CONTENT OUTLINE

LESSON 1

The Scientific Method and Psychological Science

Overview: Psychology is a science because researchers establish knowledge and test hypotheses using scientific research methods. Understanding these research methods is essential to being able to think critically about psychology.

I. Psychology and the Scientific Method

A. The **scientific method** is the systematic, empirically based investigation of phenomena through objective observations and measurements and the formulation of testable and falsifiable explanations.

B. The scientific method is actually a set of multiple methods.

C. Based on the particular research question, a researcher will identify what type of method to use.

D. Psychologists, like all scientists, conduct research to describe, measure, predict, and explain the phenomena in which they are interested.

II. Basic Concepts of the Scientific Method

Using the scientific method, psychologists make systematic, precise observations to generate ideas about behavior and to test theories and hypotheses.

A. Theories and hypotheses

1. **Theories** are coherent sets of concepts that explain a phenomenon or set of phenomena.

2. **Hypotheses** are testable statements about the relationship between two variables. Hypotheses are based on observation, research, and theory and are not random guesses.

B. Variables: A **variable** is any factor that can take on different values. It is the opposite of a constant.

1. In research, variables can be manipulated, controlled, or measured.

2. There are two basic kinds of variables in research:

   a. **Independent variables** (hypothesized causes) are variables that the researcher manipulates or selects to test the hypothesis that the variable leads to a change.

   b. **Dependent variables** (hypothesized effects) are outcome or performance measures used to determine the effect of the independent variable.

3. There are two types of independent variables:

a. A *true independent variable* is one that the researcher manipulates. The researcher assigns participants to a condition.

b. A *quasi-independent variable* is one in which the researcher selects people for having a certain trait or property (i.e., participants are chosen based on their gender, or because of a particular condition, such as brain trauma).*

C. **Sampling** is the way a researcher selects participants from a population.

1. Representative, unbiased sampling is critical for internally and externally valid results.

2. A biased sample undermines the validity of the results and limits how well the results might generalize to the intended population.

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* Throughout this lesson plan, items boxed in gray indicate content for an advanced psychology course.

For example, say a researcher wants to determine college students' political beliefs. If the researcher only surveys psychology majors, the results might not reflect the views of the general college population.

3. Other important terms include:

    a. **Population**—the entire group of people one is interested in studying.

    b. **Sample**—the subset of participants selected from the population.

    c. **Representative sample**—this kind of sample reflects the characteristics of the population.

    d. **Random sampling**—in random sampling, every individual in the population has an equal chance of being selected for the sample, which helps researchers select a representative sample.

    e. **Convenience sampling**—in convenience sampling, the researcher selects participants who are available, such as members of an introductory psychology class.

    Convenience sampling does not result in representative samples, and generalizing from a convenience sample to the population may not be possible.

GO TO ACTIVITY1.1

Sampling or Assignment?

GO TO ACTIVITY1.2

A Tasty Sample(r): Teaching About Sampling Using M&M's

III. The Research Process

A. A researcher develops a hypothesis and designates the independent and dependent variables, which must be operationally defined.

An **operational definition** is a definition of a variable or condition in terms of the specific operation, procedures, or observable behaviors. The researcher must specify exactly how variables will be manipulated, controlled, or measured.

B. Before conducting research that involves human participants, the investigator must submit the detailed plans of the project to an **institutional review board (IRB)** to ensure that the method and procedures follow the ethical guidelines for conducting research.

C. After obtaining IRB approval, the researcher will then conduct the research, collect and analyze the data, and report the findings.

D. Once the data are collected, the researcher uses statistical techniques to analyze them.

1. **Descriptive statistics** (e.g., mean, median, and mode, the standard deviation, range) are used to characterize and summarize major trends in the data.

2. **Inferential statistics** (e.g., t-tests, ANOVA) are used to draw conclusions about the data and make generalizations from the results to the larger population.

E. The final step in any scientific process is making findings public through publication and/or presentation and open to scrutiny and **replication** by other scientists.

GO TO ACTIVITY 1.3

Do Cookies/Donuts Improve Memory? Errors in Methodology

IV. Use of Nonhuman Animals in Research

A. Psychologists conduct research with nonhuman animals to study a wide range of normal and abnormal behaviors, and the biological mechanisms underlying these behaviors.

1. About 7–8% of psychological research involves the use of nonhuman animals (APA, n.d.).

2. Basic research with nonhuman animals has enabled scientists to learn more about sensory processes, motivational systems, learning, memory, cognition, evolution, and development, all of which have contributed to the health and welfare of both humans and other animals.

3. Scientists have learned much about the central nervous system from conducting research with nonhuman animals.

4. Psychological scientists use a variety of animal models to study different behaviors and disorders. Rodents and birds, primarily mice, rats, and pigeons, make up approximately 90% of animals in psychological research. Nonhuman primates, such as monkeys and apes, are involved in research to a much lesser extent (APA, n.d.).

