How the Brain Works: A Primer for Judges

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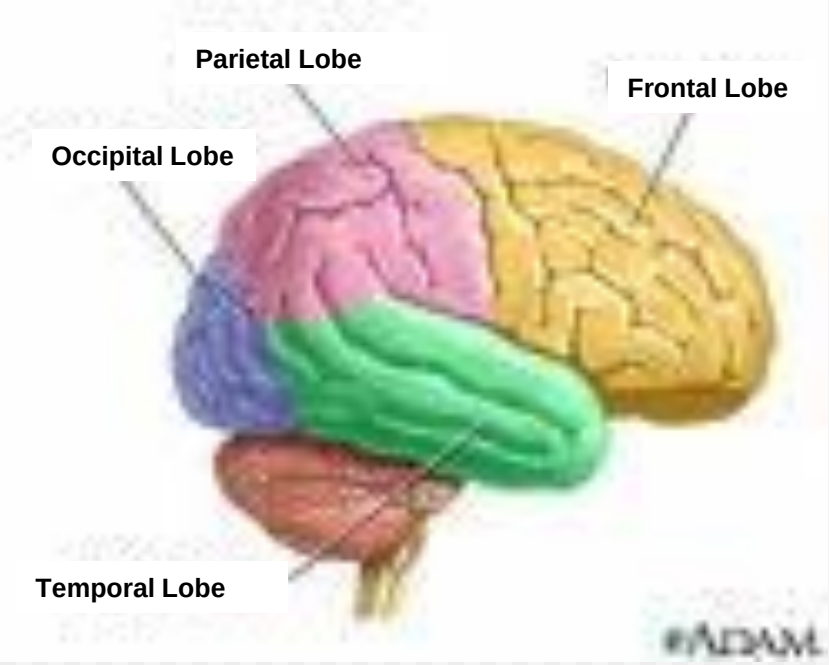
How the Brain Works

- Brain is a gelatinous-like organ
- Cerebrum responsible for cognition
- Cortical (covering) regions mediate specific aspects of mentation (language, spatial)
- Subcortical (deeper structures below the exterior) regions relate to speed of processing, some motor functions and some emotional functions

Leaving No Lobe Unturned



“How the Brain Works”

- The brain has a systematic organization of structure/function
- Follows specific principles that are generally accepted in neuroscience
- However, there is absolutely no 1:1 correspondence of structure/function
- Regions *mediate* function rather than *control* it
- We are not phrenologists--Gall, with bumps on the head

How the Brain Works: Detecting an Abnormality (2)

- Must follow deductive reasoning: there is a *pattern* or *constellation* of cognitive deficits that warrant a conclusion
- A conclusion of a specific brain area affected by impairment on a single cognitive task (test) is not warranted
- Certainly cannot relate to cellular level

How the Brain Works: Detecting an Abnormality (3)

- Luria taught us the approach
- Neuropsychologists and behavioral neurologists reason much as Judges using “if, then” approach
- In general, it must add up for a conclusion to be accurate
- One finding (e.g. test score, neurologic finding) *usually* does not a conclusion make

Lateralization

- Each hemisphere has a specialization: in most right handers, the right hemisphere is dominant for language and the left hemisphere for spatial reasoning
- Within each hemisphere, as we go from the back (posterior) to the front (anterior) the brain becomes more specialized
- Contralateral (opposite) motor control

Left Hemisphere

- LANGUAGE in most persons: a left hemisphere lesion can produce an aphasia
- Word finding problems most common language problem in left hemisphere damage
- Verbal memory (left temporal lobe)
- Linear (step by step) reasoning; analyzing component parts rather than the entire ‘gestalt’

Right Hemisphere

- Spatial reasoning, such as reading a road map or analyzing blueprints
- Spatial reasoning, such as copying a complex figure
- “Gestalt” or global perspective

Areas/Lobes of the Brain

- Cerebellum
- Cerebrum:
  - Occipital
  - Temporal
  - Parietal
  - Frontal

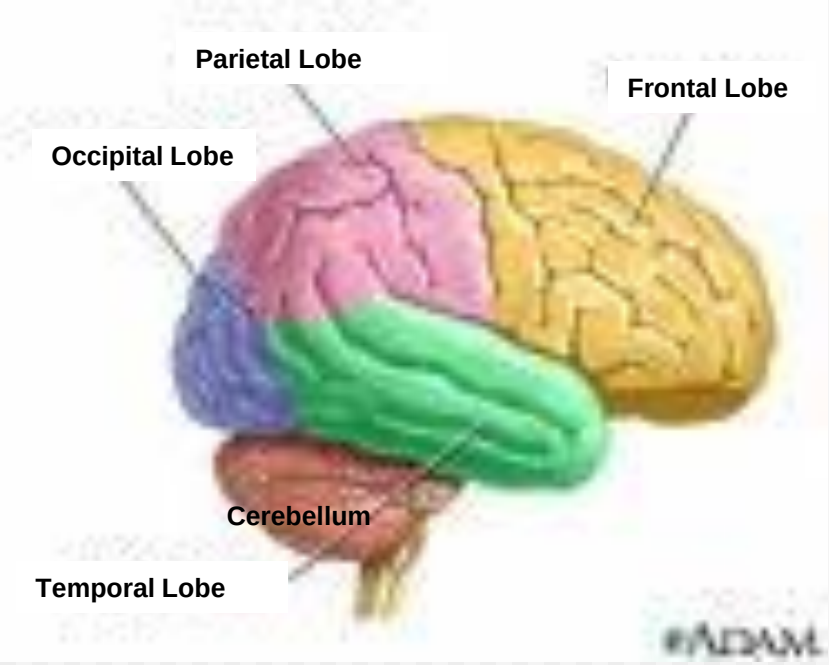
Left Hemisphere Damage

- Aphasia (language abnormality)
- Verbal memory impairment
- Decreased word generation or fluency
- Details missing or ignored

