Unit 1

Introduction To Brain & Human Behavior

LEARNING OUTCOME

At the end of this unit, you will be able to:

1. Describe the evolution of the scientific method
2. Describe the disciplines of neuroscience
3. Describe the nature of physiological psychology and the goals of research.
4. Describe the biological roots of physiological psychology.
5. Describe blindsight, the split brains, and unilateral neglect.
6. Describe the role of natural selection in the evolution of behavioral traits.
7. Discuss the evolution of the human species and a large brain.

“The more you use your brain, the more brain you will have to use.”
George A. Dorsey

“Brain: an apparatus with which we think we think.”
Ambrose Bierce

“If little else, the brain is an educational toy.”
Tom Robbins
INTRODUCTION

The human brain is packed solid with billions of nerve cells each communicating with over miles and miles of living wires (the nervous system) which operates the whole body.

The ancient wondered – why can a thought/an emotion be experienced but not seen or touched? They found that inanimate was attributable to a spirit of vital force that could be neither seen or understood (known as animism today).

People view themselves in the dualistic term, with mind traditionally seen as an entity distinct from the physical world of matter and governed by entirely separate sets of principles. The roots of dualisme are from the writings of the Greek philosopher Anaxagoras.

Plato elaborated on the concept, maintaining that the mind, or soul was the instrument with which knowledge is pursued – superior to the physical body & sense.

Monism is a belief that the world consists of matter and energy and that the mind is a phenomenon produced by the workings of the nervous system.

The field of biopsychology is relatively new; however, it is flourishing. This is partly because biopsychology relates to a number current neuroscience disciplines. Biopsychologists draw from:

- neuroanatomy — structure of the nervous system
- neurochemistry — chemistry of the nervous system
- neuroendocrinology — hormones and nervous system
- neuropathology — diseases of the nervous system
- neuropharmacology — drugs and the nervous system
- neurophysiology — electrical activity of the nervous system

The emphasis in biopsychology is upon the nervous system and behavior or cognition, whereas neuroscience emphasizes the nervous system in some specialized way.

1.1 EVOLUTION OF THE SCIENTIFIC METHOD

1.1.1 Schools of Psychology

Behaviorism (John Watson)

- Behaviorism, the school of psychology founded by John B. Watson, views observable, measurable behavior as the only appropriate subject matter for psychology. Behaviorism emphasizes the environment as the key determinant of behavior.
Structuralism (Wundt)

- Wilhelm Wundt and his student Edward Tichener are associated with the early school of thought known as structuralism, the view that the purpose of psychology is to identify the basic elements of conscious mental experience using the process of introspection.

Functionalism (James)

- The first American psychologist was William James. He was also the founder of functionalism, the view that behavior and mental processes must be studied as wholes. Functionalism is also concerned with how behavior and mental processes are used to adapt to the environment. He was greatly influenced by Darwin’s ideas.

Gestalt psychology (Wertheimer)

- Gestalt psychology, a forerunner of the cognitive school, emphasizes that the mind interprets information in terms of patterns rather than as individual bits of information. It goes by the philosophy that “The whole is greater than the sum of its parts”.

Psychodynamic theory (Freud)

- According to Freud’s theory of psychoanalysis, an individual’s thoughts, feelings, and behavior are determined primarily by the unconscious—the part of the mind that one cannot see and cannot control. The tension created by conflicts between these unconscious processes and the demands of society is the driving force behind individual development.

ACTIVITI 1.1

Revise your first year notes on the following theories.
(a) Explain the main ideas in behaviorism.
(b) Define structuralism and explain its role in the early development of psychology.
(c) Describe how Freud explain human behavior.
1.1.2 Scientific Method

Converging Operations

The use of multiple approaches to address a single question:

- Korsakoff’s syndrome – a condition characterized by severe memory loss and most commonly seen in alcoholics, Jimmie G. – an alcoholic with Korsakoff’s syndrome.
- Korsakoff’s is also seen in malnourished persons who had little or no alcohol.
- Thiamine-deficient rats exhibit memory deficits.
- Alcohol accelerates the development of brain-damage in thiamine-deficient rats.
- Korsakoff’s syndrome is the result of thiamine deficiency, but the damage is accelerated by alcohol.

