

Communication in the Nervous System

Key parts of the neuron

Soma: Cell body

Dendrites: Branching structures that receive signals from other cells

Axon: Fiber that carries signals away from soma to other cells

Myelin sheath: Insulating material that encases some axons

Terminal buttons: Small knobs at ends of axons that release neurotransmitters at synapses

The neural impulse

Resting potential: Neuron's stable, negative charge when inactive

Action potential: Voltage spike that travels along axon

Absolute refractory period: Brief time after action potential before another action potential can begin

All-or-none law: A neuron either fires or doesn't fire

Organization of the Nervous System

Central nervous system

Brain

Spinal cord

Peripheral nervous system

Somatic nervous system: Nerves to voluntary muscles, sensory receptors

Autonomic nervous system: Nerves to heart, blood vessels, smooth muscles, glands

Afferent
(incoming) nerves

Efferent
(outgoing) nerves

Sympathetic division: Mobilizes bodily resources

Parasympathetic division: Conserves bodily resources

Methods for study of brain function

EEGs monitor the electrical activity of the brain over time, yielding line tracings called brain waves.

Lesioning involves destroying a piece of the brain to learn about its function.

Electrical stimulation of the brain involves sending a weak current into a brain structure to activate it.

CT scans and **MRI scans** can provide precise images of brain structure.

PET scans can map chemical activity in the brain over time.

Brain and Behavior

Plasticity of the brain

The anatomical structure and functional organization of the brain is somewhat malleable.

Midbrain

Involved in locating things in space; dopamine synthesis

Forebrain

Thalamus:
Relay center for cortex; distributes incoming sensory signals, except smell

Cerebrum:
Handles complex mental activities, such as sensing, learning, thinking, planning

Limbic system:
Loosely connected network that contributes to emotion, memory, motivation

Hypothalamus:
Regulates basic biological needs, such as hunger, thirst, sex

Cerebellum:

Coordinates fine muscle movement, balance

Hindbrain

Pons: Involved in sleep and arousal

Medulla:
Regulates unconscious functions such as breathing and circulation

Prefrontal cortex: Involved in relational reasoning; working memory

Frontal lobes:
Primary motor cortex

Parietal lobes:
Primary somato-sensory cortex

Temporal lobes:
Primary auditory cortex

Hippocampus:
Contributes to memory

Amygdala:
Involved in learning of fear responses

Occipital lobes:
Primary visual cortex

Neurotransmitters and behavior

Acetylcholine: Released by neurons that control skeletal muscles

Serotonin: Involved in regulation of sleep; abnormal levels linked to depression and obsessive-compulsive disorder

Dopamine: Abnormal levels linked to schizophrenia; dopamine circuits activated by cocaine and amphetamines

Norepinephrine: Abnormal levels linked to depression; contributes to modulation of mood and arousal

GABA: Inhibitory transmitter that contributes to regulation of anxiety

Synaptic transmission

Synthesis and storage
of neurotransmitters in synaptic vesicles

Release of neurotransmitters into synaptic cleft

Binding of neurotransmitters at receptor sites lead to excitatory and inhibitory PSPs

Inactivation or removal (drifting away) of neurotransmitters

Reuptake of neurotransmitters by presynaptic neuron

Right Brain/Left Brain

Methods for study of lateralization

Split brain surgery: Bundle of fibers (corpus callosum) that connects two hemispheres is severed.

Perceptual asymmetries: Left-right imbalances in speed of processing are studied in normal subjects.

Left hemisphere
usually handles verbal processing, including language, speech, reading, writing

Right hemisphere
Usually handles nonverbal processing, including spatial, musical, and visual recognition tasks

Basic concepts

- **Chromosomes** are threadlike strands of DNA that carry genetic information.
- **Genes** are DNA segments that are the key functional units in hereditary transmission.
- Two genes in a specific pair may be *homozygous* (the same) or *heterozygous* (different).
- When paired genes are different, one may be *dominant* (expressed) and the other *recessive* (masked).
- **Genotype** refers to a person's genetic makeup, whereas **phenotype** refers to a person's observable characteristics.
- Most behavioral traits appear to involve *polygenic inheritance*.

Heredity and Behavior

Research methods

Family studies assess trait resemblance among blood relatives.

Twin studies compare trait resemblance of identical and fraternal twins.

Adoption studies compare adopted children to their adoptive parents and to their biological parents.

Genetic mapping determines the location and chemical sequence of specific genes, which can help to pinpoint links between particular genes and behavioral traits.

Endocrine System

- Consists of glands that secrete chemicals called hormones into the bloodstream

- Among other things, hormones regulate responses to stress, sexual development, insulin production, metabolic rate

Evolutionary Bases of Behavior

Darwin's insights

1. Organisms vary in endless ways.
2. Some traits are heritable.
3. Variations in hereditary traits might affect organisms' survival and reproductive success.
4. Heritable traits that provide a survival or reproductive advantage will become more prevalent over generations (natural selection will change the gene pool of the population).

Key concepts

Fitness refers to the reproductive success of an organism relative to the population.

Adaptations are inherited characteristics sculpted through natural selection because they helped solve a problem of survival or reproduction when they emerged.

Inclusive fitness is the sum of the individual's own reproductive success plus the reproductive success of related others.

Parental investment

- **Parental investment** refers to what each sex has to invest in time, energy, and risk to produce and nurture offspring.
- The sex that makes the smaller investment generally competes for mating opportunities with the sex that makes the larger investment, which, in turn, is more discriminating about sex.
- **Polygynous mating** tends to be found in a species when parental investment is high for females and low for males.

Key Themes

- Psychology is empirical.
- Heredity and environment jointly shape behavior.
- Behavior is determined by multiple causes.