Right Hemisphere Damage

- Impaired spatial reasoning
- Patient may get lost due to route finding impairment
- Impairment of ‘pragmatics’ and non-linguistic aspects of speech such as social cues
- “Gestalt” lost in copying a design

Cerebellum


Parietal Lobe
Frontal Lobe
Occipital Lobe
Cerebellum
Temporal Lobe

How the Brain Works: Cerebellum

- Motor movements such as gait
- Disorders of the cerebellum produce motor ataxia (impaired walking or gait) and can produce some impaired upper extremity coordination
- Disorders such as chronic alcoholism or stroke can produce a cerebellar syndrome of gait ataxia

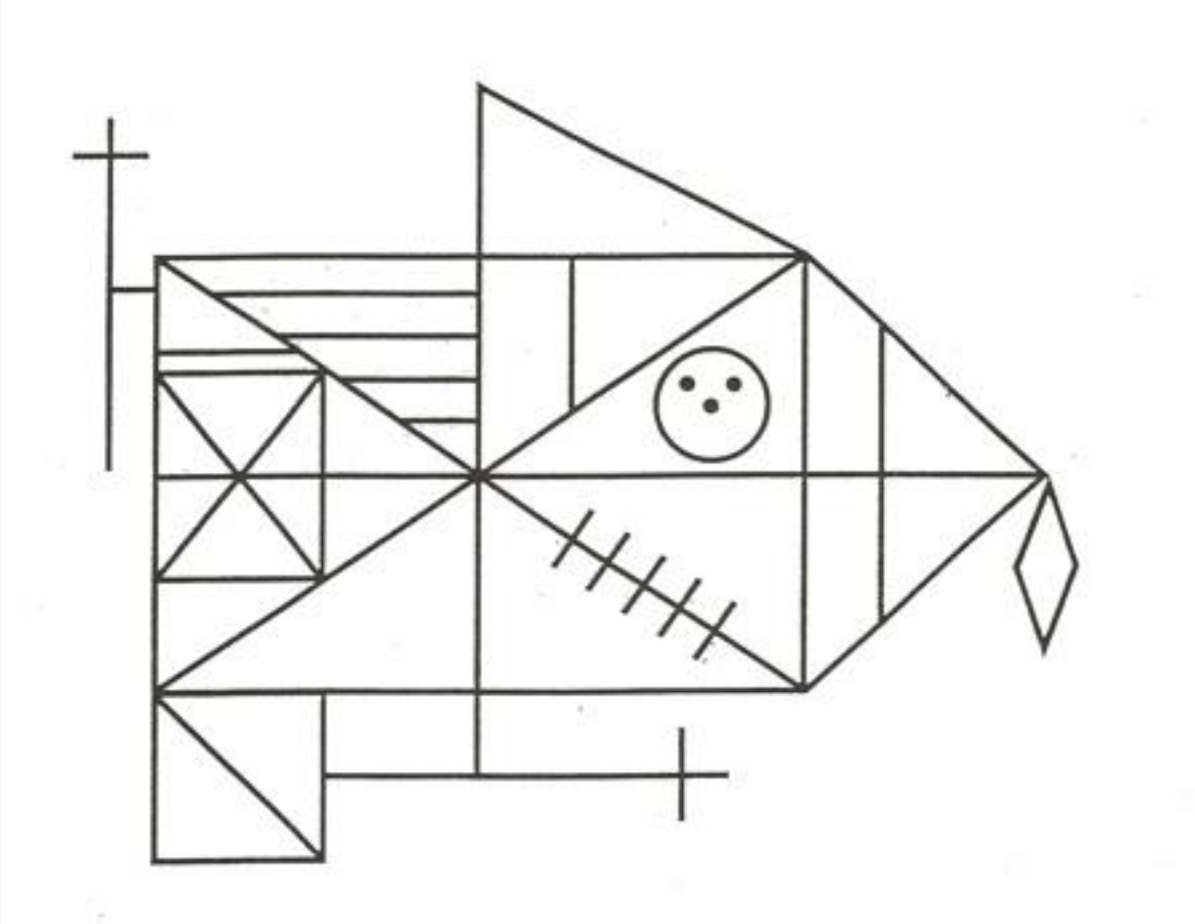
Occipital Lobe

- Vision
- Cortical blindness can result from damage to the occipital region
- Area in the occipital lobe about the size of a credit card necessary for processing vision

