

## Chapter 1 : Background The Development of Neuropsychology

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1

## Case Report : LD

- History:
  - 21 year old male
  - Fell down 5 flights of stairs, suffered CHI
  - GCS of 3
  - CT revealed bleeding and swelling on RH, then LH
  - Craniotomy to relieve pressure
  - Successful physical recovery

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2

## Case Report : LD

- Sequelae:
  - Amnesia for incident
  - NP Exam:
    - behavior : normal (?)
    - Pt and family report full recovery
    - tests:
      - impaired verbal memory
      - impaired attention
  - Unable to return to work as cook
    - can't multi-task
    - lost sense of smell and taste
  - Lost interest in socializing
  - Able to play golf at expert level

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## Case Report : LD

- Issues:
  - Lawsuit & Settlement:
    - is he injured?
    - how can he be expert golfer but not work?
  - Rehabilitation & Recovery?
  - NP Testing shows "hidden" deficits
  - Brain imaging : limited utility

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## GCS: Glasgow Coma Scale

- 13+ "Minor"
- 8-12 "Moderate"
- 3-8 "Severe"

Score	Eyes Open	Verbal	Motor
1	no	none	none
2	to pain	sounds	extension to pain
3	to voice	words	abnormal flex to pain
4	spontaneously	confused	flex/withdraw to pain
5	..	oriented	normal resp. to pain
6	..	..	obeys commands

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## Brain Anatomy

- Two hemispheres (Left, Right)
- Cortex ("bark")
- Gyri, Sulci
- Right Hand Model
- CSF
- lateral and longitudinal fissures

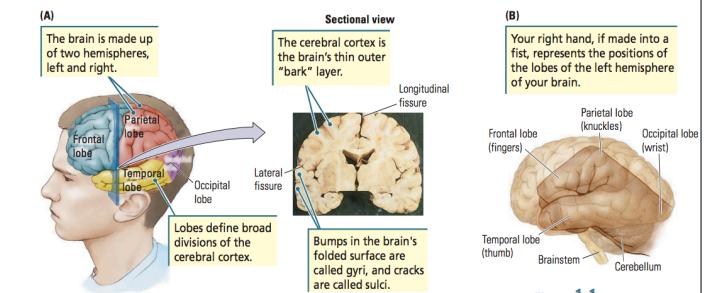


Figure 1.1

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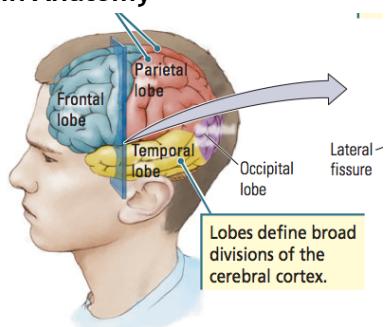
6

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## Brain Anatomy

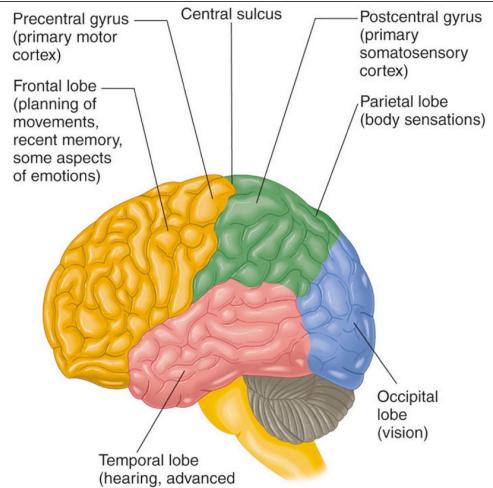
- Cortex divided into 4 lobes
  - Frontal
  - Parietal
  - Temporal
  - Occipital



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## Cerebral Cortex



© Wadsworth, Cengage Learning

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8

## Evolution

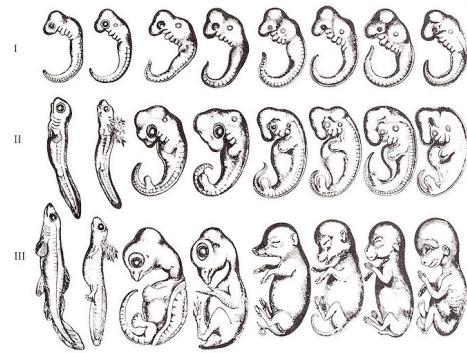
- Phylogenetics or Phylogeny
  - study of evolutionary relationships between organisms
- Ontogenetics or Ontogeny (aka morphogenesis)
  - development of organism from egg to adult

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## Ontogeny Recapitulates Phylogeny

- idea that an organism's development from egg to mature individual is similar to evolutionary development of species.



