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within subject group
In a within-subjects design, or a within-groups design, all participants take part in every condition. It's the opposite of a between-subjects design, where each participant experiences only one condition.

A within-subjects design is also called a dependent groups or repeated measures design because researchers compare related measures from the same participants between different conditions
.
Independent groups design is an experimental design where different participants are used in each condition of the experiment.

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Lecture 01

INTRODUCTION TO EXPERIMENTAL PSYCHOLOGY

Introduction to the Course

The course has the following objectives;

- To familiarize course participants with the field of Experimental Psychology, Experimental Research, and various types of Experimental designs
- To initiate an understanding of cognitive processes
- To develop an investigative and experimental approach among students

At the end of course you will be able to:

- Understand and describe important findings of experimental research
- Plan and design experiments
- Develop an interest in experiments and an experimental approach to investigation
- Learn about mental processes such as Perception, Learning, Memory, Reasoning, Problem Solving and Language

The course content

- Definition and history of Experimental Psychology
- Research designs and their procedures
- Cognitive processes; Sensory and Perceptual Processes, Learning and Memory, Reasoning, Decision Making, Problem Solving, Language and Motivation
- Classical as well as contemporary experiments will be discussed such as the famous experiment of little Albert who learned to fear furry animals through classical conditioning (Watson, 1920) and the attachment of infants experiment (Harlow, 1950)

Functions, Aims and Characteristics of Science

The goal of scientific psychology is to understand why people think and act as they do. In contrast to nonscientists, who rely on informal and secondary sources of knowledge, psychologists use a variety of well-developed techniques to gather information and develop theoretical explanations? The curiosity is at the bases of this exercise. Nonscientific people also have curiosity like children to know about the reasons for certain happenings but the difference is that scientists use objective and empirical methods and obtain information through these methods.

The scientific method is a valid way to acquire knowledge about the world around us. What characteristics of the scientific approach make it a desirable way to learn about and arrive at beliefs about the nature of things? Perhaps the best way to answer this question is to contrast science with other modes of fixing belief, since science is only one way in which beliefs are formed. More than one hundred years ago, the American philosopher Charles Sanders Peirce (1877) compared the scientific way of knowing with three other methods of developing beliefs. He called these the **authority, tenacity,** and **a priori methods.**

1) Authority method

According to Peirce, the simplest way of fixing belief is to take someone else's word on faith. A trusted authority tells you what is true and what is false. Young children believe what their parents tell them simply because mother and father are always right. As children get older, they may discover, unhappily, that Mom and Dad are not always correct when it comes to astrophysics, macroeconomics, computer technology, and other specialized fields of knowledge.

Although this may cause children to doubt some of their parents' earlier proclamations, it may not result in utter rejection of this method of fixing belief. Instead, some other authority may be sought. Religious beliefs are formed by the method of authority. Long after children have rejected their parents as the source of all knowledge, particularly about religious doctrine, they may still believe that the religious scholars are authority on matters of faith and next world.

Believing the news you see on television means that you accept CNN or some other news network as an authority. You may believe your professors because they are authorities. Since people lack the resources to investigate everything they learn, much knowledge and many beliefs are fixed by the method of authority.

2) Tenacity method

Another method of fixing belief is one in which a person steadfastly refuses to alter acquired knowledge, regardless of evidence to the contrary. The method of tenacity, as it was termed by Peirce, is commonly seen in racial bigots who rigidly cling to a stereotype even in the presence of a good counterexample. Although this method of maintaining a belief may not be entirely rational, we cannot say it is completely without value. The method of tenacity allows people to maintain a uniform and constant outlook on things, so it may relieve them from a certain amount of stress and psychological discomfort.

3) A priori method

The third nonscientific method of fixing belief discussed by is a priori. In this context, the term a priori refers to something that is believed without prior study or examination. Propositions that seem reasonable are believed. This is an extension of the method of authority. However, there is no one particular authority being followed blindly in this method. The general cultural outlook is what seems to fix belief a priori. People once believed the world was flat, and it did seem reasonable to suppose that the sun revolved around the earth as does the moon. Indeed, the world does look flat if you are not in a spacecraft.

The **scientific method** fixes belief on the basis of experience. Science is based on the assumption that events have causes and that we can discover those causes through controlled observation. This belief, that observable causes determine events, is known as **determinism**. If we define **scientific psychology** (as well as science in general) as a repeatable, self-correcting undertaking that seeks to understand phenomena on the basis of **empirical observation**, then we can see several advantages to the scientific method over the methods just outlined. Let us see what we mean by **empirical** and **self-correcting** and examine the advantages associated with those aspects of science.

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- The first advantage of the scientific method is its emphasis on **empirical observation**. None of those other methods relies on data (observations of the world) obtained by systematic observation.
- The second advantage of science is that it **offers procedures for establishing the superiority of one belief over another**. People can hold different beliefs and only way this problem can overcome is through basing a belief in data. In principle, anyone can make an empirical observation, which means that scientific data can be public and can be repeatedly obtained. Through public observations, new beliefs are compared with old beliefs, and old beliefs are discarded if they do not fit the empirical facts. This does not imply that each and every scientist instantaneously drops outmoded beliefs in favor of new opinions. Changing scientific beliefs is usually a slow process, but eventually incorrect ideas are weeded out.

Note: Empirical, public observations are the cornerstone of the scientific method, because they make science a self-correcting endeavor. Science is also progressive because it builds upon previous knowledge and takes it forward.

It is important to understand the following terms in order to understand the scientific nature of experimental Psychology;

- **Empirical**: Scientific method relies on experience more than on other means of knowledge.
- **Objective:** A way of obtaining knowledge by means of objective observation (wholly depend on data).
- **Self-Correcting**: New evidence is constantly being discovered that may contradict existing knowledge.
- **Progressive**: New evidence adds to existing knowledge and takes it forward, building upon what we already know.
- **Tentative:** It never claims to have the whole truth on any question as new information may make current knowledge obsolete at any time.
- **Parsimonious:** one should use the simplest explanation possible to account for a given phenomenon.
- **Concerned with Theory:** Its major concern is the development of a theory of how something works.

Empirical approach

- Science uses an empirical approach. Empiricism states that the only source of knowledge comes through our senses.
- These include sight, hearing, touch, taste and smell as well as kinetic senses.
- Cognitive psychology is study of our cognitive, processes that underlie the acquiring and retaining of knowledge of world.
- Hence there is much overlap between Experimental Psychology and Cognitive Psychology.

Experimental psychologists are interested in exploring theoretical questions, often by creating a hypothesis and then setting out to prove or disprove it through experimentation. They study a wide range of behavioral topics among humans and animals, including sensation, perception, attention, memory, cognition and emotion.

Experimental approach can be applied in many areas, such as child, social, positive and educational psychology. While every branch of psychology strives to understand human behavior and thought, experimental psychology solely focuses on controlled experiments with designated variables, test subjects and statistical results.

Historical Background of Experimental Psychology

"Psychology has a long past, but only a short history"
Hermann Ebbinghaus

Origin of Experimental Psychology

Philosophy and Physiology

- The development of a scientific Psychology was based on **Dualism theory** which says that mind and body are separate entities and operate according to different principles.
- The earlier philosopher, **Descartes** (1596–1650) gave idea of mutual interaction: the body could affect the mind, and the mind could influence the body.
- **Darwin's revolutionary theory** sparked interested in the relationship between biology and psychology.
- In the early 1900's, pioneering psychologists started using natural science to analyze and explain the human mind. For example, **E. B. Titchener** coined the phrase **associationism**, which referred to the idea that complex cognitive processes could be explained through simple mental activities. This theory was central to reductionist-driven structuralists.
- It is to be noted that Psychology emerged as science taking inspiration from developments in natural and physical sciences and served as aspiration of earliest psychologists to become a science.
- Break from philosophy was seen as a move towards becoming scientific.
- We must remember that human mind and behavior is too complex to be studied in same way as science studies natural phenomena. There are two problems; one is that a human mind is studying its own mental processes; hence objectivity is not at same level as human mind studying a lower level of matter or consciousness. Second problem is devising methods that ensure empirical standards that science demands.
- Philosophers and other theorists have speculated about human thought processes for more than twenty-three centuries. For example, the Greek philosopher **Aristotle** (384 –322 BC) examined topics such as perception, memory, and mental imagery. He also discussed how humans acquire knowledge through experience and observation. Aristotle emphasized the importance of empirical evidence, or scientific evidence obtained by careful observation and experimentation. His emphasis on empirical evidence and many of the topics he studied are consistent with twenty-first-century cognitive psychology. In fact, **Leahey** (2003) suggests that

Aristotle could reasonably be called the first cognitive psychologist. However, psychology as a discipline did not emerge until the late 1800s.

- Experimental psychology emerged as a modern academic discipline in the 19th century when **Wilhelm Wundt** introduced a mathematical and experimental approach to the field. A central researcher in the history of psychology is Wilhelm Wundt (pronounced "Voont"), who lived in Leipzig, Germany between 1832 and 1920.
- Historians often give credit to Wundt for creating the new discipline of psychology—a discipline that was separate from philosophy and physiology. Within several years, students journeyed from around the world to study with Wundt, who taught about 28,000 students during the course of his lifetime.
- Wundt proposed that psychology should study mental processes, using a technique called **introspection**. Introspection, in this case, meant that carefully trained observers would systematically analyze their own sensations and report them as objectively as possible. Wundt founded the first psychology laboratory in Leipzig, Germany.

Reference; Cognition by Margaret Matlin, seventh e Edition. Wiley and sons, Inc. pages 4-7.

Major contributions to Early Period of Experimental Psychology

Other major contributions to early period of Experimental psychology are;

- Another important German psychologist, named **Hermann Ebbinghaus** (1850–1909), focused on factors that influence human memory. He used non sense syllables to study memory processes such as recency effect.
- **William James** (1842–1910). James was not impressed with Wundt's introspection technique or Ebbinghaus' research with nonsense syllables. Instead, James preferred to theorize about our everyday psychological experiences. He is best known for his textbook **Principles of Psychology**, published in 1890. The particular school of thought in Psychology developed under influence of James is called Functionalism that emphasizes purpose and function of a mental phenomenon rather than examining structures in brain.
- **Gustav Fechner**, 1801-1887 was a German experimental psychologist who developed the idea of the "**just noticeable difference**" (JND), which is considered to be the first empirical psychological measurement. Fechner was a student of **Ernst Weber**, (1795–1878), a German physician whose work on measuring properties of physical stimuli such as light and weight that are bases for sensory experience led to understanding of relationship between physical stimuli and psychological experience. Taking forward Weber's work, Fechner initiated the study of Psychophysics in Experimental Psychology.
- Two good source books on history of Experimental Psychology are;
  - A History of Modern Experimental Psychology; From James and Wundt to Cognitive Science by George Mandler, 2007, MIT Press, Massachusetts, USA, London, England.
  - A classic book; History of Experimental Psychology by Edwin G. Boring, published 1929 and 1950.

The Nature of Scientific Explanation

Science is basically a method of attaining knowledge and there are two ways to learn about human behavior: Non-**empirical Methods** (Non-scientific Methods) and **Empirical Methods** (Scientific Methods)

- Non empirical methods are not necessarily based on experience and can rely on authority or intuition
- Empirical methods are based on logic and scientific investigation.

The four goals of scientific methods are;

1) **Description**; for example, an interesting study these days could be how people of a certain area interact or shop when lock down is released during pandemic. Another example can be how mothers use touch to calm down crying babies.
2) **Explanation**; for example, aggression is learned through modeling, an act or belief that is reinforced it will re occur or success experiences build self-efficacy.
3) **Prediction**; examples of predictions in experiments; such as, those who received training will do better in examinations. Exercise will reduce blood pressure and inducing hope will lead to better recovery
4) **Control**; for example, how children are taught to share their toys or can anxiety be reduced through technique of muscle relaxation?

Lecture 02

THEORIES IN SCIENTIFIC PSYCHOLOGY

Theories in Scientific Psychology

A theory can be crudely defined as a set of related statements that explains a variety of occurrences. The more the occurrences and the fewer the statements, the better the theory for example theory of gravity is a powerful theory. The law of gravity explains falling apples, the behavior of roller coasters, and the position of bodies within the solar system. With a small number of statements about the mutual attraction of bodies, it explains a large number of events. It is therefore a powerful theory.

A powerful theory in psychology is classical conditioning, explaining learning through association between stimuli. Operant conditioning is also a powerful theory as it systematically explains the effect of reward be it reinforcement or punishment on a behavioral response. It has led to many interventions and controlled experiments and has been tested again and again.

We must remember that theories in psychological science are not as quantified and precise as theories in older sciences such as physics. There are psychological events that a theory cannot explain.

Major functions of theory in psychology:

- **Organization of data**: it provides a framework for the systematic and orderly display of data
- **Prediction**: it allows the scientist to generate predictions for situations in which no data have been obtained

Theories cannot be tested directly. There is no single magical experiment that will prove a theory to be correct or incorrect. Instead, scientists perform experiments to test theories. These experiments are based on assumptions and hypotheses drawn from the theory.

Theories and Hypotheses

Certain basic elements are shared by all approaches to science. The most important of these are **data** (empirical observations) and **theory** (organization of concepts that permit prediction of data. Scientists emphasize data and view progress as working from data to theory. Such an approach is an example of induction, in which reasoning proceeds from particular data to a general theory. The opposite approach which emphasizes theory predicting data is called **deduction**; here, reasoning proceeds from a general theory to particular data.

Difference between generalization and Hypothesis

A **hypothesis** is a very specific testable statement that can be evaluated from observable data.
For example, we might hypothesize that drivers older than sixty-five years would have a higher frequency of accidents involving right turns across oncoming traffic when driving at night than do younger drivers.
A **generalization** is a broader statement that cannot be tested directly.

For example, we might generalize that older drivers are unsafe at any speed and should have restrictions, such as not being able to drive at night, on their driver's license. Since "unsafe at any speed" is not clearly defined.

A good theory can produce many generalizations and each generalization can be developed into more than one hypothesis. You may have firsthand experience of being a passenger in a car driven by a grandparent, and that experience may have caused you to agree with the generalization. This is an **inductive process** based upon data, namely casual observation of the driving behavior of elderly citizens.

Hypotheses derived from inductive process are called **common-sense hypotheses**.

- **Induction**: reasoning proceeds from particular data to a general theory
- **Deduction**: reasoning proceeds from a general theory to particular data

Criteria for a Theory

- Theory is based on some evidence or reasoning process
- It involves statement of processes underlying behavior or personality that can be turned into hypotheses
- Theory addresses a phenomenon and provides a logical explanation of that phenomenon

Social Learning theory

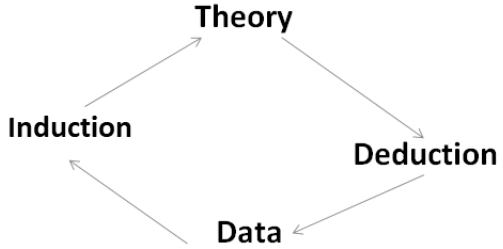
Children learn a behavior through process of modeling, by observing others. Theory may be based on number of generalized observations but it has generated specific hypotheses; Children observing another person hitting a doll will tend to do the same. Children watching a sharing of a toy will tend to copy that behavior.

Diffusion of responsibility

Social loafing which is *a tendency to put in less effort when working in groups* has been observed in number of situations. The theory diffusion of responsibility explains this by stating that in presence of large number of others, the responsibility tends to diffuse to others. Latané's studies of social loafing are an example how an interesting problem can be brought into a laboratory setting and studied in a controlled manner.

A Theory Organizes and Predicts Data

- By means of **deduction**, particular observations (data) may be predicted.
- By means of **induction**, the data suggest organizing principles (theories).
- This circular relationship shown in figure below indicates that theories are tentative pictures of how data are organized.



A good theory is fallible, means that it can be disproved. Both induction and deduction approaches have advantages, for example social loafing

observations and experimentation led to more general theory of Diffusion of responsibility which in turn guided specific hypotheses in situations other than social loafing for example a phenomenon known as bystander behavior, when people watch others in need of help and do nothing because there are lot of people around and responsibility is diffused.

Lecture 03

THE EXPERIMENTAL METHOD IN SCIENCE OF PSYCHOLOGY (I)

The Experimental Method in Science of Psychology

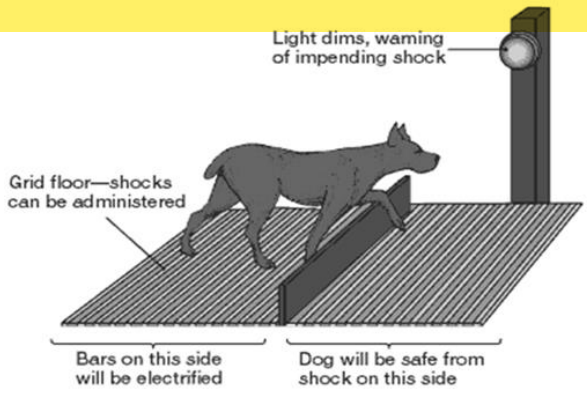
Scientific Psychology uses many methods to understand human behaviour such as **Naturalistic Observation**, **Survey** and **case studies**. Same behaviour or mental process can be studied through variety of methods, for example children helping behaviour can be observed and reported by mother or studied individually in case study. It can also be studied in lab experiments. When similar results are observed through various methods, it strengthens the theory.

An **experiment** is an investigation in which a hypothesis is scientifically tested. An independent variable (the cause) is manipulated and the dependent variable (the effect) is measured while any extraneous variables are controlled.

Examples

Independent	**Dependent**
No of stimuli	Reaction time
Food Deprivation	Rate of bar pressing
Exercise	Weight
Word length	Accurate recall
Study method	Grades

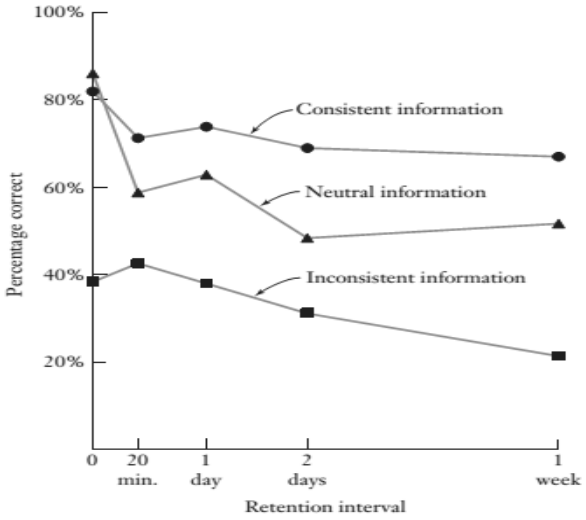
In *learned helplessness* experiment by Martin Seligman, the dogs did not try to escape the shocks if they had been conditioned through previous experience that they could not escape. Seligman proposed that when people or animals feel helpless to avoid negative situations they learn helplessness.



Another example of classical experiments in psychology is the study of memory. In the classic experiment on the **misinformation effect**, **Elizabeth Loftus** and her coauthors (1978) showed participants a series of slides. In this sequence, a sports car stopped at an intersection, and then it turned and hit a pedestrian. Half the participants saw a slide with a yield sign at the intersection; the other half saw a stop sign. Twenty minutes to a week after the participants saw the slides, they answered a questionnaire about the details of the accident. A critical question contained information that was either consistent with a detail in the original slide series, inconsistent with that detail, or neutral (i.e., did not mention the detail). For example, some people who had seen the yield sign were asked, "Did another car pass the red Datsun while it was stopped at the yield sign?" (consistent). Other people were asked, "Did another car pass the red Datsun while it was stopped at the stop sign?" (inconsistent). For still other people, the question did not mention the sign (neutral). To answer this question, all participants saw two slides, one with a stop sign and one with a yield sign. They were asked to select which slide they had previously seen.

As Figure below shows, people who saw the inconsistent information were much less accurate than people in the other two conditions. They selected a sign, based on the information in the questionnaire, rather than the original slide.

The Effect of Type of Information and Delay on Proportion of Correct Answers.



Source: Loftus et al., 1978.

Another example of experiments is based on more recent positive psychology research. Participants' mood is assessed then they are asked to count their blessings and afterwards their mood is re-assessed. Science of psychology has conducted much meaningful research that has application in many areas of practical life. These and hundreds of other experiments in science of Psychology show the strength of experimental method providing direct evidence of relation between independent and dependent variable or effect of a variable on behavior.

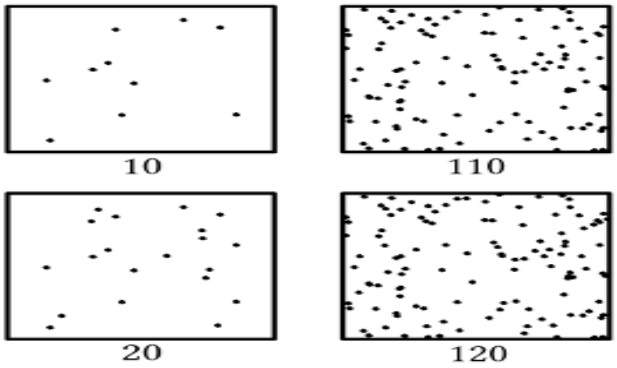
This raises the question about merits of experimental method. Experimental method has following advantages and strengths;

- **Causality** – can determine direct cause of a phenomenon hence establishing causality.
- **Control**- there are many variables and circumstances that can influence human response in any situation. Experimental method controls all variables except the one that researcher is interested in.
- **Precision** - experimental method is precise and focuses on exact study variables.
- **Objective** – experimental method is objective as it only draws conclusions based on observed data.
- **Easier to replicate**- scientific experiments can be repeated by later researchers as all procedures are openly described. This is called replication. The process of replication makes it possible for other researchers to verify the findings.

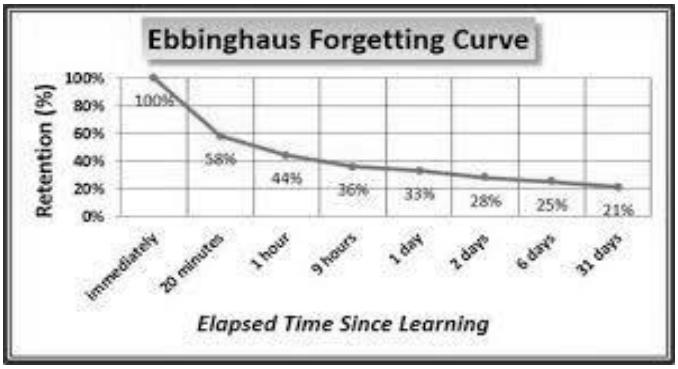
Famous Early Experiments

Sensation and perception

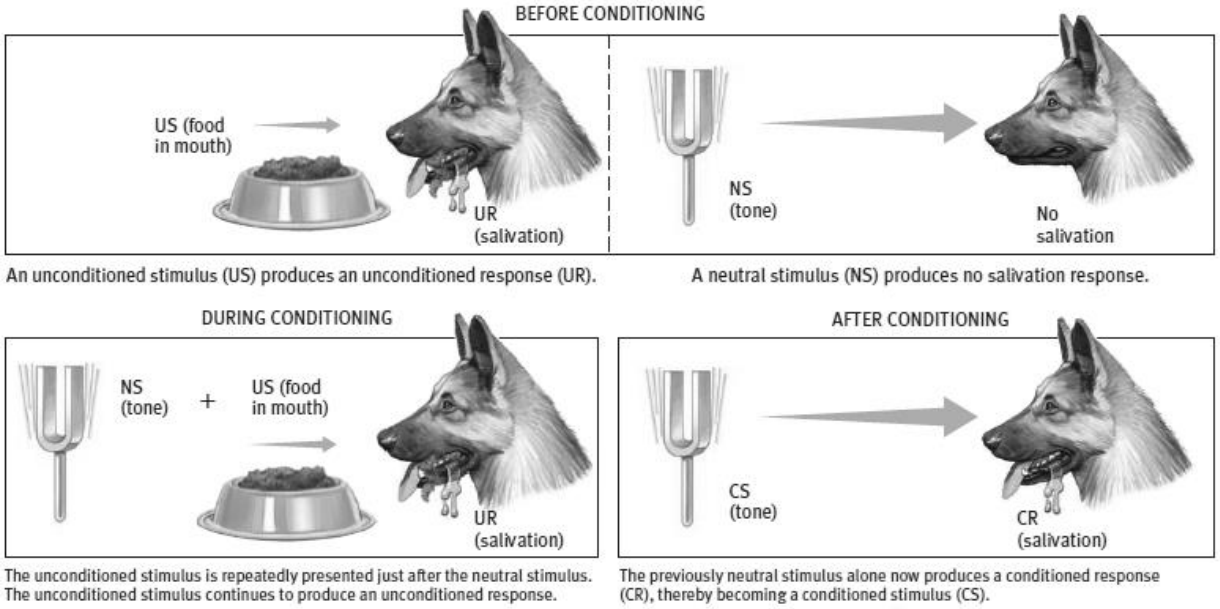
Weber and **Fechner's Law** defines the the relation between the actual change in a physical stimulus and the perceived change- 1834



Ebbinghaus forgetting curve describes the decrease in ability of the brain to retain memory over time, 1885 .



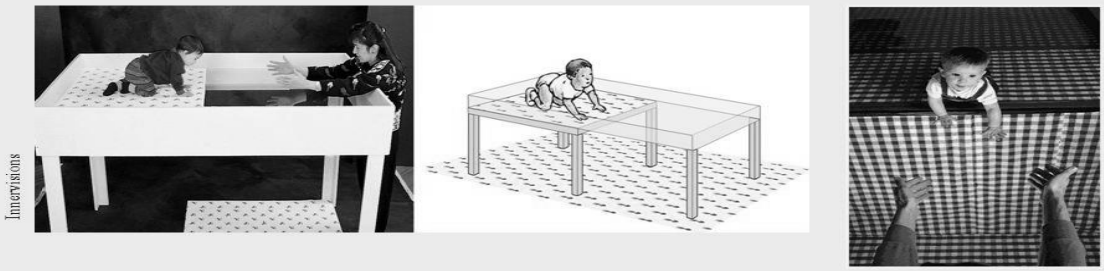
Classical Conditioning, Ivan Pavlov, 1902.



Conditioning among human infants, Watson, 1920

Depth Perception

Depth perception enables us to judge distances. Gibson and Walk (1960) suggested that human infants (crawling age) have depth perception. Even new born animals show depth perception.

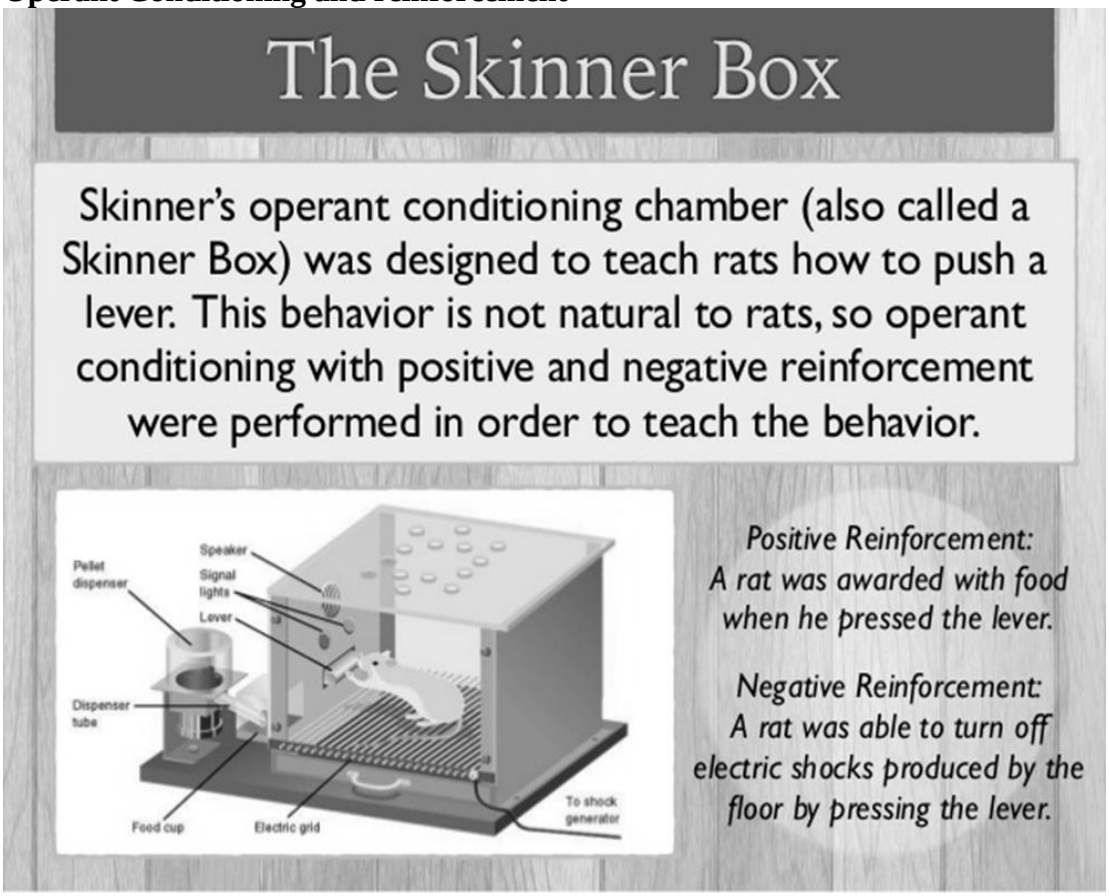


Visual Cliff Experiment-Eleanor Gibson

Modeling and vicarious learning

Albert Bandura (1960s) demonstrated that children are able to learn through the observation of adult behaviour.

Operant Conditioning and reinforcement



These experiments will be discussed in detail in later relevant topics.

Contemporary Experiments

We define contemporary in terms of experiments conducted later than 1970s.

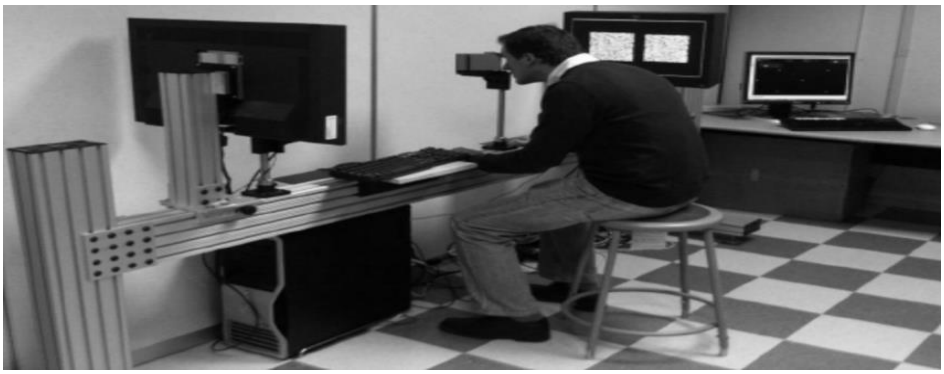
What has changed?

- Advancement in techniques
- Statistical and computational formulas
- More complex models
- Stricter ethical control
- Building on the existing theories
- Contesting earlier theories
- Subject matter and areas of study

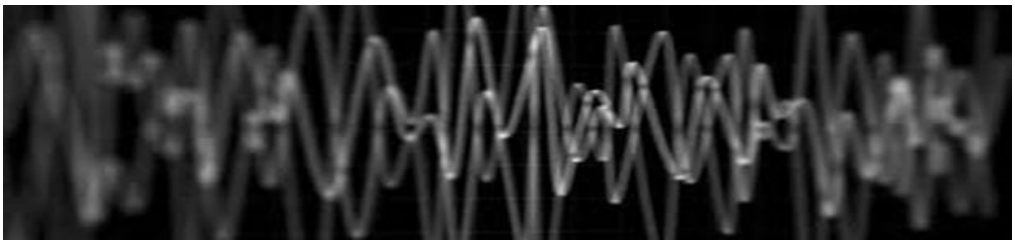
These points are discussed in detail below;

Advancement in techniques

When you take a look at the images below, you will notice that laboratory settings as well as experimental procedures have gone through tremendous refinement.

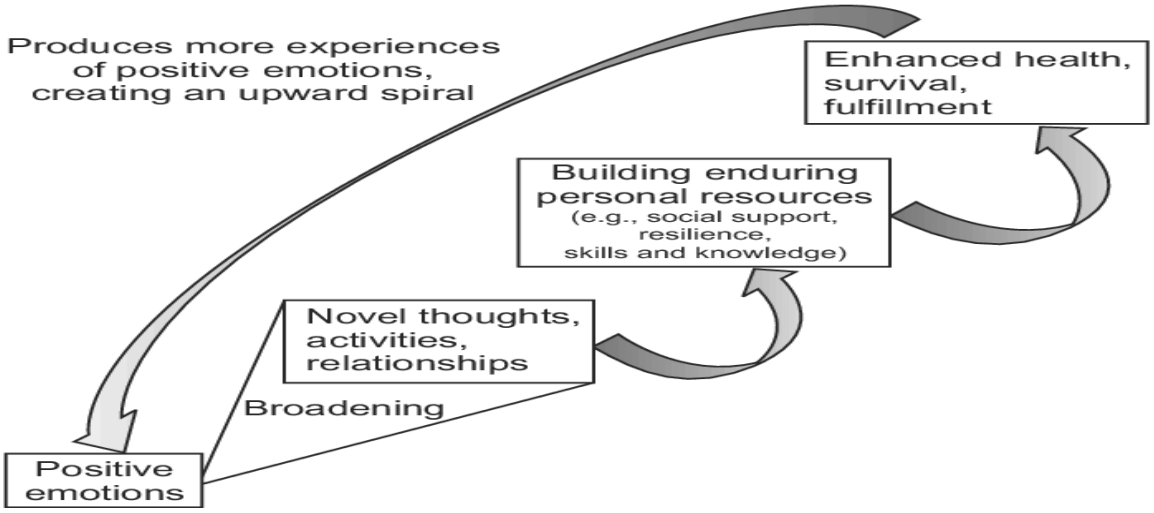


Sleep and pain lab at University of Warwick, UK



Theoretical Models

Theoretical progress was made over decades and with that more complex models of human cognitive and perceptual processes were developed. **Barbra Fredrickson** – Broaden and build model of emotions -2004 is one such example. Remember that science is self-correcting as well as progressive. It builds on existing knowledge. Therefore it is to be expected that as Experimental Psychology grew as a discipline, the researchers in this area came up with more advanced, broader and extensive explanations of human behaviour. The amount of studies also grew as did the researchers in this area.



Subject matter and areas of study

Conditioning experiments now include involuntary movements
Emotions and well-being in positive psychology experiments and Social behaviour experiments Scientific nature of experiments and the criteria for good theory continued to be rigorous and experimental investigation was extended to neuroscience and social psychology.

A significant progress in experimental psychology as well as in social sciences research in general was establishing of formal ethical standards for experiments with humans and animals. This means greater Ethical control which was ensured through American Psychological Association standards.

Participant welfare and protection became a central concern and consent of the subjects and participants had to be obtained to meet these standards. All experimental procedures had to be approved before research was carried out.

In topic of Ethics these points will be discussed in more detail.

Experiments in Pakistan

Experiments have been conducted in Pakistan since 1970s. Most of early experiments were in area of Psychophysics, and Learning and Memory. It was much later that experiments on Social behaviour or Emotions were conducted. Even then only few researchers have opted for experimental method in Pakistan. One reason is less training in experimental method due to lack of experimental laboratories. However main reason is the absence of experimental approach among Pakistani psychologists in major academic departments. As modern psychology considers controlled observation through experimental method as more rigorous and meaningful than correlational research, Pakistani research is lagging behind contemporary research being less visible in international publications. Below are some of the experiments conducted in Pakistan;

Early Pakistani experimental research examples

- Reaction Time during fasting (Dr. Hamid Shiekh)
- Can people detect pure ghee by tasting alone without smelling? (Dr. Rafia Hasan)
- Dream content (Dr Najma Najm)
- Muller-Lyer Illusion and Introvert personality (Dr. Seemeen Alam)

These are all student theses or published articles and are available to study in library of Institute of Applied Psychology, Punjab University.

Later Examples

- Intelligence testing
- Meditation reduces anxiety and enhances happiness
- Prejudiced attitudes can be changed
- Group decision making
- Operant Conditioning

Limitations

- Advanced labs need to be set up
- Mind set for experimental approach has to be developed among students and supervisors
- Training students in experimental procedures
- Not all experiments need advanced labs
- Very simple experiments can test assumptions of a theory
- Indigenous measures can be developed

Lecture 04

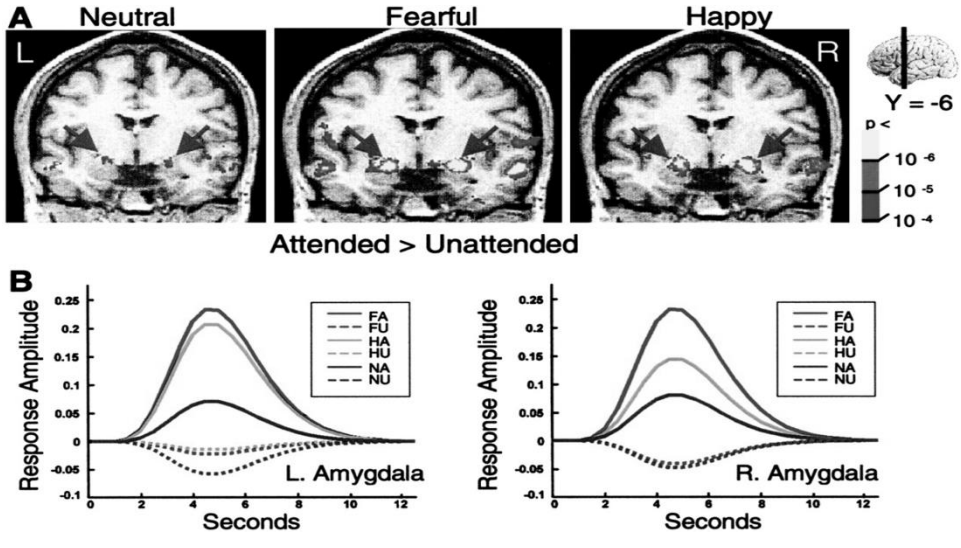
THE EXPERIMENTAL METHOD IN SCIENCE OF PSYCHOLOGY (II)

Some latest Experiments

Examples of some contemporary experiments are given below;

Attention to Emotions

The majority of work on emotion perception has focused on facial expressions. Kret and colleagues (2018, Journal of Comparative Psychology) examined whether attentional biases toward negative emotions are also observed for emotional expressions conveyed through body language, and whether this effect is species-specific. Participants were briefly presented with two pictures of male chimpanzees or people whose body postures indicated fear, anger, or a neutral expression, followed by a dot in the location of one of the pictures.



Human observers, but not chimpanzees, showed the typical emotional dot-probe effect: they were faster to tap the dot on the computer screen when it appeared in the location previously occupied by an angry or fearful expression compared to a neutral expression. People showed this effect regardless of whether the images depicted chimpanzees or people, whereas chimpanzees did not show this effect in either case. Kret and colleagues replicated the standard results in the emotional dot-probe task with emotional body postures in human observers. Iijima and colleagues (2018, Emotion) examined how this attentional bias to negative emotions measured in the lab is associated with anxious mood dynamics in daily life.
Experiencing negative events was associated with increases in anxious mood up to 90 minutes later, but this effect was greater for individuals who showed a larger attentional bias to angry faces in the dot-probe task. However, attentional bias did not affect mood more than 2–3 hours after the negative event, or the total number of negative events reported

Interpretation: Greater attentional bias toward threatening stimuli is associated with enhanced reactivity to stressors, but does not make people more sensitive to negative events or prolong experiences of anxious moods.

Psychology and Real Life

Experimental investigation of a phenomenon is taken up by psychologists for two reasons. Either it interests the researcher or he/she is searching an answer for an unanswered question that has raised their curiosity, or because they want to find solution to a problem. Therefore scientific research is often divided into two categories- **basic research** and **applied research**.

1) **Basic research**

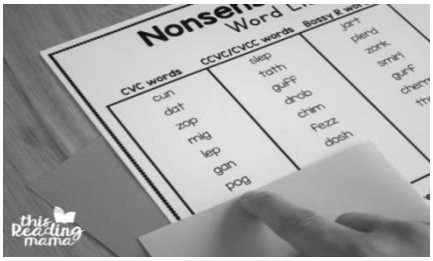
Basic research is often driven from curiosity to look deeply into a phenomenon or process and to investigate it in detail.

Examples

- Structure of neurons
- Pathways involved in perceiving movement
- Studying how caffeine affects brain

2) **Applied research**

Applied research aims at solving a specific problem e.g. how to cure bedwetting or reduce early morning caffeine intake among elderly.



Basic research has no immediate practical goal. Basic research establishes a reservoir of data, theoretical explanations, and concepts that can be tapped by the applied researcher. It takes quite a while for a concept developed by basic research to find some useful application in society. 70 percent of significant application or solutions are due to basic experimental research. However the research occurred twenty to thirty years before the ultimate use of the product.

Conditioning of nonsense syllables, an experiment conducted by Paul Chance (1977) demonstrated that nonsense syllables could be liked or disliked depending upon what these were paired with. This was basic research in classical conditioning, followed by applying same principle to conditioning of biased attitudes towards nationalities.

In an experiment conducted at Institute of Applied Psychology, the participants were presented with a nonsense syllable like pog or gan and either a pleasant or unpleasant word was spoken by the experimenter

Pog	smelly
Gan	cute
Swedish	clean
American	smelly

Conclusion: The prejudice about some nationalities is learned through process of conditioning because two words appear together often for example in media or public discourse.

Many examples of application of basic research in Pakistan can be cited. Principles of conditioning found in basic research have been used to train animals, reduce anxiety and increase desired behaviour like class room discipline. In one training we applied basic research findings from experimental psychology to help employees learn new ways of reacting in conflict situations. Studies in aggression research show that when people know about someone's disability or deficit, they react less to an irresponsible behaviour. We showed video of an interaction between two young men. One is walking and other is riding a bike. They collide on road. Some of the participants were told that the person walking was hard of hearing and did not hear the horn honking of other boy. The others were not told about any such deficit.
Conclusion: Those who were told about a deficit judged him less harshly than those who had no such information.

Advantages of Experiments

As a method of research experimental approach has many advantages over others and of course some limitations too. The advantages are;

Why Experiments

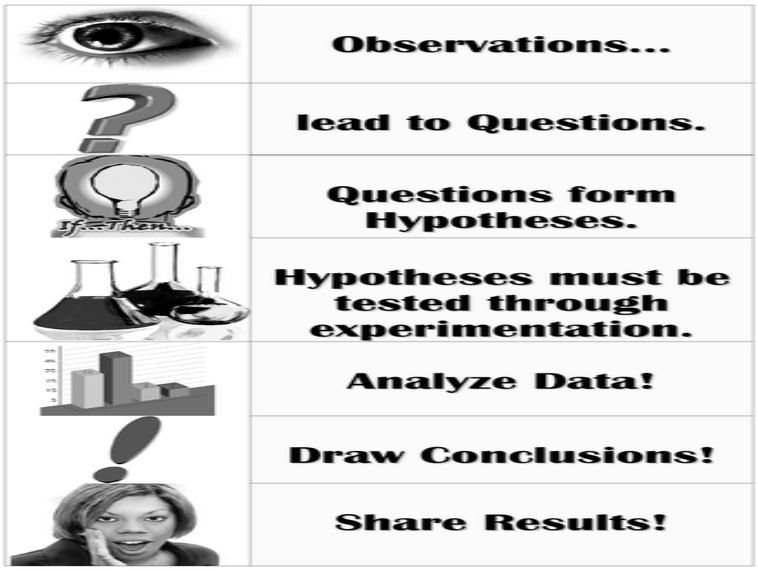
1) **Causality and control**: In an ideal experiment, no factors (variables) except the one being studied are permitted to influence the outcome. Designing experiments so that there can be only one explanation of the results is at the heart of the experimental method. This allows us to make statements about causality. We can say with confidence that the effect we found in lab was due to the independent variable and not due to some other random factor or just by chance.

2) **Precision**: In one of experiments as part of course, it is stated that 20 grains of sugar in water can be detected – water will be perceived as sweet. Hypotheses are very precise and specific. So are measures, observations and factors like time duration, number of trails and so on.

3) **Objective**: It can be observed by others in terms of procedure and results. The experimenter reports what she finds out even if it is against expectation or rejects the hypothesis.

4) **Easier to replicate**: Replication means that others can conduct the same experiment using the procedures reported by experimenter. In experimental psychology, many experiments have been replicated. Findings have been verified by further experiments or if new experiments fail to come up with same results, the theory or phenomenon is considered doubtful as the evidence is inconclusive.

The summing up of experimental approach



Lecture 05

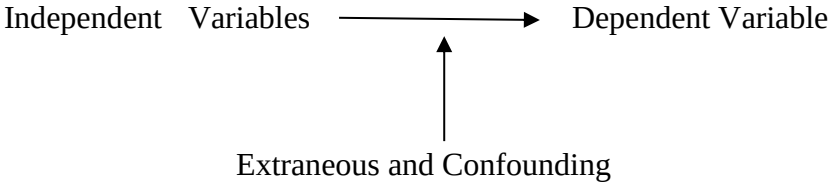
EXPERIMENTAL DESIGN

Variables; Definition

Variables

A variable is an element, feature or factor that can vary or change such as characteristic or value.
Variables play a critical role in the psychological research process.
Variables are generally used in psychology experiments to determine if changes to one thing result in changes to another.

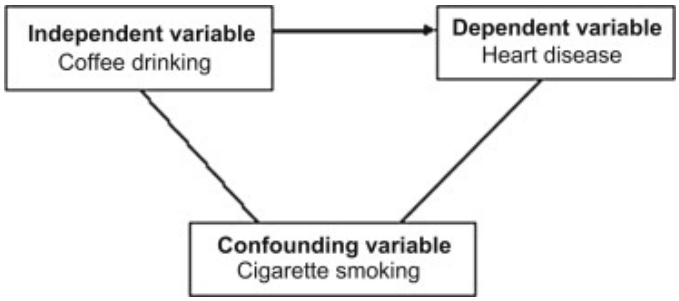
Types of variables



1) **Independent variable:** The independent variable is the variable that is controlled and manipulated by the experimenter. For example**,** in an experiment that tests the impact of sleep deprivation on test performance, **sleep deprivation** would be the independent variable.

2) **Dependent variable:** The dependent variable is the variable that is measured by the experimenter. In our previous example, the scores on the test performance measure would be the dependent variable.

3) **Confounding Variables**: Confounding variables are factors other than the independent variable that may cause a result. These *can* have an impact on the dependent variable and can make it difficult to determine if the results are due to the influence of the independent variable, the confounding variable or an interaction of the two.

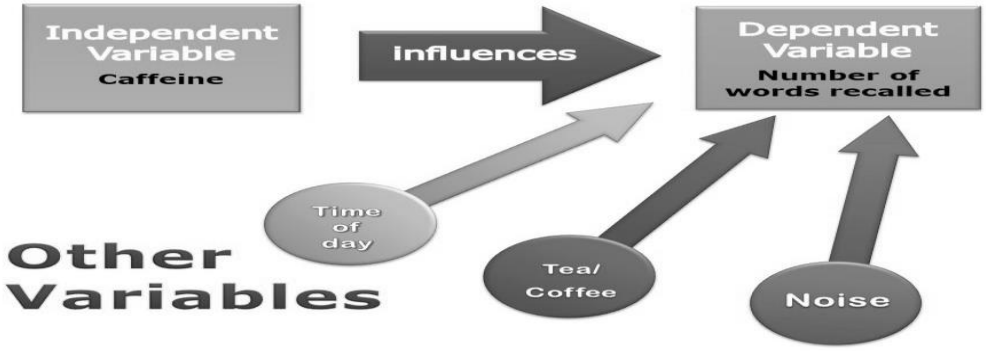


Extraneous Variables

Extraneous variables are any variables that you are not intentionally studying in your experiment but may affect the outcome or result for example temperature or noise in a laboratory or fatigue from a previous task or mere effect of being in presence of an experimenter. In an experiment we are looking to see effect of independent variable on dependent variable. Extraneous are undesirable variables that may interfere with this process of determining effect of IV on DV and often these cannot be controlled.

There are four types of extraneous variables:

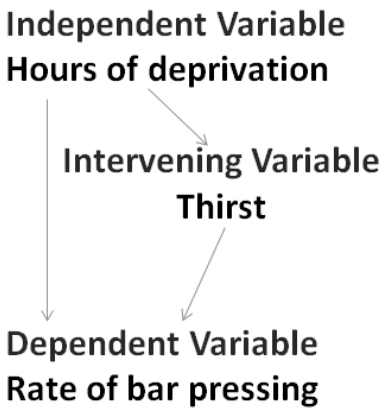
1) **Situational Variables**. These are aspects of the environment that might affect the participant's behavior, e.g. noise, temperature, lighting conditions...
2) **Participant** / Person Variable.
3) **Experimenter** / Investigator Effects. ...
4) **Demand** Characteristics.



Variables; Types

Science tries to explain the world by relating independent and dependent variables. Gravity is a familiar construct that accomplishes this goal. It can relate an independent variable, the feet of height from which an object is dropped, to a dependent variable, the speed of the object when it hits the ground.

Gravity also summarizes the effects of height on speed for all manner of objects. Gravity explains falling apples as well as falling baseballs. Science progresses when a single construct, such as gravity, explains outcomes in many different environments.

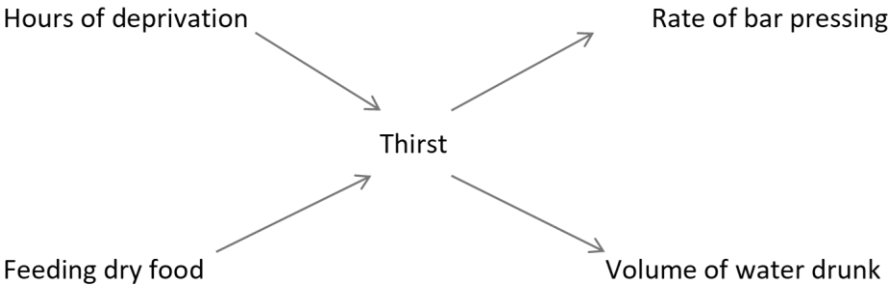


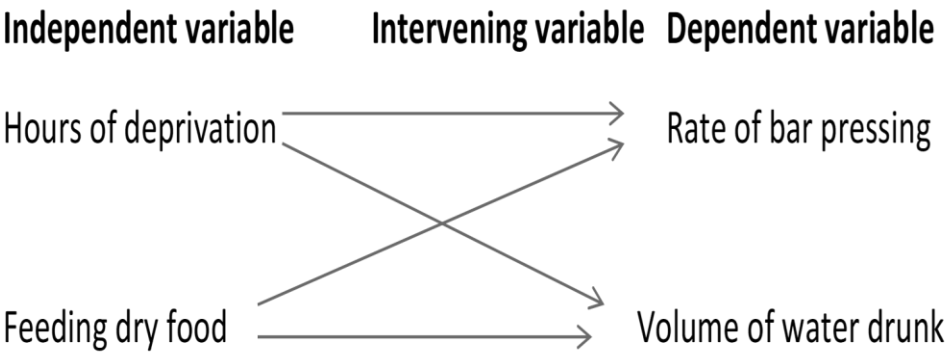
An independent variable, hours of deprivation, is related to a dependent variable, rate of bar pressing. The dependent variable is obtained by placing a rat into a small chamber where it can press a bar to obtain drinking water. The experimenter observes the rate (how many presses per minute) at which the rat presses the bar to get water.

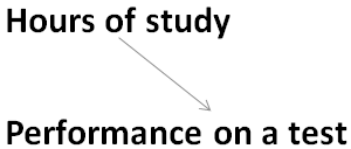
The **direct relationship** uses only one arrow to link hours of deprivation to rate of bar pressing.

The **indirect method** uses two arrows. The first arrow relates hours of deprivation to thirst, an intervening variable. The second arrow relates the intervening variable, thirst, to the rate of bar pressing.

Two independent variables







Control Variables

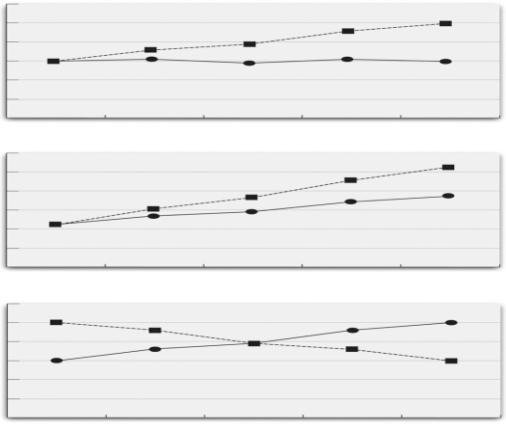
A control variable is a potential independent variable that is held constant during an experiment because it is controlled by the experimenter. For any one experiment, the list of relevant control variables is quite large, far larger than can ever be accomplished in practice.
In even a relatively simple experiment—for example, requiring people to memorize three-letter syllables—many variables should be controlled. Time of day changes your efficiency; ideally, this should be controlled. Temperature could be important, because you might fall asleep if the testing room were too warm. Time since your last meal might also affect memory performance. Intelligence is also related.

Interaction between variables; concept

Concept of Interaction

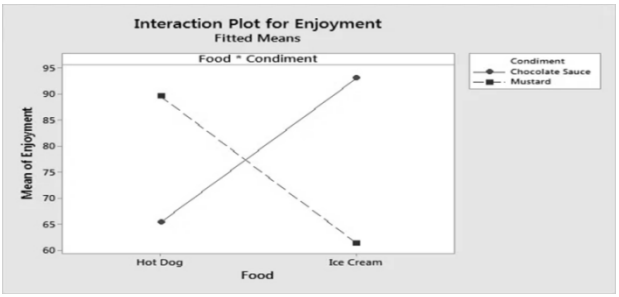
There is an interaction between two independent variables when the effect of one depends on the level of the other. Some of the most interesting research questions and results in psychology are specifically about interactions.

One of the independent variables is quantitative and the results are plotted in a line graph



In the top panel, one independent variable has an effect at one level of the second independent variable but not at the other. In the middle panel, one independent variable has a stronger effect at one level of the second independent variable than at the other. In the bottom panel, one independent variable has the opposite effect at one level of the second independent variable than at the other.

Requiring people to memorize three-letter syllables
1) Time of day changes your efficiency
2) Intelligence



Interaction Between Variables; Examples

In a research report titled "When God Sanctions Killing," Bushman, Ridge, Da, Key, and Busath (2007) described a laboratory study of aggression. Participants read a violent passage that purportedly came from either the Bible or an ancient scroll. Following that, they performed an additional task that allowed them to present loud sounds to another subject in the experiment. They controlled the intensity of this sound; higher intensities were interpreted as revealing greater aggression.

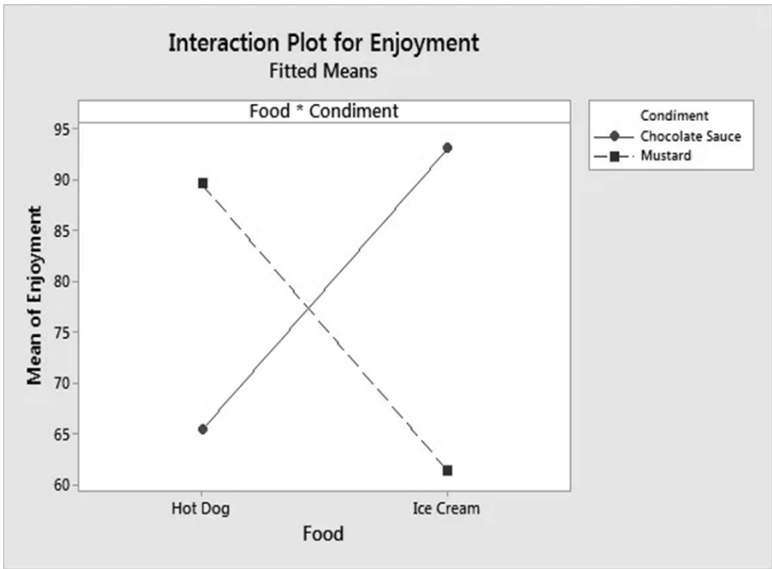
The dependent variable was the number of times participants selected the highest noise levels in a set of 25 trials. Therefore, aggression scores could range from a low of 0 to a high of 25.
There were two independent variables. The first was the source of the violent passage: either the Bible or an ancient scroll. The second independent variable was whether or not the subject believed in God; this is a special type of independent variable, called a subject variable.
Results from this experiment are shown in Figure 3.1, with each independent variable plotted by itself. Reading a passage from the Bible produced greater aggression.

Subjects who believed in God also acted more aggressively.
This simple interpretation of the results, while correct, is incomplete. Here both independent variables are plotted on the same graph, making some relationships easier to see. If there was no mention of God because the passage came from an ancient scroll, subjects who believe in God and subjects who do not believe in God exhibited similar levels of aggression.

When the passage contains no mention of God, belief in God has no effect upon aggression. But when the passage comes from the Bible, the increase in aggression is greater for subjects who believe in God than for subjects who do not believe in God. This is an interaction.
Remember, an interaction between two independent variables indicates that effects produced by one independent variable (belief in God) are not the same at each level of a second independent variable (source of the passage). But when God sanctioned violence because the passage came from the Bible, greater levels of aggression were exhibited by those subjects who believe in God.

Interaction between variables; examples

Many experiments include two or more independent variables; this means that the results may contain an interaction. Because of the frequency with which you are likely to encounter interactions, we present another example of a two-variable experiment to help you practice interpreting the results of complex experiments.



In the experiment on **social loafing by Brickner, Harkins, and Ostrom (1986),** the authors wanted to determine the effect of personal involvement in a task on the amount of social loafing shown on that task. Low-involvement tasks, such as clapping and generating uses for a knife, had been used in earlier research on social loafing.

The authors reasoned that the effort devoted to a task should be related to the intrinsic Importance or personal significance that the task has for the Individual. High personal involvement in a task should reduce social loafing, because individuals should put forth a substantial amount of effort on such tasks, regardless of whether their individual performance is monitored. So, the researchers varied the subjects' involvement in the task and also varied the amount that individual effort could be assessed

The researchers varied the subjects' involvement in the task and also varied the amount that individual effort could be assessed. If their reasoning was correct, there should be an Interaction: Low involvement should lead to social loafing (reduced effort when the individual's effort cannot be assessed), but high involvement should lead to about the same amount of effort, whether or not individual effort could be identified.

Brickner and associates had college students generate as many thoughts as they could in a 12-minute period about a proposal to implement senior comprehensive exams, which a student would have to pass in order to graduate. In the high-involvement condition, the students were led to believe that the proposal would be instituted at their college prior to their graduation.
The addition of comprehensive exams as one prerequisite to graduation should have high personal relevance. In the low personal-involvement condition, the students were led to believe that the exams would be instituted later, at another college.

The possible identifiability of individual effort was also manipulated by instructions. Subjects wrote each of their thoughts about comprehensives on an individual slip of paper.

In the low-identifiability condition, the subjects were told that their thoughts would be collected together with those of other subjects, because the committee evaluating the thoughts wanted to assess the range of opinions for the group as a whole. In the high-identifiability condition, the subjects were told that their opinions would be considered separately from those of others, because the committee in charge wanted to assess individual responses.

To summarize, the dependent variable was the number of thoughts generated in the four conditions: low identifiability and low involvement; low identifiability and high involvement; high identifiability and low involvement; and high identifiability and high involvement.

Results of the Experiment by Brickner, Harkins, and Ostrom (1986), Showed an Interaction. Social loafing (low numbers of thoughts generated with low as opposed to high identifiability) occurs with a low-involvement task but not with a high involvement one.

Lecture 06

Experiments in Social Psychology

Experiments in Social Psychology

Research of social issues

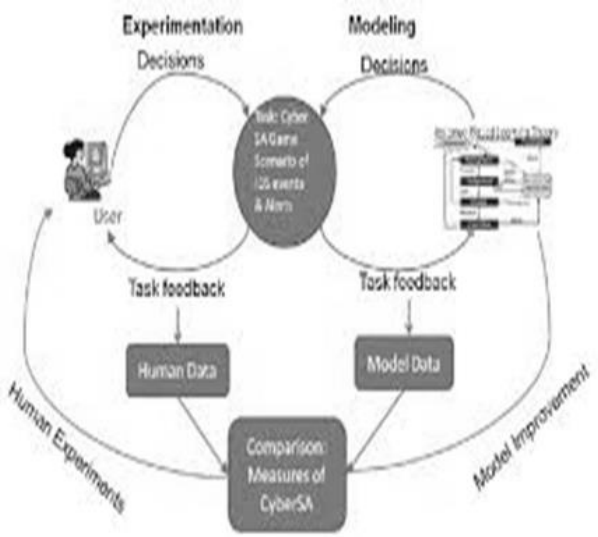
- Racial Stereotypes: Effect of Profile Characteristics and Media Priming
- First impression bias refers to the process by which people's opinion of others is highly influenced by the very first piece of information they received (Lim et al., 2000). Impressions can be greatly influenced by previously learned racial stereotypes.
- Exposure to social cues can reactivate said stereotypes (Arendt, 2013) and how negative media priming can strengthen them (Arendt, 2015).
- This study sought to provide evidence in how first impression bias can be affected by racial stereotypes and explore how media priming shapes said bias.
- The study consisted of a 2 x 2 experimental design; participants either received the priming or not (IV1) and read a profile stereotypical of a minority or majority racial group (IV2).

Results showed a significant effect of the stereotype profiles, and no significant effect of media priming, that is, participants rated the low profile as a minority and the high profile as a majority, but these judgements were not affected by the priming. However, there was a significant interaction, suggesting that media priming strengthened the racial stereotypes.
These results imply that first impressions are affected by preexisting unconscious stereotypes that must be actively addressed and shows the power that media has in shaping these encounters. Future research should study the effect of positive and negative media priming.

Strengths: Effectively randomized the groups so the participants were unable to detect what we were testing; the distractor exercise was effective; the amount of information given in each story was very similar and contained the same type of information.

Limitations: Small sample size; the participant's race as well as the race that is a majority in their hometown are possible confounds to their answers.

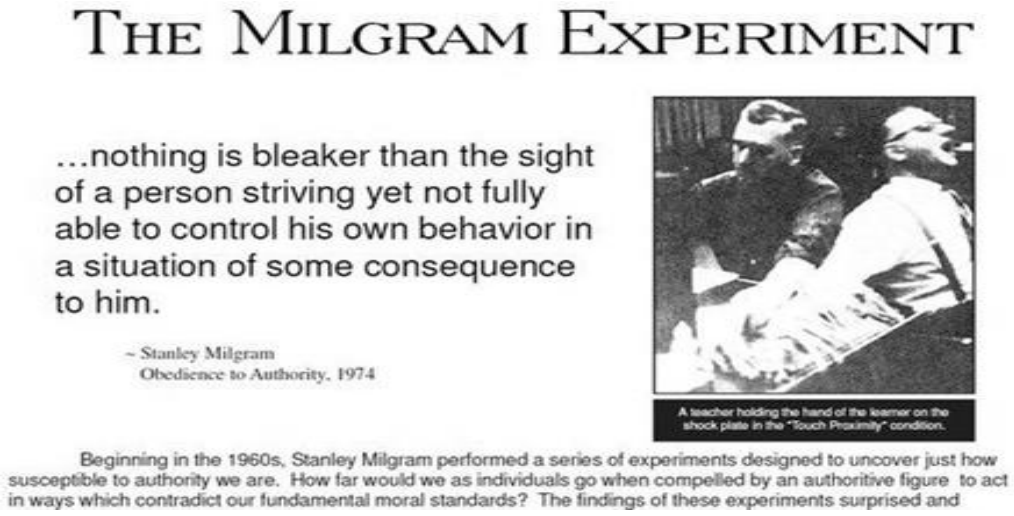
- Participants identified the low profile as a stereotypical minority and the high profile as a stereotypical majority; shows the prevalence of racial stereotypes in first impression bias even with little information available.
- The significant interaction between media priming and the stereotype profiles indicates the power that popular media has in shaping social interactions and the assumptions people make about each other.
- These results should be taken into consideration by journalists and other media providers when writing about race, as they hold the power to shape how society views racial stereotypes.



Conclusion: Experiments need to be designed with many considerations in mind in order to satisfy the criteria and assumptions of experimental method

Experiments in Social Psychology; Obedience to Authority

Famous social psychology experiments offer surprising insights into how and why people do the things they do. These were carried out to understand the causes of behavior in social situations.



In 1961, three months after Nazi Adolf Eichmann went on trial for war crimes, Yale University psychologist Stanley Milgram wondered how it was possible that Eichmann and "his million accomplices in the Holocaust were just following orders.

Milgram was interested in "researching how far people would go in obeying an instruction if it involved harming another person." He was curious to understand "how easily ordinary people could be influenced into committing atrocities, for example, Germans in WWII."

In 1961, Yale University psychology professor Stanley Milgram placed an advertisement in the New Haven Register. "We will pay you $4 for one hour of your time," it read, asking for "500 New Haven men to help us complete a scientific study of memory and learning."

https://www.theatlantic.com/health/archive/2015/01/rethinking-one-of-psychologys-most-infamous-experiments/384913/

Public Announcement

WE WILL PAY YOU $4.00 FOR ONE HOUR OF YOUR TIME

Persons Needed for a Study of Memory

*We will pay five hundred New Haven men to help us complete a scientific study of memory and learning. The study is being done at Yale University.

*Each person who participates will be paid $4.00 (plus 50c carfare) for approximately 1 hour's time. We need you for only one hour: there are no further obligations. You may choose the time you would like to come (evenings, weekdays, or weekends).

*No special training, education, or experience is needed. We want:

Factory workers	Businessmen	Construction workers
City employees	Clerks	Salespeople
Laborers	Professional people	White-collar workers
Barbers	Telephone workers	Others

All persons must be between the ages of 20 and 50. High school and college students cannot be used.

*If you meet these qualifications, fill out the coupon below and mail it now to Professor Stanley Milgram, Department of Psychology, Yale University, New Haven. You will be notified later of the specific time and place of the study. We reserve the right to decline any application.

*You will be paid $4.00 (plus 50c carfare) as soon as you arrive at the laboratory.

TO:
PROF. STANLEY MILGRAM, DEPARTMENT OF PSYCHOLOGY, YALE UNIVERSITY, NEW HAVEN, CONN. I want to take part in this study of memory and learning. I am between the ages of 20 and 50. I will be paid $4.00 (plus 50c carfare) if I participate.

NAME (Please Print). . . . . .

ADDRESS . . . . . .

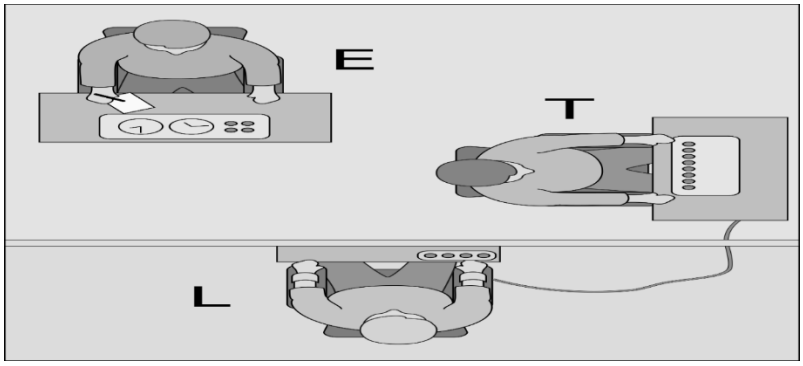
TELEPHONE NO. . . . . Best time to call you . . . . . .

AGE . . . . . OCCUPATION . . . . . SEX . . . . . .
CAN YOU COME:

WEEKDAYS . . . . . EVENINGS . . . . . WEEKENDS . . . . . .

Only part of that was true. Over the next two years, hundreds of people showed up at Milgram's lab for a learning and memory study that quickly turned into something else entirely. Under the watch of the experimenter, the volunteer—dubbed "the teacher"—would read out strings of words to his partner, "the learner," who was hooked up to an electric-shock machine in the other room. Each time the learner made a mistake in repeating the words, the teacher was to deliver a shock of increasing intensity, starting at 15 volts (labeled "slight shock" on the machine) and going all the way up to 450 volts ("Danger: severe shock").

Participants were 40 males, aged between 20 and 50, whose jobs ranged from unskilled to professional, from the New Haven area. Two rooms in the Yale Interaction Laboratory were used.



Each participant was told that they would be administering an electrical shock to the subject (though in reality no shock or pulse ever existed) for every incorrect answer.

Some people, horrified at what they were being asked to do, stopped the experiment early, defying their supervisor's urging to go on; others continued up to 450 volts, even as the learner pled for mercy, yelled a warning about his heart condition—and then fell alarmingly silent. In the most well-known variation of the experiment, a full 65 percent of people went all the way.

Until they emerged from the lab, the participants didn't know that the shocks weren't real, that the cries of pain were pre-recorded, and that the learner—railroad auditor Jim McDonough—was in on the whole thing, sitting alive and unharmed in the next room.
They were also unaware that they had just been used to prove the claim that would soon make Milgram famous: that ordinary people, under the direction of an authority figure, would obey just about any order they were given, even to torture.

It's a phenomenon that's been used to explain atrocities from the Holocaust to the Vietnam War's My Lai massacre to the abuse of prisoners at Abu Ghraib. "To a remarkable degree," Peter Baker wrote in Pacific Standard in 2013, "Milgram's early research has come to serve as a kind of all-purpose lightning rod for discussions about the human heart of darkness."

Milgram's conclusion

People can obey most abhorrent orders when given by an authority. His method and procedure as well as conclusion have been questioned.
https://www.theatlantic.com/health/archive/2015/01/rethinking-one-of-psychologys-most-infamous-experiments/384913/

b

c d

In photos above; left to right
First row; a. Stanley Milgram b. his group of participants
Bottom row; c. one participant with the shock machine d. control panel of his infamous machine.

Obedience to authority analyses
All people who participated in this procedure appeared very nervous and upset and frequently asked the experimenter what they should do next. Whenever people seemed unwilling to continue, the experimenter had a series of statements (which accelerated to commands) that the person was to obey.
The first was rather gentle: "Please go on." Next was "The experiment requires that you continue," which progressed to "It is absolutely essential that you continue." Finally, the experimenter said, "You have no other choice. You must go on."

Conditions Encouraging Obedience
There was no variation of an independent variable in the research. Thus, no information was gained about the conditions that enhance or diminish obedience to authority in this situation. One factor that could have encouraged obedience in the original study was the setting.

Sample Bias

These experiments had also been questioned due to sample bias. A narrow sample of white middle class males of a certain age does not make findings generalizable to larger diverse samples and populations.

Milgram may have discovered something alarming about the kind of person who participates in psychology experiments at Yale. Such people would be expected to be more conformist and eager to please authority figures than a truly representative sample of the populace.

Other investigators using less-biased samples drawn from other groups in the population, found significantly less compliance with the administrators' requests. Many reported meeting stiff resistance from non-college-educated and working-class people.

Who are the obedient ones?

It shows a curve from the very top of society (wealthy, white, upper-class overachievers) to the lowest (unemployed, racially diverse school dropouts). Those who had risen the highest seemed almost indecently eager to shock strangers to death when a man in a white coat asked them to. It was theorized that others who may have had negative experiences with authorities were generally willing to argue and quit the experiment before things went too far.

Less known findings

- Obedience dropped when experimenter did not wear lab coat
- When instructions were given by phone
- When they asked someone else to do it
- When experiment was conducted outside Yale University impressive campus https://allthatsinteresting.com/milgram-experiment

Criticism on Ethical grounds

The intense psychic stress test subjects have to be put through, as they are led to believe they're committing what amounts to murder, violates many of the ethical restrictions now in place on human research

Conclusion

Milgram's research on obedience allows us to see how an interesting and complicated problem concerning social influence can be investigated in the relatively controlled setting of the social psychology laboratory.

We can also relate it to many of our own society's brutalities as evident from photos of reported events below;

قتل سے چند لمحے پہلے مشتعل ہجوم کو اکسانے والے بے نقاب

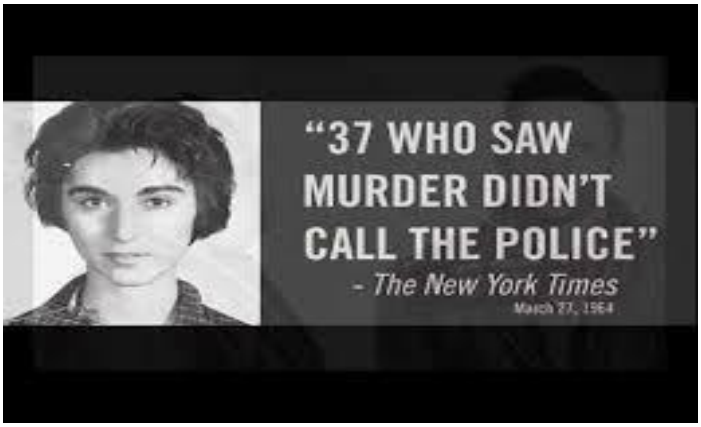
In such cases students of psychology can ask the question that was raised by Milgram; are these people obeying authority by committing such brutalities? Do individuals obey or are influenced by the mob cruelty.