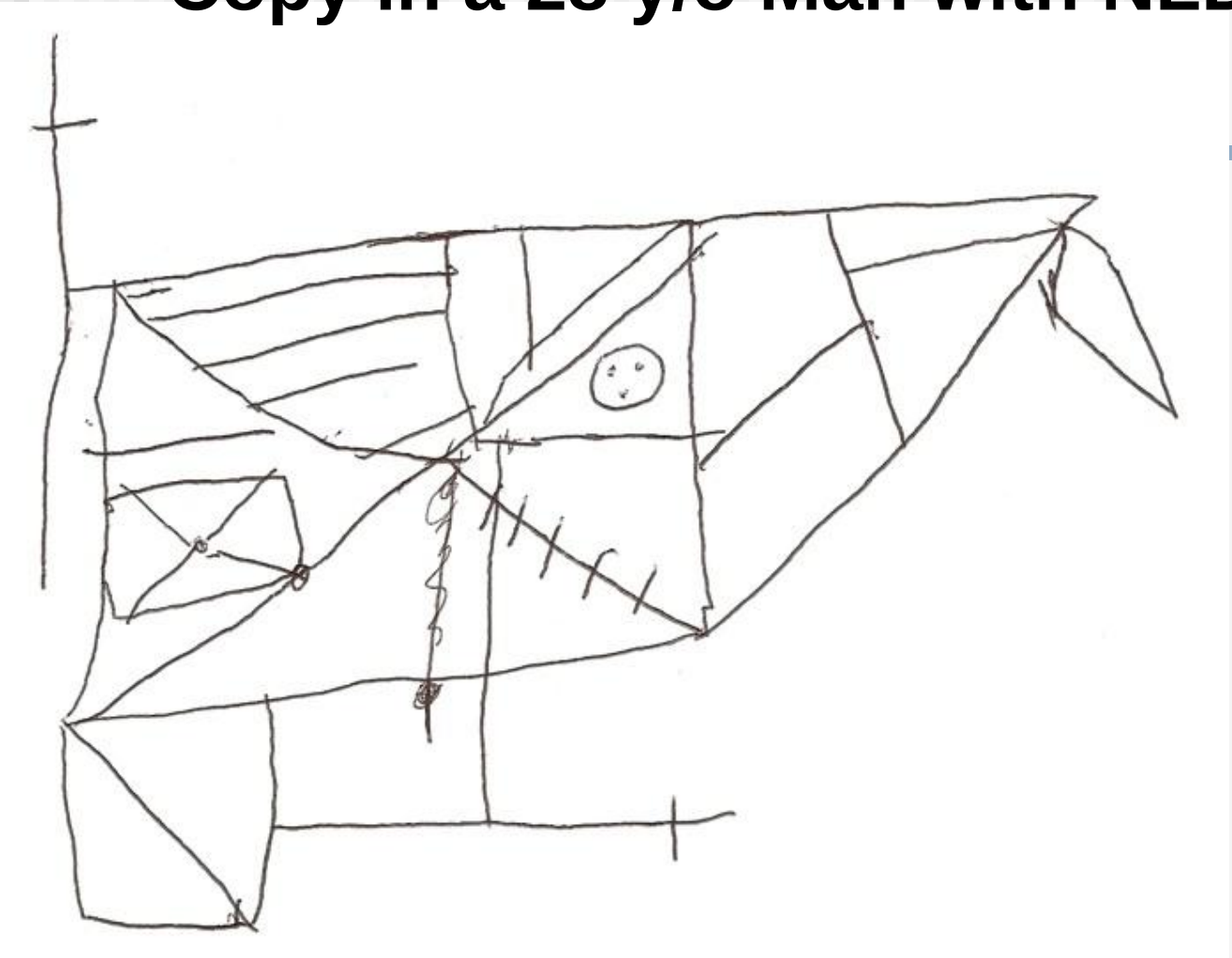
Parietal Lobe

- Integration of functions--language in left hemisphere, spatial in right
- Praxis (the ability to do on command what one can do spontaneously)

