Psychology

Introduction

Psychology is essentially the study of behavior. Behavior is rooted in many cognitive and physiological processes, and psychologists aim to understand these processes in order to solve real-world problems and make sense of our feelings and actions. Almost every aspect of the humanities and the sciences influences psychology in some way, and an understanding of psychology can be valuable in virtually any field, including business, medicine, law, education, and the arts.

A study of psychology begins with an understanding of several major ideas, each of which is covered in a chapter of this book. These major ideas include:

•	Genetics	•	The Brain
•	Development	•	Perception
•	Consciousness	•	Learning
•	Memory	•	Cognition
•	Intelligence	•	Emotion
•	Motivation	•	Personality
•	Stress	•	Psychological Disorders
•	Treatment	•	Social Psychology

Five Main Perspectives

All psychologists share a foundation of knowledge that is rooted in the work of early psychologists, such as Freud, Piaget, and Erikson. They also share a commitment to upholding ethical standards in their reserach as well as a belief in the scientific approach. However, psychologists may differ from one another in the kinds of questions they ask and how they view the data they find. Therefore, psychology can be divided into roughly five main perspectives: biological, learning, cognitive, sociocultural, and psychodynamic.

Biological Psychology

Biological psychologists are interested in the relationship between the body and the mind. They study the structure of the brain and the central nervous system, the parts of the brain and their specific functions, and the links between physical and emotional reactions to events. Biological psychology also focuses on biological processes such as hunger, thirst, and fatigue.

Learning Psychology

Learning is generally defined as a long-lasting change in the way a person or an animal acts or thinks that is attributable to experience. One of the most important concepts in learning psychology is conditioning, which is the way people associate events and outcomes. Learning psychologists study stimuli, reinforcement, and the connections between learning and behavior.

Cognitive Psychology

Cognitive psychology is the study of memory, perception, thought, and other mental processes. Cognitive psychologists are concerned with people's emotions, intelligence, motivations, and problem-solving skills. Any subject connected to knowledge, intellect, or the mind in general can fall into the realm of cognitive psychology.

Sociocultural Psychology

Sociocultural psychology concerns the ways that social environment and cultural beliefs shape our lives. Other people, cultural norms, and societal expectations all play a large role in how we act and think and what we consider "normal." Sociocultural psychologists study all aspects of society and culture, including authority, group dynamics, religious beliefs, gender roles and stereotypes, and the day-to-day things, such as food and work, that make up our lives.

Psychodynamic Psychology

Psychodynamic psychology is the study of unconscious desires and motives, those ideas and feelings that seem to motivate our actions without our being aware of it, including inner conflicts, instincts, and early memories. Psychodynamic psychology stems from psychoanalysis, a field of study that has its roots in the work of Sigmund Freud.

Psychologists who adhere to each of these schools of thought might not always answer questions the same way—their different approaches to psychology will often lead them to find different causes and explanations for behavior. Most psychologists rely on more than one perspective, but these core belief systems influence the way psychologists create, ask, and investigate questions about behavior and the brain.

Types of Psychologists

Psychologists practice and study psychology in many different ways, though all psychologists generally focus on research, practice, teaching, or a combination of the three. A Ph.D. is not required for many psychology careers, though many psychologists obtain one.

Clinical and Counseling Psychologists

Clinical and counseling psychologists work with adults or children either individually or in groups to help them deal with problems such as depression, anxiety, relationship troubles, or major mental illnesses. They may also be psychology professors or social workers.

Cognitive Psychologists

Cognitive psychologists are mostly interested in learning about perception, language, learning, and decision-making. Conducting research is often their primary work.

Developmental Psychologists

Developmental psychologists are sometimes described as studying people “womb to tomb.” They are interested in how people develop, grow, or change throughout the entire life span, from prenatal development to death. Developmental psychologists often specialize in one life stage, such as adolescence, or on changes that occur during life, such as changes in memory.

Experimental Psychologists

Experimental psychologists are deeply involved in scientific investigation and spend their careers gathering data about different psychological phenomena. Many experimental psychologists specialize in one particular area of research.

Industrial-Organizational (I/O) Psychologists

Industrial-organizational psychologists usually practice in the workplace and are concerned with employee productivity, management, hiring, and quality-of-life issues at work.

Neuropsychologists

Neuropsychologists study brain function. They are concerned with brain/behavior relationships, normal brain functioning, and the effects of accident or illness on the brain.

Quantitative Psychologists

Quantitative psychologists are experts in all of the methods and statistics of psychological research. They design and evaluate tests, experiments, and other psychological data.

This is by no means a comprehensive list of psychology occupations. Psychologists are employed in virtually every industry, and the study of psychology is not only the application of the scientific method to the investigation of problems but also a philosophy for understanding life itself.

I. Research Methods in Psychology

Psychologists do more than just wonder about human behavior: they conduct research to understand exactly why people think, feel, and behave the way they do. Like other scientists, psychologists use the scientific method, a standardized way to conduct research. A scientific approach is used in order to avoid bias or distortion of information. After collecting data, psychologists organize and analyze their observations, make inferences about the reliability and significance of their data, and develop testable hypotheses and theories.

Psychological research has an enormous impact on all facets of our lives, from how parents choose to discipline their children to how companies package and advertise their products to how governments choose to punish or rehabilitate criminals. Understanding how psychologists do research is vital to understanding psychology itself.

A) Psychological Research

Psychologists study a wide range of topics, such as language development in children and the effects of sensory deprivation on behavior. They use scientifically testable models and methods to conduct their research.

Describing Research

Scientists use the following terms to describe their research:

- **Variables:** the events, characteristics, behaviors, or conditions that researchers measure and study.
- **Subject** or **participant:** an individual person or animal a researcher studies.
- **Sample:** a collection of subjects researchers study. Researchers use samples because they cannot study the entire population.
- **Population:** the collection of people or animals from which researchers draw a sample. Researchers study the sample and generalize their results to the population.

The Purpose of Research

Psychologists have three main goals when doing research:

- To find ways to measure and describe behavior
- To understand why, when, and how events occur
- To apply this knowledge to solving real-world problems

B) The Scientific Method

Psychologists use the scientific method to conduct their research. The **scientific method** is a standardized way of making observations, gathering data, forming theories, testing predictions, and interpreting results.

Researchers make observations in order to describe and measure behavior. After observing certain events repeatedly, researchers come up with a theory that explains these observations. A **theory** is an explanation that organizes separate pieces of information in a coherent way. Researchers generally develop a theory only after they have collected a lot of evidence and made sure their research results can be reproduced by others.

Example:

A psychologist observes that some college sophomores date a lot, while others do not. He observes that some sophomores have blond hair, while others have brown hair. He also observes that in most sophomore couples at least one person has brown hair. In addition, he notices that most of his brown-haired friends date regularly, but his blond friends don't date much at all. He explains these observations by theorizing that brown-haired sophomores are more likely to date than those who have blond hair. Based on this theory, he develops a hypothesis that more brown-haired sophomores than blond sophomores will make dates with people they meet at a party. He then conducts an experiment to test his hypothesis. In his experiment, he has twenty people go to a party, ten with blond hair and ten with brown hair. He makes observations and gathers data by watching what happens at the party and counting how many people of each hair color actually make dates. If, contrary to his hypothesis, the blond-haired people make more dates, he'll have to think about why this occurred and revise his theory and hypothesis. If the data he collects from further experiments still do not support the hypothesis, he'll have to reject his theory.

Making Research Scientific

Psychological research, like research in other fields, must meet certain criteria in order to be considered scientific. Research must be:

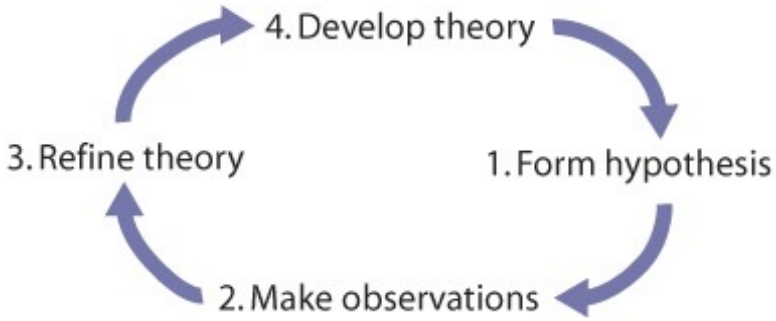
- Replicable
- Falsifiable
- Precise
- Parsimonious

Research Must Be Replicable

Research is **replicable** when others can repeat it and get the same results. When psychologists report what they have found through their research, they also describe in detail how they made their discoveries. This way, other psychologists can repeat the research to see if they can replicate the findings.

After psychologists do their research and make sure it's replicable, they develop a theory and translate the theory into a precise hypothesis. A **hypothesis** is a testable prediction of what will happen given a certain set of conditions. Psychologists test a hypothesis by using a specific research method, such as **naturalistic observation**, a**case study**, a **survey**, or an **experiment**. If the test does not confirm the hypothesis, the psychologist revises or rejects the original theory.

How Psychologists Do Scientific Research



A Good Theory

A good theory must do two things: organize many observations in a logical way and allow researchers to come up with clear predictions to check the theory.