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## Brain - 3 part division

- Three divisions:
  - Forebrain
  - Brainstem
  - Spinal Cord
- These mirror phylogeny (somewhat)

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11

## Brain

- Forebrain
  - Cerebral Cortex
  - Limbic System
    - Hippocampus
    - Cingulate Gyrus
    - Septum
    - Amygdala
  - Basal Ganglia
    - Globus Pallidus
    - Caudate
    - Putamen
- Brain Stem
  - Thalamus
  - Hypothalamus
  - Midbrain
    - RAS
  - Hindbrain
    - Medulla
    - Pons
    - Cerebellum

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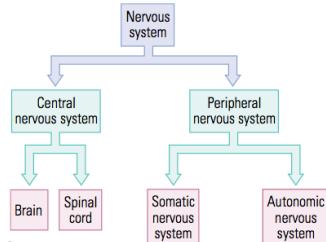
12

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## Nervous System

- Assumption
  - Nervous system -> Behavior
- Nervous system:
  - Central Nervous System (CNS)
    - Brain
    - Spinal Cord
  - Peripheral Nervous System (PNS)
    - Autonomic Nervous System (ANS)
      - Sympathetic
      - Parasympathetic
    - Somatic Nervous System (SNS)
- Endocrine system



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## The Brain Hypothesis

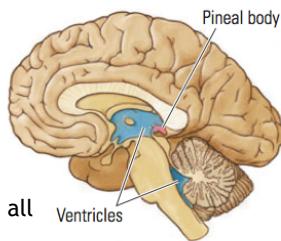
- The Brain is the seat of behavior
- c.f. The Cardiac Hypothesis

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14

## Philosophy of Mind

- Aristotle (348-322 BCE)
  - non-material *psyche* connects through heart
  - similar to “soul”
  - *psyche* = “mind”
- Descartes (1596-1650 CE)
  - materialist
  - dualism : mind-body problem
  - mind->body in pineal gland
  - Followers claim that animals, children, mentally ill all lack minds



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## Darwin, Wallace & Materialism

- Charles Darwin (1809-1892) and Alfred Russell Wallace (1823-1913)
  - studied structure and behavior of plants & animals
  - commonalities suggest relationships
  - Darwin : common descent

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## Darwin vs. Wallace : Evolution of Language

- human evolution : millions of years
- human written language : thousands of years
- How could we have language?
- Wallace : divine gift
- Darwin : ... (return to this next chapter)

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17

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## Localization of Function

- Franz Josef Gall / Phrenology
  - Cortex is functional (not just covering for the pineal gland as per Descartes)
  - ignored data from clinical cases
  - good idea, poor execution
- Paul Broca - Broca's Area
  - data based on clinical patients

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18

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## Phrenology

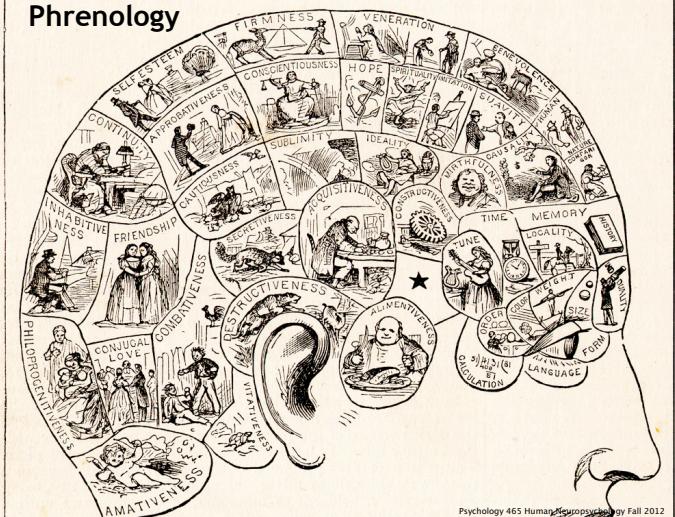
- A now discredited “science” from 1749 thru mid 1800s
  - Theory:
    - Brain controls behavior
    - Brain areas are modular
    - Cranial bone (skull) conforms to shape of brain
    - Therefore, measuring skull shape --> cognitive and emotional abilities
  - Data:
    - Data came from animal and human skulls
    - Human skulls : primarily of criminals
    - tended to ignore good data (data from brain damage)