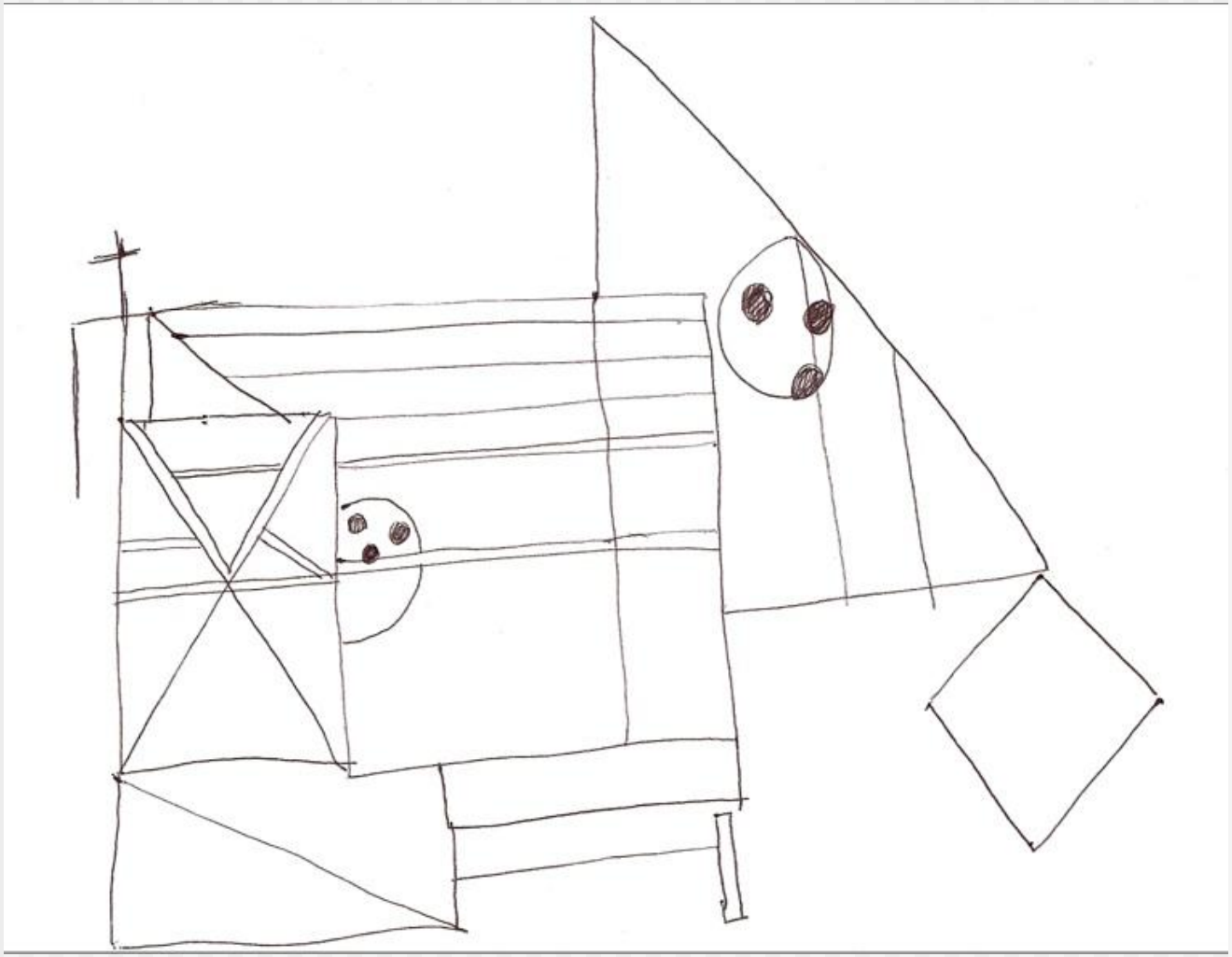
Rey Osterrieth Complex Figure



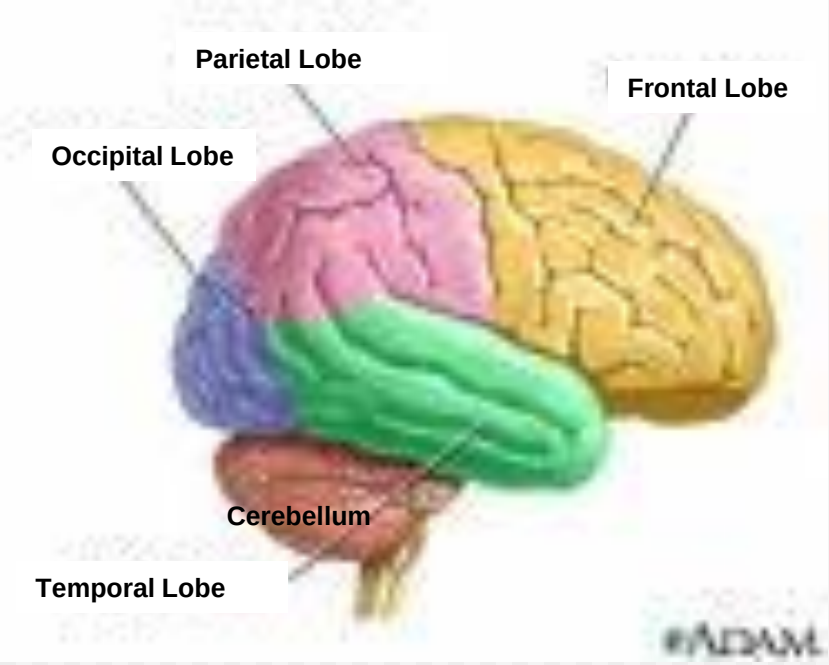
Copy in a 28 y/o Man with NLD



Copy in a 58 y/o Woman with Dementia



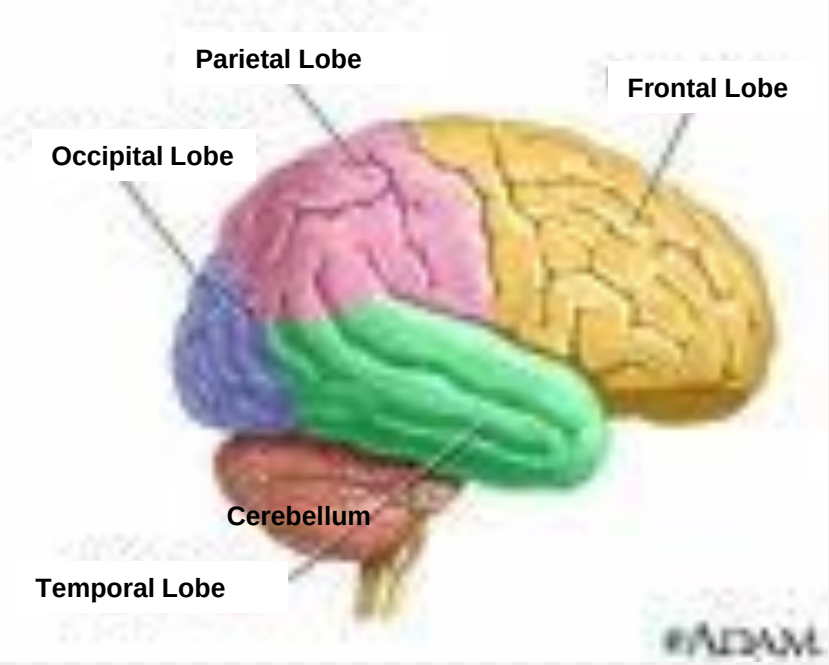
Temporal Lobe



Temporal Lobes

- Memory (verbal, left; visual, right)
- Certain personality characteristics
- Mesial Temporal Lobes: Hippocampus, critical for memory

Frontal Lobe



Frontal Lobes

- One third of the brain
- “Executive functions”--planning, strategy formation, cause/effect issues, inhibition, judgment
- Last part of brain to myelinate (children are “frontal lobe cases”)
- Relates to the ability to form intent