By exploring the possible causes of Korsakoff’s using multiple approaches, converging operations, findings are more accurate.

Scientific Inference

- The empirical method that biopsychologists use to study the unobservable.
- Scientists measure what they can observe and use these measures as a basis for inferring what they cannot observe.

Critical Thinking

- The ability to evaluate scientific claims by identifying potential omissions or weaknesses in the evidence.
- **Morgan’s Canon** – when several explanations are possible, give precedence to the simplest one.
## DISCIPLINES OF NEUROSCIENCE

Seven disciplines in neuroscience are:

<table>
<thead>
<tr>
<th>DISCIPLINE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Neuroanatomy</td>
<td>The study of the structure of the nervous system</td>
</tr>
<tr>
<td>2. Neurochemistry</td>
<td>The study of chemical bases of neural activity</td>
</tr>
<tr>
<td>3. Neuroendocrinology</td>
<td>The study of interactions between the nervous system and the endocrine system</td>
</tr>
<tr>
<td>4. Neuropathology</td>
<td>The study of nervous system disorders</td>
</tr>
<tr>
<td>5. Neuropharmacology</td>
<td>The study of effects of drugs on neural activity</td>
</tr>
<tr>
<td>6. Neurophysiology</td>
<td>The study of functions and activities of the nervous system</td>
</tr>
<tr>
<td>7. Biopsychology</td>
<td>the scientific study of the biology of behavior.</td>
</tr>
</tbody>
</table>

### 1.2.1 Biopsychology

Biopsychology is also known as:
- Psychobiology,
- Behavioral biology,
- Behavioral neuroscience

Hebb (1949) proposed that psychological phenomena might be produced by brain activity. Biopsychology is an integrative discipline, knowledge from other disciplines of neuroscience is applied to the study of behavior.

Each discipline studies a different aspect of the nervous system that informs our understanding of what produces and controls behavior.

**Biopsychological Research**

**Human and nonhuman subjects:** Simpler brains makes it more likely that brain-behavior interactions will be revealed.
Comparative approach – gain insight by making comparisons with other species
Fewer ethical restrictions

**Divisions of Biopsychology**

Six major divisions are:

<table>
<thead>
<tr>
<th>DIVISION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Physiological psychology</strong></td>
<td>The study of neural mechanisms of behavior and direct manipulation of the brain</td>
</tr>
<tr>
<td>2. <strong>Psychopharmacology</strong></td>
<td>The study of effects of drugs on the brain</td>
</tr>
<tr>
<td>3. <strong>Neuropsychology</strong></td>
<td>The study of brain damage in humans</td>
</tr>
<tr>
<td>4. <strong>Psychophysiology</strong></td>
<td>The study of the relation between physiological activity and psychological processes.</td>
</tr>
<tr>
<td>5. <strong>Cognitive neuroscience</strong></td>
<td>The study of neural bases of cognition</td>
</tr>
<tr>
<td>6. <strong>Comparative psychology</strong></td>
<td>Comparing different species to understand evolution, genetics, and adaptiveness of behavior</td>
</tr>
</tbody>
</table>
Based on material in the textbook or any other knowledge you have about the brain and behavior, fill out the right-hand column, stating the relationship each neuroscience field has with biopsychology. The first answer is given.

**Neuroscience Field Relationship to Biopsychology**

<table>
<thead>
<tr>
<th>Neuroscience Field</th>
<th>Relationship to Biopsychology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Neuroanatomy</td>
<td>The structure of the brain is related to behavior. Examples include brain size and cognition (although not always proportional), cerebral convolutions and cognition, and areas of brain and cognition.</td>
</tr>
<tr>
<td>2. Neurochemistry</td>
<td></td>
</tr>
<tr>
<td>3. Neuroendocrinology</td>
<td></td>
</tr>
<tr>
<td>4. Neuropathology</td>
<td></td>
</tr>
<tr>
<td>5. Neuropharmacology</td>
<td></td>
</tr>
<tr>
<td>6. Neurophysiology</td>
<td></td>
</tr>
<tr>
<td>7. Neural cell biology</td>
<td></td>
</tr>
</tbody>
</table>
1.3 THE NATURE OF PHYSIOLOGICAL PSYCHOLOGY

Generalization is a type of scientific explanation; a general conclusion based on many observations of similar phenomena.