B. Reasons for conducting nonhuman animal research

1. Ethical considerations

2. Understanding behavior

3. Evolutionary change and influence

4. Increased control

5. Such research benefits nonhuman animals as well

Critical Thinking Exercise

A. You conduct an experiment where you take a sample of high school students and randomly divide them into two groups. Both groups view the same videotaped lecture. For the experimental group, a cell phone goes off at random intervals during the lecture. For the control group, there are no such distractions. After the video, both groups are given the same test of the material.

1. Name the independent and dependent variables.

2. Name two factors that were controlled in this study.

3. Identify two operational definitions of variables.

4. What kinds of descriptive statistics would you compute once you have the results?

5. Name your sample and your population in this study.

LESSON 2

Research Methods

Overview: In this lesson, research methods are introduced. This lesson covers descriptive research methods such as case studies, naturalistic observation, and surveys or questionnaires and also covers qualitative research methods such as interviews, narratives, and focus groups.

I. Research Methods Can Be Qualitative or Quantitative

A. **Qualitative** research methods are those that collect and analyze non-numeric data. Researchers collect such data through interviews, focus groups, and narratives.

B. **Quantitative** research methods are those that collect numerical data to investigate phenomena of interest. Researchers gather such data through surveys, correlations, and experiments.

II. Descriptive Research Methods

Descriptive research methods are used to describe phenomena and can be either qualitative or quantitative. Descriptive methods **cannot** be used to establish cause-and-effect relationships.

A. A **case study** is an in-depth investigation of an individual or small group who may have a highly unusual trait.

1. For example, in *The Man Who Mistook His Wife for a Hat* (1985), Oliver Sacks presents case studies of some of his patients. An in-depth investigation of Phineas Gage would also be a case study.

2. Strengths include that case studies are especially useful for documenting phenomena that are rare or complex and that the research can lead to hypotheses and questions for further research.

3. Weaknesses include retrospective (hindsight) bias, where researchers inflate the importance of events that, in retrospect, seem relevant and overlook events that do not seem relevant. Case studies also have limited generalizability due to small sample size.

B. **Naturalistic observation** occurs when researchers collect observations of natural, ongoing behavior.

1. For example, researchers may observe people in multiple cultures and estimate the number of inches between two people having conversations; researchers may observe a street intersection to see how many people stopped at stop signs.

2. Strengths include the fact that all factors that might influence the behavior are present (as opposed to controlled experiments). Thus, the results have applicability to "real-world" questions.

3. Weaknesses include:

    a. The potential for both researcher and participant bias (sometimes also called subject bias, demand characteristics, and expectancy effects).

    b. Possible privacy issues due to the inability to obtain informed consent.

    c. An inability to establish causality because of lack of control over variables.

    d. The time required to conduct naturalistic observation, especially for rare events—a common practical difficulty.

GO TO ACTIVITY 2.1

Counting Fidgets: Teaching the Complexity of Naturalistic Observation

C. **Surveys or questionnaires** provide self-report data about attitudes, behaviors, or characteristics.

1. Strengths of surveys include that they can be easily administered and are efficient for gathering large amounts of data.

2. Weaknesses include:

    a. Biased samples either through poor sampling, selection bias, or low return rate.

    b. Self-presentation and social desirability biases in responding to questions.

c. Ambiguously worded or leading questions ("framing" of the questions) that bias responses.

d. Memory distortions in self-report.

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III. Qualitative Research Methods

A. Qualitative Data

1. Many complex behaviors do not lend themselves to accurate numerical measurement, such as multidimensional variables (e.g., interpretation of poetry) and categorical variables (e.g., beginner–novice–expert at a skill). In such cases, researchers employ qualitative research methods.

2. Often researchers measure both quantitative and qualitative data.

3. Qualitative research can capture complex experiences that numerical analysis does not, but the data cannot be summarized easily.

4. Types of qualitative research methods:

    a. In **interviews**, individual participants provide a verbal description of an event or behavior. For example, a researcher may interview blind participants to see how they navigate as pedestrians.

    b. **Narratives** are stories and in the narrative research method, the researcher collects the personal stories of participants.

    c. A **focus group** involves an interview with a sample of people that is representative of an important section of the population.

Critical Thinking Exercises

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B. You want to study how blind pedestrians navigate through neighborhoods with only a cane. Describe how you might use descriptive research methods such as case study, survey, and naturalistic observation. What would be the pros and cons of each method?

C. You are interested in studying attitudes about a controversial topic, such as euthanasia or abortion. What kinds of qualitative research methods might you use to study these issues? What would be the strengths and weaknesses of such methods, especially compared with quantitative methods, such as surveys?

LESSON 3

Research Methods, Continued

Overview: In this lesson, predictive (correlational) and experimental research methods are described, along with issues of validity.

I. Correlational Research Methods

Correlational methods measure the relatedness of two variables and attempt to predict the value of one based on the other.

A. **Correlations** examine the relationship **between two variables** without manipulating either one.

1. Strengths of correlational research include that it provides an index of strength of the relationship between variables and can be used to predict future behavior. Correlational research can be done with existing data or with variables that cannot be manipulated or are unethical to manipulate.

2. A weakness is that because there is no manipulation of an independent variable, the researcher cannot establish a cause-and-effect relationship using a correlation.