- Think before act in intact persons

Brain Imaging in Brain Function/Dysfunction

- CT/MRI often normal in some neurolgic disorders producing cognitive impairment (e.g. closed head injury (TBI); some dementias)
- High resolution MRI might show abnormalities (e.g. TBI)
- Neuropsychological (NP) tests sensitive to subtle cognitive effects such as early AD, subtle TBI, etc.
- NP provides functional measure of ability after neurologic illness

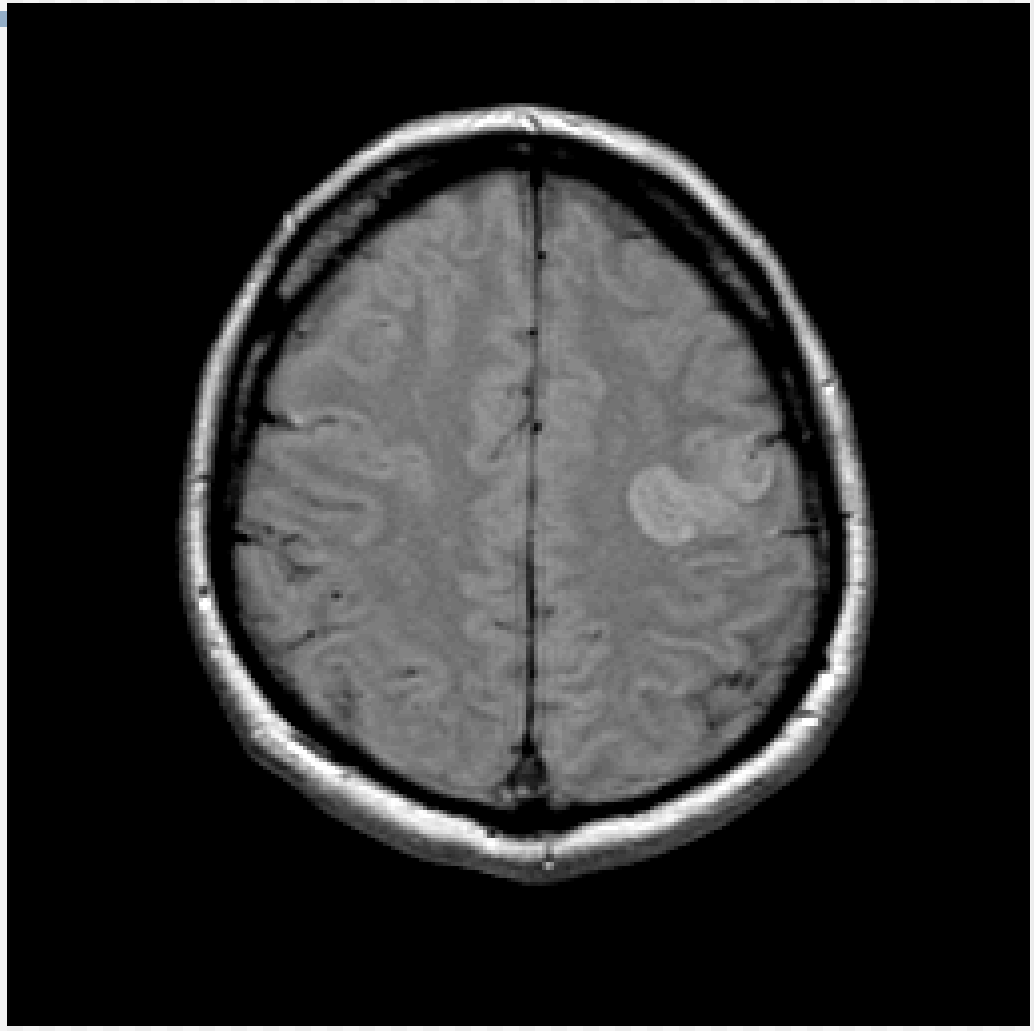
Brain Imaging

- Structural: Architecture of the Brain
  - E.g. CT or MRI
- Functional: Activity of the Brain
  - E.g., Single Photon Emission Tomography (SPECT) or Positron Emission Tomography (PET)