Helping Behavior; Bystander Intervention

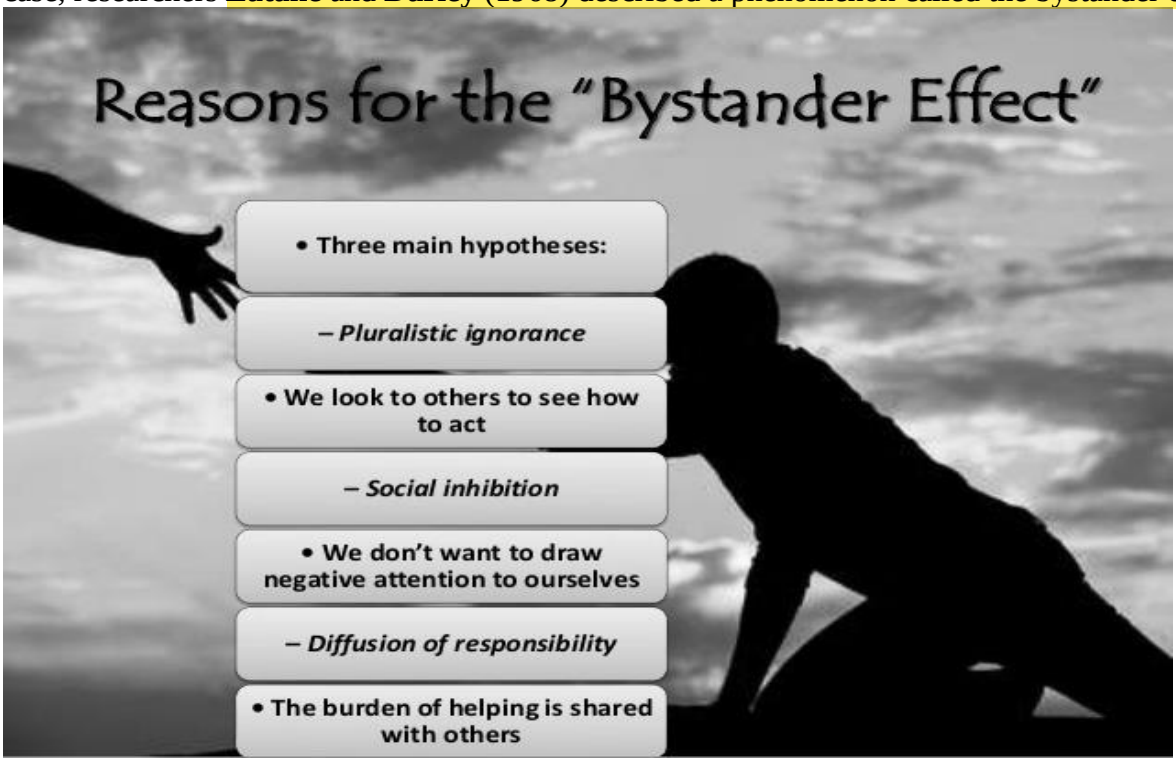
The bystander effect

- The bystander effect is the reduction in helping behavior in the presence of other people.
- The bystander effect is a phenomenon in which a witness or bystander does not volunteer to help a victim or person in distress. Instead, they just watch what is happening.

Social psychologists began trying to answer this question following the unfortunate murder of Kitty Genovese in 1964. A knife-wielding assailant attacked Kitty repeatedly as she was returning to her apartment early one morning.



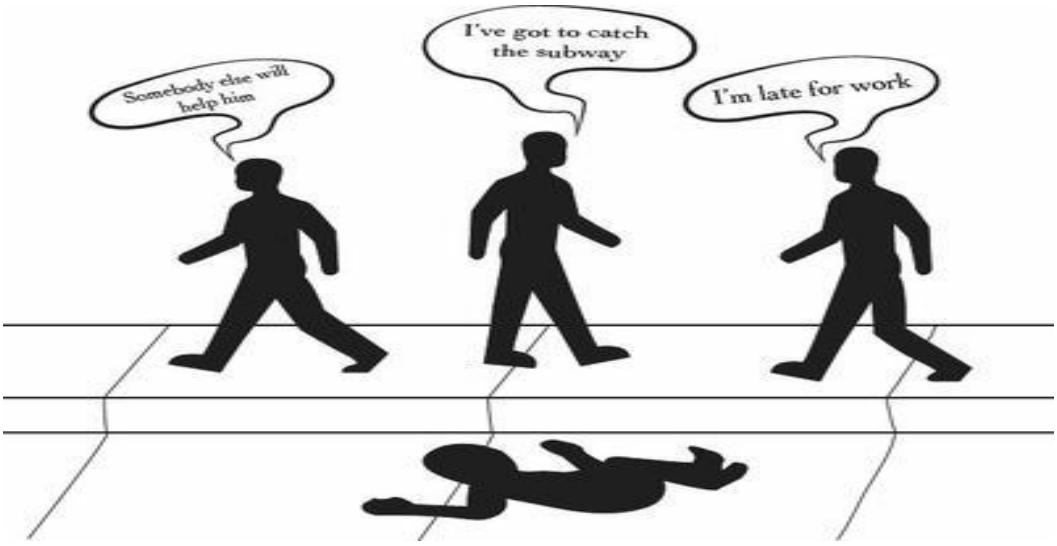
At least 38 people may have been aware of the attack, but no one came to save her. Based on this case, researchers **Latané** and **Darley** (1968) described a phenomenon called the bystander effect.



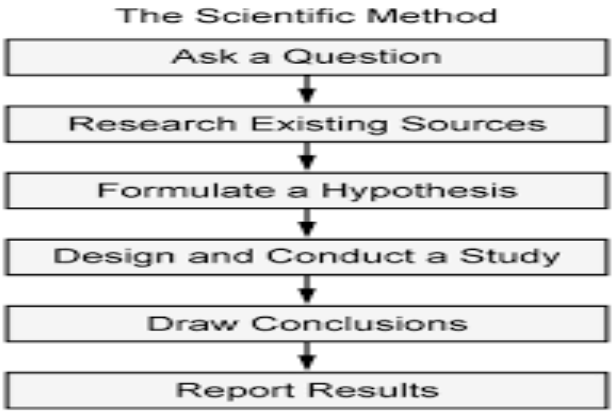
Since the original study many studies have been conducted and both field experiments and laboratory experiments have been carried out to study bystander apathy or helping.

Diffusion of responsibility

There is apparently a "diffusion of responsibility," so that the more people present the less any individual feels compelled to intervene. A student in a class with 100 other students feels less responsible for answering an instructor's question than a student in a class with five others.



Designing an Experiment To Test A Social Behaviour Hypothesis



Problem

How Does the Presence of Other People Affect an Individual's Performance on a Task? We can make a hypothesis based on observation. A well-written hypothesis is the key to any well-designed experiment. The presence of other people can affect our behavior in many ways. One example of this effect is known as social facilitation, which is the phenomenon that the presence of others can facilitate an individual's performance on a task.

From this observation, we might predict that when people work together on a task, they will actually do better than when they work alone.

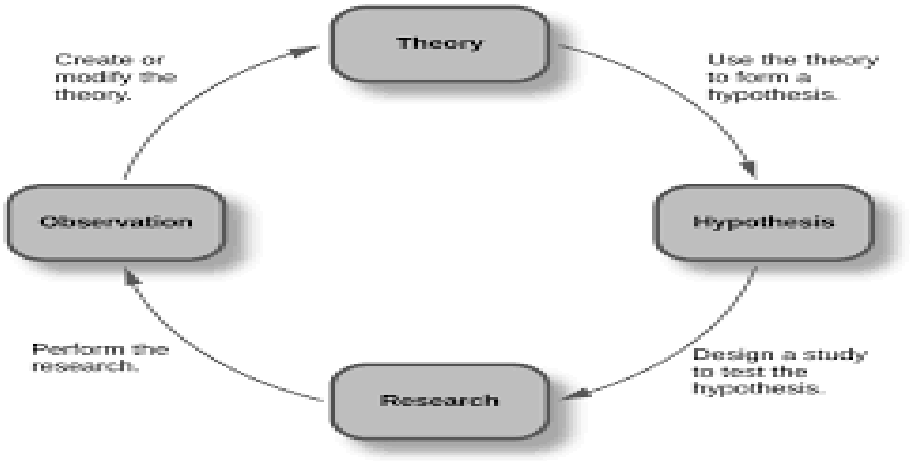
To test this hypothesis, we must first find an appropriate task for people to perform in the laboratory.

It should be something that can be performed both alone and with a group of people. The task must have an outcome that is measurable and comparable in both the individual and group situations. For example, suppose the task were to design a better telephone for the handicapped. Naturally, we would expect most group designs to be better than most individuals' designs (with the exception of an occasional genius, perhaps).

A potential candidate for this task is one involving physical exertion, such as the force with which one can pull on a rope. Let us see if this task meets the criteria outlined earlier. First, the performance measure is easily quantified. The rope can be attached to a mechanism that measures the amount of force exerted when a person pulls on it. Next, we could have all the participants pull on the rope together and compare the force exerted by the group to the sum of the individuals' forces. If the group's total is greater than the sum of the individuals' scores, we would conclude that people's individual performance improves when they perform this task with others. We would know that in general the participants exerted more effort in the group than when alone.

Second, the measure is meaningful whether one or several people pull the rope, since the metric of performance—that is, force—is the same in both situations. Finally, individual performance can be easily compared with group performance. We can ask each person to pull on the rope alone as hard as possible, and then add up all the force scores.

This sum would represent the potential contribution of each individual to the group effort and would serve as a baseline for comparing the effect of group performance.



We know more about the atom than ourselves, and the consequences are everywhere to be seen. (CARL KAYSEN)

Social psychology Experiments

- The behavior of every human is potentially determined by a web of complex social and cultural influences. Many of the acts we perform every day are determined by the culture and society into which we are born and raised.
- The psychological study of how society affects the individual is part of the field of social psychology.
- A tremendous variety of research topics falls under the general rubric of social psychology.

Among other things

- How people are influenced to change their attitudes, beliefs, and behavior
- How they form impressions of other people; why they like one another; the roots of aggression and violence; and the conditions determining altruism and helping.

Social facilitation and social loafing

Social facilitation means how the presence of others can facilitate an individual's performance on a task.

Social loafing; individuals' performance is lower in groups and becomes lower still as the group size increases. (Latané et al., 1979), the notion that responsibility diffuses among the members of a group. Social loafing occurs when an individual is an anonymous member of a group. However, when the individual knows that his or her performance can be identified, the effect can be eliminated. For example, relay racers swim faster when their individual lap times are announced than when only the overall team time is announced (Williams, Nida, Baca, & Latané, 1989).

Earlier Experiments

Sherif conducted experiments on social Norms and Auto kinetic phenomenon in 1930s. Social norms are the generalized rules of conduct that tell us how we ought to behave.

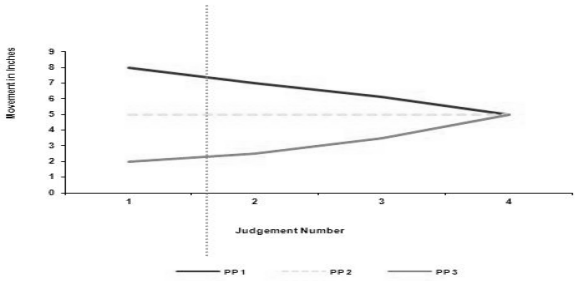
He researched the surprisingly powerful impact of social norms and their development using a perceptual illusion, the auto kinetic phenomenon. A person is placed in a room that is completely dark and a single spot of light is shown on one of the walls, the light appears to move. This apparent

movement occurs despite the fact that the light is actually stationary. The light seems to "move itself," thus giving rise to the name of the phenomenon.

Sherif discovered from a number of experiments was that a person's judgments of how the spot of light moved were greatly influenced by reports of other participants. If the experimenter (or another subject) led a subject to expect the light to move in a wide arc, then the subject would usually report that, in fact, it did seem to move in a wide arc. These experiments indicated that a person's perceptual reports could be manipulated by social influence in a dramatic way and that this process could be studied experimentally.

Norm Development
Sherif, 1935

- 100 judgements in private: how far in inches?
- Autokinetic effect (*appears* to oscillate)
- Judgements with 2/ 3 others present
- Converge away from individual to common standard= Social Norm
- Pps deny being influenced by others



Experiments on conformity

Asch (1956, 1958) demonstrated that group judgment can influence individual judgment even when individual has his or her own direct information from senses to rely upon. There were 18 trials; in each case, one comparison line was equal to the standard. The confederates were instructed to give the correct answer on 6 of the trials but a consistently wrong answer on 12 trials. The question of interest was whether the real subject in the procedure would conform to the group judgment and go against his or her own perception.

Subjects in the perceptual discrimination task used by Asch were asked to decide which of the comparison lines (B) was the same length as that of the standard (A). How do you think you would respond if five people before you had all said that comparison line 3 was the correct?

In February 1999, four New York City Police officers shot Amidou Diallo 41 times as he reached for his wallet. Diallo was unarmed, but police shot because they believed he was reaching for a weapon. Might the police officers have been biased by Diallo's race? That is, could his being black have affected their misidentification of the wallet as a gun? To study this experimentally, Payne (2001) created a priming experiment.

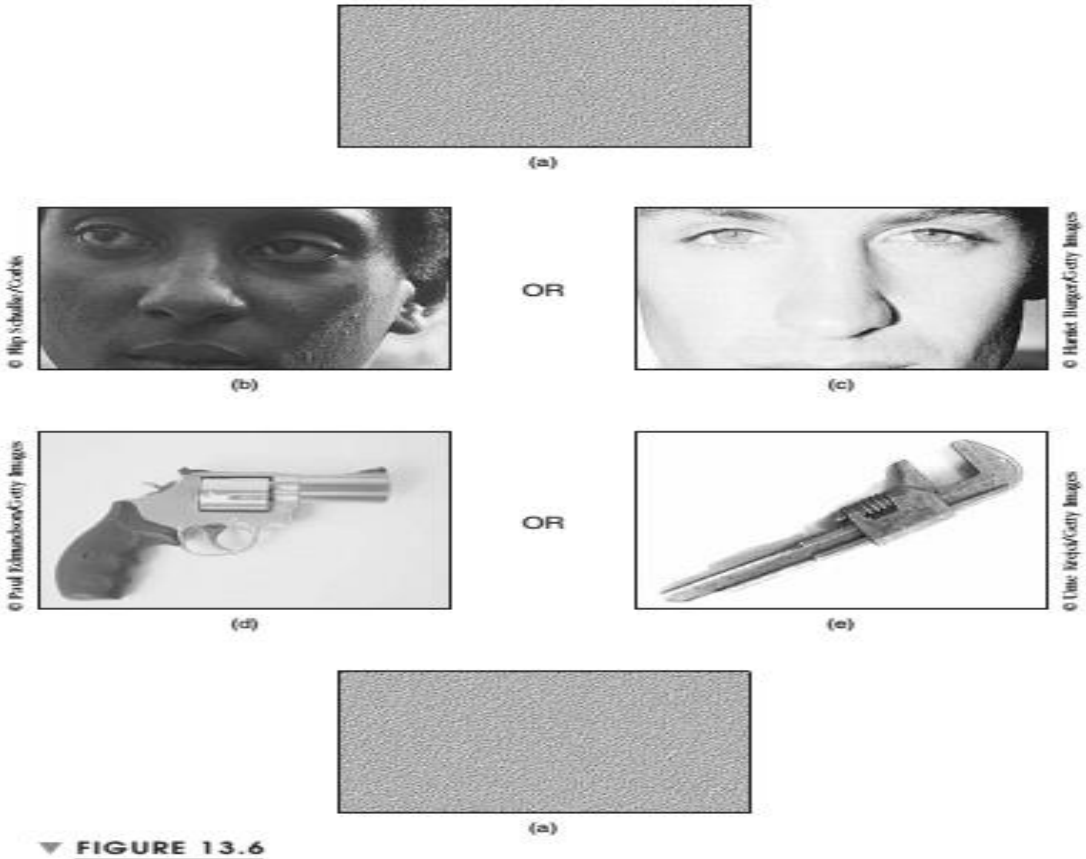


FIGURE 13.6

On each trial, a black or white face was briefly flashed, followed by a gun or tool. Visual masks began and ended each trial. The task was to press a key indicating "gun" or "tool." Adapted from Payne (2001).

Subjects were much faster to press the "gun" key if the picture had been preceded by a black face rather than a white face. Overall, subjects were more likely to make errors for tools than guns,

mistakenly calling tools “guns.” However, critically, subjects misidentified more tools as guns after a black face than after a white face. The case of Amidou Diallo; the police officers were reacting quickly and under stress.

Payne’s data suggest that when people are responding quickly, seeing a black person will increase their likelihood of misperceiving a harmless object as a gun. When in a hurry, people are forced to rely on stereotypes (which can act as a heuristic or shortcut); unfortunately, Americans have a stereotype of black people as dangerous (Devine & Elliot, 1995).

This study has also very important implications in current scenario in USA and Canada where many incidents of unfair police action against black men or indigenous or immigrants have been reported and reactions have been mounting. Using understanding from such studies can help psychologists prepare trainings that reduce implicit prejudice through opposite priming.

This section has described the experimental Design with examples so students can learn how experiments have been designed in earlier period and how latest experiments are being designed. In practical component of this course you will carry out some experiments related to various topics in this course.

Lecture 07

ETHICS IN EXPERIMENTS (I)

Meaning and Need for Ethics

Meaning

- Ethics are morals, which are rules to guide our behavior.
- They also contain ideas about what is good and what is desirable in human behavior.
- Professional Ethics are a moral framework that is applied to a narrow group of people such as doctors, or Educationists or psychologists.
- The double-edged potentiality of scientific knowledge poses ethical problems for all scientists. To the extent that psychological research deals with important problems and potent methods, psychologists must recognize and alert others to the fact that the potential for misuse of research increases its potential for constructive application. (American Psychological Association, 1982, P. 16)

Need for Ethical Principles

- Psychologists are committed to increasing scientific and professional knowledge of behavior and people's understanding of themselves and others and to the use of such knowledge to improve the condition of individuals, organizations, and society.
- Psychologists respect and protect civil and human rights and the central importance of freedom of inquiry and expression in research, teaching, and publication.
- They strive to help the public in developing informed judgments and choices concerning human behavior.
- In doing so, they perform many roles, such as researcher, educator, diagnostician, therapist, supervisor, consultant, administrator, social interventionist, and expert witness.
- The Ethics Code is intended to provide guidance for psychologists and standards of professional conduct that can be applied by the APA and by other bodies that choose to adopt them. The Ethics Code is not intended to be a basis of civil liability.

Ethics Code

- Provides a common set of principles and standards upon which psychologists build their professional and scientific work.
- Ethics Code is intended to provide specific standards to cover most situations encountered by psychologists.

How to Ensure Ethical Conduct

Given the importance of ethics for the conduct of research, it should come as no surprise that many different professional associations, government agencies, and universities have adopted specific codes, rules, and policies relating to research ethics.

Ethics Monitoring Bodies

- Government agencies;
- National Institutes of Health (NIH)
- American Society for Clinical Laboratory Science

- American Psychological Association
- Statement on Professional Ethics (American Association of University Professors).

Monitoring bodies Pakistan

- Pakistan Medical Association
- Higher Education Commission
- Pakistan Psychiatric Association
- Pakistan Psychological Association
- Board of Studies in Psychology

Ensuring Ethics in Experiments

- Approval through an official body
- Review process
- Section on ethics in research reports and articles
- Monitoring by supervisors and examiners
- Ethical reporting

Approval

- Complexity of process depends on complexity and risks of the study
- All research with humans (and animals) must:
  - use valid methods
  - follow legal/ethical standards
  - be IRB approved
- Project must meet responsibility and qualification criteria
  - Responsible for welfare/dignity of participants
  - Qualified to do the research (students with supervision OK)
- With humans, voluntary implied consent required
- Consent forms must:
  - Be descriptive and clear
  - Explain confidentiality/anonymity procedures
  - Provide participants with stated rights and protections inherent in the study

Institutional Approval

When institutional approval is required, psychologists provide accurate information about their research proposals and obtain approval prior to conducting the research. They conduct the research in accordance with the approved research protocol.

Five General Principles of The APA Code

Principle A: Beneficence and Non-maleficence – The first principle states that "In their professional actions, psychologists seek to safeguard the welfare and rights of those with whom they interact professionally and other affected persons and the welfare of animal subjects of research"`

Principle B: Fidelity and Responsibility – Outlining the value of conscientiousness in the psychological practice and research, the second principle somewhat overlaps with the first one. It differs in the focus it has, moving into an overview of what to mind when working with our

colleagues and within our work network. While responsibility is a universally understood value, the principle also states that "

Principle C: Integrity – The third principle summarizes what we are supposed not to do in our practice as researchers. Cases of manipulation, fraud, fabricating results and general scientific misconduct are not unheard of, affecting tremendously the field.

Principle D: Justice – The fourth principle states that "…fairness and justice entitle all persons to access to and benefit from the contributions of psychology and to equal quality in the processes, procedures, and services being conducted by psychologists"

Principle E: Respect for People's Rights and Dignity – The fifth principle in a way encompasses the previous four, adding an emphasis on obtaining individual's consent and protecting their confidentiality and privacy.

Rights of Participants

- Right to withdraw
- Informed consent
- Confidentiality
- Anonymity

1. Rights to Withdraw

- Participants should be allowed to decline to participate or to withdraw at any time.
- People who are unhappy about participating should have the freedom to withdraw.
- Definition of a willing volunteer participant; subject pool for the depression and memory experiment: undergraduate students taking introductory psychology.
- They sign up to participate in experiments
- Usually receive some sort of course credit for their service.
- If the students actually receive extra credit, they are likely to be acting on their own volition.
- If they must participate as part of a course requirement, then the freedom to participate or not is less obvious.
- When students are required to participate, they should have some optional way of fulfilling the requirement, such as writing a paper or attending a special lecture.
- Generally, when the pool of potential participants is a captive audience, such as students, prisoners, military recruits, and employees of the experimenter, the ethical researcher considers the individual's freedom to withdraw or to participate.

2. Informed Consent

1. Informed Consent is a voluntary agreement to participate in research.
2. Obtaining consent involves informing the subject about his or her rights, the purpose of the study, the procedures to be undergone, and the potential risks and benefits of participation.

3. The ethical researcher informs participants, prior to participation, of all aspects of the research that might reasonably be expected to influence willingness to participate and explains all other aspects of the research about which participants inquire. This means that the participants must

be forewarned about those aspects of the research that may have detrimental effects. Participants are rarely misled as to the nature of the experiences they will have during the experiment. Furthermore, an experimenter usually states the purpose of the experimental procedure truthfully.

4. Participants are rarely misled as to the nature of the experiences they will have during the experiment. Furthermore, an experimenter usually states the purpose of the experimental procedure truthfully.
5. Experimenters sometimes mislead participants about the true purpose of an experiment. This false description is often referred to as a "cover story." This kind of deception is usually done to control subject reactivity.
6. A researcher interested in whether people behave more assertively in same-gender groups than in mixed-gender groups tells people that they will be working on problems that require group cooperation. Also told the purpose of the experiment is to evaluate the difficulty of these tasks.
7. Performance may change, not decision to participate.

3. The Ethical Dilemma

- People must be warned if the procedure will place them in serious danger of physical or psychological harm. Deception in such cases is clearly unethical. When a procedure involves only minor risks, the decision regarding full disclosure to participants is more difficult
- A researcher interested in whether people behave more assertively in same-gender groups than in mixed-gender groups tells people that they will be working on problems that require group cooperation. Also told the purpose of the experiment is to evaluate the difficulty of these tasks. Performance may change, not decision to participate
- In all cases, the potential benefits of the research must be weighed against the actual and potential costs to the participant. However, participants should always receive as much information as possible, and they should know that they can end their participation at any time without negative consequences.

4. Confidentiality

Confidentiality refers to a condition in which the researcher knows the identity of a research subject, but takes steps to protect that identity from being discovered by others and kept safely with the experimenter

Sometimes one ethical principle has to be sacrificed for another for example to protect welfare of a subject, confidentiality may have to be given up

5. Anonymity

Anonymity means that responses or performance given by subjects is not traceable to them. Their identity is not disclosed. In some instances the identity of subjects is not known to researchers even.

Deception and Debriefing

- Debriefing is a crucial component for any research involving the use of deception or incomplete disclosure.

- Debriefing occurs when subjects are given the full explanation of how and why subjects were deceived and the true hypotheses being tested by the research.

How Deception is Inevitable

- Deception is usually done to control subject reactivity.
- People responding on a word association test may only give spontaneous response when not told about the true purpose of experiment. They are also told that the purpose of the experiment is to test their verbal reaction time. The researcher is concerned that participants' behavior might change if they knew the real purpose of the experiment**.**
- Deception is, unfortunately, necessary to answer some research questions. For example, if an investigator wants to see how well people recall information that they are not actively trying to remember, he or she might not inform participants that the experiment requires a memory test. Obviously, the omission of information prevents participants from giving fully informed consent.

Standard: 8.07 Deception in Research

(a) Psychologists do not conduct a study involving deception unless they have determined that the use of deceptive techniques is justified by the study's significant prospective scientific, educational, or applied value and that effective non deceptive alternative procedures are not feasible.

(b) Psychologists do not deceive prospective participants about research that is reasonably expected to cause physical pain or severe emotional distress. c) Psychologists explain any deception that is an integral feature of the design and conduct of an experiment to participants as early as is feasible, preferably at the conclusion of their participation, but no later than at the conclusion of the data collection, and permit participants to withdraw their data (APA Ethics Code 2002, p. 12)

Standard: 8.08 Debriefing

(a) Psychologists provide a prompt opportunity for participants to obtain appropriate information about the nature, results, and conclusions of the research, and they take reasonable steps to correct any misconceptions that participants may have of which the psychologists are aware.

(b) If scientific or humane values justify delaying or withholding this information, psychologists take reasonable measures to reduce the risk of harm.

(c) When psychologists become aware that research procedures have harmed a participant, they take reasonable steps to minimize the harm. (APA Ethics Code, 2002)

Lecture 08

ETHICS IN EXPERIMENTS (II)

Welfare of Human Subjects

Welfare is assured through many steps to abide by the principle of beneficence
At all times any distress to subject or lasting effects that may be undesirable are weighed against the benefits gained from the experiment.

Standard: 3.04 Avoiding Harm
(a) Psychologists take reasonable steps to avoid harming their clients/patients, students, supervisees, research participants, organizational clients, and others with whom they work, and to minimize harm where it is foreseeable and unavoidable.
(b) Psychologists do not participate in, facilitate, assist, or otherwise engage in torture, defined as any act by which severe pain or suffering, whether physical or mental, is intentionally inflicted on a person, or in any other cruel, inhuman, or degrading behavior that violates 3.04(a).

Ethical issues in Context (Welfare of human subjects)
Imagine you are a psychologist interested in determining to what extent depressive feelings influence how well people remember. One very important reason why you want to study this topic is that depression is a fairly common emotional problem among college students, and you would like to determine how this problem could affect academic performance. You decide to do a tightly controlled laboratory experiment to determine the effects of depression on memory. You want to induce depression in some of your participants, and then compare their memory to that of others who were not induced to be depressed.

You induce depression in your participants by a procedure devised by Velten (1968).
In this procedure people read aloud 60 self -referent statements associated with the mood in question.

In this case, the participant reads statements that are supposed to induce depression, beginning with relatively mild ones, such as "Today is neither better nor worse than any other day," and progressing to more extreme ones, such as "I feel so bad that I would like to go to sleep and never wake up."

Velten's procedure induces a mild, temporary depression; participants report feeling depressed, and their behavior suffers on a variety of tasks. Because the effects of the mood induction were known to be temporary, the researchers believed that partial information was enough to permit informed consent. Here, although some information was omitted, participants were not misled about what to expect in the experiment.

The APA suggests an additional safeguard to provide research participants with protection from harm. The subjects should have a way to contact the investigator following participation in the research. Even the most scrupulously ethical project of the minimal-risk sort may have unintended aftereffects. Thus, the participant should be able to receive help or advice from the researcher if problems should arise.

The people who signed up to participate were told that some of the things they were going to do in the experiment might make them feel unhappy, and they were given the opportunity to refuse to participate. The specific nature of the manipulation, such as the Velten technique and who was going to serve in the experimental group, was not disclosed ahead of time. People may have reacted unusually if they knew all the details.

We have had participants cry (out of frustration and embarrassment) during what was supposed to be a standard, innocuous memory experiment. Those participants may have carried away from the experiment a negative self-image or strong feelings of resentment toward the experimenter in particular or research in general. Because of such unintended effects, the prudent researcher provides a detailed debriefing, which means that the investigator explains the general purposes of the research. Furthermore, the researcher completely describes the manipulations so that any questions or misunderstandings may be removed.

Debriefing and Protection from Harm

In the depression and memory experiment, at the end of that project, the participants were given a list of phone numbers of people who could be contacted in the unlikely event that the subjects felt depressed following the experiment. The list of contacts included the principal investigator, a counselor, and the dean of student affairs and his assistant. Also, the day after participation, one of the experimenters, who tried to determine whether the participant was having any negative aftereffects, phoned each subject who had read the depression-inducing statements.
The participants received thorough debriefing. They were told about the mood induction procedure and how its effects were temporary. The experimenter answered any questions asked by the participants.

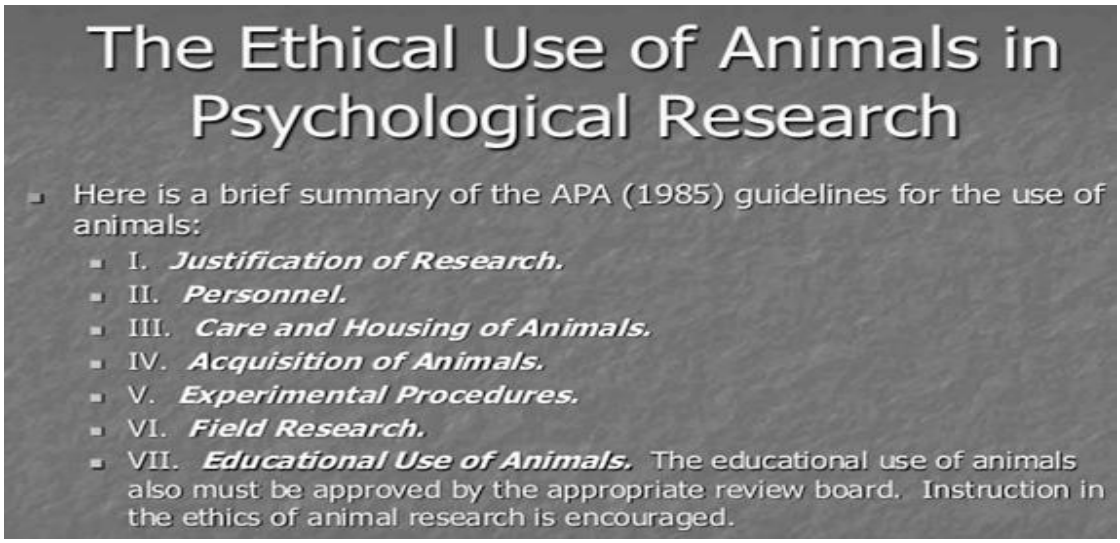
Removing Harmful Consequences

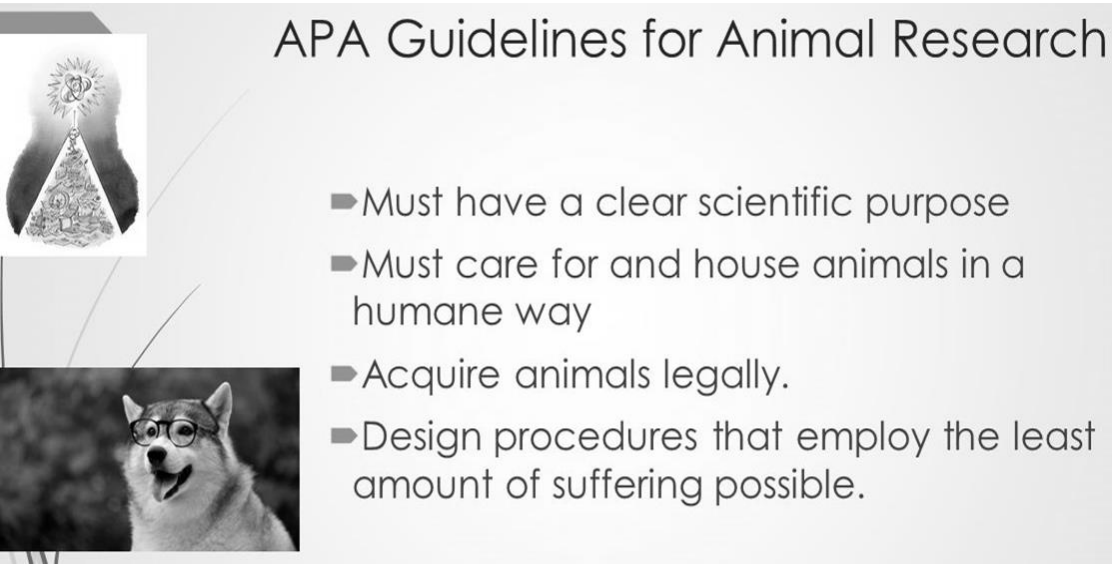
- If a participant could suffer long-term consequences as a result of serving in a research project, the investigator has the responsibility for removing harmful consequences. Prior to the debriefing in the depression and memory experiment, the participants read a series of self-referent statements designed to induce elation. This exercise was supposed to counteract the effects of the negative mood induced earlier. The participants were then questioned about their current feelings, and they were also asked to sign a statement that said they left the experiment feeling no worse than when they began it.
- All participants signed the statement, but had they not, a contingent plan was to keep them in the laboratory under the supervision of one of the experimenters until they felt better.
- The feelings of resentful people may be difficult to reverse, because the resentment may be unintended and undetected. However, the ethical investigator must take steps to minimize known risks.

Welfare of Animal Subjects and Environment

- The following guidelines were developed by the American Psychological Association (APA) for use by psychologists working with nonhuman animals. They are informed by Section 8.09 of the Ethical Principles of Psychologists and Code of Conduct (APA, 2010).

- The acquisition, care, housing, use, and disposition of nonhuman animals in research must be in compliance with applicable federal, state, and local, laws and regulations, institutional policies, and with international conventions to which the United States is a party. APA members working outside the United States must also follow all applicable laws and regulations of the country in which they conduct research.





To the extent that psychological research deals with important problems and potent methods, psychologists must recognize and alert others to the fact that the potential for misuse of research increases its potential for constructive application. (AMERICAN PSYCHOLOGICAL ASSOCIATION, 1982, P. 16)

Principles of Ethical Conduct of Research And Practice

Psychologists are committed to increasing scientific and professional knowledge of behavior and people's understanding of themselves and others and to the use of such knowledge to improve the condition of individuals, organizations, and society.

- Psychologists respect and protect civil and human rights and the central importance of freedom of inquiry and expression in research, teaching, and publication.
- They strive to help the public in developing informed judgments and choices concerning human behavior.
- In doing so, they perform many roles, such as researcher, educator, diagnostician, therapist, supervisor, consultant, administrator, social interventionist, and expert witness.
- Ethics Code
- It provides a common set of principles and standards upon which psychologists build their professional and scientific work.
- Ethics Code is intended to provide specific standards to cover most situations encountered by psychologists.

Five general principles of the APA code:

1. Beneficence and non-malfeasance: Constantly weigh costs and benefits; produce greatest good
2. Fidelity and responsibility: Constantly aware of responsibility to society
3. Integrity: Scrupulously honest
4. Justice: Fair treatment
5. Respect for people's rights and dignity: Safeguard welfare, protect rights

Good Practice

- Beneficence and non-malfeasance
- Constantly weigh costs and benefits; produce greatest good
- Example of research on disaster affectees
- Creating positive mood through counting blessings
- Creating depressive mood

Beneficence and non-malfeasance

In a review of research on mood and memory, Blaney (1986) listed a number of studies in which depression was induced in college students. In some experiments, a happy mood was induced in subjects. Do the ethical considerations depend on the kind of mood—happy or sad—that is induced in a person? Researchers have used several different mood-induction procedures in their experiments. Besides the Velten (1968) procedure previously described, hypnosis and music have been used to induce a depressed or happy mood. Do ethical considerations depend on the mood-induction technique?

Fidelity and responsibility

It refers to being constantly aware of responsibility to society. Many social psychology experiments have been inspired by social incidents that worried or interested psychologists
Are we doing it enough? Are we doing it in Pakistan?

Integrity

It refers to be scrupulously honest, Are we? Even in classic experiments results were not reported accurately. Sometimes we present what are not real findings. Help in creating nonobjective reports "There has been a real change in the last 10 years in people talking more frequently and more openly about ethical dilemmas of all sorts."
Psychologist June Tangney, PhD. George Mason University

Ethics in Experiments

Criticism

Psychological research deals with important problems and potent methods. It sometimes misuses but potential for constructive application is very vast. There have been ethical issues with some experiments

The Stanford prison experiment

Zimbardo and his colleagues (1973) were interested in finding out whether the brutality reported among the among the guard in American prison was due to the sadistic personalities of the guards (i.e. dispositional) or had more to do with the prison environment (i.e. situational.)
Prisons could be disrespectful of law; Guards could be aggressive. Alternatively, prisoners and guards may behave in a hostile manner due to the rigid power structure of the social environment in prison. Zimbardo predicted the situation made people act the way they do rather than their disposition (personality. Zimbardo converted a basement of the Stanford University psychology building into mock prison. He advertised asking for volunteers to participate in a study of the psychological effects of prison. Out of 75 applicants, 24 were selected after screening for mental and medical problems and crime history.

Assigning roles

- Participants were randomly assigned to either prisoners of guard roles.
- Guards wore uniform, prisoners wore prison grab with numbers
- Guards were allowed to do anything to maintain law and order.
- Prisoners were bullied and humiliated, given boring tasks and called by numbers
- A rebellion broke out that was put down with force and punishment
- Experiments intended to continue for two weeks was terminated in 6 days
- Due to the emotional breakdown of prisoners, and excessive aggression of the guards

Some Theoretical Explanations

- Deindividuation
- Learned helplessness
- Power of social roles
- Lack of ethical control
- Or lack of fear of God

Ethical Criticism

- Lack of fully informed consent
- Psychological harm, experiencing incidents of humiliation and distress
- Debriefing and reducing harm was carried out

Approval of the study was given by the Office of Navel Research, the Psychology Department and the University Committee of Human Experimentation. It also needs to be questioned that abuse in

Abu Gharib prison under the authority of American Armed forces in the aftermath of the 2003 Iraq was, social roles or direct orders.

Contribution

- Prison rules and treatment improved
- American Psychological Association ethical guidelines were elaborated and binding
- Institutional Review Board (US) or Ethics committee (UK), universities and Govt. agencies carefully examined all proposals

In 1958, Scientific American Published a research indicating that bosses suffer more stress than their underling. Titled, "Ulcers in 'Executive Monkeys,' the study subjected pairs of rhesus macaques to electric shock every 20 second over period of xix hours.

"There has been a real change in the last 10 years in people talking more frequently and more openly about ethical dilemmas of all sorts"
Psychologist June Tangney, PHD, George Mason University

Lecture 09

REPORT WRITING: PRESENTING THE FINDINGS OF EXPERIMENTS

Report Writing

Steps:

- Idea
- Review of the pertinent literature
- Designing a procedure
- Collecting data
- Analyzing the results.

Your course may require a written record of your research. Even if it does not, you are obligated to publicize the results of a carefully done project.

Purpose of Experimental Report

- To maintain the self-correcting nature of science, it is important to publish good data.
- To make available experimental research findings for future researchers and students
- To present for course credit and evaluation

A good lab report does more than present data, it demonstrates the writer's comprehension of the concepts behind the data, their understanding of findings, their training in experimental method, and presentation skills.

Merely recording the expected and observed results is not sufficient you should also identify how and why differences occurred explain how they affected your experiment and show your understanding of the principles the experiment was designed to examine.

As a social science, experimental psychology uses empirical inquiry to help understand human behavior. Psychology writing has three elements: describing, explaining, and understanding concepts from a standpoint of empirical investigation (Thrass & Sanford 2000).

Principles of Writing in Psychology

- **Using plain language**: Psychology writing is formal scientific writing, plain and straightforward.
- **Conciseness and clarity of language**: Clear, concise prose, make connections between empirical evidence, theories, and conclusions.
- **Evidence-based reasoning** : Psychology bases its arguments on empirical evidence. Personal examples, narratives, or opinions are not appropriate for psychology.
- **Use of APA format**: Psychologists use the American Psychological Association (APA) format for publications. Tip; keep class notes to help format final report.

Context of Writing

1. Writing for Instructor and class fellows
2. Research group members

3. Presentation to larger audience
4. Article for publication

https://owl.purdue.edu/owl/subject_specific_writing/writing_in_the_social_sciences/writing_in_psychology_experimental_report_writing/index.html

Experimental Reports

- Follow a general to specific to general pattern.
- Start off broadly in introduction and discussion of the literature
- The report narrows as it leads up to specific hypotheses, methods, and results.
- The discussion transitions from specific results to more general implications, future work, and trends in similar research.

Sections

- Title
- Abstract
- Introduction
- Method
- Results
- Discussion
- References

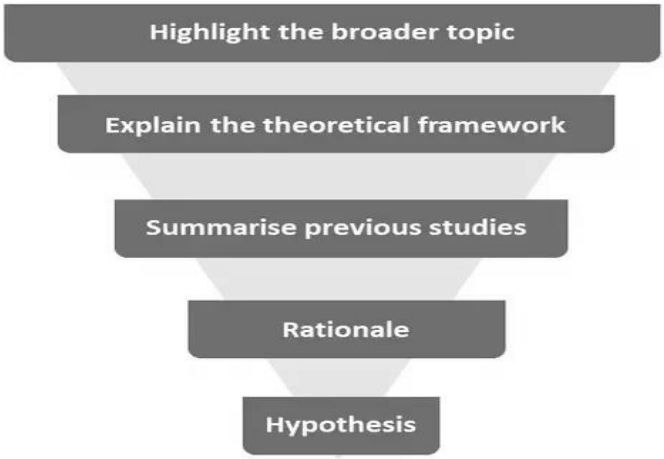
Abstract

The abstract gives a concise summary of the contents of the report. Abstracts should be brief (about 100 words)**.** Abstracts should be self-contained and provide a complete picture of what the study is about. Abstracts should be organized just like your experimental report—introduction, literature review, methods, results and discussion. Abstracts should be written last during your drafting stage.

Advice: The abstract comes at the beginning of your report but is written at the end (as it summarizes information from all the other sections of the report).

Introduction

The introduction in an experimental article should follow a general to specific pattern, where you first introduce the problem generally and then provide a short overview of your own study. The introduction includes three parts: opening statements, literature review, and study overview.



Sections and subsections

Method:

1. purpose, variables and operational definitions
2. Participants
3. Design
4. Instruments or measures
5. Procedure/data collection
6. Any deception used

Results:

- Tables, figures, graphs
- A concise presentation of how results were calculated and analyzed
- The results section of a paper usually present the descriptive statistics followed by inferential statistics. Report the means, standard deviations and 95% confidence intervals (CIs) for each IV level. If you have four to 20 numbers to present, a well-presented table is best, APA style.
- Name the statistical test being used. Report appropriate statistics (e.g., t-scores, *p* values.) Report the magnitude (e.g., are the results significant or not?) as well as the direction of the results (e.g., which group performed better?).
- It is optional to report the effect size Remember this applies if you are doing experiment on a number of participants. Most class room experiments are on single subject and each student uses his/her own participant.

Discussion

- Restate purpose
- Present findings
- Hypothesis confirmed or not
- Previous findings on similar problem
- Explain findings theoretically
- Limitations and recommendations
- Implications

Lab Report Format

Title page, abstract, references and appendices are started on separate pages (subsections from the main body of the report are not). Use double-line spacing of text, font size 12, and include page numbers. The report should have a thread of argument linking the prediction in the introduction to the content in the discussion.

Title Page

Title page formatting is as follows:

- A running head and page number in the upper right corner (right aligned)
- A definition of running head in IN ALL CAPS below the running head (left aligned)
- Vertically and horizontally centered paper title, followed by author and affiliation

References

This section is the list of all the sources cited (in alphabetical order). It is not a bibliography (a list of the books you used). Every time you refer to a name (and date) of a psychologist you need to reference the original source of the information. If you have been using textbooks this is easy as the references are usually at the back of the book and you can just copy them down. If you have been using websites then you may have a problem as they might not provide a reference section for you to copy. References need to be set out APA style.

Books:

Author, A. A. (year). *Title of work*. Location: Publisher.

Journal Articles:

Author, A. A., Author, B. B., & Author, C. C. (year). Article title. *Journal Title, volume number* (issue number), page numbers

use GOOGLE SCHOLAR. Just type the name and date of the researcher in the search box and click on the 'cite' link.

Abstract should only mention

- What was investigated clearly giving variables in your title for example "the study investigated the relationship between optimism and quality of life among cardiovascular patients"
- Sample
- Measurement
- analysis
- Findings. Last sentence should be "findings and implications are discussed".

Rules of thumb for writing introductions

- Write in plain English
- Take the time and space to introduce readers to your problem step-by-step;
- Do not plunge them into the middle of the problem without an introduction (Bem, 2006)
- Use examples to illustrate difficult or unfamiliar theories or concepts. The more complicated the concept or theory, the more important it is to have clear examples. Open with a discussion about people and their behavior, not about psychologists and their research.

Thais and Sanford (2000) recommend the following organization for introductions:

- Provide an introduction to your topic
- Provide a very concise overview of the literature
- State your hypotheses and how they connect to the literature
- Provide an overview of the methods for investigation used in your research
- Start with a preamble (tamheed)
- Introduce the variables, say all you know about variables and their relationship
- Convince the reader why it is important to learn about this topic.
- Clearly and in detail describe what has been done before in this area.
- What more can be done to improve the understanding of this phenomena
- Unanswered on inconclusive findings are identified in research. These are called gaps in evidence.

Research study or experiment is a story and introduction is the main script of that story Naumana Amjad, 2015-2019

An Example:
Title: Words and actions: do reported beliefs predict behaviour?
In everyday life we often express our adherence to certain ideals, ideas and beliefs. In research questionnaires and self-reported scales respondents answer questions about personal attributes, general attitudes and tendencies. It is assumed that their statements reflect reality. However these measures are not behavioural measures.

Previous studies have shown low to moderate to high correlation between self reported measures and actual behaviour. The trouble is that behaviour is also self-reported. Very few studies have assessed a behavioural correlate of reported attitude or belief (for example see Amjad & wood, 2009; Smith, Galton & Baron , 1996).

This study proposes a series of experiments in which individuals will be tested in real time on behaviour that they supported in their self-report measure for example altruism will be tested by asking for volunteer work participation .Self report of Honesty will be matched with lying and cheating in a simulated situation.

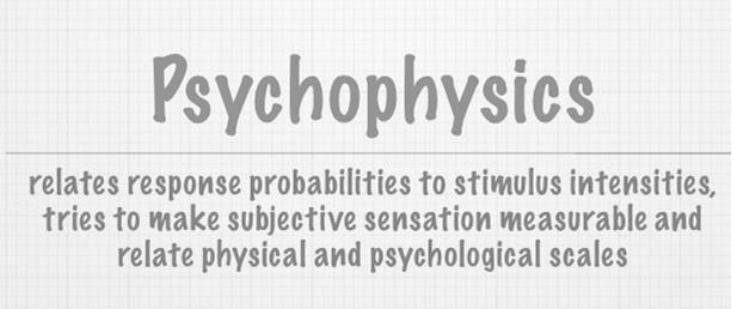
Religious beliefs will be assessed and then participants will be tested for praying on time and voting for a bill against violence. The study adds to attitude theories and has implications for real life. We all fall short of our ideals but awareness of this may help us become more honest persons. The following section will present theoretical and empirical literature and objectives of research.

Lecture 10

PSYCHOPHYSICS (I)

History and importance of psychophysics

Psychophysics: The branch of psychology that deals with the relationship between physical stimuli and subjective experience or mental phenomena. Scientific Psychophysics involves the determination of the psychological reaction to events that lie along a physical dimension.



History of psychophysics

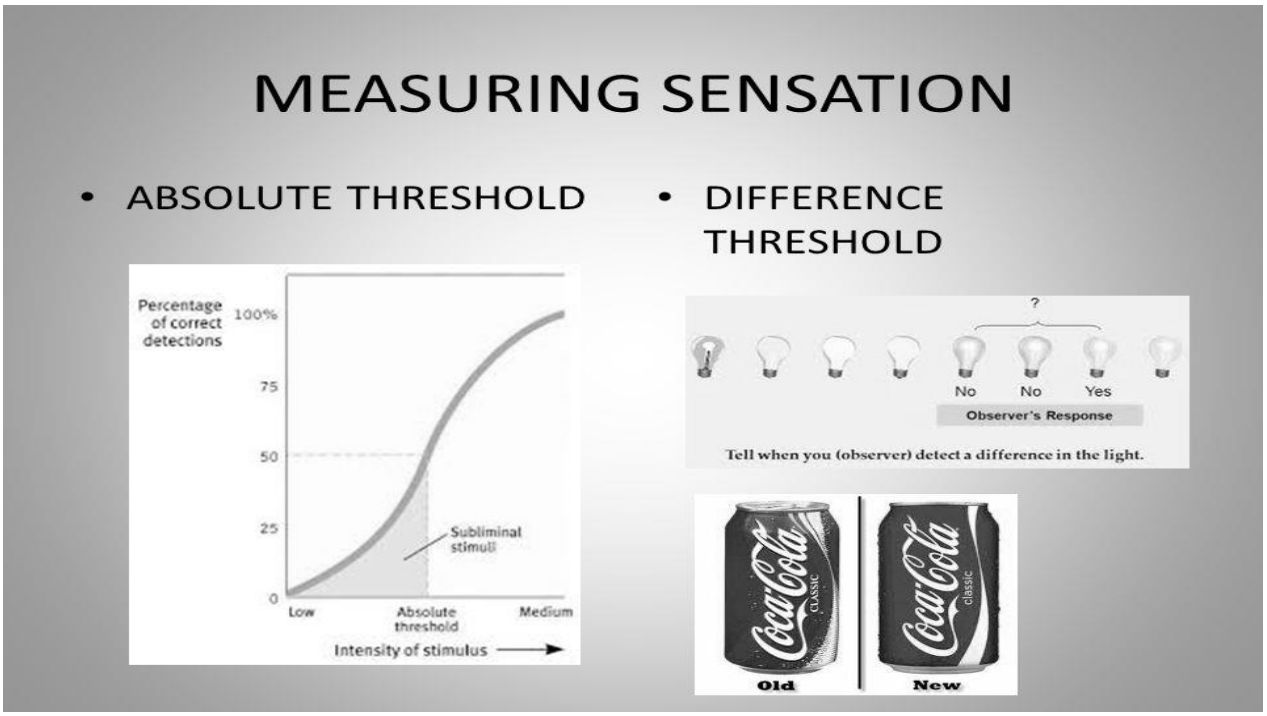
- The introduction of techniques to measure the relation between internal impressions (the psycho of psychophysics) and the external world (the physics) marked the onset of scientific psychology (Edwin G. Boring, 1950). His methods, showed that psychological judgments varied in particular ways according to the intensity of the stimulus and the particular sensory modality of the stimulus (i.e., judgments of visual stimuli differed from judgments of auditory stimuli, which differed from judgments of taste stimuli, and so on).
- Scientists using psychophysical techniques were able to formulate the first mathematical laws of psychological phenomena.
- Gustav Fechner formalized the psychophysical methods, which measure attributes of the world in terms of their psychological values (1860/1966).
- Both in the 1800s and today, a prominent use of psychophysics is to measure seemingly simple sensations such as brightness.
- Since these relations held, at least approximately, for many different people, Fechner and other researchers concluded that private, internal judgments had been measured accurately.
- Psychophysicists could measure the psychological attributes of brightness, loudness, heaviness, and pain just as physicists measured the corresponding physical attributes of light intensity, auditory intensity, and so on.

Physical Visual Intensity → Psychological Brightness
Physical Auditory Intensity → Psychological Loudness
Physical Measure of Weight → Psychological Heaviness
Physical Electrical Intensity → Psychological Pain

Measuring sensations

- Is difficult because they are not open to public measurement as is light intensity or the weight of a stone.

- The internal judgments are not identical to the amount of physical energy influencing the sensory apparatus.
-



Importance and Implications

- Suppose a dentist (or a patient) wanted a way to make pain more tolerable without administering drugs. The measurement of pain is a psychophysical problem, since the degree of pain must be inferred from the behavior of the patient in the dentist's chair.
- A sweet-smelling odor could make pain more tolerable.
- Cold-pressor test requires subjects to immerse their dominant hand and forearm into cold water (5° C) for up to 4 minutes.
- Subjects were told to leave their hand in the water for as long as they could tolerate the pain.
- Subjects who breathed a sweet-smelling odor kept their hand in the cold water almost three times as long as subjects in a control condition where no odor was present. A recent psychophysical study by Prescott and Wilkie, 2007.
- Rarely a direct one-to-one relation between physical values and psychological values.
- For a listener to judge the sound to be twice as loud, the energy level would have to be increased roughly 10 times.
- Amplifier dials and telephones

Thermal Sensation

Slightly Cool	Neutral	Slightly Warm

Thermal Comfort

e	Just Uncomfortable	Just Comfortable

Sensory Modalities

Pain judgments in response to increases in electrical intensity of shocks applied to the skin grow much more rapidly than do loudness judgments in response to increases in sound energy. For one shock to be judged twice as painful as another, the intensity of the shock needs to have been increased about one-third.

Sensory Modalities

- Each unique type of sensation is called a **sensory modality,** and a given sensory neuron carries information for only one modality, be it somatic, visceral, or "special"
  - **Somatic senses** include tactile sensations (touch, pressure, vibration, itch, and tickle), thermal sensations (warm and cold), pain sensations, and proprioception (awareness of limb and joint position in space)
  - **Visceral senses** provide information about conditions within internal organs

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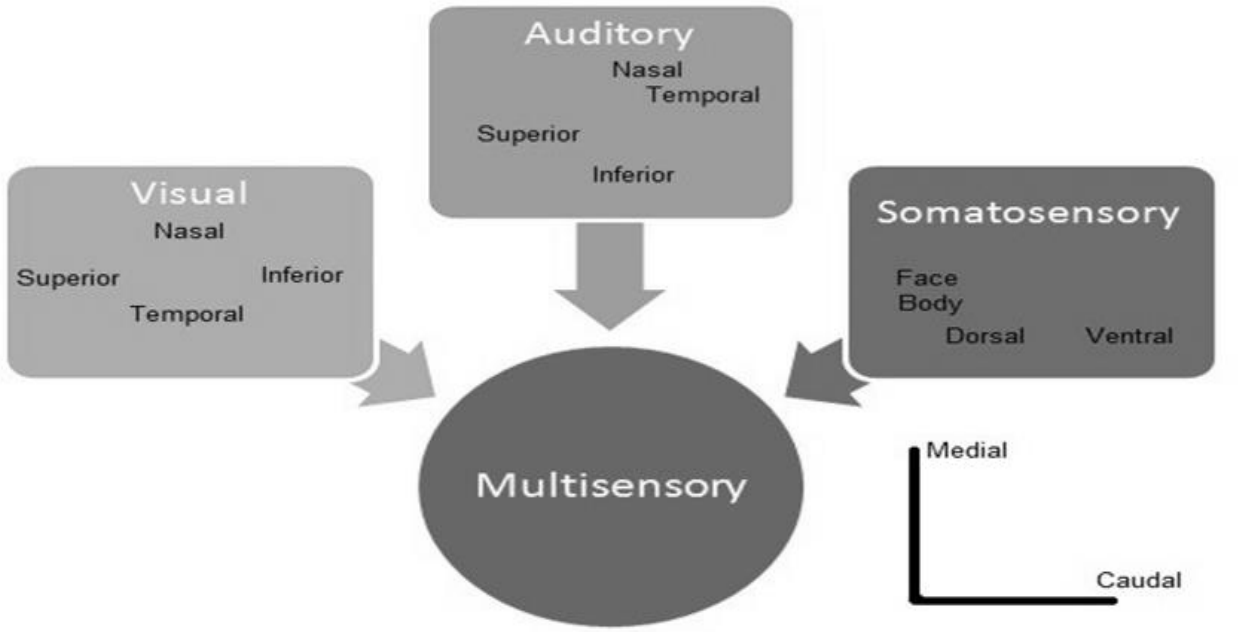
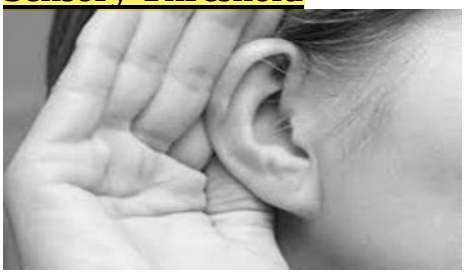
Methods and measures

- Not simple to measure loudness or painfulness
- Operational definitions: describe the procedures used to produce a concept, allow us to communicate successfully
- Scales; the assignment of numbers or names to objects and their attributes
- Small-n designs



Sensory Threshold



Dependent variables

- Observers in psychophysical studies are asked to make one of two kinds of judgments about stimuli that have been presented.
- If only one stimulus has been presented on a particular trial, an absolute judgment is required.
- Absolute judgments can be simple statements about the presence or absence of a signal ("Yes, I saw it" or "No, I did not see it") or direct estimates about some property of the stimulus (answering) ("How many grams does this weigh?)."

Absolute Threshold

'A threshold based on an observer's ability to detect a signal, is called an absolute threshold'.

If two stimuli must be compared on a particular trial, a relative judgment is required. Again, simple statements, such as "Stimulus A is a larger than (or smaller than) stimulus B," can be made; or direct estimates, such as "Stimulus A is twice as large as stimulus B," can be given.

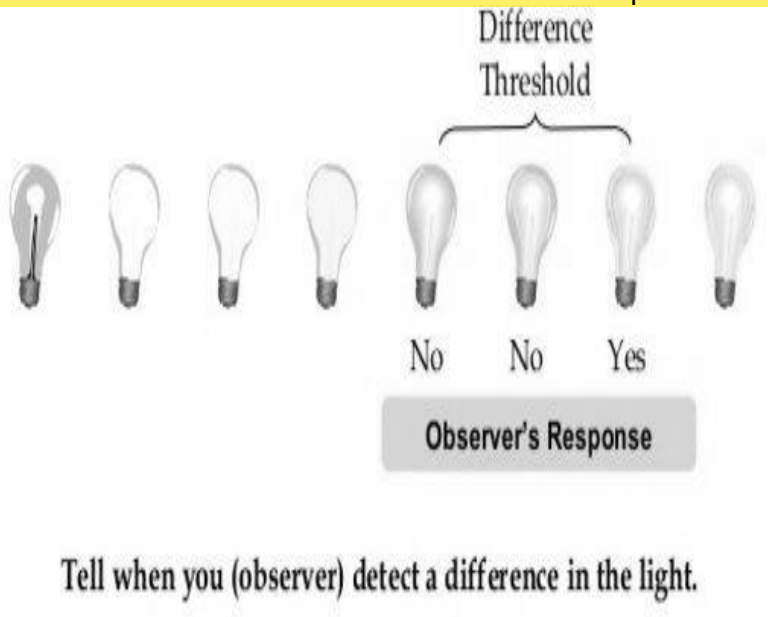
Examples of Absolute Thresholds

Adopted from Brown et al., 1962
D. Weston, 2003

Sense	Threshold
Vision	A candle flame 30 miles away
Hearing	A watch ticking 20 feet away
Smell	A drop of perfume in a six-room house
Taste	A teaspoon of sugar in a gallon of water
Touch	A wing of a fly on your cheek, dropped 1 cm

The Difference threshold

(called DL from the German Differenze Limen, which is translated as "difference threshold") is the smallest difference between two stimuli that a person can detect.



Tell when you (observer) detect a difference in the light.

Independent Variables

The major independent variables manipulated in psychophysical studies are the magnitude and the quality of stimuli. Changing the intensity—the physical correlate of loudness—of a tone would be a manipulation of stimulus magnitude, as would be changing the weight of an object or the concentration of an odor.

The frequency—the physical correlate of pitch—of a tone would be manipulated to produce a qualitative change in the stimulus. Other qualitative judgments could require that observers compare various foods (spinach versus turnips) or the styles of different singers
(for example Reshman versus Nayyera Noor)

Sensory Threshold 2

A sensory threshold can be defined generally as a stimulus intensity that produces a response in half of the trials.A sensory threshold is the level of strength a stimulus must reach to be detected. Sensory threshold is a theoretical concept used in psychophysics. A stimulus that is less intense than the sensory threshold will not elicit any sensation.

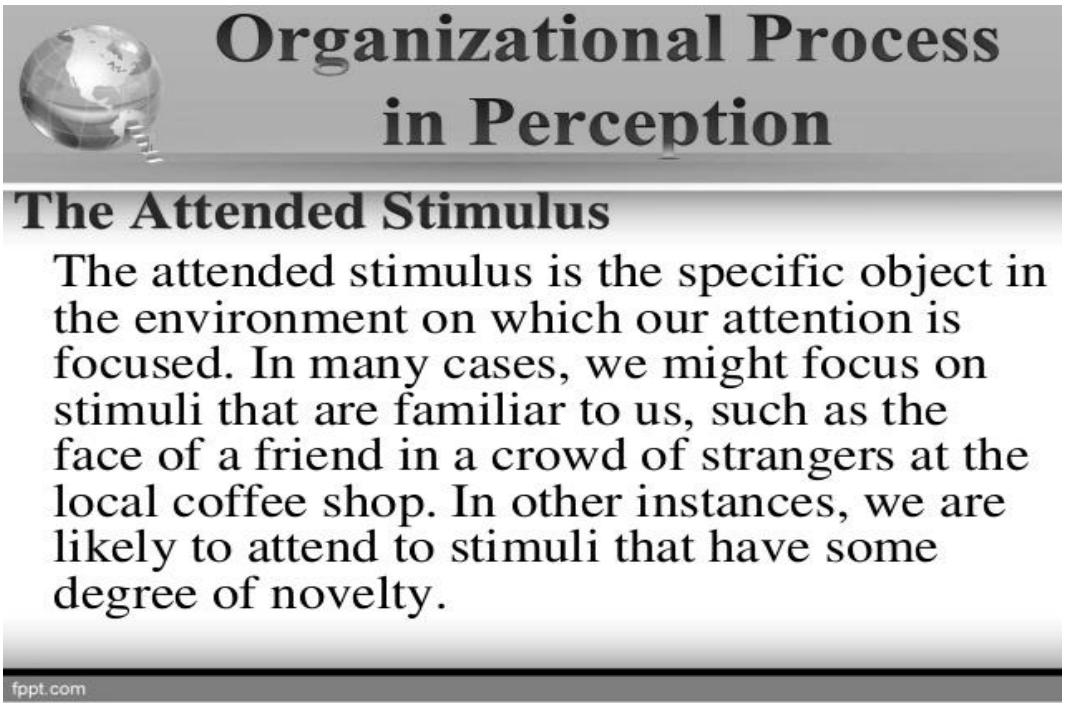
Stimulus:

The stimulus exists both "out there," in the environment, and within the person's body.

Environmental Stimuli and Attended Stimuli:

The environmental stimulus is all of the things in our environment that we can potentially perceive. The attended stimulus changes from moment to moment

The nervous system receives input through an array of sense organs (for example, the eye, ear, or nose) and transforms the information.



- **Absolute threshold:** the lowest level at which a stimulus can be detected.
- **Recognition threshold:** the level at which a stimulus can not only be detected but also recognized.
- **Differential threshold:** the level at which an increase in a detected stimulus can be perceived.
- **Terminal threshold:** the level beyond which a stimulus is no longer detected.

Psychophysical methods; method of constant stimuli

Methods of Psychophysics

For measuring relation between stimuli and subjective judgment some methods have been developed. These will be discussed with examples.

Measuring sensations

- Is difficult because they are not open to public measurement as is light intensity or the weight of a stone.
- The internal judgments are not identical to the amount of physical energy influencing the sensory apparatus.
- At first, the answer may seem obvious. All we have to do is slowly increase the intensity of a stimulus, such as a tone or a dim light, until the observer responds, "Yes, there it is." Unfortunately, when we try to repeat this process, the point at which an observer suddenly detects the stimulus changes from trial to trial. To deal with this variability, classical psychophysicists developed statistical methods to estimate the best value for the threshold. Developed by Fechner and known as the method of limits.

Method of Limits

In the method of limits, the experimenter presents stimuli in either ascending order (intensity is increased) or descending order (intensity is decreased).

Using the Method of Limits to Determine an Absolute Threshold.

Stimulus Intensity	Response				
	↓		↓		
200			Yes		
180	Yes		Yes		
160	Yes		Yes		
140	Yes	Yes	Yes		
120	Yes	No	No	Yes	
100	Yes	No		No	
80	No	No		No	
60		No		No	
40		No		↑	
20		No			
		↑			
					Mean
Threshold	90	130	130	110	115

Note: In the first series of trials, the experimenter starts with a strong stimulus and decreases its intensity until the observer can no longer detect it. The threshold is the mean of the stimulus intensities that yield the first "no" response and the last "yes" response. In the next series of trials, a weak stimulus is increased in intensity until it is detected. It is customary to start each series at a different stimulus intensity to make it less likely that the observer's responses will be influenced by the length of a series. Stimuli are in arbitrary units—that is, the intensities ranging from 20 to 200 could represent weight or anything else that might vary in intensity.

If we performed an experiment using the method of limits to determine the threshold for a tone, results would look like those shown in Table.

Each column represents data from one block of trials. The first block starts with a clearly audible tone, to which the observer responds "yes." The tone intensity is lowered in successive steps until

the observer reports "no," thus ending that trial block. The next block of trials starts with an intensity so low that the observer cannot hear the tone and responds "no."

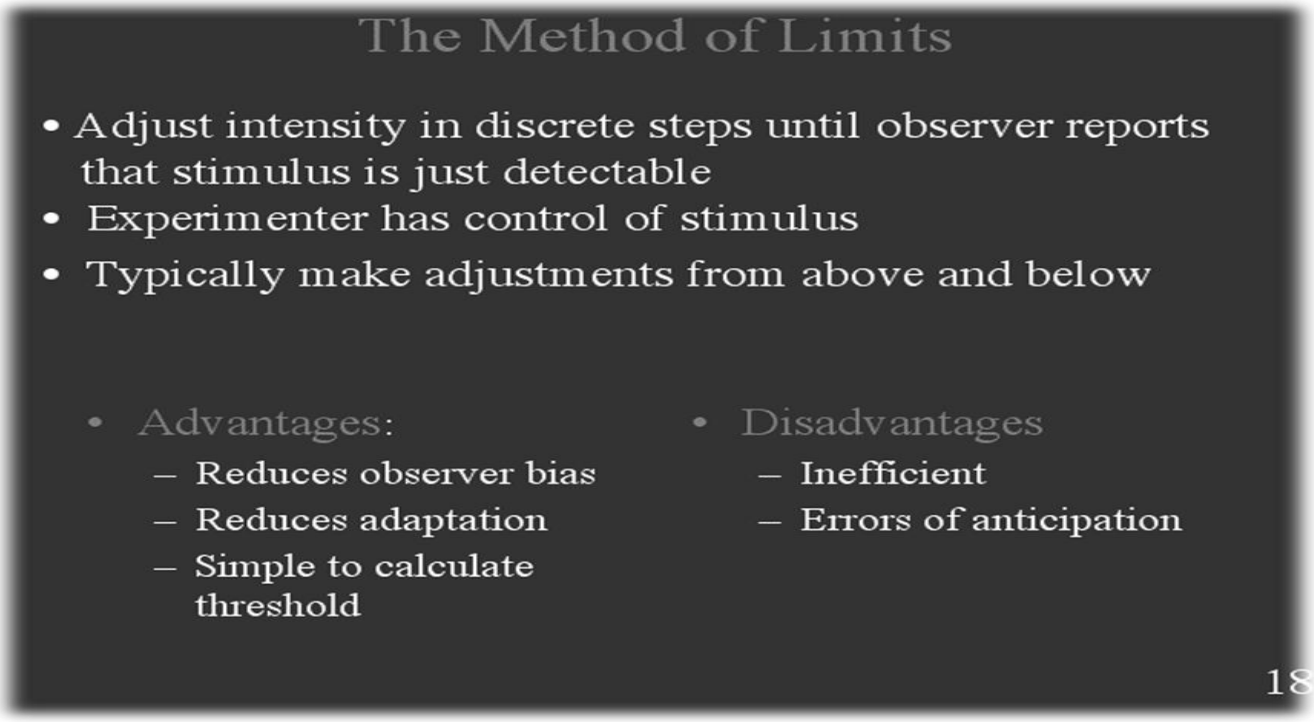
On successive trials, the intensity is gradually increased, until the observer reports hearing the tone. This process of alternating trial blocks continues until Table is complete. Each block is started at a different intensity to avoid extra cues that might mislead the observer.

If the observer were a perfect observer were a perfect stimulus detector, the point at which responses switched from "yes" to "no" (or vice versa) would always be the same. This ideal point would be the threshold.

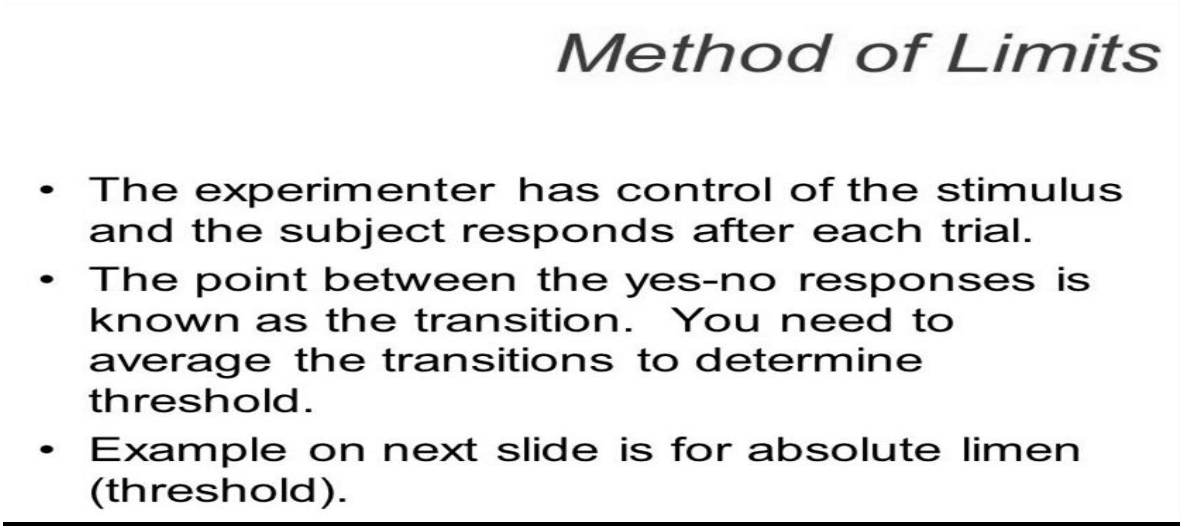
- **Stimuli less intense than this value would never be detected, and stimuli greater than or equal to this ideal threshold would always be detected.**
- **Unfortunately, real data from real people do not have this ideal characteristic; they look like the data in Table**
- **Premature yes or no in trails**

The threshold is operationally defined as the mean (average) of the points in each trial block at which the observer switches from "yes" to "no" (or "no" to "yes").

This operational definition is a statistical one. A threshold defined this way, based on an observer's ability to detect a signal, is called an absolute threshold, since the yes-no judgments are not based on a comparison of two stimuli but are absolute judgments about a single stimulus



Method of Limits



Measuring sensations

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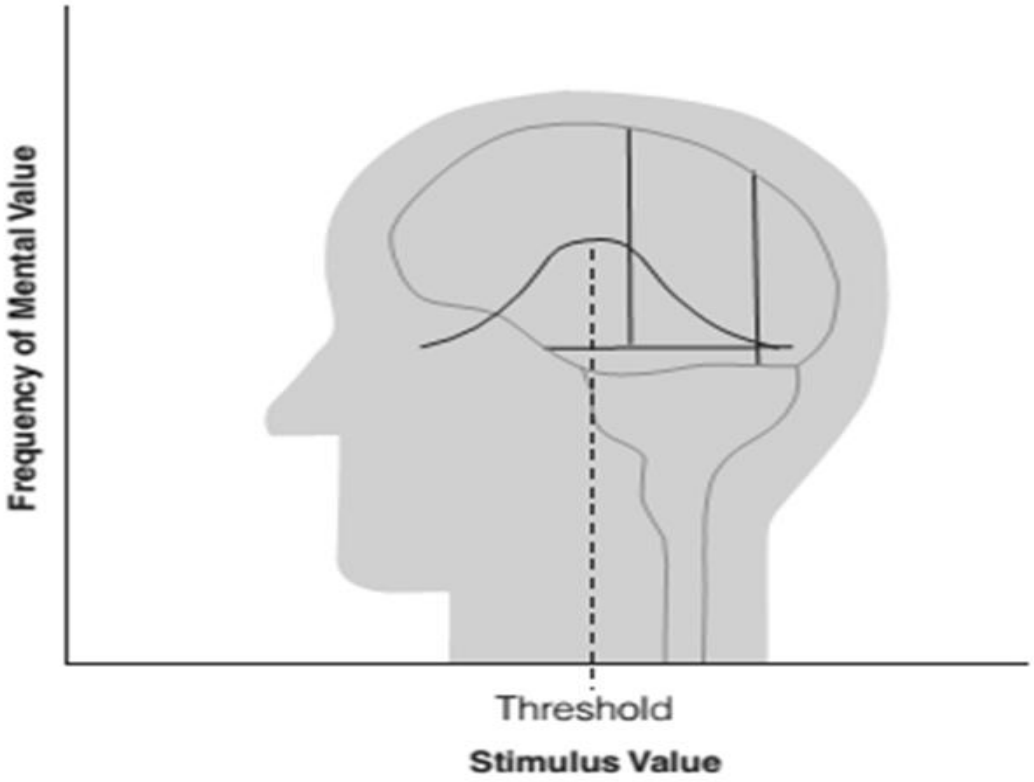
- To deal with this variability, classical psychophysicists developed statistical methods to estimate the best value for the threshold.

