

**Psychology 105**  
**Chapter 2**

**Biopsychology - Part 2**  
**Central Nervous System**

Spring 2008

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**Biopsychology - Outline**

**Part 1: Internal communications in the body**

**Part 2: The Brain, Mental Processes and Behavior**

- **Methods for studying the brain**
- **Major Structures and Functions of the Brain**
- **Plasticity of the Brain**
- **Hemispheric Specialization and Handedness**
- **Split Brain studies**

**Part 3: Genetics and Behavior: Nature and Nurture**

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**The Brain**

*➤ How does the brain produce behavior and mental processes?*

*The brain is composed of many specialized and interconnected modules that operate in parallel and interact to produce behavior, consciousness, thought and mind.*

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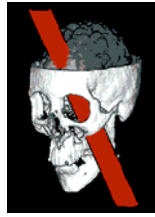
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### Studying the Brain - Research Methods

➤ **Lesions** - damage to brain tissue caused by stroke, disease, tumor or injury

- Location of lesion and nature of behavioral change gives information about what the injured part of the brain is responsible for.
- In humans, lesions are usually "naturally occurring" or a result of corrective surgery. In other animals, lesions are made deliberately to study brain function.



Phineas Gage

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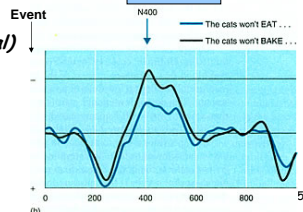
### How is the Brain Studied, Cont.

➤ **EEG (ElectroEncephaloGraphy)** - Device for recording brain waves, typically from electrodes placed on the scalp

- Brain Waves - patterns of electrical activity generated by brain



➤ **ERP (Event-Related Potential)** - average of records from many EEG tracings shows timing and relationships between brain waves and event



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### How is the Brain Studied, cont.

- **Epilepsy** - location of seizure and resulting impact on behavior points to brain function at that location
- **Electrical Stimulation** - Stimulating brain tissue with tiny electrodes and noting behavior or patient reports
- **Recording** - directly recording electrical activity with tiny electrodes stuck into brain tissue itself; done far less frequently in humans than in other animals

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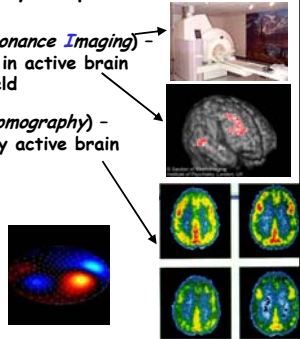
### How is the Brain Studied, Cont.

➤ **External Brain Imaging** - recording brain's electrical or chemical activity at specific sites during mental activity

• **fMRI (functional Magnetic Resonance Imaging)** - measures increased blood flow in active brain areas, in a strong magnetic field

• **PET scan (Positron Emission Tomography)** - radioactive glucose taken up by active brain cells emits positrons

• **MEG scan (MagnetoEncephaloGraphy)** - changes in magnetic field of scalp in response to electrical activity in brain




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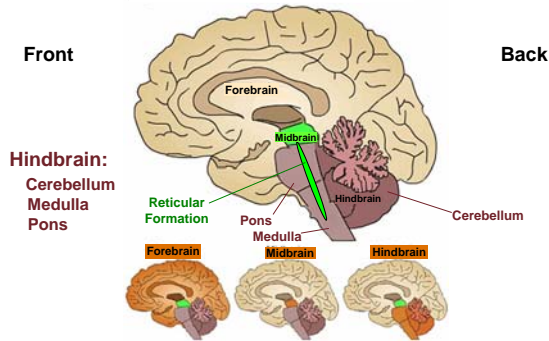
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### Forebrain, Midbrain and Hindbrain Overview




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### Major functions: Hindbrain

These structures operate largely outside of conscious awareness and are evolutionarily the oldest structures of the brain

➤ **Medulla:** respiration and heartbeat, reflexes

➤ **Pons:** sleep and wakefulness

➤ **Cerebellum:** coordinates movement, balance, posture, maintains equilibrium, involved in procedural memory

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### Midbrain

- > **Reticular formation** (reticular activating system): alertness, attention, screens irrelevant sensory input
- > **Superior Colliculus:** Involuntary eye movements
- > **Red nucleus and Substantia nigra:** Sensorimotor control

Psych 105 - Chapter 2: Biopsychology Modified from Pinel (2006), p 66. 10

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### Forebrain

- > **Cerebral Cortex**
- > **Subcortical Structures**
  - Thalamus
  - Hypothalamus
  - Limbic System (amygdala, hippocampus...)
  - Basal Ganglia
  - Corpus Callosum

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### Forebrain: subcortical structures

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### The Limbic "System"

➤ **Function:** regulation of emotional and motivated behavior

- The four Fs of motivated behavior: Fleeing, Feeding, Fighting and Mating
- Some major components:
  - **Amygdala:** Aggression, fear, rage
  - **Hippocampus:** formation of memories
  - Parts of **Hypothalamus**
  - Parts of **Thalamus?**