Research Must Be Falsifiable

A good theory or hypothesis also must be **falsifiable**, which means that it must be stated in a way that makes it possible to reject it. In other words, we have to be able to prove a theory or hypothesis wrong. Theories and hypotheses need to be falsifiable because all researchers can succumb to the confirmation bias. Researchers who display **confirmation bias** look for and accept evidence that supports what they want to believe and ignore or reject evidence that refutes their beliefs.

Example:

Some people theorize that the Loch Ness Monster not only exists but has become intelligent enough to elude detection by hiding in undiscovered, undetectable, underwater caves. This theory is not falsifiable. Researchers can never find these undiscovered caves or the monster that supposedly hides in them, and they have no way to prove this theory wrong.

Research Must Be Precise

By stating hypotheses precisely, psychologists ensure that they can replicate their own and others' research. To make hypotheses more precise, psychologists use operational definitions to define the variables they study. **Operational definitions** state exactly how a variable will be measured.

Example:

A psychologist conducts an experiment to find out whether toddlers are happier in warm weather or cool weather. She needs to have an operational definition of happiness so that she can measure precisely how happy the toddlers are. She might operationally define happiness as "the number of smiles per hour."

Research Must Be Parsimonious

The **principle of parsimony**, also called **Occam's razor**, maintains that researchers should apply the simplest explanation possible to any set of observations. For instance, psychologists try to explain results by using well-accepted theories instead of elaborate new hypotheses. Parsimony prevents psychologists from inventing and pursuing outlandish theories.

Parsimony

Parsimonious means "being thrifty or stingy." A person who values parsimony will apply the thriftiest or most logically economical explanation for a set of phenomena.

Example:

Suppose a student consistently falls asleep in her statistics class. She theorizes that before each class, her statistics professor secretly sprays her seat with a nerve gas that makes her very drowsy. If she had applied the principle of parsimony, she would not have come up with this theory. She can account for her sleepiness with a much simpler and more likely explanation: she finds statistics boring.

C) Research Methods

Psychologists use many different methods for conducting research. Each method has advantages and disadvantages that make it suitable for certain situations and unsuitable for others.

Descriptive or Correlational Research Methods

Case studies, surveys, naturalistic observation, and laboratory observation are examples of **descriptive** or**correlational research methods**. Using these methods, researchers can describe different events, experiences, or behaviors and look for links between them. However, these methods do not enable researchers to determine causes of behavior.

Remember: **correlation is***not* **the same as causation**. Two factors may be related without one *causing* the other to occur. Often, a third factor explains the correlation.

Example:

A psychologist uses the survey method to study the relationship between balding and length of marriage. He finds that length of marriage correlates with baldness. However, he can't infer from this that being bald causes people to stay married longer. Instead, a third factor explains the correlation: both balding and long marriages are associated with old age.

Measuring Correlation

A **correlation coefficient** measures the strength of the relationship between two variables. A correlation coefficient is always a number between –1 and +1. The sign (+ or –) of a correlation coefficient indicates the nature of the relationship between the variables.

A **positive correlation** (+) means that as one variable increases, the other does too.

Example:

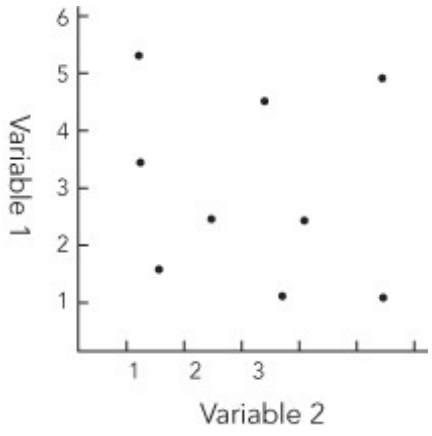
The more years of education a person receives, the higher his or her yearly income is.

A **negative correlation** (–) means that when one variable increases, the other one decreases.

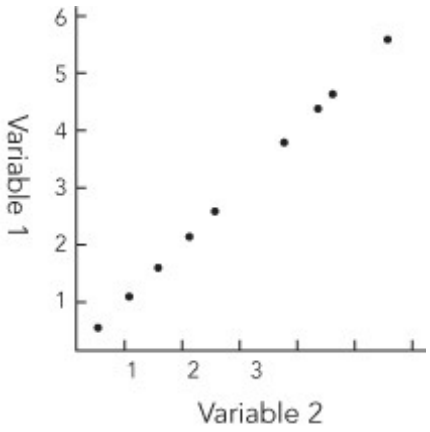
Example:

The more hours a high school student works during the week, the fewer A's he or she gets in class.

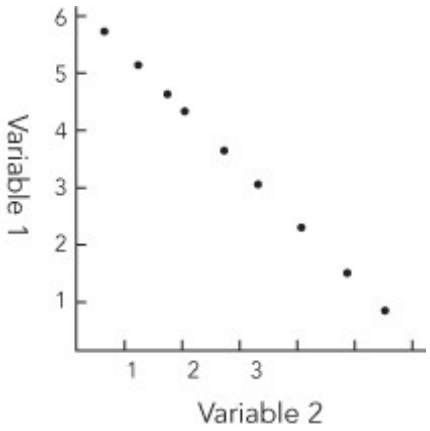
The higher the correlation coefficient, the stronger the correlation. A +0.9 or a –0.9 indicates a very strong correlation; a +0.1 or a –0.1 indicates a very weak correlation. A correlation of 0 means that no relationship exists between two variables.



No correlation
Correlation coefficient = 0



Perfect positive correlation
Correlation coefficient = +1



Perfect negative correlation
Correlation coefficient = –1

Common correlational research methods include case studies, surveys, naturalistic observation, and laboratory observation.

Case Studies

In a **case study**, a researcher studies a subject in depth. The researcher collects data about the subject through interviews, direct observation, psychological testing, or examination of documents and records about the subject.

Surveys

A **survey** is a way of getting information about a specific type of behavior, experience, or event. When using this method, researchers give people questionnaires or interview them to obtain information.

When subjects fill out surveys about themselves, the data is called **self-report data**. Self-report data can be misleading because subjects may do any of the following:

- Lie intentionally
- Give answers based on wishful thinking rather than the truth
- Fail to understand the questions the survey asks
- Forget parts of the experience they need to describe

Naturalistic Observation

When using naturalistic observation, researchers collect information about subjects by observing them unobtrusively, without interfering with them in any way. Researchers create a record of events and note relationships among those events. With naturalistic observation, researchers face the challenge of getting a clear view of events without becoming noticeable to the subjects.

Laboratory Observation

As the name implies, researchers perform **laboratory observation** in a laboratory rather than in a natural setting. In laboratory observation, researchers can use sophisticated equipment to measure and record subjects' behavior. They can use one-way mirrors or hidden recording devices to observe subjects more freely while remaining hidden themselves. Unlike observation in a natural setting, laboratory observation offers researchers some degree of control over the environment.

Psychological Tests

Researchers use **psychological tests** to collect information about personality traits, emotional states, aptitudes, interests, abilities, values, or behaviors. Researchers usually**standardize** these tests, which means they create uniform procedures for giving and scoring them. When scoring a test, researchers often compare subjects' scores to **norms**, which are established standards of performance on a test. A well-constructed standardized test can evaluate subjects better than self-report data.

Reliability

A test has good **reliability** if it produces the same result when researchers administer it to the same group of people at different times. Researchers determine a test's **test-retest reliability** by giving the test to a group of people and then giving the test again to the same group of people at a later time. A reliable test will produce approximately the same results on both occasions.

Psychologists also use **alternate-forms reliability** to determine a test's reliability. They measure alternate-forms reliability by giving one version of a test to a group of people and then giving another version of the same test to the same group of people. A reliable test will produce roughly the same results no matter which version of the test is used.

Validity

A test is **valid** if it actually measures the quality it claims to measure. There are two types of validity:

- **Content validity** is a test's ability to measure all the important aspects of the characteristic being measured. An intelligence test wouldn't have good content validity if it measured only verbal intelligence, since nonverbal intelligence is an important part of overall intelligence.
- **Criterion validity** is fulfilled when a test not only measures a trait but also predicts another criterion of that trait. For example, one criterion of scholastic aptitude is academic performance in college. A scholastic aptitude test would have good criterion validity if it could predict college grade point averages.

