pick up on signals below the cortex

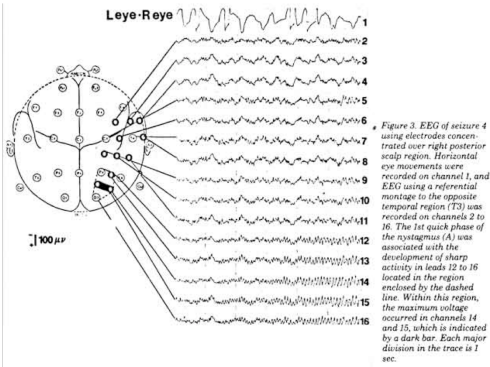
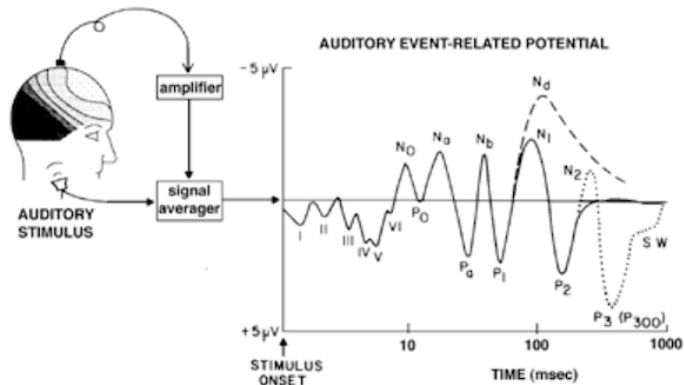
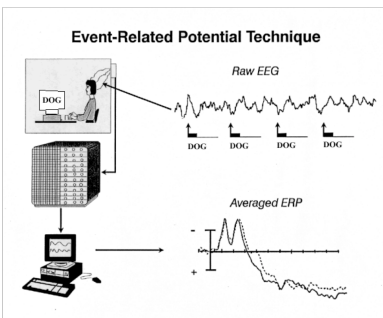
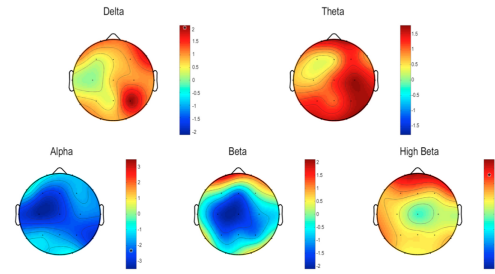


Figure 3. EEG of seizure-4 using electrodes concentrated over right posterior scalp region. Horizontal eye movements were recorded on channel 1, and EEG using a referential montage to the opposite temporal region (T3) was recorded on channels 2 to 16. The 1st quick phase of the nystagmus (A) was associated with the development of sharp activity in leads 12 to 16 located in the region enclosed by the dashed line. Within this region, the maximum voltage occurred in channels 14 and 15, which is indicated by a dark bar. Each major division in the trace is 1 sec.



the response to a single event (such as presenting stimuli in an experiment) is noisy
 the response to many, similar events can be averaged together to detect common features
 typically look at:

- latency - timing of response (e.g. 100 ms after stimulus presentation)
- amplitude - strength of electrical response (e.g. stronger signal for salient stimuli)
- origin - location on scalp (e.g. occipital lobe for visual stimuli)

Animal Techniques

these would not typically fall under neuropsychology,
but are included because they are driving the field of neuroscience

a specific area of the brain is damaged by removal, drugs, or electrical stimulation
allows for the conclusion that an area is necessary for a function

inserting electrodes directly into the brain to isolate action potentials for single neurons in highly specific brain areas
useful for understanding how individual neurons in an area respond to stimuli
neurons can also be stimulated to affect behavior

