Psychology 020-Chapter 3
Nervous System/Neurophysiology
Tues. Sept.25, 2007

- **Structure of the nervous system**

Central nervous system (CNS): brain and spinal cord (covered next lecture)
Peripheral nervous system: branches out from the CNS to all parts of the body
→ afferent pathways
Neurons that carry signal from the sensory receptor cell to the brain and spinal Cordially
→ efferent pathways
Neurons that carry messages from the brain and spinal cord to effectors cells in the muscles and glands
Somatic nervous system
→ Nerve fibers running to skeletal muscles
→ Control voluntary actions
Autonomic nervous system
→ Control muscles running to internal organs and glands
→ Involuntary (i.e. occurs automatically)
1.sympathetic division
- mobilizing the body's resources for action
- increase heart rate, blood pressure
- inhibits digestion
2.parasympathetic division
- dominates under conditions of relaxation
-conserve and replenish body' s energy
- decreases heart rate, and blood pressure

Biopsychology: deals with the *biological* bases of our thoughts, feelings, and behaviors

Studying the brain:
Neuropsychological tests: measures of verbal and non verbal behaviour that are known to be effected by brain damage.
Brain damage studies
→Animal studies-areas of the brain are damaged or surgically removed and evaluated effects
→Human studies-study effects if damage following accident, stroke
Stimulation techniques
Specific regions of the brain can be stimulated with tiny electrodes and mild electric current
Study effects of stimulation
Penfield (1960's)
Montreal neurosurgeon
-cortical mapping
Electrical recording (EEG) (Electroencephalogram)
Large electrodes placed on the scalp
Records patterns of functioning in various areas of the brain

Brain imaging

CT SCAN (computerized axial tomography)
X-rays of narrow slices of the brain
computer generates 3-d images based on these slices
useful for studying brain structure

PET SCAN(positron emission tomography)
Harmless radioactive glucose is injected
Active neurons consume glucose
Pet scan reads the amount of glucose consumed and generates images of patterns of Activity

MRI (magnetic resonance imaging)
Records how brain responds to a magnetic pulse delivered by a device
Useful for studying brain structure and the amount of chemicals (neurotransmitters) that are active in tissue

fMRI (functional magnetic resonance imaging)
Images of blood flow taken seconds apart
Allows live presentations of brain activity in response to various tasks
Allows for study of function, as opposed to structure (regular MRI)

Cutting edge technology and forensic psychology

Brain fingerprint technique- new brain imaging technology used to probe the memory centers of a criminal's mind

The procedure:
→When a crimes is committed a memory is formed of the event/crime scene
→ Evidence (picture/word) from the crime is presented and brain activity is recorded
→ Brain activity-differs if person has a memory of the event
*Research-judged to be 100%accurate
*More accurate than polygraph test

- **The neural base of behavior**

Types of cells in the brain:
→ GLIA-neural glue
-support cells: supply nutrients, clean up, repair
-constantly replacing themselves
-1 trillion Glia cells
→NEURON-information processing cells
~100 billion neurons in adult brain
~ less able than other cells to replaced themselves

Neurons:
→Soma - cell body
→Dendrites- receives signals
→Axon- transmits signals
→Synapse-tiny space between neurons

Neural impulse: electrochemical beginnings
The more an area is used, the more complex the branching. Less used regions may be overtaken.