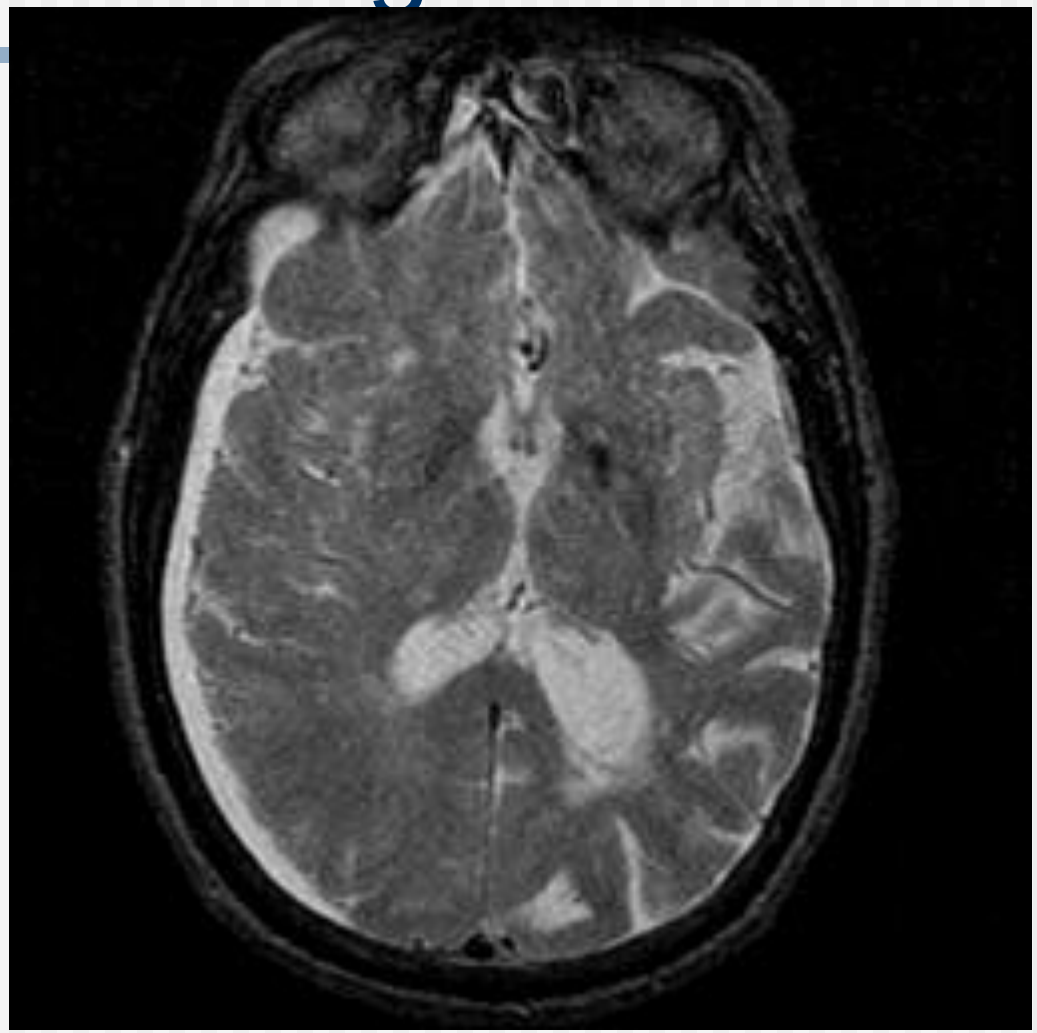
Brain Imaging: Structural

- CT and MRI most common
- Measures of brain architecture
- They measure the *structure* of the brain, not the *function*
- Space occupying lesions and structural abnormalities (e.g. enlarged ventricles, generalized atrophy--shrinkage) appear on structural brain imaging