Method of constant stimuli

- In the method of constant stimuli, the experimenter presents five to nine stimuli with different intensities in random order
- Classical psychophysics assumes that the physical stimulus produces a normal distribution of mental events (Figure 6.2). Thus, the actual mental value produced by the same physical stimulus varies from trial to trial. The threshold is a statistical concept that corresponds to the mean of this normal distribution.
- Since a normal distribution is symmetrical, the threshold is the stimulus value that can be detected 50 percent of the time
- The Same Physical Stimulus Produces a Range of Mental Values



- In the method of constant stimuli, the experimenter presents stimuli with different intensities in random order
- The method of constant stimuli is the most accurate method because it involves many observations and stimuli are presented in random order.
- The disadvantage of this method is that it is time-consuming

Lecture 11

PSYCHOPHYSICS (II)

Method of Adjustment

The psychophysical approach to perception focuses on the relationship between the physical properties of stimuli and the perceptual responses to these stimuli.

The classical psychophysical methods for measuring the relationship between stimuli and perception;

1) Limits
2) Constant stimuli
3) Adjustment

- Are a set of procedures to relate the intensity of a physical stimulus—measured in physical units—to the magnitude of the sensory experience—measured in psychological units (Fechner, 1860/1966).
- The observer adjusts the stimulus intensity continuously until the observer can just barely detect the stimulus.
- The observer might be told to turn a knob to decrease the intensity of a sound, until the sound can no longer be heard, and then to turn the knob back again so the sound is just barely audible.
- This just barely audible intensity is taken as the absolute threshold.
- This procedure can be repeated several times and the threshold determined by taking the average setting.

- Subjects adjust stimulus intensity (or difference between two stimuli) until they can just about detect or discriminate the stimulus. This stimulus intensity (or difference) is the threshold
- Usually done in ascending and descending series like method of limits (but under subjects' control
- The method of adjustment is faster because observers can determine their threshold in just a few trials by adjusting the intensity themselves.

Examples

This is an example of Bekesy tracking, a type of method of adjustment. The listener pushes a button as long as he can hear the tone and let's go when he stops hearing the tone, so the level goes up and down around threshold. In Bekesy tracking, the frequency of the tone changes during the course of the test so that thresholds can be estimated at many frequencies.

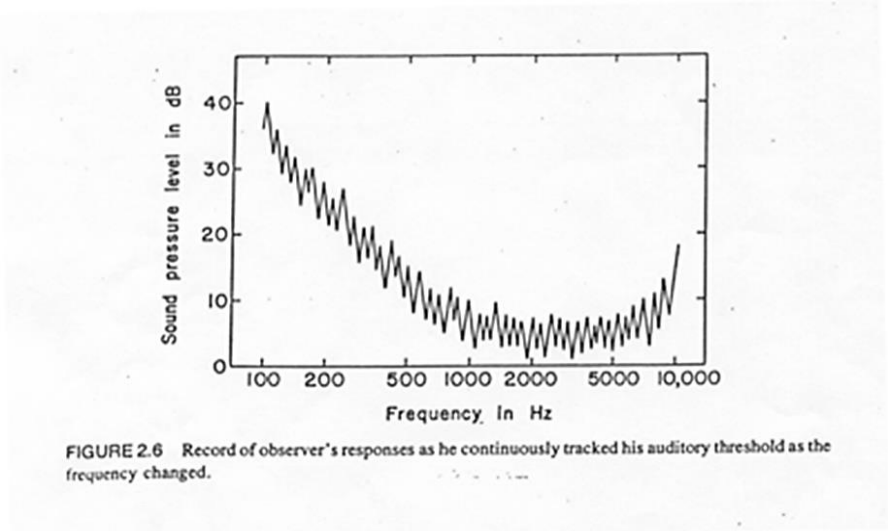
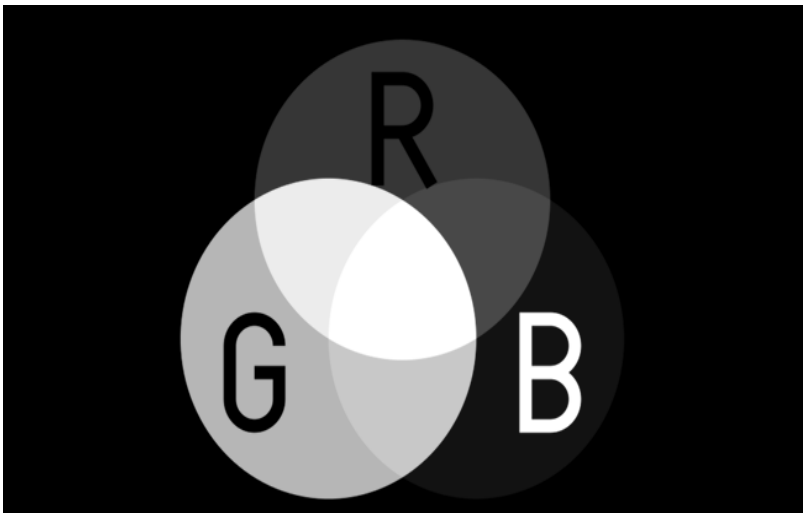


FIGURE 2.6 Record of observer's responses as he continuously tracked his auditory threshold as the frequency changed.

- At optician testing for new glasses, he drops lenses of increasing number and asks how clearly you can see.
- Color matching in which user can be presented with a square with a blue color with RGB of [0,0,255] and asked to create a matching color swatch by using a dial, trials in ascending and descending order and a grand mean RGB is calculated.



Comparing Methods

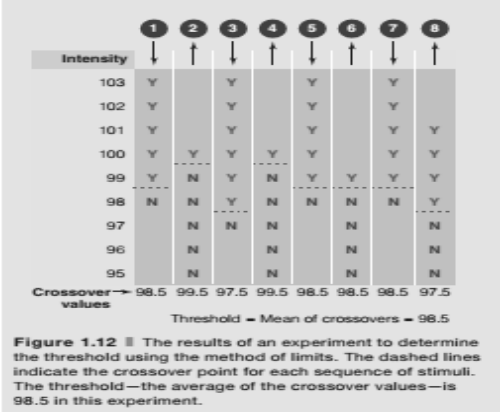


Figure 1.12 The results of an experiment to determine the threshold using the method of limits. The dashed lines indicate the crossover point for each sequence of stimuli. The threshold—the average of the crossover values—is 98.5 in this experiment.

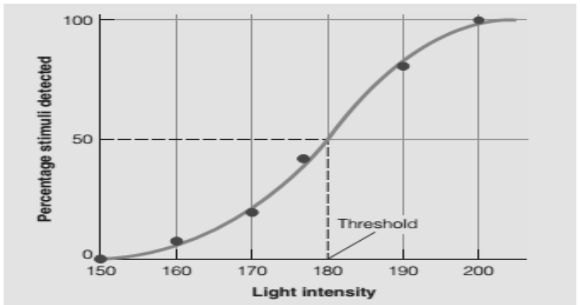
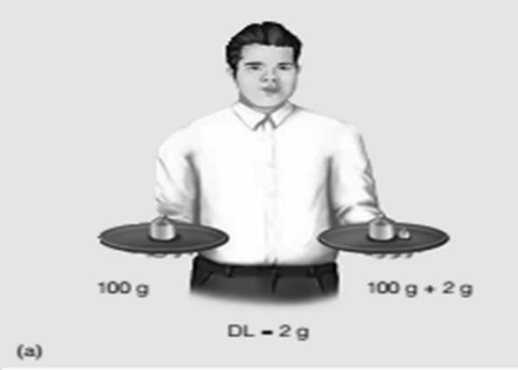


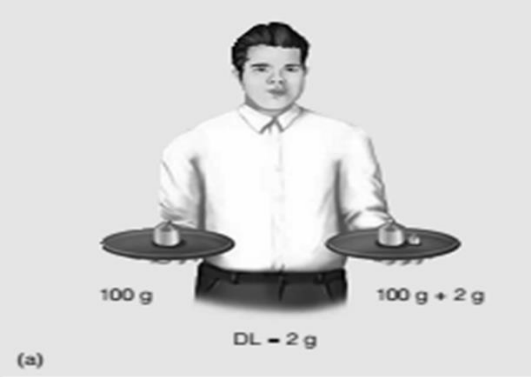
Figure 1.13 Results of a hypothetical experiment in which the threshold for seeing a light is measured by the method of constant stimuli. The threshold—the intensity at which the light is seen on half of its presentations—is 180 in this experiment.

Goldstein, 2010, page 14

Difference Threshold

- The minimum difference or change in intensity to detect a difference
- Comparison stimulus, standard stimulus
- Judging weight
- Smaller differences less detectable
- Weber's Law; as the magnitude of the stimulus increases, so does the size of the **DL . KL/S = DL**





- **K** is a constant-the Weber fraction
- **S** = the value of the standard stimulus.
- 100-gram standard, K 2 g/100 g 0.02, and for the 200-gram standard, K 4 g/200 g 0.02
- The Weber fraction (K) is constant.
- Weber's Law can be applied to variety of sensory modalities (brightness, loudness, , line length).
- The size of the Weber fraction varies across modalities
- Tends to be a constant within a specific task modality.

TABLE 1.1 Weber Fractions for a Number of Different Sensory Dimensions

Electric shock	0.01
Lifted weight	0.02
Sound intensity	0.04
Light intensity	0.08
Taste (salty)	0.08

Source: Teghtsoonian (1971).

Difference Threshold

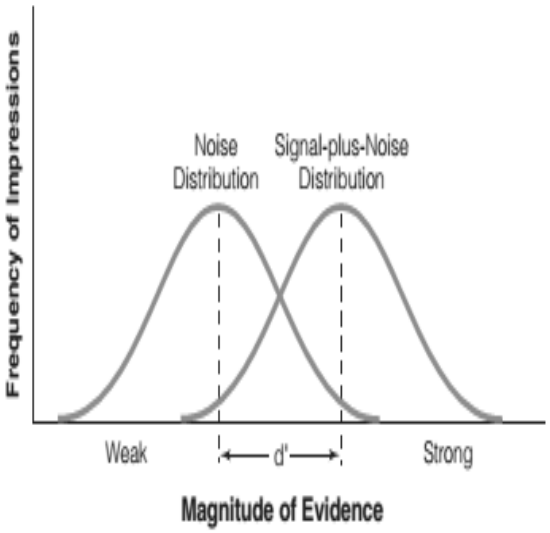
- **Just Noticeable Difference –JND**
- Is the minimum amount by which stimulus intensity must be changed in order to produce a noticeable variation in sensory experience**.**
- **Point of Subjective Equality- PSE**
- The point or value at which the participant judges the comparison stimulus to be equal to standard stimulus.

Signal Detection Theory and Application

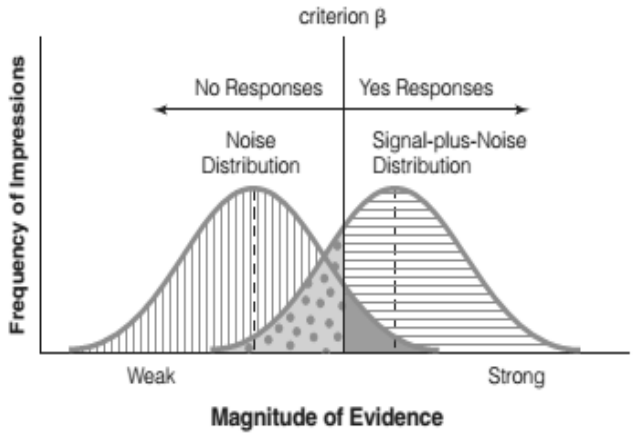
Signal Detection

- According to the theory of signal detection, our perception in general is controlled by **evidence** and **decision processes**.
- A signal or stimulus creates (hypothetical) evidence that depends on the intensity of the signal and the acuity of the observer, which partly determine a "yes" response.
- There are other determiners of a decision to say "yes, there is a stimulus present," including factors that influence the willingness of the observer to say a signal is present.
- Signal-detection theory assumes that noise, a disturbance that can be confused with signals, is always present when a human attempts to detect signals.
- This background disturbance is owing to such things as environmental changes, equipment changes, spontaneous neural activity, and direct experimental manipulations.
- Typical experiments
  - Trail 1 = flash light ⟶ white noise
  - Trail 2 = flash light ⟶ white noise and tone
  - Response = Yes/ No
- Signal-detection theory assumes that any stimulus, even noise, produces distribution of evidence. The evidence on each trial is only one point, and the distributions are built up from many trials, each occurring at a different point in time.
- Evidence cannot be directly observed the distributions for stimulus trials and for noise trials are hypothetical.
- The evidence arising from a trial for which only noise occurred will tend to be small.

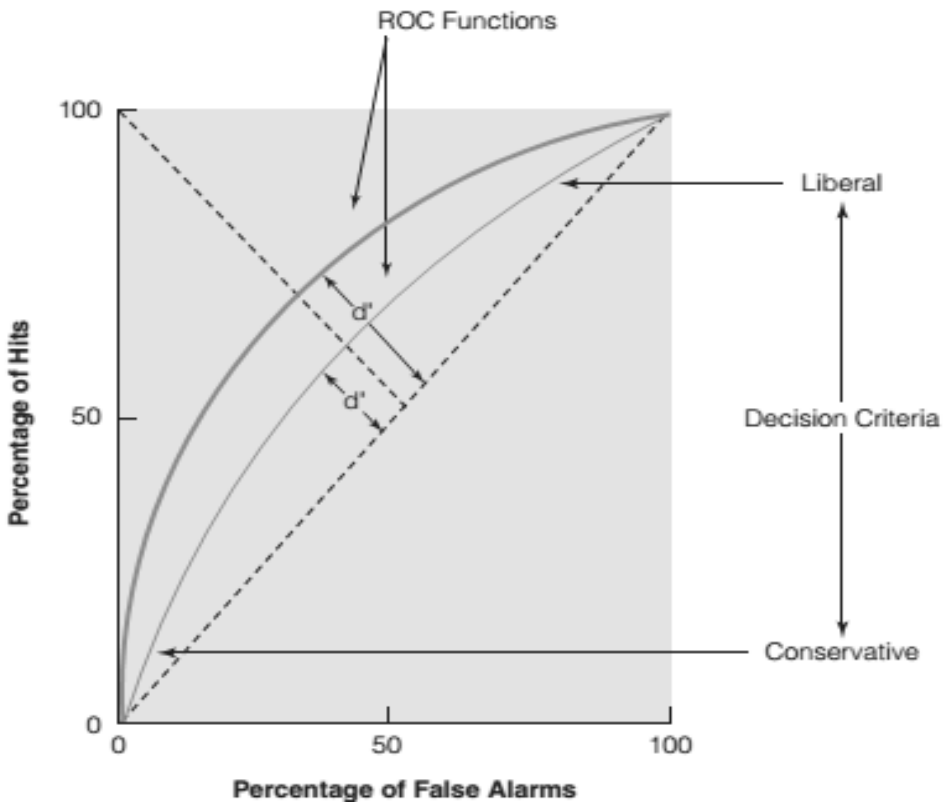
- Over many trials, a (hypothetical) distribution with a small mean will be established. When a signal plus noise is presented, the evidence will be larger, so that a distribution with a greater mean will be formed over many trials.
- Repeated trials generate two distributions—one for noise only and one for the signal plus noise



Hypothetical Distributions of the Evidence Resulting from Noise and Signal Plus Noise. The frequency of the impressions is the Y-axis and the magnitude of evidence is the X-axis. The strength of the signal and the sensory acuity of the observer determine the amount of overlap of the two distributions. A stronger signal or a more sensitive observer would move the signal-plus-noise distribution to the right (toward the strong end of the X-axis). The dashed vertical lines are the mean (average) of each distribution, and the distance between the two means is called **d'**.



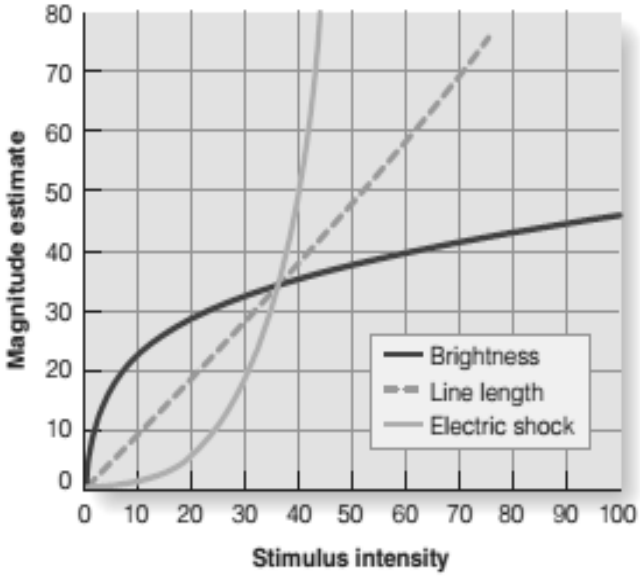
Correctly detecting a signal when it is presented is called a **hit** Incorrectly responding "yes" when only noise is presented is called a **false alarm**.



Receiver-operating characteristic

- A major advantage of signal-detection methods over a classical psychophysical procedure, such as the method of limits, is the ability to measure both sensitivity and response bias.
- The Experiments on analgesics by Hardy and associates (1952)
- Decision criterion or sensitivity?
- The classical psychophysical methods were developed to measure absolute and difference thresholds.
- Most of our everyday experience consists of perceptions that are far above threshold, when we can easily see and hear what is happening around us.
- Measuring these above-threshold perceptions involves a technique called magnitude estimation.
- If we double the intensity of a tone, does it sound twice as loud?
- If we double the intensity of a light, does it look twice as bright?
- S. S. Stevens developed a technique called scaling, or magnitude estimation, that accurately measured this relationship
- (S. S. Stevens, 1957, 1961, 1962).
- A "standard" stimulus presented to the observer (let's say a light of moderate intensity), a value of 10 then lights of different intensities
- The observer is asked to assign a number to each of these lights that is proportional to the brightness of the standard stimulus.
- If the light appears twice as bright as the standard, it gets a rating of 20; half as bright, a 5; and so on. Thus, each light intensity has a brightness assigned to it by the observer.

- There are also magnitude estimation procedures in which no "standard" is used. But the basic principle is the same: The observer assigns numbers to stimuli that are proportional to perceived magnitude.



The relationship between perceived magnitude and stimulus intensity for electric shock, line length, and brightness.
(Adapted from Stevens, 1962.)

Response Compression

- Doubling the intensity does not necessarily double the perceived brightness.
- When intensity is 20, perceived brightness is 28. If we double the intensity to 40, perceived brightness does not double, to 56, but instead increases only to 36.
- This is called response compression.
- As intensity is increased, the magnitude increases, but not as rapidly as the intensity. To double the brightness, it is necessary to multiply the intensity by about 9

Response expansion

- Curve also show sensation caused by an electric shock presented to the finger and for the perception of length of a line.
- The electric shock curve bends up, indicating that doubling the strength of a shock more than doubles the sensation of being shocked.
- Increasing the intensity from 20 to 40 increases perception of shock sensation from 6 to 49. This is called response expansion.
- As intensity is increased, perceptual magnitude increases more than intensity. The curve for estimating line length is straight, with a slope of close to 1.0, meaning that the magnitude of the response almost exactly matches increases in the stimulus (i.e., if the line length is doubled, an observer says it appears to be twice as long).
- The relationship between the intensity of a stimulus and our perception of its magnitude follows the same general equation for each sense.

- The power functions; equation P KS ^{n} Perceived magnitude, P, equals a constant, K, times the stimulus intensity, S, raised to a power, n.
- This relationship is called **Stevens's power law.**

Physiology of perception 1

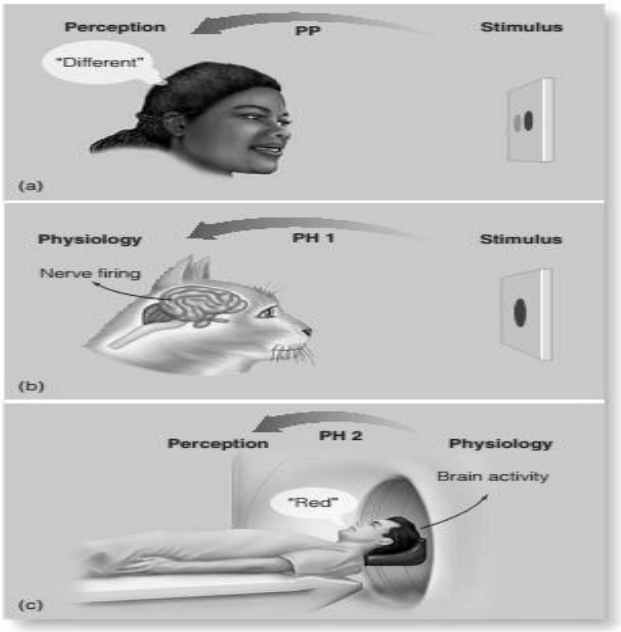
Psychophysical (PP) and physiological (PH) approaches to perception.

- Psychophysical (PP) relationship between stimuli and perception,
- The physiological (PH1) relationship between stimuli and physiological processes
- The physiological (PH2) relationship between
- Physiological processes and perception.

Examples

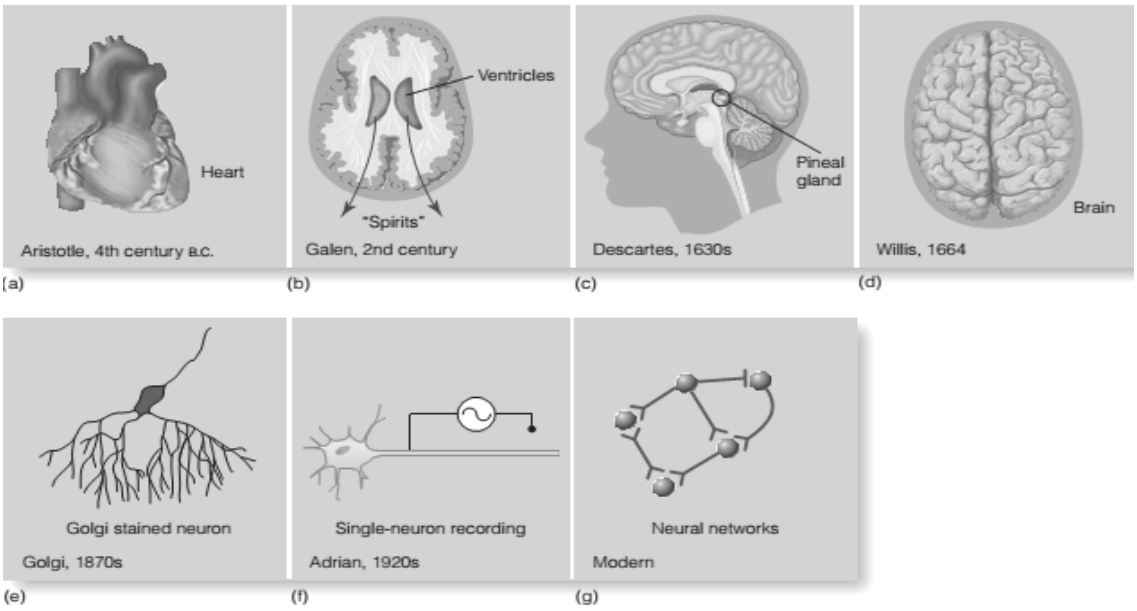
Physiological processes are most often studied by measuring electrical responses in the nervous system, but can also involve studying anatomy or chemical processes.

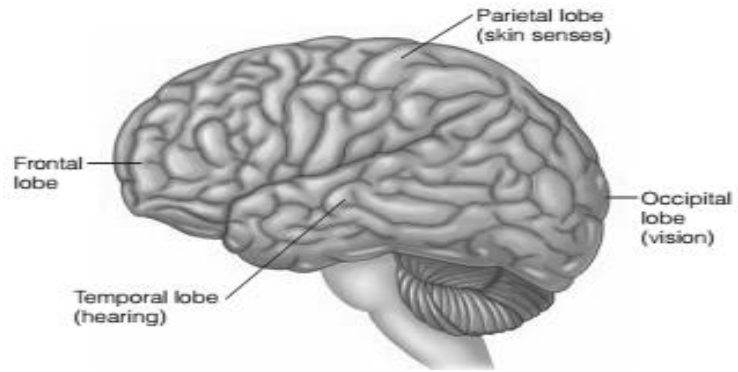
- Stimulus-physiology(PH1) ; measuring how different colored lights result in electrical activity generated in neurons in a cat's cortex
- Physiology-perception; a person's brain activity is measured as the person describes the color of an object he is seeing.



Some notable ideas and events regarding the physiological workings of the mind

- From early philosophers to contemporary scientists the understanding of physiology of brain has become more detailed.
- Does not necessarily mean that we know more about how mind works !

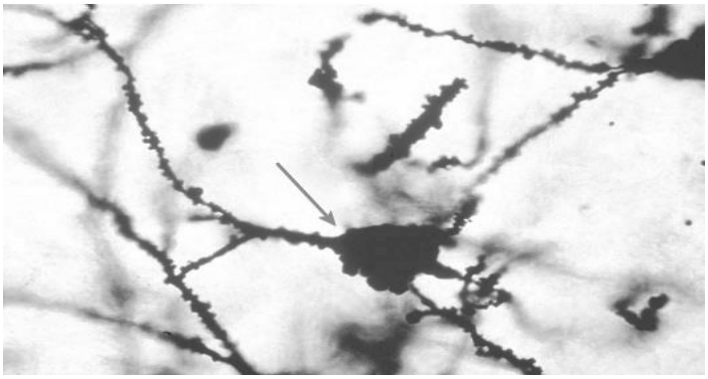




The human brain

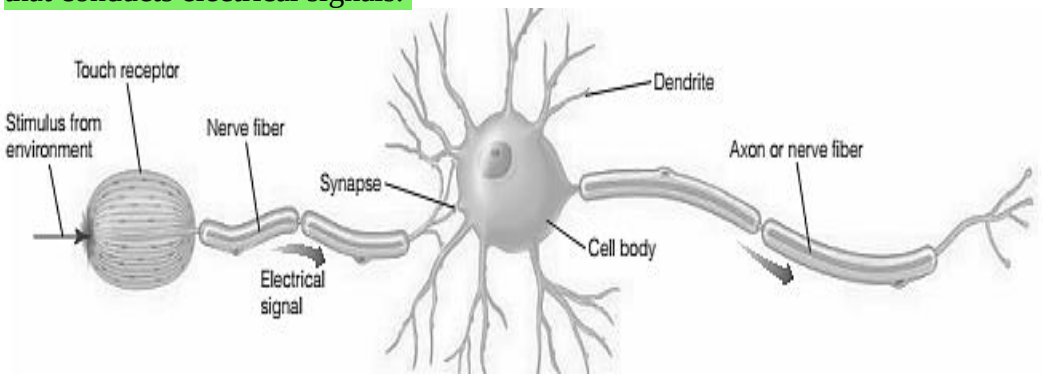
The locations of the primary receiving areas for the senses in the

- **Temporal lobe**- hearing
- **Occipital lobe**- Vision
- **Parietal lobe**- skin senses, touch, pain, temperature
- **The frontal lobe**, which is involved with integrating sensory functions, receives signals from all of the senses, and plays an important role in perceptions that involve the coordination of information received through two or more senses.

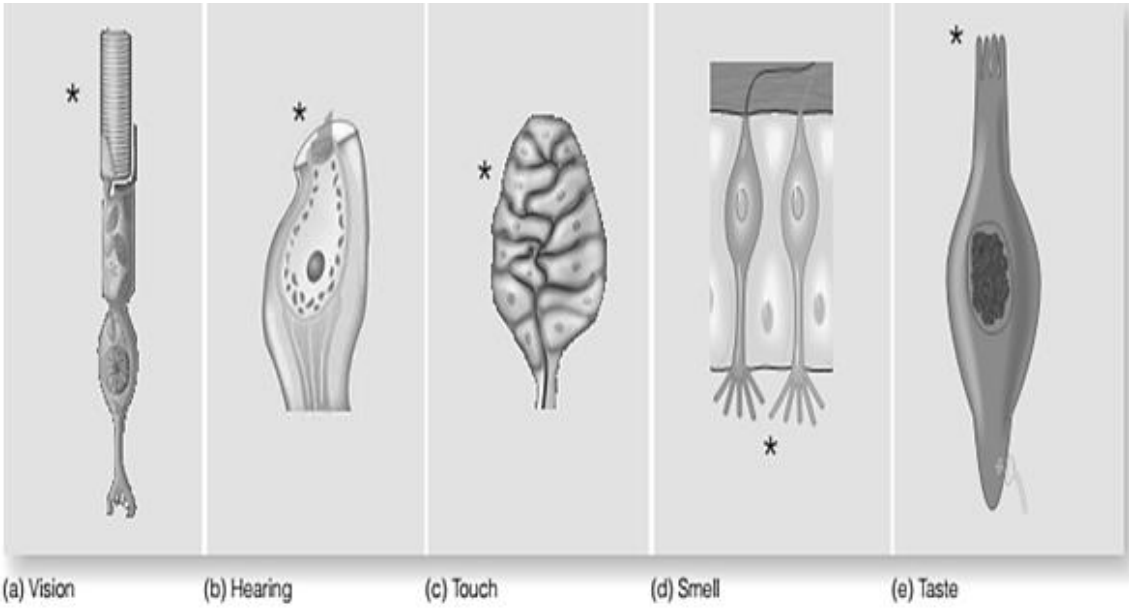


Neurons: Cells That Create and Transmit Electrical Signals

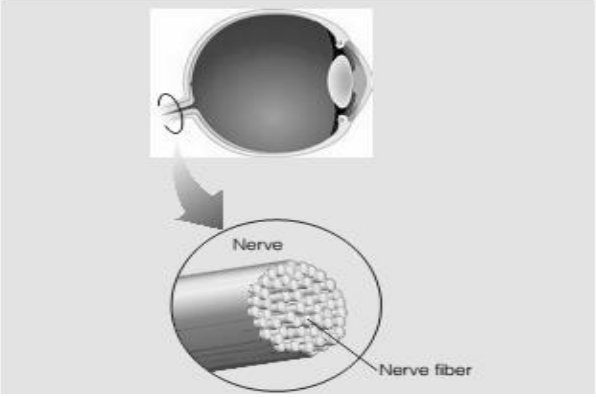
- **Transduction** and Communication with other neurons
- **Cell body, axon, dendrite**
- Cell body contains mechanisms to keep the cell alive, Dendrites branch out from the cell body to receive electrical signals from other neurons and the axon, or nerve fiber, is filled with fluid that conducts electrical signals.



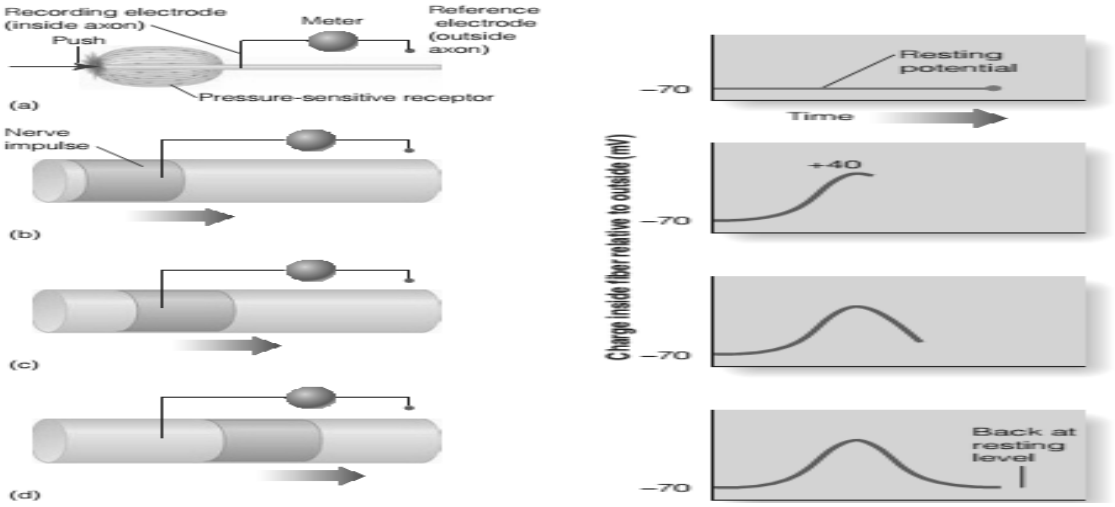
There are variations on this basic neuron structure: Some neurons have long axons; others have short axons or none at all. Especially important for perception are a type of neuron called **receptors**, which are specialized to respond to environmental stimuli such as pressure for touch.


(a) Vision
(b) Hearing
(c) Touch
(d) Smell
(e) Taste

Physiology of Perception 2



Nerves contain many nerve fibers. The optic nerve transmits signals out the back of the eye. Shown here schematically in cross section, the optic nerve actually contains about 1 million nerve fibers.



Measured by the meter on the left; the difference in charge measured is displayed on the right.

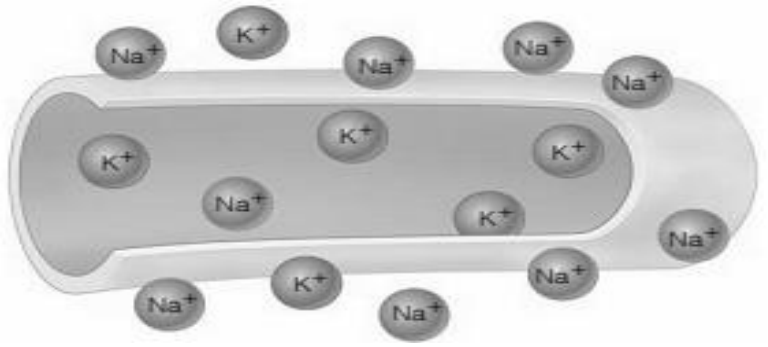
Recording from a neuron

(a)Nerve fiber at rest, a difference in charge of 70 mV between the inside and the outside of the fiber

(b) As the nerve impulse, passes the electrode, the inside of the fiber near the electrode becomes more positive. This positivity is the rising phase of the action potential.

(c) Nerve impulse moves past the electrode, the charge inside the fiber becomes more negative, falling phase of the action potential.

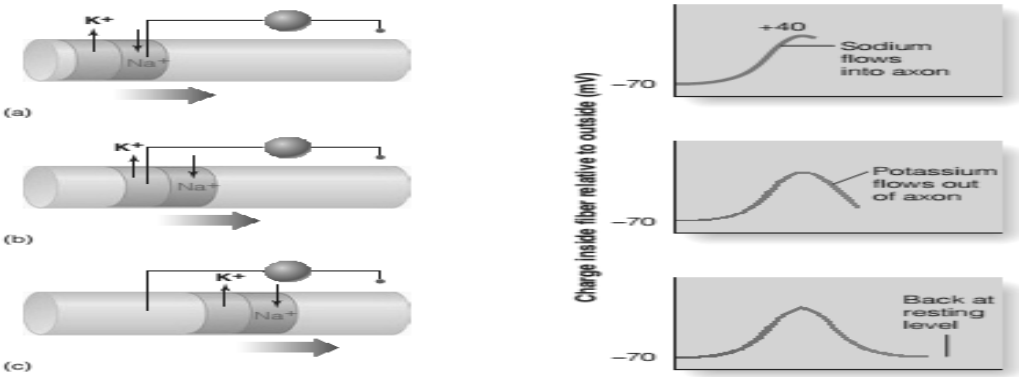
(d) Neuron returns to its resting state.



- Neurons are surrounded by a solution rich in ions, molecules that carry an electrical Charge. A nerve fiber, showing the high concentration of sodium outside the fiber and potassium inside the fiber.
- Other ions, such as negatively charged chlorine, are not shown.

Action potential

As the signal passes the recording electrode, the charge inside the axon rises to 40 millivolts compared to the outside. As the signal continues past the electrode, the charge inside the fiber reverses course and starts becoming negative again (Figure 2.7c), until it returns to the resting level (Figure 2.7d). This signal, which is called the action potential, lasts about 1 millisecond (1/1000 second).

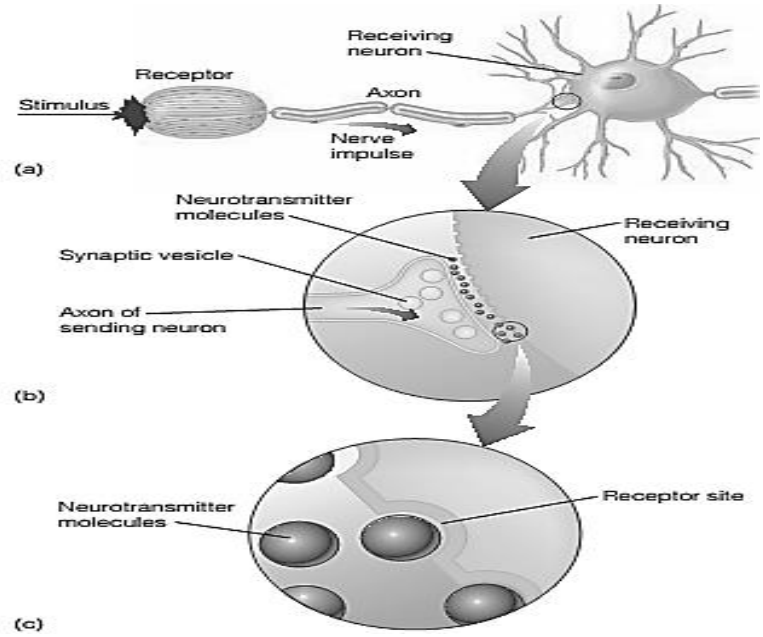


(a) As positively charged sodium (Na) flows into the axon, the inside of the neuron becomes more positive (rising phase of the action potential). (b) As positively charged potassium (K) flows out of the axon, the inside of the axon becomes more negative (falling phase of the action potential). (c) The fiber's charge returns to the resting level after the flow of Na and K has moved past the electrode.

Synapse

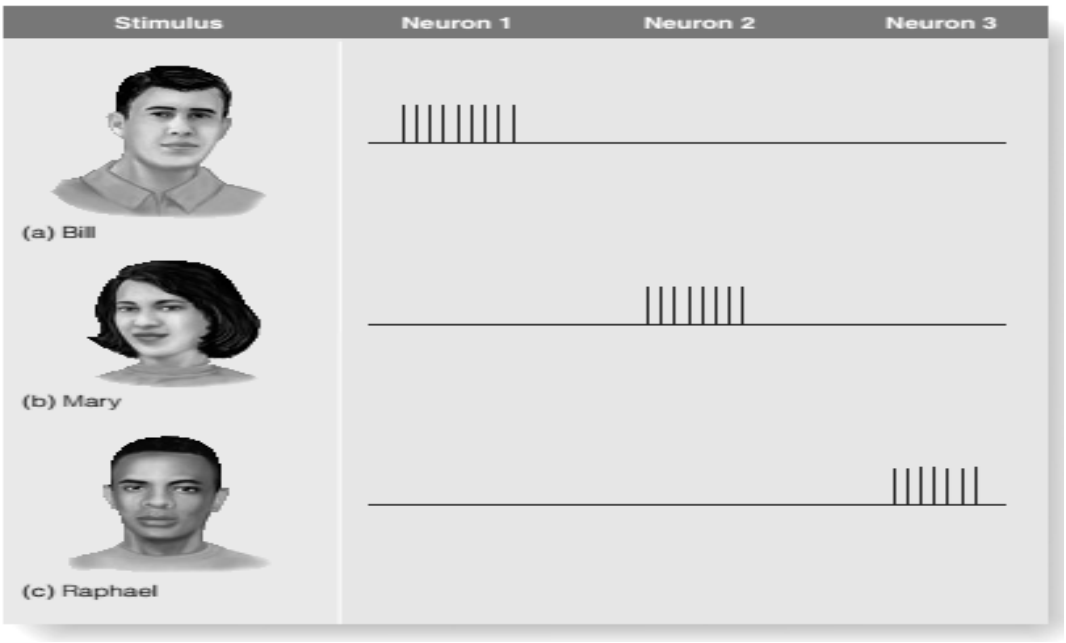
- Small space between two neurons is called **synapse**, the Action potential is transmitted across synapse through neurotransmitters
- When an electrical signal reaches the synapse, it triggers a chemical process that in turn triggers a change in voltage in the receiving neuron.
- The direction of this voltage change depends on the type of transmitter that is released and the nature of the cell body of the receiving neuron.

- **Excitatory transmitters** cause the inside of the neuron to become more positive, a process called depolarization.
- Enough excitatory neurotransmitter must be released to increase depolarization to the level
- Once **depolarization** reaches that level, an action potential is triggered.
- Depolarization can trigger an action potential, an excitatory response.
- **Inhibitory transmitters** cause the inside of the neuron to become more negative, a process called **hyperpolarization**.



- Hyperpolarization is considered an inhibitory response because it can prevent the neuron from reaching the level of depolarization needed to generate action potentials.

How faces could be coded by specificity coding. Each face causes one specialized neuron to respond.



Mind–body problem

How do physical processes such as nerve impulses or sodium and potassium molecules flowing across membranes (the body part of the problem) become transformed into the richness of perceptual experience?

Lecture 12

THE FIVE SENSES: VISUAL SYSTEM

Sense Receptors, Stimuli and Pathways

Sensation the process by which stimulation of a sensory receptor gives rise to neutral impulses that result in an experience, or awareness, of conditions inside or outside the body

Sensory receptor

A sensory receptor is a structure that reacts to a physical stimulus in the environment, whether internal or external.

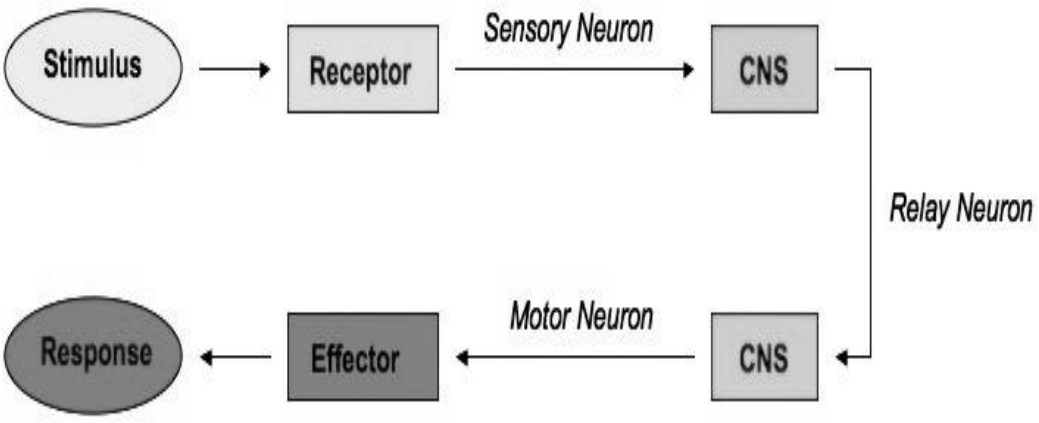
It is a sensory nerve ending that receives information and conducts a process of generating nerve impulses to be transmitted to the brain for interpretation and perception.

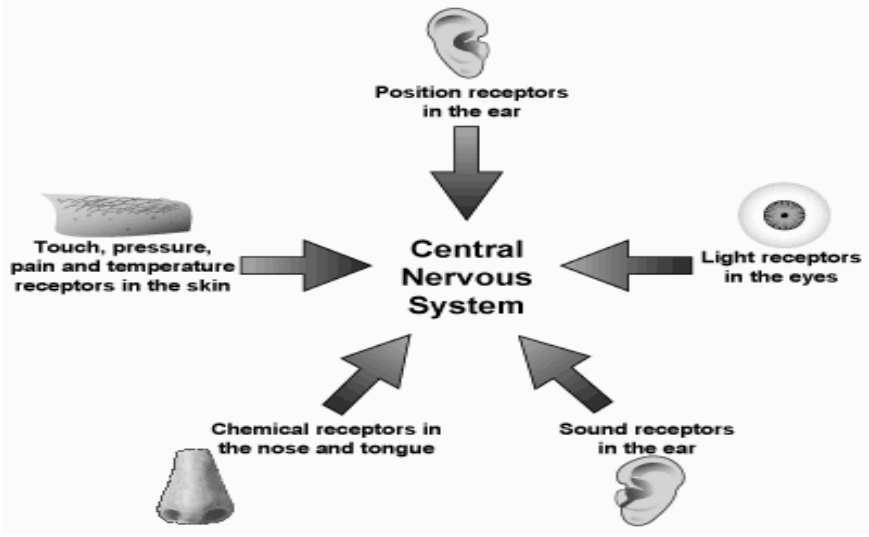
Sense	Receptor	Stimulus
Vision	Eye	Light
Hearing	Ear	Sound
Touch	Skin	Pressure/ temperature
Taste	Tongue	Molecules of food
Smell	Nose	Air Molecules

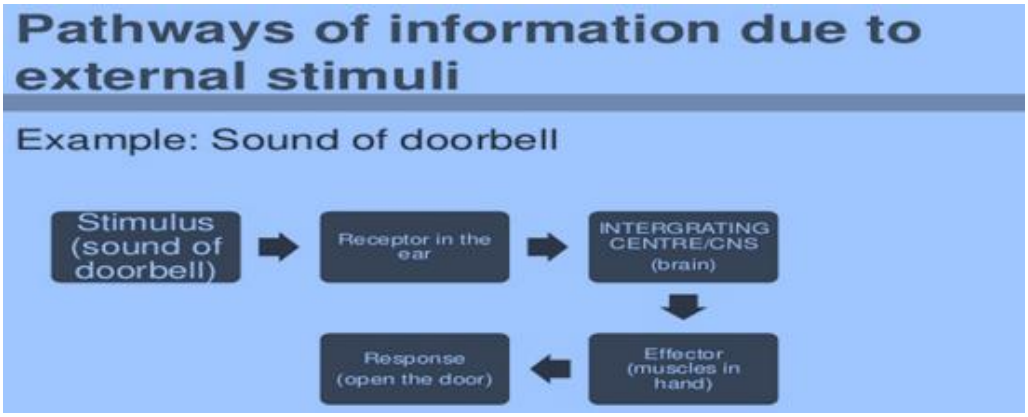
Sense modality	Detection Threshold
Light	**A candle flame seen at 30 miles on a dark clear night**
Sound	**A tick of a watch under quiet conditions at 20 feet**
Taste	**One teaspoon of sugar in 2 gallons of water**
Smell	**One drop of perfume diffused in a 3 room apartment**
Touch	**The wing of bee falling on your cheek from a distance of 1 centimeter**

Receptive Field

The receptive field of a neuron is the area on the receptors that influences the firing rate of the neuron.

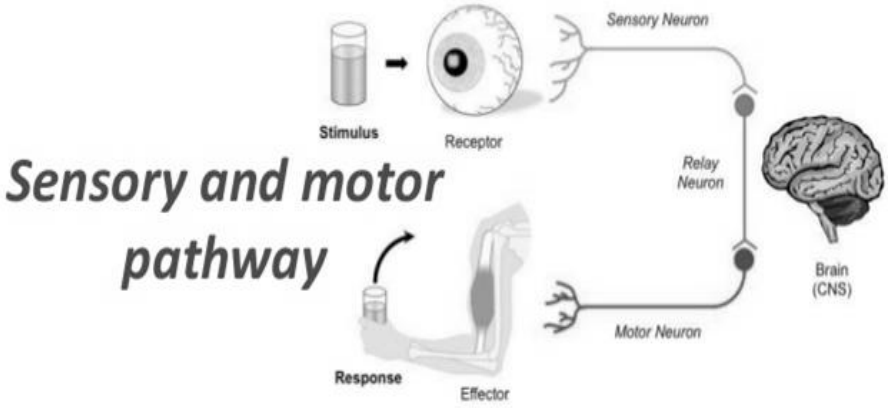






Physiology Of Sensation; Neurons and Neural Processing

Physiology of sensation refers to the registration of an incoming (afferent) nerve impulse in that part of the brain called the sensorium, which is capable of such perception. Therefore, the awareness of a stimulus as a result of its perception by sensory receptors.



Components of Sensation

1. **Stimulation** – Stimulus (change in the environment that can activate certain sensory neurons) occurs within the sensory neuron's receptive field (region that can respond to stimuli).
2. **Transduction** – A sensory receptor or sense organ must respond to the stimulus and transduce (convert it to a generator potential).

General Receptors or Special Receptors

- General receptors --
- throughout skin
- Or body: muscle spindles and tendon organs

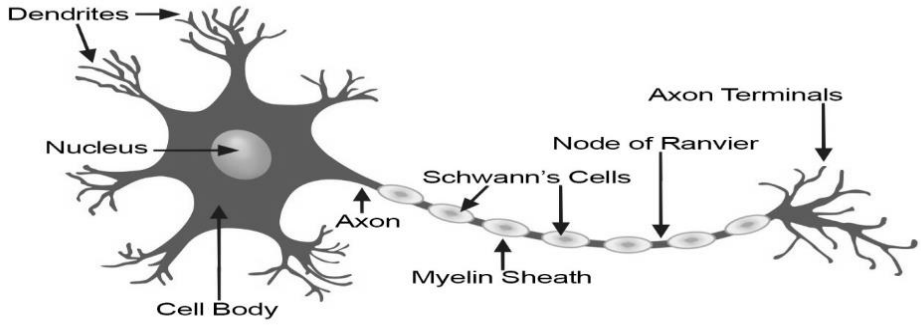
Special Sense Receptors

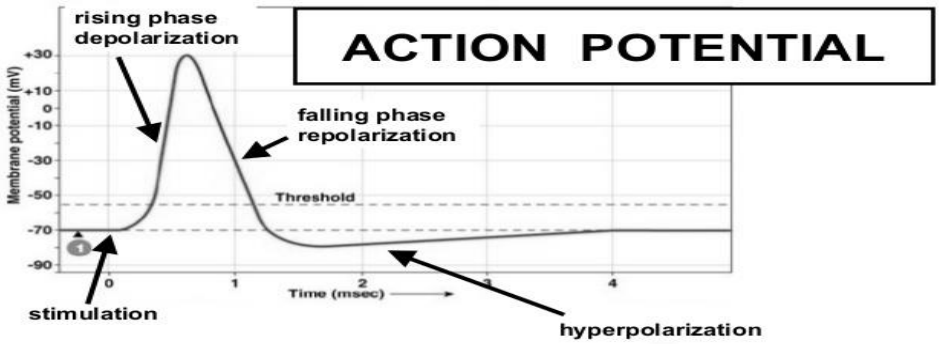
- Given location(s) where stimuli are detected
- Taste buds, nasal cavity
- Eyes and ears

Neuron

- Neuron (also called nerve cell) is a cell that carries electrical impulses. Neurons are the basic (functional and sructural) units of our nervous system.
- Neurons are connected to one another and tissues. They do not touch each other, instead they form tiny gaps called synapses.
- Every neuron is made of a cell body (also called soma or cyton), dendrites and an axon. Dendrites and axons are nerve fibers.
- There are about 86 billion neurons in the human brain, which comprises roughly 10% of all brain cells. Human brain has roughly 16 billion neurons in the cerebral cortex.
- The neurons are supported by glial cells and astrocytes.

Structure of a Typical Neuron

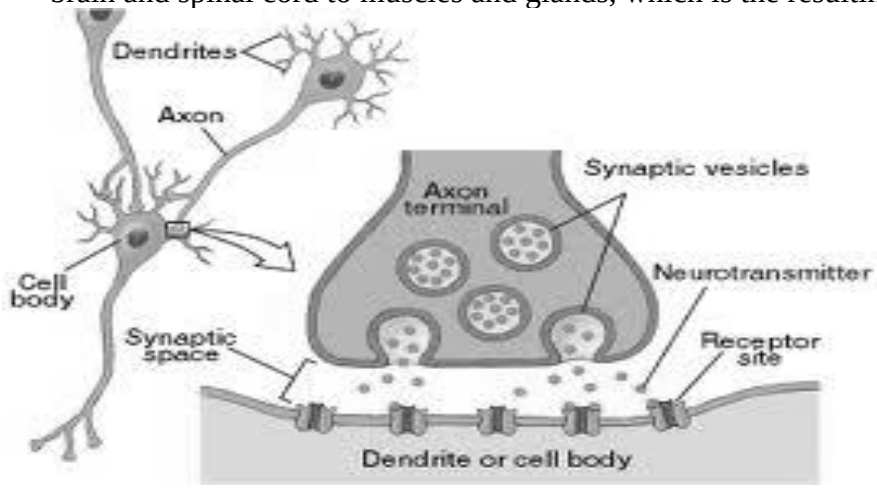


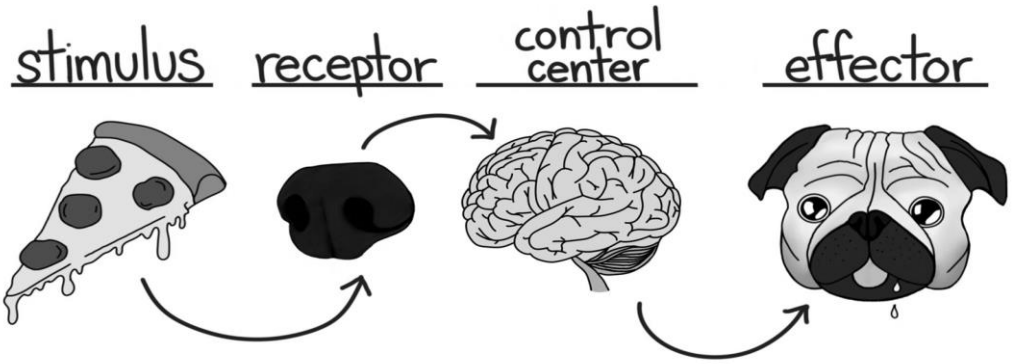


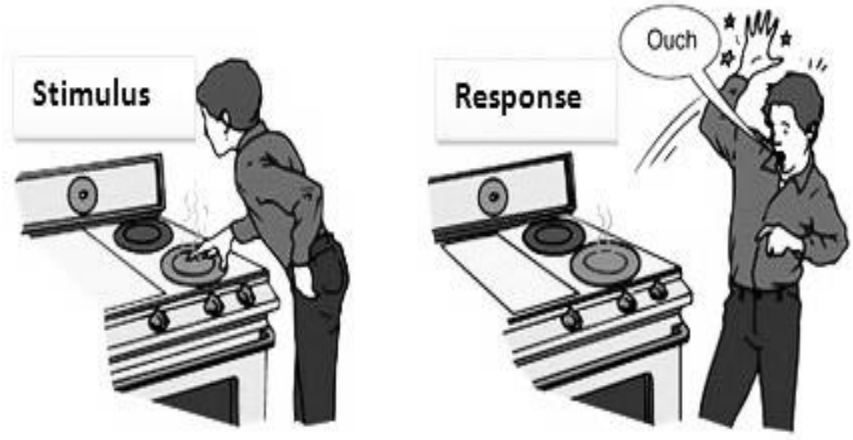
Action potential (nerve impulse) occures at excitable tissues (mostly neuron fibers or muscle cells) when graded potential reaches the threshold (gate threshold) – firing level.
It is all-or-none (it happens or do not happen).

Neural Processing

- Neural impulses from sensory receptors are sent to the brain and spinal cord for processing.
- After the brain has processed the information, neural impulses are then conducted from the brain and spinal cord to muscles and glands, which is the resulting motor output.







Sense of vision

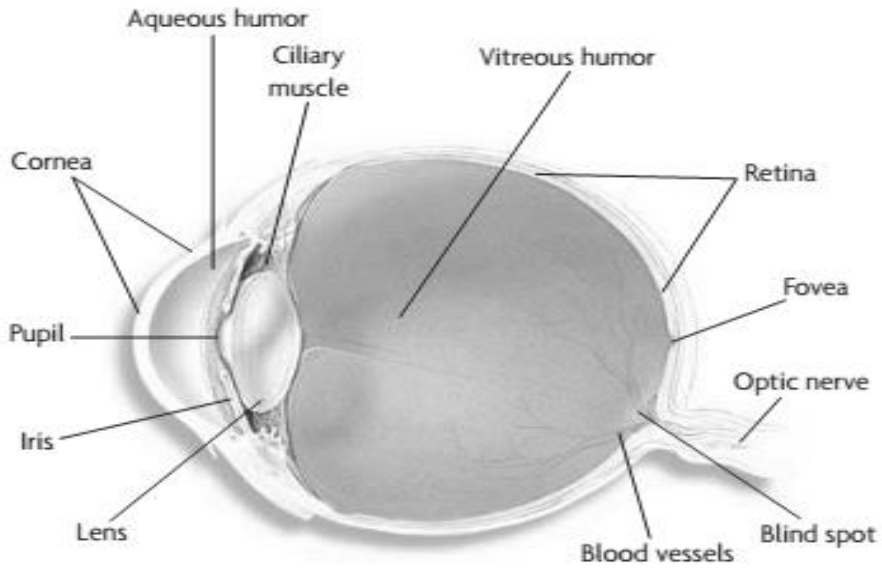
Approaches to perception

- The direct approach to perception (Gibson, 1979) argues that the usually reliable cues in the optic array of a scene directly provide information about depth and distance.
- Indirect approach to perception argues that our judgments of depth are made on the basis of our past experience with the depth cues (Gregory, 1970).

Do you remember seeing this before? Is it optic array or experience?

The Visual System

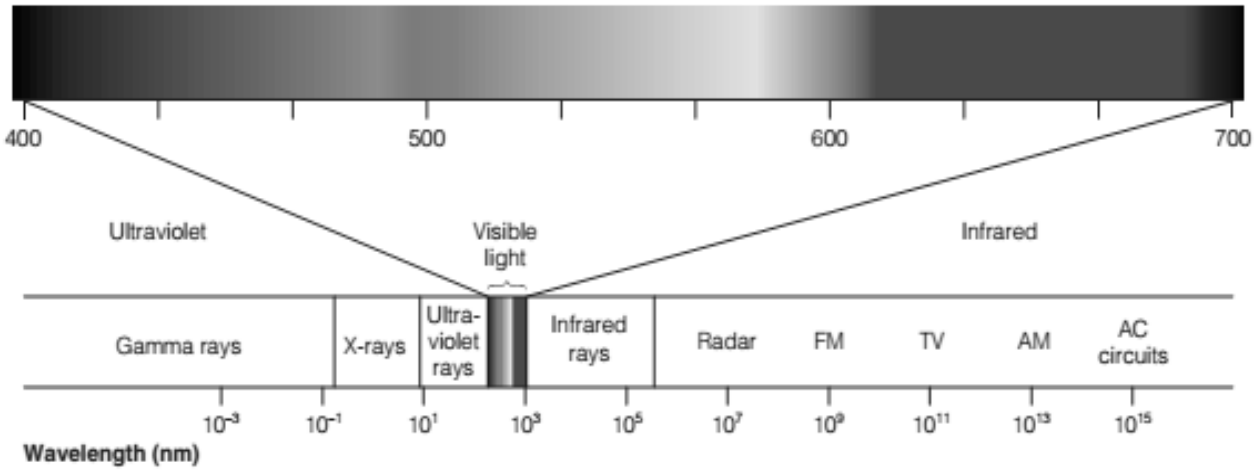
- Vision is the most complex, highly developed, and important sense for humans and most other mobile creatures.
- Good vision helps animals detect their prey or predators from a distance.
- Vision enables humans to be aware of changing features in the physical environment and to adapt their behavior accordingly.
- Vision is also the most studied of all the senses.



- The eye is the camera for the brain's motion pictures of the world. A camera views the world through a lens that gathers and focuses light. The eye also gathers and focuses light—light enters the cornea, a transparent bulge on the front of the eye. Next it passes through the anterior chamber, which is filled with a clear liquid called the **aqueous humor.** The light then passes through the pupil, an opening in the **opaque iris.**

- To focus a camera, you move its lens closer to or farther from the object viewed. To focus light in the eye, a bean-shaped crystalline lens changes its shape, thinning to focus on distant objects and thickening to focus on near ones. To control the amount of light coming into a camera, you vary the opening of the lens. In the eye, the muscular disk of the iris changes the size of the pupil, the opening through which light passes into the eyeball.

- At the back of a traditional camera body is the photosensitive film that records the variations in light that have come through the lens. Similarly, in the eye, light travels through the vitreous humor, finally striking the retina, a thin sheet that lines the rear wall of the eyeball.

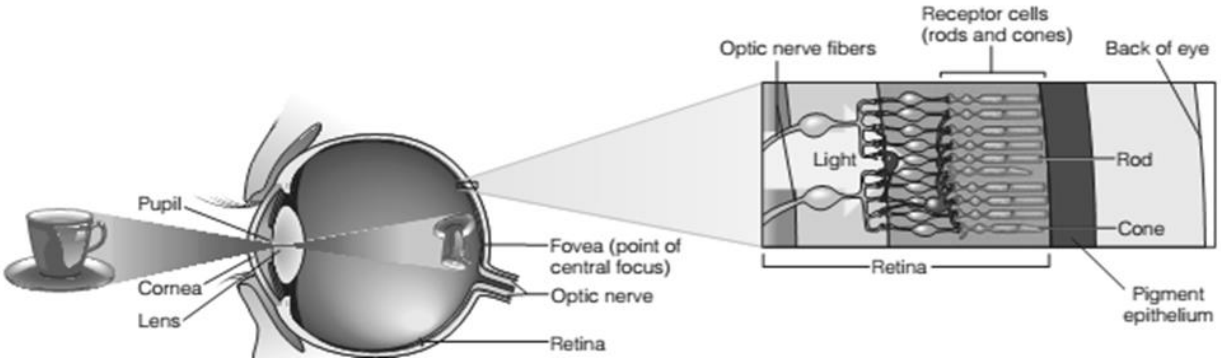


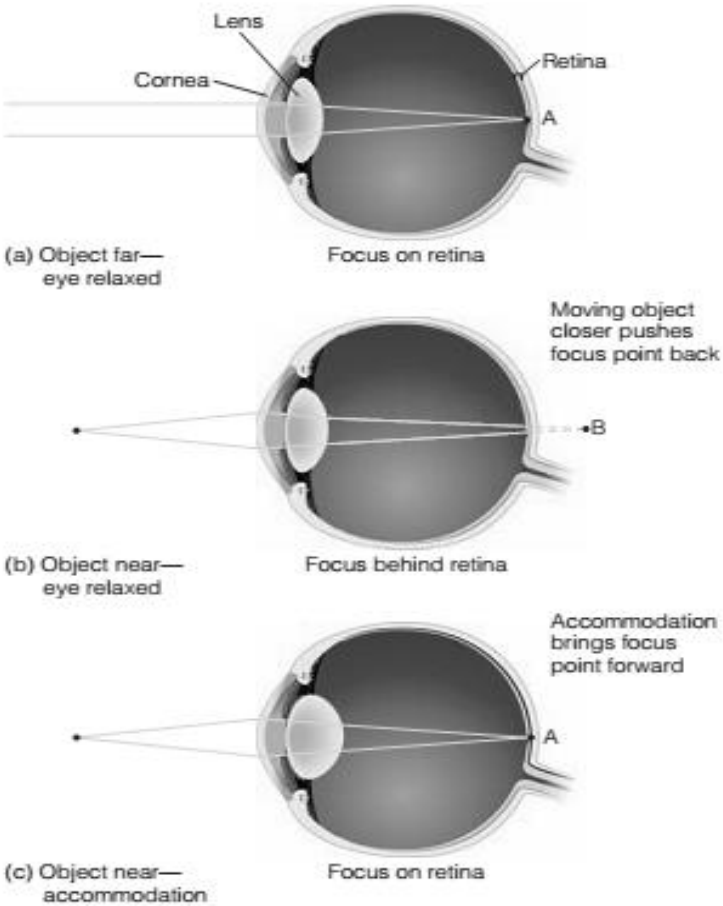
Light reflected from objects in the environment enters the eye through the pupil and is focused by the cornea and lens to form sharp images of the objects on the retina, which contains the receptors for vision. There are two kinds of visual receptors, rods and cones, which contain light-sensitive chemicals called visual Pigments that react to light and trigger electrical signals.
These signals flow through the network of neurons that make up the retina.

Lecture 13

VISUAL SYSTEM

The signals then emerge from the back of the eye in the optic nerve, which conducts signals toward the brain. The cornea and lens at the front of the eye and the receptors and neurons in the retina lining the back of the eye shape what we see by creating the transformations that occur at the beginning of the perceptual process.





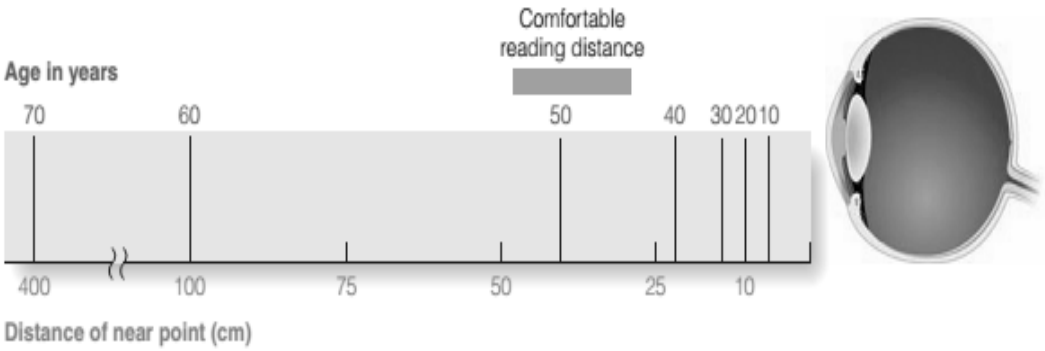
Becoming Aware of What Is in Focus

Accommodation occurs unconsciously, so you are usually unaware that the lens is constantly changing its focusing power so you can see clearly at different distances. This unconscious focusing process works so efficiently that most people assume that everything, near and far, is always in focus. You can demonstrate that this is not so by holding a pencil point up, at arm's length, and looking at an object that is least 20 feet away. As you look at the faraway object, move the pencil point toward you without actually looking at it (stay focused on the far object).

The pencil will probably appear blurred. Then move the pencil closer, while still looking at the far object, and notice that the point becomes more blurred and appears double. When the pencil is about 12 inches away, focus on the pencil point. You now see the point sharply, but the faraway object you were focusing on before has become blurred. Now, bring the pencil even closer until you can't see the point sharply no matter how hard you try. Notice the strain in your eyes as you try unsuccessfully to bring the point into focus.

When you changed focus during this demonstration, you were changing your accommodation. Accommodation enables you to bring both near and far objects into focus, although objects at different distances are not in focus at the same time. But accommodation has its limits. When the pencil was too close, you couldn't see it clearly, even though you were straining to accommodate. The distance at which your lens can no longer adjust to bring close objects into focus is called the **near point**. The distance of the near point increases as a person gets older, a condition called presbyopia (for "old eye"). The near point for most 20-year-olds is at about 10 cm, but it increases to 14 cm by age 30, 22 cm at 40, and 100 cm at 60. This loss of ability to accommodate occurs because the lens hardens with age, and the **ciliary muscles** become weaker.
These changes make it more difficult for the lens to change its shape for vision at close range.

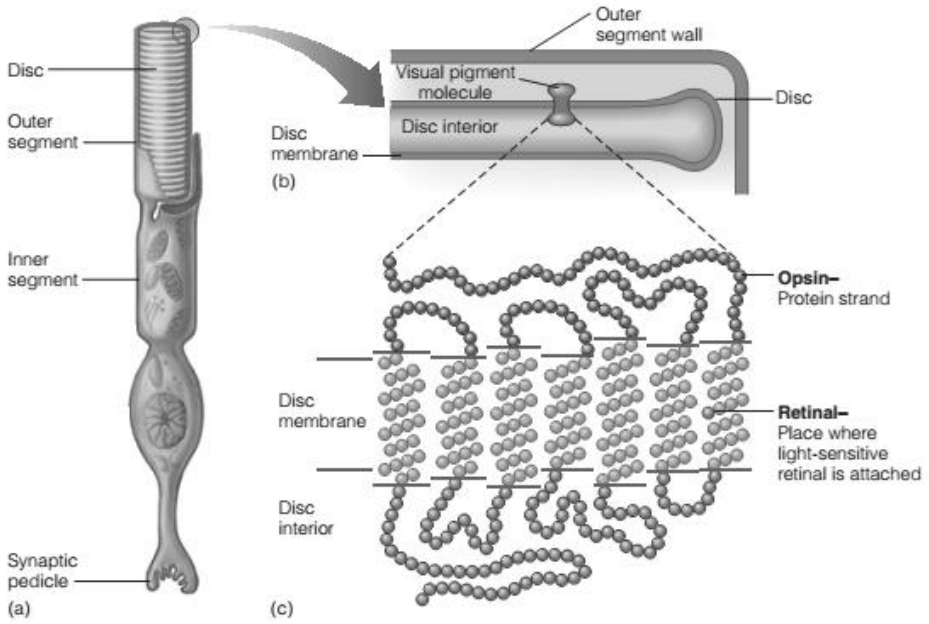
Though this gradual decrease in accommodative ability poses little problem for most people before the age of 45, at around that age the ability to accommodate begins to decrease rapidly, and the near point moves beyond a comfortable reading distance. There are two solutions to this problem. One is to hold reading material farther away. If you've ever seen someone holding a book or newspaper at arm's length, the person is employing this solution. The other solution is to wear glasses that add to the eye's focusing power, so it can bring light to a focus on the retina. person is employing this solution. The other solution is to wear glasses that add to the eye's focusing power, so it can bring light to a focus on the retina.



Vertical lines show how the distance of the near point (green numbers) increases with increasing age. When the near point becomes farther than a comfortable reading distance, corrective lenses (reading glasses) become necessary.

Transforming Light Into Electricity

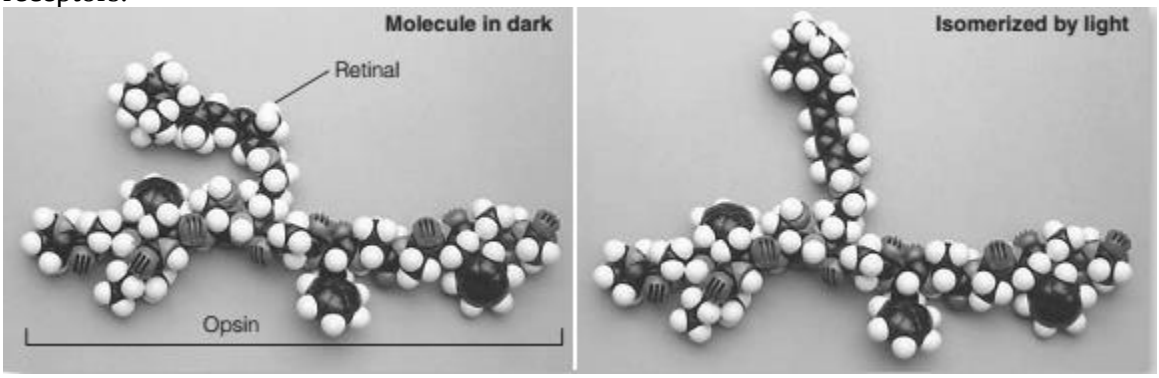
- The transformation of light into electricity is the process of transduction. Transduction is carried out by receptors; neurons specialized for receiving environmental energy and transforming this energy into electricity (see page 7). The receptors for vision are the rods and the cones. The rods and cones have different properties that affect our perception.
- However, they both function similarly during transduction, so to describe transduction we will focus on the rod receptor shown in Figure below;



(a) Rod receptor showing discs in the outer segment. (b) Close-up of one disc showing one visual pigment molecule in the membrane. (c) Close-up showing how the protein opsin in one visual pigment molecule crosses the disc membrane seven times. The light sensitive retinal molecule is attached to the opsin at the place indicated.

The key part of the rod for transduction is the outer segment, because it is here that the light acts to create electricity (a). Rod outer segments contain stacks of discs. Each disc contains thousands of visual pigment molecules (b). Zooming in on an individual molecule, we can see that the molecule is a long strand of protein called **opsin**, which loops back and forth across the disc membrane seven times (c). Our main concern is one particular place where a molecule called retinal is attached. Each visual pigment molecule contains only one of these tiny retinal molecules. The retinal is crucial for transduction, because it is the part of the visual pigment that is sensitive to light. Transduction is triggered when the light-sensitive retinal absorbs one photon of light. (Remember that a photon is the smallest possible packet of light energy.) Figure below shows what happens. Before light is absorbed, the retinal is next to the opsin (a). (Only a small part of

the opsin, where the retinal is attached, is shown here). When a photon of light hits the retinal, it changes shape, so it is sticking out from the opsin. This change in shape is called **isomerization**, and it is this step that triggers then formation of the light entering the eye into electricity in the receptors.