Reduction is a type of scientific explanation; a phenomena is described in terms of the more elementary processes that underlie it.

1.3.1 Understanding Human Consciousness

Blindsight is the ability of a person who cannot see objects in his or her blind field to accurately reach for them while remaining unconscious of perceiving them; caused by damage to the mammalian visual system of the brain.

Split Brains

![Figure 1.1: The split brain operation.](image)

A window has been opened in the side of the brain so that we can see the corpus callosum being cut at the midline of the brain.

The corpus callosum is the largest commissure of the brain; interconnecting the areas of the neocortex on each side of the brain. Epilepsy occurs when nerve cells in one side of the brain become overreactive, and the overreactivity is transmitted to the other side by the corpus callosum.

The split-brain procedure involves cutting the corpus callosum, a band of axons that interconnect the two hemispheres of brain. Split-brain operation is brain surgery that is occasionally performed to treat a form of epilepsy; the surgeon cuts the corpus callosum, which connects the two hemispheres. After the surgery, the two hemispheres are
disconnected and operate independently; their sensory mechanisms, memory and motor systems can no longer exchange information.

Under appropriate testing conditions, the different functions of the two hemispheres (language in the left, odor on the right) can be demonstrated in a split-brain patient.

Cerebral hemispheres are the two symmetrical halves of the brain; constitute the major part of the brain. They receive sensory information from the opposite sides of the body and control movement of the opposite sides.

Unilateral neglect is a syndrome in which people ignore objects located anywhere. Most often, it is caused by damage to the right parietal lobe.

1.3.2 Biological Roots of Physiological Psychology

The second section involves the understanding of physiological events that underlie our psychological existence. The biological roots of physiological psychology are traced back to the work of Descartes and Darwin.

The Pneuma Theory

The theory, which attributed the functions of mind to invisible spirits, emerged during the rise of Greek civilization.

- Hippocrates (5 century, B.C.) theorized that the brain was the controlling mechanism of all mental & emotional faculties.
- Galen, Greek physician (6 century) – suggested that the inability to vocalize is a proof of the relationship between the nervous system & behavior (based on research on a pig’s larynx).

Luigi Galvani, Italian physician (1790) – discovered that electric current applied to the muscle of a frog produce muscle movement. He correctly theorized that the nerves are capable of conducting electricity (identified that the nature of pneuma was a unique substances he called animal electricity).

Descartes & the brain

Descartes rejected the Greek notion that human fate is subject to the whim of invisible & unknowable force. He theorized that many behaviors formerly thought to be beyond the scope of conventional scientific investigation, eg. Basic sensory experiences, could be explained mechanistically, the same way you might explain the working of a complicated machine.

As Descartes observed, some movements of the human body were automatic and involuntary. He called these reflexes (from the Latin reflectre, “to bend back upon itself. A reflex is an automatic, stereotyped movement produced as the direct result of a stimulus. A Model is a mathematical or physical analogy for a physiological process; for example, computers have been used as models for various functions of the brain.

Johannes Muller was a forceful advocate of the application of experimental techniques to physiology. The Doctrine of specific nerve energies is based on Muller’s conclusion that
because all nerve fibers carry the same type of message, sensory information must be specified by the particular nerve fibers that are active.

Experimental ablation is the research method in which the function of a part of the brain is inferred by observing the behaviors an animal can no longer perform after that part of the brain is damaged. Through this method, Pierre Flourens, a nineteenth-century French physiologist claimed to have discovered the regions of the brain that control heart rate and breathing, purposeful movements and visual and auditory reflexes.

Paul Broca, a French Surgeon, applied the principle of experimental ablation to the human brain. Broca’s observation lead him to conclude that a portion of the brain of the cerebral cortex on the left side of the brain performs functions that are necessary for speech.

