

Education 173
Cognition and Learning
in Educational Settings

The Brain and Learning

Fall Quarter 2007

Mind and Brain

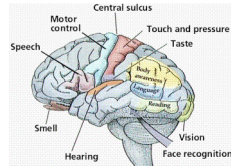
- **Not Equivalent**
- **The Mind Relies on the Physical Brain**

Brain Anatomy

- **Brainstem, Cerebellum, Cerebrum**
 - *Brainstem controls breathing, heart rate, sleeping, alertness*
 - *Cerebellum controls balance and coordination*
 - *Cerebrum: somatosensory functions*
- **Cerebral Cortex**
 - *Higher functions: Larger in humans than in animals*
 - *Last part of brain to develop, so it's more sensitive to environmental influences*

Four Lobes

- **Frontal Lobe**
 - Behind Forehead
 - Conscious Thinking
 - Planning, inhibition (delayed gratification), attention, reasoning, decision making, strategies, goal setting, self-monitoring
- **Parietal Lobe**
 - Top of head
 - Somatosensory functions
- **Temporal Lobe**
 - Above ears
 - Complex auditory info (Language)
- **Occipital Lobe**
 - Back of head
 - Visual processing
- **Association Areas**



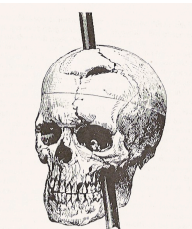
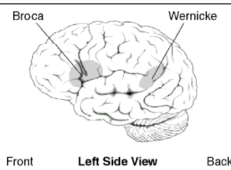
Lateralization

- Control/Sensation of Opposite Side
 - Motor: Left Hemisphere Controls Right Hand
 - » Traumatic Brain Injury: Paralysis, Speech Disruption
 - Sensory: Crossover for vision; partial crossover for hearing
- Relative Specialization
 - Left hemisphere: language and analytic thought
 - » 90 percent of right handers have language functions focused in left hemisphere
 - » But only 60 percent of left handed people have language functions in the left hemisphere
 - Right hemisphere: spatial and holistic thought
 - In normal populations, a division of labor

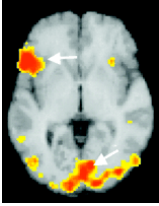


Modularity

- Broca's and Wernicke's Areas
 - Broca's: Grammatically Correct Speech
 - Wernicke's: Meaningful Speech
- Phineas Gage, Railroad Man
- Plasticity and Redundancy
 - The violinist re-mapping
 - Re-mapping after injury or surgery

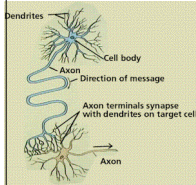


Brain Circuits



- Complex Performance
 - » Neuroimaging: fMRI and PET
 - » Almost always, multiple areas (circuits) are activated
- Brain Imaging and Mathematical Reasoning
- Brain Imaging and Reading

Neuron Anatomy and Adaptation



- Neurons
 - Cell body, dendrites, axon, terminal buttons
 - Myelin sheath
 - About 100 billion neurons
 - » About 7 billion people on earth
 - » Up to 100,000/sec prenatally
 - » Neurogenesis in adulthood

Synapses and Neurotransmitters

- Synapses is Gap
 - » Neurons don't touch
- Excitatory, Inhibitory
- Threshold of Excitation
- Neurotransmitters
 - » Dopamine, serotonin
 - » Mood/Depression

Blooming and Pruning

- **Blooming**

- Children have many more synapses than do adults
- Synaptogenesis: Between birth and age 3
- Rapid proliferation of synapses

- **Pruning**

- Synapses disappear if not used (resorption)
- Formation depends on chemicals (neurotrophins)
- In cortex, pruning extends into adolescence

Other Developmental Changes

- **Increased Myelination**
 - Just before birth and into 20s
- **Maturation of Frontal Lobes**
 - Into early adulthood

Brain Development and Experience

- **Experience-Expectant Development**
 - » Any normal environment—visual perception, language
 - » Disrupted by malnutrition
 - » Disrupted by sensory or social deprivation
 - » Disrupted by toxins
- **Experience-Dependant Development**
 - » Specialized skills for a particular culture
 - » Literacy produces a thicker corpus callosum

Learning and Brain Structure

- **Learning: Many Mechanisms**
 - Search for the “Engram”
 - Knowledge rarely or never a single spot
 - Karl Lashley’s surgery on rats’ brains
 - » Still remembered maze
 - Where’s Grandma?

Learning and Brain Structure

- **Experience and Synaptic Density**
 - Rats in two kinds of cages
 - Diamond and rat brain density
 - Effects of deprivation
- **Learning and Brain Efficiency**
 - UCI Study: Better performance associated with lower brain metabolism

Learning and Brain Structure

- **The Hippocampus--Basis for LTM**
 - Amnesia—The case of HM
 - An inability to learn--almost
 - Consolidation of memory
 - Fast and slow processes

Exercise and Nutrition

- **Exercise**

- Brain is Physical Structure
- Exercise and Vascularization
- Exercise and Neurotrophins

- **Nutrition**

- Glucose
- Essential fats—Omega 3

A Bridge Too Far

- **Overextending Brain Research**

- **John Bruer**
- **Right brain/Left brain**
- **Critical periods**
 - Language Learning: Phonemic Awareness
 - But these can be overcome
 - Early study of music

- **The Middle Island of Cognitive Science**