3. In a correlation, one variable might cause the other, but correlational designs do not give us enough information to make that determination. Correlation does not equal causation.

4. The directionality problem is a limitation in correlations because even if one variable causes the other, we can't determine the direction of causation.

   For example, if a study found that people who retire later in life are healthier, it may imply that working longer leads to better health. However, it is equally likely that less healthy people retire earlier because of health problems.

5. The third variable problem refers to the fact that two variables that are correlated may not be directly related to one another; rather, a third variable might be affecting them both.

For example, many people believe that sugar is related to hyperactivity in children; research has shown no such relation. Rather, the activities (e.g., birthday parties) surrounding sugar consumption can be the causal factor.

6. **Illusory correlations** are when two data sets show a correlation even though there is no relationship at all.

   For example, violent video game producers have tried to tie the increase in game sales to the decrease in violent crimes as reported by the F.B.I. While this is a negative correlation, it is doubtful that the two sets of data are related. Other examples are the perceived positive correlation between ice cream sales and murders (both are correlated to hot summer months), and the tendency to perceive members of minority groups as being correlated to unique, distinctive events.

B. **Correlation coefficients** are statistical measures of the relationship between two variables. Correlation coefficients are expressed from -1.00 (a perfect negative correlation) to +1.00 (a perfect positive correlation).

   1. A correlation is reported as a decimal value (e.g., .60, -.70, .90). To interpret a correlation, break it down into two parts, the sign (positive or negative) and the absolute value or magnitude (between 0.0 and 1.0).

   2. The direction of relationship is either positive or negative:

      a. In a **positive** correlation, as one variable increases, so does the other (and vice versa). For example, as class attendance increases, so do grades.

      b. In a **negative** correlation, as one variable increases, the other decreases (and vice versa). For example, as class absences increase, grades decrease.

   3. The closer the absolute value of the coefficient is to 1.0, the stronger the correlation between the variables. The closer to zero, the weaker the relationship between variables. Therefore, a correlation of -.75 is stronger than a correlation of +.46.

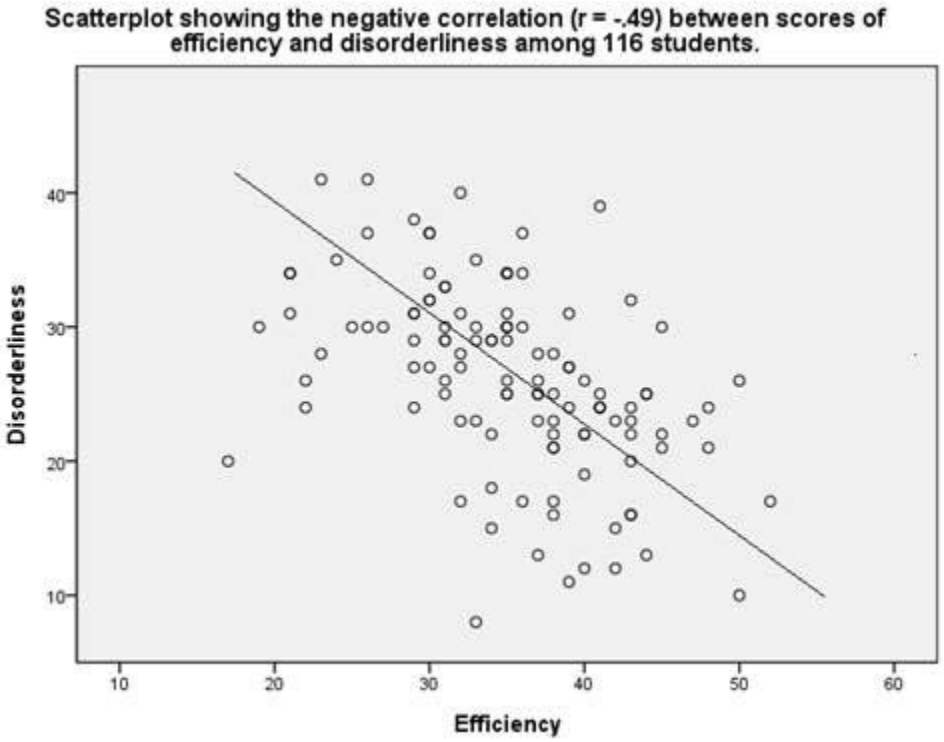
C. Scatterplots

   1. **Scatterplots** are typically used to illustrate correlations. They show the relationship between two dependent variables.

2. The values of one variable are marked on the *x*-axis, and the values of the other variable are marked on the *y*-axis. Unlike other graphs, each individual data point is displayed as a point whose location is determined by its value on each variable. The closer the data points are to forming a line, the stronger the correlational relationship is.