Myelin sheath:
→Many axons are covered with a tube-like **Myelin sheath**- a fatty whitish insulation layer derived from glial cells
→Nodes of ranvier -intervals where the myelin is either thin or absent
Allows electrical conduction to skip from node to node (300 km/h)
→Grey matter-unmyelinated
→White matter-myelinated
cMultiple sclerosis- loss of myelination of neural pathways

Hodgkin and Huxley (1950's)

GIANT SQUID STUDIES : (Giant squids have huge axons, able to study even in 1950's)
- Fluids inside and outside of neuron
- Electrically charged particles (ions)
-Neuron at rest: negative charge inside compared to outside
-"Resting potential": -70 millivolts

Neural impulse: the action potential
-Stimulation causes cell membraned to open briefly
-Positively charted sodium ions flow in
-Shift in electrical charge travels along the neuron
-The action potential results with sufficient charge (up to -55 millivolts)

PROCESS OF NEURAL TRANMISSIONS
Graded potentials:
-Occur when the dendrites of a cell body are stimulated by the axons of another neuron
-Proportional to stimulation
-May cause partial depolarization, or if strong enough, may trigger an action potential
Action potentials (or nerve impulse): the sudden reversal of the membrane's voltage (inside momentarily move from -70 mv to +40 mv)
All-or nothing law: either an action potential occurs at maximum intensity or it does not occur at all – ANALOGY: Gun either fires or doesn't, depending on how far trigger is depressed.
Neurotransmitters: chemical messengers that diffuse across synapses and activate receptor sites on adjacent cells
→Excitatory
-Cause depolarization
- Cause inflow of sodium or other (+ions)
- "yes" vote
→Inhibitory
- Cause hyperpolarization
- (+ions) flow out and (-ions) flow in
- "no" vote

Thresholds: See diagrams.
Temporal Summation: activity summed over time
Spatial Summation: activity summed over space (different regions around the neuron)

→After an impulse passes any pint on the axon, the membrane isn't excitable and can't fire an action potential
- Refractory period-1/1000s (repolarization of the neuron)

How neurons communicate:
-Synaptic transmission
-Action potential travels down axon to terminals
-Stimulates release of neurotransmitter molecules
-Molecules travel across synapse to bind with receptor sites on dendrites of post – synaptic neuron

Neurotransmitters: (Lock and Key: specific transmitter only works with specific neuron)

a) monoamines-share similar chemical building blocks, important for regulating cognitive function, emotion, learning and movement
   1) dopamine-prominently in
      -frontal cortex, hypothalamus and limbic system (learning, memory, regulating emotion)
      -basal ganglia (regulates movement)
         -schizophrenia: excess dopamine
         - parkinson's disease: dopamine deficit
   2) norepinephrine-derived from epinephrine(adrenaline)
      - throughout brain and spinal Cordially,
      - higher in cortex and limbic system
      - Eating, sleeping, arousal, emotion
      - Depression
   3) serotonin
      -high in brain stem and thalamus
      -arousal-related activities and sleep
      - emotion control
      - depression
b) acetylcholine
   -brain and neuromuscular junctions
   -muscle movement, learning, and memory
   -snake bite paralysis => blocks acetylcholine sites
c) gaba(gamma-aminobutyric acid)
   -throughout brain and spinal Cordialy
   -emotion, anxiety and arousal
   -inhibitory transmitter
   -high anxiety can be treated with meds increasing GABA
d) endorphins
   - modulate pain and pleasure
   - regulate eating and drinking
   - produced naturally by brain during periods of stress and axiety
   -opiates (e.g.. heroin) fit into and stimulated body's endorphin neurotransmitter sites

Neural Coding: How does the brain integrate all this information?

Type of Information:

Neurons each have specialized function, and the brain sorts information based on activity of different activated neurons.

Strength/Intensity:

More intense stimuli evoke more (faster) action potentials in neurons. The brain interprets the strength of the information (e.g., something being more or less hot) by the speed of these potentials.

Putting it All together

- Neurons communicate with each other through neural impulses.
  - Graded impulses
  - Action potentials
  - Excitatory & inhibitory (both spatial and temporal summation)
- These inter neural messages are transmitted by neurotransmitters including:
  - Dopamine
  - Norepinephrine
  - Serotonin
  - Acetylcholine
  - GABA
  - Endorphins
- The brain integrates all of this information:
  - Specific neuron function (heat, cold, vision, etc.)
  - Intensity of neuron function