Overview of Research Methods

Research method	Advantages	Disadvantages
Survey	• Yields a lot of information • Provides a good way to generate hypotheses • Can provide information about many people since it's cheap and easy to do	• Provides information about behavior that can't be observed directly • Relies on self-report data, which can be misleading • Doesn't allow conclusions about cause-and-effect relationships
Case study	• Provides a good way to generate hypotheses • Yields data that other	• Sometimes gives incomplete information • Sometimes relies

	methods can't provide	only on self-report data, which can be misleading • Can be subjective and thus may yield biased results • Doesn't allow conclusions about cause-and-effect relationships
Naturalistic observation	• Can be useful for generating hypotheses • Provides information about behavior in the natural environment	• Sometimes yields biased results • May be difficult to do unobtrusively • Doesn't allow conclusions about cause-and-effect relationships
Laboratory observation	• Enables use of sophisticated equipment for measuring and recording behavior • Can be useful for generating hypotheses	• Sometimes yields biased results • Carries the risk that observed behavior is different from natural behavior • Doesn't allow conclusions about cause-and-effect relationships
Test	• Gives information about characteristics such as personality traits, emotional states, aptitudes, interests, abilities, values, and behaviors	• Requires good reliability and validity before it can be used • Doesn't allow conclusions about cause-and-effect relationships
Experiment	• Identifies cause-and-effect relationships • Distinguishes between placebo effects and real effects of a treatment or drug	• Can be artificial, so results may not generalize to real-world situations

Experiments

Unlike correlational research methods or psychological tests, **experiments** can provide information about cause-and-effect relationships between variables. In an experiment, a researcher manipulates or changes a particular variable under controlled conditions while observing resulting changes in another variable or variables. The researcher manipulates the **independent**

variable and observes the **dependent variable**. The dependent variable may be affected by changes in the independent variable. In other words, the dependent variable depends (or is thought to depend) on the independent variable.

Experimental and Control Groups

Typically, a researcher conducting an experiment divides subjects into an experimental group and a control group. The subjects in both groups receive the same treatment, with one important difference: the researcher manipulates one part of the treatment in the experimental group but does *not* manipulate it in the control group. The variable that is manipulated is the independent variable. The researcher can then compare the experimental group to the control group to find out whether the manipulation of the independent variable affected the dependent variable.

Often, subjects in the control group receive a placebo drug or treatment, while subjects in the experimental group receive the real drug or treatment. This helps researchers to figure out what causes the observed effect: the real drug or treatment, or the subjects' expectation that they will be affected.

Example:

Suppose a researcher wants to study the effect of drug A on subjects' alertness. He divides 100 subjects into two groups of 50, an experimental group and a control group. He dissolves drug A in saline solution and injects it into all the subjects in the experimental group. He then gives all the control group subjects an injection of only saline solution. The independent variable in this case is drug A, which he administers only to the experimental group. The control group receives a placebo: the injection of saline solution. The dependent variable is alertness, as measured by performance on a timed test. Any effect on alertness that appears only in the experimental group is caused by the drug. Any effect on alertness that appears in both the experimental and control groups could be due to the subjects' expectations or to extraneous variables, such as pain from the injection.

Extraneous Variables

Ideally, subjects in the experimental and control groups would be identical in every way except for the variables being studied. In practice, however, this would be possible only if researchers could clone people. So researchers try to make groups with subjects that

are similar in all respects that could potentially influence the dependent variable. Variables other than the independent variable that could affect the dependent variable are called **extraneous variables**.

One way to control extraneous variables is to use random assignment. When researchers use **random assignment**, they create experimental and control groups in a way that gives subjects an equal chance of being placed in either group. This guarantees the two groups' similarity.

Disadvantages of Experiments

The main disadvantage of experiments is that they usually don't fully reflect the real world. In an experiment, researchers try to control variables in order to show clear causal links. However, to exert control in this way, researchers must simplify an event or a situation, which often makes the situation artificial.

Another disadvantage of experiments is that they can't be used to study everything. Sometimes researchers can't control variables enough to use an experiment, or they find that doing an experiment would be unethical—that is, it would be painful or harmful in some way to the subjects being studied.

Bias in Research

Bias is the distortion of results by a variable. Common types of bias include sampling bias, subject bias, and experimenter bias.

Sampling Bias

Sampling bias occurs when the sample studied in an experiment does not correctly represent the population the researcher wants to draw conclusions about.

Example:

A psychologist wants to study the eating habits of a population of New Yorkers who have freckles and are between the ages of eighteen and forty-five. She can't possibly study all people with freckles in that age group, so she must study a sample of people with freckles. However, she can generalize her results to the whole population of people with freckles only if her sample is representative of the population. If her sample includes only white, dark-haired males who are college juniors, her results won't generalize well to the entire population she's studying. Her sample will reflect sampling bias.

Subject Bias

Research subjects' expectations can affect and change the subjects' behavior, resulting in **subject bias**. Such a bias can manifest itself in two ways:

- A**placebo effect** is the effect on a subject receiving a fake drug or treatment. Placebo effects occur when subjects believe they are getting a real drug or treatment even though they are not. A **single-blind** experiment is an experiment in which the subjects don't know whether they are receiving a real or fake drug or treatment. Single-blind experiments help to reduce placebo effects.
- The **social desirability bias** is the tendency of some research subjects to describe themselves in socially approved ways. It can affect self-report data or information people give about themselves in surveys.

Experimenter Bias

Experimenter bias occurs when researchers' preferences or expectations influence the outcome of their research. In these cases, researchers see what they want to see rather than what is actually there.

A method called the **double-blind** procedure can help experimenters prevent this bias from occurring. In a double-blind procedure, neither the experimenter nor the subject knows which subjects come from the experimental group and which come from the control group.

D) Ethical Considerations

In the past, researchers performed all kinds of questionable experiments in the name of science. For example, in one famous experiment, psychologist Stanley Milgram led his subjects to believe that they were giving painful electric shocks to other people. Many people consider this experiment unethical because it caused the subjects emotional discomfort. Today, researchers must abide by basic ethical norms when conducting research. Most important, they must consider whether they might harm their human or animal subjects while doing research.

Ethics

Ethics refers to a system of moral values or the way people distinguish right from wrong. The American Psychological Association (APA) requires all its members to adhere to its code of ethics, which applies to the treatment of both humans and animals.

Research with Human Subjects

Researchers must get informed consent from their subjects before beginning research. **Informed consent**means that subjects must know enough about the research to decide whether to participate, and they must agree to participate voluntarily. Furthermore, researchers have an ethical obligation to prevent physical and mental harm to their subjects. If there is any risk of harm, they must warn subjects in advance. Researchers also must allow subjects to withdraw from a study at any time if they wish to stop participating. Finally, researchers have an obligation to protect the anonymity of their subjects.

Some psychological research cannot be done when subjects are fully informed about the purpose of the research, because people sometimes behave differently when under observation. To study people's normal behavior, researchers sometimes have to deceive subjects. Deception is considered ethical only if:

- The study will give researchers some valuable insight
- It would be impossible to do the study without deception
- Subjects can learn the truth about the study's purpose and methods afterward

Research with Animal Subjects

Although most psychological research involves human subjects, some psychologists study animal subjects instead of or in addition to humans. Research with animal subjects has helped psychologists do the following:

- Learn facts about animal species
- Find ways to solve human problems
- Study issues that can't be studied using human subjects for practical or ethical reasons
- Refine theories about human behavior
- Improve human welfare

Many people question the ethics of animal research because it can involve procedures such as deprivation, pain, surgery, and euthanasia. Psychologists have ethical obligations to treat animal subjects humanely and to do research on animals only when the benefits of the research are clear.
People who are against animal research maintain three arguments:

- Animals should have the same rights as humans.
- Society should enact safeguards to protect the safety and welfare of animals.
- Researchers should not put the well-being of humans above the well-being of animals.

E) Interpreting Data

After psychologists develop a theory, form a hypothesis, make observations, and collect data, they end up with a lot of information, usually in the form of numerical data. The term**statistics** refers to the analysis and interpretation of this numerical data. Psychologists use statistics to organize, summarize, and interpret the information they collect.

Descriptive Statistics

To organize and summarize their data, researchers need numbers to describe what happened. These numbers are called **descriptive statistics**. Researchers may use **histograms** or **bar graphs** to show the way data are distributed. Presenting data this way makes it easy to compare results, see trends in data, and evaluate results quickly.

Example:

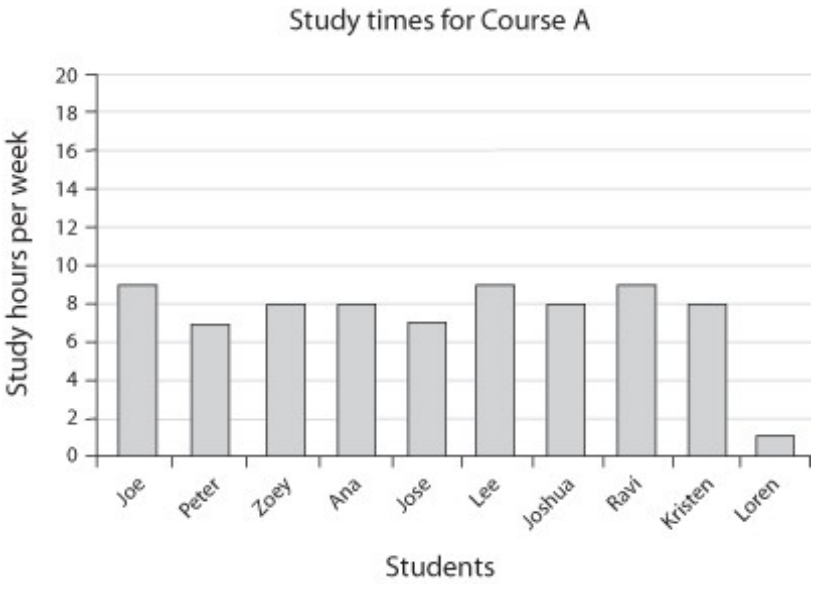
Suppose a researcher wants to find out how many hours students study for three different courses. Each course has 100 students. The researcher does a survey of ten students in each of the courses. On the survey, he asks the students to write down the number of hours per week they spend studying for that course. The data look like this:

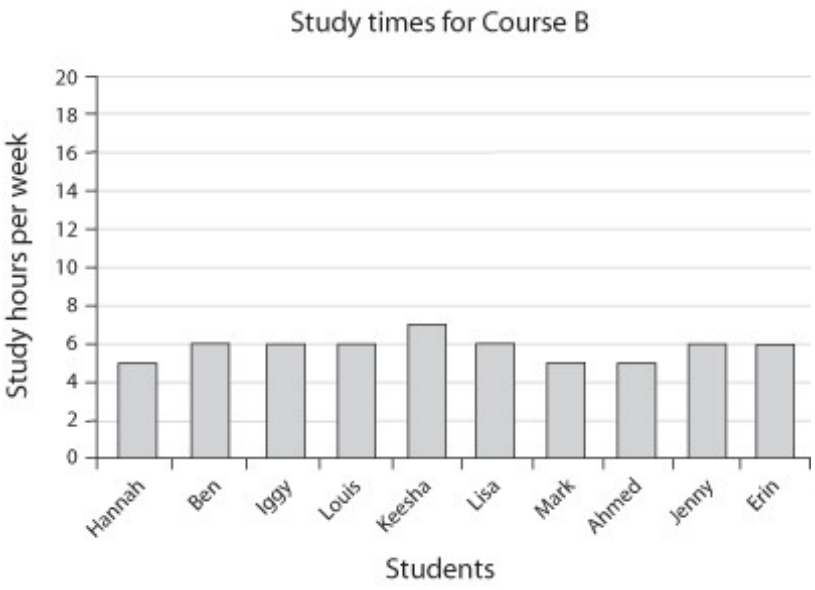
Hours of Study per Week

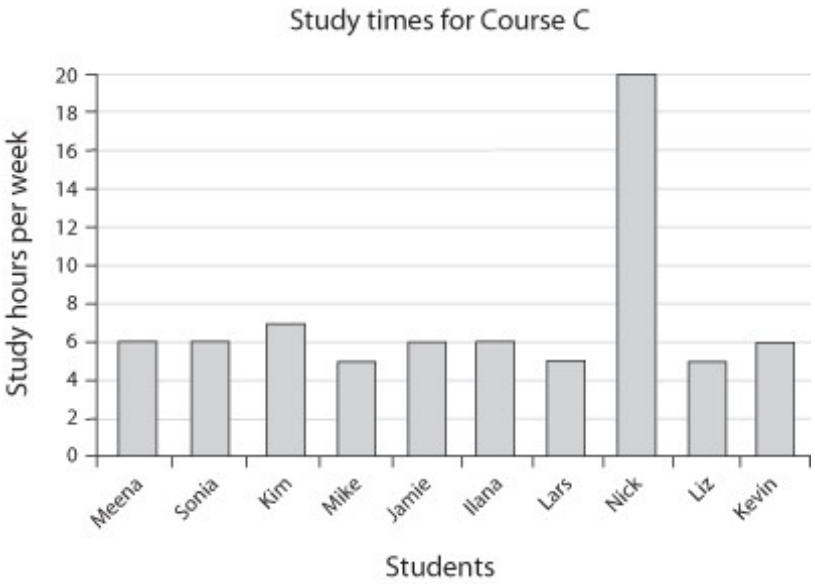
Course A		**Course B**		**Course C**	
Student	Hours per week	Student	Hours per week	Student	Hours per week

Joe	9	Hannah	5	Meena	6
Peter	7	Ben	6	Sonia	6
Zoey	8	Iggy	6	Kim	7
Ana	8	Louis	6	Mike	5
Jose	7	Keesha	7	Jamie	6
Lee	9	Lisa	6	Ilana	6
Joshua	8	Mark	5	Lars	5
Ravi	9	Ahmed	5	Nick	20
Kristen	8	Jenny	6	Liz	5
Loren	1	Erin	6	Kevin	6

To get a better sense of what these data mean, the researcher can plot them on a bar graph. Histograms or bar graphs for the three courses might look like this:







Measuring Central Tendency

Researchers summarize their data by calculating **measures of central tendency**, such as the mean, the median, and the mode. The most commonly used measure of central tendency is the **mean**, which is the arithmetic average of the scores. The mean is calculated by adding up all the scores and dividing the sum by the number of scores.

However, the mean is not a good summary method to use when the data include a few extremely high or extremely low scores. A distribution with a few very high scores is called a **positively skewed distribution**. A distribution with a few very low scores is called a **negatively skewed distribution**. The mean of a positively skewed distribution will be deceptively high, and the mean of a negatively skewed distribution will be deceptively low. When working with a skewed distribution, the median is a better measure of central tendency. The **median** is the middle score when all the scores are arranged in order from lowest to highest.

Another measure of central tendency is the mode. The **mode** is the most frequently occurring score in a distribution.

Statistics

Statistics is a branch of mathematics. Psychologists need a solid foundation in math to describe, analyze, and summarize the results of their research.

Measuring Variation

Measures of variation tell researchers how much the scores in a distribution differ. Examples of measures of variation include the range and the standard deviation. The**range** is the difference between the highest and the lowest scores in the distribution. Researchers calculate the range by subtracting the lowest score from the highest score. The**standard deviation**provides more information about the amount of variation in scores. It tells a researcher the degree to which scores vary around the mean of the data.

Inferential Statistics

After analyzing statistics, researchers make inferences about how reliable and significant their data are.

Example:

The researcher's survey of the students in three classes showed differences in how long the students studied for each course. The mean number of hours for students in Course A was about eight hours, and for students in Courses B and C, the average was about six hours. Does this mean Course A requires the most hours of study? Were the differences the researcher observed in study time real or just due to chance? In other words, can he generalize from the samples of students he surveyed to the whole population of students? He needs to determine the reliability and significance of his statistics.

If researchers want to generalize confidently from a sample, the sample must fulfill two criteria:

- It must be large and varied enough to be representative.
- It must not have much variation in scores.

Researchers can use **inferential statistics** to figure out the likelihood that an observed difference was just due to chance. If it's unlikely that the difference was due to chance, then the observed difference could be considered statistically significant. Psychologists usually consider a result to be **statistically significant** if such a result occurs just by chance 5 or fewer times out of every 100 times a study is done. They call this statistical significance at the $p \leq .05$ level (p less than or equal to point oh-five).

However, statistical significance alone does not make a finding important. Statistical significance simply means that a result is probably not due to chance.

II. Evolution and Genes

Which has the greater effect on human behavior: nature or nurture? Hair color, height, and many other physical characteristics depend on genes, or nature, but the origin of behavior, intelligence, and personality is not so clear. Most scientists agree that both genes and the environment play a role in behavioral development, but disputes still rage over the degree of influence exerted by each.

A branch of psychology known as behavior genetics examines the genetic base of behavioral and personality differences among people. Behavior genetics is a controversial field, since misuse of psychological research into the genetic roots of behavior can have horrifying results. Several generations ago, psychologists and other scientists used arguments about the genetic influence on behavior and intelligence to support racist theories about the superiority of Anglo Americans. Moreover, these theories often became the foundation of public policies that discriminated against African Americans and Native Americans. Today, behavior geneticists carefully consider the potential political repercussions of their work.

A) Principles of Genetics

Behavior genetics is a branch of psychology that examines the genetic base of behavior and personality differences among people. An understanding of genetics begins with the following basic concepts:

- A vast number of cells make up the human body. Each cell has forty-six chromosomes, which come in twenty-three pairs. The only exceptions are sex cells.
- Sex cells are sperm in males and eggs in females. Each sex cell has only twenty-three chromosomes.
- **Chromosomes** are made up of thin strands of deoxyribonucleic acid (DNA). Each chromosome pair contains thousands of genes.
- **Genes** are segments of DNA that function as hereditary units. Genes are carried on chromosomes.
- DNA is made up of units called **nucleotides**. There are only four different nucleotides, labeled A, C, G, and T. Long strings of nucleotides make up genes.
- Genes get translated into proteins, which carry out various functions in our bodies. For instance, some proteins serve as the building blocks of cells. Other proteins function as enzymes or hormones.

Who Shares Genes?

No two people share the exact combination of genes unless they are identical twins. However, all family members share some genes with one another. The closer the biological relationship between individuals, the more genes they share. The chart below shows the percentage of genes any person shares with his or her close relatives:

Percentage of Shared Genes

Identical twin	100 percent
Parent	50 percent
Brother or sister	50 percent
Nonidentical twin	50 percent
Grandparent	25 percent

Monogenic and Polygenic Traits

Some characteristics or traits are controlled by a single gene, which means they are**monogenic**. A single gene, for example, can be part of what brings about alcoholism or schizophrenia.

Most traits are controlled by the actions of several genes, which means they are**polygenic**. For example, a person's intelligence is linked to the combination of several genes.