Structural Image with Lesion



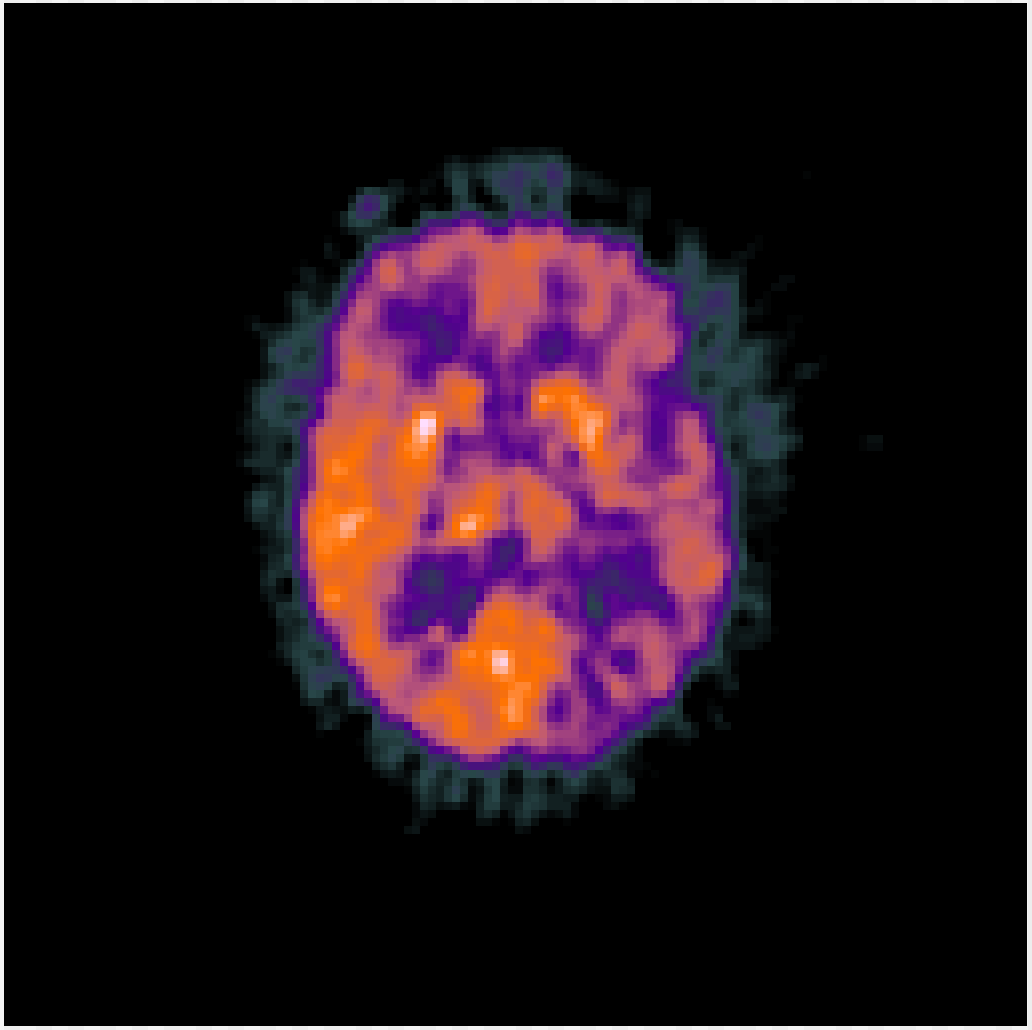
Example of MRI with Enlarged Ventricles



Functional Neuroimaging: PET and SPECT

- PET works by injecting an energy source available to the brain and determining areas of increased/reduced activity or blood flow
- Utilizes a database of normals (how many?) with dozens (hundreds?) of areas/pixels
- Potential for false + and false -

Functional Neuroimaging: Positron Emission Tomography



Brain Imaging

- Much like the news, just because it's in print (picture form) doesn't mean it's real
- Just because it *looks like* the brain doesn't mean it *is* the brain
- Mathematic reconstruction based upon density of water or metabolic uptake (PET) or blood flow (SPECT) to produce colorful image

Brain Imaging

- Functional Imaging can have significant false positive and false negative findings
- Indeed, colossal errors can occur
- Much relates to normative database for the reconstruction of the image
- Thousands of pixel reconstructions based upon oftentimes small samples of data

Clinical Correlation Important

- Important to correlate structural or functional imaging findings with clinical findings, such as from neuropsychological testing
- Are the imaging findings relevant? E.g. “unidentified bright objects” or false positives

Cognitive Testing

- Usually performed by a neuropsycholgist
- Specialist within psychology
- Generic license for psychologist but board certification available for ‘neuropsychologist’
- Neuropsychology: Use of formal psychometric tests to detect a cognitive or intellectual abnormality

Format of Neuropsychological Examination

- Interview
- Administration of a battery of tests
  - Tests can be a collection of discrete tests or a published battery such as the Halstead Reitan NP Battery or the Neuropsychology Assessment Battery (NAB)
- Tests usually take several hours (up to 8 or so) to administer, then must be scored & normed

Frye and Daubert Issues

- Most peer reviewed published tests are accepted by community
- “Legitimate” published tests (by national publishers) have undergone peer review with known validity and reliability
- Validity: Does it measure what it purports to measure
- Reliability: Same findings over time

Frye and Daubert Issues

- Sources of information on test validity and reliability: *Standards for Educational and Psychological Testing* published by the American Psychological Association
- Burros Institute's: *Mental Measurements Yearbook.* Peer reviews of tests

Areas Commonly Assessed

- Motivation/Level of Effort
- Intelligence
- Academic abilities (if appropriate)
- Attention/concentration
- Language
- Visuospatial
- Learning & Memory
- Motor
- Executive/Frontal
- Mood & Personality

Motivation

- Valid assessment assumes full effort
- If level of effort is compromised, then entire battery of results is in question
- “Effort testing” should always be done whenever there is a reward for appearing more impaired than is truly the case
- Need for more sophisticated tests as examinees become more sophisticated

Methods to Assess Motivation or Level of Effort

- Tests have been improved considerably over the past decade or more
- Original tests used “symptom validity” approach--two choices and did the person perform below chance using binomial theorem?
- Now we recommend using multiple tests to assess effort

Tests for Effort (Malingering)

- Best examples are ‘Test of Memory Malingering” (TOMM) or ‘Validity Indicator Profile’
- Panoply of tests available, some useful, some have too high of a false + or false - rate
- Most not appropriate for mental retardation or dementia