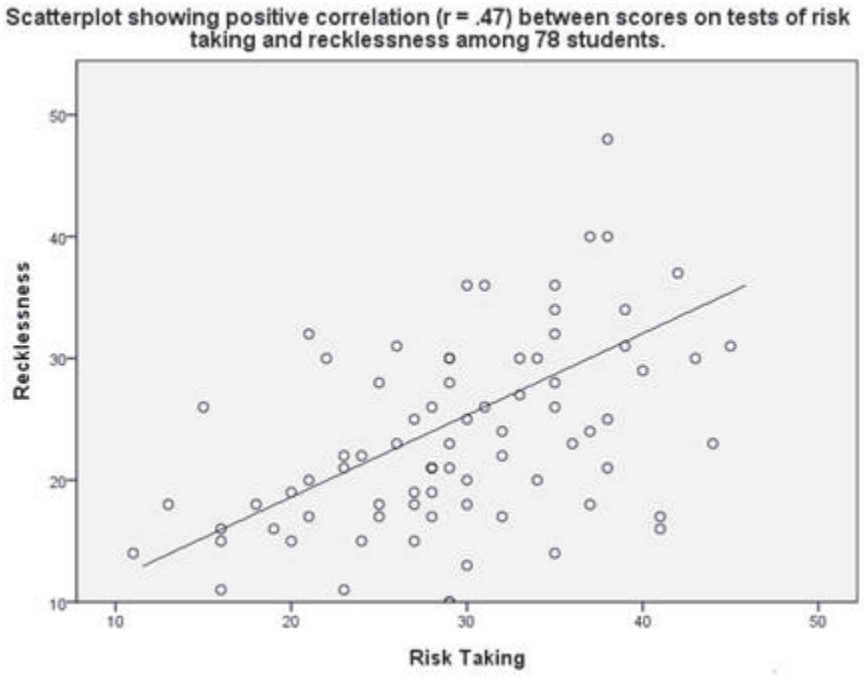
3. Here is an example of a scatterplot showing a negative correlation. The figure below reflects a negative correlation between two traits, disorderliness and efficiency. In this example, as a person's disorderliness level increases, the efficiency score decreases:

Figure 1



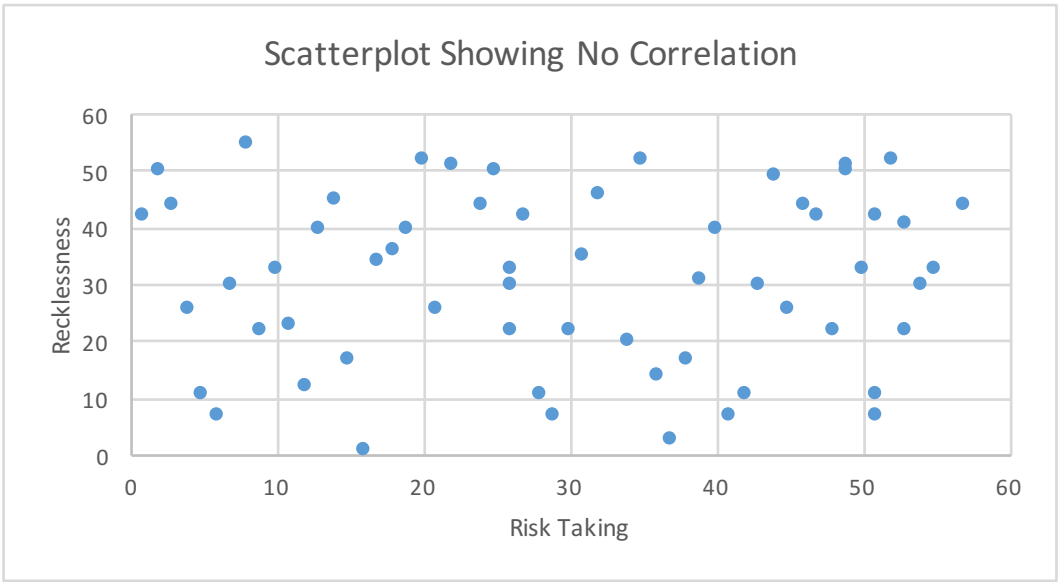
4. Here is an example of a scatterplot showing a positive correlation. The figure below reflects a positive correlation between scores on tests of recklessness and risk taking. In this example, as a person's recklessness increases, their risk-taking score increases:

Figure 2



Here is an example of a scatterplot showing no correlation:

Figure 3



II. Experimental Methods

Experimental methods involve both independent and dependent variables.

A. In **experiments**, manipulation or selection of one variable (the **independent variable**) takes place under controlled conditions to observe its effect on another variable (the **dependent variable**).

1. Experiments require multiple groups or conditions. At its most basic, an experimental group and control group is used:

    a. The **experimental group** is the group that receives the treatment.

    b. The **control group** is the group that does not receive treatment or receives a treatment presumed to be ineffective (e.g., a placebo). The control group serves as the basis for comparison of results from the experimental group.

        i. Proper control groups ensure that the impact of the independent variable can be assessed accurately. A control group should experience and do everything the experimental group does EXCEPT the independent variable.

        ii. Having a control group allows comparison of a treatment condition to a nontreatment condition to determine if the independent variable affected the dependent variable.

        iii. Administering a **placebo** (e.g., drug or behavioral treatment that the participant believes is a treatment but is actually not) is a common way to create a control group.

        iv. **Random assignment** is used to create comparable groups.