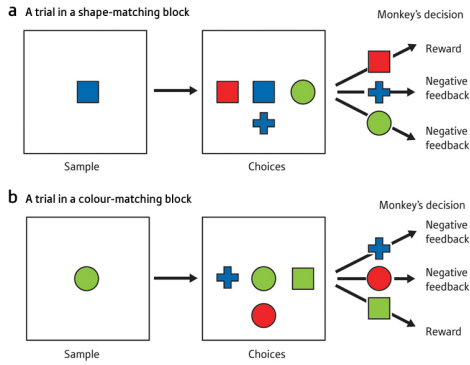
introducing new DNA to alter the physiology of an organism
examples: increase or decrease a specific receptor, transmitter, or metabolic protein

measure or alter the molecular make-up of neurons
example: measuring neurotransmitters in synapses, adding genetic material to inhibit RNA
historically, measuring a molecule required removing the tissue and potentially destroying it
new techniques allow for the live imaging of molecules in tissue in awake, behaving animal

Behavioral Tasks

tasks that are intended to measure a concept of brain functionality
could diagnose a deficit in a patient or quantify an ability in a population

taking an abstract concept (e.g. working memory) and assigning an objective measure (e.g. numbers recalled)
even when an experiment is technically well-executed (e.g. randomized subjects, valid stimuli, good analysis),
there can be much debate about whether the task is a good operationalization of a concept



Wisconsin Card Sorting

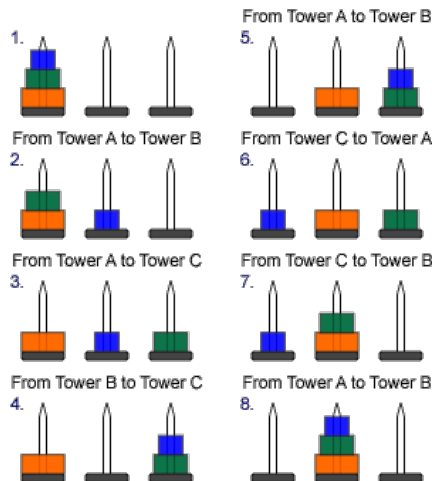
measures _____

subject sorts cards with different colors, shapes and number of items
 the rule for sorting is not revealed and must be guessed
 the rule occasionally changes and subject has to detect and adapt to change

Go/No Go

measures: _____

on most trials subject is shown a green circle ("go") and responds as quickly as possible by pressing a button
 on a minority of trials, a red circle ("stop") is shown instead and subject must not react with the usual button press



Tower of Hanoi

measures: _____

subject must re-stack wooden rings onto 3 different pegs
 in order to match a target pattern
 only one ring can be moved at a time
 subject doesn't physically manipulate them, but instead has to solve mentally and describe the moves

Source: people.missouristate.edu/lesreid/POW01_03.html

Facial Emotions

measures: _____

subject is shown a series of faces expressing different emotions and has to identify the emotion



Clinical Scales

used in both clinical and research settings
typically measure lifestyle or chronic conditions
self-reported scales are easily influenced by survey environment and subject's intentions
there are often multiple, "equally valid" scales for a particular topic, though one may dominate by tradition

Glasgow Coma

ratings for verbal response, eye tracking and muscle response
score of 3 indicates full coma, 18 indicates normal consciousness
predictive of outcome month later

Barratt Impulsiveness Scale (BIS, [link](#))

self-report (answered by subject about themselves)
I say things without thinking, I concentrate easily, I like puzzles
factors: attention, motor, self-control, cognitive complexity, perseverance, and cognitive instability impulsiveness
adults with ADHD score higher on BIS and perform worse in a continuous monitoring task ([Malloy-Diniz et al, 2007](#))

Beck Depression Inventory

self-report (answered by subject about themselves)
I am sad all the time and I can't snap out of it, I don't cry any more than usual
factors: hopelessness, irritability, guilt, fatigue, weight loss, libido
facilitated a shift away from a psychodynamic approach towards a cognitive approach
Related: Hopelessness Scale (BHS), the Scale for Suicide Ideation (SSI)
correlation between Beck and serotonin sensitivity ([Peirson & Heuchert, 2000](#))

Other

left/right split visual displays

deliver information to a specific hemisphere of the brain
test for lateralization of a function

identify physiological changes in the brain after death
started with Broca & Wernicke in 1860s
some modern diseases can only be diagnosed post mortem
e.g. plaques that indicate Alzheimer's disease versus non-AD dementia

measure the electrical resistance of the palms

an emotional response typically cause the palms to sweat, which reduces the resistance

can indicate an emotional reaction to a stimulus without requiring a verbal/conscious report

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