The environment also shapes traits, and later in this chapter we will discuss how genes interact with the environment to produce psychological traits.

Heritability

In a group of people, a particular psychological trait, such as intelligence, usually varies a lot. Differences in groups may be due to genes or the environment, and researchers use a statistic called heritability to see which has the largest influence. **Heritability** is a mathematical estimate that indicates how much of a trait's variation can be attributed to genes. There are three important principles of heritability:

- Heritability estimates don't reveal anything about how much genes influence a person's traits. These figures tell us only to what extent trait differences between people can be attributed to genes.
- Heritability depends on the similarity of the environment for a group of people. In a group of people who share similar environments, heritability of a particular trait may be high. However, that same trait may have low heritability in a group of people who operate in different environments.
- Even if a trait is highly heritable, it can still be influenced by environmental factors.

Example:

Imagine that ten people live in identical environments. Somehow, they experienced identical prenatal environments while in their mothers' wombs, were raised in identical homes by parents who were identical in every way, and had all the same childhood and adulthood experiences. Suppose that these ten people turn out to be different with respect to one trait, such as the rate at which they can wiggle their ears. Since both genes and environment can influence traits, these differences would have to be genetic, since they could not be due to differences in environment. In such a case, heritability of the ear-wiggling trait would be close to 100 percent. Now suppose some of these ten people enter different ear-wiggle training camps. The camps vary in effectiveness, so the subjects in some camps increase their ear-wiggling rates, while other subjects remain the same. After the camp training, environment would account for some of the differences among the ten people in ear-wiggling ability. A smaller proportion of the differences would be due to genes alone. Therefore, heritability would be lower.

B) Types of Genetic Studies

Researchers do different kinds of studies to see whether and to what extent a characteristic might be genetically transmitted.

Family Studies

In **family studies**, researchers look at similarities among members of a family with respect to a particular trait. If the trait is genetically inherited, it should be similar in blood relatives. The closer the blood relationship, the more similar people should be.

Family studies alone don't reveal whether a trait is genetically inherited. A family shares genes, but they also share similar environments. When researchers find trait similarity in a family study, their findings may suggest that the trait is genetically inherited, but the study can't prove it.

Twin Studies

Compared to family studies, **twin studies** give researchers more solid evidence about whether a trait is inherited. In twin studies, researchers compare pairs of identical twins to fraternal, or nonidentical, twins. When doing these studies, researchers assume that identical twin pairs share the same environment, just as fraternal twin pairs do. However, identical twins share all of their genes with each other, while fraternal twins share only half of their genes. When a trait shows more similarity between identical twins than between fraternal twins, the greater similarity probably comes from shared genes, not shared environment.

One problem with this type of study is that identical twins may not in fact share an identical environment while fraternal twins do. People tend to treat identical twins in unusual ways. For example, people may treat identical twins as if they are similar in every respect, or they might focus intensely on differences between them.

Studies of Separated Twins

In order to avoid uncertain environmental factors, researchers sometimes study separated twins. Twins who are separated when they are very young and brought up in different families have different environmental influences but identical genes. Trait similarities between separated twins result mostly from genes.

However, separated twin studies can also be problematic. The environments of separated twins may not actually be that different from each other for the following reasons:

- The twins shared a similar prenatal environment before they were born.
- Adoption agencies may tend to place twins in similar households.
- Since they are similar in appearance and in genetically inherited abilities, the twins may evoke similar responses from people around them.

As in other types of studies, trait similarities in separated twins may be due to both similar genes and similar environments.

Experiences and Behavior

Experiences affect behavior partly because environmental stimulation forms and maintains neural connections. For example, psychological research shows that babies need consistent, loving contact with a caregiver in order to achieve optimal brain development. Neglected babies, lacking attention and physical contact, experience unpleasant emotions that are not simply transitory. Their experiences determine the development of their neural connections. Similarly, soldiers on active combat duty can suffer mental damage from the continuously stressful environment, even if they never experience physical injury.

Adoption Studies

In **adoption studies**, researchers compare adopted children to their biological parents and to their adoptive parents. Adopted children share more genes with their biological parents. The children's living environments, however, more closely resemble the environments of their adoptive parents. When adoptive children resemble their biological parents more than their adoptive parents with respect to a certain trait, researchers can hypothesize that the trait has a genetic basis.

Interaction of Genes and Environment

In conducting all these types of studies, researchers have found that while genes influence psychological traits, they don't act alone. Highly influential environmental factors also play a major role. These factors include:

- Prenatal influences
- Child-rearing and other parental influences
- Nutrition
- Experiences throughout life

- Peer influences
- Culture

Cultural Norms

Cultural norms are sets of societal expectations that influence behavior. Norms tell us what kinds of behavior are appropriate. For example, in the United States, one cultural norm mandates that children be potty-trained by their third birthday. Parents of children who aren't potty-trained by that point may start to feel worry, shame, and social pressure as their child's third birthday passes.

Genes and environment interact in complex ways. People usually inherit a vulnerability or predisposition to having a particular psychological trait, and the environment in which those people live shapes the development of that trait. The opposite is also true: people's psychological traits influence their environments. People don't just live in environments—they also shape their worlds by exerting their traits.

Example:

Suppose there are two nonidentical twins, Ben and Tom. Ben is calm by nature, while Tom has always been fussy. Mom and Dad will be more taxed by Tom, so they may be less responsive and patient with him than they are with Ben. Therefore, Tom and Ben experience different parental influences, which may make Tom less trusting than Ben as they grow up. Genes and environment influence Tom's personality, but the interaction between genes and environment also plays a role.

C) Evolution and Natural Selection

Evolution is a change in the frequency of genes in a population over time. Evolutionary psychologists try to explain universal behaviors. They study how natural selection has encouraged certain behavior patterns to develop.

The Theory of Natural Selection

Charles Darwin (1809–1882) was a British naturalist who is best known for his contributions to evolutionary theory. Although others had noted that species evolved over time, Darwin first put forward the **theory of natural selection** to explain the process of evolution.

According to this theory, certain inherited characteristics give an organism a survival or reproductive advantage. Organisms pass on these characteristics more often than they pass on other inherited traits.

Example:

The species of primates called mandrills have evolved to have bright blue rear ends, because brightly colored rumps help them attract mates and give them a reproductive advantage. Porcupines evolved to have quills, because quills help them to avoid predators and reproduce. This gives porcupines a survival advantage.

On the Origin of Species

In 1831, Darwin joined a naval expedition on a ship called the HMS Beagle as the unofficial naturalist onboard. Darwin collected many specimens during the ship's five-year expedition around the world. After returning to England, he began developing his ideas about evolution. In 1859, Darwin published his great work, On the Origin of Species.

A characteristic that gives a **reproductive advantage** helps an organism to mate successfully and pass on its genes to the next generation. A characteristic that gives a**survival advantage** helps an organism to live long enough to reproduce and pass on its genes.

Reproduction of the Fittest

People often use the phrase "survival of the fittest" instead of "reproduction of the fittest," but according to evolutionary theory, survival alone isn't enough. Creatures need to survive long enough to reproduce. Reproductive success is measured by how many offspring a creature produces.

Inclusive Fitness

Another concept related to reproductive success is inclusive fitness, described by W. D. Hamilton in the 1960s. **Inclusive fitness** is the reproductive fitness of an individual organism plus any effect the organism has on increasing reproductive fitness in related organisms. Some researchers believe that the concept of inclusive fitness explains why certain organisms sacrifice themselves to save others in the species. According to this theory, people might risk their lives to save their children or close relatives, but not to save distant relatives or unrelated people. Because people share more genes with close relatives, saving them has more payoff in terms of passing on genes to the next generation.

Adaptations

An **adaptation** is an inherited characteristic that becomes prevalent in a population because it provides a survival or reproductive advantage. Because evolution occurs over a long period, an adaptation can remain in a population even after it has stopped being useful.

Example:

Human beings have a genetic preference for fatty foods, which explains why fried chicken, french fries, and buttery popcorn are so popular. Evolutionary psychologists say that the preference for fatty foods derives from the days when people hunted and gathered and food was scarce. Eating high-fat foods was important because fat gave people the calories they needed. In other words, the preference for fat was adaptive. Today, in wealthy countries with abundant food and sedentary lifestyles, the preference for fat remains, despite the fact that it no longer has beneficial effects. In fact, consuming fatty foods can lead to health problems.

Mutations

Evolution relies on **mutations**, or small changes in genes. Mutations happen because of two events that can occur during the formation of egg and sperm cells:

- An error during copying of DNA
- Random rearrangement of small pieces of DNA in a chromosome pair

Sometimes, a mutation results in a new trait. If the individual with the mutation reproduces successfully, the mutation will be passed on. If the new trait proves advantageous, the mutated gene that caused the trait will increase in the population over a long period and thus propel evolution.

D) Evolutionary Psychology

Evolutionary psychology uses evolutionary theory to explain similarities in psychological characteristics. According to evolutionary psychologists, patterns of behavior have evolved through natural selection, in the same way that physical characteristics have evolved. Because of natural selection, **adaptive behaviors**, or behaviors that increase reproductive success, are kept and passed on from one generation to the next.