2. In experiments a distinction is made between true experiments and quasi-experiments.

    a. **True experiments** use true independent variables and are the only research method that allows a cause-and-effect relationship to be established.

b. **Quasi-experiments** treat subject variables (e.g., gender, race, age) like they are independent variables. They are like correlations in that no causality can be established.

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3. We can also distinguish between **lab experiments**, in which control is maximized but mundane realism (i.e., the real-world environment) is sacrificed, and **field experiments**, in which realism is maximized but control is sacrificed.

4. Strengths of experiments include:

    a. In experiments in general, the researcher has greater control over the whole situation than in any other research method.

    b. True experiments address causality.

5. Weaknesses of experiments include:

    a. **Generalizability**: Since experimental studies are often conducted in a controlled lab setting, the results may not reflect real-world events because some important factors may be missing from the experimental situation (compared with naturalistic observation).

    b. **Confounds or confounding variables**: These are uncontrolled variables that affect the outcome of the experiment; they are variables for which the researcher is not interested that covary with the independent variable and are almost always the result of a research design flaw. The researcher may believe the result is due to the independent variable, but it may really be due to an uncontrolled, confounding variable.

    c. **Ethical considerations**: All research has ethical dimensions, but this is especially true with experiments because the experimenter is manipulating the behavior of participants and causing them to do things they may not normally do.

    d. **Participant bias**: A participant knows he or she is in an experiment and may not act naturally.

    e. **Experimenter bias**: the experimenter may treat participants differently and influence their behavior according to the research hypothesis.

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f. **Carryover effect**: Sometimes what the participant does in one task may influence how they act in another task.

B. Longitudinal research and cross-sectional research methods are types of experimental methods typically used to study behavior over time.

1. In **longitudinal research**, the researcher studies the same group of people over a long period of time to see developmental changes.

2. In **cross-sectional research**, the research design involves the comparison of people of different age groups (cohorts) at the same time.

GO TO ACTIVITY 3.1

Pattern Recognition

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III. Validity in Research

Validity means that an operational definition is a true and accurate reflection of the phenomenon being studied.

A. Internal validity

1. **Internal validity** means that the results of a study reflect the effects of the variables being studied.

2. Here is how researchers try to control for threats to internal validity:

   a. In a **blind study**, participants are ignorant ("blind") to their group assignment—they are not told whether they are in the treatment or control condition, which controls for participant bias.

   b. In a **double blind study**, both participants and the experimenter are unaware of group assignment, which controls for both participant and experimenter bias. At least one person will know which condition each participant is in, which is critical for interpreting results.

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c. **Counterbalancing** is used to control for any order effects, where the impact of different levels of a variable depends on the order in which they occur. To counterbalance, the researcher would change the order of tests from one person to the next.

   For example, say a psychologist conducts an experiment on performance times (e.g., runners' sprint times). One trial may be done using the runner's typical preparation, with a second trial done using visualization (e.g., the runner is asked to visualize their peak performance). The researcher would want to counterbalance which preparation condition comes first. Half of the participants would do typical preparation first while the other half would do visualization first.

B. **External validity** is related to whether the research will generalize to other contexts outside the particular research setting. For example, if all participants in a given research study are White college age students from a private school, how can those results be generalized to a person who isn't college educated, or is 68 years old, or is African American or Latino?

Relevant questions include:

1. Is the sample in the research representative of the population to which the researcher wants to generalize the results?
2. Will the results of the research be the same if the psychologist repeats the study with different people or different nonhuman animals?
3. Will participants' behaviors recur if those behaviors are observed elsewhere—for example, outside of a laboratory rather than in a laboratory setting?

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Critical Thinking Exercises

D. Regarding the study of blind pedestrians (see Critical Thinking Exercise B), would it be better to use quantitative or qualitative methods? Describe both the qualitative and quantitative data you might measure.

E. You want to study the impact of video games on student learning. How might you study this with correlational methods and experimental methods? Design both studies and describe the strengths and weaknesses of each.

LESSON 4

Ethical Issues in Research

Overview: Research involves the systematic collection of data to further our knowledge about the world in which we live. Psychological research involves studying not only people but also other animals. In research, we observe the behavior of participants, and typically we control or manipulate their behavior. Such actions entail a responsibility on the part of psychologists to conduct research in an ethical manner. Conducting research is a privilege and investigators should be knowledgeable about effectively dealing with ethical issues that can arise throughout the research process.

I. Ethical Framework for Research With Human Participants

A. *Ethical Principles of Psychologists and Code of Conduct* (APA, 2010)

1. The APA Ethics Code governs the ethical conduct of psychologists both in practice and in research.
2. The code covers a wide range of ethical issues, from professional conduct of therapists to plagiarism in publications. Highlights of the code relating specifically to research include:
    a. informed consent
    b. freedom to withdraw
    c. protection from harm and discomfort
    d. confidentiality
    e. debriefing
3. APA also publishes ethical guidelines for a variety of specific situations and populations. There is a separate set of guidelines for high school students conducting research. See the Research Ethics section at **http://www.apa.org/science/about/publications/index.aspx** for more details.