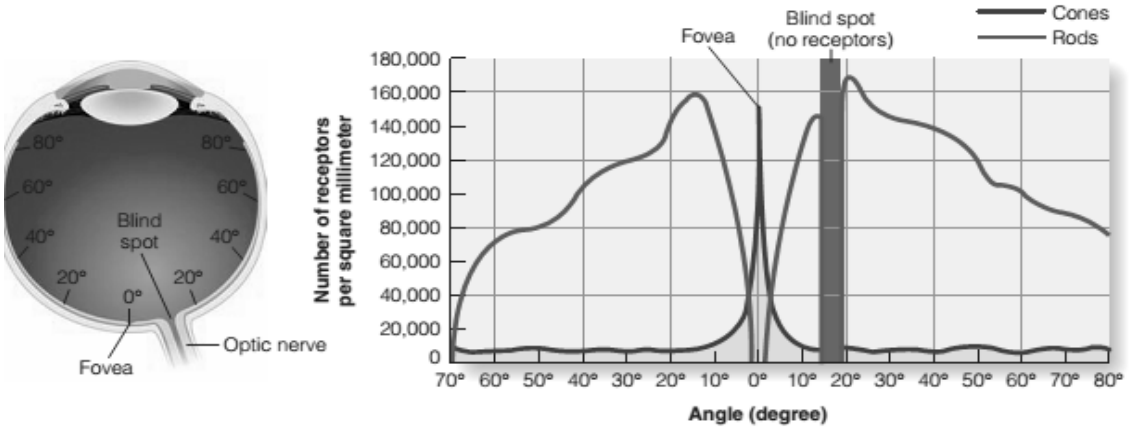
Model of a visual pigment molecule

The horizontal part of the model shows a tiny portion of the huge opsin molecule near where the retinal is attached. The smaller molecule on top of the opsin is the light-sensitive retinal. The model on the left shows the retinal molecule's shape before it absorbs light. The model on the right shows the retinal molecule's shape after it absorbs light. This change in shape is one of the steps that results in the generation of an electrical response in the receptor.

Distribution of the Rods and Cones

Figure below shows;

- There is one small area, the **fovea**, that contains only cones. When we look directly at an object, its image falls on the fovea.
- The peripheral retina, which includes all of the retina outside of the fovea, contains both rods and cones. Although the fovea is the place where there are only cones, there are many cones in the peripheral retina. The fovea is so small (about the size of this "o") that it contains only about 1 percent, or 50,000, of the 6 million cones in the retina (Tyler, 1997a, 1997b).
- There are many more rods than cones in the peripheral retina because most of the retina's receptors are located there and because there are about 120 million rods and 6 million cones.



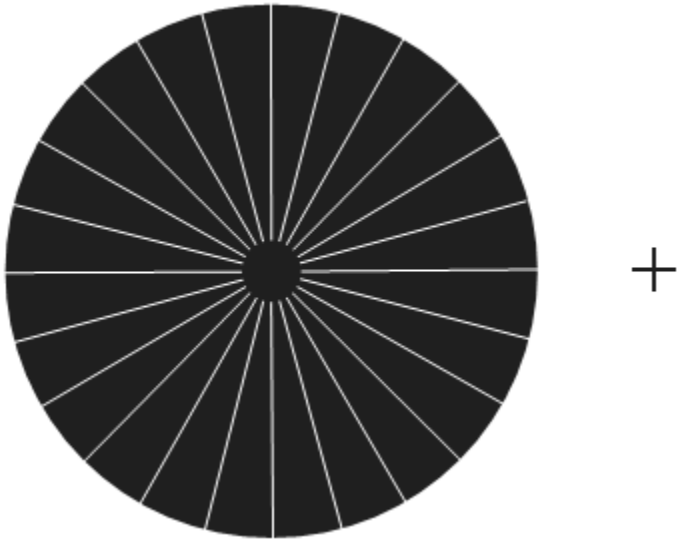
The distribution of rods and cones in the retina

The eye on the left indicates locations in degrees relative to the fovea. These locations are repeated along the bottom of the chart on the right. The vertical brown bar near 20 degrees indicates the place on the retina where there are no receptors because this is where the ganglion cells leave the eye to form the optic nerve. (Adapted from Lindsay & Norman, 1977.)

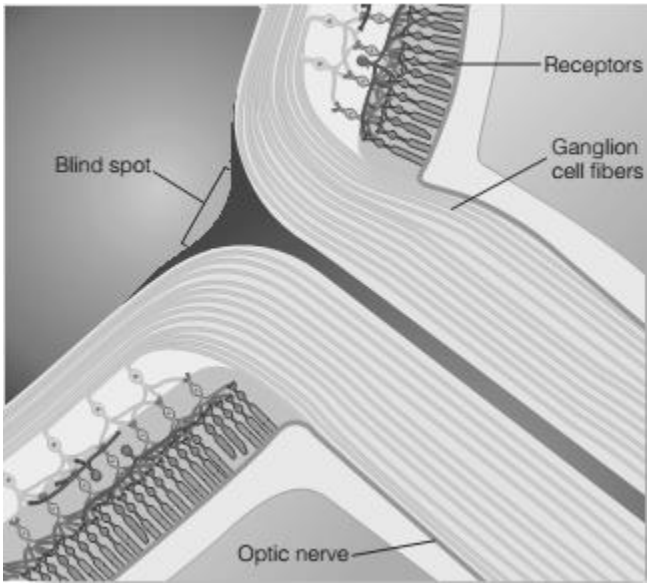
DEMONSTRATION

Filling in the Blind Spot

Close your right eye and, with the cross in Figure lined up with your left eye, move the "wheel" toward you. When the center of the wheel falls on your blind spot, notice how the spokes of the wheel fill in the hole (Ramachandran, 1992).

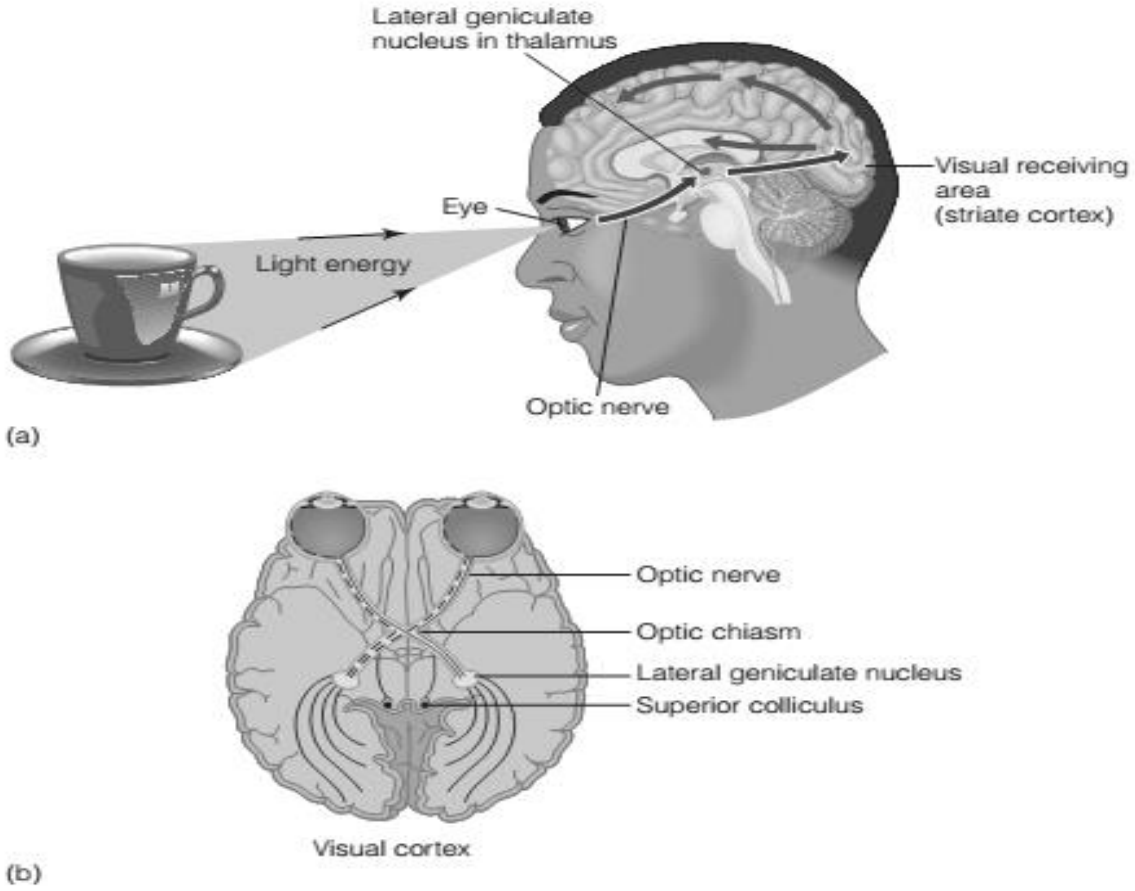


View the pattern as described in the text, and observe what happens when the center of the wheel falls on your blind spot. (From Ramachandran, 1992.)

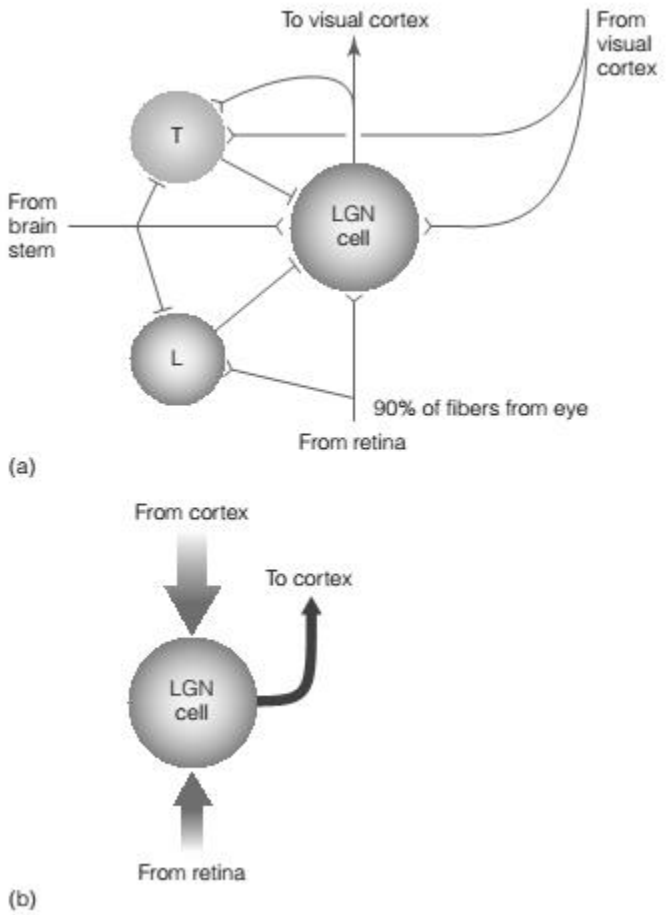


There are no receptors at the place where the optic nerve leaves the eye. This enables the receptor's ganglion cell fibers to flow into the optic nerve. The absence of receptors in this area creates the blind spot.

The Visual System



An overview of the visual system above, pictures the pathway that the neural signals follow once they leave the retina. Most of the signals from the retina travel out of the eye in the optic nerve to the lateral geniculate nucleus (LGN)in the thalamus. From here, signals travel to the primary visual receiving area in the occipital lobe of the cortex. The visual receiving area is also called the striate cortex because of the white stripes (striate striped) that are created within this area of cortex by nerve fibers that run through it (Glickstein, 1988). From the striate cortex, signals are transmitted along two pathways, one to the temporal lobe and the other to the parietal lobe (blue arrows). Visual signals also reach areas in the frontal lobe of the brain.



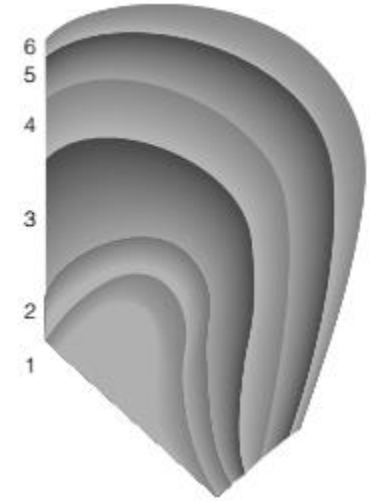
- Inputs and outputs of an LGN neuron. The neuron receives signals from the retina and also receives signals from the cortex, from elsewhere in the thalamus (T), from other LGN neurons (L), and from the brain stem. Excitatory synapses are indicated by Y's and inhibitory ones by T's.
- Information flow into and out of the LGN. The sizes of the arrows indicate the sizes of the signals. (Part a adapted from Kaplan, Mukherjee, & Shapley, 1993.)

Information Flow in the Lateral Geniculate

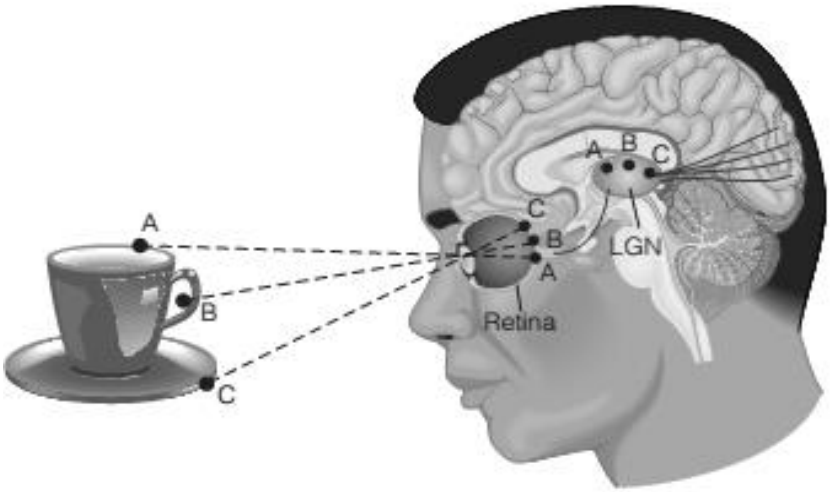
- Nucleus The LGN does not simply receive signals from the retina and then transmit them to the cortex. Figure below shows that it is much more complex than that. Ninety percent of the fibers in the optic nerve arrive at the LGN. (The other 10 percent travel to the superior colliculus.) But these signals are not the only ones that arrive at the LGN. The LGN also receives signals from the cortex, from the brain stem, from other neurons in the thalamus (T), and from other neurons in the LGN (L). Thus, the LGN receives information from many sources, including the cortex, and then
- Thus, the LGN receives information from many sources, including the cortex, and then sends its output to the cortex.

Organization by Left and Right Eyes

The lateral geniculate nucleus (LGN) is a bilateral structure, which means there is one LGN in the left hemisphere and one in the right hemisphere. Viewing one of these nuclei in cross section reveals six layers (Figure below). Each layer receives signals from only one eye. Layers 2, 3, and 5 (red layers) receive signals from the ipsilateral eye, the eye on the same side of the body as the LGN. Layers 1, 4, and 6 (blue layers) receive signals from the contralateral eye, the eye on the opposite side of the body from the LGN. Thus, each eye sends half of its neurons to the LGN that is located in the left hemisphere of the brain and half to the LGN that is located in the right hemisphere. Because the signals from each eye are sorted into different layers, the information from the left and right eyes is kept separated in the LGN.



Cross section of the LGN showing layers. Red layers receive signals from the ipsilateral (same side of the body) eye. Blue layers receive signals from the contralateral (opposite side) eye.



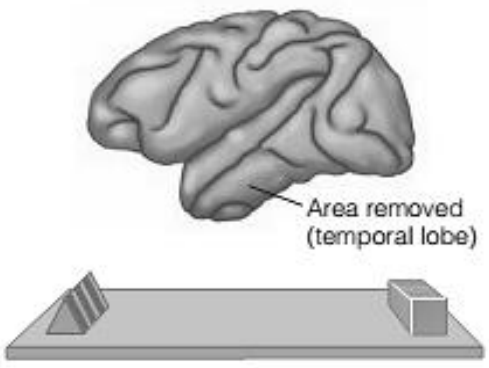
Points A, B, and C on the cup create images at A, B, and C on the retina and cause activation at points

A, B, and C on the lateral geniculate nucleus (LGN). The correspondence between points on the LGN and retina indicates that there is a retinotopic map on the LGN.

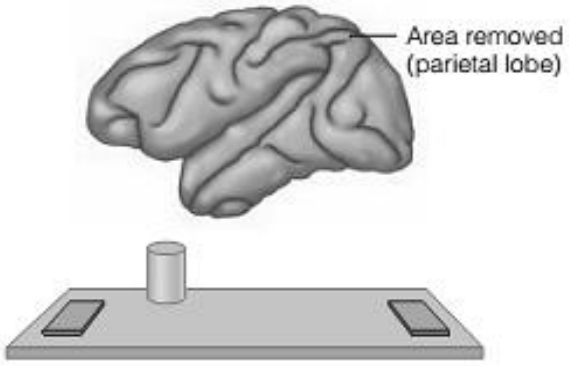
Streams; Pathways For What, Where and How

In the 1980s that a large number of researchers began investigating how stimulation of the retina causes activity in areas far beyond the striate cortex. One of the most influential ideas to come out of this research is that there are pathways, or "streams," that transmit information from the striate cortex to other areas in the brain. This idea was introduced in 1982, when Leslie Ungerleider and Mortimer Mishkin described experiments that distinguished two streams that served different functions. Ungerleider and Mishkin (1982) used a technique called **ablation** (also called lesioning). Ablation refers to the destruction or removal of tissue in the nervous system.

The goal of a brain ablation experiment is to determine the function of a particular area of the brain. This is accomplished by first determining an animal's capacity by testing it behaviorally. Most ablation experiments have used monkeys because of the similarity of their visual system to that of humans and use monkeys can be trained to determine perceptual capacities such as acuity, color vision, depth perception, and object perception. Once the animal's perception has been measured, a particular area of the brain is ablated removed or destroyed), either by surgery or by injecting a chemical at the area to be removed. Ideally, one particular area is removed and the rest of the brain remains intact. After ablation, the monkey is retrained to determine which perceptual capacities remain and which have been affected by the ablation.



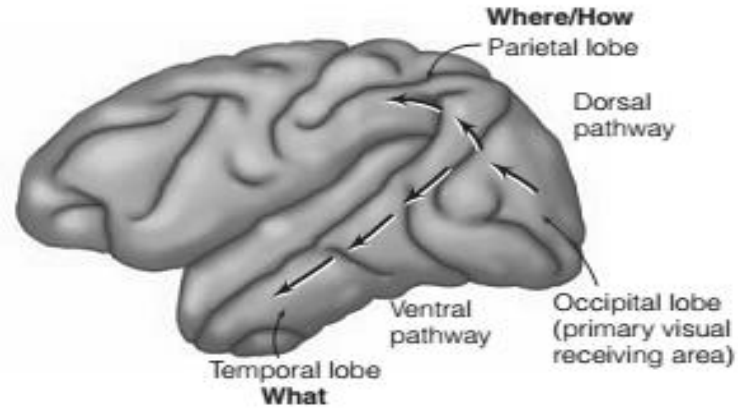
(a) Object discrimination



(b) Landmark discrimination

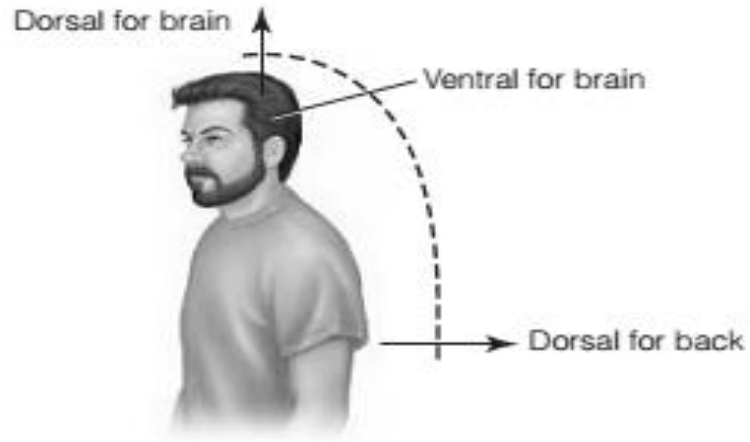
The two types of discrimination tasks used by Ungerleider and Mishkin. (a) **Object discrimination**: Pick the correct shape. Lesioning the temporal lobe (shaded area) makes this task

difficult. (b) **Landmark discrimination**: Pick the food well closer to the cylinder. Lesioning the parietal lobe makes this task difficult. (From Mishkin, Ungerleider, & Macko, 1983.)



The monkey cortex, showing the what, or ventral, pathway from the occipital lobe to the temporal lobe, and the where, or dorsal, pathway from the occipital lobe to the parietal lobe. The where pathway is also called the how pathway. (From Mishkin, Ungerleider, & Macko, 1983.)

The pathway that leads to the parietal lobe is responsible for determining an object's location, therefore called **The where pathway =** leading from the striate cortex to the parietal lobe**.**
The what and where pathways are also called the ventral pathway(what) and the dorsal pathway(where), because the lower part of the brain, where the temporal lobe is located, is the ventral part of the brain, and the upper part of the brain, where the parietal lobe is located, is the dorsal part of the brain. The term dorsal refers to the back or the upper surface of an organism; thus, the dorsal fin of a shark or dolphin is the fin on the back that sticks out of the water. Figure below shows that for upright, walking animals such as humans, the dorsal part of the brain is the top of the brain. (Picture a person with a dorsal fin sticking out of the top of his or her head!) Ventral is the opposite of dorsal, hence it refers to the lower part of the brain.

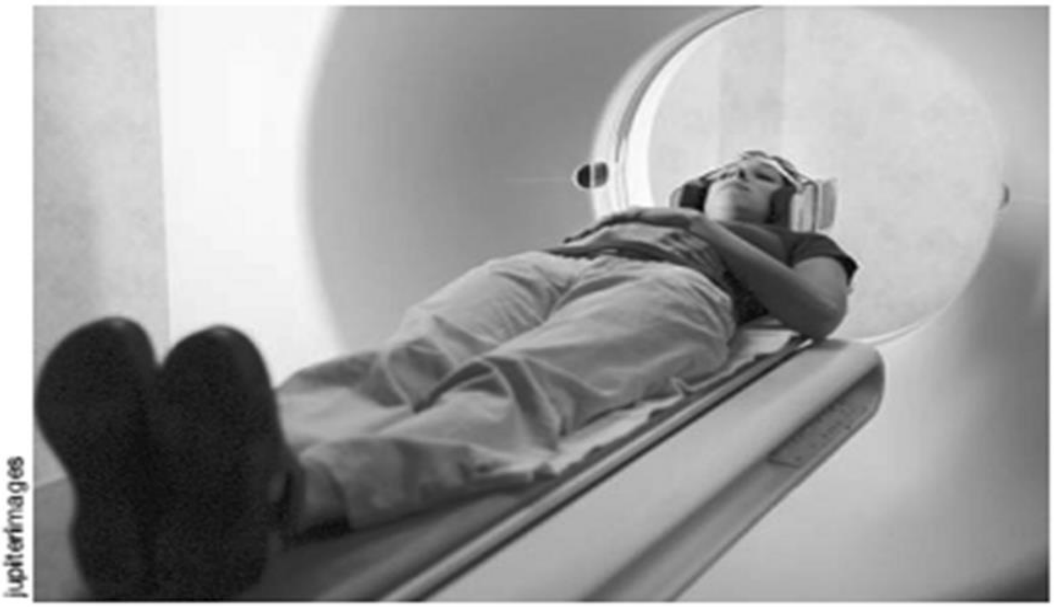


Although there is good evidence that the ventral and dorsal pathways serve different functions, it is important to note that (1) the pathways are not totally separated, but have connections between

them; and (2) signals flow not only "up" the pathway toward the parietal and temporal lobes, but "back" as well (Merigan & Maunsell, 1993; Ungerleider & Haxby, 1994).

Experimental Techniques used to study visual processes

- Recording From Neurons; with an electrode that penetrates the LGN obliquely (at a small angle to the surface)
- Brain imaging; Brain imaging refers to a number of techniques that result in images that show which areas of the brain are active.
- Positron emission tomography (PET), was introduced in 1976 (Hoffman et al., 1976; Ter-Pogossian et al., 1975).



Functional magnetic resonance imaging (f MRI)

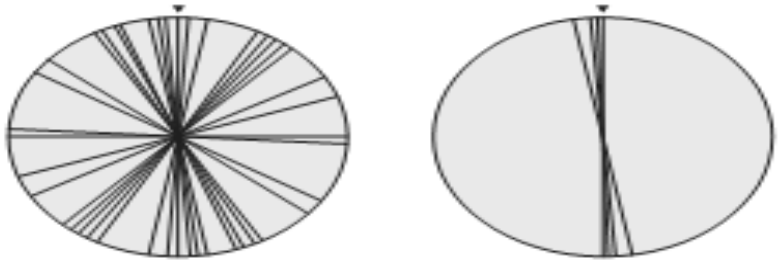
Evidence from neuropsychology

One of the basic principles of neuropsychology is that we can understand the effects of brain damage by studying **dissociations**—a situation in which one function is absent while another function is present. There are two kinds of dissociations: single dissociations, which can be studied in a single person, and double dissociations, which require two or more people. To illustrate a single dissociation, let's consider a woman, Alice, who has suffered damage to her temporal lobe. She has difficulty naming objects but has no trouble indicating where they are located (see table below the text, row a).

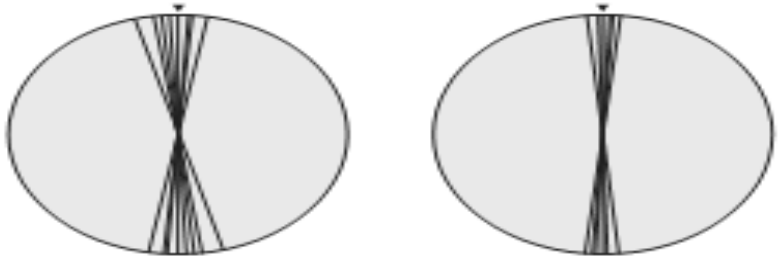
Alice demonstrates a single dissociation—one function is present (locating objects) and another is absent (naming objects). From a single dissociation such as this, in which one function is lost while another function remains, we can conclude that two functions (in this example, locating and naming objects) involve different mechanisms, although they may not operate totally independently of one another. We can illustrate a double dissociation by finding another person who has one function

present and another absent, but in a way opposite to Alice. For example, Bert, who has parietal lobe damage, can identify objects but can't tell exactly where they are located (in table row b). The cases of Alice and Bert, taken together, represent a double dissociation. Establishing a double dissociation enables us to conclude that two functions are served by different mechanisms and that these mechanisms operate independently of one another.

	NAMING OBJECTS	DETERMINING OBJECTS' LOCATIONS
(a) ALICE: Temporal lobe damage (ventral stream)	NO	YES
(b) BERT: Parietal lobe damage (dorsal stream)	YES	NO



(a) Perceptual orientation matching



DF Control

(b) Active "posting"

Milner and Goodale (1995) studied D.F., a 34-year-old woman who suffered damage to her ventral pathway from carbon monoxide poisoning. D.F. was not able to match the orientation of a card held in her hand to different orientations of a slot. She Performed poorly in the static orientation-matching task, did well as soon as action was involved. It is a case of single dissociation; judging orientation and coordinating vision and action involve different mechanisms. People with damage to dorsal streams can judge visual orientation, can't accomplish the vision + task. A better description of the dorsal pathway would be the how pathway, or the action pathway. In our normal daily behavior we aren't aware of two visual processing streams, one for what and the other for how they work together seamlessly as we perceive objects and take actions toward them.

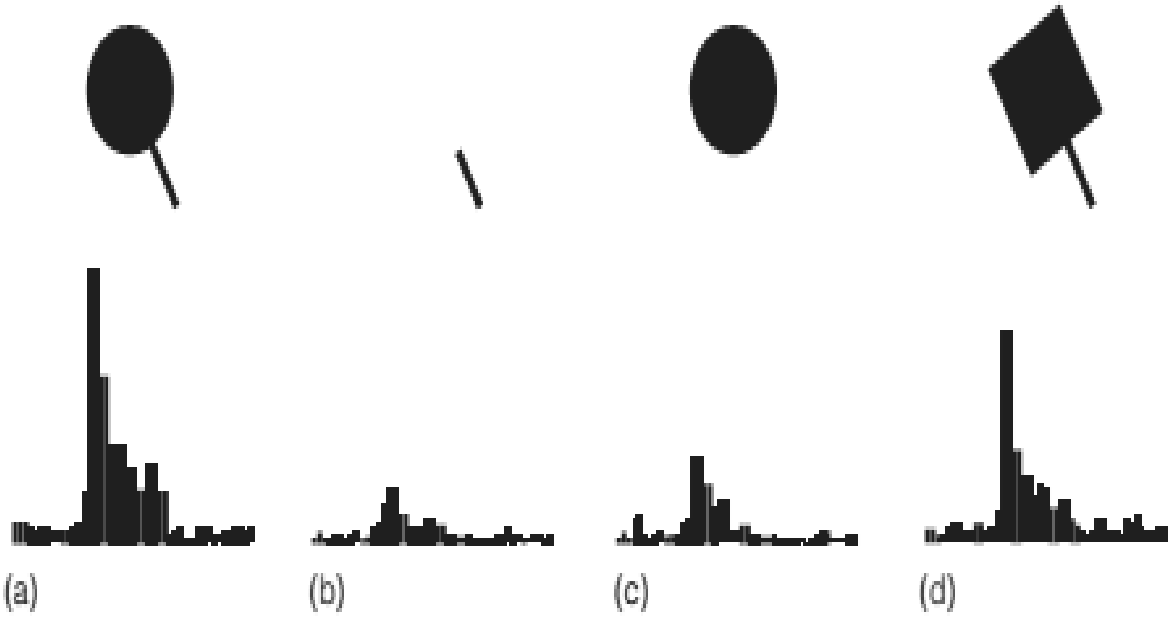
Psychophysical experiments that measure how people perceive and react to visual illusions have demonstrated the dissociation between perception and action that was evident for D.F.

Lecture 14

PERCEPTION

Perceiving Objects and Scenes

Researchers have found neurons that responded best to more complex stimuli. Neurons that respond to similar stimuli are often grouped together in one area of the brain. A structure that is specialized to process information about a particular type of stimulus is called a module.



- How a neuron in a monkey's temporal lobe responds to a few stimuli. This neuron responds best to a circular disc with a thin bar.(Adapted from Tanaka et al., 1991.)
- Brain has been called "**The most mysterious thing in the world**." here are some reasons why it is mysterious.
- The neural circuits involved in creating a "face-detecting" neuron extremely complex.
- Each neuron in the cortex receives inputs from an average of 1,000 other neurons. Therefore the potential connections between neurons in the cortex is astronomical.
- Imagine the vast complexity of the neural interconnections that must be involved in creating a neuron that responds best to faces

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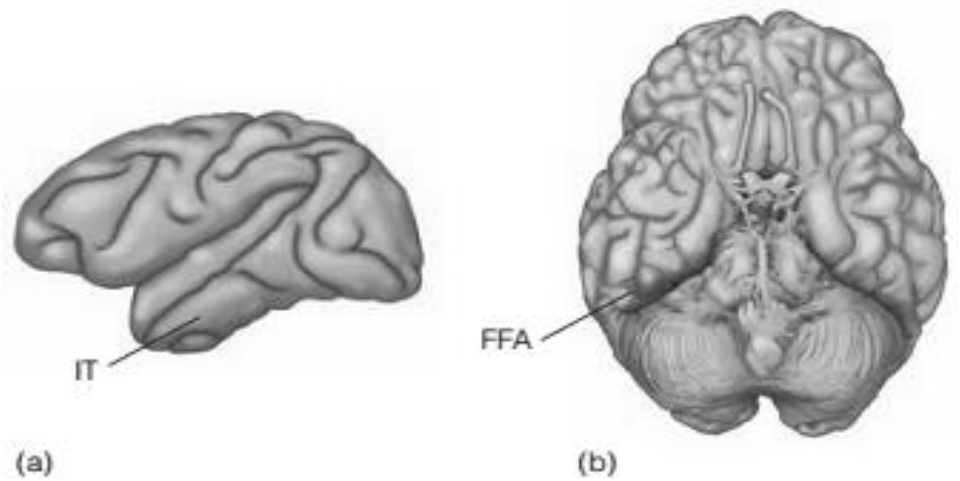
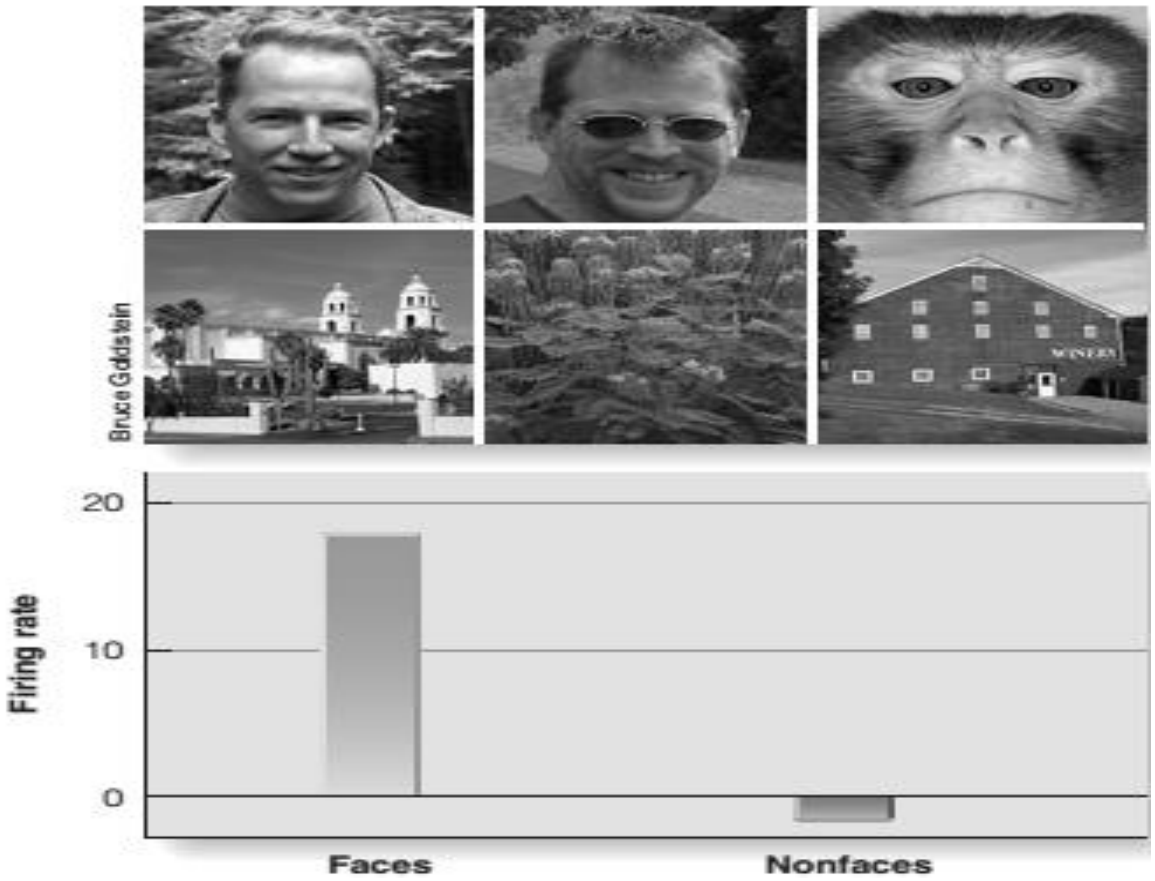
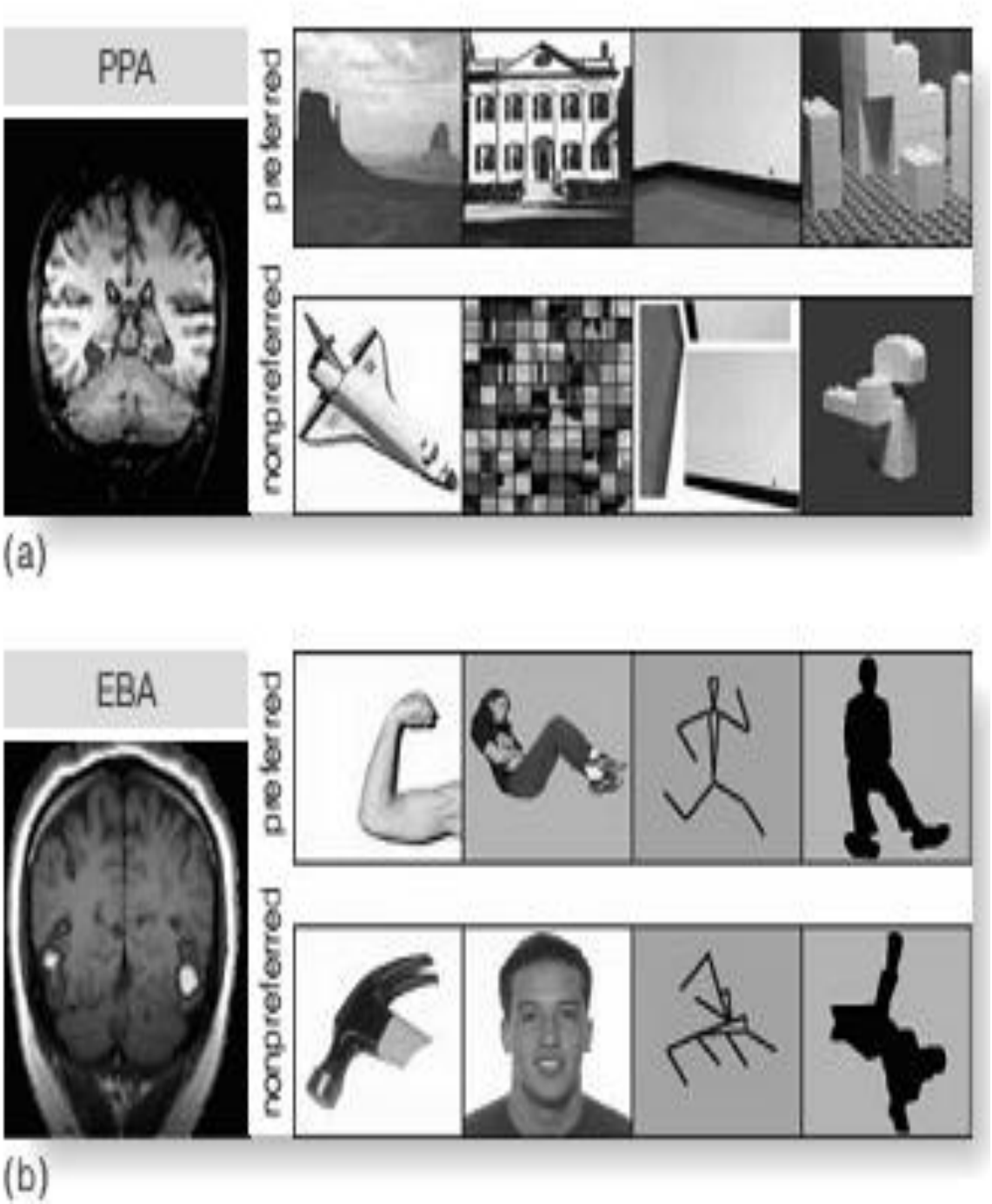


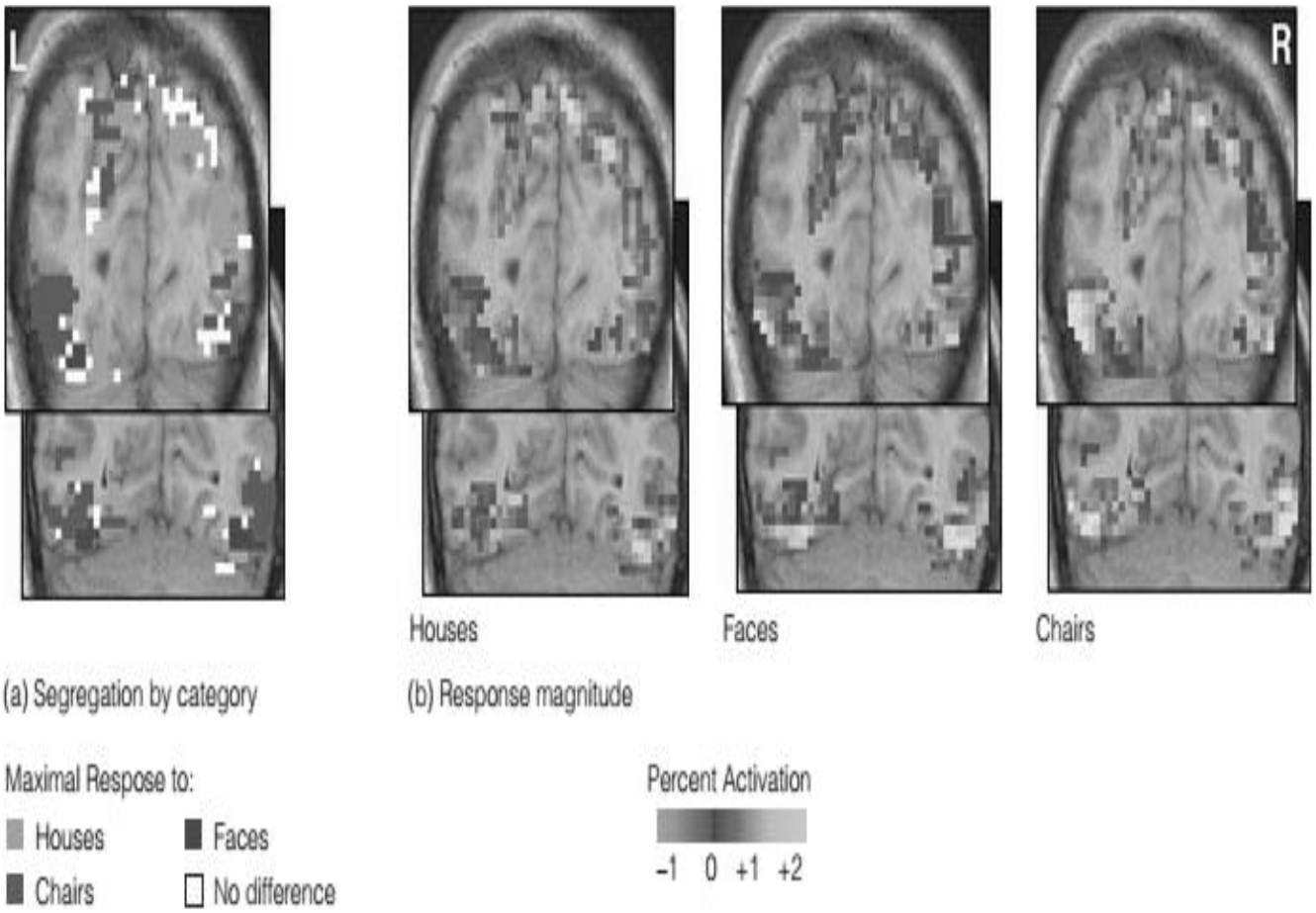
(a) Monkey brain showing the location of the inferotemporal (IT) cortex. (b) Human brain showing the location of the fusiform face area (FFA), which is located just under the temporal lobe.



Size of response of a neuron in the monkey's IT cortex that responds to face stimuli but not to nonface stimuli. (Based on data from Rolls & Tovee, 1995.)



(a) The parahippocampal place area is activated by places (top row) but not by other stimuli (bottom row). (b) The extrastriate body area is activated by bodies (top), but not by other stimuli (bottom). Even though stimuli like faces and buildings activate specific areas of the brain, these stimuli also activate other areas of the brain as well.



The photo above shows fMRI responses of the human brain to various types of stimuli: (a) areas that were most strongly activated by houses, faces, and chairs; (b) all areas activated by each type of stimulus. (From Alumit Ishai, Leslie G. Ungerleider, Alex Martin, James V. Haxby, "The representation of objects in the human occipital and temporal cortex," Journal of Cognitive Neuroscience,12:2 (2000), 35–51. © 2000 by the Massachusetts Institute of Technology.)

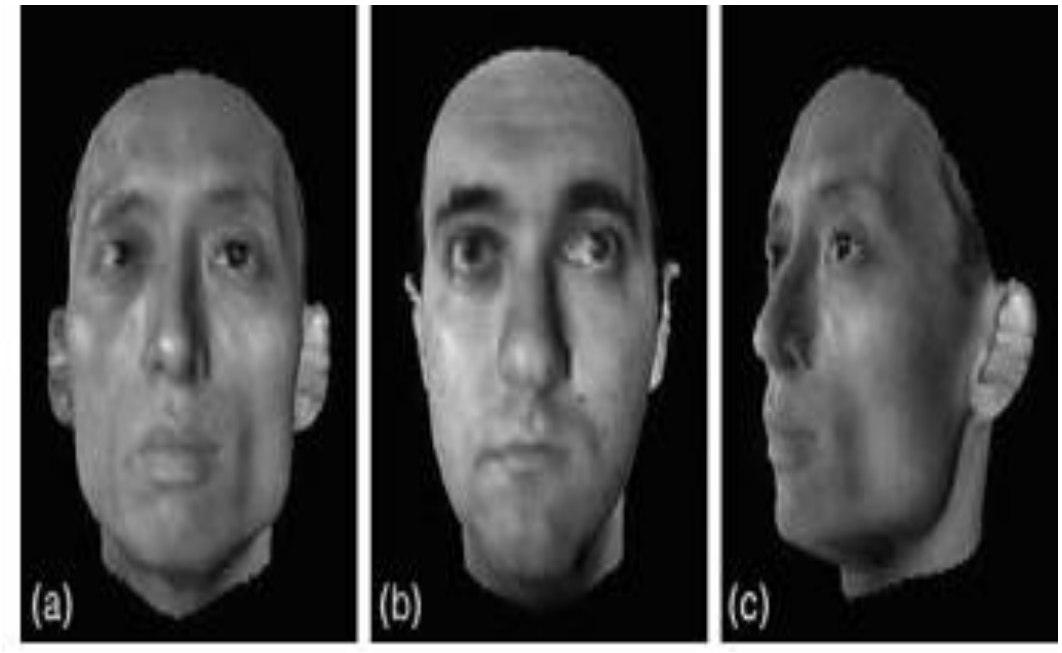
Perception is complex

In 1960s' it was predicted that devices with capacities approaching human vision would be available within 10 or 15 years.

Designing a computer that could equal human vision is still not possible due to following reasons.

- The stimulus on the receptors is ambiguous
- Objects can be hidden or blurred
- Objects look different from different viewpoints

Although humans continue to perceive the object as the same chair viewed from different angles, this isn't so obvious to a computer

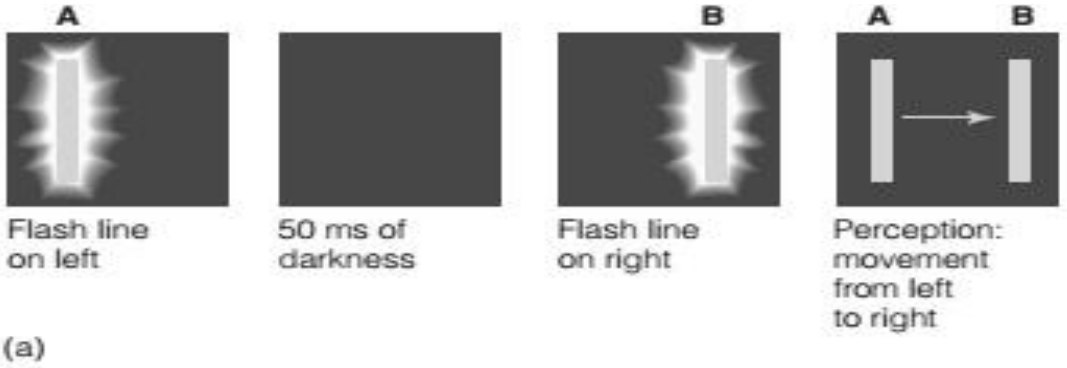


People's ability to achieve viewpoint invariance enables them to identify the images in Figure above , a and c as being the same person, but a computer face recognition system would rate faces a and b as being more similar (Sinha, 2002).

The two pictures above show two scenes from a window. Both are from instructor's private camera. When we look at these many areas of brain are stimulated even those that involve memory since our geographical and cultural knowledge is stored there and we recognize one as a mountain area where view is from top whereas the other as a big city probably in a western country which has some hills near the town. the physical regularities in the scene provide information that one is city and other a village.

Gestalt Principles of Perceptual Organization

Gestalt psychology says that **the whole differs from the sum of its parts**. Gestalt means whole in German language. The researchers grouped under Gestalt approach described some principles that are guiding the organizing of visual information into meaningful whole or objects we can recognize. Perception means sensation plus meaning hence unless visual information from eye to brain isn't organized we cannot attach meaning to it and therefore cannot perceive the objects in the environment. Gestalt approach means a whole configuration that cannot be described merely as the sum of its parts Wundt's structuralism approach suggested that perceptions are created by combining elements called sensations. This Idea disputed by Gestalt psychologists; Max Wertheimer, Kurt Koffka and Ivo Kohler, laboratory at the University of Frankfurt.



(a)

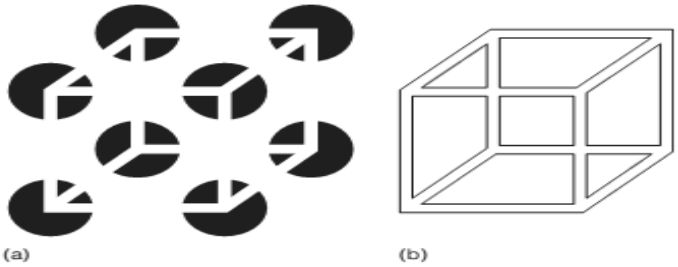
(b)

(a) Wertheimer's demonstration of apparent movement. (b) Moving electronic signs such as this one, in which the words are scrolling to the left, create the perception of movement by applying the principles of apparent movement.

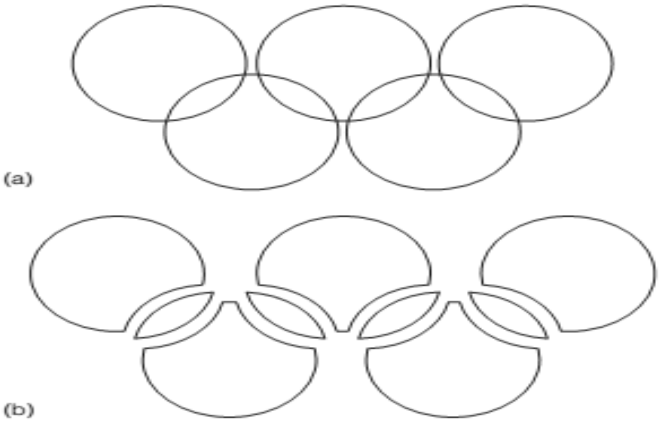
Perceptual organization

involves the grouping of elements in an image to create larger objects

Gestalt psychologists have proposed six laws that govern the perceptual organization

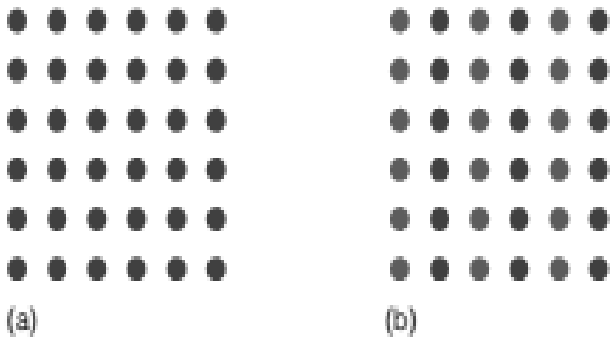


(a) This can be seen as a cube floating in front of eight discs or as a cube seen through eight holes. In the first case, the edges of the cube appear as illusory contours. (b) The cube without the black circles. ("Organizational Determinants of Subjective Contour: The Subjective Necker Cube," Bradley and Petry, 1977, American Journal of Psychology,90, 253–262.



(a) This is usually perceived as five circles, not as the nine shapes in (b). This demonstrates the law of Pragnanz.

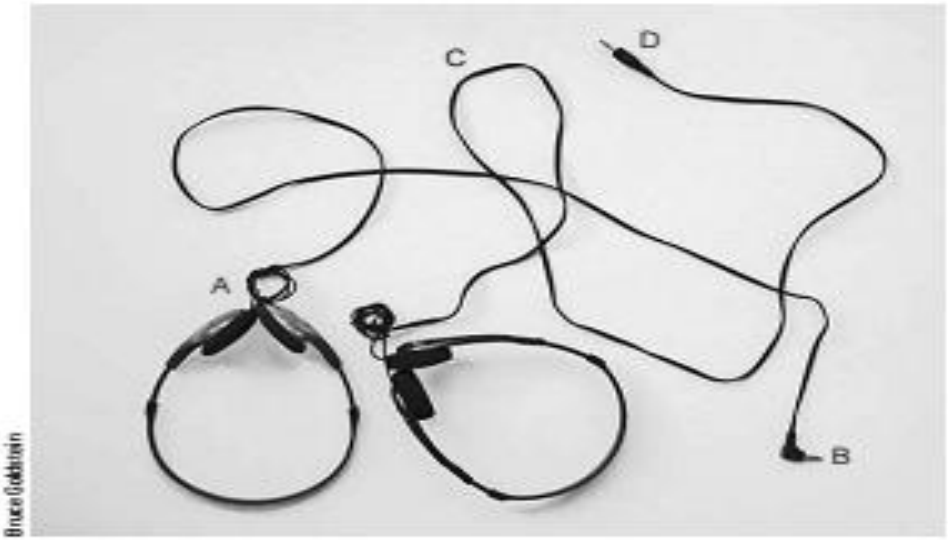
The law of similarity



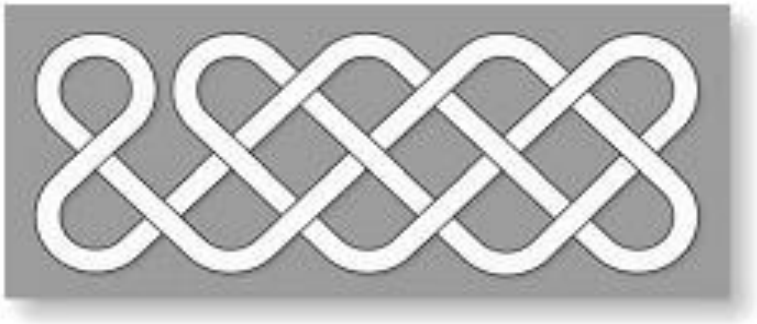
Perceived as horizontal rows or vertical columns or both. change the color of some of the columns (b) most people perceive vertical columns of circles; Similar things appear to be grouped together.

What are they looking at? Whatever it is,

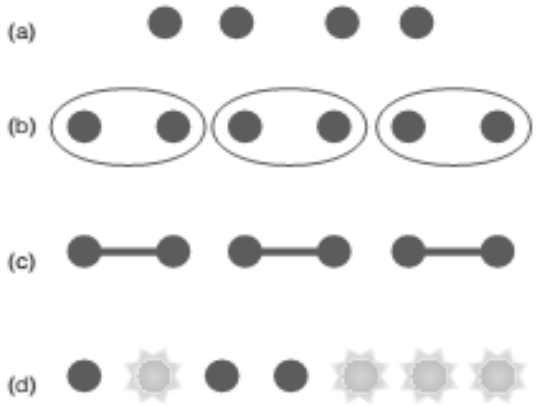
Tiger Woods and Phil Mickelson have become perceptually linked because of the similar orientations of their arms, golf clubs, and bodies. This also demonstrates the law of similarity.



This demonstrates the law of good continuation, which helps us perceive two separate wires, even though they overlap.



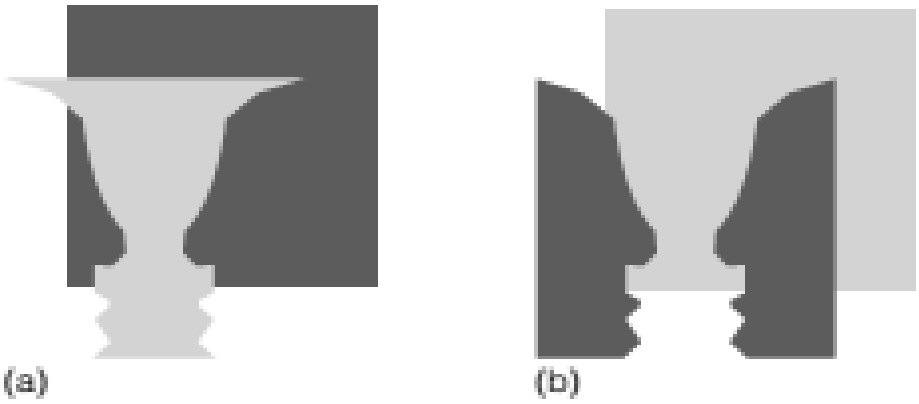
Because of good continuation, we perceive this pattern as continuous interwoven strands.



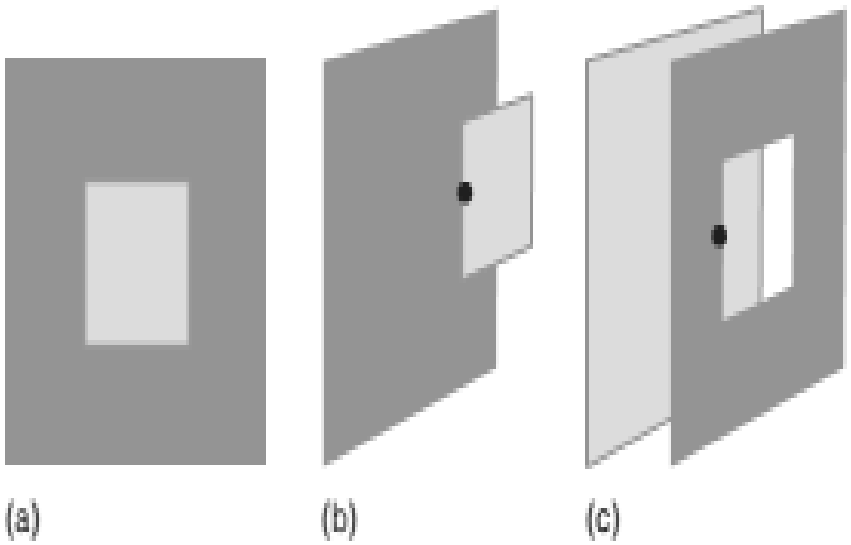
Grouping by (a) proximity; (b) common region; (c) connectedness; and (d) synchrony. Synchrony occurs when the yellow lights blink on and off together.

A flock of birds that are moving in the same direction are seen as grouped together. When a portion of the flock changes direction, their movement creates a new group. This illustrates the law of common fate.

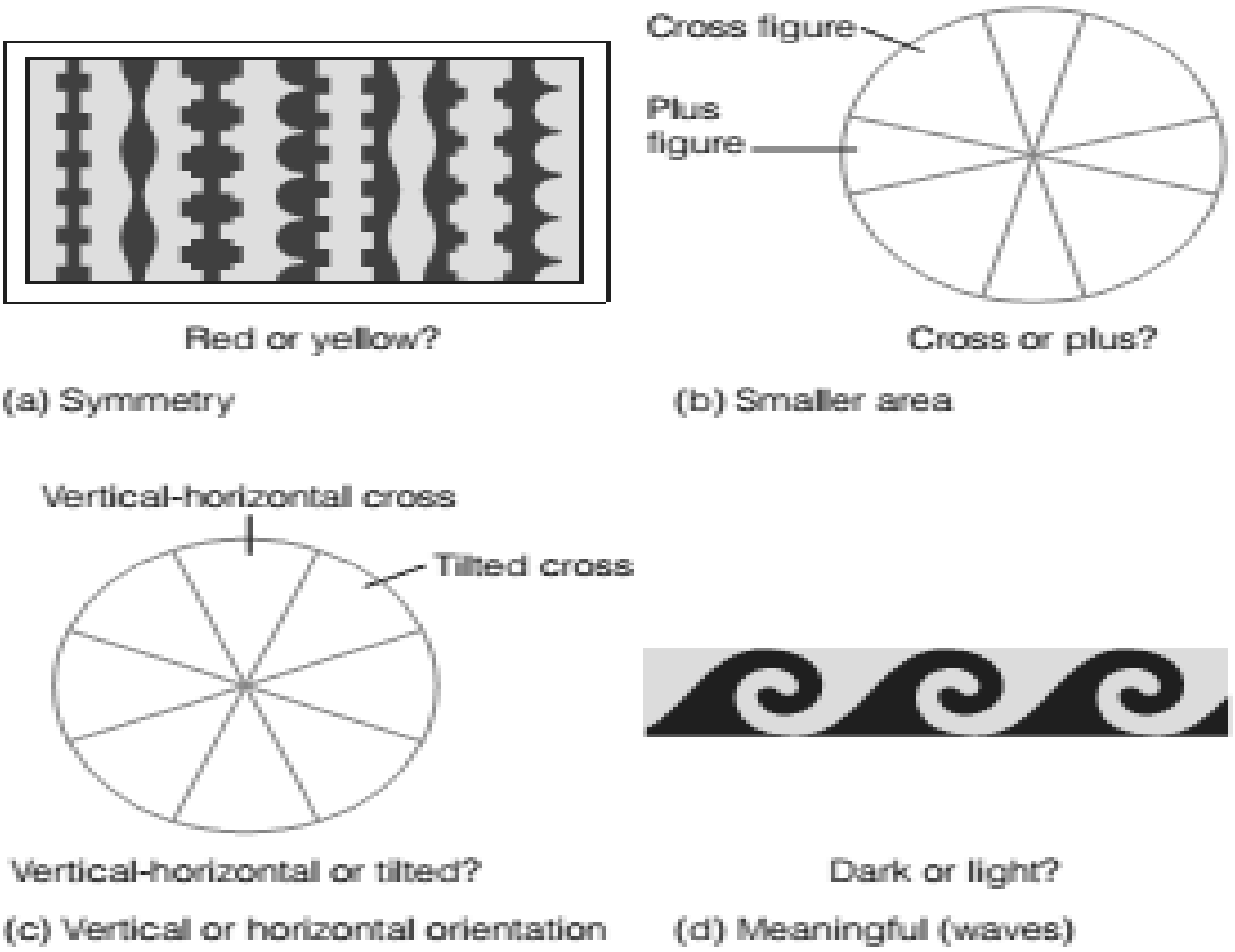
Figure and Ground



(a) When the vase is perceived as figure, it is seen in front of a homogeneous dark background.
(b) When the faces are seen as figure, they are seen in front of a homogeneous light background.



(a) This display can be perceived in two ways.
(b) When it is perceived as a small square sitting on top of a dark background, the border belongs to the small square, as indicated by the dot.
(c) When it is perceived as a large dark square with a hole in it, the border belongs to the dark square.



Examples of how (a) symmetry, (b) size, (c) orientation, and (d) meaning contribute to perceiving an area as figure.

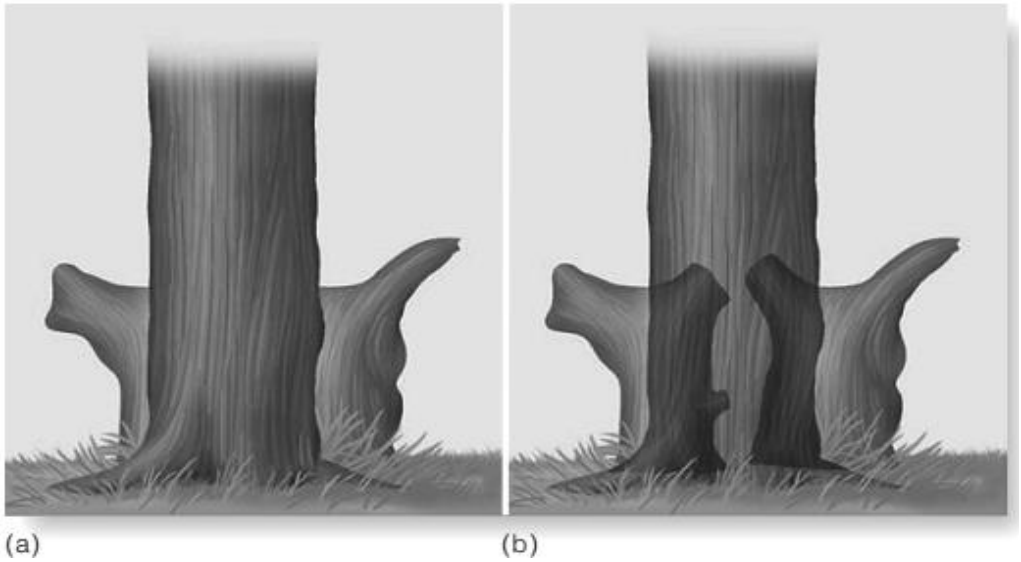
Meaningfulness or Familiarity

According to the law of familiarity, things that form patterns that are familiar or meaningful are likely to become grouped together (Helson, 1933; Hochberg, 1971). You can appreciate how meaningfulness influences perceptual organization by doing the following demonstration.

Perceiving Scenes and Objects In Scenes

At first glance this scene appears to contain mainly trees, rocks, and water. But on closer inspection you can see some faces in the trees in the background, and if you look more closely, you can see that a number of faces are formed by various groups of rocks. Can you find all 13 faces hidden in this picture?

The Forest Has Eyesby Bev Doolittle (1984). Can you find 13 hidden faces in this picture? E-mail the author at bruceg@email.arizona.edu for the solution.

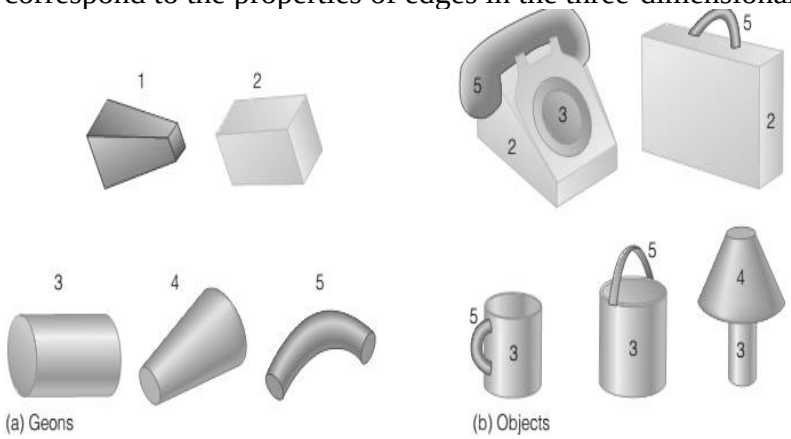


(a) What lurks behind the tree? (b) It is two strangely shaped tree stumps, not an animal!

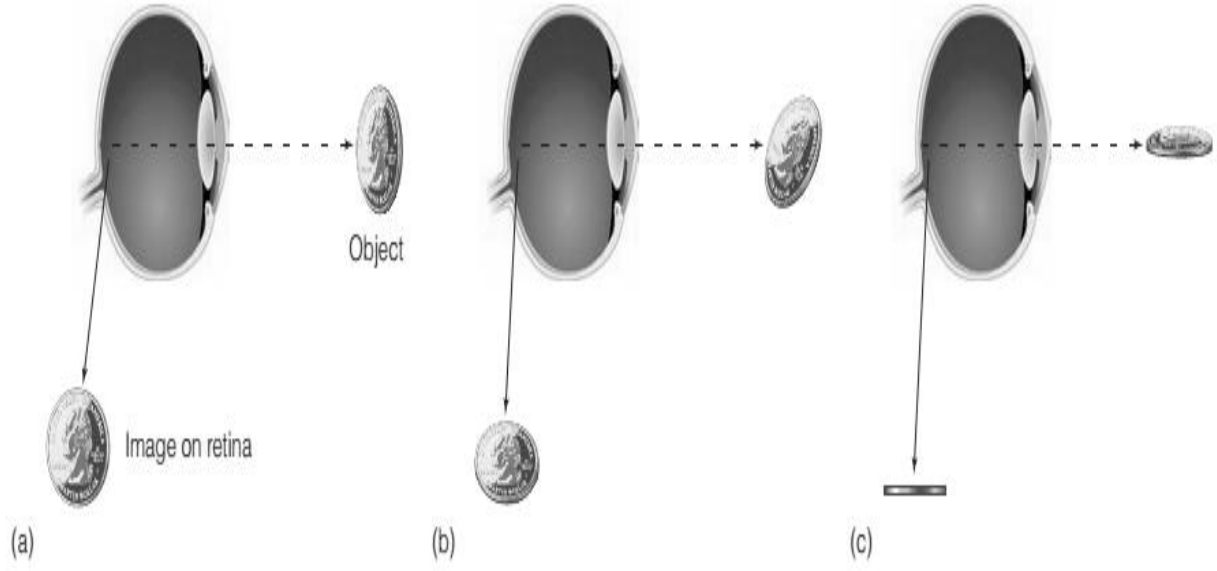
Gestalt principles as heuristics

Instead of laws these are more accurately described as **heuristics**—rules of thumb that provide a best-guess solution to a problem. A more recent approach to object perception called **recognition** by components. Recognition-by-components (RBC) theory, was proposed by Irving Biederman

(1987). Proposing that our recognition of objects is based on features called geons, a term that stands for "geometric ions," these geons are basic units of objects just as ions are basic units of molecules non-accidental properties (NAPs). NAPs are properties of edges in the retinal image that correspond to the properties of edges in the three-dimensional environment.



(a) Some geons. (b) Some objects created from these geons. The numbers on the objects indicate which geons are present. recognizable objects can be formed by combining just two or three geons, the relations between the geons matter, the cup and the pail.

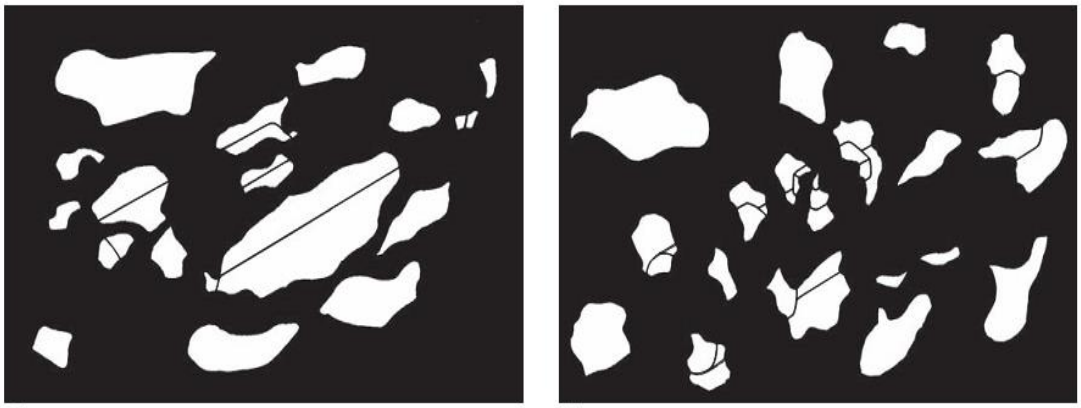


What happens to a quarter's image on the retina as it is tilted. Most views, such as (a) and (b), create a curved image on the retina. The rare accidental viewpoint shown in (c) creates an image of a straight line on the retina.

Main principle of recognition-by-components theory

- If we can perceive an object's geons, we can identify the object.
- The ability to identify an object if we can identify its geons is called the principle of componential recovery.

- This principle is what is behind our ability to identify objects in the natural environment even when parts of the objects are hidden by other objects.



(a) It is difficult to identify the object behind the mask, because its geons have been obscured. (b) Now that it is possible to identify geons, the object can be identified as a flashlight. ("Recognition-by-Components: A Theory of Human Image Understanding," by I. Biederman, 1985, Computer Vision, Graphics and Image Processing, 32,29–73.

Our vision is far too complex to be determined by a few geons ?

- There are factors in addition to geons that help us identify objects.
- Distinguish between two birds with the same shape, texture of feathers, markings on their wings.
- Some things in the environment, such as clouds, are difficult to create using geons (although even clouds are sometime arranged so that geons are visible, leading us to see "objects" in the sky).
- A **scene** is a view of a real-world environment that contains (1) background elements and (2) multiple objects that are organized in a meaningful way relative to each other and the background (Epstein, 2005; Henderson & Hollingworth, 1999).
- Objects are acted upon, scenes are extended in space and are acted within.

Perceiving the Gist of a Scene

- Mary Potter (1976) showed a target picture and then asked observers to indicate whether they saw that picture as they viewed a sequence of 16 rapidly presented
- Observers could do this with almost 100-percent accuracy even when the pictures were flashed for only 250 ms (milliseconds; 1/4 second).
- Li Fei-Fei and coworkers (2007), presented pictures of scenes for times ranging from 27 ms to 500 ms, asked observers to write a description of what they saw, used masking to remove persistence of vision.

Global Image features

1) **Degree of naturalness**. Natural scenes have textured zones and undulating contours. Man-made scenes, such as the street, are dominated by straight lines and horizontals and verticals.
2) **Degree of openness**. Open scenes, a visible horizon line and contain few objects. The street scene not as open as the beach; forest a low degree of openness.

3) **Degree of roughness**. Smooth scenes (low roughness) like the beach contain fewer small elements. Scenes with high roughness like the forest contain many small elements and are more complex
4) **Degree of expansion; Convergence of parallel lines**, like railroad tracks that appear to vanish in the distance, indicates a high degree of expansion.
5) **Color**. Some scenes have characteristic colors, like the beach scene (blue) and the forest (green and brown)
6) **Physical Regularities**; Regularly occurring physical properties of the environment. For example, there are more vertical and horizontal orientations in the environment than oblique (angled) orientations, in human-made environment as well as natural
7) **Semantic regularities**; Semantic regularities are the characteristics associated with the functions carried out in different types of scenes
8) Inference



Global image features are holistic and rapidly perceived. They are properties of the scene as a whole and do not depend on time-consuming processes such as perceiving small details, recognizing individual objects, or separating one object from another. Another property of global image features is that they contain information that results in perception of a scene's structure and spatial layout. For example, the degree of openness and the degree of expansion refer directly to characteristics of a scene's layout, and naturalness also provides layout information that comes from knowing whether a scene is "from nature" or contains "human-made structures."