Test of Memory Malingering

- Test of Memory Malingering (TOMM)
  - Looks very difficult but in fact, most patients obtain near perfect scores
  - Measures “working memory” rather than secondary memory
  - Validated across many clinical groups
  - Good data on true versus false positives: good sensitivity and specificity

Validity Indicator Profile (VIP)

- Verbal & Nonverbal portions
- Most accurate when using both parts
- Easy/difficult items mixed up
- Two choices for each question
- Answers graphed from easiest to hardest, producing a performance curve

Mixed Strategies: VIP

- Four results: valid, inconsistent, irrelevant, suppressed
- Inconsistent means person intended to do well but exerted varying levels of effort
- Irrelevant means the person responded without regard to item content: that is, they responded randomly
- Suppressed=picking the WRONG answer (intentionally)

VIP

- One of the most sophisticated of all the effort tests
- Some of the best accuracy data
- Be careful with an inconsistent result: most false positives here

Detection of Malingering

- Clinical NP tests used also: Do the results make “neuropsychological sense?”
- Are the results consistent with behavior in the exam or known functioning?

Effort: Special Populations

- Mental illness
  - Depressed patients may be inconsistent
  - Schizophrenia or psychotic illness might cause failure on “ceiling effect” tests producing false positives
- People with known brain dysfunction can “fail” effort tests for many reasons
- Mental Retardation
  - 50% inconsistent on VIP nonverbal
  - Dot Counting Test least effected in MR

Malingering

- Does not usually identify whether poor effort is due to conscious or non-conscious factors
- Only two means to determine result is due to conscious factors:
  - Statistically below chance performance
  - Surveillance showing the person doing things inconsistent with the testing

Intelligence

- Wechsler Adult Intelligence Scale-IV (WAIS-IV)
  - Most known of all IQ tests
  - Gold standard
  - Now, just Full Scale IQ and GAI
  - VCI, PRI, WMI, PSI (PSI most sensitive)
  - Relate these results to estimate of premorbid IQ

Attention/Concentration

- Frontal and subcortical regions
- Simple attention (digit span)
- Sustained attention (CPT)
- Divided attention
- Severe attentional problem can signal a delirium which affects all cognition
- Mild attentional problems due to many disorders including ADHD, frontal systems disturbance or medication effects

Language

- Sensitive to disturbances or injury to the dominant (usually left) hemisphere
- Naming ability (word finding) most sensitive function to left hemisphere injury
- Aphasia--subtypes relate to location of damage and can affect comprehension and production of language

Visuospatial

- Sensitive to right hemisphere dysfunction
- Analogous to map reading or analyzing blueprints
- More “silent” areas of dysfunction
- Can still be quite disabling
- Need this to “read people” and interpret nonverbal social cues

Learning & Memory

- Sensitive to temporal lobe dysfunction
- Critical to assess--important for everyday activities/abilities
- Usually affected in traumatic brain injury because of anatomy
- Test both verbal & nonverbal; list learning and story recall
- Memory impairment ubiquitous in neurologic disorders affecting cerebrum

Executive

- Critical domain to evaluate: can relate to ability to form intent
- Relates to planning, judgment, impulse control, inhibition, adjusting to novelty
- Impairment has major implications for working, behaving appropriately, planning, handling novelty, ***even if IQ is high***

Examples of Executive Function Tests

- Wisconsin Card Sorting Test (WCST)
- Stroop Color Interference Test
- Mazes
- Judgment
- Trail Making Test B or Color Trails 2
- Category Test
- Behavior

Mood/Personality

- Important to assess as depression or anxiety can affect results
- Many objective tests have validity scales
- Depression can result from neurologic illness
- Don’t overinterpret: many personality tests were not normed on neurologic patients
- E.g. “Schizophrenia” scale on MMPI-2 often elevated in persons with a seizure disorder
- Caution with Rorschach & other projective tests in neurologic patients

Forensic Applications for NP

- Assist with detection of poor effort
- Do the data converge to suggest a neurologic injury?
- Determination of the *severity* of injury
- Determination of the *type* of cognitive impairment (e.g. executive dysfunction)

Misuses of NP Test Results

- Over-intepretation--basing a conclusion on a single score
- Concluding ‘impairment’ based upon variability amongst normal range scores
- Performing a ‘standard interpretation’ in an unstandard situation, such as with special populations (mentally retarded, aphasic, ESL)

Misuses, continued

- Likelihood of false positive findings greater than false negative findings based on number of tests/scores obtained
- Must factor in emotional state as a potential contributor of abnormal results
- Conclusion of impairment because of assertion of extremely high premorbid ability

Misuses, continued

- Inappropriate normative data for cognitive tests of PET findings
  - Small samples
  - Demographic mismatching for cognitive tests
  - Cultural/language factors for cognitive tests
  - Even within the same language, regional/cultural differences exist (e.g. Spain vs. US vs. South America; UK vs. US)

Integration of Information

- There should be converging agreement amongst quantitative measures of brain function such as imaging & cognitive results
- Tools only as good as the clinicians, experts and courts interpreting them
- Potential for false positive results high

Caveat Emptor

- It has been said that *Science is Truth Found Out*
- It has also been said *The Truth Can Be Made Up if You Know How*
- Be wary and analytical: often common sense is, in the end, the most useful tool
- Sound methods and sound interpretation lead to sound conclusions