Mating Behavior

Because reproductive success is such a hot topic in evolutionary theory, evolutionary psychologists often choose to study mating behavior. Researchers such as Robert Trivers have proposed that mating strategies depend on the amount of parental investment made by males and females of a species.**Parental investment** refers to all the resources spent to produce and raise offspring.In many species, males and females don't make equal parental investments. The sex that invests less competes with others of its sex to mate with the sex that invests more. The sex that invests more in parenting tends to discriminate more when selecting a mate.

Sexual Selection

Usually, the female of the species invests more in parenting. Females of many species choose their mates based on certain characteristics, such as large canine teeth in a male baboon or flashy tail feathers on a peacock, which in turn means those traits will be passed on to their male offspring. Biologists call this process **sexual selection**, which is related to natural selection. Whereas natural selection results in adaptations that make organisms more likely to survive, sexual selection just makes them more likely to mate. Sometimes the adaptations that are a result of sexual selection, such as flashy tail feathers, are not actually much help in terms of survival.

Polygyny

A situation called **polygyny** arises when a single male mates with many different females. Polygyny tends to occur in certain animal species, notably those in which females invest more in parenting than males. In a polygynous mating system, males compete with other males in order to get access to females. Females tend to pick the winners of such competitions. Picking winners helps to ensure that their offspring will have good genes.

Example:

Mountain gorillas are polygynous. The females and children live in groups defended by a mature male, with whom they mate. If they choose, however, females may select a stronger, more desirable mate. In such a case, the hopeful suitor would challenge the dominant male and the females would choose the winner.

Problems with Evolutionary Explanations

Scientists have used evolutionary theory to explain human behavior patterns, such as a female tendency toward monogamy and a male tendency toward promiscuity. However, other researchers argue that such explanations don't apply well to humans, because the theories stem from stereotypes. Humans behave in complex and variable ways, and factors such as culture strongly influence this behavior. Furthermore, it is difficult to tie variation in behavior to variation in reproductive success. Evolutionary explanations also raise controversy because people can use them to support various social and political agendas.

Some researchers criticize evolutionary explanations because anyone can work backward from an observation to develop an evolutionary explanation. These psychologists point out that the fact that a trait exists does not necessarily mean that trait is adaptive. The trait may have been helpful earlier in our human history but did not remain adaptive, or the trait could be a side effect of another adaptive trait.

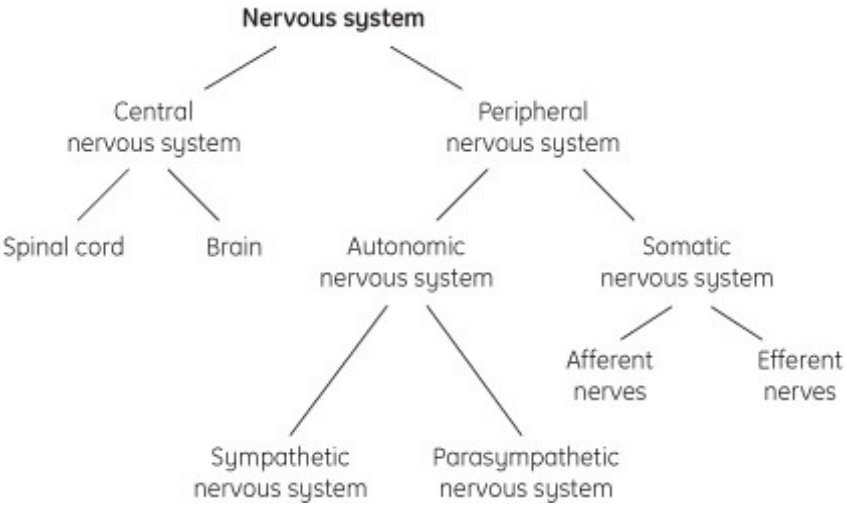
III. Neurons, Hormones, and the Brain

The brain is an essential part of the nervous system, a complex, highly coordinated network of tissues that communicate via electrochemical signals. We use our brains in virtually everything we do, from keeping our heart beating to deducing the existence of black holes. Within our brains lie our deepest secrets, our earliest memories, our most amazing capabilities, and the keys to the mystery of consciousness itself.

Hippocrates (460–377 B.C.), the most famous physician of the ancient world, first theorized that our thoughts, feelings, and ideas came from the brain, while others at the time thought the heart and stomach were the seats of emotion. Today, researchers are paying more attention to the roles played by the brain and the hormones that affect it in experiences such as mother-infant bonding, religious ecstasy and prayer, extreme stress, and meditation. Researchers now realize that though our minds and brains may not be exactly the same thing, they are intimately connected.

A) The Nervous System

The **nervous system** is a complex, highly coordinated network of tissues that communicate via electro chemical signals. It is responsible for receiving and processing information in the body and is divided into two main branches: the central nervous system and the peripheral nervous system.



The Central Nervous System

The **central nervous system**receives and processes information from the senses. The brain and the spinal cord make up the central nervous system. Both organs lie in a fluid called the **cerebrospinal fluid**, which cushions and nourishes the brain. The**blood-brain barrier** protects the cerebrospinal fluid by blocking many drugs and toxins. This barrier is a membrane that lets some substances from the blood into the brain but keeps out others.

The **spinal cord** connects the brain to the rest of the body. It runs from the brain down to the small of the back and is responsible for **spinal reflexes**, which are automatic behaviors that require no input from the brain. The spinal cord also sends messages from the brain to the other parts of the body and from those parts back to the brain.

The **brain** is the main organ in the nervous system. It integrates information from the senses and coordinates the body's activities. It allows people to remember their childhoods, plan the future, create term papers and works of art, talk to friends, and have bizarre dreams. Different parts of the brain do different things.

Damage to the Spinal Cord

The spinal cord is what connects the brain and body, and it is protected by the bones in the spinal column. Injuries to the spinal cord can cause serious problems, such as paralysis. Even relatively minor damage to the spinal cord can cause loss of feeling in parts of the body, impaired organ function, and loss of muscular control. Though spinal cord injuries are usually permanent, current research into regenerated axons and stem cells offers hope that one day these injuries may be treated successfully.

The Peripheral Nervous System

All the parts of the nervous system except the brain and the spinal cord belong to the **peripheral nervous system**. The peripheral nervous system has two parts: the somatic nervous system and the autonomic nervous system.

The Somatic Nervous System

The **somatic nervous system** consists of nerves that connect the central nervous system to voluntary skeletal muscles and sense organs. Voluntary skeletal muscles are muscles that help us to move around. There are two types of nerves in the somatic nervous system:

- **Afferent nerves** carry information from the muscles and sense organs to the central nervous system.
- **Efferent nerves** carry information from the central nervous system to the muscles and sense organs.

The Autonomic Nervous System

The **autonomic nervous system** consists of nerves that connect the central nervous system to the heart, blood vessels, glands, and smooth muscles. **Smooth muscles**are involuntary muscles that help organs such as the stomach and bladder carry out their functions. The autonomic nervous system controls all the automatic functions in the body, including breathing, digestion, sweating, and heartbeat. The autonomic nervous system is divided into the sympathetic and parasympathetic nervous systems.

- The **sympathetic nervous system** gets the body ready for emergency action. It is involved in the fight-or-flight response, which is the sudden reaction to stressful or threatening situations. The sympathetic nervous system prepares the body to meet a challenge. It slows down digestive processes, draws blood away from the skin to the skeletal muscles, and activates the release of hormones so the body can act quickly.
- The **parasympathetic nervous system** becomes active during states of relaxation. It helps the body to conserve and store energy. It slows heartbeat, decreases blood pressure, and promotes the digestive process.

Crisis Mode

The sympathetic nervous system's activation may manifest as a rapidly thumping heart, sweaty palms, pale skin, or panting breath—the kinds of things we experience during a crisis. We may experience these kinds of symptoms during a panic attack, for example.

B) Neurons: Cells of the Nervous System

There are two kinds of cells in the nervous system: glial cells and neurons. **Glial cells**, which make up the support structure of the nervous system, perform four functions:

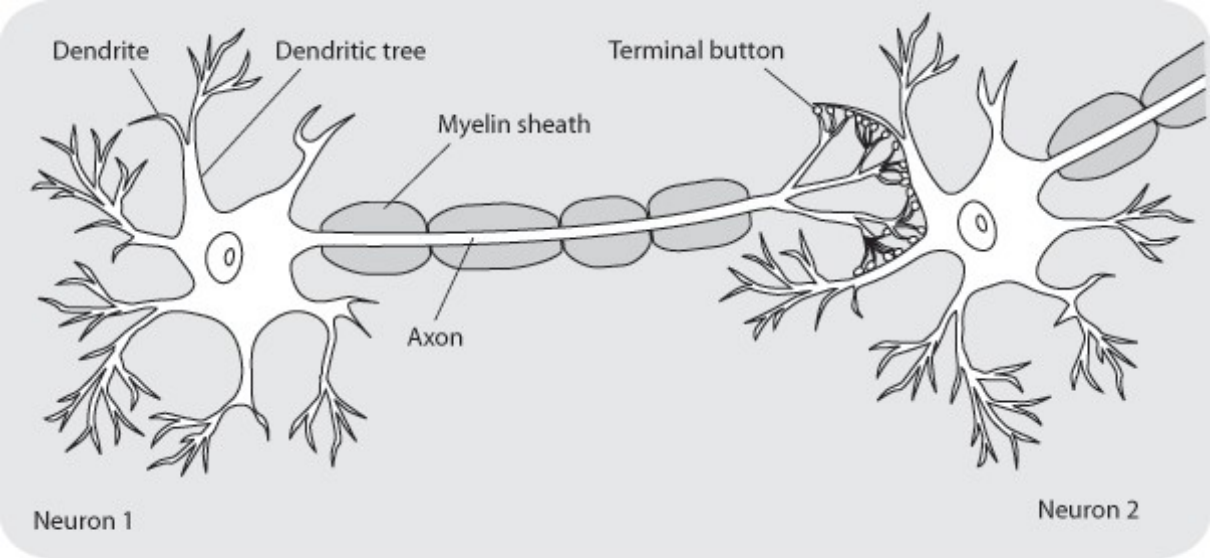
- Provide structural support to the neurons
- Insulate neurons
- Nourish neurons
- Remove waste products

The other cells, **neurons**, act as the communicators of the nervous system. Neurons receive information, integrate it, and pass it along. They communicate with one another, with cells in the sensory organs, and with muscles and glands.