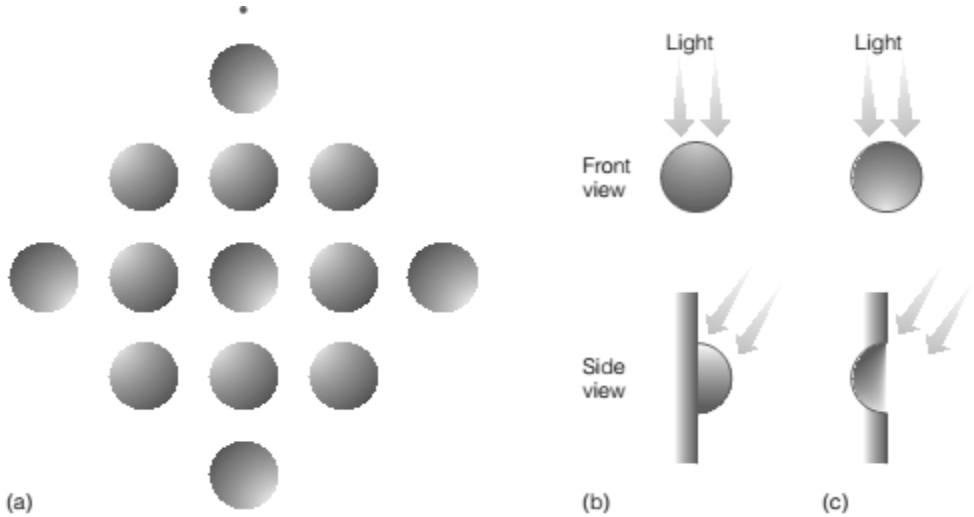
Global image properties not only help explain how we can perceive the gist of scenes based on features that can be seen in brief exposures, but also illustrate the following general property of perception: Our past experiences in perceiving properties of the environment plays a role in determining our perceptions. We learn, for example, that blue is associated with open sky, that landscapes are often green and smooth, and that verticals and horizontals are associated with buildings. Characteristics of the environment such as this, which occur frequently, are called regularities in the environment.

Physical regularities

Physical regularities refer to features such as light falling on objects, horizontal and vertical lines or directions. Physical regularities are regularly occurring physical properties of the environment. For example, there are more vertical and horizontal orientations in the environment than oblique (angled) orientations. This occurs in human-made environment (for example, buildings contain lots of horizontals and verticals) and also in natural environments (trees and plants are more likely to be vertical or horizontal than slanted).

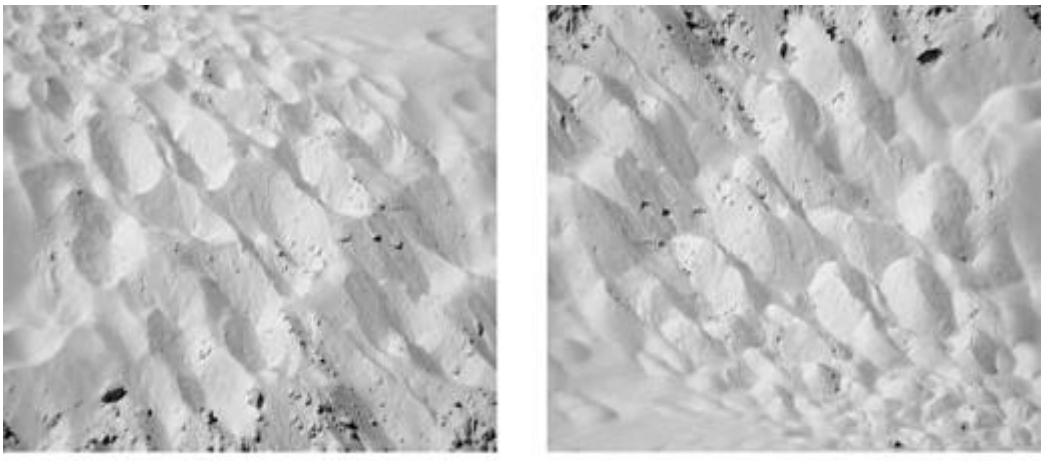
Demonstration

When you look at the figure below, do some of the discs look as though they are sticking out, like parts of three dimensional spheres, and others appear to be indentations? If you do see the discs in this way, notice that the ones that appear to be sticking out are arranged in a square. After observing this, turn the page over so the small dot is on the bottom. Does this change your perception?



If we assume that light is coming from above (which is usually the case in the environment), then patterns that are light on the top would be created by an object that bulges out (Figure below), but a pattern that are light on the bottom would be created by an indentation in a surface . The assumption that light is coming from above has been called the light-from-above heuristic (Kleffner & Ramachandran, 1992). Apparently, people make the light-from-above assumption because most light in our environment comes from above. This includes the sun, as well as most artificial light sources.

The photos below another example of light heuristic. These are indentations created by people walking in the sand. But when we turn this picture upside down, as shown here, then the indentations in the sand become rounded mounds.



Why does (a) look like indentations in the sand and (b) look like mounds of sand? You will find the answer in text above.

Semantic Regularities

In language, semantics refers to the meanings of words or sentences. Applied to perceiving scenes, semantics refers to the meaning of a scene. This meaning is often related to the function of a scene—what happens within it. For example, food preparation, cooking, and perhaps eating occur in a kitchen; waiting around, buying tickets, checking luggage, and going through security checkpoints happens in airports. Semantic regularities are the characteristics associated with the functions carried out in different types of scenes.

Lecture 15

PERCEIVING DEPTH AND SIZE

Perceiving Depth

We live in three dimensional world, see things as near and far and of different sizes. To perceive a three dimensional scene from two-dimensional information on retina is an amazing ability

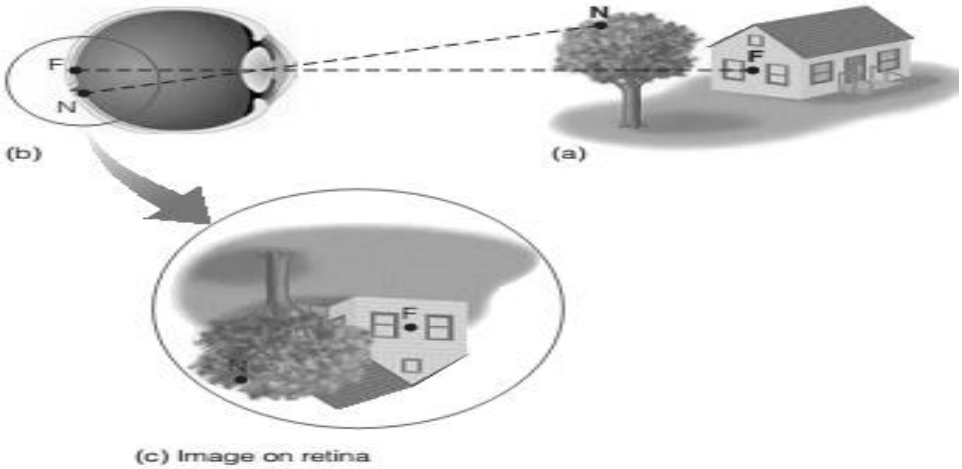
Cue approach to depth Perception

- Identifying information in the retinal image that is correlated with depth in the scene
- Occlusion, is a signal, or cue, that one object is in front of another
- We learn the connection between this cue and depth through our previous experience with the environment.

The association between particular cues and depth becomes automatic, and when these depth cues are present, we experience the world in three dimensions

Types of depth cues

1. Oculomotor: Cues based on our ability to sense the position of our eyes and the tension in our eye muscles.
2. Monocular: Cues that work with one eye.
3. Binocular: Cues that depend on two eyes.



(a) The house is farther away than the tree, but (b) the images of points F on the house and N on the tree both fall on the two-dimensional surface of the retina, (c) these two points, themselves, do not tell us the distances to the house and the tree.

1. **The oculomotor cues**

- **Convergence**, the inward movement of the eyes that occurs when we look at nearby objects.
- **Accommodation**, the change in the shape of the lens that occurs when we focus on objects at various distances. We can feel the inward movement of the eyes that occurs when the eyes converge to look at nearby objects, and we feel the tightening of eye muscles that change the shape of the lens to focus on a nearby object.

Feelings in Your Eyes

Look at your finger as you hold it at arm's length. Then, as you slowly move your finger toward your nose, notice how you feel your eyes looking inward and become aware of the increasing tension inside your eyes.

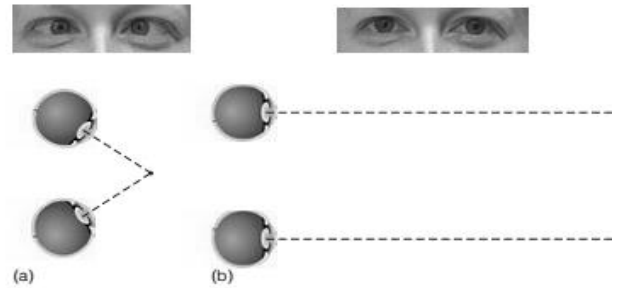
2. **Monocular cues**

Pictorial cues are sources of depth information that can be depicted in a picture. Occlusion occurs when one object hides or partially hides another from view. The partially hidden object is seen as being farther away, so the mountains are perceived as being farther away than the hill.

Relative height

Objects that are below the horizon and have their bases higher in the field of view are usually seen as being more distant.

Perspective Convergence



(a) Convergence of the eyes occurs when a person looks at something that is very close.
(b) The eyes look straight ahead when the person observes something that is far away.

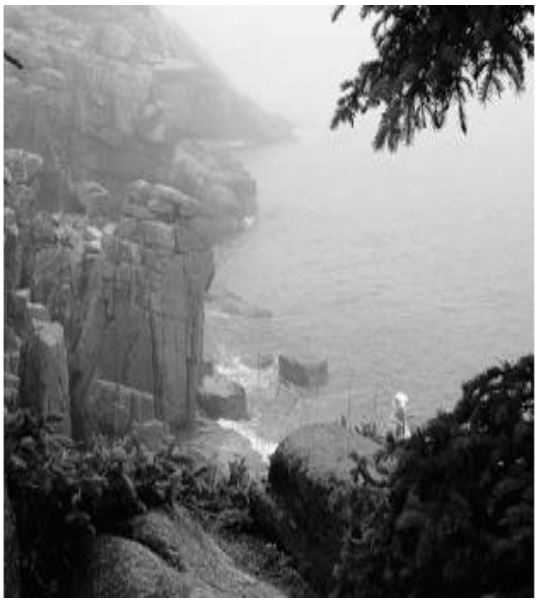
Familiar size

When we judge distance based on our prior knowledge of the sizes of objects.

Drawings of the stimuli used in Epstein's (1965) familiar-size experiment. The actual stimuli were photographs that were all the same size as a real quarter

Atmospheric Perspective

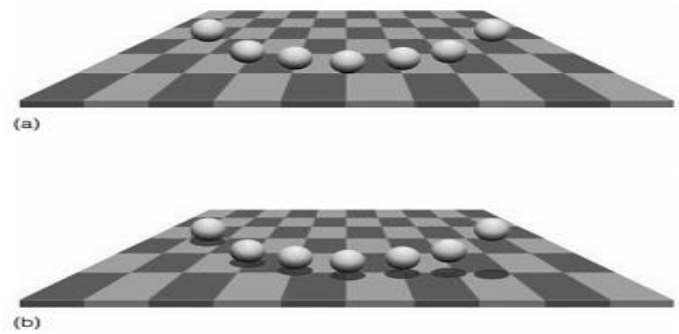
Occurs when more distant objects appear less sharp and often have a slight blue tint. The farther away an object is, the more air and particles (dust, water droplets, airborne pollution) we have to look through, making objects that are farther away look less sharp and bluer than close objects



Texture gradient

Elements that are equally spaced in a scene appear to be more closely packed as distance increases, as with the textured ground in the scene.

Shadows

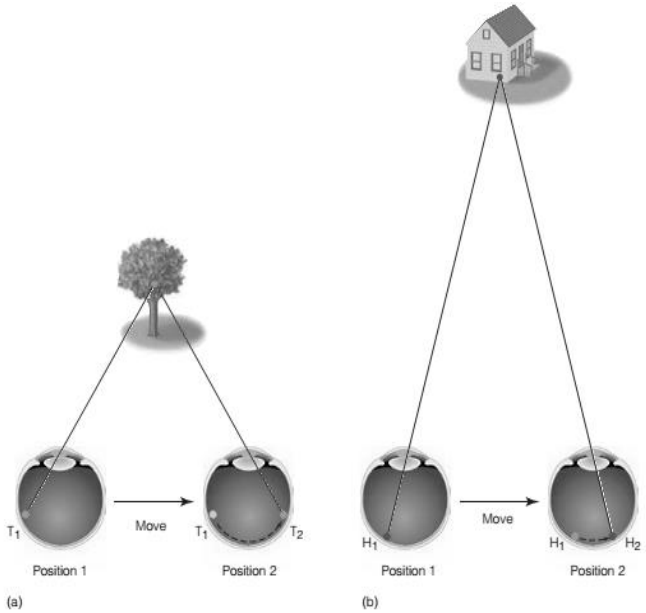


Shadows that are associated with objects can provide information regarding the locations of these objects.

Perceiving Depth 2

Motion-Produced Cues

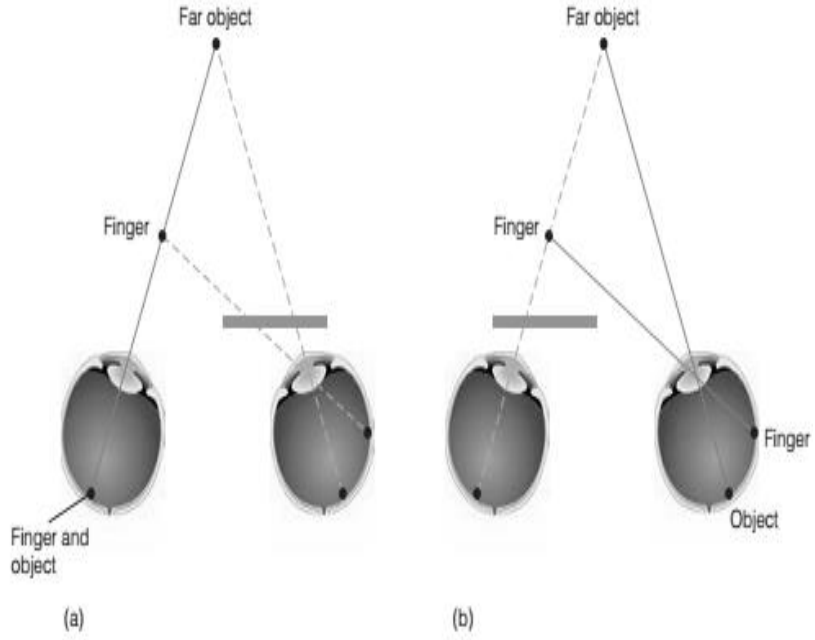
Motion parallax occurs when, as we move, nearby objects appear to glide rapidly past us, but more distant objects appear to move more slowly. Eye moving past (a) a nearby tree; (b) a faraway house. Notice how the image of the tree moves farther on the retina than the image of the house.



Motion parallax occurs when, as we move, nearby objects appear to glide rapidly past us, but more distant objects appear to move more slowly. Eye moving past (a) a nearby tree; (b) a faraway house. Notice how the image of the tree moves farther on the retina than the image of the house.

Binocular disparity

Is the difference in the images in the left and right eyes.



Two Eyes: Two Viewpoints

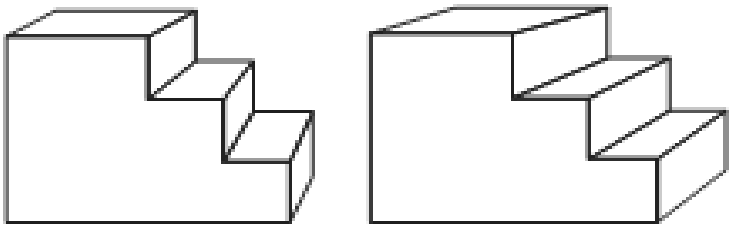
Close your right eye. Hold your finger vertically about 6 inches in front of you and position it so it is partially covering an object in the distance. Look directly at the distant object with your left eye, then close your left eye and look directly at the distant object with your right eye. When you switch eyes, how does the position of your finger change relative to the far object?

Stereoscope

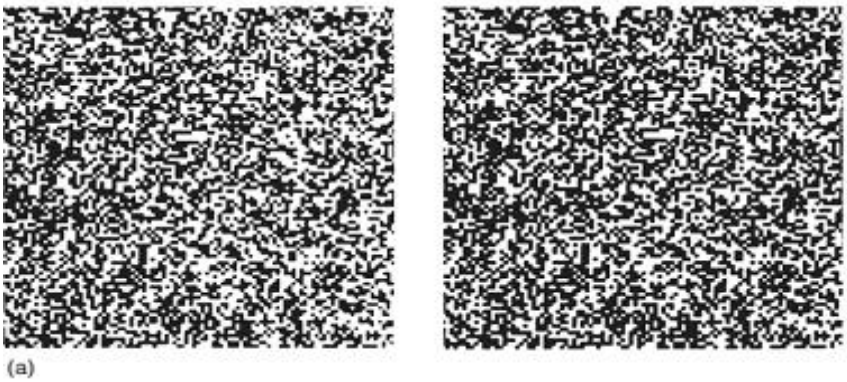
A device introduced by the physicist Charles Wheatstone (1802–1875)

Binocular Depth from a Picture, Without a Stereoscope

Place a 4 X 6 card vertically, long side up, between the stairs in Figure, and place your nose against the card so that you are seeing the left-hand drawing with just your left eye and the right-hand drawing with just your right eye. Wait for the two drawings to merge. you should see the stairs in depth, just as you would if you looked at them through a stereoscope.



The principle behind the stereoscope is also used in 3-D movies. The left-eye and right-eye images are presented simultaneously on the screen, slightly displaced from one another, to create disparity. These images can be presented separately to the left and right eyes by coloring one red and the other green and viewing the film through glasses with a red filter for one eye and a green filter for the other eye.

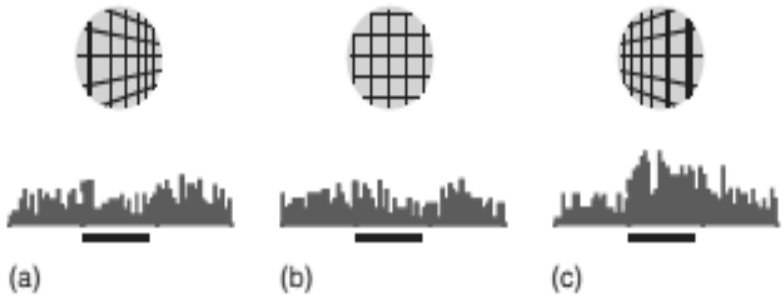


(a)

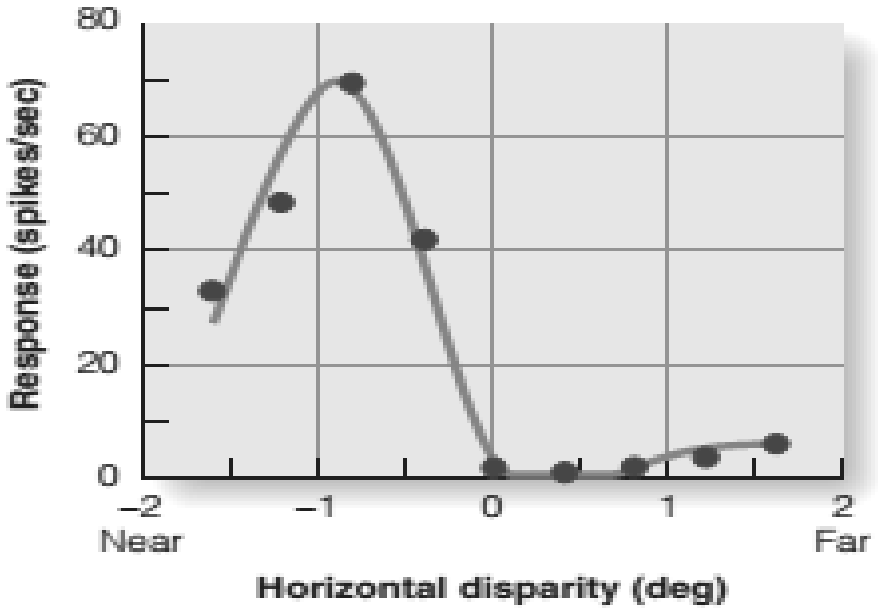
Observers can perceive depth in displays that contain no depth information other than disparity. Random-dot stereogram, are Patterns, constructed by first generating two identical random-dot

patterns on a computer and then shifting a square-shaped section of the dots one or more units to the side.

Neurons That Respond to Pictorial Depth



Ken-Ichino Tsutsui and coworkers (2002, 2005) studied the physiology of neurons that respond to the depth indicated by texture gradients by having monkeys match stimuli to three-dimensional displays created by stereograms. monkeys perceive the pattern a as slanting to the right, b as flat, and c as slanting to the left

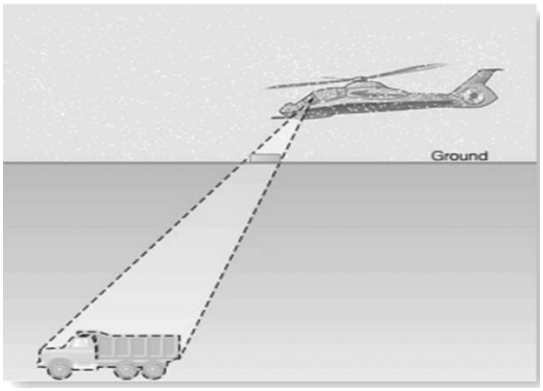


Disparity tuning curve for a neuron sensitive to absolute disparity. This curve indicates the neural response that occurs when stimuli presented to the left and right eyes create different amounts of disparity. (From Uka, T., & DeAngelis, G. C. (2003). Contribution of middle temporal area to coarse depth discrimination: Comparison of neuronal and psychophysical sensitivity. Journal of Neuroscience, 23, 3515–3530.)

Perceiving Size

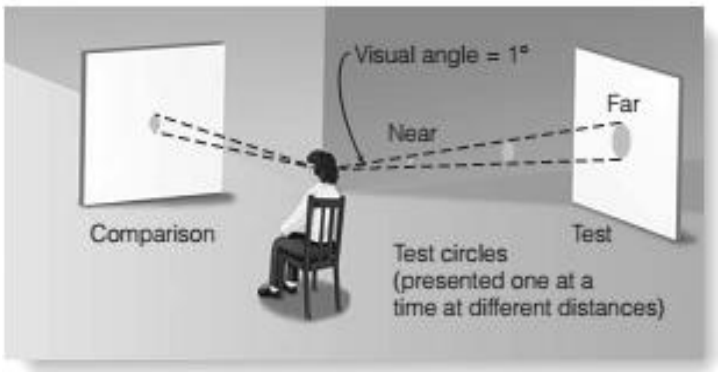
Perception of Size Affected by Perception of Depth

When a helicopter pilot loses the ability to perceive distance, due to "whiteout," a small box that is close can be mistaken for a truck that is far away.



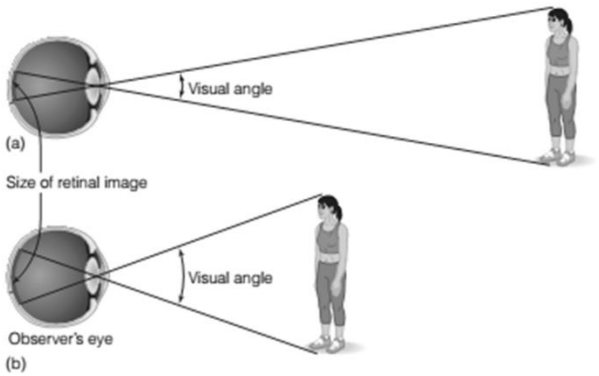
The Holway and Boring Experiment

Observers in Holway and Boring's experiment sat at the intersection of two hallways and saw a luminous test circle when looking down the right hallway and a luminous comparison circle when looking down the left hallway. The comparison circle was always 10 feet from the observer, but the test circles were presented at distances ranging from 10 feet to 120 feet. The observer's task on each trial was to adjust the diameter of the comparison circle on the left to match their perception of the size of the test circle on the right.



Visual angle

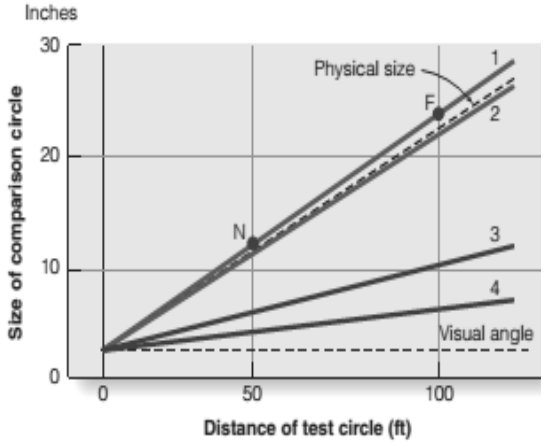
Is the angle of an object relative to the observer's eye. We determine the visual angle of a stimulus (a person, in this example) by extending lines from the person to the lens of the observer's eye. The angle between the lines is the visual angle. Notice that the visual angle depends both on the size of the stimulus and on its distance from the observer, so when the person moves closer, as in picture the visual angle becomes larger.



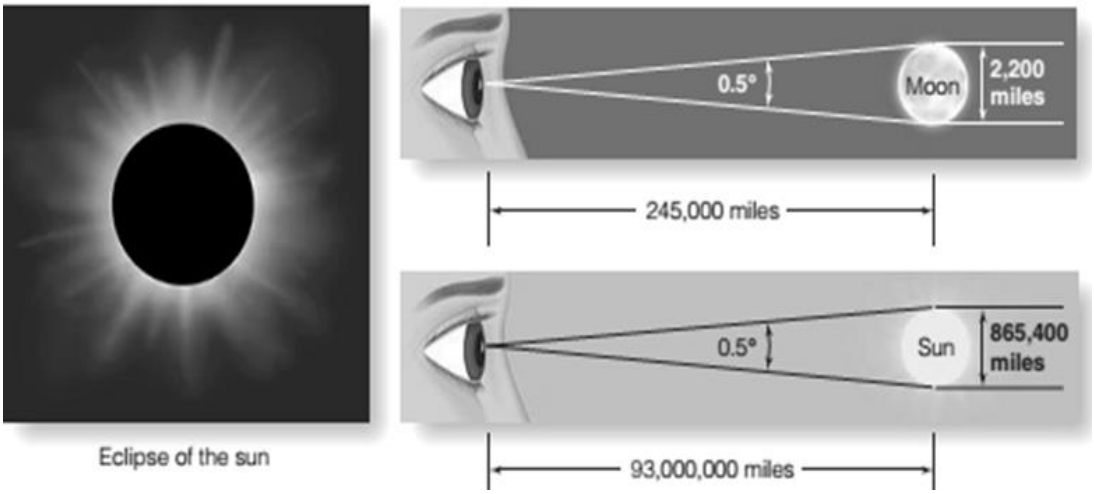
The visual angle between the two fingers is the same as the visual angle of the Eiffel Tower

Holway and Boring's (1941)

The dashed line marked "Physical size" is the result that would be expected if the observers adjusted the diameter of the comparison circle to match the actual diameter of each test circle. The line marked "Visual angle" is the result that would be expected if the observers adjusted the diameter of the comparison circle to match the visual angle of each test circle



The moon's disk almost exactly covers the sun during an eclipse because the sun and the moon have the same visual angle.



The moon is small (diameter 2,200 miles) but close (245,000 miles from Earth), whereas the sun is large (diameter 865,400 miles) but far away (93 million miles from Earth). Even though these two celestial bodies are vastly different in size, we perceive them to be the same size because, as we are unable to perceive their distance, we base our judgment on their visual angles.We perceive objects viewed from a high-flying airplane as very small. Because we have no way of accurately estimating the distance from the airplane to the ground, we perceive size based on objects' visual angles, which are very small because we are so high up.

- Link between our perception of size and our perception of depth with good depth perception favoring accurate size perception.
- And even though our perception of size is not always totally accurate (Gilinsky, 1951), it is good enough to cause psychologists to propose the principle of size constancy.

Size constancy principle

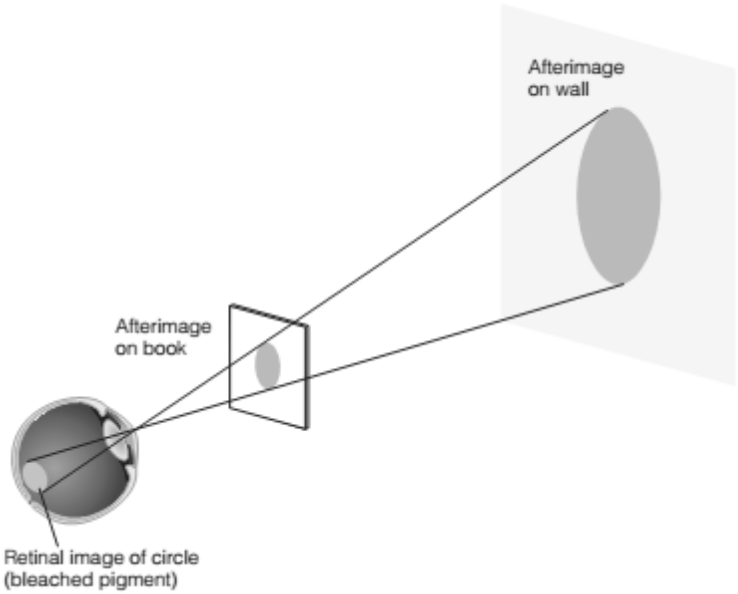
- If I stand 3 feet from my class, they estimate my height same as if I stand 6 feet
- Though image on retina has shrunk by my moving, perception remains the same
- This perception of sixe remaining constant irrespective of distance = size constancy

Perceiving Size at a Distance

Hold a quarter between the fingertips of each hand.. Hold one coin about a foot from you and the other at arm's length. Observe the coins with both of your eyes open and note their sizes. most people perceive the near and far coins as being approximately the same size. Close one eye, and holding the coins so they appear side-by-side, notice how your perception of the size of the far coin changes so that it now appears smaller than the near coin. size constancy is decreased under conditions of poor depth information.

Perceiving Size 2

- Link between our perception of size and our perception of depth with good depth perception favoring accurate size perception.
- And even though our perception of size is not always totally accurate (Gilinsky, 1951), it is good enough to cause psychologists to propose the principle of size constancy



Look at the center of the circle for about 60 seconds. Then look at the white space to the side of the circle and blink to see the circle's afterimage. Before the afterimage fades, also look at a wall far across the room. You should see that the size of the afterimage depends on where you look. If you look at a distant surface, such as the far wall of the room, you see a large afterimage that appears to be far away. If you look at a near surface, such as the page in front of you , you see a small afterimage that appears to be close.

Size constancy principle

The principle behind the observation that the size of an afterimage increases as the afterimage is viewed against more distant surfaces

Size Constancy as a Calculation

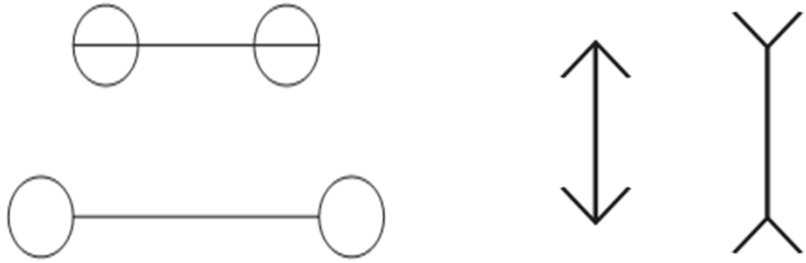
The link between size constancy and depth perception has led to the proposal that size constancy is based on a mechanism called size–distance scaling that takes an object's distance into account (Gregory, 1966). Size–distance scaling operates according to the equation S K(R D), where S is the object's perceived size, K is a constant, R is the size of the retinal image, and D is the perceived distance of the object.

The size of this wheel becomes apparent when it can be compared to an object of known size, such as the person. If the wheel were seen in total isolation, it would be difficult to know that it is so large

Two cylinders resting on a texture gradient. According to Gibson (1950), the fact that the bases of both cylinders cover the same number of units on the gradient indicates that the bases of the two cylinders are the same size.

Visual illusions

Fascinate people because they demonstrate how our visual system can be "tricked" into seeing inaccurately (Bach & Poloschek, 2006)



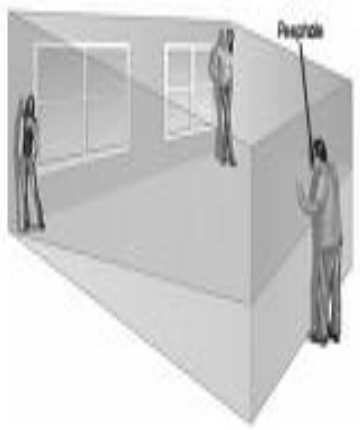
In the **Müller-Lyer illusion**, the right vertical line appears to be longer than the left vertical line, even though they are both exactly the same length.

According to Gregory (1966), the Müller-Lyer line on the left corresponds to an outside corner, and the line on the right corresponds to an inside corner. Note that the two vertical lines are the same length.

Conflicting Cues Theory

R. H. Day (1989, 1990) has proposed the conflicting cues theory, which states that our perception of line length depends on two cues: (1) the actual length of the vertical lines, and (2) the overall length of the figure. According to Day, these two conflicting cues are integrated to form a compromise perception of length. Because the overall length of the right figure is larger due to its outward-oriented fins, the vertical line appears larger.

Ponzo Illusion



The Ames room, showing its true shape.

The woman on the left is actually almost twice as far from the observer as the one on the right; however, when the room is viewed through the peephole, this difference in distance is not seen. In order for the room to look normal when viewed through the peephole, it is necessary to enlarge the left side of the room.

An artist's conception of the how the moon

Is perceived when it is on the horizon and when it is high in the sky. The visual angle of the horizon moon is depicted as larger than the visual angle of the moon high in the sky, the picture is simulating the illusion. In the environment, the visual angles of the two moons are the same.

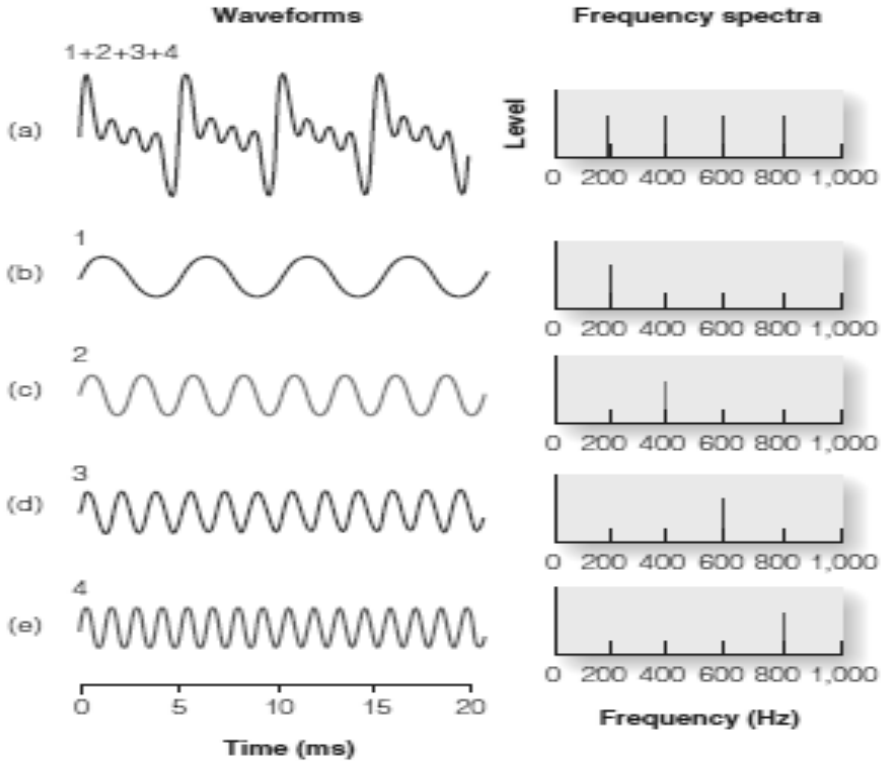
Lecture 16

SOUND PERCEPTION

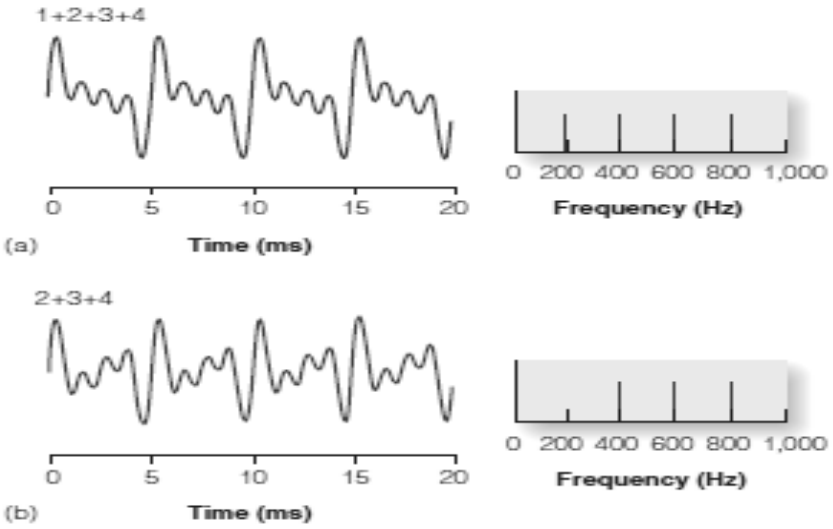
Perceiving Sound

Loudness

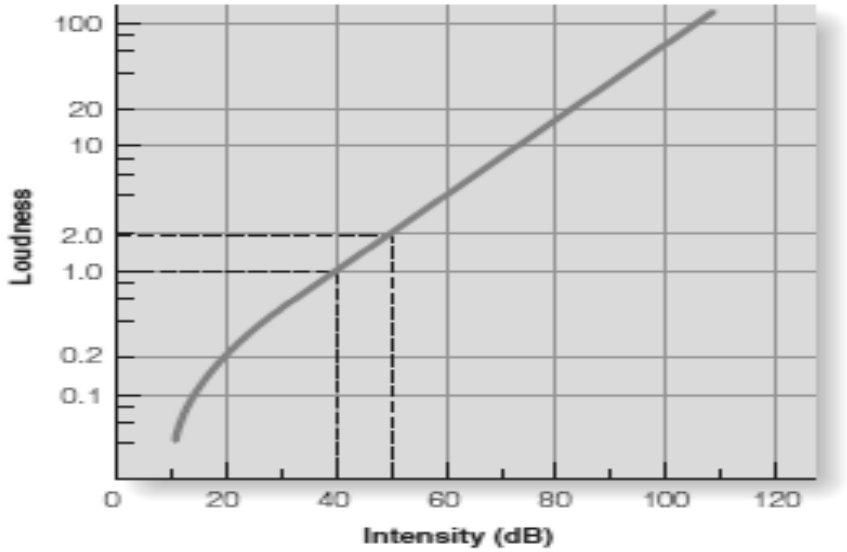
- Loudness is the quality most closely related to the amplitude or sound pressure, which is also called the level of an auditory stimulus.
- Thus, decibels are often associated with loudness. Decibels are a physical measure, whereas loudness is psychological



Left: Waveforms of (a) a complex periodic sound with a fundamental frequency of 200 Hz;
(b) fundamental (first harmonic) 200 Hz;
(c) second harmonic 400 Hz;
(d) third harmonic 600 Hz;
(e) fourth harmonic 800 Hz.
Right: Frequency spectra for the tones on the left.



(a) The complex tone with its frequency spectrum; (b) the same tone with its first harmonic removed.

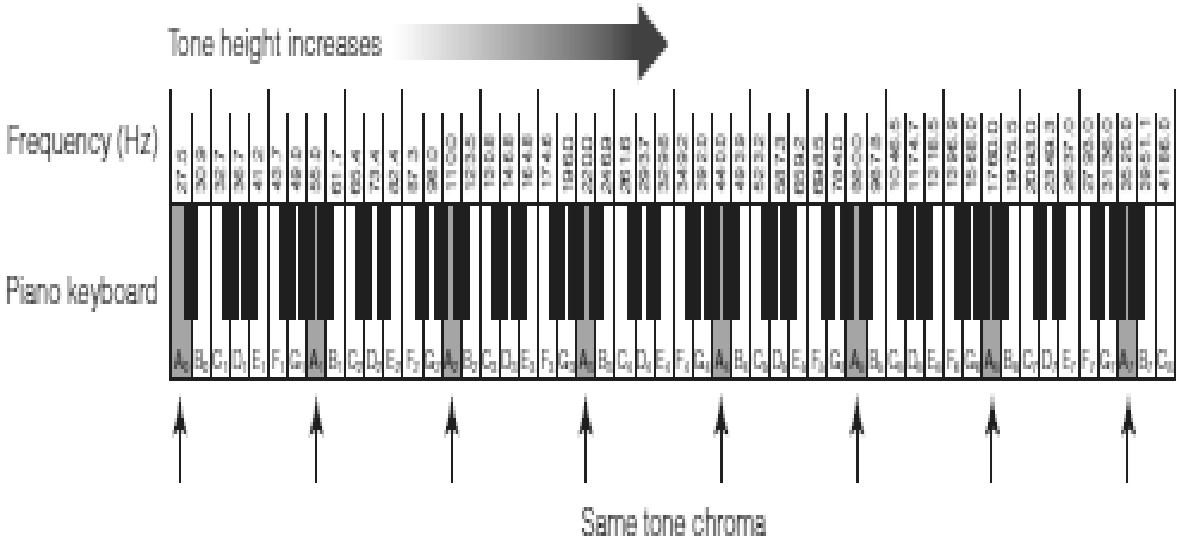


Loudness of a 1,000-Hz tone as a function of intensity, determined using magnitude estimation. The dashed lines show that increasing the intensity by 10 dB almost doubles the loudness.

Pitch

Pitch, the perceptual quality we describe as "high" or "low" is defined as the attribute of auditory sensation in terms of which sounds may be ordered on a musical scale (Bendor & Wang, 2005). Pitch is most closely related to the physical property of frequency. Low fundamental frequencies are associated with low pitches, and high fundamental frequencies are associated with high pitches.

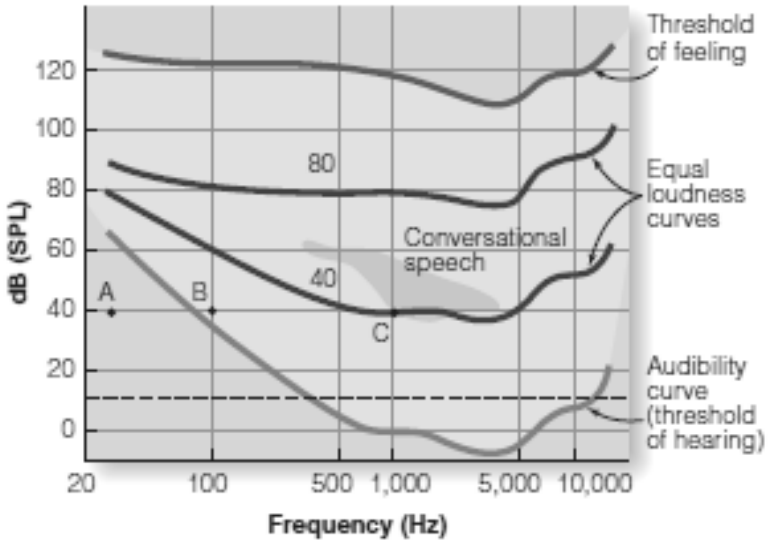
Tone height is the perceptual experience of increasing pitch that accompanies increases in a tone's fundamental frequency. Starting at the lowest note on the piano, at the left end of the keyboard (fundamental frequency 27.5 Hz), and moving to the right toward the highest note (fundamental 4,166 Hz) creates the perception of increasing tone height.



A piano keyboard, indicating the frequency associated with each key. Moving up the keyboard to the right increases frequency and tone height. Notes with the same letter, like the A's(arrows), have the same tone chroma.

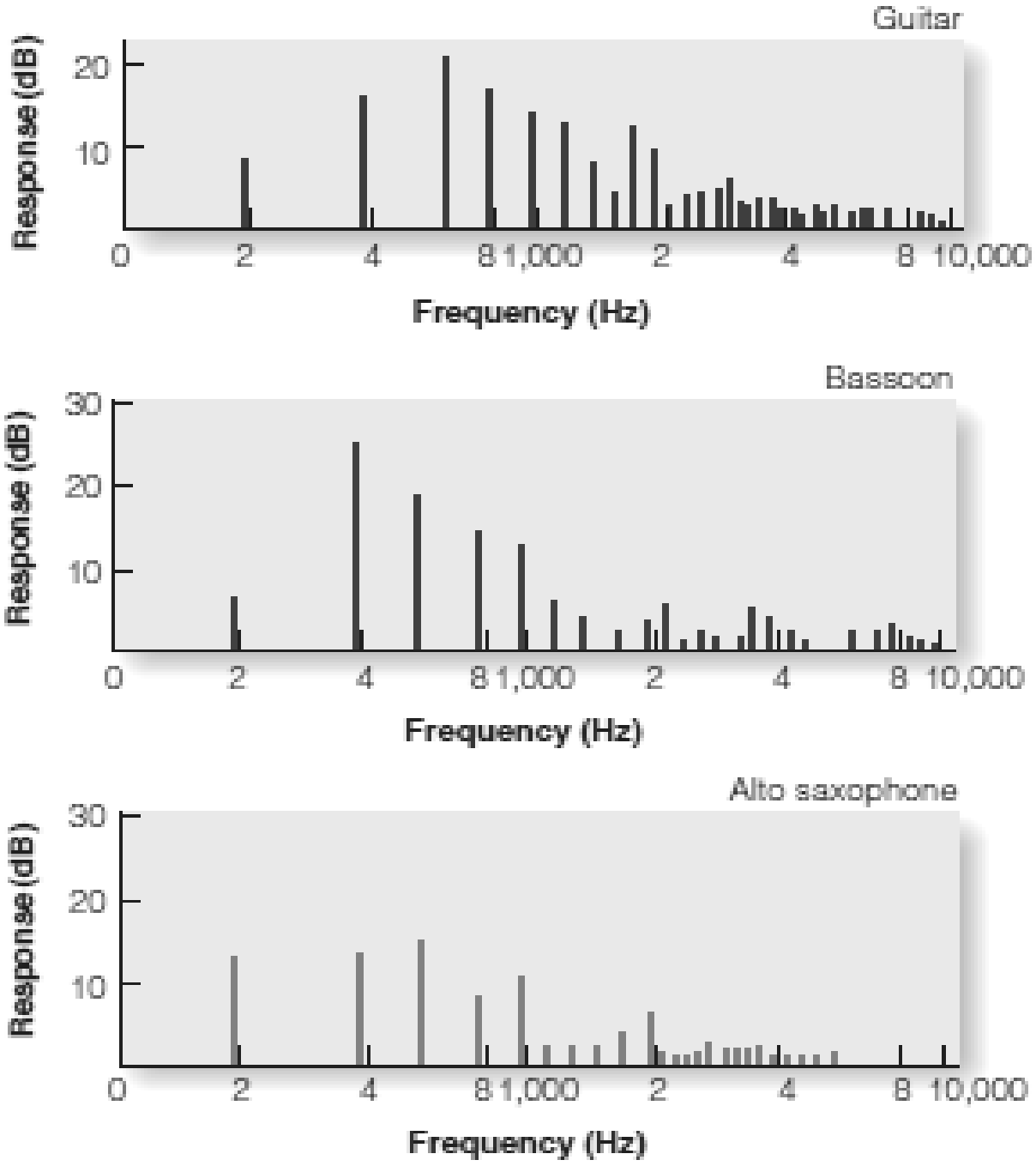
Timbre

Timbre is the quality that distinguishes between two tones that have the same loudness, pitch, and duration, but still sound different. For example, when a flute and a bassoon play the same note with the same loudness, we can still tell the difference between these two instruments. We might describe the sound of the flute as clear or mellow and the sound of the bassoon as nasal or reedy. When two tones have the same loudness, pitch, and duration, but sound different, this difference is a difference in timbre



The audibility curve and the auditory response area

Hearing occurs in the light green area between the audibility curve (the threshold for hearing) and the upper curve (the threshold for feeling). Tones with combinations of dB and frequency that place them in the light red area below the audibility curve cannot be heard. Tones above the threshold of feeling result in pain. Where the dashed line at 10 dB traverses the auditory response area indicates which frequencies can be heard at 10 dB SPL.

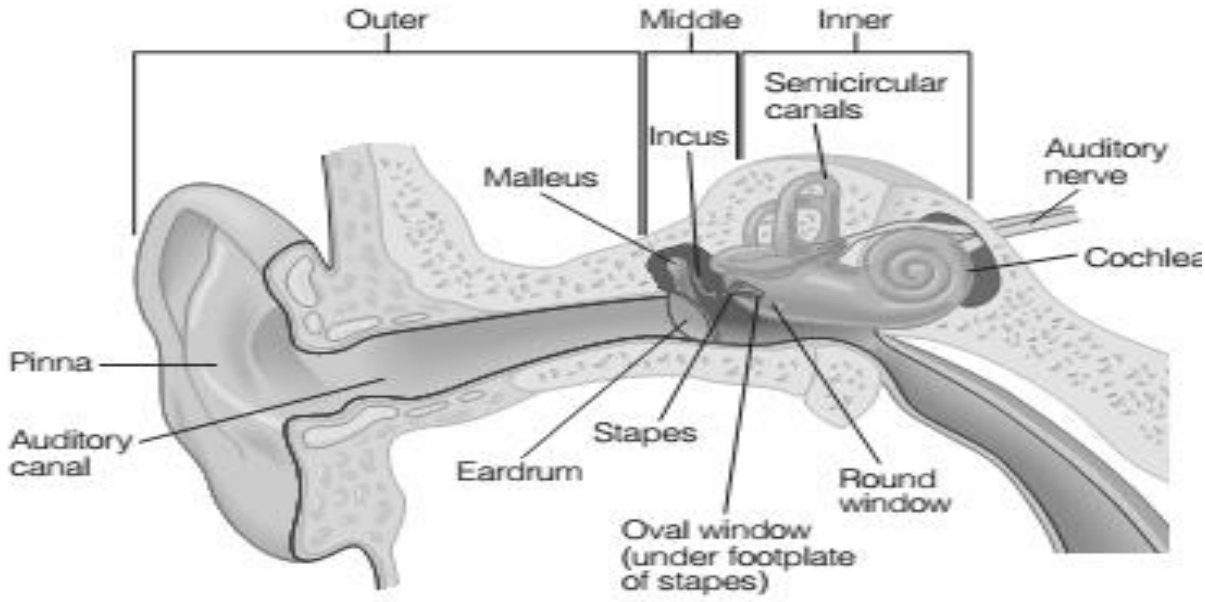


Frequency spectra for a guitar, a bassoon, and an alto saxophone playing a tone with a fundamental frequency of 196 Hz. The position of the lines on the horizontal axis indicates the frequencies of the harmonics, and their height indicates their intensities.

Structure of the Ear

The Ear

The auditory system must accomplish three basic tasks before we can hear. First, it must deliver the sound stimulus to the receptors. Second, it must transduce this stimulus from pressure changes into electrical signals, and third, it must process these electrical signals so they can indicate qualities of the sound source such as pitch, loudness, timbre, and location.



A device that resembles "a contraption some ingenious plumber has put together from spare parts."
Diane Ackerman (1990)

The Outer Ear

When we talk about ears in everyday conversation, we are usually referring to the pinnae, the structures that stick out from the sides of the head. Although this most obvious part of the ear is important in helping us determine the location of sounds and is of great importance for those who wear eyeglasses, it is the part of the ear we could most easily do without.

The major workings of the ear are found within the head, hidden from view.
Sound waves first pass through the outer ear, which consists of the pinna and the auditory canal.
The auditory canal is a tube like structure about 3 cm long in adults that protects the delicate structures of the middle ear from the hazards of the outside world.

In addition to its protective function, the outer ear has another effect: to enhance the intensities of some sounds by means of the physical principle of resonance.

Resonance occurs in the auditory canal when sound waves that are reflected back from the closed end of the auditory canal interact with sound waves that are entering the canal.
We can appreciate how the resonant frequency depends on the length of the canal by noting how the tone produced by blowing across the top of a soda bottle changes as we drink more soda.

Drinking more soda increases the length of the air path inside the bottle, which decreases the resonant frequency, and this creates a lower-pitched tone.

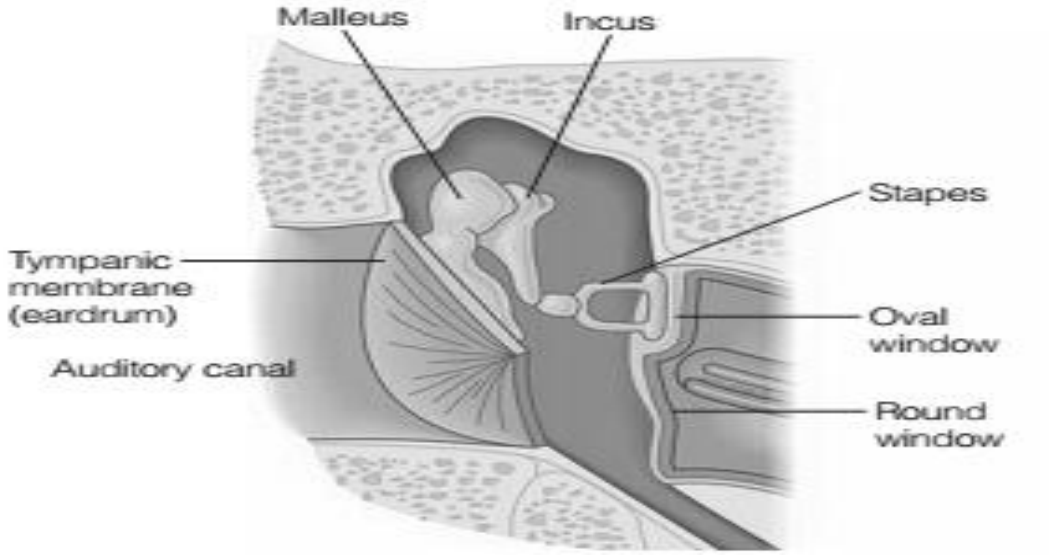
Measurements of the sound pressures inside the ear indicate that the resonance that occurs in the auditory canal has a slight amplifying effect on frequencies between about 1,000 and 5,000 Hz

This interaction reinforces some of the sound's frequencies, with the frequency that is reinforced the most being determined by the length of the canal. The frequency reinforced the most is called the resonant frequency of the canal.

Functions of Inner Ear

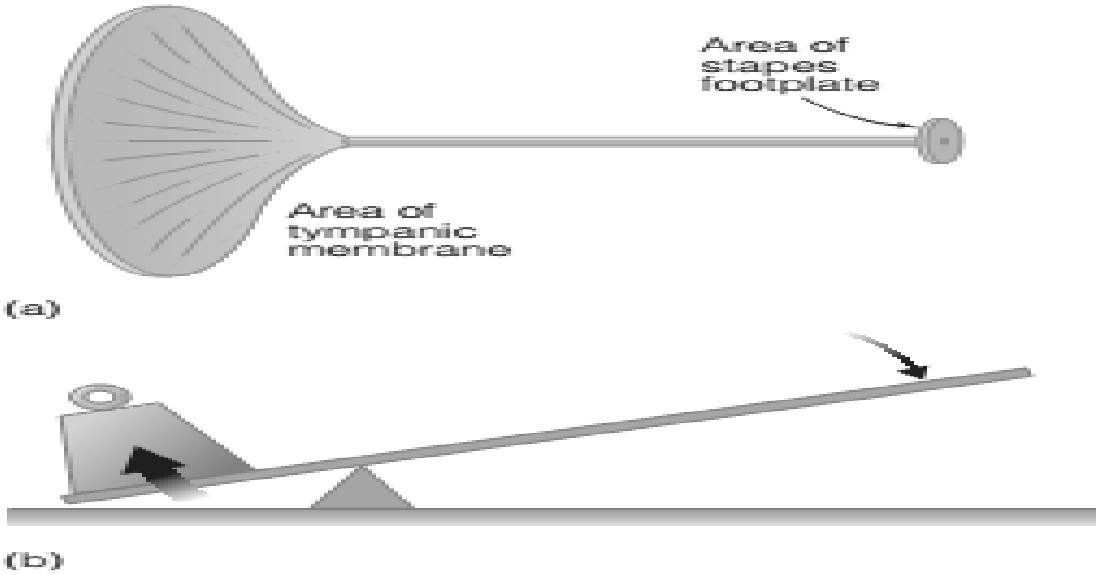
The Middle Ear

- When airborne sound waves reach the **tympanic membrane** at the end of the auditory canal, they set it into vibration, and this vibration is transmitted to structures in the middle ear, on the other side of the tympanic membrane.
- The middle ear is a small cavity, about 2 cubic centimeters in volume, which separates the outer and inner ears. This cavity contains the **ossicles**, the three smallest bones in the body. The first of these bones, the **malleus** (also known as the hammer), is set into vibration by the tympanic membrane, to which it is attached



- The middle ear. The three bones of the middle ear transmit the vibrations of the tympanic membrane to the inner ear
- The malleus transmits its vibrations to the incus(or anvil), which, in turn, transmits its vibrations to the stapes(or stirrup). The stapes then transmits its vibrations to the inner ear by pushing on the membrane covering the oval window
- Ossicles are necessary because middle ear is filled with air (low density)and inner ear is filled with watery liquid (higher density)

If vibrations had to pass directly from the air in the middle ear to the liquid in the inner ear, less than 1 percent of the vibrations would be transmitted (Durrant & Lovrinic, 1977). It would be like hearing underwater to people on the surface

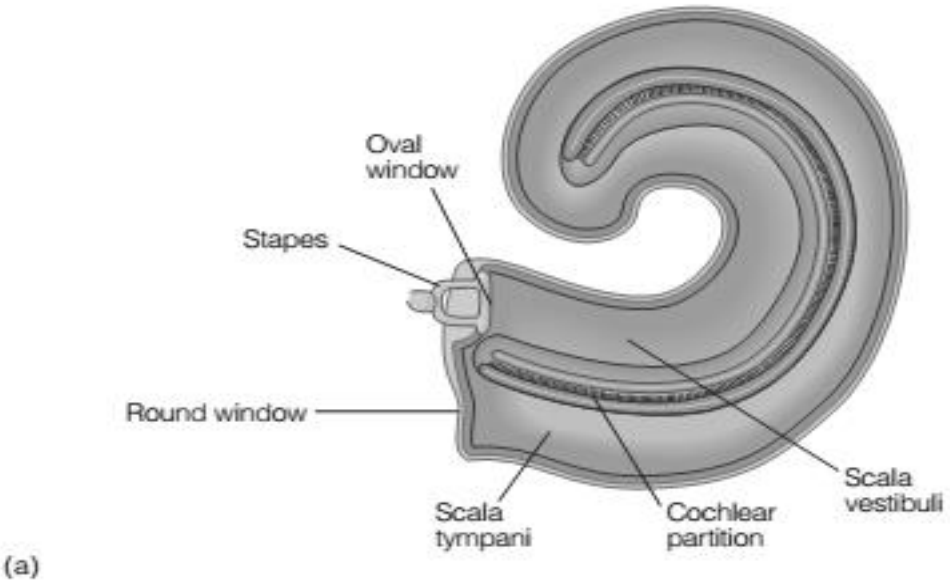


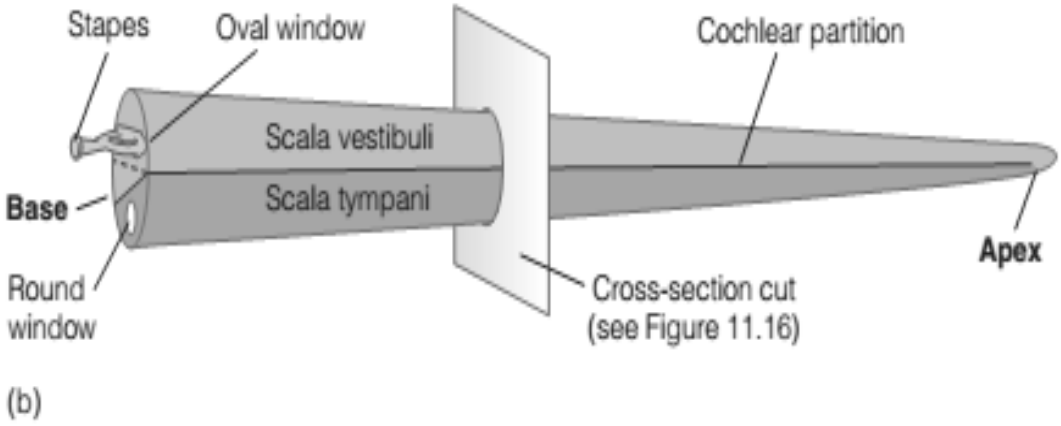
(a) A diagrammatic representation of the tympanic membrane and the stapes, showing the difference in size between the two. (b) How lever action can amplify a small force, presented on the right, to lift the large weight on the left. The lever action of the ossicles amplifies the sound vibrations reaching the tympanic inner ear. (Adapted from Schubert, 1980.)

The ossicles help solve this problem in two ways: (1) by concentrating the vibration of the large tympanic membrane onto the much smaller stapes, which increases the pressure by a factor of about 20; and (2) by being hinged to create a lever action that creates an effect similar to what happens when a fulcrum is placed under a board, so pushing down on the long end of the board makes it possible to lift a heavy weight on the short end.

The Inner Ear

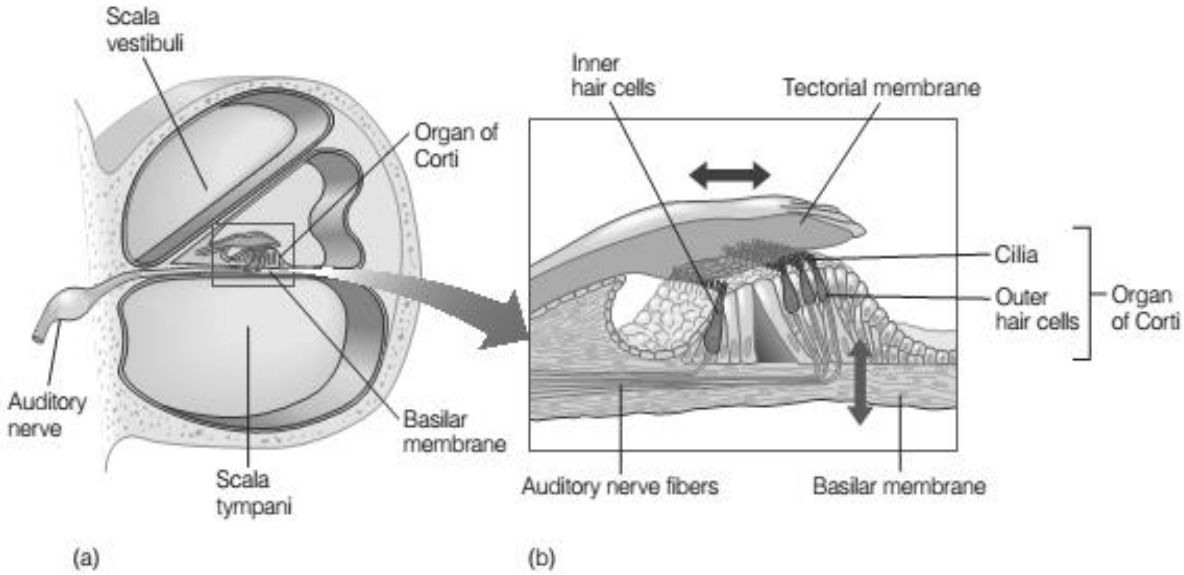
The main structure of the inner ear is the liquid-filled cochlea, the snail-like structure
The liquid inside the cochlea is set into vibration by the movement of the stapes against the oval window.
A partially uncoiled cochlea. (b) A fully uncoiled cochlea. The cochlear partition, indicated here by a line, actually contains the basilar membrane and the organ of Corti.





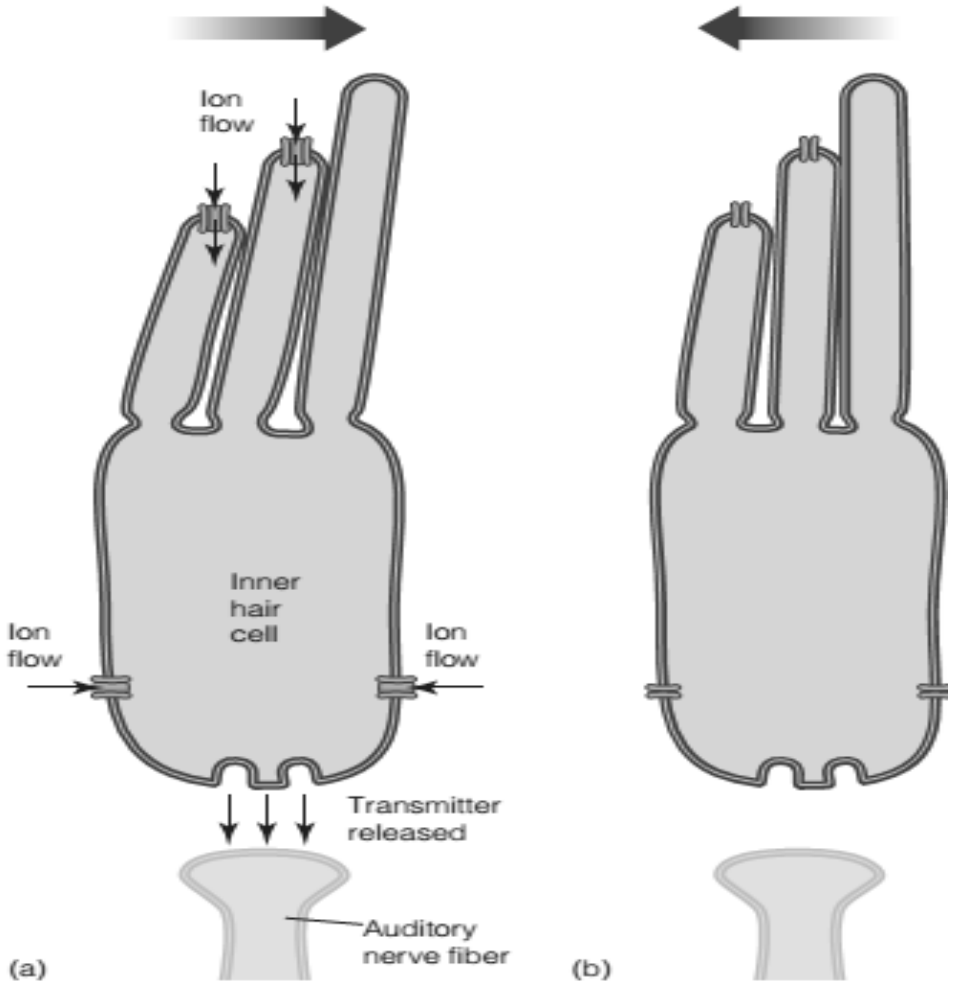
- **Hair Cells**; Inner hair cells, outer hair cells
- **The cilia**; protrude from the tops of the cells, here the sound acts to produce electrical signals.
- About 3,500 inner hair cells

- 12,000 outer hair cells
- The basilar membrane; supports the organ of Corti and vibrates in response to sound.
- The tectorial membrane; extends over the hair cells.



(a) Cross section of the cochlea. (b) Close-up of the organ of Corti, showing how it rests on the basilar membrane. Arrows indicate the motions of the basilar membrane and tectorial membrane that are caused by vibration of the cochlear partition. (Adapted from Denes & Pinson, 1993.)

- Bending of the cilia of the inner hair cells, which are responsible for transduction—the conversion of the vibrations caused by the sound stimulus into electrical signals.
- The in-and-out movement of the stapes creates pressure changes in the liquid inside the cochlea that sets the cochlear partition into an up-and-down motion, as indicated by the blue arrow in Figure.
- This up-and-down motion of the cochlear partition causes two effects: (1) it sets the organ of Corti into an up-and down vibration, and (2) it causes the tectorial membrane to move back and forth, as shown by the red arrow. These two motions cause the cilia of the inner hair cells to bend because of their movement against the surrounding liquid and affects the outer hair cells because some of the cilia are in contact with the tectorial membrane.



(a) Movement of hair cilia in one direction opens ion channels in the hair cell, which results in the release of neurotransmitter onto an auditory nerve fiber. (b) Movement in the opposite direction closes the ion channels, so there is no ion flow and no transmitter release

- Very small amount of movement needed to hear a sound
- The auditory system can detect extremely small pressure changes
- So small, cause the eardrum to move only 10 –11 cm, less than the diameter of a hydrogen atom
- The air pressure at threshold in the most sensitive range of hearing only 10 to 15 db above the air pressure generated by the random movement of air molecules.
- This means that if our hearing were much more sensitive than it is now, we would hear the background hiss of colliding air molecules!

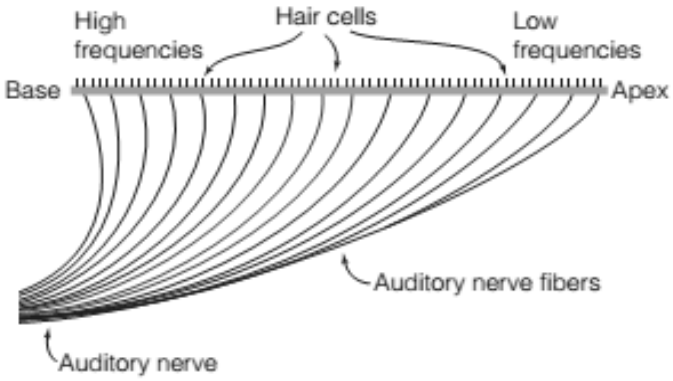
The Representation of Frequency

Physiological mechanisms behind our perception of pitch

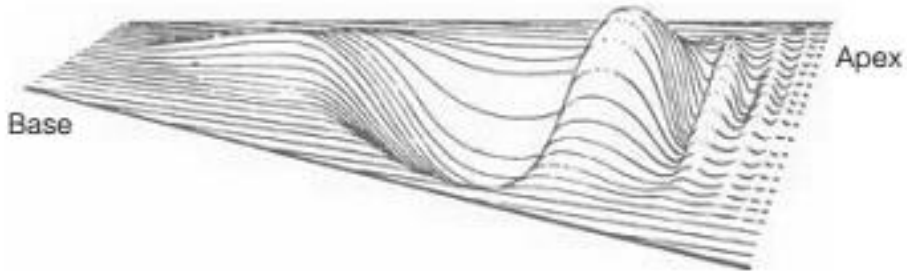
- Perception of pitch closely linked to a tone's frequency
- How frequency is represented by the firing of neurons in the auditory system
- Classic research by Georg von Békésy, the Nobel Prize in physiology and medicine, 1961, research on the physiology of hearing.

Place Theory of Hearing

The frequency of a sound is indicated by the place along the cochlea at which nerve firing is highest. Low frequencies cause maximum activity in the hair cells and auditory nerve fibers at the apex end of the basilar membrane. High frequencies cause maximum activity in hair cells and auditory nerve fibers at the base of the membrane.

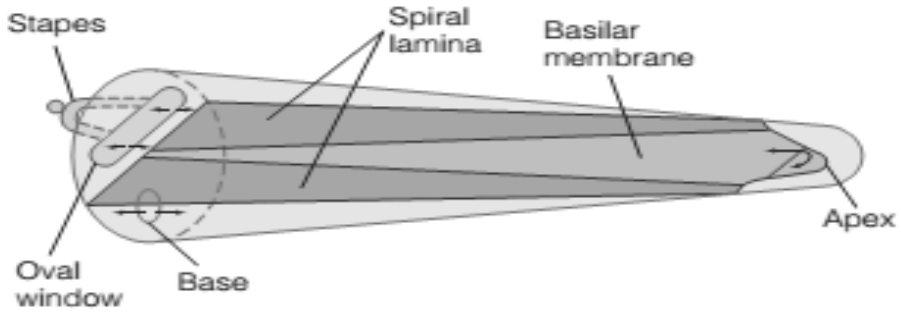


Hair cells all along the cochlea send signals to nerve fibers that combine to form the auditory nerve. Low frequencies; maximum activity at the apex end of the cochlea, high frequencies maximum activity at the base. Activation of the hair cells and auditory nerve fibers indicated in red would signal that the stimulus is in the middle of the frequency range for hearing.

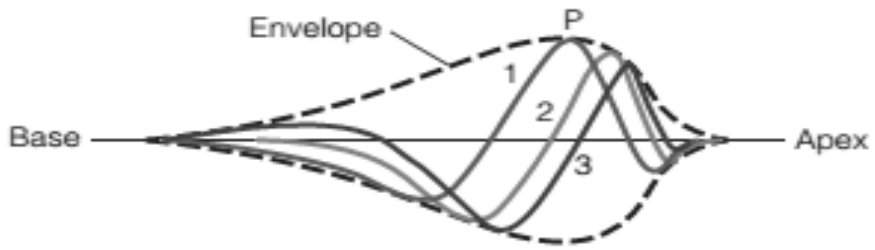


A perspective view showing the traveling wave motion of the basilar membrane

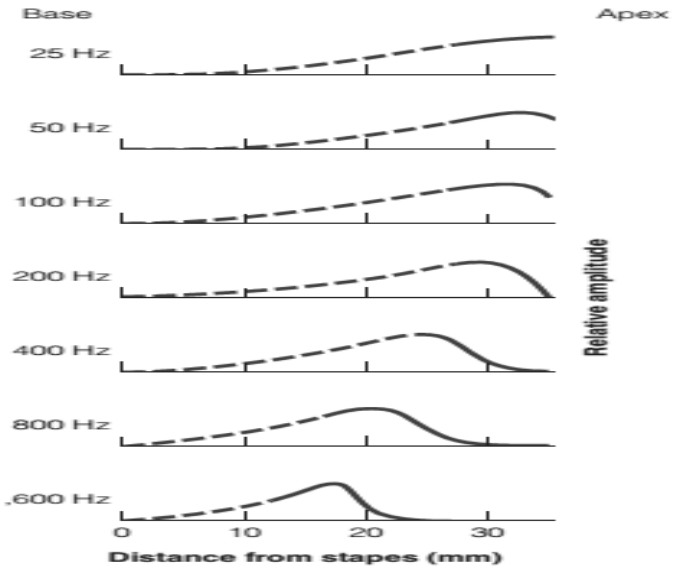
This picture shows what the membrane looks like when the vibration is "frozen" with the wave about two thirds of the way down the membrane.