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1

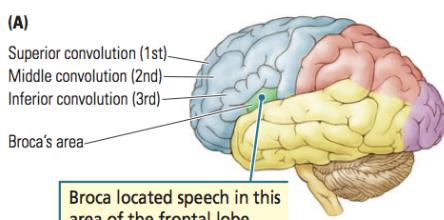


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20

## Broca's Aphasia

- Patient ML
    - lost expressive speech, except to say “tan” and swear
      - “aphasia”
    - paralyzed on right side
    - could understand spoken speech
    - autopsy showed brain damage in LH



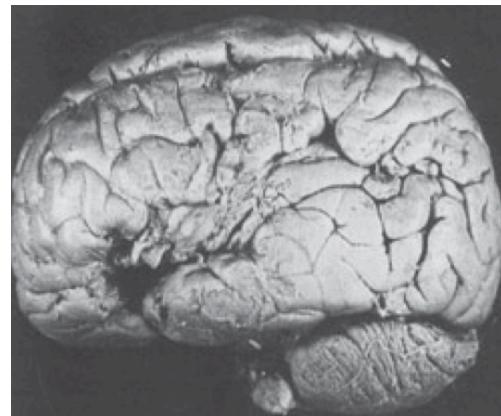
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## Broca's Aphasia

- Autopsy picture



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22

## Broca's aphasia

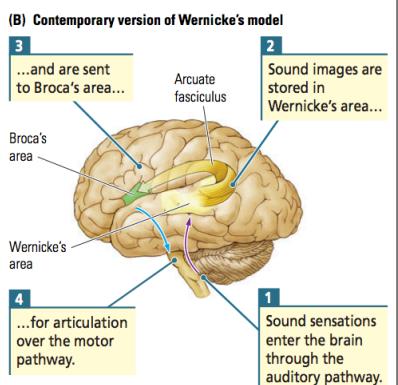
- Established two principles:
    - Localization
    - Lateralization

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## Wernicke's Aphasia

- Symptoms
    - can speak, but nonsense
    - can not understand or repeat spoken speech
    - hearing is fine
    - no paralysis

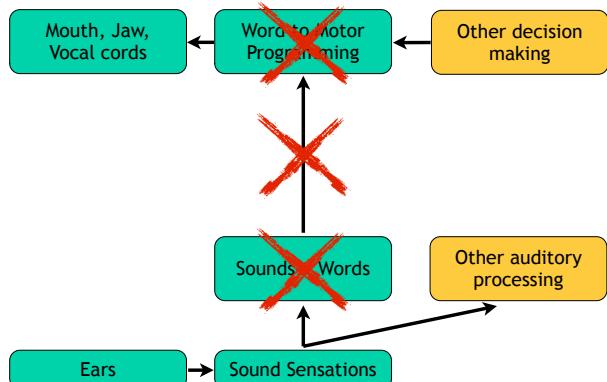


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34

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## Block Model of Aphasia (Wernicke-Geshwind model)

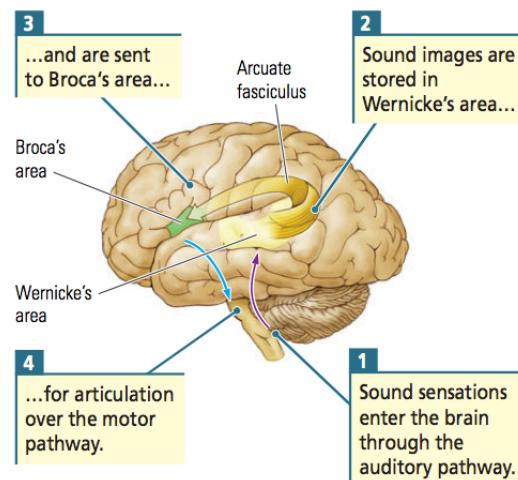


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## (B) Contemporary version of Wernicke's model



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26

## Sequential Programming & Disconnection

- Some abilities require multiple brain areas
- Areas operate in sequence
- Possible to damage the **connections** between areas w/o damaging areas
- “Disconnection” Syndromes

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27

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## Evidence against Localization

- Pierre Flourens
  - Animal experiments
  - removed portions of cortex
  - behavior initially reduced
  - followed by partial recovery
- Conclusion:
  - cortex is generalized, not localized

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28

## Hierarchical Organization and Distributed Systems

- John Hughlings-Jackson
  - brain has hierarchy
  - higher levels of function depend on lower levels
  - damage can result in *dissolution* of behavior (opposite of *evolution*)