**Natural Selection and Evolution**

The human brain is perhaps one of the most exciting exhibits of evolution. Emphasize how evolution may explain many features of our brains. The following website is useful: Clues to the evolution of humans’ large brain by the Wellcome Trust:
http://www.wellcome.ac.uk/en/genome/genesandbody/hg07f008.html

**Functionalism and the Inheritance of Traits**

Functionalism is a belief that characteristics of living organisms perform useful functions. The principle holds that the best way to understand a biological phenomenon (a behavior or a physiological process) is to try to understand its useful functions for the organism.

Natural selection is the process by which inherited traits that confer a selective advantage (increase an animal’s likelihood to live and reproduce) become more prevalent in a population.

Mutation is an accidental change in the genetic information contained in the chromosomes of sperm or eggs, which can be passed on to an organism’s offspring; provides genetic variability.

Selective advantage is a characteristic of an organism that permits it to produce more than the average number of offspring of its species. The animal is more likely to live long enough to reproduce and hence to pass on its chromosomes to its own offspring.

**Evolution of the Human Species**

Evolution is a gradual change in the structure and physiology of a plant and animal species, generally producing more complex organisms, as a result of natural selection. New species evolve when organisms develop novel characteristics that can take advantage of unexploited opportunities in the environment.

**Evolution of Large Brains**

Human beings possessed several characteristics that enabled them to compete with other species, agile hands, excellent color vision, mastery of fire, their upright posture and bipedalism, and their linguistic abilities. All these characteristics required a large brain.
Neoteny is a slowing of the process of maturation, allowing more time for growth; an important factor in the development of large brains. The mature human head and brain retain some of their infantile characteristics including their disproportionate size.

**Evolution of the human brain**
- human brain—weighs 1,350 grams: less than whale or elephant brains at 5,000–8,000 grams
- no relationship between brain size and intelligence
- larger animals have larger brains—more tissue to control (e.g., male brains larger on average than female brains)
- brain size as a percentage of body weight NOT adequate (e.g., shrew has highest brain/body ratio, but NOT most intelligence)
- focus on cerebral hemispheres
- number of *convolutions*—folds in the cerebral surface—relate to greater surface area of cerebral cortex

**ACTIVITY 1.2**
(a) Explain the function of split brain operations.
(b) Explain natural selection. Discuss the evolution of the human brain.
SELF TEST

1. _______ is the belief that natural phenomena such as winds and tides are caused by spirits.
2. _______ is the belief that the mind and body are separate entities.
3. Transection of the _______ may be useful for reducing the symptoms of _______.
4. A reflex is considered to be a(n) _______ movement elicited by a(n) _______.
5. Galvani showed that _______ of a frog nerve caused _______ of the attached muscle.
6. Pierre Flourens is known _________________.
7. Experimental ablation involves _________________.
8. Mutations involve _________________.
9. _______ are physicians trained to diagnose and to treat central nervous system diseases.
10. Rene Descartes asserted that ___________________.
Suggested Text and References

Required Reading:


Suggested Readings


Suggested Web Sites

Wikipedia on *Biological Psychology*:

Brain and Behavior Course
[http://www.nyu.edu/classes/azmitia/lecture/](http://www.nyu.edu/classes/azmitia/lecture/)

Broca’s Classic Paper on Patient Tan
[http://www.yorku.ca/dept/psych/classics/Broca/perte-e.html](http://www.yorku.ca/dept/psych/classics/Broca/perte-e.html)

The Descent of Man by Charles Darwin

Split-Brain Syndrome
[http://www.uwm.edu/~johnchay/sb.htm](http://www.uwm.edu/~johnchay/sb.htm)

Founders of Neurology
[http://www.uic.edu/depts/mcne/homepage/neurofounders.html](http://www.uic.edu/depts/mcne/homepage/neurofounders.html)
Self-check

1. Animism
2. Dualism
3. corpus callosum; epilepsy
4. involuntary; external stimulus
5. electrical stimulation; contraction
6. for his development and use of the experimental ablation technique
7. the intentional damage to a portion of the brain.
8. accidental changes in the chromosomes.
9. Neurologists
10. the mechanical nature of animals is controlled by environmental stimuli.