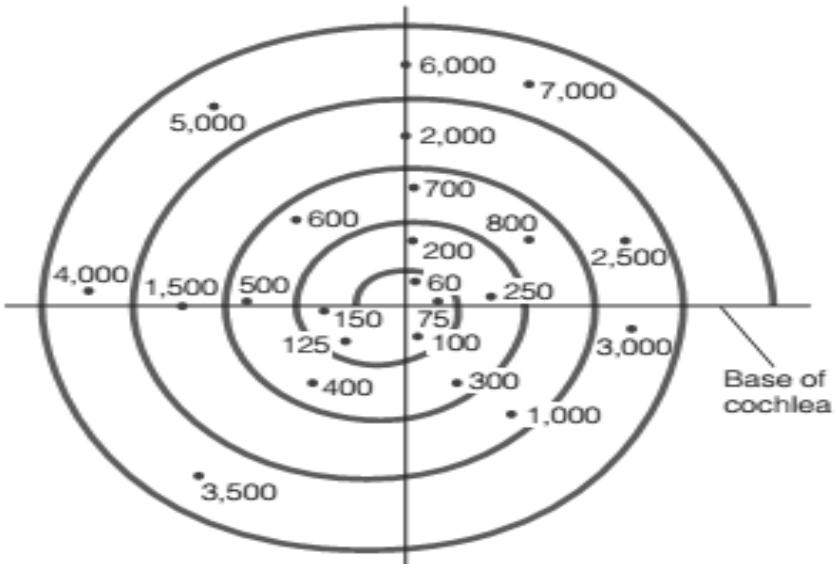
A perspective view of an uncoiled cochlea, showing how the basilar membrane gets wider at the apex end of the cochlea. The spiral lamina is a supporting structure that makes up for the basilar membrane's difference in width at the base and the apex ends of the cochlea



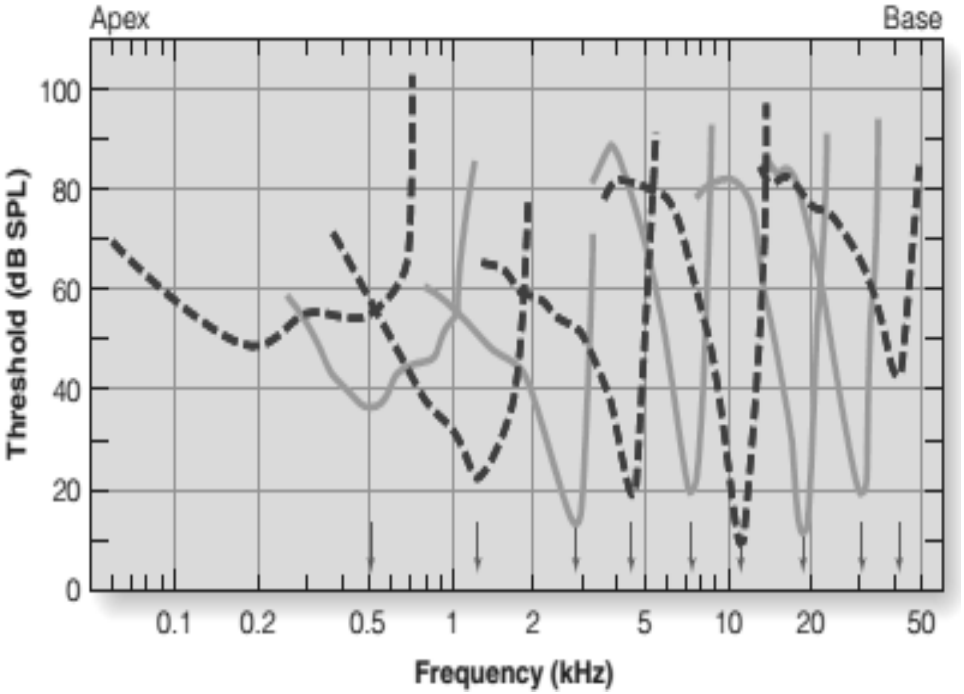
Vibration of the basilar membrane, showing the position of the membrane at three instants in time, indicated by the blue, green, and red lines, and the envelope of the vibration, indicated by the black dashed line. **P** indicates the peak of the basilar membrane vibration. (From Békésy, 1960.)



Evidence for Place Theory



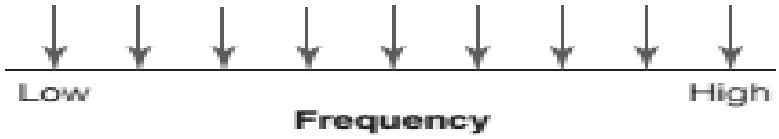
- Measurement of electrical response of the cochlea and of individual hair cells and auditory nerve fibers.
- Placing disc electrodes at different places along the length of the cochlea and measuring the electrical response to different frequencies
- A monotopic map—an orderly map of frequencies along the length of the cochlea



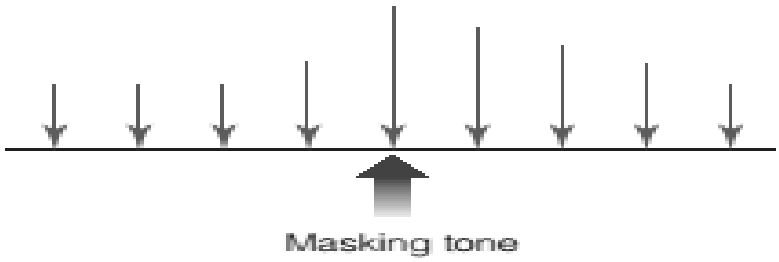
The characteristic frequency of each fiber , the arrows along the frequency axis. The frequency scale is in kilohertz (kHz), where 1 kHz = 1,000 Hz.

(Palmer, Physiology of the cochlear nerve and cochlear nucleus, British Medical Bulletin on Hearing, 43,1987, 838–855

Auditory masking
Psychophysical experiments on the phenomenon of auditory masking

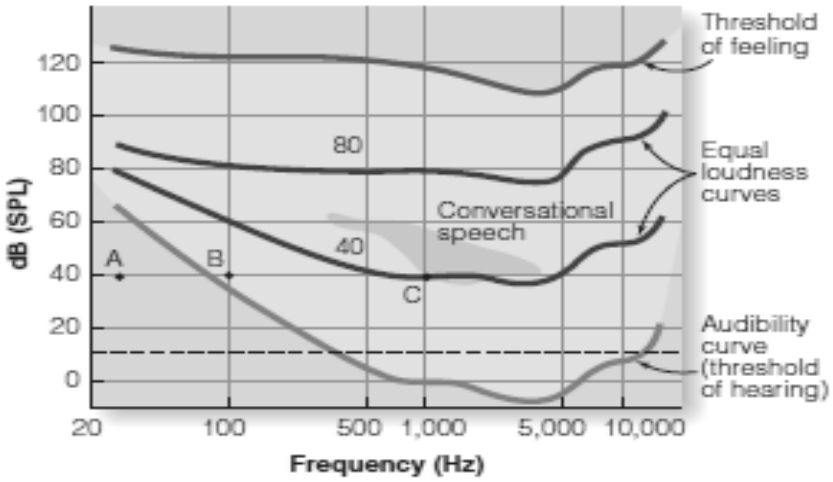


(a) Measure thresholds at different frequencies (blue arrows)

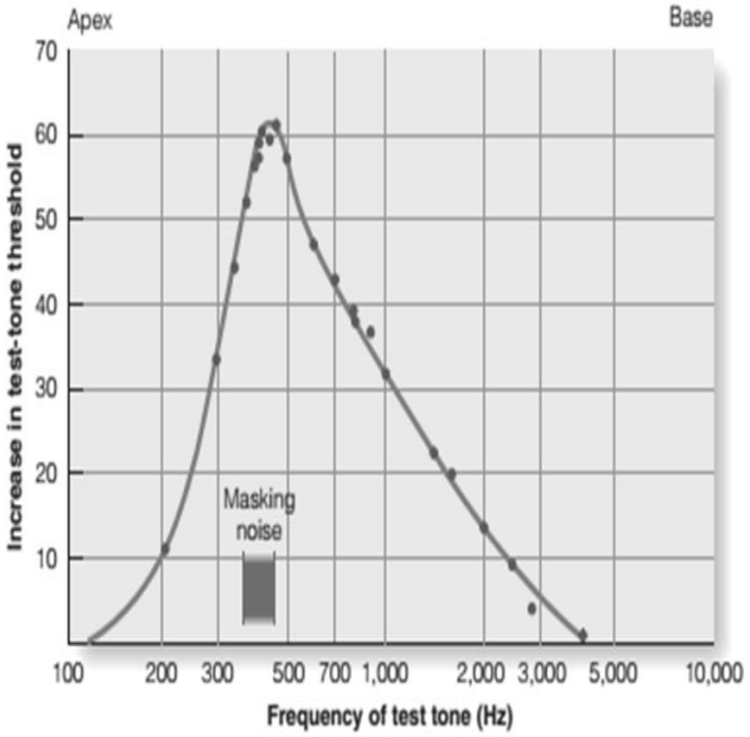


(b) Remeasure thresholds with the masking tone present

Auditory Threshold



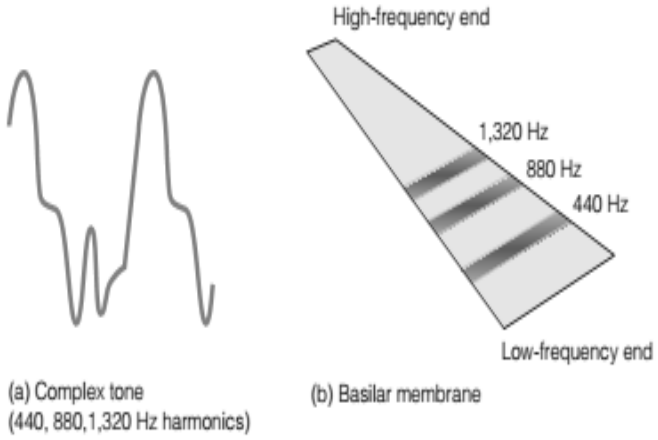
- Hearing occurs in the light green area between the audibility curve (the threshold for hearing) and the upper curve (the threshold for feeling).
- Tones with combinations of dB and frequency in the light red area below the audibility curve cannot be heard.
- Tones above the threshold of feeling result in pain.
- Where the dashed line at 10 dB traverses the auditory response area indicates which frequencies can be heard at 10 dB SPL.



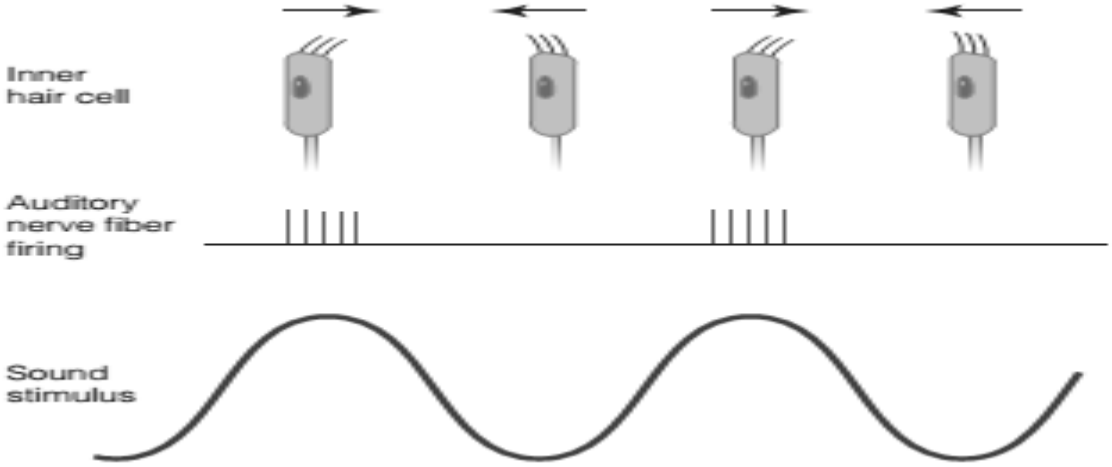
The threshold increases the most near the frequencies of the masking noise, and the masking effect spreads more to high frequencies than to low frequencies. (From Egan & Hake, 1950.)

Acoustic Prism

- The link between frequency and activation of specific places along the basilar membrane.
- The way the cochlea separates frequencies along its length has been described as an acoustic prism
- Just as a prism separates white light, which contains all wavelengths in the visible spectrum, into its components, the cochlea separates frequencies entering the ear into activity along different places on the basilar membrane.



(a) Waveform of a complex tone consisting of three harmonics. (b) Basilar membrane. The shaded areas indicate locations of peak vibration associated with each harmonic in the complex tone



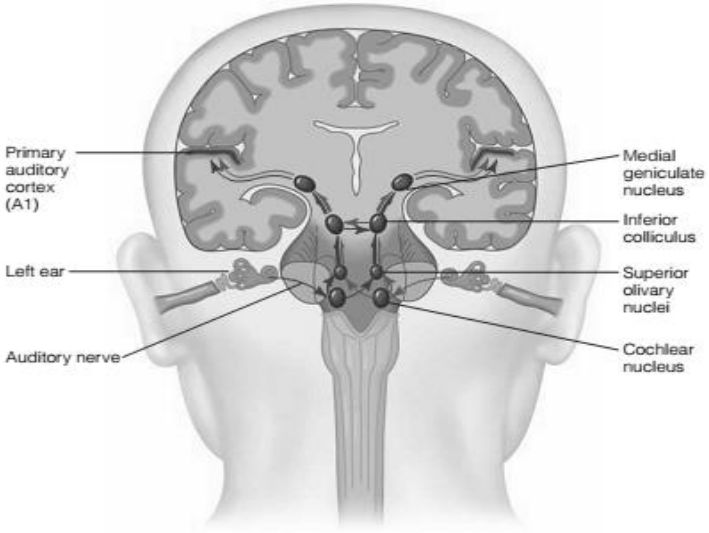
How hair cell activation and auditory nerve fiber firing are synchronized with pressure changes of the stimulus. The auditory nerve fiber fires when the cilia are bent to the right. This occurs at the peak of the sine-wave change in pressure.

- **Phase locking;** firing at the same place in the sound stimulus, fire in bursts separated by silent intervals, the timing of these bursts matches the frequency of the stimulus.
- **Temporal coding;** The connection between the frequency of a sound stimulus and the timing of the auditory nerve fiber firing
- **Measurements of the pattern of firing** indicate that phase locking occurs up to a frequency of about 4,000 Hz.

Hearing loss

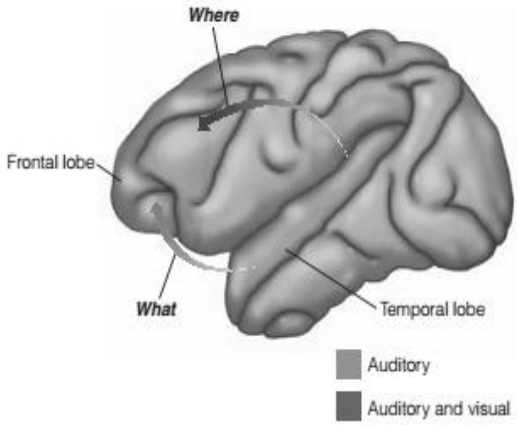
- Blockage of sound from reaching the receptors, called conductive hearing loss
- Damage to the hair cells
- Damage to the auditory nerve or the brain.
- Hearing loss due to damage to the hair cells, auditory nerve, or brain is called sensorineural hearing loss
- Cochlear transplants and new technology

Diagram of the auditory pathways



- The auditory structures are bilateral, exist on both the left and right sides of the body so messages can cross over between the two sides
- The auditory nerve carries the signals generated by the inner hair cells away from the cochlea and toward the auditory receiving area in the cortex
- Auditory nerve fibers from the cochlea synapse in a sequence of subcortical structures—structures below the cerebral cortex
- Begins with the cochlear nucleus and continues to the superior olivary nuclei in the brain stem
- Consists of a number of subdivisions that serve different functions, the inferior colliculus in the midbrain, and the medial geniculate nucleus in the thalamus.
- **SONIC MG** (a very fast sports car); the three structures between the cochlear nucleus and the auditory cortex:
  - **SON** = superior olivary nuclei
  - **IC** = inferior colliculus
  - **MG** = medial geniculate nucleus

What and Where Streams



Lecture 17

SENSE OF TOUCH

Sense of Touch

The sense of touch is also called the **cutaneous senses**. These are important for following reason;

- Sense of touch gives us information about environment
  - The perceptions we experience through our skin are crucial for carrying out everyday activities
- Protecting ourselves from injury
- Motivating sexual activity
- Providing and receiving comfort
- Maintaining temperature

Somatosensory System

(1) The **cutaneous senses**, which are responsible for perceptions such as touch and pain, caused by stimulation of the skin

(2) **Proprioception** is the ability to sense the position of the body and limbs

(3) **Kinesthesis**, the ability to sense the movement of the body and limbs.

These perceptions are crucial to our survival and to the survival of our species.

We experience pain

We can detect texture and temperature

Proprioception and Kinesis

The Skin

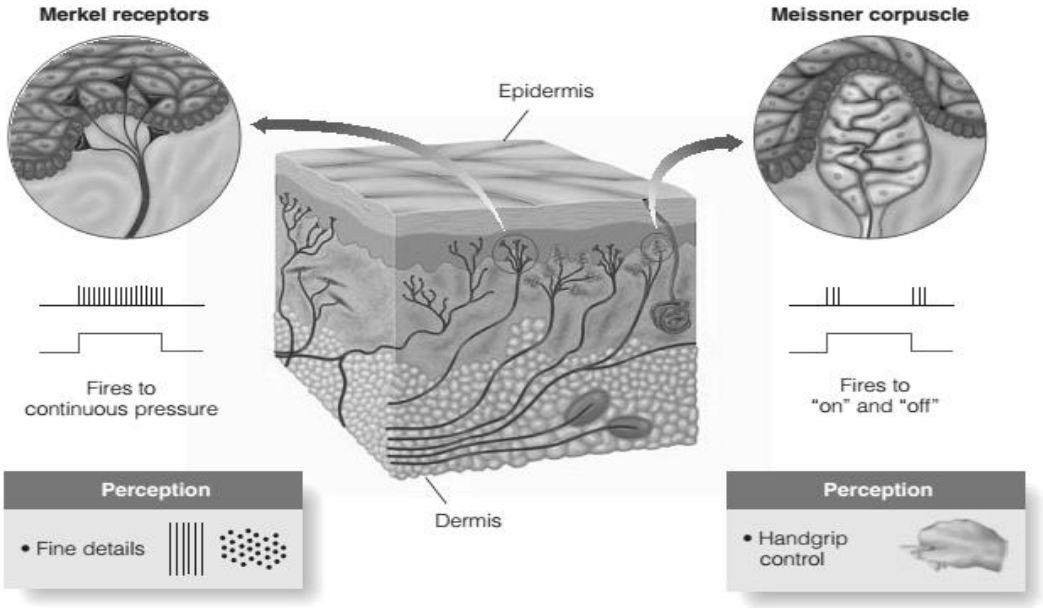
The "monumental facade of the human body", Comel (1953)

- The heaviest organ in the human body, one of the largest and most obvious
- Warning function, prevents body fluids from escaping, protects us by keeping bacteria, chemical agents, and dirt from penetrating our bodies.
- Maintains the integrity of what's inside and protects us from what's outside
- Also provides us with information about the various stimuli that contact it.

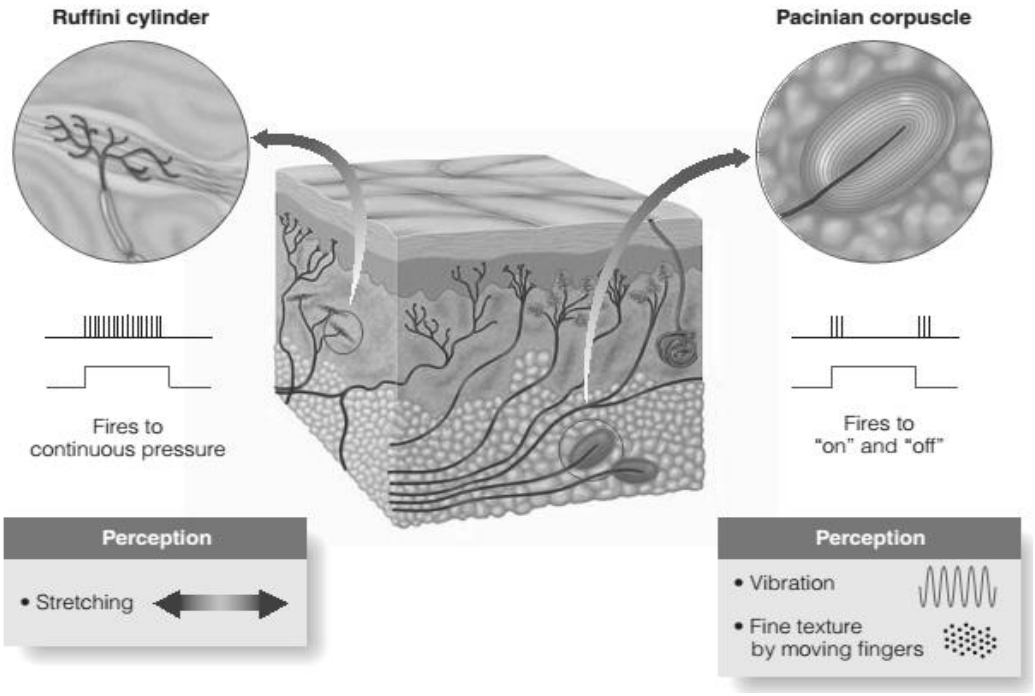
- The sun's rays heat our skin, and we feel warmth; whereas a pinprick is painful;
- When someone touches us, we experience pressure or other sensations

Structure of skin

- **Epidermis** and **Dermis** (below the epidermis); it is in these two layers that we find the mechanoreceptors, receptors that respond to mechanical stimulation such as pressure, stretching, and vibration
- **Merkel receptor** and the **Meissner corpuscle** located close to surface, i.e., epidermis
- Merkel receptor senses the fine details, whereas Meissner corpuscle controls the handgrip



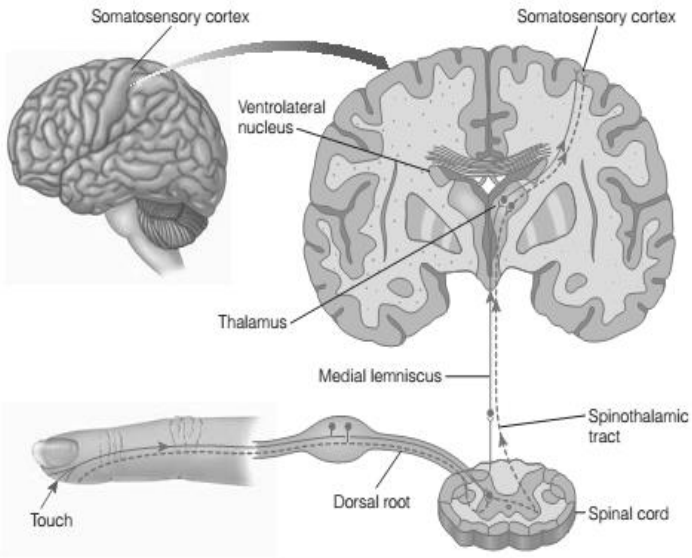
- **The Ruffini cylinder** and **Pacinian corpuscle** located deeper in the skin
- The Ruffini cylinder responds continuously to stimulation
- The Pacinian corpuscle responds when
  - the stimulus is applied and removed.
- The Ruffini cylinder, associated with perceiving stretching of the skin
- The Pacinian corpuscle with sensing rapid vibrations and fine texture



Perceiving Details

Pathways of Cutaneous Senses

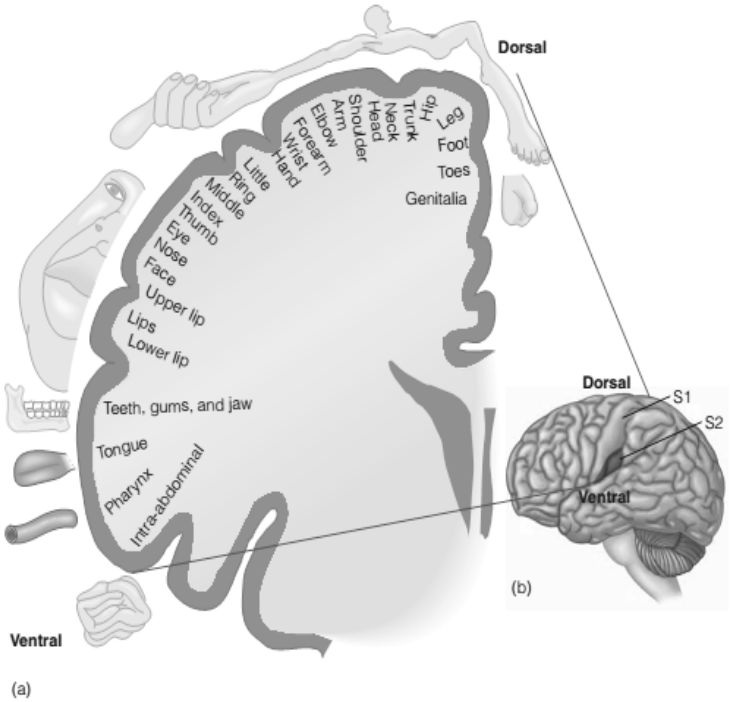
- Nerve fibers from receptors in the skin travel in bundles called **peripheral nerves** that enter the spinal cord through the dorsal root
- The nerve fibers then go up the spinal cord along two major pathways: **the medial lemniscal pathway** and **the spinothalamic pathway**



The medial lemniscus and the spinothalamic tract

These pathways synapse in the ventrolateral nucleus of the thalamus and then send fibers to the somatosensory cortex in the parietal lobe.

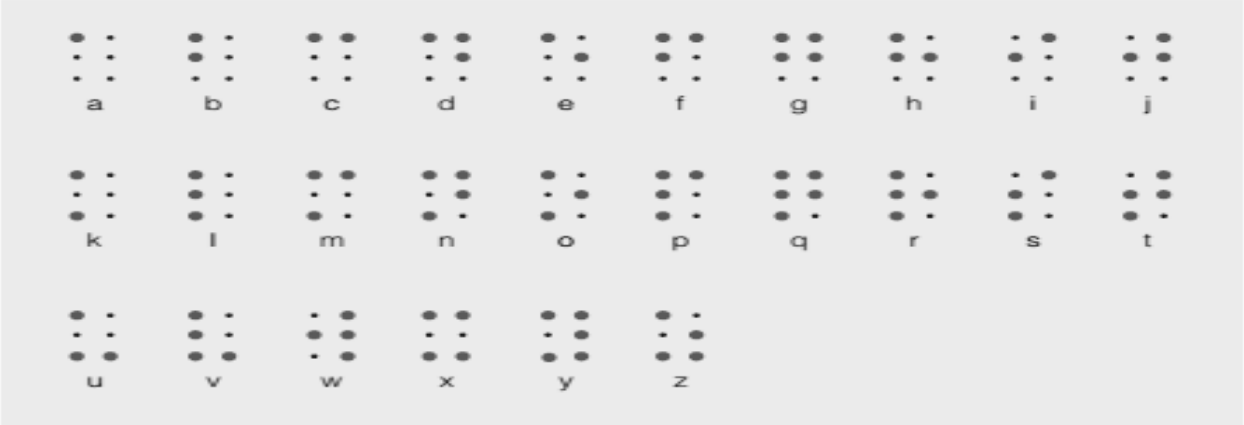
- Lemniscal pathway, large fibers carry signals related to sensing the positions of the limbs (proprioception) and perceiving touch
- The spinothalamic pathway, smaller fibers that transmit signals related to temperature and pain
- Lan Waterman lost the ability to feel touch and to sense the positions of his limbs (lemniscal pathway), but was still able to sense pain and temperature (spinothalamic pathway)

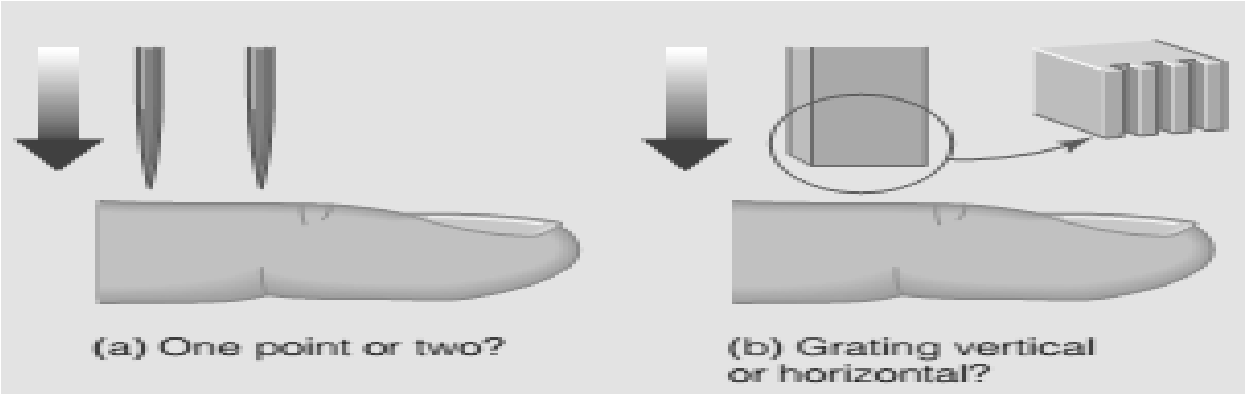


(a) The **sensory homunculus** on the somatosensory cortex. Parts of the body with the highest tactile acuity are represented by larger areas on the cortex.

(b) The **somatosensory cortex** in the parietal lobe. The primary somatosensory area, S1 receives inputs from the ventrolateral nucleus of the thalamus. The secondary somatosensory area, S2 is partially hidden behind the temporal lobe. (Adapted from Penfield & Rasmussen, 1950.

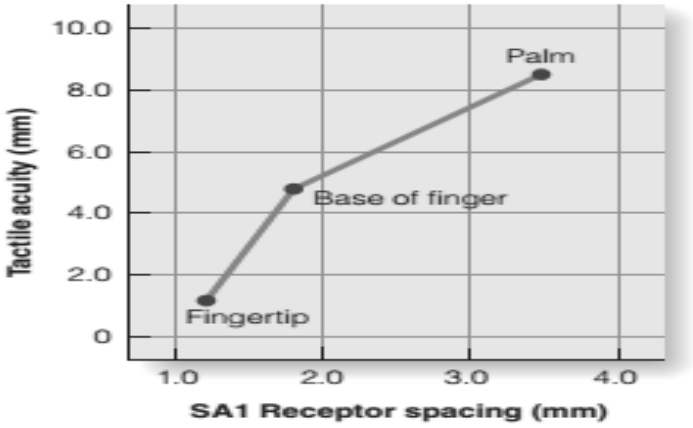
The Braille alphabet consists of raised dots in a **2 x 3 matrix**. The large dots indicate the location of the raised dot for each letter. Blind people read these dots by scanning them with their fingertips.





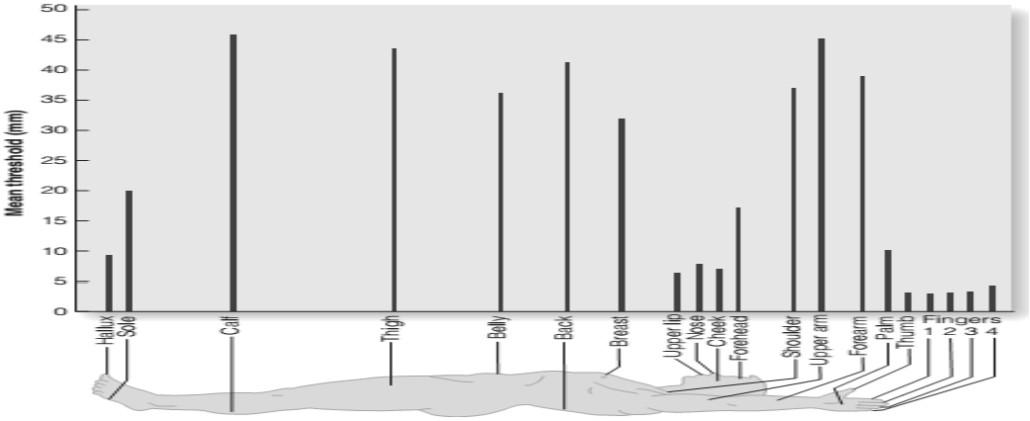
Tactile Acuity

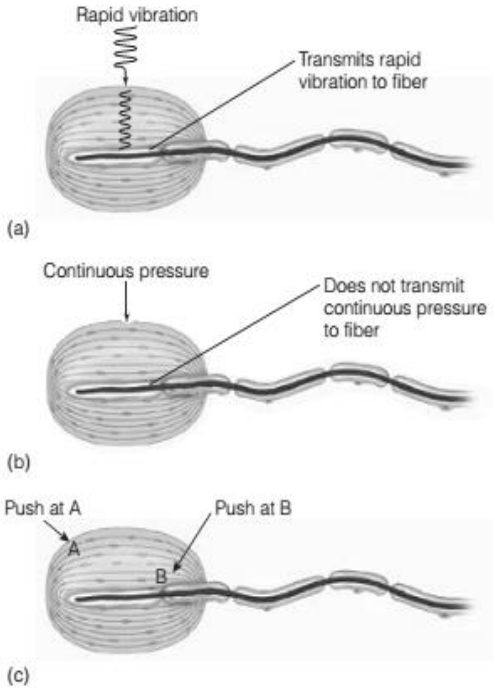
Tactile Acuity is the ability to detect details on the skin. Two-point Touch Threshold refers to detecting whether a sharp point on skin is one or two. Grating acuity refers to detecting direction of the grooves in a bar whether these are vertical or horizontal. experiments in psychophysics test these thresholds to understand under what conditions and at what distance two points can be accurately perceived.



Correlation between density of Merkel receptors and tactile acuity

Two-point threshold measured on different parts of the male body. Compare these two-point thresholds to how different parts of the body are represented in the brain, regions of high acuity, like the fingers and lips, are represented by larger areas on the cortex.





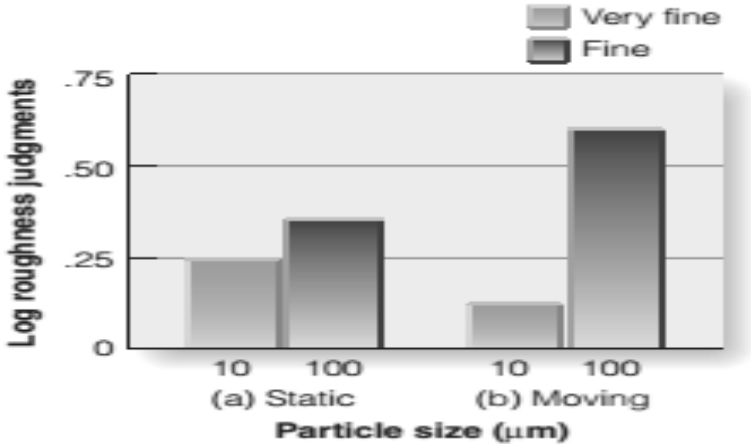
(a) When a vibrating pressure stimulus is applied to the Pacinian corpuscle, it transmits these pressure vibrations to the nerve fiber. (b) When a continuous pressure stimulus is applied to the Pacinian corpuscle, it does not transmit the continuous pressure to the fiber.

(c) Lowenstein determined how the fiber fired to stimulation of the corpuscle (at A) and to direct stimulation of the fiber (at B)

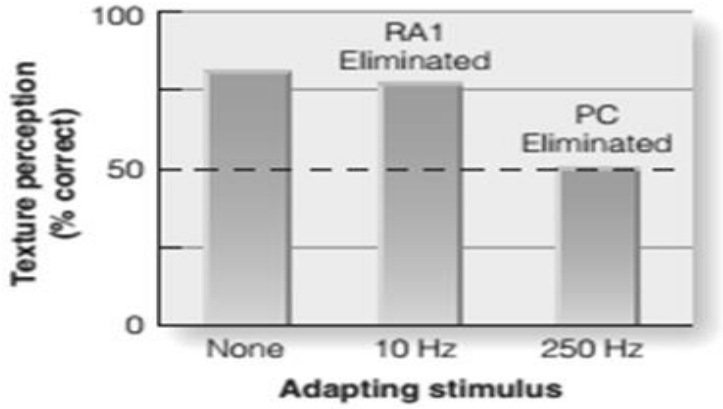
Vibration plays the role in perceiving details of tactile stimulation and vibration is based on physiological activity. Pacinian corpuscle (PC), fibers respond poorly to slow or constant pushing, but respond well to high rates of vibration. It is made of layers. Texture and its details like roughness and smoothness are also perceived this way.

Spatial Cues mean relatively large surface elements, such as bumps and grooves. **Temporal Cues** means vibration by skin moving on a surface (Katz, 1925).

Physiology of Tactile Perception



(a) Participants perceived the roughness of two fine surfaces to be essentially the same when felt with stationary fingers (b) could perceive the difference between the two surfaces when they were allowed to move their fingers. Hollins and Reisner (2000).



Eliminating the action of fibers associated with the Meissner corpuscle by adaptation to a 10-Hz vibration had no effect on perception of a fine texture, but eliminating the action of the Pacinian corpuscle by adapting to a 250-Hz vibration eliminated the ability to sense the fine textures.

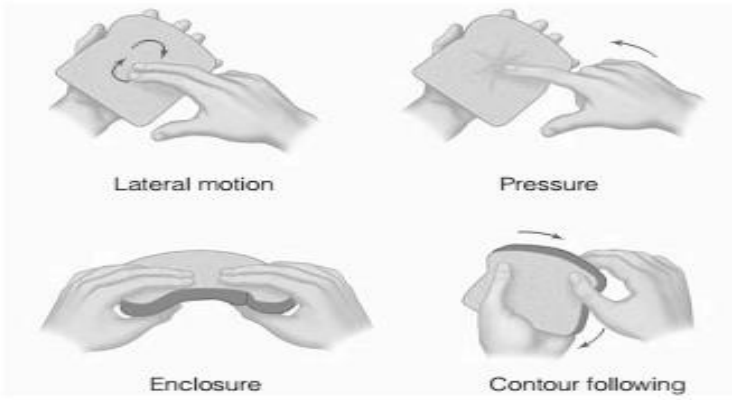
- **Active touch**—touch in which a person actively explores an object, usually with fingers and hands.
- **Passive touch**, occurs when touch stimuli are applied to the skin
- **Haptic perception**— in which three-dimensional objects are explored with the hand

Haptic perception highly complex. It involves

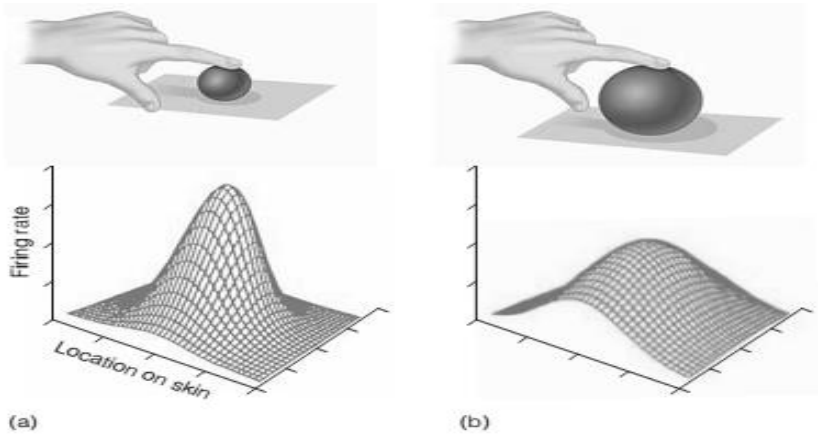
(1) the sensory system, involved in detecting cutaneous sensations such as touch, temperature, and texture and the movements and positions of fingers and hands

(2) the motor system, involved in moving fingers and hands

(3) the cognitive system, which was involved in thinking about the information provided by the sensory and motor systems.



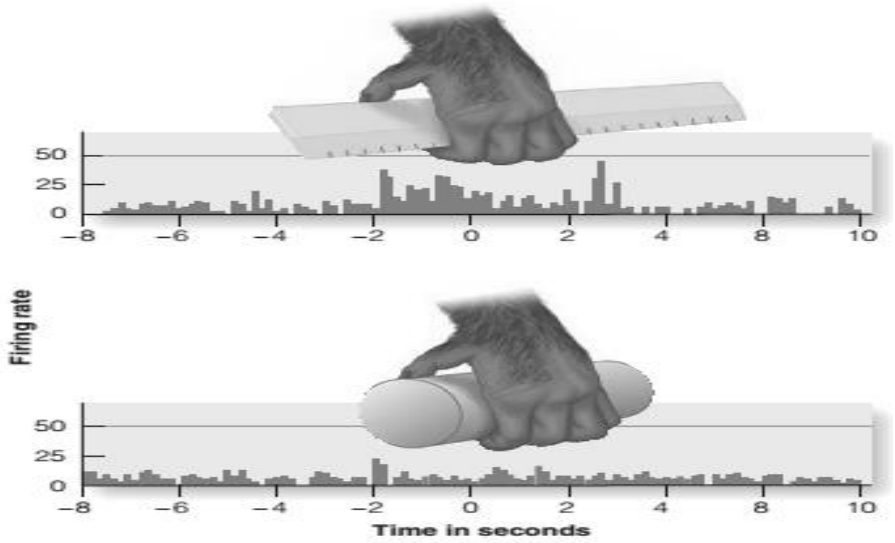
Some of the exploratory procedures (EPs) observed by Lederman and Klatzky as participants identified objects.



(a) Response of fibers in the fingertips to touching a high-curvature stimulus. The height of the profile indicates the firing rate at different places across the fingertip. (b) The profile of firing

to touching a stimulus with more gentle curvature. Some neurons in cortex with center surround receptive fields and others that respond to more specialized stimulation of the skin.

- Some neurons in cortex with center surround receptive fields and others that respond to more specialized stimulation of the skin.
- Attention and Cortical Neurons stimulation of the receptors may trigger a response, but the size of the response can then be affected by processes such as attention, thinking, and other actions of the perceiver.



The response of a neuron in a monkey's parietal cortex that fires when the monkey grasps a ruler but that does not fire when the monkey grasps a cylinder.

Lecture 18

SENSE OF SMELL

Sense of smell; Neural code, Higher Order Processing

Functions of Olfaction

- Olfactory sense is crucial for many species' survival
- Olfaction takes place when chemical molecules are assimilated in body.
- Gate keepers; detect good odors that need to be consumed and detect things that are bad for body.
- Pleasant and unpleasant smells have associations and memories

Neurogenesis Sense receptors for taste and smell are exposed to harmful materials such as bacteria and dirt. These receptors go through process of birth, development and death. Other receptors for vision and hearing and skin are protected. Receptors for smell and taste need to be renewed.

Human Pheromones

Chemical signals released by an individual that affect the physiology and behavior of other individuals is known as pheromones. Menstrual synchrony is experienced by women who live or work together often have menstrual periods at about the same time.

There is role of fragrance and scents in daily life, in feeling pleasant, neat, attractive and well. It also has a role in special occasions such as devotional occasions, weddings and death rituals. Sense of smell is not necessary for survival, but enhances life and protects from dangerous consumption.

Human Odor Detection Thresholds

COMPOUND	ODOR THRESHOLD IN AIR (PARTS PER BILLION)
Methanol	141,000
Acetone	15,000
Formaldehyde	870
Menthol	40
T-butyl mercaptan	0.3

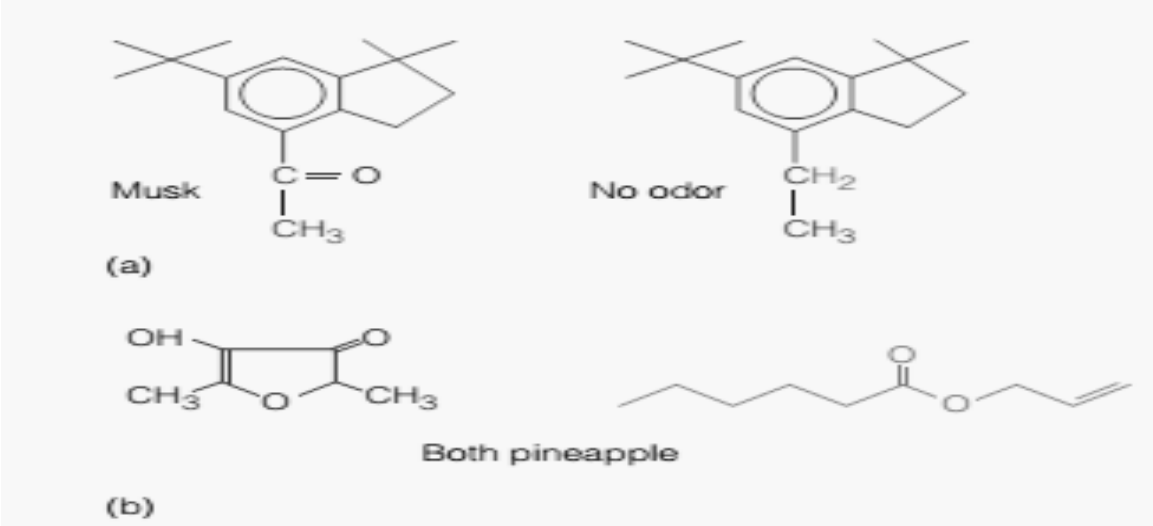
Source: Devos et al., 1990.

Rats are 8 to 50 times more sensitive to odors than humans, and dogs are from 300 to 10,000 times more sensitive, depending on the odorant (Laing, Doty, & Breipohl, 1991). Human olfactory receptors can be excited by the action of just 1 molecule of odorant. Humans have far fewer receptors than dogs—only about 10 million receptors, compared to one Billion for dogs.

Identifying Odors

- Humans can discriminate between as many as 100,000 different odors (Firestein, 2001)

- Knowing the correct label for the odor actually seems to transform our perception into that odor
- Detecting absolute and difference thresholds for smell
- Forced choice Method
- Anosmia, the loss of the ability to smell as a result of injury or infection



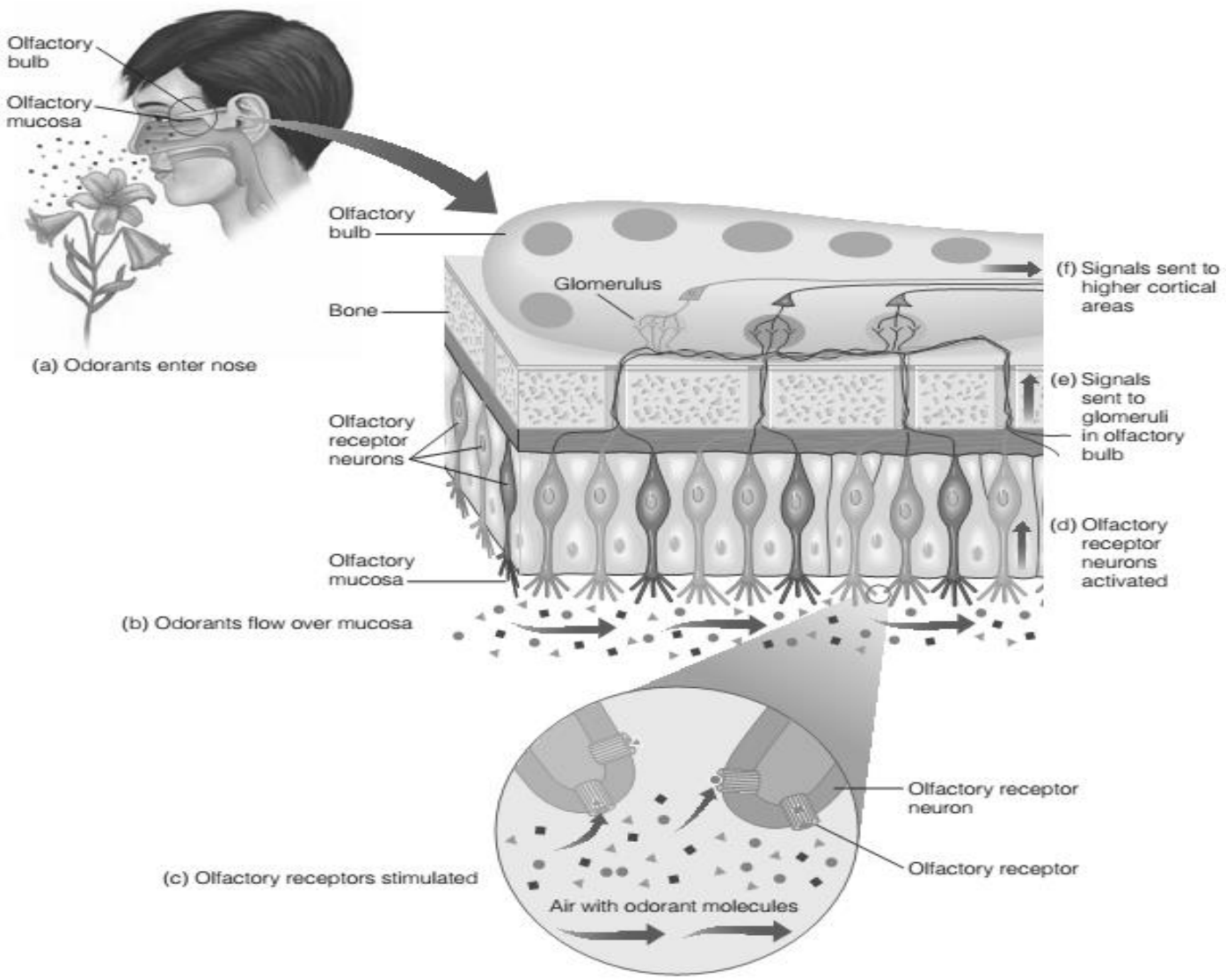
(a) Two molecules that have the same structures, but one smells like musk and the other is odorless.
(b) Two molecules with different structures but similar odors.

Neural Code for Olfactory System

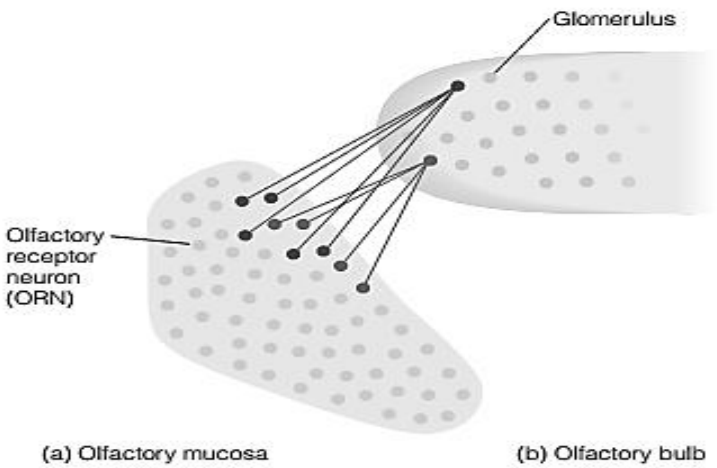
The Olfactory Mucosa

- The mucosa is a dime-sized region located high in the nasal cavity that contains the receptors for olfaction on the roof of the nasal cavity and just below the olfactory bulb.
- **Odorant molecules** are carried into the nose in an air stream, which brings these molecules into contact with the mucosa.
- **Olfactory receptor neurons** (ORNs) are located in the mucosa and the supporting cells.

The structure of the olfactory system



- Odorant molecules flow over the olfactory mucosa, which contains 350 different types of olfactory receptor neurons (ORNs).
- Three types of ORNs are shown here, indicated by different colors. Each type has its own specialized receptor.
- Like rods and cones, ORNs are proteins that cross the membrane of receptor neuron
- Linda Buck and Richard Axel (1991), received the 2004 Nobel Prize in Physiology and Medicine for their research on the olfactory system.
- Activation of receptors in the mucosa causes electrical signals in the ORNs that are distributed across the mucosa. These ORNs send signals to structures called glomeruli in the olfactory bulb.



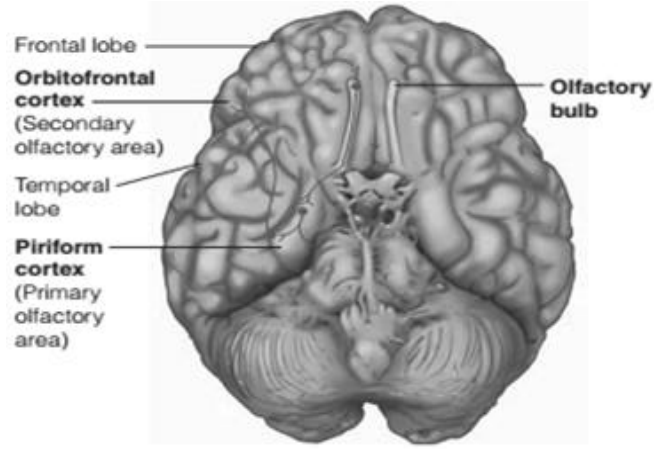
(a) A portion of the olfactory mucosa, 350 types of ORNs and about 10,000 of each type. The red circles = 10,000 of one type of ORN, the blue circles = 10,000 of another type. (b) All ORNs of a particular type send their signals to one or two glomeruli in the olfactory bulb.

Techniques for studying olfactory process

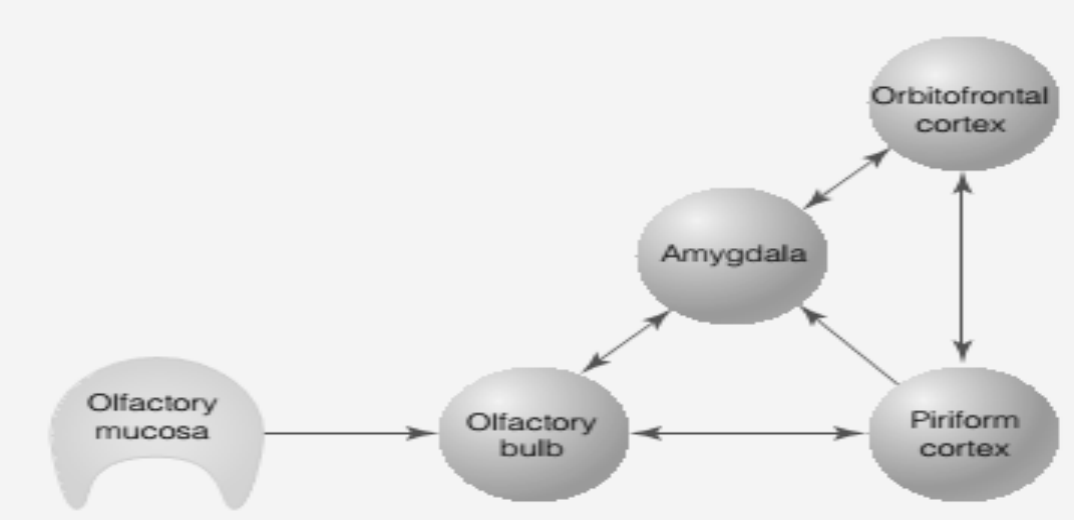
- Calcium Imaging; concentration of calcium ions (Ca++) increases inside the ORN when receptor responds soaking olfactory neurons in a chemical, ORN to fluoresce green glow when exposed to ultraviolet (380 nm)Light.
- Optical imaging used to measure the activity of large areas of the olfactory bulb by measuring how much red light reflected.

Higher Order Olfactory Processing

Mode of olfactory perception that relies on processes beyond the pattern of firing in olfactory receptors, involves the cortex, responses to more complicated odorants than hardwired responses, always the same for a given chemical. For example in kitchen, many smells are experienced at Iftar time. Aroma is created by more than 100 different molecules.



The underside of the brain, showing the neural pathways for olfaction. On the left side, the temporal lobe has been deflected to expose the olfactory cortex. (Adapted from Frank & Rabin, 1989.)

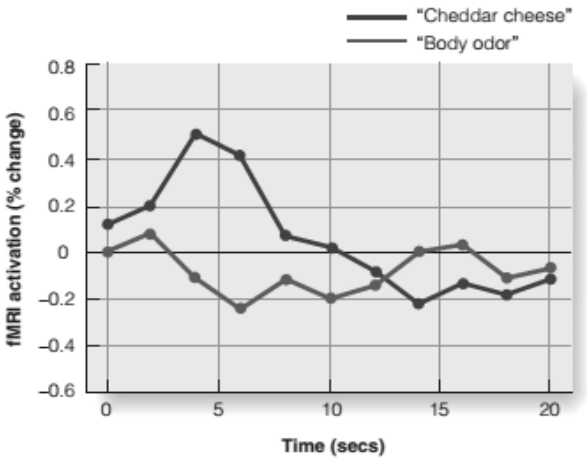


Flow diagram of the pathways for olfaction

- When an onion smell is labeled "pizza," people perceive it more positively than if it is labeled "body odor" (Herz, 2003).
- adding red coloring to white wine causes wine tasters to describe the aroma of the white wine in terms usually associated with red wine (Morrot et al., 2001)
- Learning can also influence odor perception, odors that have been paired with sucrose are judged to smell sweeter when they are later presented alone (Stevenson, 200)

Many molecules creating a single perception like "coffee" or " kebabs". We have the ability to separate odors from one another in the environment. The effect of past experience and learning on odor perception indicate that odor perception must involve more than just a hardwired "readout" of the pattern of ORN firing. Individual compounds cause widespread activity across the piriform Cortex. The neurons in the piriform cortex can learn to discriminate between different odors. This learning may be involved in our ability to tell the difference between different odors in the environment. Neurons in the piriform cortex do not, therefore, always respond in exactly the same way to a particular odorant, but can change their response

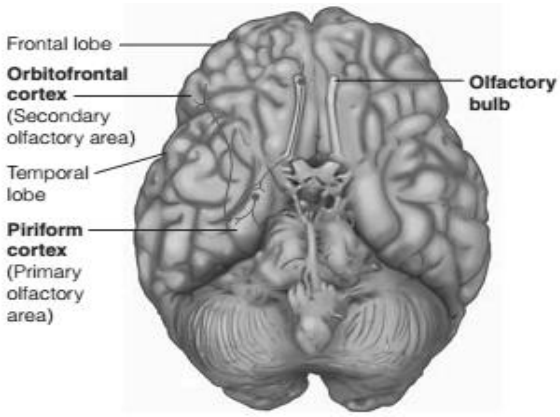
In an experiment a test odor was presented, which was a mixture of isovaleric acid (which smells like sweat) and cheddar cheese flavoring. As participants smelled the test odour they saw the words "cheddar cheese" on some trials and "body odor" on other trials. When asked to rate the pleasantness of the odors, participants rated the test odour as more pleasant when it was labeled "cheddar cheese" than when it was labeled "body odour." Ivan de Araujo and coworkers (2005). Differences in pleasantness ratings were associated with differences in activity in the orbitofrontal cortex, measured by fMRI, with higher pleasantness ratings being associated with more activity in the orbitofrontal cortex. Different labels caused the same chemical (the test odor) to result in different perceptions of pleasantness, and these different perceptions were reflected in the activity in the orbitofrontal cortex.

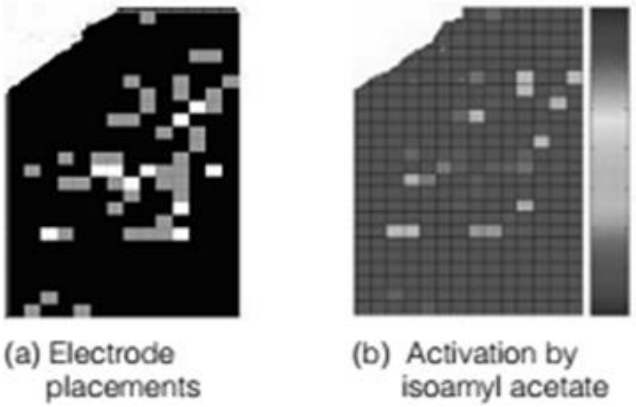


Pattern of ORNs activated by the test odor is the same no matter what the label, the differences caused by the label must be a higher order "cognitive" effect. The results of experiments on both the piriform and orbitofrontal cortex, therefore, show that to fully understand olfaction, we need to look beyond the pattern of activation of olfactory receptor neurons.

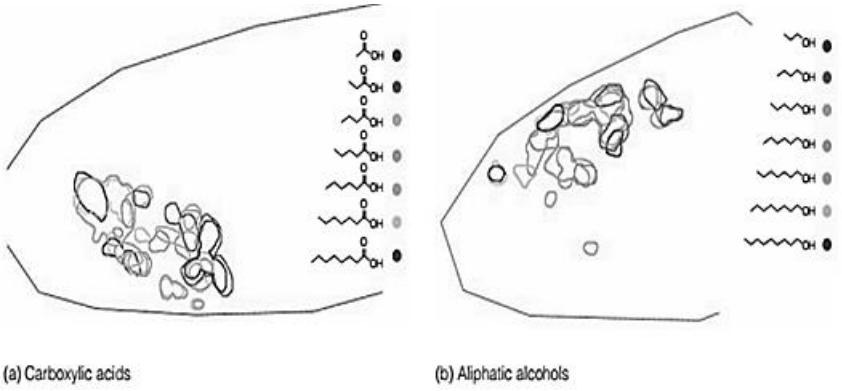
Higher order olfactory processing

- We can differentiate between many different smells in environment for example aromas from kitchen
- Olfactory stimulus activate many areas in brain
- People's past experiences or expectations can influence their perception
- Research on the physiology of higher-order processes has focused on the piriform cortex and the orbitofrontal cortex





Piriform cortex of rat; Isoamyl acetate causes activation across the cortex. Other compounds also cause widespread activity, and there is substantial overlap between the patterns of activity for different compounds (Rennaker and coworkers (2007). In the mucosa and olfactory bulb activity is more localized and doesn't overlap as much for different compounds. This overlapping activity may mean that the piriform cortex is involved in the process of perceiving complex Odours such as "coffee" or "french fries" created from the overlapping activity of many different odorant molecules (Wilson & Stevenson, 2006).



Areas in the olfactory bulb that are activated by various chemicals: (a) a series of carbolic acids; (b) a series of aliphatic alcohols (Uchida, Talahashi, Tanifuji ., & Mori, 2000)

Higher Human consciousness

Human connections persist. Infants sense mothers smell before they recognize faces. Pets can recognize their masters from their smell. People who leave for other world are remembered by the way they smelled.

Perfume and intimacy are closely linked. And Scent has been seen as erotic as well as sacred for centuries in all cultures.

Lecture 19

SYSTEM OF TASTE; FUNCTIONS AND QUALITIES

System of Taste; Functions and qualities

Taste detects molecules that enter the mouth in solid or liquid form, susually as components of the foods we eat. Olfactory and taste senses are closely linked. They serve a gate keeper's function as we use taste to choose which foods to choose and which to avoid.

Taste Quality and Effect

Sweetness is associated with compounds with nutritive or caloric value; Important for sustaining life. Sweet compounds cause an automatic acceptance response, an anticipatory metabolic response that prepares gastrointestinal system for processing.

Salty tastes

Means presence of sodium. People deprived of sodium seek out salty foods to replenish the salt their body needs.

Bitter compounds trigger automatic rejection responses to help the organism avoid harmful substances. Bitter harmful substances; poisons strychnine, arsenic, and cyanide.

Taste is not perfect

Not all bitter foods dangerous; Some have metabolic value. We can modify our responses

By developing a taste for bitter but nutritious food.

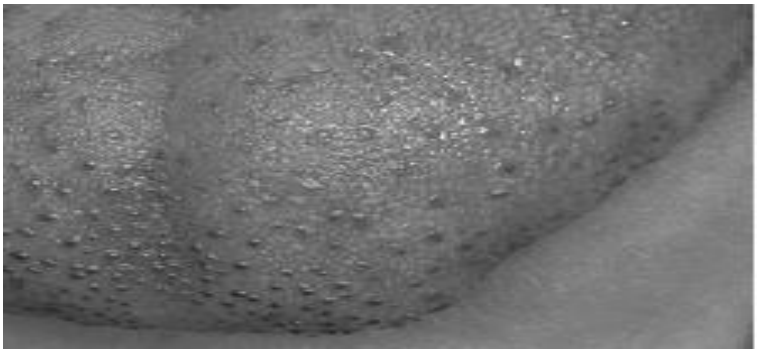
Basic Taste Qualities

Salty, sour, sweet, bitter; early research found four basic tastes. Later studies added fifth basic taste **umami** described as meaty, brothy, or savory. Some substances have a predominant taste; other substances result in combinations of the four tastes. Sodium chloride (salty), hydrochloric acid (sour), sucrose (sweet), and quinine (bitter).

Structure of Taste System

Organ of Taste; The Tongue

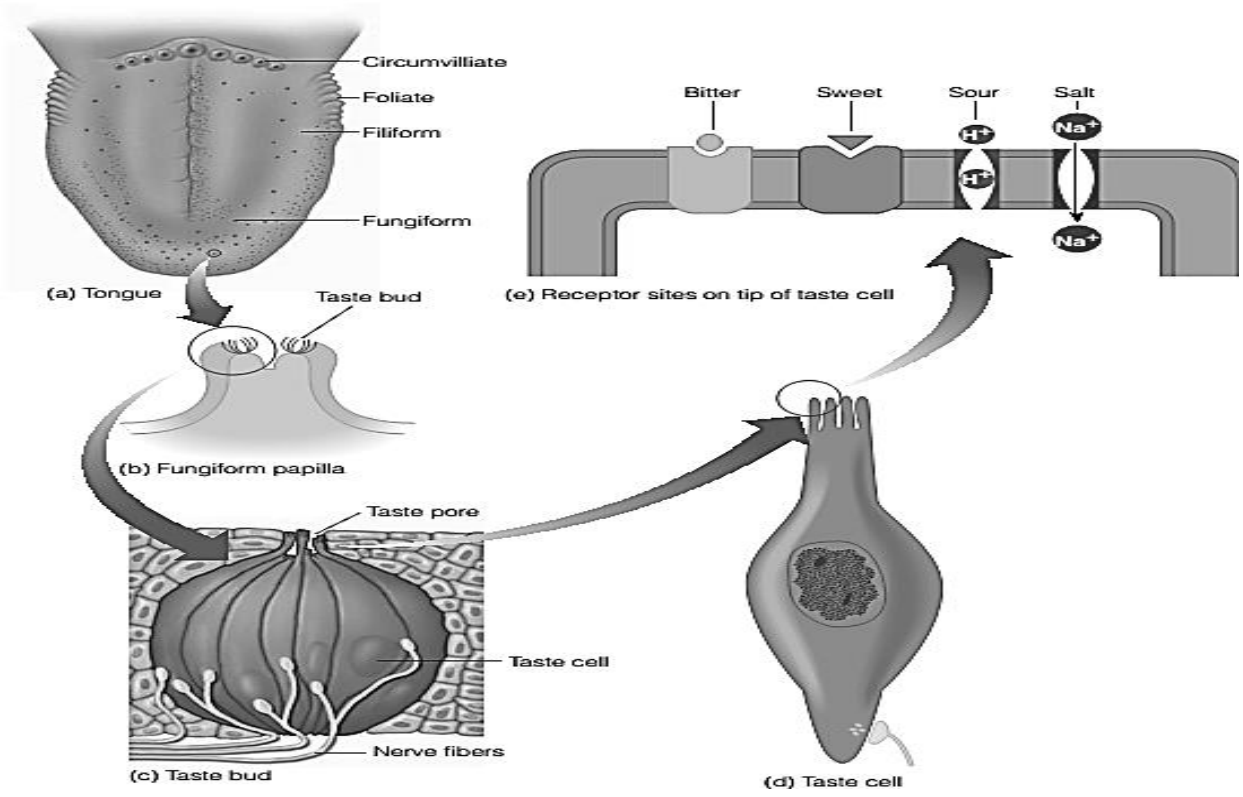
Receptors are stimulated by taste stimuli. Ridges and valleys on surface of the tongue are structures called **papillae**.



The surface of the tongue

The red dots are **fungiform papillae**. (Shahbake, M.,Anatomical and psychophysical aspects of the development of the sense of taste in humans, PhD thesis, 2008, University of Western Sydney, pp. 148–153).

1. **Filiform papillae**, shaped like cones found over the entire tongue surface of the tongue, rough appearance.
2. **Fungiform papillae** shaped like mushrooms, found at the tip and sides of the tongue
3. **Foliate papillae**, series of folds along the back of the tongue on the sides
4. **Circumvilliate papillae**, flat mounds surrounded by a trench, found at the back of the tongue

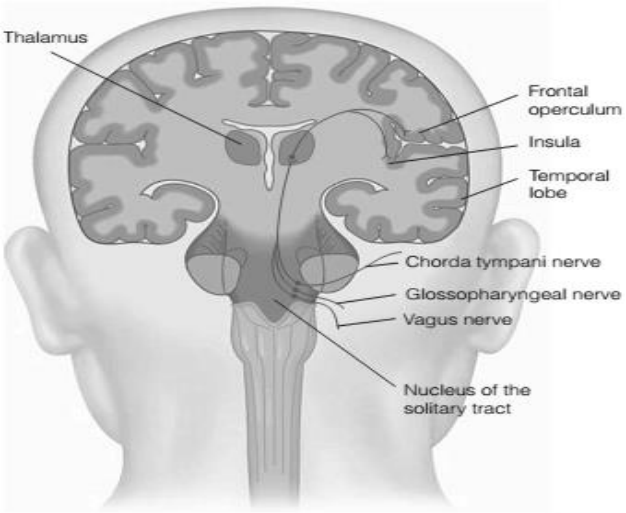


(a) The tongue (b) A fungiform papilla on the tongue; each papilla contains a number of taste buds. (c) Cross section of a taste bud showing the taste pore where the taste stimulus enters. (d) The taste cell; the tip of the taste cell is positioned just under the pore. (e) Close-up of the membrane at the tip of the taste cell, showing the receptor sites for bitter, sour, salty, and sweet substances.

Structure	Description
Tongue	The receptor sheet for taste. Contains papillae and all of the other structures
Papillae	There are four kinds, each with a different shape
Taste buds	Contained on the papillae. There are about 10,000 taste buds
Taste cells	Cells that make up a taste bud. There are a number of cells for each bud, and the tip of each one sticks out into a taste pore. One or more nerve fibers are associated with each cell
Receptor sites	Sites located on the tips of the taste cells. There are different types of sites for different chemicals. Chemicals contacting the sites cause transduction by affecting ion flow across the membrane of the taste cell

Each taste bud contains 50–100 taste cells, which have tips that protrude into the taste pore. Transduction occurs when chemicals contact receptor sites located on the tips of taste cells. Electrical signals generated in the taste cells are transmitted from the tongue in a number of different nerves.

1. The **chorda tympani nerve** (from taste cells on the front and sides of the tongue)
2. The **glossopharyngeal nerve** (from the back of the tongue)
3. The **vagus nerve**, from the mouth and throat)
4. The **superficial petronasal nerve** (from the soft palette—the top of the mouth)

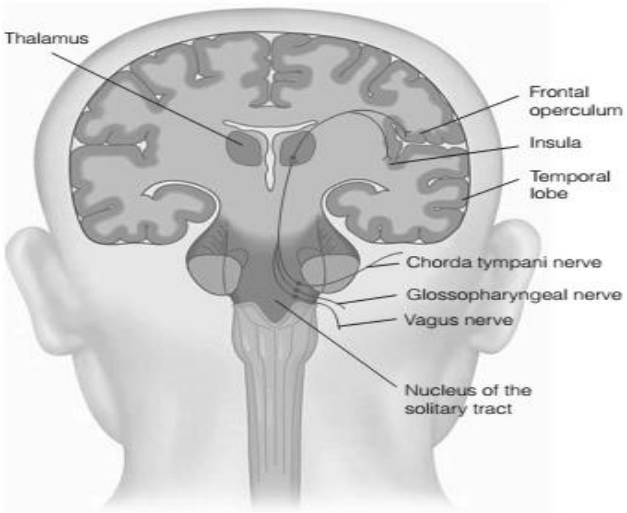


The central pathway for taste signals, showing the nucleus of the solitary tract (NST), where nerve fibers from the tongue and the mouth synapse in the medulla at the base of the brain. From the NST, these fibers synapse in the thalamus and the frontal lobe of the brain.

Neural Coding for And Physiology of Flavour Perception

Pathway for Taste

The fibers from the tongue, mouth, and throat make connections in the brain stem in the nucleus of the solitary tract. The N signals travel to the thalamus and then to two areas in the frontal lobe—the insula and the frontal operculum cortex—that are partially hidden behind the temporal lobe. Fibers serving the taste system also reach the orbitofrontal cortex (OFC), which also receives olfactory signals.



- **Specificity Coding**; the idea that quality is signaled by the activity in neurons that are tuned to respond to specific qualities.
- **Distributed Coding**; quality is signaled by the pattern of activity distributed across many neurons.