\*there is disagreement about components of limbic system, and whether it should be called a "system"

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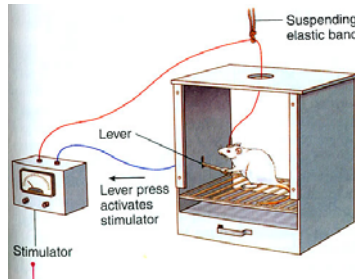
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### Electrical Stimulation of Hypothalamus: Control of Motivation



An electrode is placed in rat's hypothalamus. Rat presses lever to receive electrical stimulation – thousands of times per hour (Olds and Milner, 1954)

Move electrode, and pulse electrode: rat may drink or eat excessively, or refuse to eat, or refuse to drink, depending on its placement in hypothalamus

**FIGURE 15.7** A rat pressing a lever to obtain rewarding brain stimulation.

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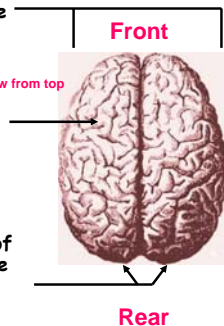
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### The Cerebrum: Higher Cognitive Functions

**Cerebrum** -  
Topmost layer of the brain; the bulbous cap over the limbic system

**Cerebral cortex** -  
Thin gray-matter covering of the cerebrum, wrinkled and folded; carries out perceiving, thinking and voluntary motor control

**Cerebral hemispheres** -  
The two walnut shaped halves of the cerebrum, connected by the *corpus callosum*




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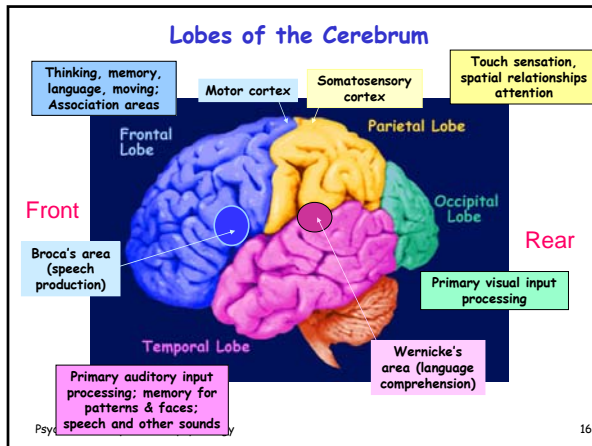
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### The Triune Brain Hypothesis (McClean)

*Older brain structures are overlaid with newer ones, but old structures and functions remain in place in mammals that evolved later*

**Evolution**

**Ancient**

Turtle

Rat

Cat

Human

**Recent**

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- **Reptilian brain** (primitive brain)
  - Drive vital functions, such as heart rate, breathing, digestion, movement
- **Limbic system** (old mammalian brain)
  - Adds emotions, complex motives, increased memory abilities
- **Cerebrum and Neocortex** (new mammalian brain)
  - Cerebrum and neocortex: Enables cognitive skills: perception, reasoning, planning, creating, problem solving, decision making, imagining, language

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### Localization and Distribution of Function

- **Localization of Function** - neurons with similar functions are grouped together
  - Stimulating one brain region can trigger a sensation, thought or behavior; stimulating a different brain region triggers a different sensation, thought or behavior
  - Examples:
    - *Broca's Area and Wernicke's Areas*: production of speech and understanding of speech
    - *Inferotemporal cortex* - pattern recognition, form perception, facial recognition
    - *Medial temporal cortex* - movement perception
    - *Motor cortex* - control of voluntary movement
- **Distribution of function** - many complex behaviors involve more than one area of the brain, often both halves of the brain

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### Summary - 1

- Body, behavior and mind are interdependent
- Nervous system is composed of neurons
- Neurons transmit information via electrical impulses
- Neural information is passed from one neuron to the next at the synapse, via neurotransmitters
- Neurotransmitters are vital to control of behavior, mood and experience
- The brain is composed of billions of neurons with trillions of connections among them
- The brain is organized into areas responsible for control of different functions, which are highly integrated with each other

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### Summary - 2

- The old brain is responsible for basic control of heart beat and respiration
- The limbic system is responsible for emotional and motivational control and homeostasis
- The cerebral cortex is responsible for sensory, motor, and higher cognitive functions such as language
- Much of the cortex is association cortex, which is responsible for things such as planning, judgment, and complex social and emotional understanding and response.

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### Summary - 3

- Plasticity of the brain - the ability to change and reorganize - enables us to respond to change throughout our lives
- One or the other half of the brain is (mostly) responsible for some brain functions (lateralization).
- The left side of the brain receives input from and controls the right side of the body, and vice versa (crossover of function).
- Splitting the brain results in dual consciousness but no change of personality or intellect

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Summary - 4

➤The endocrine system is a slower means of communication and control via hormones, and is largely controlled by the hypothalamus and pituitary in the brain.

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