B. Historical context: *Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research*

The current APA Ethics Code is strongly influenced by the Belmont Report, which was published in 1979 after public attention was drawn to abuses of human subjects, particularly in studies conducted by the Nazis around the time of World War II. The report provides an analytical framework to guide the resolution of ethical issues that arise during the conduct of research with human participants.

C. Oversight of research with human participants

1. Federal regulations for the protection of human research participants were issued in 1981. These regulations specify in detail the basic requirements for ensuring that the rights and welfare of participants are protected, including:

    a. criteria for obtaining informed consent

    b. criteria for respecting the privacy of individuals

    c. the confidentiality of the data they provide

    Furthermore, these regulations prescribe how research with human participants should be monitored through the establishment of an institutional review board (IRB), which is charged with protecting the rights and well-being of research participants.

2. The IRB reviews research proposals, prior to the start of the study, to ensure that the study complies with all applicable federal regulations and institutional policies. The IRB has the authority to approve, require modifications to, or disapprove proposed research involving human participants.

3. IRBs must have at least five members with varying backgrounds, in both scientific and nonscientific areas, as well as one member who is not affiliated with institution.

II. Examples of Research With Ethical Concerns

A. The Tuskegee (Public Health Service) Syphilis Study (1932–1972)

B. Research on obedience to authority by Milgram

C. The Stanford prison experiment by Zimbardo

D. Although these classic examples might illustrate unethical research practices, ethical dilemmas in research typically may be much more nuanced. For example, in studying the creation of

false memories, is it ethical to plant a false memory of a negative experience in a child? In studying hand-washing behavior, is it an invasion of a person's privacy to observe and record his or her behavior in a public bathroom?

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III. Standards for the Humane Treatment and Care of Nonhuman Animals in Research

A. There are numerous safeguards, at various levels within the scientific community, to ensure the humane care and treatment of laboratory animals.

1. In 1966, Congress passed the Animal Welfare Act (AWA), which governs the care and use of many warm-blooded animals in research. Other federal policies include the *Policy on Humane Care and Use of Laboratory Animals* and the *Guide for the Care and Use of Laboratory Animals.*

2. An **Institutional Animal Care and Use Committee (IACUC)** is charged with reviewing all proposed research projects involving the use of nonhuman animals.

B. APA has also established guidelines for the care and use of nonhuman animals in research.

1. The *Guidelines for Ethical Conduct in the Care and Use of Laboratory Animals in Research* discusses all aspects of nonhuman animal use, including justification of the research, personnel, acquisition, care, and housing of laboratory animals, experimental procedures, field research, and the use of nonhuman animals in education. See **http://www.apa.org/science/leadership/care/guidelines.aspx**.

2. The *Guidelines for the Use of Nonhuman Animals in Behavioral Projects in Schools (K-12)* discusses the use of nonhuman animals in teaching demonstration and research projects at the elementary through high-school levels. See **http://www.apa.org/science/leadership/care/animal-guide.aspx**.

GO TO ACTIVITY4.1

Research Ethics

Critical Thinking Exercises

F. Assume that you are volunteering to participate in an experiment in the psychology department at a university. According the APA Ethical Guidelines, what must the researcher tell you before starting the experiment?

G. You want to test the idea that people are more likely to help others of their own race. You want to conduct an experiment where you will stage a kidnapping in front of a busy store to see who will seek help for the "victim." You will manipulate whether the person posing as the victim is of European or African descent. What are the ethical issues involved? If you were a member of the IRB, what questions would you ask of the researchers? Do you think such an experiment would be ethical? Can you design an experiment that tests the same idea but raises fewer ethical issues?

LESSON 5

Statistics

Overview: Psychologists use statistics to analyze research data. There are two basic kinds of statistics, descriptive and inferential. Descriptive statistics are used to summarize the major characteristics of a data set. Inferential statistics are used to draw conclusions about data (e.g., is the difference between means statistically significant?) and make generalizations from the sample to the population (e.g., if a researcher were to repeat this study with different participants, would he or she get the same results?). It is a critical component in psychological research, but it is a much more complex topic than descriptive statistics.

I. Descriptive Statistics

Descriptive statistics refer to a set of tools that permit the summary of the major characteristics of a large amount of data.

II. Frequency Distributions

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A. Frequency distributions are a simple yet effective way of summarizing a large data set and revealing the important characteristics of the data.

1. Instead of listing every data point, a frequency distribution shows the frequency of occurrence of any possible score or class of scores. Thus, each score is only shown once, followed by its frequency of occurrence.

2. For example, a data set of 1, 1, 2, 2, 2, 4, 4, 4, 4, 4, 5, 6, 6 is shown in the following frequency distribution. Note how each score is only listed once, and the frequency of occurrence makes it easy to count total frequency for each score:

Score	Freq.
1	2
2	3
3	0
4	5
5	1
6	2

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3. For data sets with a large range of scores from high to low, a researcher can create a grouped frequency distribution, which requires classes of scores and the number of cases in each class. To be effective, the classes must be mutually exclusive, or nonoverlapping, and of uniform width.