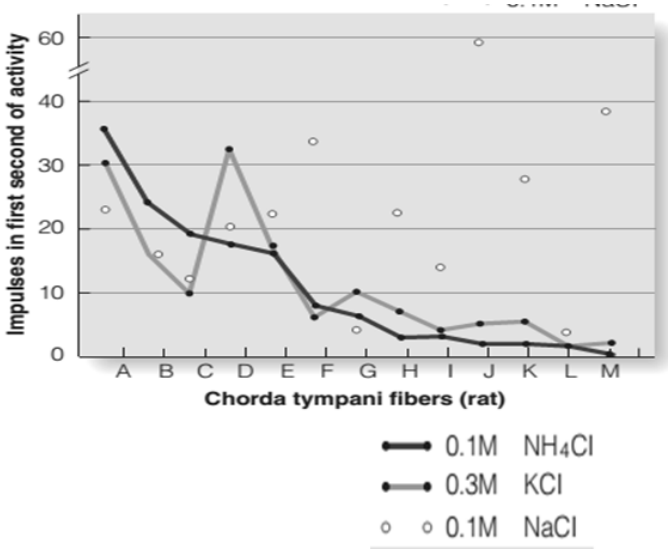
Which type of coding for taste*; it is not clear!*

Evidence for Distributed Coding

Experiments on rats by Robert Erickson (1963), presenting taste stimuli to rats tongue and recording response of chorda tympani nerve across-fiber patterns; 13 fibers responded to chloride solution, potassium, sodium and ammonium.

Across-fiber patterns of the response of fibers in the rat's chorda tympani nerve to three salts. Each letter on the horizontal axis indicates a different single fiber.

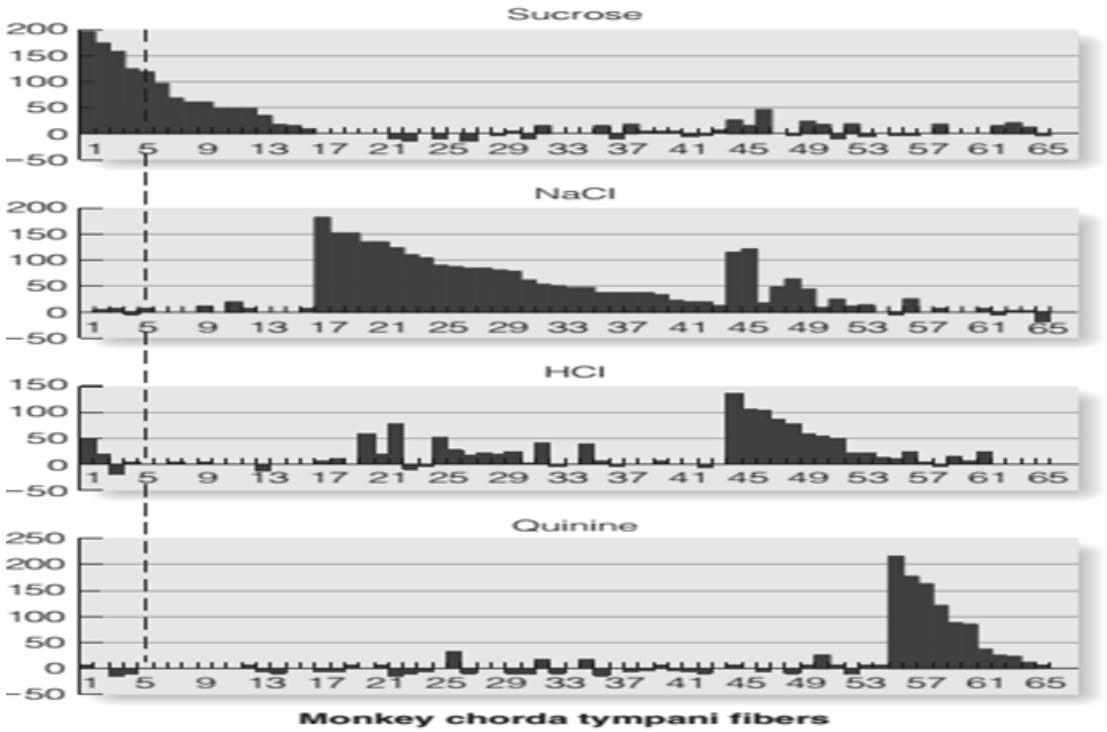
1) Ammonium chloride (NH4 Cl)
2) Potassium chloride (kcl)
3) Sodium chloride (nacl)



Experiments on human subjects also support distributed coding. Solutions judged more similar psychophysically had similar patterns of firing, as distributed coding would predict.

Specificity Coding

Research focused on the taste receptors and recording neural activity early in the taste system. Genetic cloning in rats; adding receptors for PTC bitter taste that rats lack, start avoiding PTC, cyclohexamide (Cyx) experiments , behavioural avoidance as well as lack of firing in nerves



Good evidence for specific taste receptors. However distributed coding is involved in determining taste as well, especially at higher levels of the system. Basic taste qualities could be determined by a specific code. Distributed coding could determine subtle differences between tastes within a category.

Perception of Flavour

"No single flavor ever dominates a dish. At first you find yourself searching for flavors in this complex tapestry, fascinated by the way they are woven together. In the end, you just give in and allow yourself to be seduced. Each meal is a roller coaster of sensations"

People eat out not for survival but for pleasure. Enjoyment of flavour and complexity of some aspects of perceiving flavour is based on stimulation of receptors of taste and smell plus other sensation; it is always a combination**.**

Flavor = Taste + Olfaction

Flavor is the overall impression that we experience from the combination of nasal and oral stimulation. If you taste or drink something closing your nostrils, its difficult to detect the flavour

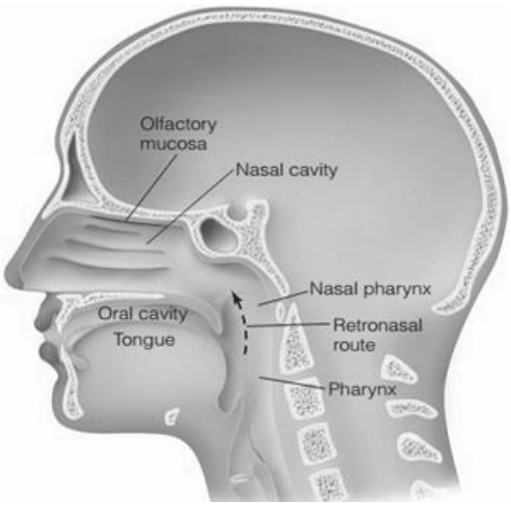
Odour stimuli from the food reach the olfactory mucosa by following the retronasal route, from the mouth through the nasal pharynx, the passage that connects the oral and nasal cavities.

Although pinching the nostrils shut does not close the nasal pharynx, it prevents vapors from reaching the olfactory receptors by eliminating the circulation of air through this channel

(Murphy & Cain, 1980)

Odorant molecules released by food in the oral cavity and pharynx can travel through the nasal pharynx (dashed arrow) to the olfactory mucosa in the nasal cavity.

This is the retronasal route to the olfactory receptors



Olfaction in Sensing Flavour

- Experiments on chemical solutions and typical foods
- Most chemicals and foods are affected if tasted with pinched nostrils
- People going through chemotherapy loose flavour
- Monosodium glutamate (MSG) has about the same flavor

Physiology of Flavour Perception

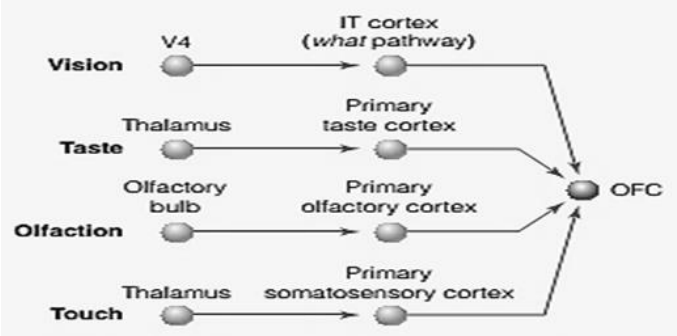
Several cortical areas that serve both taste and olfaction involved in flavour perception. Research on the cortical response to food focuses not on the primary olfactory cortex, but on the orbitofrontal cortex (OFC), because taste and smell responses are first combined here.

The OFC receives inputs

- From the primary cortical areas for taste and olfaction
- From the primary somatosensory cortex and from the inferotemporal cortex in the visual *what* pathway
- Because of this Convergence of neurons from different senses, the OFC contains many bimodal neurons, which respond to more than one sense

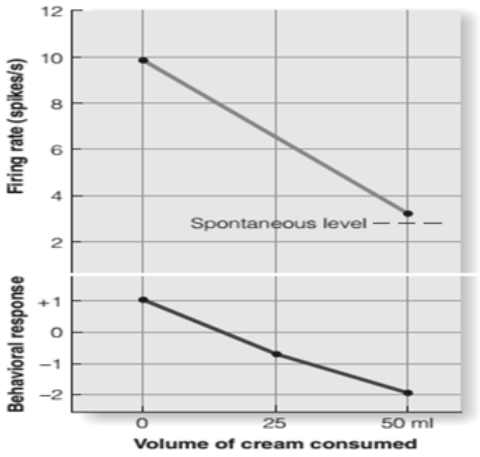
The Bimodal Neurons

- Often respond to similar qualities
- A cell that responds to the taste of sweet fruits would also respond to the smell of these fruits
- This means that neurons are tuned to respond to qualities that occur together in the environment



OFC receives inputs from vision, taste, olfaction, and touch. It is the first area where signals from the taste and smell systems meet.

- How consuming dairy cream affects the firing rate of neurons in the monkey's OFC (top panel) and the monkey's response to the cream (bottom panel).
- Consuming the cream causes a decrease in the neuron's response to the cream, but not to other substances (not shown).
- It also causes the monkey to become less interested in drinking the cream, and eventually to actively reject it.
- The Neurons in the primary taste area not affected by hunger
- The firing of neurons in the OFC reflects the extent to which an animal will consume a particular food



- The responses of neurons in the OFC are essentially reflecting the pleasantness of flavors, and in doing so, help control food intake

Aur Naheen Khana !!!!!

Individual Differences in Taste

Individuals Differences exist in various types of taste; For example

- Taste in… food, clothes, décor, friends
- Preference for flavours
- Preference for spicy or mild Food
- Preference for regional cuisine, Chinese, Desi, Italian
- Preference for basic tastes; sweet, salty and sour

People may also **differ in their thresholds** for tolerance of spicy or tangy food items and culture plays a role in such taste adaptations. Cuisine of a certain region or culture may be unfamiliar in taste to people of other cultures at first but we can adapt to new tastes as we get used to them over time.

Research has also identified **genetic differences** in taste along following dimensions;

- Differences in tasting the bitterness of Phenylthiocarbamide (PTC) discovered accidentally by Arthur L. Fox in 1932. He dispensed PTC crystals to 2,500 of the conference attendees. 28 percent of them described it as tasteless, 66 percent as bitter, and 6 percent as having some other taste
- There is difference between tasters and non-tasters. The tasters are those professional people who are experts in tasting flavours and judging them for various characteristics like how old a wine is, or how pure a tea is.
- Recent experiments with a substance called 6-n-propylthiouracil, or PROP, which has properties similar to those of PTC (Lawless, 1980, 2001) provide evidence for causes of these differences. The findings suggest that people have different number of taste buds. Video microscopy was conducted to count the taste buds. Researchers also suspect that it is not only receptor density but that PROP and PTC tasters have specialized receptors that are absent in non-tasters.

Preference and Experience

There is a great deal of variability in taste experience across different people. Preference means that you like sweet things more than your sister does but a difference in taste experience means that you experience more intense sweet tastes than your sister does.

The photos above show two deserts or sweet dishes , pudding and kheer, and two savoury dishes, Naan and Lasagne. As you can see these are from different cultural regions. you can feel your self remembering the taste of dishes you are familiar with. you may have tasted all of them and liked the Lasagne that is an Italian dish and pudding that is European. This is called acquired taste. Some people may prefer the Naan to a foreign dish or some like me may like a foreign dish more than our local Naan. preference also may vary according to mood of person. These are all good ideas for experiments on taste.

There are also some more points to remember about social aspects of taste. Culturally acquired tastes

- Preferences may change when exposed to new flavours
- We also choose food sometimes that our body needs even if does not taste very delicious.
- Children show their own preferences and sometimes forced choice of food is not a good idea.
- Special Diets like sugar free, vegan, wheat free or Keto diet that excludes wheat, rice, sugar and fried items needs a great degree of self-discipline
- Associations with some food items can be both good and bad as food can be strongly linked to memory
- Experiments have shown that playing loud music makes people eat more quickly and classical music in pubs or clubs means people will spend more money on wine

Lecture 20

LEARNING: CLASSICAL CONDITIONING

Introduction to Learning

- Learning is a process based on experience that results in a relatively consistent change in behavior or behavior potential
- Learning can take place only through experience.
- Experience includes taking in information (and evaluating and transforming it) and making responses that affect the environment
- Learning consists of a response influenced by the lessons of memory
- Not physical maturation or brain development as the organism ages
- Nor those caused by illness or brain damage
- For example an infant is ready to crawl, stand, walk, run, and be toilet trained at a certain age
- No amount of training or practice will produce those behaviors before the child has matured sufficiently

A Change in Behavior or Behavior Potential

- Learning cannot be directly measured
- Is demonstrated through memory
- Sometimes we acquire general attitudes
- An appreciation of classical music or an understanding of Spirituality or environment
- May not be apparent in measurable actions
- Potential for behaviour change
- Have learned attitudes and values that can influence the kinds of books we read, way we spend our time, or activities and choices we make
- Examples; save water wastage, Zikr and recite Quran more, not do backbiting, listen to certain singers
- The learning-performance distinction—the difference between what has been learned and what is expressed, or performed, in overt behavior

A Relatively Consistent Change

- Consistent over time

- May forget but most or some of that learning remains
- Some skills like swimming become permanent even if we don't practice
- Some need practice to remain at a certain level

Learning and Habituation

- A decrease in behavioral response when a stimulus is presented repeatedly
- For example a novel scene or thrilling drama ; emotional response decreases after first viewing
- Habituation helps keep your focus on novel events in the environment
- You don't expend behavioral effort to respond repeatedly to old stimuli

Habituation is not Learning

- There's a change in behavior (your emotional response is weaker) that is based on experience (you've seen the image repeatedly), and that behavior change is consistent (you do not return to your original level of emotional response).
- However, the change in emotional response is unlikely to be permanent

Sensitization

- When sensitization occurs, response to a stimulus becomes stronger, rather than weaker, when it occurs repeatedly e.g.; same painful stimulus several times in short succession
- Even if the intensity of the stimulus remained constant, you would report greater pain in response to the final stimulus in the series than you would in response to the first stimulus
- Even if the intensity of the stimulus remained constant, one would report greater pain in response to the final stimulus in the series than one would in response to the first stimulus
- Sensitization fits the definition of learning because experience in the world (repeated experiences of a painful stimulus) leads to a consistent change in behavioral response (reports that the pain is more intense**)**

Behaviourism

- John Watson(1878–1958), founded the school of psychology known as behaviorism
- Argued that introspection, reports of internal states or mental events too subjective

- Scientific study of observable behavior

Behavior Analysis

- B. F. Skinner(1904–1990), radical behaviourism, behaviour analyses
- Skinner's view; mental events, such as thinking and imagining, do not cause behavior
- Rather, they are examples of behavior that are caused by environmental stimuli
- A pigeon pecking at high rate result of deprivation; an environmental event, no need to infer hunger
- The area of psychology that focuses on the environmental determinants of learning and behavior
- Techniques have been developed from this approach
- Focus on observable actions
- Small behaviour units
- Applied Behaviour analyses; ABA

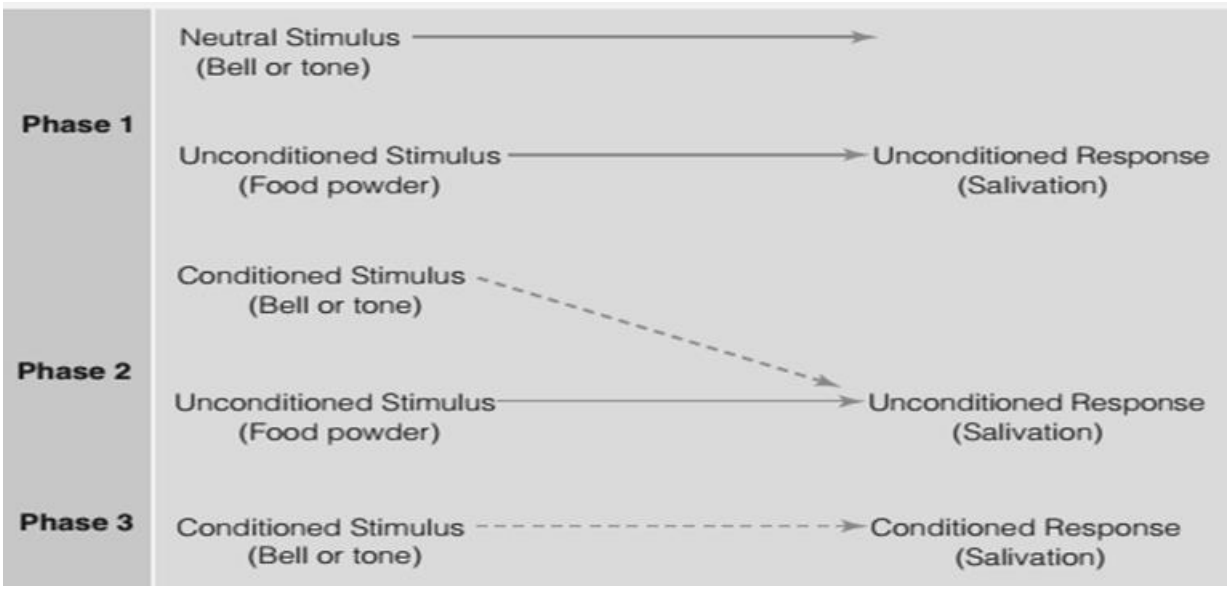
Classical Conditioning; Pavlovian Legacy

- Early in this century, some fundamental psychological discoveries were made by Ivan P. Pavlov (1849–1936)
- He was trained as a physiologist
- Pavlov received the Nobel Prize for medicine in 1904 for his important work on gastric juices involved in digestion; a physiological reflex

Incidental Discoveries

- It was not even necessary to place food in contact with the mouth to obtain salivary and gastric secretions
- Sight of food, the food dish, even the sight of the person who usually fed the animal would produce the secretions

Ivan Pavlov and his staff are shown here with one of the dogs used in his experiments. The dog was harnessed to the wooden frame shown in the picture. Saliva was conducted by a tube to a measuring device that could record the rate and quantity of salivation.



An Outline of the Stages in Classical Conditioning

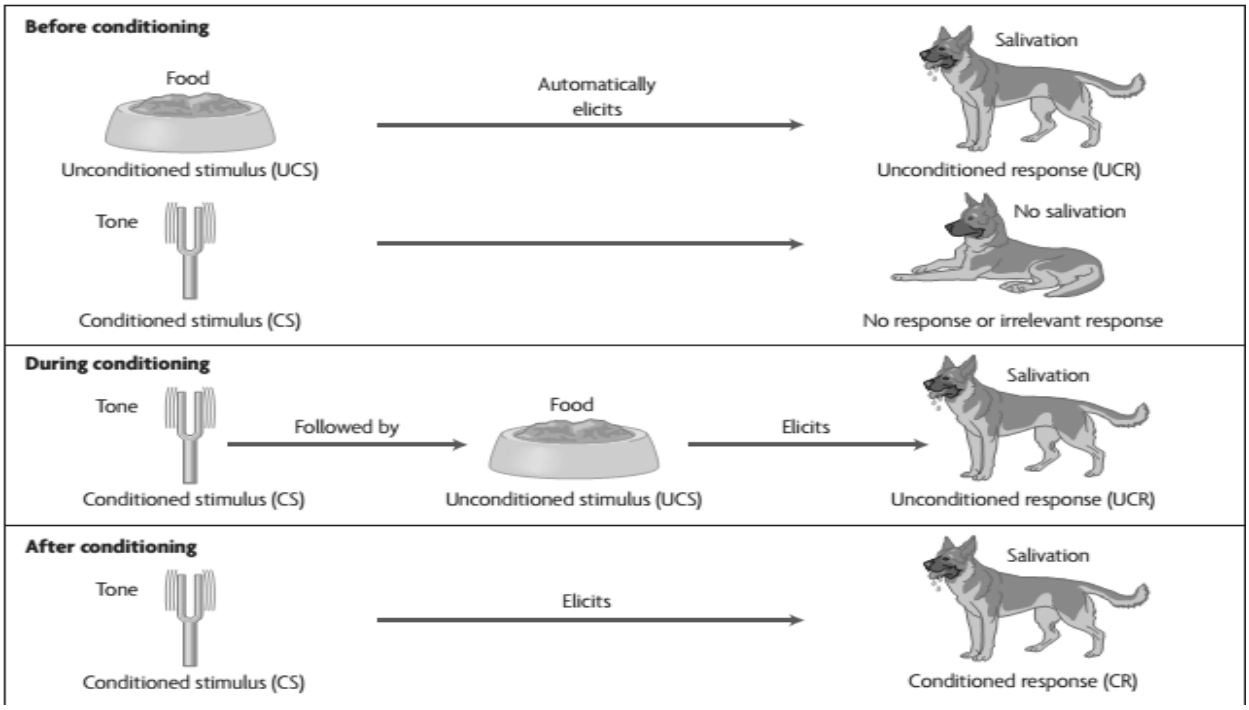
A **neutral stimulus**, such as a bell, that elicits no salivation when presented by itself is delivered to the organism slightly before an **unconditioned stimulus**, such as food powder, that produces an unconditioned response, salivation. If the neutral stimulus predicts the unconditioned stimulus, then after a number of pairings (as in phase 1), the neutral stimulus becomes associated with the unconditioned response, indicated by the broken line in phase 2.

The neutral stimulus is now called the **conditioned stimulus**. Eventually (phase 3), the conditioned stimulus will elicit salivation in the absence of the unconditioned stimulus, and this salivation is

called the **conditioned response** (CR). If the conditioned stimulus is repeatedly presented without the unconditioned stimulus, the CR will grow weaker and eventually extinguish.

In his original experiments, Pavlov used a variety of stimuli such as tones, bells, lights, and metronomes to serve as neutral stimuli. The experimenter presented one of these neutral stimuli and then the food powder. The dog's saliva was collected through a tube.

Classical Conditioning; Experiments



In early experiments, a reflex was used as unconditioned stimulus; salivation, eye blink, Knee jerk, pupil contraction.

Any stimulus that naturally elicits a reflexive behavior is called an unconditioned stimulus (UCS) because learning is not a necessary condition for the stimulus to control the behavior.

The behavior elicited by the unconditioned stimulus is called the **unconditioned response** (UCR)

- The stimuli such as lights and tones did not originally trigger the reflex response of salivation
- Over time each neutral stimulus was repeatedly paired with the unconditioned stimulus
- This neutral stimulus is called the conditioned stimulus (CS): Its power to elicit behavior is conditioned on its association with the UCS.
- After several trials, the CS will produce a response called the conditioned response (CR)

Experiments with Humans

- Eating favorite food while watching nonsense syllables; preference and liking
- Nonsense syllables paired with adjectives; liking rating
- Nationalities paired with adjectives; liking rating
- A drug paired with a tone; alone the tone produced BP control

Contingency

Rescorla trained dogs to jump a barrier from one side of a shuttle box to the other to avoid an electric shock delivered through the grid floor

If the dogs did not jump, they received a shock; if they did jump, the shock was postponed. Rescorla used the frequency with which dogs jumped the barrier as a measure of fear conditioning

Sometimes CS paired with UCS, tone was followed by shock, sometimes not. Dogs jumped frequently if the sounding of the tone was a reliable predictor of the delivery of the shock.

Process of Conditioning

Learning is a process based on experience that results in a relatively consistent change in behavior or behavior potential

- Learning can take place only through experience.
- Experience includes taking in information (and evaluating and transforming it) and making responses that affect the environment.

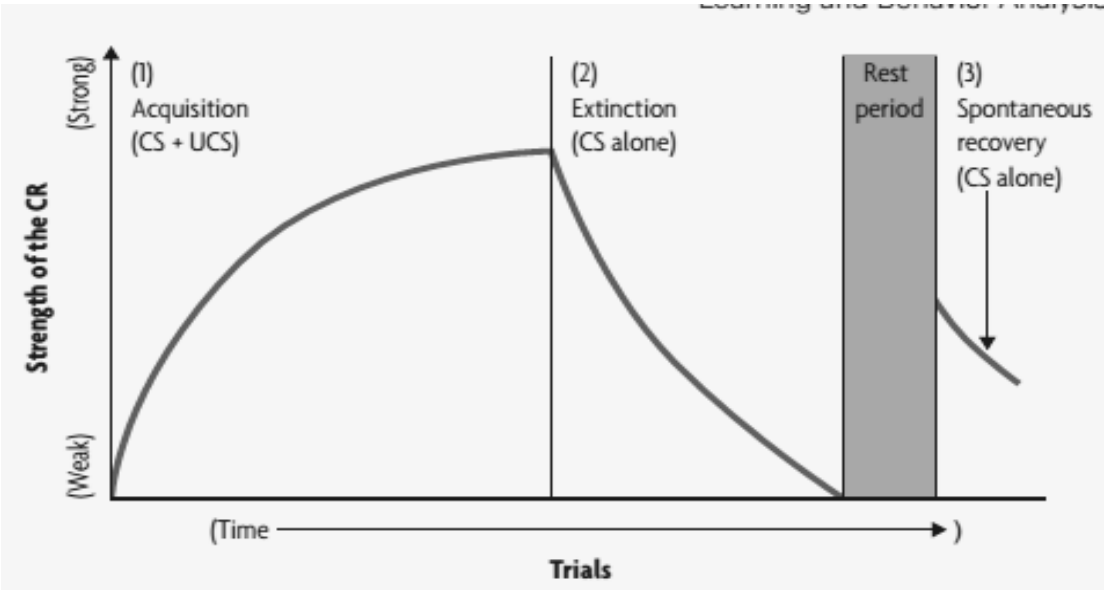
Conditioning is One Type of Learning

- **Intuition**
    - Insight, Incubation, source unknown
- **Trial and Error**
    - Trying solutions, using intelligence
- **Modeling**
    - Imitation, copying others , children way of learning

An Association Process

Conditioning is described as a process that takes place through association between Stimuli or between Stimuli and Response so presenting one will result in the other

- Classical Conditioning is an association between two stimuli
- Condition and unconditioned
- Response to unconditioned stimulus is unconditioned response
- food in mouth - salivation
- Loud sound- fear startle
- When a previously neutral stimulus appears near in time before unconditioned stimulus, it becomes associated with unconditioned stimulus hence conditioned
- After repeated trails of such pairing,
- The response that was given to unconditioned stimulus is given to conditioned stimulus
- Salivation happens at sound of bell that always sounds before food



Stimulus Generalization and Discrimination

- In a classic conditioning experiment little Albert became conditioned

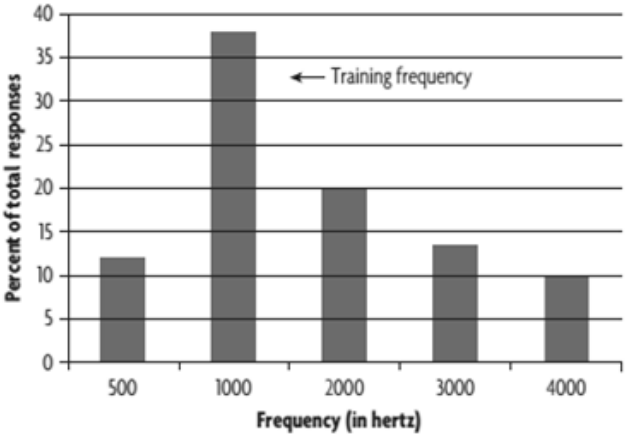
- Startle , fear response was elicited when a stuffed a rabbit was brought to him because rabbit was associated with loud sound
- Consequently he gave same response to other similar objects
- All furry toy animals
- A mask
- In general, once a CR has been conditioned to a particular CS, similar stimuli may also elicit the response.

Why might a child who has been frightened by one dog develop a fear response to all dogs?

- If conditioning was to a high-frequency tone, a slightly lower tone could also elicit the response
- A child bitten by a big dog is likely to respond with fear even to smaller dogs
- This automatic extension of responding to stimuli that have never been paired with the original UCS is called stimulus generalization

Generalization Gradient

- Rabbits were trained so that they produced a conditioned response (they closed their outer eyelid) when they heard a 1000 hertz tone (Siegel et al., 1968)
- During an extinction phase, the rabbits were tested on the training tone as well as tones that varied in distance from that tone
- Tones more similar to the training tone produced more conditioned responses than those further away



Everyday Experience

- Important stimuli rarely occur in exactly the same form every time in nature
- Stimulus generalization builds in a similarity safety factor by extending the range of learning beyond the original specific experience

- New but comparable events recognized as having the same meaning, or behavioral significance, despite apparent differences
- A predator and prey,

Stimulus Discrimination:

- The process by which an organism learns to respond differently to stimuli that are distinct from the CS on some dimension
- An organism's discrimination among similar stimuli (tones of 1,000, 1,200, and 1,500 Hz, for example)
- Is sharpened with discrimination training
- In discrimination training only one of them (1,200 Hz, for example) predicts the UCS, the others are repeatedly presented without it
- Early in conditioning, stimuli similar to the CS will elicit a similar response, although not quite as strong
- As discrimination training proceeds, the responses to the other, dissimilar stimuli weaken: The organism gradually learns which event-signal predicts the onset of the UCS and which signals do no
- To perform optimally in an environment, generalization and discrimination must have a balance
- We should not be overselective—it can be quite costly to miss the presence of a predator or danger
- But also not be to be overresponsive- fearful of every shadow, we will waste time and energy to dispel our worry.
- Classical conditioning provides a mechanism that allows creatures to react efficiently to the structure of their environments

Acquisition

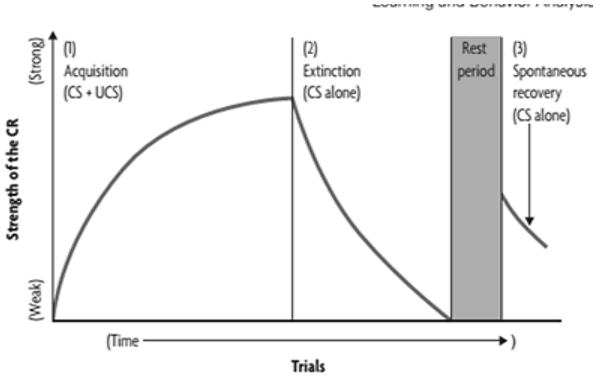
It is the stage in a classical conditioning experiment during which the conditioned response is first elicited by the conditioned stimulus. A number of trials are needed before acquisition takes place, however for some stimuli few or even one trial – electric shock from a switch or nausea after a food is quickly acquired and may become long term.

Extinction

In classical conditioning, the weakening of a conditioned association in the absence of an unconditioned stimulus is called Extinction,

Spontaneous Recovery

The reappearance of an extinguished conditioned response after a rest period is known as spontaneous recovery. During acquisition (CS 1UCS), the strength of the CR increases rapidly. During extinction, when the UCS no longer follows the CS, the strength of the CR drops to zero. The CR may reappear after a brief rest period, even when the UCS is still not presented. The reappearance of the CR is called spontaneous recovery.



In addition to the CS being contiguous—occurring close in time—with the UCS, the CS must also reliably predict the occurrence of the UCS in order for classical conditioning to occur (Rescorla, 1988)

This finding makes considerable sense. After all, in natural situations, where learning enables organisms to adapt to changes in their environment, stimuli come in clusters and not in neat, simple units, as they do in laboratory experiments

- A stimulus must be informative in the Environment
- Conditioned rats to respond to a tone followed by shock, added light
- No conditioning
- Because it adds no new information
- Conditioning occurs most rapidly when the CS stands out against the many other stimuli that may also be present in an environment.
- A stimulus is more readily noticed the more intense it is and the more it contrasts with other stimuli

Application of classical conditioning

Knowledge of classical conditioning can help us understand significant everyday behavior

- Emotions and Preferences
- Likes and Dislikes
- Fears and Phobias
- Reminders and memories
- Apprehensions and anxieties

- Avoidance behaviour
- Aversions

Associations between Stimuli

All these are examples of association between stimuli

Something that was demonstrated in early classical conditioning experiments

- UCS → UCR
- CS + UCS → UCR
- CS →CR

Applications

- Phobias and fears
- Psycho-immunology
- Addiction
- Food aversion
- Advertising
- Adaptation to novel situation
- Interpersonal Attraction
- Phobias are irrational fears of an object, space or person
- Treatment of phobias
  - Counter conditioning
  - Systematic Desensitization
- Phobias for open or high spaces or specific objects; relaxation training to reduce anxiety, pictures of feared object, gradual exposure = counter conditioning
- Social phobia is fear of facing an audience or gathering
- Treatment; gradual exposure to social situations, relaxation training for anxiety.
- May need more in-depth counseling, social support and change in self-image or self-efficacy.

Addiction

- **Aversion Therapy** = pairing a nausea inducing drug with narcotic
- Used for alcohol and narcotics abuse becomes the conditioned response

Human Immune System

- "Compound CS" , a liquid that tasted of cod liver oil and had the smell of a rose

- CS paired with the cyclophosphamide treatments on 666 occasions for a year
- Every other month of treatment, no cyclophosphamide, simply gave their patient compound CS ,
- 11 year old patient still evidenced immunosuppression and continued to do well after a 555 year follow up

Counter conditioning

- Psych immunology- human immune system can be classically conditioned
- Addiction and substance tolerance why overdose in unfamiliar settings is fatal

The setting of drug use acts as a conditioned stimulus for drug use. The body learns to protect itself by preventing the drug from having its usual effect The drug (UCS) brings about certain physiological responses to which the body responds with countermeasures intended to reestablish homeostasis = the unconditioned response (UCR) . Over time compensatory response also becomes the conditioned response.

In settings ordinarily associated with drug use (the CS), the body physiologically prepares itself (the CR) for the drug's expected effects. Tolerance arises because, in that setting, the individual must consume an amount of the drug that overcomes the compensatory response before starting to get pleasant effect.

Siegel and a colleague interviewed heroin addicts who had come close to death from supposed overdoses. In 7 out of 10 cases, the addicts had been shooting up in a new and unfamiliar setting (Siegel, 1984). Although this natural experiment provides no conclusive data, it suggests that a dose for which an addict has developed tolerance in one setting may become an overdose in an unfamiliar setting.

Advertising

- A field where classical conditioning is used the most
- Companies use cartoon characters used in commercials of those products which are associated with kids
- Female models are used in ads for products for females or housework
- Sportsmen for products associated with men
- Fragrance in restaurants or malls make people spend more
- Using extinction and discrimination process to extinguish painful, disgust or fear associations
- Chemotherapy psychological after effects
- Extinction of unwanted or bad associations is not easy since process is not conscious
- Can be used to replace negative associations with new ones, children aversion to medicine or school

Classical conditioning in life

Sounds Familiar?

- A certain perfume reminds of someone?
- A child starts crying entering a dentist office?
- You feel nausea at sight of a dish that made you sick?
- Music in horror movie makes our heart beat faster?
- Someone avoids elevators or closed places ?
- Perfume association with a personality
  - A liked person, a loved one = UCS
  - pleasant feeling = UCR
  - perfume = CS pleasant feeling = CR
- Sickness = UCS, Nausea = UCR, Food = CS
- Injection pain = UCS , Dentist clinic = CS, Crying response = CR
- Music = CS, Horror scene = UCS, Fear = UCR, fear response to music = CR

Generalization

- Bitten by one dog, afraid of all dogs
- Bad experience one, hatred for whole group
- Sickness after Chinese soup once, aversion for such soup from all places
- Fear conditioning has a powerful impact on people's lives.
- A single traumatic event can condition you to respond with
  - strong physical, emotional, and cognitive reactions—perhaps for a lifetime

Learning Prejudice

- A study showed the process how we learn prejudice through conditioning and association
- Consistent and repeated appearing of a nationality or faith name with bad adjectives (Stats, 1977)
- What happened after 9/11
- Hindu = enemy or Jew = scheming
- No real experience, only conditioning Enemy = bad

Classical Conditioning in Life; Examples

- Creating Happy Associations
- Conditioning can be Very Early in Life
  - Case of new born conditioning

- Cried at injection first day
- Next day, cried when nurse removed diaper even before injection

Fatal Overdose

The setting of drug use acts as a conditioned stimulus for drug use.

The body learns to protect itself by preventing the drug from having its usual effect The drug (UCS) brings about certain physiological responses to which the body responds with countermeasures intended to reestablish homeostasis = the unconditioned response (UCR) . Over time compensatory response also becomes the conditioned response.

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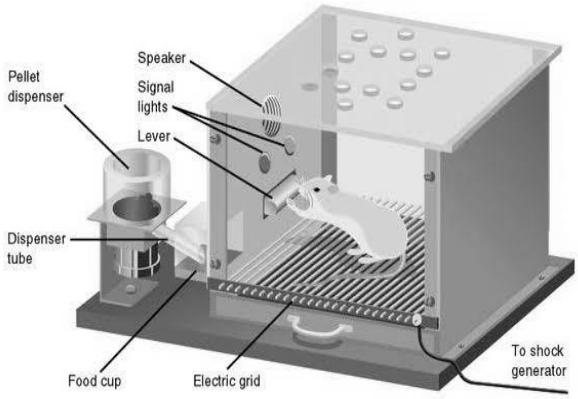
- When a saline solution was paired with a drug that can slow down behavior (scopolamine), the saline solution alone resulted in a slowing down of behavior
- Placebo Use instead of pain killers
- Conditioning of watching cartoons with eating food

Lecture 21

LEARNING: OPERANT CONDITIONING

Operant Conditioning

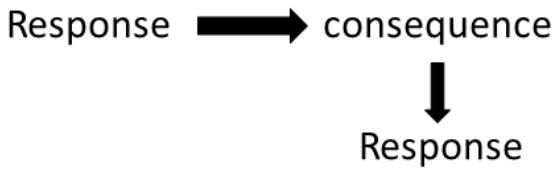
- Called Operant conditioning because response operates on the environment
- Operant condition = learning about consequence
- Instrumental conditioning- because response is instrumental in bringing about a consequence such as a reward or a punishment
- The connection or association is between response and consequence
- Earliest examples of study of operant or instrumental conditioning are those by Skinner and Thorndike
- The primary datum of interest in the study of operant conditioning is the rate at which some response occurs.
- The primary responses that have been studied are lever pressing by rats and key pecking by pigeons in operant-conditioning apparatuses (Skinner boxes).
- A **Skinner box** is simply a small, well-lit box with a lever or key that can be depressed and a place for dispensing food.



A typical Skinner box equipped with a response lever and a food cup below it. A lever press by the animal makes a pellet of food drop into the cup. All of this machinery is controlled by programming equipment that allows the experimenter to set different tasks for the animal.

- Not all responses or behaviour are learned by association between stimuli
- Or as passive recipients
- Organisms, animals and humans are active responders and agents of behaviour
- They learn through experience which responses bring about desirable or undesirable consequences
- these consequences either weaken or strengthen the responses

Process of Operant Conditioning



- Either repeat response or withhold response depending upon consequences
- Rat presses the lever, gets food, keeps pressing again , repeats response till he is hungry
- Presses the lever, gets shock, withholds response

Operant Conditioning; Applications

Consequences

- Desirable, positive = food, pleasant sensation
- Undesirable, negative = shock, no food, puff of air
- Desirable consequences are called rewards; called reinforcement because they strengthen the response
- Undesirable = punishment
- Rewards and reinforcements are mostly used for teaching a behaviour
- Punishments to stop a behaviour
- Due to powerful nature of consequences and relevance to human and animal real experiences operant conditioning has important implications
- They also have wider applications for learning and behaviour
- The principles of operant and instrumental conditioning have been used frequently in many settings and situations

Examples in Real Life

- Child takes first step, everyone claps
- Child says salam he receives praise
- Grades, trophies, bonus, food , raise in salary
- Circus animal performs receives favourite food
- Student completes homework, gets time to play
- Finish dinner, take medicine, get chocolate
- Cross red light, over speed, get a fine
- Hit another child, get punished

Process of Application

- Identify the behaviour that needs to be learned or stopped
- Identify reinforcers; type and quantity of reinforcement
- Plan a schedule of reinforcement
- Carry out trials
- Record responses after reinforcement

- Before and after testing

Applications

- School settings
- Clinical settings and psychotherapy
- Animal training
- Organizational and work settings
- Children behaviour and socialization
- Sports training
- Medicine adherence
- Teachers use rewards for performance, compliance such as punctuality and completion of work
- Parents; rewards for toilet training, good behaviour
- Time out, taking away play activity, physical and verbal punishment for avoiding harm and extinguishing disruptive behaviour
- Therapy techniques; Token economy, contingency management
- Employees; certificates, bonus
- Students, medals, honours

Some Constraints

- Behavioural analyses of past reinforcing contingencies
- Use of food can lead to satiation so a limit is set and deprivation is needed
    - an animal who is not hungry will not be interested in food
    - Someone who dislikes chocolates will not see it as reinforcement
- Punishment can have adverse effects so least preferable
- Withholding reward is better than punishment

Law of Effect; Thorndike Experiments

Consequences strengthen or weaken a Response

The Law of effect is a basic law of learning that states that the power of a stimulus to evoke a response is strengthened when the response is followed by a reward and weakened when it is not followed by a reward.

At about the same time that Pavlov was using classical conditioning to induce Russian dogs to salivate to the sound of a bell, Edward L. Thorndike (1874–1949) was watching American cats trying to escape from puzzle boxes.

A Thorndike Puzzle Box

To get out of the puzzle box and obtain food, Thorndike's cat had to manipulate a mechanism to release a weight that would then pull the door open.

- Thorndike; observations and inferences about the kind of learning taking place The cats at first only struggled against their confinement, but once some "impulsive" action allowed

them to open the door "all the other unsuccessful impulses [were] stamped out and the particular impulse leading to the successful act [was] stamped in by the resulting pleasure"
    - (Thorndike, 1898, p. 13)
- Learning an association between stimuli in the situation and a response that an animal learned to make: a stimulus–response (S–R) connection
- The cats had learned to produce an appropriate response (for example, clawing at a button or loop) that in these stimulus circumstances (confinement in the puzzle box) led to a desired outcome (momentary Freedom
- The learning of these S–R connections occurred gradually and automatically in a mechanistic way as the animal experienced the consequences of its actions through blind trial and error
- Gradually, the behaviors that had satisfying consequences increased in frequency; eventually became the dominant response when the animal was placed in the puzzle box
- Thorndike referred to this relationship between behavior and its consequences as the law of effect: A response that is followed by satisfying consequences becomes more probable and a response that is followed by dissatisfying consequences becomes less probable

Experimental Analyses of Behaviour; Skinner's Experiments

- B. F. Skinner agreed with Thorndike's view that environmental consequences exert a powerful effect on behavior.
- Skinner outlined a program of research to discover, by systematic variation of stimulus conditions, the ways that various environmental conditions affect the likelihood that a given response will occur
- A natural datum in a science of behavior is the probability that a given bit of behavior will occur at a given time. An experimental analysis deals with that probability in terms of frequency or rate of responding.
- The task of an experimental analysis is to discover all the variables of which probability of response is a function (Skinner, 1966, pp. 213–214).
- Being an experimenter and empiricist, Skinner designed Operant procedures to manipulate consequences of an animal's behavior to observe how these affected subsequent behaviour
- An operant is any behavior that is emitted by an organism and can be characterized in terms of the observable effects it has on the environment; operant means affecting the environment, or operating on it.
- **Operants** are not elicited by specific stimuli as classically conditioned behaviors are
- Pigeons peck, rats search for food, babies cry and coo, some people gesture while talking, and others stutter; the probability of these behaviors occurring in the future can be increased or decreased by manipulating the effects they have on the environment.
- For example, a baby's coo prompts desirable parental contact, the baby will coo more in the future.
- Operant conditioning, then, modifies the probability of different types of operant behavior as a function of the environmental consequences they produce.

- An apparatus to manipulate the consequences of behavior, the operant chamber. When, after having produced an appropriate behavior defined by the experimenter, a rat presses a lever, the mechanism delivers a food pellet.
- The experimenters can study the variables that allow rats to learn—or not to learn—the behaviors they define.
- A lever press produces a food pellet only after a rat has turned a circle in the chamber, the rat will swiftly learn through process of shaping to turn a circle before pressing the lever.
- The measure of interest is how much of a particular behavior an animal carries out in a period of time Researchers record the pattern and total amount of behavior emitted during an experiment.
- The effect of reinforcement contingencies on animals' behavior could be studied.

Lecture 22

REINFORCEMENT

Reinforcement Contingencies

- A reinforcement contingency is a consistent relationship between a response and the changes in the environment that it produces
- For example, an experiment in which a pigeon's pecking a disk (the response) is generally followed by the presentation of grain (the corresponding change in the environment)
- This consistent relationship, or reinforcement contingency, will usually be accompanied by an increase in the rate of pecking
- For delivery of grain to increase only the probability of pecking, it must be contingent only on the pecking response—the delivery must occur regularly after that response but not after other responses, such as turning or bowing

Based on Skinner's work modern behavior analysts seek to understand behavior in terms of reinforcement contingencies. These are applied in

- Behaviour modification therapies
- Trainings
- Management of behavior

A **reinforcer**, any stimulus that—when made contingent on a behavior—increases the probability of that behavior over time.

Reinforcement is the delivery of a reinforcer following a response.

Reinforcers are always defined empirically, in terms of their effects on changing the probability of a response.

Individual differences in reinforcers

Positive and Negative Reinforcers

- Positive, Neutral, Negative
- Positive = Appetitive(we want them)
- Negative = aversive, want to avoid them
- A behavior followed by the delivery of an appetitive stimulus, is positive reinforcement
- A response followed by removal of an aversive stimulus = negative reinforcement

What is reinforcing for a child?

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And for young persons

Properties of Reinforcement

- Your pet rat will turn circles if a consequence of circle turning is the delivery of desirable food
- humans will tell jokes if a consequence of their joke telling is a type of laughter they find pleasurable
- Child will stop crying if she is picked up or given a candy
- Each one of these are consequences of behaviour and act as reinforcers
- Consequences are learnt fast and serve to strengthen the behaviour or response
- but not each reinforcer is positive and comes with a cost
- Sometimes a child needs comfort
- But if we console each time a child throws a tantrum or is disruptive, it becomes reinforcer for that behaviour
- Cost; they learn that crying is only way to get attention or comfort

Remember "a behavior is followed by the removal of an aversive stimulus, the event is called negative reinforcement "

- A child is disruptive in class, gets attention
- Does not sit still, is given many distracters
- A wife panics and gets lot of attention
- A mother gets sick and gets her way

- A behaviour we want to stop is being reinforced

Two types of learning circumstances where negative reinforcement applies

- In escape conditioning, animals learn that a response will allow them to escape from an aversive Stimulus
- You learn to use an umbrella to escape the aversive stimulus of getting wet
- In avoidance conditioning, animals learn responses that allow them to avoid aversive stimuli before they begin
- car buzzer if not buckle seat belt
- Both positive reinforcement and negative reinforcement increase the probability of the response that precedes them
- Positive reinforcement increases response probability by the presentation of an appetitive stimulus following a response
- Negative reinforcement does the same in reverse, through the removal, reduction, or prevention of an aversive stimulus following a response
- Reinforcers are the power brokers of operant conditioning: they change or maintain behavior
- have a number of interesting and complex properties
- can be learned through experience rather than be biologically determined
- can be activities rather than objects
- In some situations, even ordinarily powerful reinforcers may not be enough to change a dominant behavior pattern (in this case, we would say that the consequences were not actually reinforce

Primary and Conditioned Reinforcers

- ✓ Handful of primary reinforcers, such as food and water, whose reinforcing properties were biologically determined
- ✓ Over time neutral stimuli have become associated with primary reinforcers and now function as conditioned reinforcers for operant responses
- ✓ Secondary reinforcers; money, cheques, valuables
- ✓ a great deal of human behavior is influenced less by biologically significant primary reinforcers than by a wide variety of conditioned reinforcers
- ✓ Social reinforcers; Grades, smiles of approval, gold stars, and various kinds of status symbols
- ✓ Virtually any stimulus can become a conditioned reinforcer by being paired with a primary reinforcer
- ✓ In one experiment, simple tokens were used with animal learners.

Schedules of Reinforcement

Operant Extinction

- If reinforcement is withheld operant extinction occurs
- if a behavior no longer produces predictable consequences, it returns to the level it was at before operant conditioning-it is extinguished

- Example; putting coins in machine to get a cola, machine does not deliver, after trying few times, you stop putting coins- response extinguished

Spontaneous Recovery

- You may come back later or kick the machine to try after some time
- Pigeon no longer recieves grain when he pecks at the green light in skinner box- he stops pecking
- next time the pigeon is put back in the apparatus with the green light on, the pigeon would likely spontaneously peck
- Spontaneous recovery occurs but response rate is less and stops very quickly

Punishers

- Another technique for decreasing the probability of a response- punishment
- A punisher is any stimulus that-when it is made contingent on a response-decreases the probability of that response over time
- Punishment is the delivery of a punisher following a response
- When a behavior is followed by the delivery of an aversive stimulus, the event is called positive punishment (positive because something is added to the situation); touching a hot stove, pain, next time not likely to touch the stove
- When a behavior is followed by the removal of an appetitive stimulus, the event is referred to as negative punishment(negative because something is subtracted from the situation)a parent withdraws a child's allowance when hits her baby brother.

A way to remember

Type	Positive Adds something	Negative Remove something
Reinforcement	candy, pizza, cold drink, praise, smile	headache, pain, loud noise, criticism
Punishment	physical punishment, scolding,	Pocket money, TV time, video , play activity Concept of time out

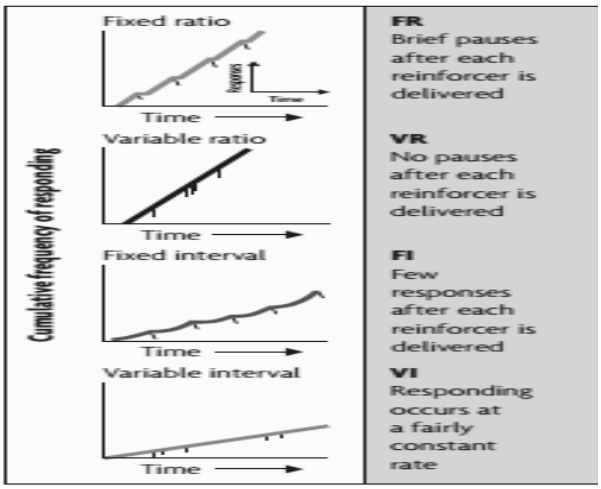
- A time out is "the contingent
- withholding of the opportunity to earn reinforcement . . . from rewarding stimuli including attention from the parent, as a consequence of some form of misbehavior" (Morawska & Sanders, 2011, p. 2)
- Be sure time out is punishing not enjoyable; Children may learn this is a way to escape a task they don't wont to do
- Make request again after time ends

- Effective for children 3-7 years

Schedules of Reinforcement

A Story

B. F. Skinner; It seems that one weekend he was secluded in his laboratory with not enough of a food-reward supply for his hardworking rats. He economized by giving the rats pellets only after a certain interval of time—no matter how many times they pressed in between, they couldn't get any more pellets. Even so, the rats responded as much with this partial reinforcement schedule as they had with continuous reinforcement.



- **Fixed-Ratio Schedules**: In fixed-ratio (FR) schedules, the reinforcer comes after the organism has emitted a fixed number of responses
- Many salespeople are on FR schedules: They must sell a certain number of units before they can get paid
- In a **variable-ratio** (VR) **schedule**, the average number of responses between reinforcers is predetermined
- A VR-10 schedule means that, on average, reinforcement follows every 10th response, but it might come after only 1 response or after 20 responses. Variable-ratio schedules generate the highest rate of responding and the greatest resistance to extinction, especially when the VR value is large
- On a **fixed-interval** (FI) **schedule**, a reinforce is delivered for the first response made after a fixed period of time
- For **variable-interval (VI) schedules**, the average interval is predetermined; on a VI-20 schedule, reinforcers are delivered at an average rate of 1 every 20 seconds, generates a moderate but very stable response rate
- Extinction under VI schedules is gradual and much slower than under fixed-interval schedules
- A pigeon pecked 18,000 times during the first 4 hours after reinforcement stopped and required 168 hours before its responding extinguished completely (Ferster & Skinner, 1957)

- A professor, who gave occasional, irregularly scheduled quizzes; do you study your notes all the time.

Schedules of reinforcement; Applications and Interventions

B. F. Skinner agreed with Thorndike's view that environmental consequences exert a powerful effect on behavior. Skinner outlined a program of research to discover, by systematic variation of stimulus conditions, the ways that various environmental conditions affect the likelihood that a given response will occur.

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  - **Continuous Reinforcement**; each response is rewarded, pigeon gets food after each peck
  - **Partial reinforcement**; reward, food is delivered on some occasions and not on others

Partial reinforcement can be after a certain number of responses, or an interval schedule, after the first response following a specified interval of time. In each case, there can be either a constant, or fixed, pattern of reinforcement or an irregular, or variable, pattern.

  - Fixed Interval, Fixed ratio
  - Variable Interval, Variable Ratio
  - Interesting aspects have been noticed about these various schedules

- The rats whose lever pressing had been partially reinforced continued to respond longer and more vigorously than did the rats who had gotten payoffs after every response
- Different schedules of reinforcement in; when you raise your hand in class, the teacher sometimes calls on you and sometimes does not

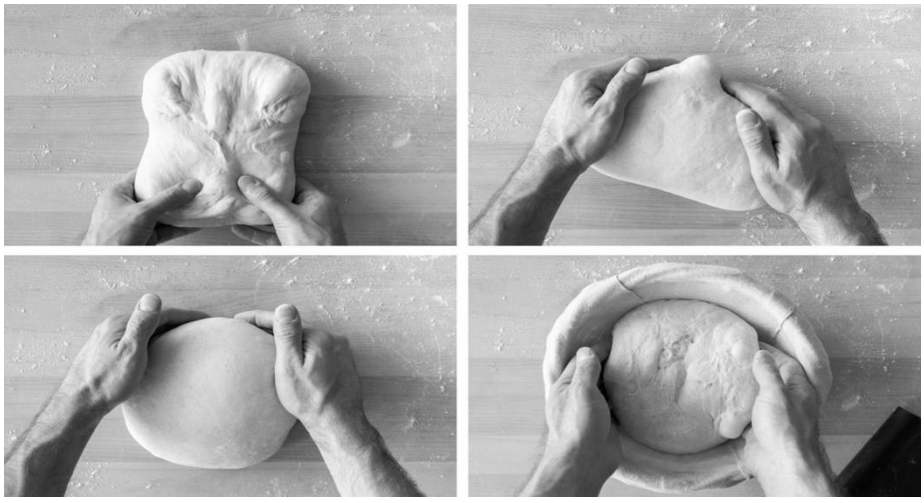
- Some slot machine players continue to put coins in the one-armed bandits even though the reinforcers are delivered only rarely
- FI schedule when you reheat a slice of pizza. Suppose you set the oven's timer for 2 minutes. You probably won't check very much for the first 90 seconds, but in the last 30 seconds, you'll peek in more often
- Gambling would seem to be under the control of VR schedules. The response of dropping coins in slot machines is maintained at a high, steady level by the payoff, which is delivered only after an unknown, variable number of coins has been deposited. VR schedules leave you guessing when the reward will come—you gamble that it will be after the next response, not many responses later
- A thought; waiting for good deeds to be rewarded in hereafter- is it reinforcement delayed but yet effective?

Lecture 23

SHAPING

Shaping

A desired behaviour is developed by first rewarding any behaviour that approximates it. Gradually, through selective reinforcement of behaviour more and more closely resembling the desired behaviour, the final behaviour is shaped. This technique is sometimes called successive approximation.



For example, Ali never does his math homework. You would like to have him complete his homework on a daily basis. You realize that if you wait for him to complete his homework before you reinforce him in some way, you may never (or infrequently) have the opportunity to administer a positive consequence. Therefore, you decide to break down the desired behaviour into sub-steps that are progressively more demanding. These steps might be

1. Will write his name at the top of the worksheet.
2. Complete one problem of his choice.
3. Five problems of his choice.
4. Complete either all the odd numbered problems or all the even numbered problems.
5. Complete all problems except one.
6. Will complete all problems

Chaining is the processes of adding small behaviors together to create a larger, more complex and sophisticated behavior.

For example, if you are attempting to teach someone to tie their shoes, you are attempting to build a chain by reinforcing the different acts that we complete in tying a shoe

- Differential reinforcement sets the occasion for behaviour
- Increases the probability that a previously reinforced behaviour will occur

- Each step in the chain serves a differential reinforce for the next step
- Each step in the chain serves as a conditioned reinforce to the preceding step, conditioned from the final reinforce

There are two chaining procedures: forward and backward.

As the name implies **forward—**start at beginning of chain (often similar to shaping) **backward—** start near end of chain (More frequent chaining technique).

Shaping

- To train new or complex behaviors, you will want to use a method called shaping by successive approximations—in which you reinforce any responses that successively approximate and ultimately match the desired response
- Pigeon turns his body, looks towards the light, goes near the light, raises head to look at light; each step is reinforced
- Once he Pecks then reward is only given at desired ultimate response- pecking at light

Prompts are events that help initiate a response

Allow response to occur and be reinforced

Examples:

a. Physical guidance

b. Instruction

c. Pointing

d. Planned visual cues

e. Modeling

Fading

- Gradual removal of a prompt
- Provide prompt less frequently
- Provide prompt at a lower level of intensity
- Modify prompt to be more like naturally occurring cues
- If fading is too quick, rate of responding will drop

This woman is assisted by a monkey who has been operantly shaped to perform tasks such as getting food or drink, retrieving dropped or out-of-reach items, and turning lights on or off

A 21-year-old university pole vaulter

- Couldn't extend his arm to desired length needed to raise him self

- Shaping was used to reinforce each extension till final goal was met
- Many physical trainings can be done that way
- Children to learn complex manners
- Autistic kids to approximate behaviour, speech therapy

Prejudiced Attitudes are learned; An experiment in Pakistan

- Original Study; Staats and Staats, 1976,1977
- Nonsense syllables were presented with some adjectives
- Some syllables are paired with positive adjectives like sweet, nice, fragrant, kind
- Some are paired with negatives ones like mean, smelly, ugly, stingy
- Hypothesis; the nonsense syllables paired with positive words will be liked more than those paired with negative words
- based on association principle in classical conditioning; result confirmed their assumption
- They suggested that prejudice for certain nationalities could be learned the same way- association of a name with a bad word usually through both appearing together in media

An Experiment in Pakistan

Exp.1; Nonsense syllables

CET	fresh
QEH	smelly
SUF	prickly
GOJ	sweet
JAV	rough
MIP	fragrant

Result

Meaningless syllables paired with Positive words average rating = 7

Syllables paired with negative adjectives, average rating = 4

Rating means liking

- Can we learn dislike or prejudice for some nations through association process shown in this experiment
- Problem with names of nations;
- American , German, Afghan, Chinese, Indian, ……many nationalities are familiar for us and may hold previous associations so our experiment will be confounded
- We found unfamiliar nationalities and tested for familiarity and previous associations; Peruvian, Swedish, Morrocan, Bolivian, Finnish
- Paired with good or bad adjectives
- Kind, Mean, Cruel, Neurotic, Dirty

- Liking rating; nations paired with good words were liked more than those paired with negative words
- Though the difference was not as significant as for syllables
- Conclusion; we learn to dislike some nations or groups through process of association

Word Association Method

- Say the first word that comes to mind as I say; Politician, Mother–in-Law, step mother, Muslim, Hindu
- Interesting associations were revealed
- Politician- corrupt, Hindu- scheming
    - Now that association is changing
- Mother-in-Law mixed associations; monster, friend, amie
- Step mother- churail, helpful, trouble
- Individual experience or media driven?

Biological constraint on learning

- Some instances of conditioning not only on the relationship between stimuli and behaviour but also on the way an organism is genetically predisposed toward stimuli in its environment
- Animals appear to have encoded, within their genetic inheritance, the types of sensory cues—taste, smell, or appearance—that are most likely to signal dimensions of reward or danger
- Instinctual drift; the tendency for learned behavior to drift toward instinctual behavior over time
- Biological preparedness: a particular species members require less learning experience than normal to acquire a conditioned response
- Going against these genetic links; experiment wont be much success
- humans are biologically prepared to acquire intense fears—known as phobias—to stimuli such as snakes and spiders which have posed danger in history
- Circus animals and instinctual drift ;Raccoons rubbed, pigs root and tossed

Taste Aversion Learning

- When presented with a new food or flavor, rats take only a very small sample
- Only if it fails to make them sick will they go back for more
- If researcher include a substance with the new flavor that does make the rats ill—they'll never consume that flavor again
- This phenomenon is known as taste-aversion learning
- Is a powerful mechanism
- This genetic capacity to sample and learn which foods are safe and which are toxic has great survival value
- taste aversion is learned with only one pairing of a CS (the novel flavor) and its consequences (the result of the underlying UCS-the element that actually brings about the illness
- even with a long interval, 12 hours or more, between consuming and illness

- is permanent after one experience

Inborn Bias

Results from Garcia and Koelling's study (1966) showed that rats possess an inborn bias to associate certain cues with certain outcomes. Rats avoided saccharin-flavored water when it predicted illness but not when it predicted shock. Conversely, rats avoided the "bright-noisy water" when it predicted shock but not when it predicted illness.

- Conditioned aversion to cold water among rats
- Initially preferred cold water, were injected nausea inducing substance after cold water, avoided cold water, drank warm water
- the researchers introduced the novel flavor of saccharin
- Rats that got sick after drinking water that was both cold and sweet acquired an aversion to both components of the novel stimulus: They subsequently avoided both cold water and warm saccharin
- To stop coyotes from killing sheep (and sheep ranchers from shooting coyotes), John Garcia and colleagues have put toxic lamb burgers wrapped in sheep fur on the outskirts of fenced-in areas of sheep ranches
- The coyotes that eat these lamb burgers get sick, vomit, and develop an instant distaste for lamb meat
- Their subsequent disgust at the mere sight of sheep makes them back away from the animals instead of attacking

Comparing Classical and Operant Conditioning

Both classical and operant conditioning rely on process of association.

However there are many differences in how the association takes place and between which two things.

Comparing Classical and Operant Conditioning		
	Classical conditioning	**Operant conditioning**
Response	Involuntary, automatic, elicited	Voluntary, operates on environment, emitted
Acquisition	Associating events; CS announces UCS	Associating response with a consequence (reinforcer or punisher)
Extinction	CR decreases when CS is repeatedly presented alone	Responding decreases and stops sometime after reinforcement stops
Cognitive processes	Organism develop expectation that CS signals the arrival of UCS	Organism develops the expectation that a response will be reinforced or punished; also exhibit latent learning without reinforcement
Biological constraints	Natural predispositions constrain what stimuli and responses can easily be associated	Organisms best learn behaviour similar to their natural behaviour; unnatural behaviour instinctively drift back towards natural ones

- There are some examples of learning where we see combined effects of classical and operant conditioning
- In classical conditioning response after the stimulus
- In operant conditioning experimenter awaits response before they can reinforce
- Sometimes training required to carry out experiment in lab for example pigeons learn to eat in Skinner box food chamber and have to be deprived to learn
- In real life applications both are used for various purposes-both have limitations
- Beyond association, model of expectation
- Latent learning; a learning that wasn't demonstrated till reinforcement was given
- Guthrie model showed that learning wasn't dependent upon reinforcement, performance was
- Beyond reinforcement, Intrinsic reinforcement

Lecture 24

MEMORY

Memory

Definition of Memory

Memory is the capacity and processes involved in retaining, retrieving, and using information about stimuli, images, events, ideas, and skills after the original information is no longer present. Memory is a type of information processing that involves receiving, processing, retaining and storing and bringing up the stored content.

What experiences can you recall from your year in the eighth grade? Think of them for a moment. You learned many facts there; lots of things happened to you. Probably you will never recall even a small fraction of the facts you learned or experiences you had then. What has happened to these memories? Are they lost forever? Or are the memories still stored somewhere but never actively recalled because you have not had an appropriate situation to bring them to mind? There are some things you will never forget, even if you want to, but others you cannot recall, no matter how urgent the need. If a budding romance had a catastrophic ending, this memory from your days in the eighth grade may stick with you long after other events have been relegated to the dim recesses of the past. Why?

The humorist Robert Benchley, in an essay called "**What College Did to Me**," attempted to recall the things he had learned in college years before and to classify these by the year in which they were learned. There were 39 items in the list. He remembered 12 things from his freshman year; this decreased to only 8 things recalled from his senior year. It is selective only with regard to the number of pieces of information included, so that it does give a fair representation of the depth and range of the lasting knowledge acquired in college. You should, of course, be happy and proud to know that you too may soon have a college degree, a certificate that proclaims your knowledge of certain basic facts such as these.

Is this all Benchley really remembers from his college days? If you made a list from your days in the eighth grade, it would probably be similarly brief. This leads to an interesting question: How can we study memories that cannot be recalled? If a person cannot recall an experience, can we assume that the memory trace representing that experience has vanished?

Ebbinghaus's contribution—when memory was young

The experimental investigation of human memory was begun by a German psychologist, Hermann Ebbinghaus. He was a true scientific pioneer. He believed, unlike his famous contemporary, Wilhelm Wundt , that experimental psychology could be developed to study the higher mental processes and not just sensory processes. His main achievement was demonstrating how empirical research could answer interesting questions about memory. This research was published in 1885 in a remarkable book, *Memory: A Contribution to Experimental Psychology.* One of the first questions Ebbinghaus faced was the one we have been considering: how to measure memory. Ebbinghaus served as the only subject in all his experiments; the materials he invented to be memorized are called **nonsense syllables.** He typically used meaningless syllables that

contained a vowel sandwiched between two consonants (therefore called CVC syllables), such as ZOK, VAP, and so on. By using these syllables, he hoped to minimize the influence of linguistic associations that would have been present had he used words, sentences, or (as he sometimes did) passages of poetry as materials to be remembered. (Later research has shown that "nonsense" syllables is a misnomer, because a few items he used were words. Also, in learning even nonsense words, people imbue them with meaning.)

Ebbinghaus selected these syllables at random from a master set of 2,300 and placed them into lists that varied in length. If the list contained, say, 30 nonsense syllables, Ebbinghaus would read the syllables aloud to himself at a uniform rate. Immediately afterward, he would cover up the list and then try to repeat it back to himself or write it down. Obviously, on the first trial, this feat was impossible, but he could measure the number of syllables he was able to recall correctly. He would then read the list aloud a second time, attempt recall, and so on. One measure of the difficulty of recalling a list that Ebbinghaus used is the number of such study/test trials (or the amount of time) needed for one perfect recitation of the list. This is called a **trials to criterion** measure of memory; it was widely used in memory research for years, though it is rare now.

Suppose Ebbinghaus wanted to test his memory of a list a month after learning it. He might, as an initial cue, provide himself with the fi rst nonsense syllable in the list. But suppose this did not help him recall the list and that, try as he might, he could recall nothing further. Would this mean that the series he had memorized a month earlier had left no lasting impression? How could we ever know? Ebbinghaus invented an ingenious method of answering this question. In measuring memory for a series of nonsense syllables, Ebbinghaus attempted to relearn the series, just as he had learned it in the first place, by repeatedly reading it aloud and then attempting to recite it or write it. Once again, he could measure the number of trials or the amount of time necessary to learn the list. The memory for the list at the time of relearning could be measured by the savings in terms of fewer trials or less time needed to relearn the list; this measure of memory would be obtainable even when a person could recall nothing of the material before relearning it. Ebbinghaus found that even when he could recall none of the nonsense syllables in a list, he often still exhibited a considerable savings in the number of trials or amount of time it took him to relearn the list, indicating that memory for the list could exist without active recall.

The **savings score** that Ebbinghaus used was the percentage of trials saved in relearning a list relative to the original number of trials it took to learn the list in the first place. For example, if Ebbinghaus took 10 trials to learn a list of nonsense syllables in order, and then a week later, he took only 5 trials to relearn the list, this would represent 50 percent savings (10 minus 5 divided by 10 X 100%). To put it more generally, percentage savings is defined as the difference between the number of trials in original learning (OL) of a list and its relearning (RL) divided by the number of trials in original learning (OL), with this ratio multiplied by 100. To show you that it makes sense, consider that immediately after learning a list perfectly, it will take no additional trials to relearn it, so the savings would be 100 percent. However, if a person waited 10 years to relearn the list, it would probably be like starting over, so the savings would be 0 percent (if it took the same number of trials to relearn the list as it did to learn it originally: 10 over 10 X 100% = 0%).

The examples we just used were hypothetical, but what is the relation between savings and time since original learning? Ebbinghaus asked this question and in answering it provided one of his

best-known findings, which is shown in Figure below. The graph shows the relation between the amount of savings and the time since original learning, or how forgetting is related to time. As you can see, Ebbinghaus found that forgetting is rapid soon after learning but then slows. The **savings method** is still used today to ask important questions about memory (e.g., MacLeod, 1988; Keisler & Willingham, 2007). Although Robert Benchley may have exhibited poor recall for information he learned in college, if he had been required to retake his courses, he probably would, like Ebbinghaus, have exhibited considerable savings. (He tells us that these courses included such gems as Early Renaissance Etchers, the Social Life of Minor Sixteenth- Century Poets, and the History of Lace Making.) Perhaps you may recall little of your geometry course in high school (or first few lectures of this course, for that matter), but presumably you would find the course much easier if you were to take it again.

You may wonder whether Ebbinghaus's findings are representative of human memory in general, since he studied only one subject (himself) repeatedly, a method that is rarely acceptable in modern research. However, his findings have been replicated many times with larger groups of subjects and are still considered valid.

What do we use memory for?

As a first look at memory, let's see what do we use memory for?

Below is just a brief list of functions that memory serves

- Material ; *exam notes, recipes, operating instructions*
- Daily schedule
- Names
- Phone numbers
- Directions to places
- Remembering to do things in future; prospective memory
- Retrieving learned material
- Past events

Also very important ….

We need memory for labeling familiar objects and for having conversations (keeping track of flow of conversation). Imagine you forget each word as it is spoken by your mother or teacher while having a conversation or while having a chat with your fiancé. What would it look like ? How would you continue listening and responding? We also need memory to know how to behave in a situation, like in a bus, or at a restaurant. We need memory in order to find our way to places, classroom, shops, houses, doctors, workshops and so on. We will be lost without our memory; lost for words, lost in the world. We will not be able to follow sequence in events in films in stories.

This should not frighten you as most of us have normal memory. There are examples of memory loss cases in text books, in real life and in movies that highlight how amazing and how crucial our memory is and we should be thankful for it and not take it for granted.

Case of Mr. Clive Wearing

- Total loss of memory except immediate actions or face or name of person
- destroyed parts of his temporal lobe that are important for forming new memories
- Lives in most recent one or two minutes of his life
- Clive Wearing's diary; sometimes
- he would cross out previous entries because he could only remember writing the most recent entry

Some Questions about Memory

- What is the best way to get things into memory, especially remembering people's names?
- Why we cannot remember some things, where are my keys, or name of a place ?
- When two people describe same event, why is their memory different
- What is happening in brain when above things take place ?
- Why is it that sometimes I know that I know something, but I just can't remember it, then later it pops into my head?
- What is happening in my brain that causes all of the above things to happen?

An explanation of how memory works is needed to answer these questions and best way to do that is to learn about types of memory as well as various models of memory presented by researchers and theorists.

Varieties of Memory

The term *memory* is quite broad and covers many different kinds of skills and abilities.
All have in common the properties that something is learned, retained over time, and then used in some particular situation, but beyond that, types of memory may differ considerably (see Roediger, Marsh, & Lee, 2002, for a summary). You have probably had an experience like this: You are introduced to three people and utterly forget the first person's name by the time you shake the third person's hand. This spectacularly fast forgetting seems quite different from the slower forgetting studied by Ebbinghaus. Remembering information such as a telephone number over a brief interval reflects **short term** or working memory, and some psychologists believe that it has different properties from **long-term memory** (the kind Ebbinghaus studied) and that it should properly be considered a distinct memory system or store. One way of defining short-term memory is the recovery of information shortly after it has been perceived, before it has even left conscious awareness (James, 1890). Long-term memory, then, refers to retrieval of memories that have disappeared from consciousness after their initial perception.

This general definition of long-term memory today seems too broad to most psychologists, who make further distinctions among types of memory. These are discussed more fully later, when we

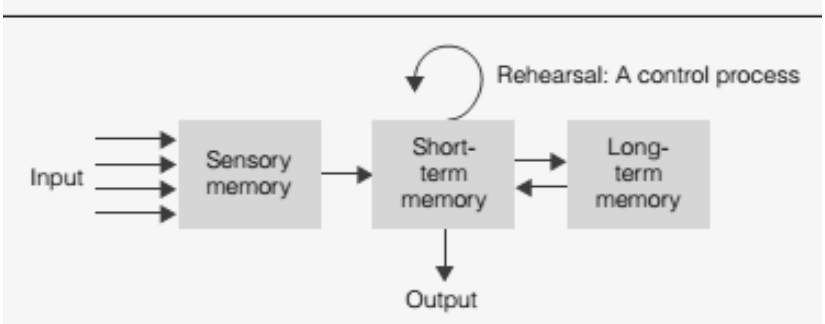
illustrate how memory is studied in different ways. One basic distinction that guides much research today is explicit memory versus implicit memory (Graf & Schacter, 1985; Schacter, 1987).