Each neuron has the same structure:

- Each neuron has a **soma**, or cell body, which is the central area of the neuron. It contains the nucleus and other structures common to all cells in the body, such as mitochondria.
- The highly branched fibers that reach out from the neuron are called **dendritic trees**. Each branch is called a **dendrite**. Dendrites receive information from other neurons or from sense organs.
- The single long fiber that extends from the neuron is called an axon. **Axons** send information to other neurons, to muscle cells, or to gland cells. What we call **nerves** are bundles of axons coming from many neurons.

- Some of these axons have a coating called the **myelin sheath**. Glial cells produce myelin, which is a fatty substance that protects the nerves. When an axon has a myelin sheath, nerve impulses travel faster down the axon. Nerve transmission can be impaired when myelin sheaths disintegrate.
- At the end of each axon lie bumps called terminal buttons. **Terminal buttons** release**neurotransmitters**, which are chemicals that can cross over to neighboring neurons and activate them. The junction between an axon of one neuron and the cell body or dendrite of a neighboring neuron is called a **synapse**.



Neuron Structure

Role of Myelin

People with multiple sclerosis have difficulty with muscle control because the myelin around their axons has disintegrated. Another disease, poliomyelitis, commonly called "polio," also damages myelin and can lead to paralysis.

Communication Between Neurons

In 1952, physiologists **Alan Hodgkin** and **Andrew Huxley** made some important discoveries about how neurons transmit information. They studied giant squid, whose neurons have giant axons. By putting tiny electrodes inside these axons, Hodgkin and Huxley found that nerve impulses are really electrochemical reactions.

The Resting Potential

Nerves are specially built to transmit electrochemical signals. Fluids exist both inside and outside neurons. These fluids contain positively and negatively charged atoms and molecules called **ions**. Positively charged sodium and potassium ions and negatively charged chloride ions constantly cross into and out of neurons, across cell membranes. An inactive neuron is in the **resting state**. In the resting state, the inside of a neuron has a slightly higher concentration of negatively charged ions than the outside does. This situation creates a slight negative charge inside the neuron, which acts as a store of potential energy called the **resting potential**. The resting potential of a neuron is about –70 millivolts.

The Action Potential

When something stimulates a neuron, gates, or channels, in the cell membrane open up, letting in positively charged sodium ions. For a limited time, there are more positively charged ions inside than in the resting state. This creates an **action potential**, which is a short-lived change in electric charge inside the neuron. The action potential zooms quickly down an axon. Channels in the membrane close, and no more sodium ions can enter. After they open and close, the channels remain closed for a while. During the period when the channels remain closed, the neuron can't send impulses. This short period of time is called the **absolute refractory period**, and it lasts about 1–2 milliseconds. The absolute refractory period is the period during which a neuron lies dormant after an action potential has been completed.

The All-or-None Law

Neural impulses conform to the **all-or-none law**, which means that a neuron either fires and generates an action potential, or it doesn't. Neural impulses are always the same strength—weak stimuli don't produce weak impulses. If stimulation reaches a certain threshold, or minimum level, the neuron fires and sends an impulse. If stimulation doesn't reach that threshold, the neuron simply doesn't fire. Stronger stimuli do not send stronger impulses, but they do send impulses at a faster rate.

The Synapse

The gap between two cells at a synapse is called the **synaptic cleft**. The signal-sending cell is called the **presynaptic neuron**, and the signal-receiving cell is called the **postsynaptic neuron**.

Neurotransmitters are the chemicals that allow neurons to communicate with each other. These chemicals are kept in **synaptic vesicles**, which are small sacs inside the terminal buttons. When an action potential reaches the terminal buttons, which are at the ends of axons, neurotransmitter-filled synaptic vesicles fuse with the presynaptic cell membrane. As a result, neurotransmitter molecules pour into the synaptic cleft. When they reach the postsynaptic cell, neurotransmitter molecules attach to matching receptor sites. Neurotransmitters work in much the same way as keys. They attach only to specific receptors, just as certain keys fit only certain locks.

When a neurotransmitter molecule links up with a receptor molecule, there's a voltage change, called a**postsynaptic potential (PSP)**, at the receptor site. Receptor sites on the postsynaptic cell can be excitatory or inhibitory:

- The binding of a neurotransmitter to an excitatory receptor site results in a positive change in voltage, called an **excitatory postsynaptic potential** or **excitatory PSP**. This increases the chances that an action potential will be generated in the postsynaptic cell.
- Conversely, the binding of a neurotransmitter to an inhibitory receptor site results in an **inhibitory PSP**, or a negative change in voltage. In this case, it's less likely that an action potential will be generated in the postsynaptic cell.

Unlike an action potential, a PSP doesn't conform to the all-or-none law. At any one time, a single neuron can receive a huge number of excitatory PSPs and inhibitory PSPs because its dendrites are influenced by axons from many other neurons. Whether or not an action potential is generated in the neuron depends on the balance of excitation and inhibition. If, on balance, the voltage changes enough to reach the threshold level, the neuron will fire.

Neurotransmitter effects at a synapse do not last long. Neurotransmitter molecules soon detach from receptors and are usually returned to the presynaptic cell for reuse in a process called **reuptake**.

C) Neurotransmitters

So far, researchers have discovered about 15–20 different neurotransmitters, and new ones are still being identified. The nervous system communicates accurately because there are so many neurotransmitters and because neurotransmitters work only at matching receptor sites. Different neurotransmitters do different things.

Neurotransmitter	Major functions	Excess is associated with	Deficiency is associated with
Acetylcholine	Muscle movement, attention, arousal, memory, emotion		Alzheimer's disease
Dopamine	Voluntary movement, learning, memory, emotion	Schizophrenia	Parkinsonism
Serotonin	Sleep, wakefulness, appetite, mood, aggression, impulsivity, sensory perception, temperature regulation, pain suppression		Depression

Endorphins	Pain relief, pleasure		
Norepinephrine	Learning, memory, dreaming, awakening, emotion, stress-related increase in heart rate, stress-related slowing of digestive processes		Depression
GABA	Main inhibitory neurotransmitter in the brain		
Glutamate	Main excitatory neurotransmitter in the brain	Multiple sclerosis	

Agonists and Antagonists

Agonists are chemicals that mimic the action of a particular neurotransmitter. They bind to receptors and generate postsynaptic potentials.

Nicotine and Receptors

Nicotine is an acetylcholine agonist, which means that it mimics acetylcholine closely enough to compete for acetylcholine receptors. When both nicotine and acetylcholine attach to a receptor site, the nerve fibers become highly stimulated, producing a feeling of alertness and elation.

Antagonists are chemicals that block the action of a particular neurotransmitter. They bind to receptors but can't produce postsynaptic potentials. Because they occupy the receptor site, they prevent neurotransmitters from acting.

Paralysis and Poison Arrows

Curare is a drug that causes paralysis. As an acetylcholine antagonist, it binds to acetylcholine receptors at nerve-muscle junctions, preventing communication between nerves and muscles. Doctors sometimes use curare to immobilize patients during extremely delicate surgery. South American tribes have long used curare as an arrow poison.

D) Studying the Brain

To examine the brain's functions, researchers have to study a working brain, which means they can't use cadavers. Invasive studies, in which researchers actually put instruments into the brain, can't be done in humans, though they can be done occasionally during medically necessary brain surgery. Researchers usually use invasive techniques in animal studies. There are two main types of invasive animal studies:

- **Lesioning studies:** Researchers use an electrode and an electric current to burn a specific, small area of the brain.
- **Electric stimulation of the brain:** Researchers activate a particular brain structure by using a weak electric current sent along an implanted electrode.

Because they cannot use such invasive techniques on humans, researchers study human brains in two ways:

- They examine people with brain injuries or diseases and see what they can and can't do.