4. For example, for a set of data that range from 10 to 44, the grouped frequency distribution might look like the following:

Class	Freq.
10–14	1
15–19	3
20–24	6
25–29	4
30–34	4
35–39	1
40–44	2

5. Columns listing cumulative frequency, percent, and cumulative percent can be added to either grouped or ungrouped frequency distributions.

III. Quantitative Descriptive Statistics

When dealing with quantitative data, researchers often compute descriptive statistics that can summarize important characteristics of the data numerically. There are two basic classes of quantitative statistics: measures of central tendency and measures of variability or dispersion.

Note: Instruction on how to calculate statistics are not included here. If you wish to teach students to compute statistics, it would be best to consult a book on behavioral statistics for thorough instructions. Some resources are given at the end of this lesson plan.

A. Measures of central tendency

1. **Measures of central tendency** tell us how most people generally scored.

2. The **mean**, or arithmetic average, is the most commonly used measure of central tendency for quantitative data because it is the most sensitive measure.

   a. The mean is calculated by adding up all the scores and dividing this total by the number of scores.

b. The sensitivity of the mean can cause a problem if there are one or two extreme outlying scores compared to the rest of the sample (see skewed distributions below). When this is the case, the mean becomes misleading, and the median is preferred. This is why income is always reported in terms of the median.

3. The **median** is the score that divides a distribution in half. In other words, it is the middle score in an ordered set of scores. If the dataset includes an even number of scores, the median is determined by taking the average of the two middle scores. For example, in the dataset 1, 1, 2, 3, 4, 4, the median would be (2+3)/2 = 2.5. The median is also the 50th percentile.

4. The **mode** is the score that occurs most frequently in the distribution. Although there can only be one mean and one median in a dataset, it is possible to have multiple modes. There may also be no mode present.

B. Measures of variability or dispersion

Researchers also need measures of the spread or dispersion of scores. These indicate how different or varied scores are within the group. Here are the two most commonly used measures of variability:

1. The **range** is the distance between the highest and lowest score.

2. The **standard deviation** is an index of variability that reflects how widely distributed or clustered around the mean the scores tend to be. The standard deviation is found by calculating how far each score in the data set is from the mean.

IV. Describing Frequency Distributions

A. **Frequency distributions** and their resulting graphs often take on characteristic shapes.

1. A frequency histogram shows possible scores on the x-axis and the frequency of occurrence on the y-axis. If it is symmetrical, then the distribution on the low side mirrors the distribution on the high side. For symmetrical distributions, the mean equals the median.

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2. If a distribution is not symmetrical, it is said to be skewed. Data cannot be skewed; only distributions are skewed. Skewed means pulled; the distribution has been pulled—either positive or negative—from extreme observations.

    a. A **positive skew** is caused by one or a small group of unusually high value(s), where most of the data cluster near the lower scores in the distribution.

        i. The skew is named "positive" for the tail of the distribution, which is a high value relative to most other scores in the distribution. The mean is pulled in the positive direction due to the extreme high scores. The median is not affected as much and the mode is not affected at all.

        ii. An example of a positive skew is an extremely hard exam where most people do poorly but one or two students do very well.

    b. A **negative skew** is caused by one or a small group of unusually low value(s), where most of the data cluster near the higher scores in the distribution.

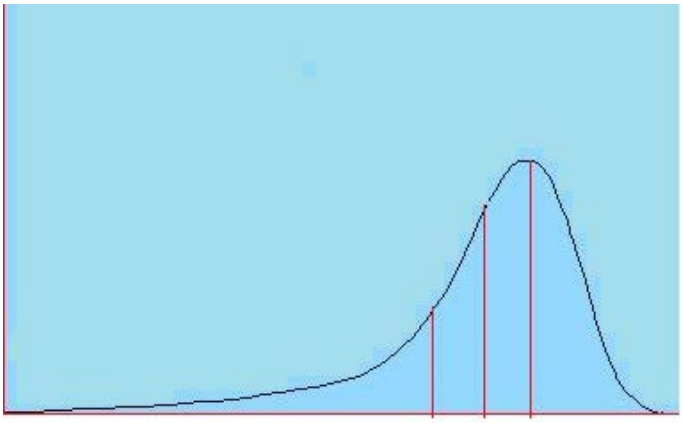
        i. The skew is named "negative" for the tail of the distribution, which is a low value relative to most other scores in the distribution. The mean in a negatively skewed distribution is pulled in the negative direction due to the extreme low scores. The median is less affected, and the mode is not affected at all.

        ii. An example of negative skew is an extremely easy test where most students do very well, but one or two still do poorly.

3. In a skewed distribution, outliers distort the mean, making the median the best measure of what constitutes a typical score in a highly skewed distribution.

    Here is an example of a negatively skewed distribution. The *x*-axis indicates scores and the *y*-axis indicates frequency of occurrence of the score:

Figure 4



NEGATIVELY SKEWED DISTRIBUTION

B. The **normal distribution** is a specific form of a bell-shaped, symmetrical frequency distribution with mathematical properties that make it especially useful for statistics and measurement. It is sometimes called the “bell curve,” but that is misleading. While all normal curves are bell shaped, not all bell-shaped curves are normal.