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29

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## The Split Brain Studies

- Joseph Bogen and Phillip Vogel, neurosurgeons
- Cut corpus callosum to reduce seizures
- Patients: in many ways, normal
- Experiments showed:
  - both hemispheres operate somewhat independently
  - LH and RH different modes, strengths
  - LH
    - spoken language
    - analytic, sequential, details
  - RH
    - visual, spatial
    - holistic, gestalt

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30

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## Conclusions re: localization

- “Distributed Hierarchy”
- Distributed
  - cognitive functions localized in more than one place
  - multiple systems interact
- Hierarchy
  - Higher level behavior is made up of lower level parts
  - parts are often relatively independent
- Dissociation (see next slide)

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31

## Dissociation

- Single or simple dissociation:
  - Lesion to brain area L1 causes behavior problem B1
  - Lesion to other area L2 does not cause B1
- Double Dissociation:
  - Lesion to brain area L1 causes B1 but not B2
  - Lesion to other area L2 causes B2 but not B1

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32

## The Neuron Hypothesis

- Anatomical observations
- Electrical stimulation
  - led to behavior
- Connections between neurons
  - created to store information
- Neurotransmitters
  - chemicals which convey impulse from neuron to another

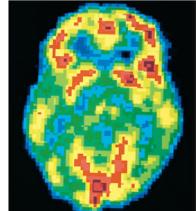
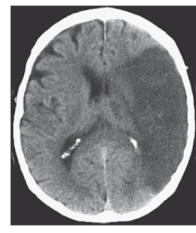
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33

## Neuroimaging

- Visualizing the brain *in vivo*
- CT : Computed Tomography
  - xray
  - cheap(er), quick
  - low resolution
- PET : Positron Emission Tomography
  - radioactive injection
  - tag chemicals to image

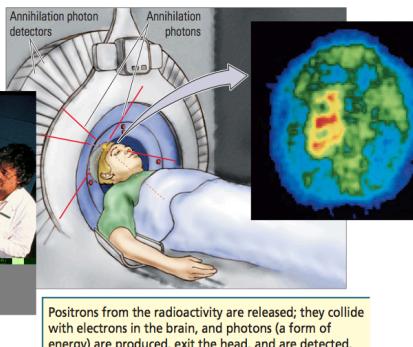


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## PET Scanner

A small amount of radioactively labeled water is injected into a subject. Active areas of the brain use more blood and thus have more radioactive labels.

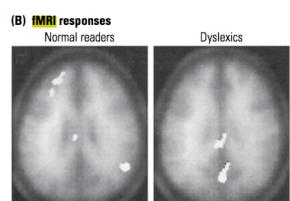
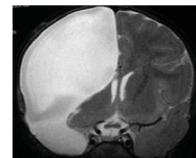


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35

## Neuroimaging

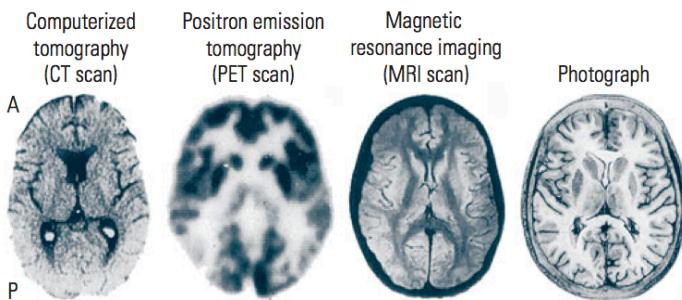
- MRI : Magnetic Resonance Imaging
  - magnetic fields
  - detailed
  - expensive
- fMRI : Functional MRI
  - metabolism in real time



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36

## Comparison of Neuroimaging images



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37

## Neuropsychology and related fields

- MS/MA
- Ph.D.
  - Experimental
    - Neuroscience
    - Cognitive Science
    - Psychology
  - Biopsychology, Cognitive, Developmental, Educational, Forensic, Personality, Social...
- Counseling
- Clinical
  - Neuropsychology
- M.D.
  - Neurology
  - Psychiatry

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38

## Clinical Neuropsychology

- Old School
  - localize site of lesion by way of behavioral testing
  - “Well, your brain is broken!”
- New School
  - diagnose disease by behavioral testing
  - provide clinical guidance re: ADLs, vocational
  - track recovery & rehabilitation
  - uses neuroimaging for finding lesions
  - forensic
  - research : behavioral testing
    - drug research
    - TBI
    - etc...

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39