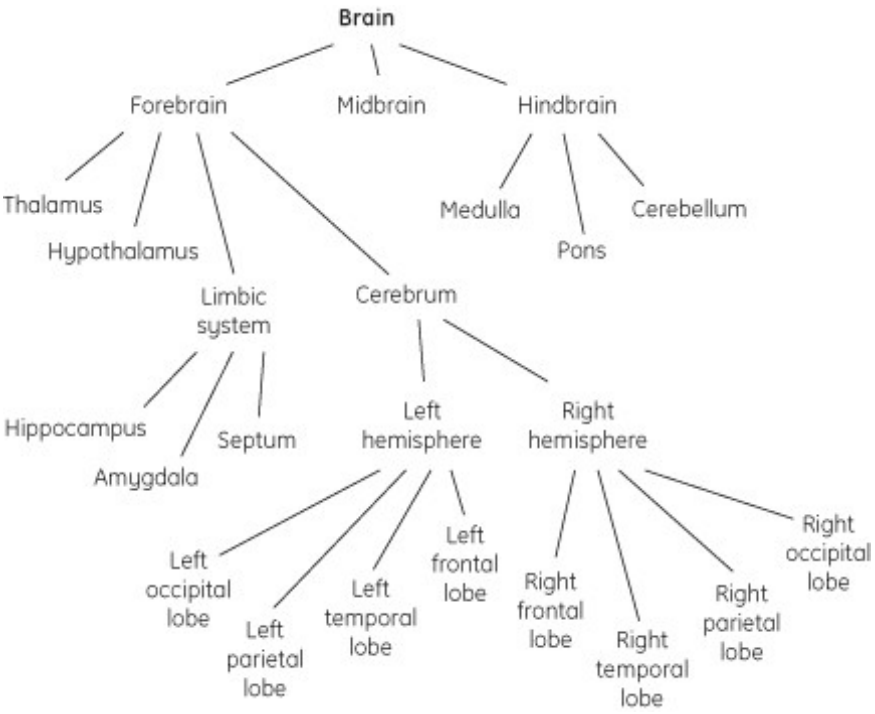
- They use**electroencephalographs (EEGs)**, which can record the overall electrical activity in the brain via electrodes placed on the scalp.

Recently, high-tech innovations have made studying human brains easier. Researchers use three types of imaging equipment to study the brain:

- **Computerized tomography (CT):** In CT, a number of x-rays are taken of the brain from different angles. A computer then combines the x-rays to produce a picture of a horizontal slice through the brain.
- **Magnetic resonance imaging (MRI):** Both brain structure and function can be visualized through MRI scans, which are computer-enhanced pictures produced by magnetic fields and radio waves.
- **Positron emission tomography (PET):** For PET scans, researchers inject people with a harmless radioactive chemical, which collects in active brain areas. The researchers then look at the pattern of radioactivity in the brain, using a scanner and a computer, and figure out which parts of the brain activate during specific tasks, such as lifting an arm or feeling a particular emotion.

E) Structure and Functions of the Brain

The brain is divided into three main parts: the hindbrain, the midbrain, and the forebrain.



The Hindbrain

The **hindbrain** is composed of the medulla, the pons, and the cerebellum. The**medulla** lies next to the spinal cord and controls functions outside conscious control, such as breathing and blood flow. In other words, the medulla controls essential functions.
The **pons** affects activities such as sleeping, waking, and dreaming. The**cerebellum** controls balance and coordination of movement. Damage to the cerebellum impairs fine motor skills, so a person with an injury in this area would have trouble playing the guitar or typing a term paper.

The Midbrain

The **midbrain** is the part of the brain that lies between the hindbrain and the forebrain. The midbrain helps us to locate events in space. It also contains a system of neurons that releases the neurotransmitter dopamine. The **reticular formation** runs through the hindbrain and the midbrain and is involved in sleep and wakefulness, pain perception, breathing, and muscle reflexes.

The Forebrain

The biggest and most complex part of the brain is the **forebrain**, which includes the thalamus, the hypothalamus, the limbic system, and the cerebrum.

Thalamus

The **thalamus** is a sensory way station. All sensory information except smell-related data must go through the thalamus on the way to the cerebrum.

Hypothalamus

The **hypothalamus** lies under the thalamus and helps to control the pituitary gland and the autonomic nervous system. The hypothalamus plays an important role in regulating body temperature and biological drives such as hunger, thirst, sex, and aggression.

Limbic System

The **limbic system** includes the **hippocampus**, the **amygdala**, and the septum. Parts of the limbic system also lie in the thalamus and the hypothalamus. The limbic system processes emotional experience. The amygdala plays a role in aggression and fear, while the hippocampus plays a role in memory.

Cerebrum

The **cerebrum**, the biggest part of the brain, controls complex processes such as abstract thought and learning. The wrinkled, highly folded outer layer of the cerebrum is called the cerebral cortex. The **corpus callosum** is a band of fibers that runs along the cerebrum from the front of the skull to the back. It divides the cerebrum into two halves, or hemispheres. Each hemisphere is divided into four lobes or segments: the occipital lobe, the parietal lobe, the temporal lobe, and the frontal lobe:

- The occipital lobe contains the primary visual cortex, which handles visual information.
- The parietal lobe contains the primary somatosensory cortex, which handles information related to the sense of touch. The parietal lobe also plays a part in sensing body position and integrating visual information.
- The temporal lobe contains the primary auditory cortex, which is involved in processing auditory information. The left temporal lobe also contains**Wernicke's area**, a part of the brain involved in language comprehension.
- The frontal lobe contains the primary motor cortex, which controls muscle movement. The left frontal lobe contains **Broca's area**, which influences speech production. The frontal lobe also processes memory, planning, goal-setting, creativity, rational decision making, and social judgment.

Brain Hemispheres

Lateralization refers to the fact that the right and left hemispheres of the brain regulate different functions. The left hemisphere specializes in verbal processing tasks such as writing, reading, and talking. The right hemisphere specializes in nonverbal processing tasks such as playing music, drawing, and recognizing childhood friends.

Roger Sperry, Michael Gazzaniga, and their colleagues conducted some of the early research in lateralization. They examined people who had gone through **split-brain surgery**, an operation done to cut the corpus callosum and separate the two brain hemispheres. Doctors sometimes use split-brain surgery as a treatment for epileptic seizures.

Control of the Body

Because of the organization of the nervous system, the left hemisphere of the brain controls the functioning of the right side of the body. Likewise, the right hemisphere controls the functioning of the left side of the body.

Vision and hearing operate a bit differently. What the left eye and right eye see goes to the entire brain. However, images in the left visual field stimulate receptors on the right side of each eye, and in-formation goes from those points to the right hemisphere. Information perceived by the right visual field ends up in the left hemisphere.

In the case of auditory information, both hemispheres receive input about what each ear hears. However, information first goes to the opposite hemisphere. If the left ear hears a sound, the right hemisphere registers the sound first.

The fact that the brain's hemispheres communicate with opposite sides of the body does not affect most people's day-to-day functioning because the two hemispheres constantly share information via the corpus callosum. However, severing the corpus callosum and separating the hemispheres causes impaired perception.

Split-Brain Studies

If a researcher presented a picture of a Frisbee to a split-brain patient's right visual field, information about the Frisbee would go to his left hemisphere. Because language functions reside in the left hemisphere, he'd be able to say that he saw a Frisbee and describe it. However, if the researcher presented the Frisbee to the patient's left visual field, information about it would go to his right hemisphere. Because his right hemisphere can't communicate with his left hemisphere when the corpus callosum is cut, the patient would not be able to name or describe the Frisbee.

The same phenomenon occurs if the Frisbee is hidden from sight and placed in the patient's left hand, which communicates with the right hemisphere. When the Frisbee is in the patient's left visual field or in his left hand, the patient may not be able to say what it is, although he would be able to point to a picture of what he saw. Picture recognition requires no verbal language and is also a visual-spatial task, which the right hemisphere controls.

F) The Endocrine System

The **endocrine system**, made up of hormone-secreting glands, also affects communication inside the body. **Hormones** are chemicals that help to regulate bodily functions. The glands produce hormones and dump them into the bloodstream, through which the hormones travel to various parts of the body. Hormones act more slowly than neurotransmitters, but their effects tend to be longer lasting.

The **pituitary gland**, which lies close to the hypothalamus of the brain, is often called the master gland of the endocrine system. When stimulated by the hypothalamus, the pituitary gland releases various hormones that control other glands in the body. The chart below summarizes the better known hormones along with some of their functions.

Hormone	Produced by	Involved in regulating
Thyroxine	Thyroid gland	Metabolic rate
Insulin	Pancreas	Level of blood sugar
Melatonin	Pineal gland	Biological rhythms, sleep
Cortisol,**Norepinephrine**,**Epinephrine**,**Adrenaline**	Adrenal glands	Bodily functions during stressful and emotional states
Androgens	Testes (and ovaries and adrenal glands to a lesser extent)	Male secondary sex characteristics, sexual arousal in males and females
Estrogens	Ovaries (and testes and adrenal	Breast development and menarche in females

	glands to a lesser extent)	
Progesterone	Ovaries (and testes and adrenal glands to a lesser extent)	Preparation of uterus for implantation of fertilized egg