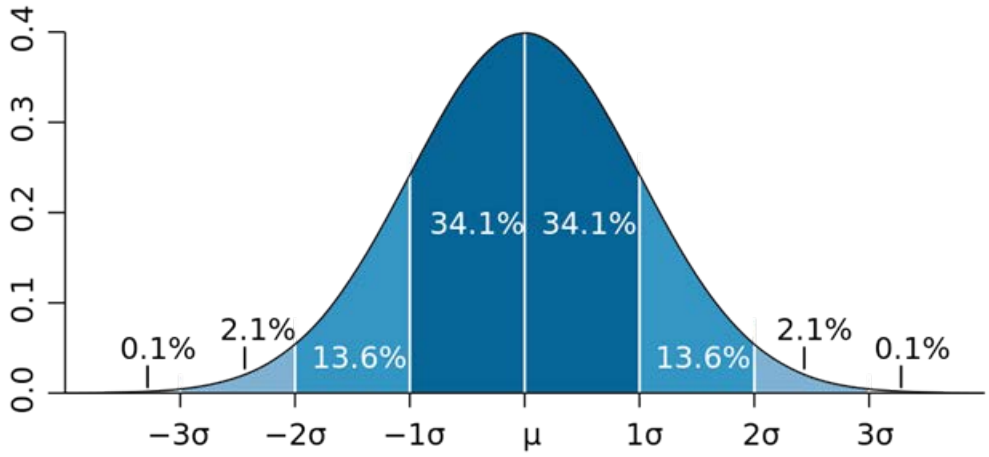
1. Like all bell-shaped and symmetrical curves, the mean, median, and mode in the normal distribution are all equal and at the highest point of frequency distribution.

2. Many physical and psychological traits approach being distributed in a normal curve. Psychological tests such as the IQ test are standardized so that the scores form a normal curve.

3. The distribution of cases between the mean and various standard deviations are the same for any normal curve. For example, 34% of data fall between the mean and the first standard deviation (either positive or negative), 14% fall between the first and second standard deviation, and 2% fall between the second and third standard deviation.

4. Here is a diagram of a normal curve, showing the distribution of cases as a function of the mean and standard deviations. Note that σ is the symbol for standard deviation. (Source: Wikimedia Commons)

Figure 5



V. Inferential Statistics

Inferential statistics allow the researcher to determine if results from the study are statistically significant and potentially generalizable beyond the research setting.

A. If a researcher concludes that the difference between groups is statistically significant, he or she is concluding that the results are not due to chance variation and that if the researcher were to conduct the research again, he or she could expect to get comparable results.

GO TO ACTIVITY 5.1

Statistical Significance

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B. The basics of inferential statistics

1. Inferential statistics are based on **probability**. They do not tell the researcher if a hypothesis is absolutely true or false. Rather, they allow the researcher to make conclusions based on probabilities, and there is always a probability that the researcher has made the incorrect conclusion.

2. Inferential statistics do not test the experimental hypothesis directly. Instead, they test the **null hypothesis**, which generally states that the results are due to chance factors and that the independent variable had no effect on the dependent variable.

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3. In addition to the null hypothesis, there is also an **alternative hypothesis** (sometimes called a **research hypothesis** or an **experimental hypothesis**) that says that the results are not due to chance—that is, the results are hypothesized to be due to the independent variable.

4. Researchers hope to reject the null hypothesis and indirectly support the alternative hypothesis.

5. If the probability is very small that the obtained results were due to chance, then the researcher will reject the null hypothesis and say the results are not due to chance but must reflect systematic differences, presumably from the independent variable.

    a. In other words, a test of significance indicates the probability of the null hypothesis being true.

    b. This is known as finding **statistically significant results**. It means the results are not due to chance and if the experiment were repeated, similar results would likely be obtained.

6. But how unlikely must it be that the null hypothesis is actually true in the population (the results are due to chance) before the researcher is willing to reject the null hypothesis? Before beginning the study, the researcher selects a level of significance that she or he will use to determine the cut-off for "unlikely." If the probability that the null hypothesis is true is less than or equal to the preselected level of significance, the null hypothesis is rejected. Otherwise, the researcher fails to reject the null hypothesis. The probability used to determine the decision regarding the null hypothesis is usually either $p = .05$ or $p = .01$. It may help students to conceptualize p as the percentage of the likelihood of the results being due to chance.

7. Note, however, that there is still a small probability that the results are due to chance and the researcher has made an error.

GO TO ACTIVITY 5.1

Statistical Significance

ADVANCED

C. There are many tests of significance that are used for different situations.

1. The most common are *t* tests and analysis of variance (ANOVA), but there are multiple kinds of each of these tests, and there are many other kinds of tests. The most appropriate test is determined by the type of research design and the number and type of variables measured.

2. No matter what kind of test is used, the test usually tells the researcher the probability that the results are due to chance, or the probability that the null hypothesis is true given the obtained results.

Critical Thinking Exercise

H. Collect some data from your class, such as favorite restaurant, number of shoes owned, amount of time spent on computer, favorite movie, highest bowling score, etc., and use the data to practice using descriptive statistics.