Explicit memory (sometimes called **episodic memory**) refers to the conscious recollection of events (or episodes) in one's life. People may be asked to recall what they learned in a particular time or place or to distinguish things that happened to them from plausible distractors. Examples would be answering the question of what you did last Saturday night, what you learned in your introductory psychology course, or what you have done thus far today. Tasks typically used to measure both short-term and long-term memory would be classified as explicit memory tests, because people are explicitly told to retrieve information from their past.

Implicit memory, on the other hand, refers to the expression of past learning in which a person need not make any conscious effort to retrieve information from the past (Roediger & McDermott, 1993; Schacter, 1990). It just happens, more or less automatically. For example, when you bend over to tie your shoelaces, you need not say to yourself, "How do I do this? When did I learn to do this? Can I remember how?" Instead, the behavior occurs relatively effortlessly, and if you stop to reflect on exactly how you are doing it, you may actually do worse. Of course, information expressed implicitly was learned, but the crux of the distinction is that, unlike explicit remembering, implicit expressions of memory do not require people consciously to retrieve information from their past. In fact, as we shall see later in the chapter, patterns of performance on explicit and implicit tests of memory are often quite different (Roediger, 1990).

Models of Memory

Many models have been proposed to explain memory but the most prominent model among all is **Atkinson and Shiffrin's model of memory (1968).**



This is also called **modal model of memory** because it included many of the features of memory models being proposed in the 1960s. This model became extremely influential and shaped research on memory for many years. The stages in the model are called the structural features of the model.

Structural Features

1. **Sensory memory**; an initial stage, holds all incoming information for seconds or fractions of a second

2. **Short-term memory** (STM) holds 5–7 items for about 15–30 seconds

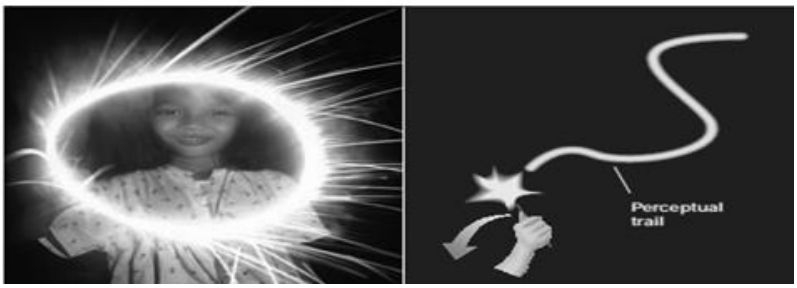
3. **Long-term memory** (LTM) can hold a large amount of information for years, decades or life time control processes, are active processes that can be controlled by the person and may differ from one task to another.

Control Processes

- **Rehearsal**- repeating a stimulus over and over, a telephone number in order to hold it in your mind
- Strategies to make an information more memorable, selective attention
- **Encoding**; The process of storing the number in long-term memory Retrieval; remembering information stored in long-term memory.
- Memory components work together not in isolation.

Experiments on Sensory Memory

Sensory memory is the retention, for brief periods of time, of the effects of sensory stimulation and it retains a perception of the sparkler's light for a fraction of a second that is the persistence of vision.

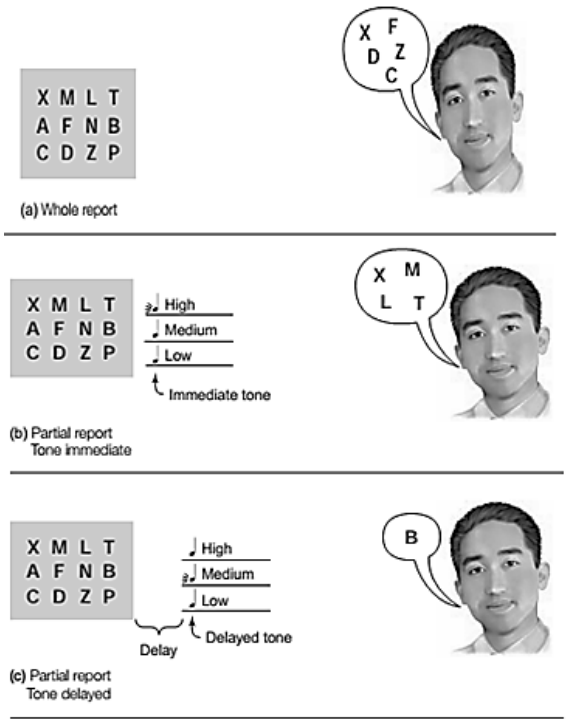


Persistence of vision in films

The images appear so rapidly (24 per second) that we don't see individual images, but see a moving image created by the rapid sequence of images. Intervals of darkness are filled by our perception. This illusion of movement is called **apparent movement**.

What happens	What is on screen	What do we perceive
Film frame is projected	Picture 1	Picture 1
Shutter closes and film moves to the next frame	darkness	Picture 1 persistence of vision
Shutter opens and film frame 2 is projected	Picture 2	Picture 2

The persistence of vision effect that adds a trail to our perception of moving sparklers and fills in the dark spaces between frames in a film (Boring, 1942). **Sperling** attempted to determine how much information people can take in from briefly presented stimuli. In a famous experiment, he flashed an array of letters, on the screen for 50 milliseconds (50/1000 second) and asked his participants to report as many of the letters as possible.

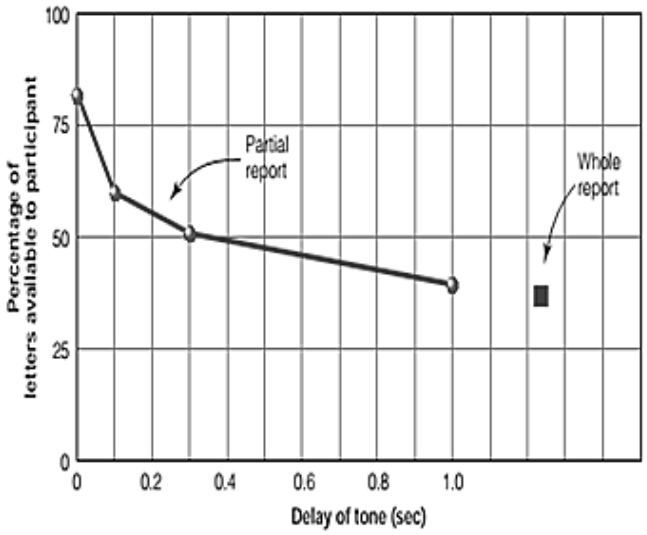


(a)**Whole report method**: Person saw all 12 letters at once for 50 ms and reported as many as he or she could remember; could remember 4.5 out of the 12 letters. Perhaps perception faded while they were trying to report or they didn't see all the numbers. (b) **Partial report**: Person saw all 12 letters, as before, but immediately after they were turned off, a tone indicated which row the person was to report. (c) **Delayed partial report**: Same as (b), but with a short delay between extinguishing the letters and presentation of the tone.

Results of Sperling's (1960) partial report experiments

The decrease in performance is due to the rapid decay of iconic memory (sensory memory in the modal model) 82 percent in partial method without delay. The explanation is that they saw all but as they reported initial letters, others faded.

Sperling concluded from these results that a short-lived sensory memory registers all or most of the information that hits our visual receptors, but that this information decays within less than a second. This brief sensory memory for visual stimuli is called iconic memory or the visual icon (icon means "image"), and corresponds to the sensory memory stage of Atkinson and Shiffrin's model.



Echoic Memory

Echoic Memory sounds also persist in the mind. This persistence of sound, which is called echoic memory, lasts for a few seconds after presentation of the original stimulus (Darwin et al., 1972).

Short-term memory (STM)

STM is the system involved in storing small amounts of information for a brief period of time (Baddeley et al., 2009). Whatever you are thinking about right now, or remember from what you have just heard is in your short-term memory. Most of this information is eventually lost, only some of it reaches the more permanent store of long-term memory (LTM). Because of the brief duration of STM, it is easy to downplay its importance compared to LTM

Everything we think about or know at a particular moment in time involves STM because short-term memory is our window on the present How much information can short term or working memory hold ? What is duration of this memory?

A Recall Test

Participants are presented with stimuli and then, after a delay, are asked to remember as many of the stimuli as possible. Memory performance can be measured as a percentage of the stimuli that are remembered (a list of 10 words and later recalling 3 of them is 30 percent recall).

Participants' responses can also be analyzed to determine if there is a pattern to the way items are recalled, a list consisting of types of fruits and models of cars, recall can be analyzed to determine

whether the cars grouped together and fruits together as recalled. Recall is also involved when a person is asked to recollect life events, such as graduation, or to recall facts they have learned, such as the capital of China.

Measuring recognition, in which people are asked to pick an item they have previously seen or heard from a number of other items that they have not seen or heard, as occurs for multiple-choice questions on an exam. Recognition tests can also be used to test STM

Duration of Short Term Memory

Demonstration

You can do this with a friend or sibling. You will say some letters and then a number. The task of other person will be to remember the letters. When she hears the number, she will repeat it and begin counting backwards by 3s from that number. For example, if you say ABC 309, then she says 309, 306, 303, and so on, until you say "Recall." When you say "Recall," she will stop counting immediately and say the three letters she heard just before the number. It is important that she counts out loud because this prevents her from rehearsing the letters. Once she starts counting, you will time 20 seconds, and say "recall." Note how accurately the person recalled the three letters and continue to the next trial, noting the person's accuracy for each trial.

Trial 1: F Z L 45

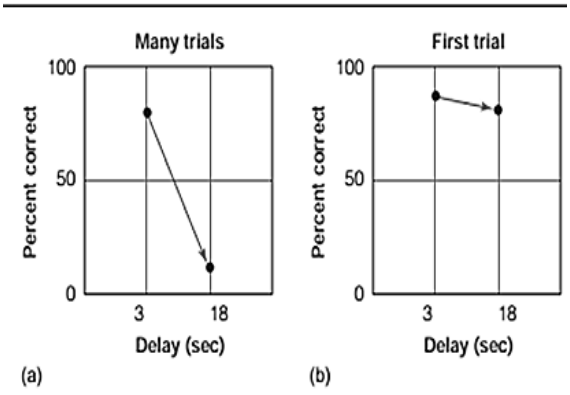
Trial 2: B H M 87

Trial 3: X C G 98

Trial 4: Y N F 37

Trial 5: M J T 54

Peterson and **Peterson** found that their participants were able to remember about 80 percent of the letters after counting for 3 seconds but could remember an average of only 12 percent of the three-letter groups after counting for 18 seconds.



Interpretation; participants forgot the letters because of decay, their memory trace decayed because of the passage of time after hearing the letters. Note falloff in just one trail and number of trials.

Keppel and Underwood suggested that the drop-off in memory was due not to decay of the memory trace but to proactive interference (PI)-interference that occurs when information that was learned

previously interferes with learning new information. In daily life, events follow one after another, thus needing attention, they interfere with each other. The effective duration of STM, when rehearsal is prevented, is about **15–20 seconds**.

Recap on STM

- Short term memory is our window on to the present moment
- Brief, immediate memory for material that you are currently processing
- Listening to this sentence, holding in memory
- Organizes cognitive activities
- Holds visual and spatial information; plans strategies
- Has a short duration of 15-20 seconds

Capacity of short term memory

Not only the information is lost quickly, there is a limit to how much we can hold in STM. One measure for capacity of STM is provided by the Digit Span- the number of digits a person can remember.

Demonstration

2 1 4 9

3 9 6 7 8

6 4 9 7 8 4

7 3 8 2 0 1 5

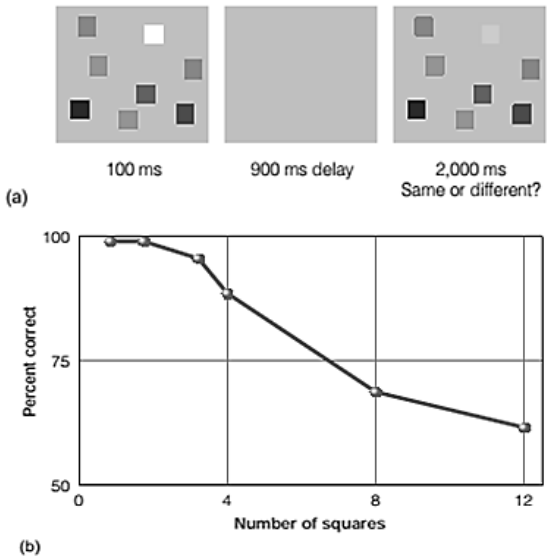
8 4 2 6 4 1 3 2

4 8 2 3 9 2 8 0 7

5 8 5 2 9 8 4 6 3 7

According to measurements of digit span, the average capacity of STM is about 5 to 9 items-about the length of a phone number. **George Miller** (1956, a famous paper, **"The Magical Number Seven, Plus or Minus Two"**. More recent measures of STM capacity have set the capacity at about 4 items (Cowan, 2001).

Experiments; **Luck** and **Vogel** (1997); the capacity of STM, tested by flashing arrays of colored squares separated by a brief delay. Participants' indicated whether the second array was the same as or different from the first array, the color of one square was changed performance was almost perfect when there were 1 to 3 squares in the arrays, began decreasing when there were 4 or more squares participants were able to retain about 4 items in their short-term memory.



Chunking

Miller proposed that people engage in internal mental processes in order to convert stimuli into a manageable number of chunks small units (like words) can be combined into larger meaningful units, like phrases, sentences, paragraphs, or stories. Chunk is defined as a collection of elements that are strongly associated with one another but are weakly associated with elements in other chunks.

Chunking in terms of meaning increases our ability to hold information in STM. We can recall a sequence of 5 to 8 unrelated words, but arranging the words to form a meaningful sentence so that the words become more strongly associated with one another increases the memory span to 20 words or more (Butterworth et al., 1990). In example below, chunks of digits are easier to remember because they are meaningful under a category such as a city code or a certain mobile provider code.

- 0333, 0300, 0321
- 92, 042, 051, 046….216

Country code, city code, actual number

In example below words can remembered also in meaningful pairs or chunks.

Child, ticket, monkey, lock, jump, zoo, banana, look

Encoding

Coding refers to the way information is represented in mind. **Encoding** is the process of coding

It makes the processing and storing of information possible by organizing it according to meaning or some other feature of information.

Types of Coding

- Physiological approach to coding- pattern of firing of neurons
- Mental approach to coding-how a stimulus or an experience is represented in the mind
- Memory of this lecture includes; image or face of instructor, voice of instructor and remembering meanings and topic. These represent three types of coding.

Type of Coding	Example
Auditory	Sound of the person's voice
Visual	Image of a person
Semantic	Meaning of what the person is saying

Auditory coding involves representing items in STM based on their sound. In early experiments by R. Conrad, in 1964 the participants saw target letters briefly on a screen, were told to write down the letters in the order they were presented. Participants were most likely to misidentify the target letter as another letter that sounded like the target, "F" was most often misidentified as "S" or "X," two letters that sound similar to "F," not as likely to be confused with letters like "E," that look like the target.

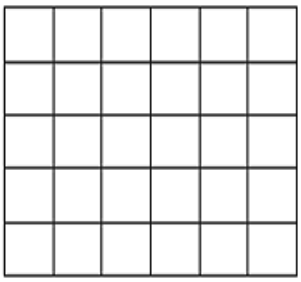
Thus, even though the participants saw the letters, the mistakes they made were based on the letters' sounds Conrad concluded that the code for STM is auditory (based on the sound of the stimulus), rather than visual (based on the visual appearance of the stimulus). In everyday life we memorize phone numbers by repeating rather than by looking, sound rather than visual coding.

Visual coding involves representing items visually, as would occur when remembering the details of a floor plan or the layout of streets on a map. Experiment by Sergio Della Sala and coworkers (1999); the patterns are difficult to code verbally, so completing the pattern depends on visual memory as in pattern below.

Here is a small experiment.

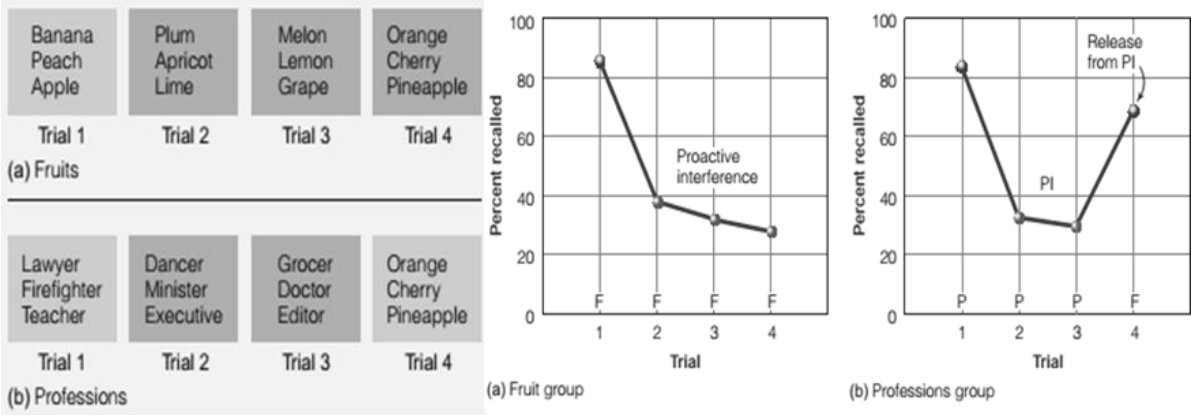
Answer matrix for the visual recall test. Put a check in each square that was darkened in the pattern you just looked at.

2 x 2, 5x 6 matrices were presented in an experiment. The participants were able to complete patterns consisting of an average of 9 shaded squares before making mistakes



Semantic Similarity of the Items

Meaning of words can also have an important effect on the number of items that you can store Semantic coding is representation of items in memory in terms of their meanings.



Results of Wickens et al.'s (1976) proactive inhibition experiment

(a) Fruit group, showing reduced performance on trials 2, 3, and 4 caused at least partially by proactive interference (indicated by blue points). (b) Professions group, showing reduced performance on trials 2 and 3 but improved performance on trial 4. The increase in performance on trial 4 represents a release from proactive interference caused by the change of category from professions to fruits.

Lecture 25

CONCEPT OF WORKING MEMORY

Concept of Working Memory

As research on STM progressed, researchers were convinced that view of STM as a mere storage is too narrow. It involves both holding information and processing it

Let's do some Mental maths; multiply 43 x 6. Notice the steps in doing mental maths. This calculation involves both storage (holding the 8 in memory; remembering the 6 and 4 for the next multiplication step) and active processes (carrying the 1, multiplying 6 × 4) at the same time.

STM and the modal model do not consider dynamic processes that unfold over time. This led **Baddeley** to begin considering alternatives to the modal model. Baddeley noticed something else that was not explained by the modal model: under certain conditions it is possible to carry out two tasks simultaneously.

What kind of model can take into account both (1) the dynamic processes involved in cognitions such as understanding language and doing math problems and (2) the fact that people can carry out two tasks simultaneously?

Baddeley concluded that the short term process must be dynamic and must also consist of a number of components that can function separately. According to this idea, the digit span task in the demonstration (holding numbers in your memory) would be handled by one component while comprehending the paragraph would be handled by another component. The model Baddeley proposed was first described in a paper with Graham Hitch (Baddeley & Hitch, 1974) and, as we will see, was later modified to explain new findings.

In this model, the short-term component of memory is called **working memory**. Working memory is defined as *a limited-capacity system for temporary storage and manipulation*

Demonstration

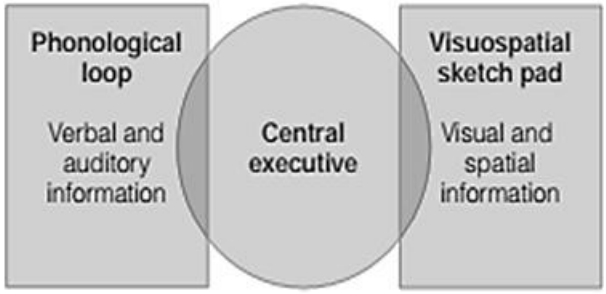
Keep the numbers 7, 1, 4, and 9 in your mind as you read the following passage:

Baddeley reasoned that if STM had a limited storage capacity of about the length of a telephone number, filling up the storage capacity should make it difficult to do other tasks that depend on STM. But he found that participants could hold a short string of numbers in their memory while carrying out another task, such as reading or even solving a simple word problem. Short term memory processes are dynamic, and have multiple components since multiple tasks can be performed. Working memory is defined as a limited-capacity system for temporary storage and manipulation of information for complex tasks such as comprehension, learning, and reasoning.

Working Memory and STM

1. Short-term memory is concerned mainly with storing information for a brief period of time (e.g. a phone number), whereas working memory is concerned with the manipulation of information that occurs during complex cognition (e.g. remembering numbers while reading a paragraph).

2. Short-term memory consists of a single component, whereas working memory consists of a number of components.

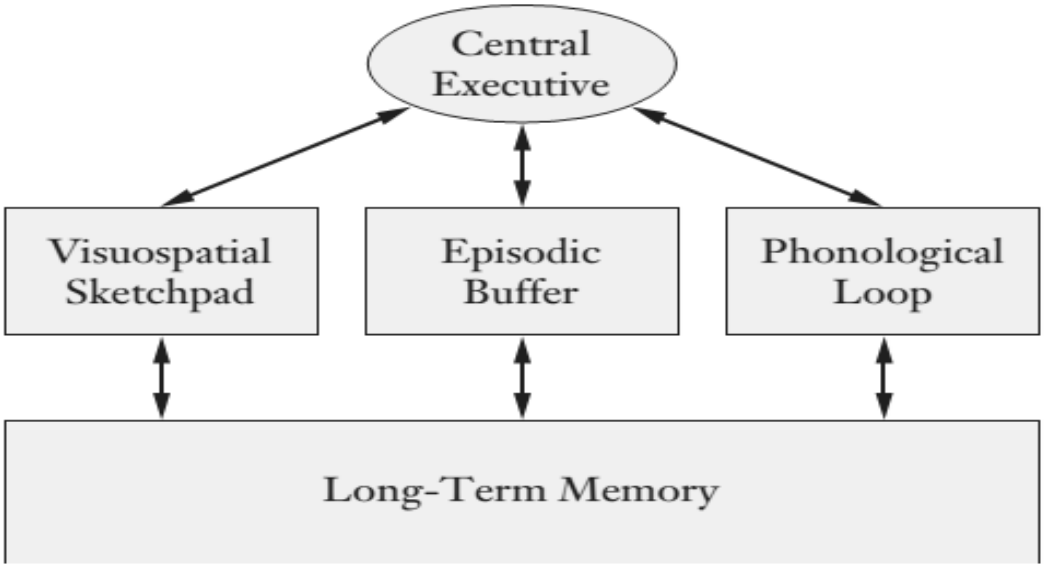


Baddeley's working memory model

Components of Working Memory

Working-memory approach proposed by Baddeley, our immediate memory is a multipart system that temporarily holds and manipulates information as we perform cognitive tasks. Working memory accomplishes the manipulation of information through the action of three components;

1. The phonological loop
2. The visuospatial sketch pad
3. The central executive



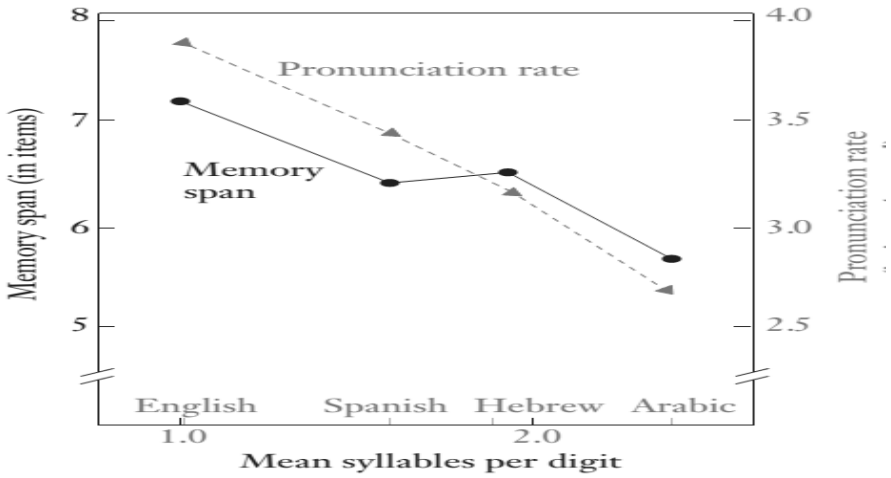
Based on Baddeley (2000b)

Baddeley and Hitch (1974) provided convincing evidence that working memory is not unitary. Random string of numbers and reasoning task – *BA*, B follows A, requiring yes answer. *AB*, A follows B, requiring no answer. String of numbers' length did not increase errors. This study contradicts Miller's magic seven in STM.

Phonological Loop

It holds limited number of sounds for a limited time

You can pronounce country names such as Burma and Greece fairly quickly, so you can rehearse a large number of them quickly. In contrast, you can pronounce only a limited number of longer names, such as Switzerland and Nicaragua. When you need to rehearse a large number of these long names, some will inevitably be lost from the phonological loop



Pronunciation Time

Researchers also report that the relationship between pronunciation time and recall accuracy holds true, whether you actually pronounce the words aloud or use subvocalization, pronouncing the words silently

Visuo-spatial sketchpad

- Processes both visual and spatial information. This sketchpad allows you to look at a complex scene and gather visual information about objects and landmarks. It also allows you to navigate from one location to another.
- Has limited storage like phonological loop
- The visuospatial sketchpad allows you to store a coherent picture of both the visual appearance of the objects and their relative positions in a scene
- The visuospatial sketchpad also stores visual information that you encode from verbal stimuli

The Central Executive

- Integrates information from the phonological loop, the visuospatial sketchpad, the episodic buffer, and from long-term memory
- Most researchers emphasize that the central executive plans and coordinates, but it does not store information

The Episodic Buffer

Approximately twenty-five years after Alan Baddeley proposed his original model of working memory, he proposed a fourth component of working memory called the episodic buffer.

The episodic buffer serves as a temporary storehouse where we can gather and combine information from the phonological loop, the visuospatial sketchpad, and long-term memory.

Functions of Components Of Working Memory

Research on Acoustic Confusions

A classic study by Conrad and Hull (1964) showed participants two kinds of lists of letters of the English alphabet. Some lists featured letters that had similar-sounding names, such as the sequence C, T, D, G, V, B. Other lists featured letters with different-sounding names, such as the sequence C, W, Q, K, R, and X. The participants correctly recalled more letters from the second list, where the sounds were different People confuse acoustically similar sounds with one another when they are rehearsing the items, not when these items are simply stored in the phonological loop. Suppose, for example, that you want to remember the sequence of letters mentioned above: C, T, D, G, V, B. Dylan and his colleagues (2004) suggest that you try to pronounce these letters in order to repeat them silently to yourself. You may stumble and silently pronounce the wrong sound. The phonological loop plays a crucial role in our daily lives, beyond its obvious role in working memory for example; we use it on simple counting tasks. Try counting the number of words in the previous sentence, for example. Can you hear your "inner voice" saying the numbers silently?

- Now try counting the number of words in that same sentence, but rapidly say the word the while you are counting. When your phonological loop is preoccupied with saying the, you cannot perform even a simple counting task!
- The phonological loop plays an important role in reading,

The Phonological Loop is active when we acquire new vocabulary words in our first language and in a foreign language. It helps with mathematical calculations and problem-solving tasks in order to keep track of numbers and other information. It is important whenever you are working on a complex task that requires you to remember the task instructions for an extended period of time.

Visuospatial Sketchpad

On one occasion, Baddley decided to listen to a football game while driving along a California freeway. In order to understand the game, he tried to form clear, detailed images of the scene and the action. While creating these images, however, he discovered that his car began drifting out of its lane!

Students in psychology and other social sciences use the phonological loop more often than the visuospatial sketchpad. However, students in disciplines such as engineering, art, and architecture frequently use visual coding and the visuospatial sketchpad in their academic studies. Watching television, you cannot use spatial imagery and watch television, this kind of task has both spatial and visual components.

Visuospatial Sketchpad in everyday life

Look at several objects that are within your reach. Now close your eyes and try to touch one of these objects. Your sketchpad allowed you to retain a brief image of that scene while your eyes were closed. Visuospatial sketchpad is activated when trying to find way from one location to another useful in many leisure activities, such as videogames, jigsaw puzzles, and games involving a maze.

The Central Executive

It plays a major role in focusing attention, planning strategies, transforming information, and coordinating behavior and is responsible for suppressing irrelevant information. It controls or monitors day dreaming. There are individual differences in central executive functions. There is much less research on central executive than phonological loop.

The Episodic Buffer

As the component of working memory where auditory, visual, and spatial information can be combined with the information from long-term memory. This arrangement helps to solve the theoretical problem of how working memory integrates information from different modalities. It actively manipulates information so that you can interpret an earlier experience, solve new problems, and plan future activities.

Suppose that you are thinking about an unfortunate experience that occurred yesterday, when you unintentionally said something rude to a friend. You might review this event and try to figure out whether your friend seemed offended; naturally, you'll need to access some information from your long-term memory about your friend's customary behavior. You'll also need to decide whether you do have a problem, and, if so, how you can plan to resolve the problem.

Working Memory and Brain

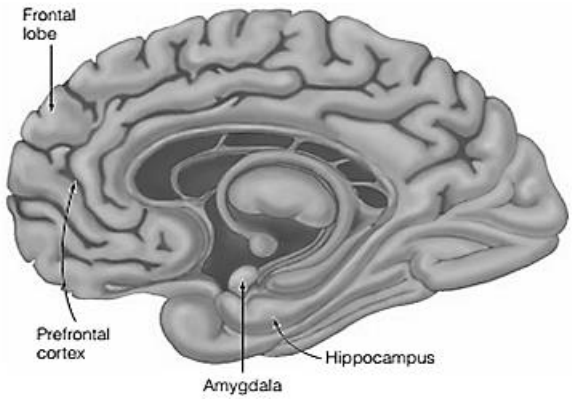
Cross section of the brain showing some of the key structures involved in memory

The major methods for studying brain are:

(1) Analysis of behavior after brain damage, either animal (Method: Brain Ablation) or human (Method: Dissociations in Neuropsychology

(2) Recording from single neurons in animals

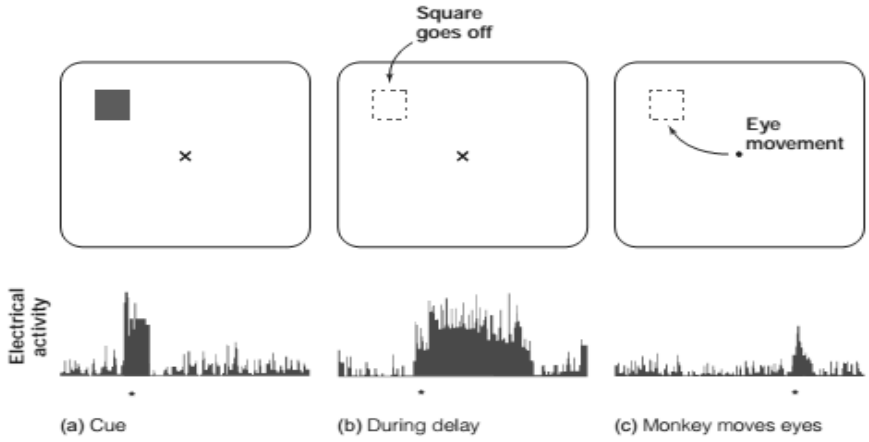
(3) Recording electrical signals from the human brain (Method: Event-Related Potential and measuring activity of the human brain (Method: Brain Imaging).



Cross section of the brain showing some of the key structures involved in memory

An important characteristic of memory is that it involves delay or waiting. Something happens, followed by a delay, which is brief for working memory; then, if memory is successful, the person remembers what has happened. Researchers, therefore, have looked for physiological mechanisms that hold information about events after they are over.

If their prefrontal cortex is removed, their performance drops to chance level, so they pick the correct food well only about half of the time. This result supports the idea that the prefrontal (PF) cortex is important for holding information for brief periods of time. Infants under 8 months, out of sight out of mind, having seen an object act as if it didn't exist after its hidden. Their frontal and prefrontal cortex does not become adequately developed until about 8 months of age.

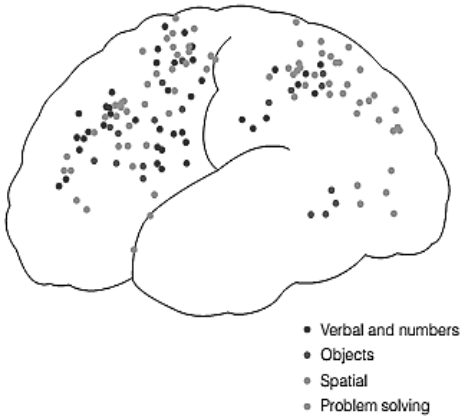


Neurons have been found that remain activated after an object has been moved

Working Memory and Brain Processes

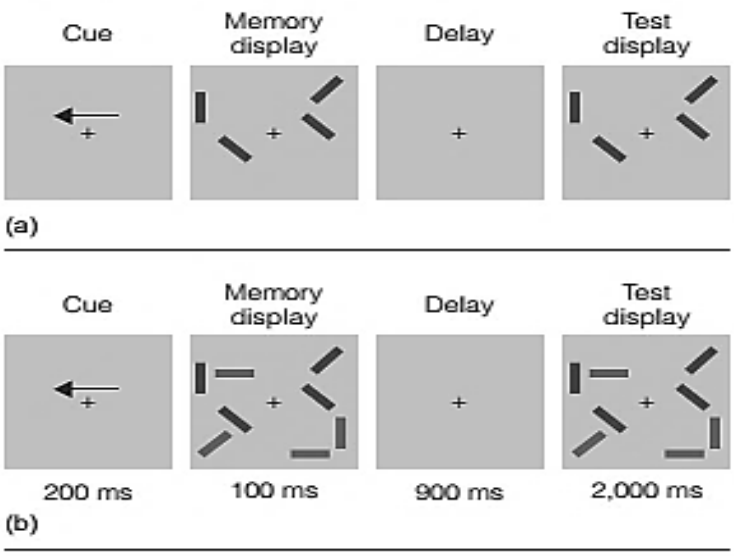
Research has also found neurons that are involved with working memory in other areas of the brain, including the primary visual cortex, which is the first area of the brain to receive visual signals and the temporal and parietal areas, where visual information is transmitted from the primary visual cortex. Although the PF cortex may be the brain area that is most closely associated with working memory, other areas are also involved.

This figure summarizes the findings from many experiments using imaging techniques of PET and fMRI to measure brain activity in humans. As a person carries out a working memory task, activity occurs in the prefrontal cortex and in other areas as well, in addition to the prefrontal cortex, other areas in the frontal lobe and also areas in the parietal lobe and the cerebellum are involved in working memory. Some of the areas in the cortex that have been shown by brain imaging research to be involved in working memory. The colored dots represent the results of more than 60 experiments that tested working memory for words and numbers (red), objects (blue), spatial location (orange), and problem solving (green).



Workings of Working Memory

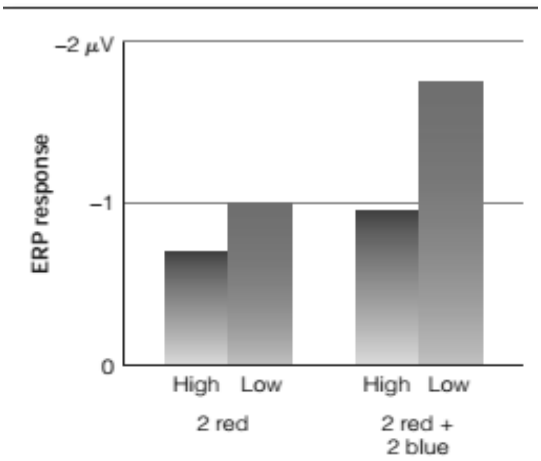
Central executive focuses attention on items important for a task and ignores items that are not relevant to the task. Vogel and colleagues measured even related potential ERP to see allocation of attention. The response measured was related to encoding items in working memory, so a larger ERP response means more space used in working memory.



Sequence for the Vogel et. al (2005) task

The arrow in this example tells the participant to pay attention to the left side of the memory and test displays. The task is to indicate if the red rectangles on the attended side are the same or different in the two displays. (a) Display with two red rectangles on each side of the display. (b) Display with two blue rectangles added to each side. The participant is told to ignore the blue rectangles.

They separated participants into two groups based on their performance on a test of working memory. Participants in the high memory capacity group were able to hold a number of items in working memory; participants in the low memory capacity group were able to hold fewer items in working memory.



The key finding is that performance is about the same for high- and low-capacity participants when only the red rectangles are present (left pair of bars), but although adding the two blue rectangles has little effect for the high-capacity participants, it causes an increase in the response for the low capacity participants (right pair of bars)

Adding the two blue rectangles had little effect on the response of the high-capacity group means that these participants were very efficient at ignoring the distractors, so the irrelevant blue stimuli did not

take up any space in working memory. Allocating attention is a function of the central executive, this means that the central executive was functioning well for these participants

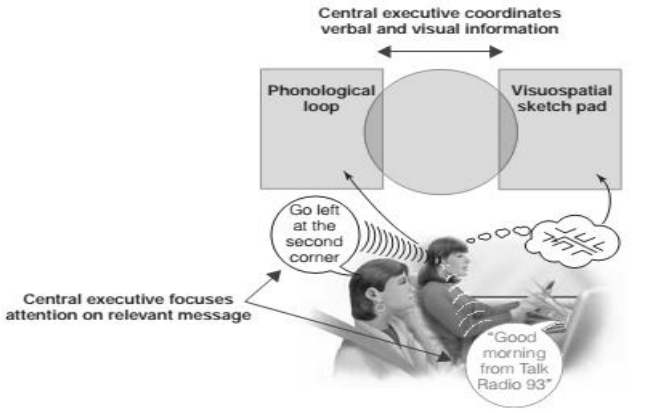
The low-capacity group was not able to ignore the irrelevant blue stimuli, blue rectangles were taking up space in working memory. The central executive of these participants is not operating as efficiently as the central executives of the high-capacity participants Conclusion; some people's central executives are better at allocating attention than others' .

Why is it important

Other experiments have shown that people with more efficient working memories are more likely to perform well on tests of reading and reasoning ability and on tests designed to measure intelligence. It also means better reading Span; storage and processing functions of working memory and success in comprehension tests.

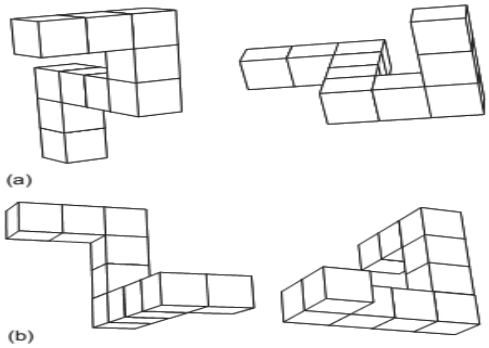
Experiments on Visuospatial Sketchpad

Tasks processed by the phonological loop (hearing directions; listening to the radio) and visuospatial sketch pad (visualizing the route) being coordinated by the central executive. The central executive also helps the person ignore the messages from the radio, so attention can be focused on hearing the direction. The visuospatial sketch pad handles visual and spatial information and is therefore involved in the process of visual imagery- the creation of visual images in the mind in the absence of a physical visual stimulus.

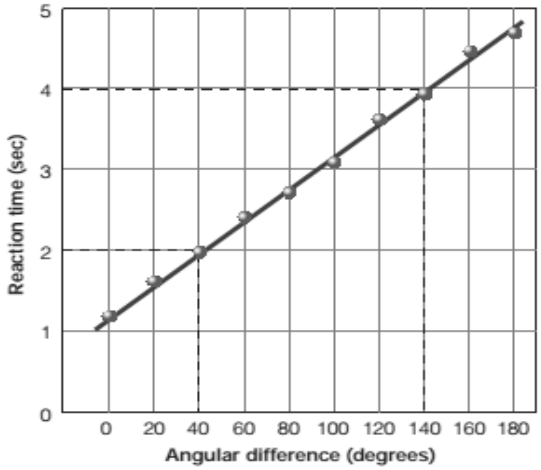


Demonstration; Comparing Objects

Look at the two pictures in Figure **a** and decide, as quickly as possible, whether they represent two different views of the same object ("same") or two different objects ("different"). Also make the same judgment for the two objects in Figure **b**.



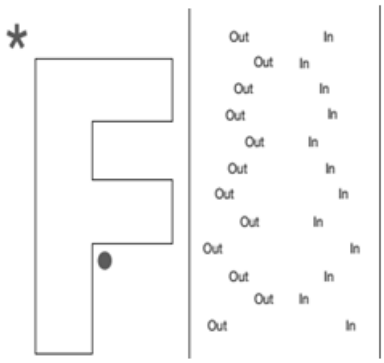
- When Shepard and Metzler measured participants' reaction time to decide whether pairs of objects were the same or different, they obtained the relationship shown here for objects that were the same.
- It took 2 seconds to decide that a pair was the same shape, but for a difference of 140 degrees (like Figure b), it took 4 seconds.
- Participants were solving the problem by rotating an image of one of the objects in their mind.



- It took 2 seconds to decide that a pair was the same shape, but for a difference of 140 degrees (like Figure b), it took 4 seconds
- Participants were solving the problem by rotating an image of one of the objects in their mind

This mental rotation is an example of the operation of the visuospatial sketch pad because it involves visual rotation through space

Most people find that the pointing task is more difficult. The reason is that holding the image of the letter and pointing are both visuospatial tasks, so the visuospatial sketch pad becomes overloaded. In contrast, saying "**Out**" or "**In**" is an articulatory task that is handled by the phonological loop, so speaking didn't interfere with visualizing the **F.**



In exams often, thoughts rush in about how prepared you are for the exam, how hard it's likely to be, and so on. These anxious thoughts often exhaust students' working memory capacity and make it difficult for them to perform well. The researchers created a testing situation that put particular pressure on students (by promising them a monetary reward if they did well).

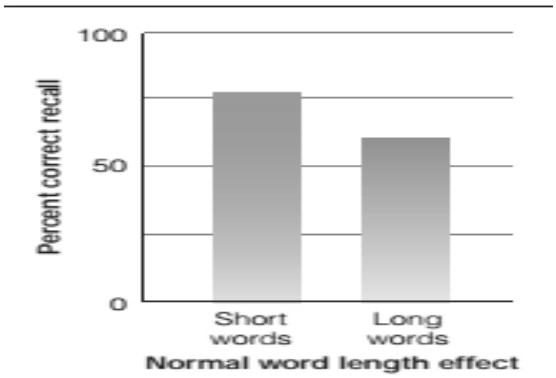
The researchers assigned a subset of the students to a control group. Those students sat quietly for 10 minutes waiting for the exam to start. The other students experienced an intervention: They spent the same 10 minutes "writing about their thoughts and feelings regarding the math problems they were about to perform". The thoughts and feelings, expressed, no longer compete for the students' working

memory capacity in the exam; the students in the expressive writing group performed better than the control group on math problems

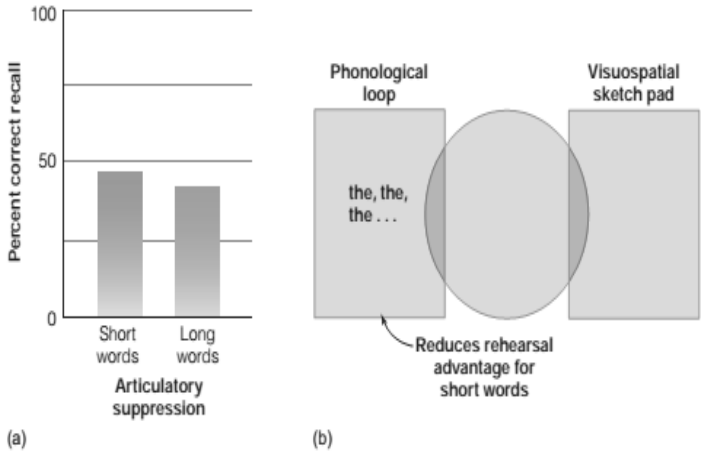
Experiments on Phonological Loop

- The phonological similarity effect is the confusion of letters or words that sound similar
- In a memory test people often confuse similar sounding letters, such as "F" and "S."
- The idea of auditory coding; phonological similarity effect occurs when words are processed in the phonological store part of the phonological loop
- Memory suffers for similar items because they are confused with one another

The word length effect occurs when memory for lists of words is better for short words than for long words.



- One way that the operation of the phonological loop has been studied is by determining what happens when its operation is disrupted.
- when a person is prevented from rehearsing items to be remembered by repeating an irrelevant sound, "the, the, the . . ." (Baddeley, 2000b)
- This repetition of an irrelevant sound results in a phenomenon called articu**latory suppression**, reduces memory because speaking interferes with rehearsal.
- According to the word length effect, a list of one-syllable words should be easier to recall than a list of longer words because the shorter words leave more space in the phonological loop for rehearsal. However, eliminating rehearsal by saying "the, the, the . . ." eliminates this advantage for short words, so both short and long words are lost from the phonological store.



The Episodic Buffer

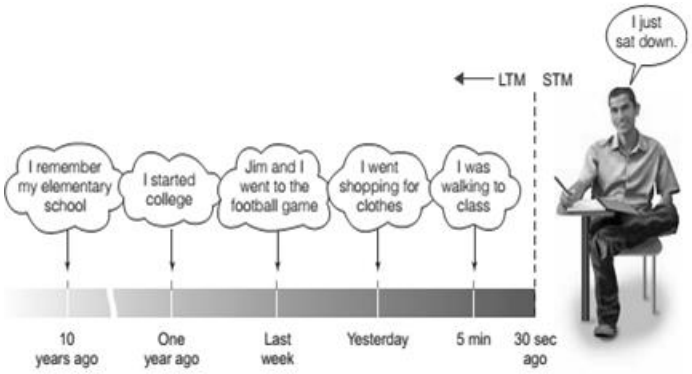
- Approximately twenty-five years after Alan Baddeley proposed his original model of working memory, he proposed a fourth component of working memory called the episodic buffer.
- The episodic buffer serves as a temporary storehouse where we can gather and combine information from the phonological loop, the visuospatial sketchpad, and long-term memory.

Lecture 26

LONG TERM MEMORY

Long Term Memory

Two basic categories called working memory (the brief, immediate memory for material we are currently processing) and long-term memory. Long-term memory has a large capacity; it contains our memory for experiences and information that we have accumulated over a lifetime.



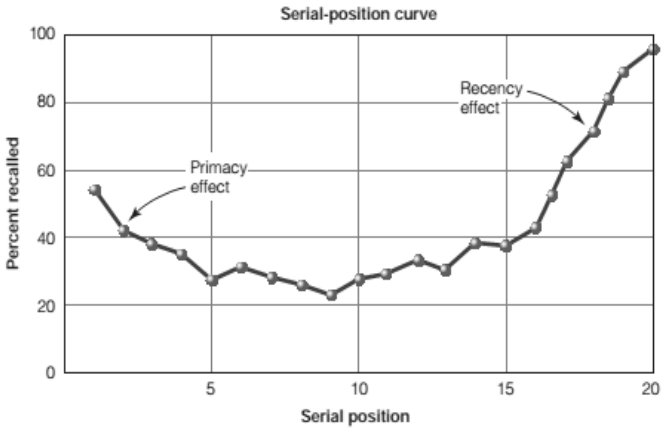
Long term memory (LTM) is the storehouse of all the experiences, events, information, emotions, skills, words, categories, rules, and judgments that have been acquired from sensory and short-term memories. LTM constitutes each person's total knowledge of the world and of the self.

Division of Long-term Memory

1) **Semantic memory**; Describes our organized knowledge about the world, including knowledge about words and other factual information.
2) **Procedural memory**; Knowledge about how to do something, how to ride a bicycle, and how to send an e-mail message to a friend.
3) **Episodic Memory** allows us to travel backward in subjective time to reminisce about earlier episodes in our life includes memory for an event that occurred ten years ago, as well as a conversation 10 minutes ago; covers a long span; all of this student's memories, except the memory "I just sat down" and anything the student was rehearsing, would be classified as long-term memories.

When psychologists speak of long-term memory, it is with the knowledge that memories often last a lifetime. Therefore, whatever theory explains how memories are acquired for the long term must also explain how they can remain accessible over the life course.

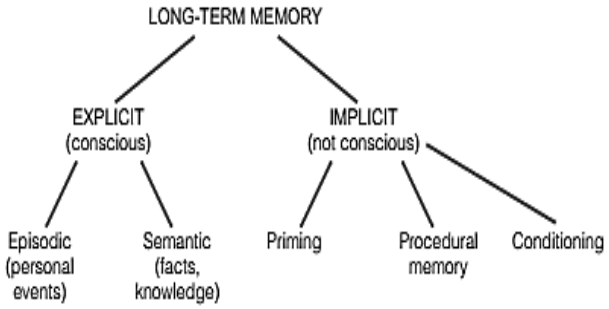
- Encoding refers to initial acquisition of information; during encoding, information is embedded in our memory.
- Retrieval refers to locating information in storage and accessing that information
- Autobiographical memory refers to memory for events and topics related to our own everyday life.



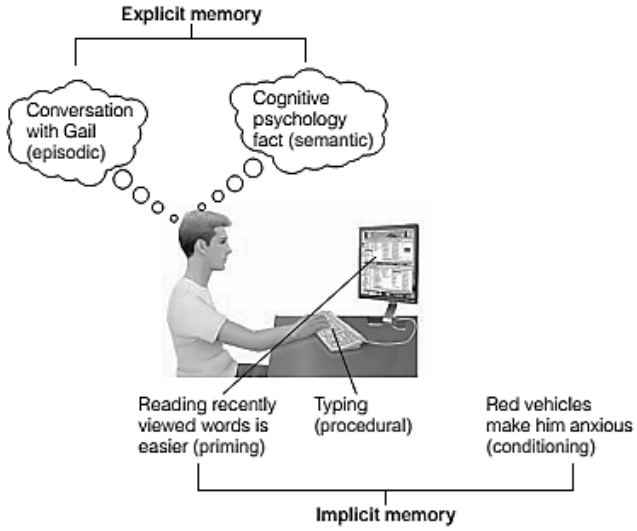
Serial position curves (Murdoch, 1962)

Memory is better for words presented at the beginning of the list (primacy effect) and at the end (recency effect). Three types of coding; acoustic, visual and semantic can occur in LTM. Semantic coding is the predominant type of coding in LTM. Errors that people make in tasks that involve LTM, e.g. misremembering the word tree as bush would indicate that the meaning of the word tree (rather than its visual appearance or the sound of saying "tree") is what was registered in LTM.

Long-term memory can be divided into **explicit memory** and **implicit memory**. We can also distinguish between two types of explicit memory, episodic and semantic. There are a number of different types of implicit memory. Three of the main types are priming, procedural memory, and conditioning.



This person is experiencing two types of explicit memory (episodic and semantic), and his behavior is being influenced by three types of implicit memory (priming, procedural, and conditioning).



Episodic memory involves mental time travel-the experience of traveling back in time to reconnect with events that happened in the past; this experience of mental time travel/episodic memory is described as self-knowing or remembering by **Tulving**. The experience of semantic memory involves accessing knowledge about the world that does not have to be tied to remembering a personal experience. It involves facts, vocabulary, numbers, and concepts. When we experience semantic memory, we are not traveling back to a specific event from our past, but we are accessing things we are familiar with and know about.

Types of Rehearsal

- **Maintenance rehearsal** ; helps maintain information in STM/WM, but it is not an effective way of transferring information into long-term memory
- **Elaborative rehearsal**; more effective at transferring information into LTM; it occurs when you think about the meaning of an item or make connections between the item and something you know.

Fergus Craik and **Robert Lockhart** (1972) proposed the idea of levels of processing (LOP). LOP Theory proposes that memory depends on how information is encoded. "Deeper" processing means better encoding and retrieval than "shallow" processing. Meaningful kinds of information processing can lead to more permanent retention than shallow, sensory kinds of processing.

- Memory depends on how information is programmed into the mind
- **Shallow processing** means paying attention to physical features of a word for example, CAPITAL or small letters, number of vowels = maintenance rehearsal
- **Deeper processing** involves paying close attention and focusing on meaning of words and relating them to something = elaborative rehearsal

Craik and Tulving's experiment

1. Shallow processing: A question about physical features of the word

Question: Is the word printed in capital letters?

Word: bird

2. Deeper processing: A question about rhyming

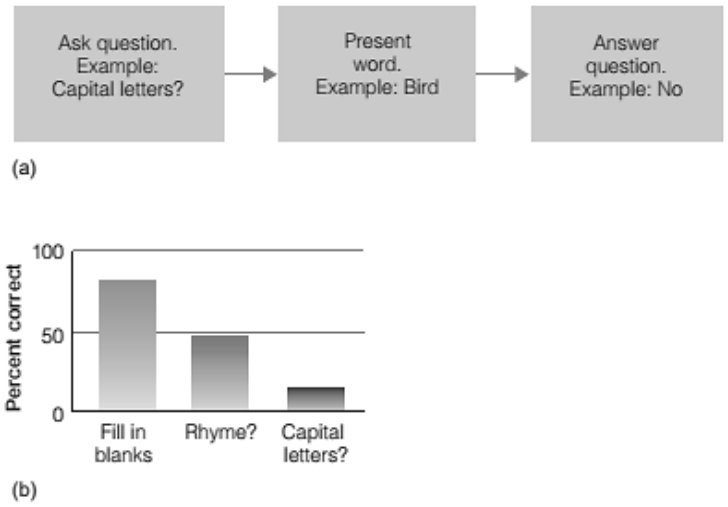
Question: Does the word rhyme with train?

Word: pain

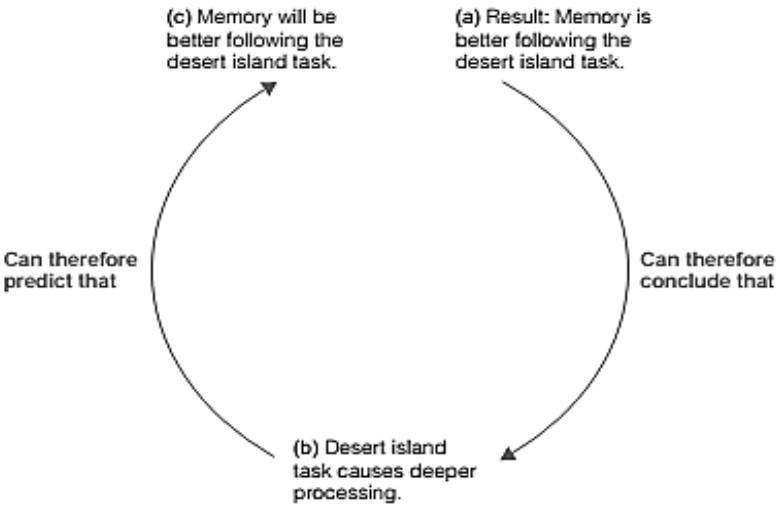
3. Deepest processing: fill-in-the-blank

Question: Does the word fit into the sentence "He saw a……. on the street"?

Word: car



(a) Sequence of events in Craik and Tulving's (1975) experiment. (b) Results of this experiment. Deeper processing (fill-in-the blanks question) is associated with better memory.



There is a difficulty in defining depth of processing due to circular reasoning.

Yet it has inspired a lot of research. Main conclusion of levels-of-processing theory is that memory retrieval is affected by how items are encoded.

Remembering Lists

Count the number of vowels in each word and then go right on to the next one.

- Chair
- Mathematics
- Elephant
- Lamp
- Car
- Elevator
- Thoughtful
- Cactus

Instructions: Count backward by 3s from 100. When you get to 76, write down the words you remember

Part 2. Cover and uncover each word one by one. This time, visualize how useful the item might be if you were stranded on an uninhabited island. When you get to the end of the list, follow the instructions.

- Umbrella
- Exercise
- Forgiveness
- Rock

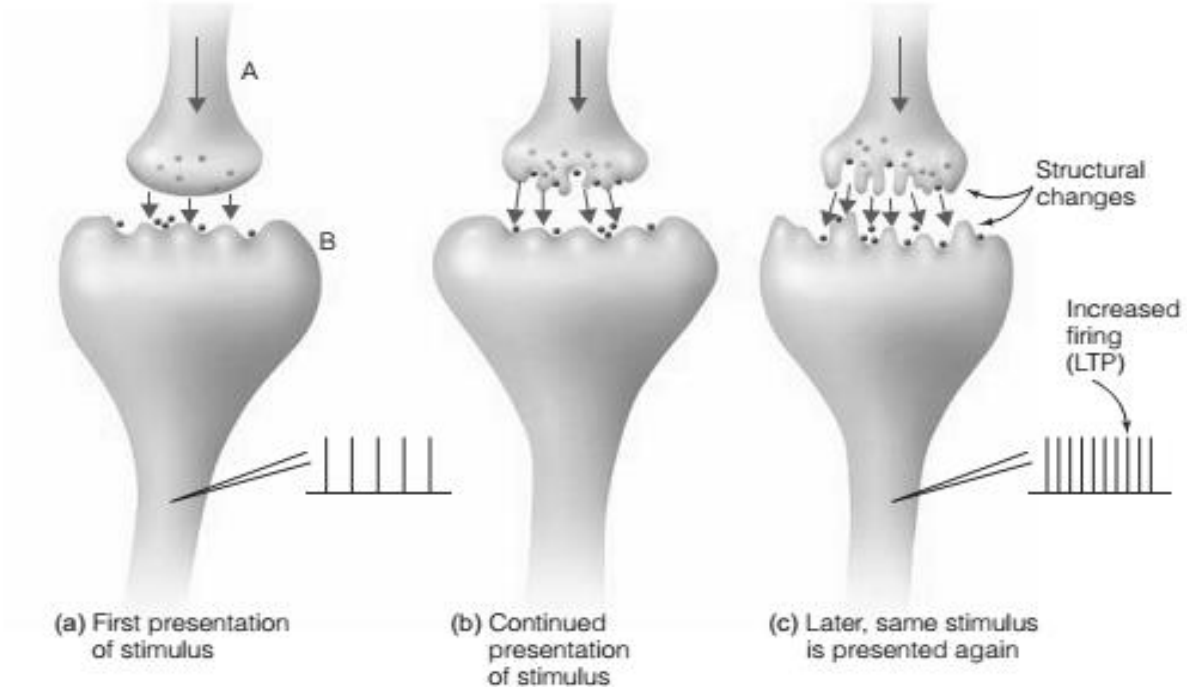
- Hamburger
- Sunlight
- Coffee
- Bottle

Instructions: Count backward by 3s from 99. When you reach 75, write down the words you remember.

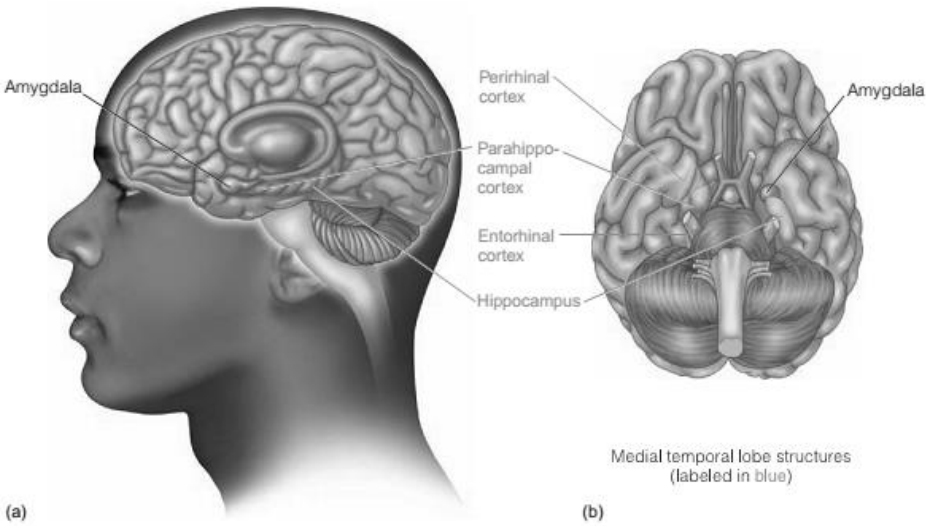
Locating Memory in the Brain

Hebb (1948) introduced the idea that learning and memory are represented in the brain by physiological changes that take place at the synapse. A particular experience causes nerve impulses to travel down the axon of neuron A, and when these impulses reach the synapse, neurotransmitter is released onto neuron B. This activity strengthens the synapse by causing structural changes, greater transmitter release, and increased firing (b and c).

What happens at a synapse as a stimulus is first presented. The record next to the electrode indicates the rate of firing recorded from the axon of neuron B. (b) As the stimulus is repeated, structural changes are beginning to occur. (c) After many repetitions, more complex connections have developed between the two neurons, which causes an increase in the firing rate.

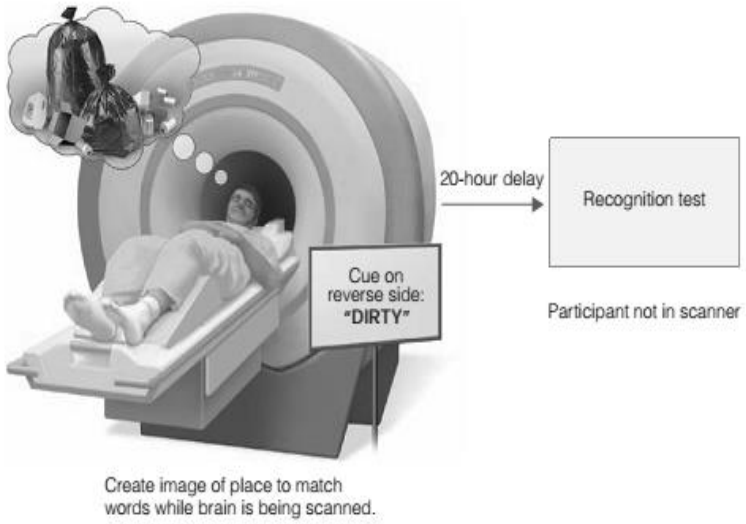


Changes that occur in the hundreds or thousands of synapses that are activated by a particular experience provide a neural record of the experience.



a) Side view of the brain and (b) underside of the brain, showing the amygdala and structures in the medial temporal lobe (perirhinal cortex, Para hippocampal cortex, entorhinal cortex, and hippocampus) Medial temporal lobe (MTL), which contains the structures shown in Figure

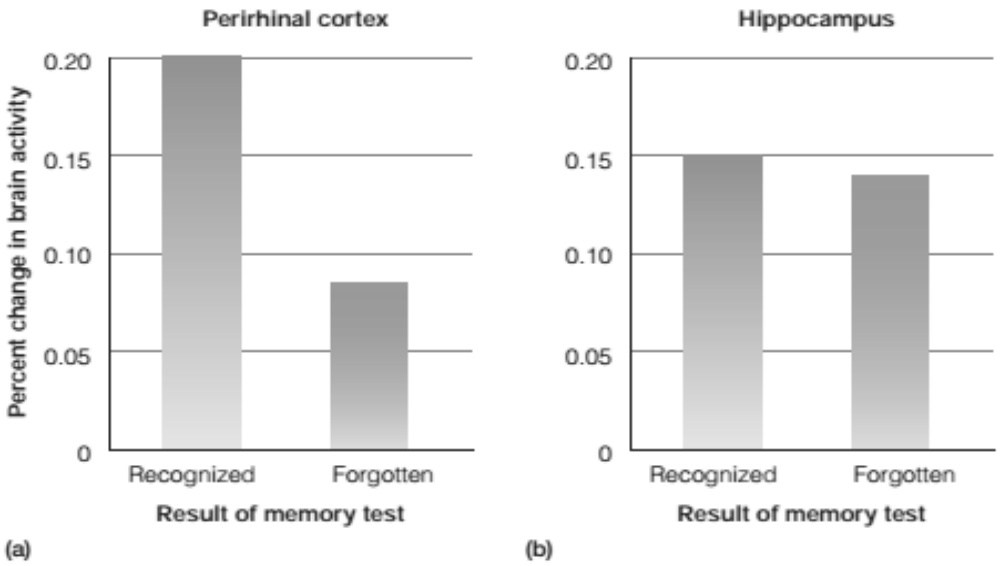
One of the most clearly established facts about memory and the brain is that the hippocampus, one of the structures in the MTL, is crucial for forming new LTMs.



Design of Davachi's experiment

During encoding, participants in a scanner created images in their mind in response to words. During retrieval 20 hours later, the participants' task was to recognize the words they had seen

participants remembered 54 percent of the old words (said “yes” to an old word) and forgot the remaining 46 percent (they said “no” to an old word).



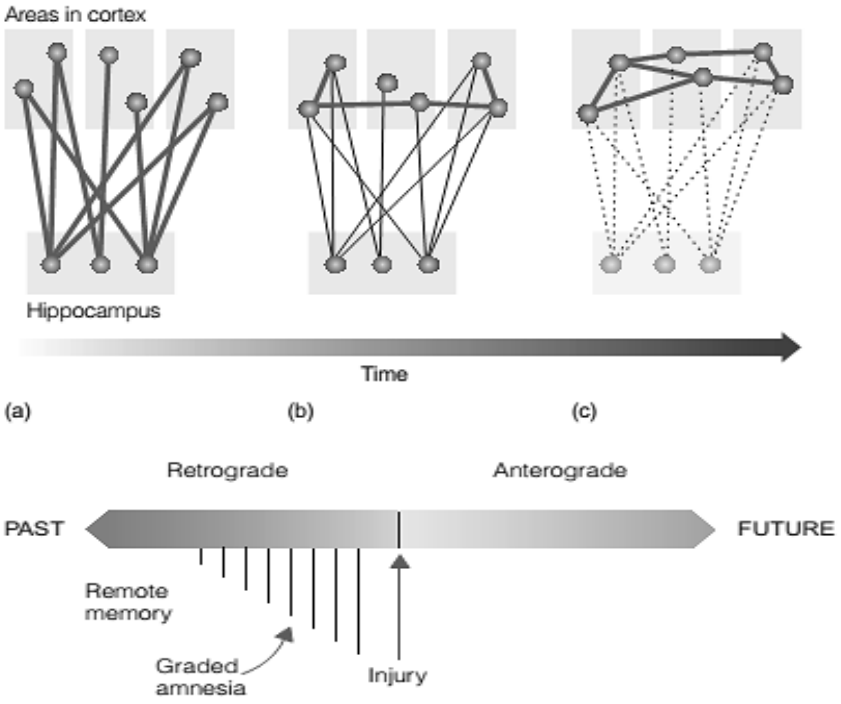
(a) Response in perirhinal cortex during encoding for items that were recognized and forgotten in the retrieval test. (b) Response of the hippocampus for recognized and forgotten item.

The **hippocampus** is important for aspects of memory other than recognition, such as remembering the context within which an object appears, it plays a crucial role in forming new memories, the Para hippocampal area responds to places, such as pictures of buildings or rooms), and the enthorhinal area, like the perirhinal area, is involved with recognition memory.

Many areas are involved in maintaining LTM, they serve different functions and these areas communicate and interact with each other But LTM extends beyond the MTL, to other areas in the parietal and frontal lobes, as well as to the amygdala which is important for emotional memories. New memories are fragile state, can be disrupted.

Consolidation

Consolidation is the process that transforms them to a more permanent state so they are resistant to disruption. Synaptic consolidation occurs at synapses, happens rapidly, over a period of minutes, involves the structural changes. Systems consolidation involves the gradual reorganization of circuits within brain regions, takes place on a longer time scale, lasting weeks, months, or even years.



Accessing semantic memory is involved in answering general knowledge questions

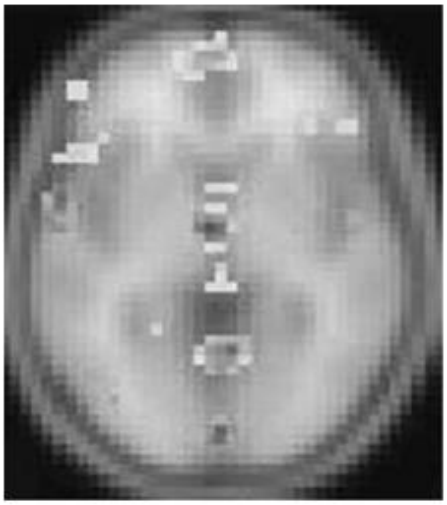
The Separation of Episodic and Semantic Memories

Neurophysiological evidence from patients with brain damage

- K.C., at the age of 30 rode his motorcycle off a freeway exit ramp and suffered severe damage to his hippocampus and surrounding structures, can no longer relive any of the events of his past. He does know that certain things happened, which would correspond to semantic memory.
- An Italian woman who was in normal health until she suffered an attack of encephalitis at the age of 44 had difficulty recognizing familiar people; had trouble shopping because she couldn't remember the meaning of words on the shopping list or where things were in the store; and she could no longer recognize famous people or recall facts like identity of Beethoven or that Italy was involved in World War II.

Brain imaging Experiments

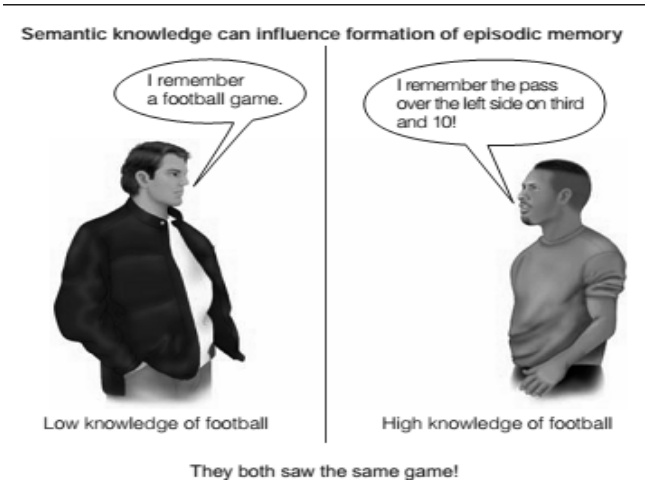
Brian Levine and coworkers (2004), participants keep diaries on audiotape describing everyday personal events and facts drawn from their semantic knowledge, later listened to these audiotaped descriptions while in an MRI scanner, the recordings of everyday events elicited detailed episodic autobiographical memories (people remembered their experiences), while the other recordings simply reminded people of semantic facts.



Brain showing areas activated by episodic and semantic memories

- The yellow areas represent brain regions associated with episodic memories; the blue areas are regions associated with semantic memories.
- Researches indicate that while there is overlap between activation caused by episodic and semantic memories, there are major differences. Other research has also found differences between the areas activated by episodic and semantic memory.

- Episodic memories can be lost; leaving only semantic memories- I may forget when did I learn a particular fact or knowledge for example table of 9 but this table is embedded in my memory.
- Semantic memories that have personal significance are easier to remember. Name of a famous singer whom concert we attended.
- Semantic Memory Can Influence Our Experience by Influencing Attention.



Endel Tulving (1985) has suggested that episodic and semantic memory can also be distinguished based on the type of experience associated with each. Episodic memory involves mental time travel-the experience of traveling back in time to reconnect with events that happened in the past; this experience of mental time travel/episodic memory is described as self-knowing or remembering

The experience of semantic memory is described as 'knowing', we access knowledge about the world, doesn't have to be tied to a personal experience. Facts, vocabulary, numbers, and concepts.

We are not traveling back to a specific event from our past, but we are accessing things we are familiar with and know about for example which countries are in Asia and which team won world cup in cricket.

Implicit memory in Lab and Every day Experience

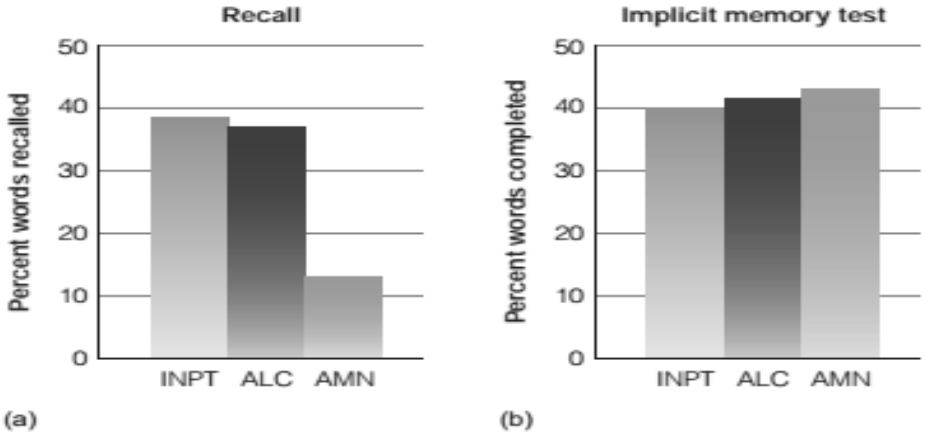
Explicit memory is conscious. Implicit memory occurs when some previous experience influences our performance on a task, even though we do not consciously remember the previous experience. We may not even be aware of exactly how we are accomplishing a particular task; we just do it.

Priming occurs when the presentation of one stimulus (the priming stimulus) changes the response to a subsequent test stimulus (the test stimulus), either positively (positive priming, causes an increase in speed or accuracy of the response to the test stimulus) or negatively (negative priming, a decrease in the speed or accuracy of response to the test stimulus). Repetition priming, occurs when the test stimulus is the same as or resembles the priming stimulus. For example, seeing the word bird may cause you to respond more quickly to another presentation of the word bird than to a word you had not seen, even though you may not remember seeing bird earlier.

Conceptual priming occurs when the enhancement caused by the priming stimulus is based on the meaning of the stimulus. For example, presentation of the word furniture might cause you to respond faster to a later presentation of the word chair. Repetition and conceptual priming both considered implicit memory; their effects can occur even though participants may not remember the original presentation of the priming stimulus when responding to the test stimulus.

Experiments on patients with amnesia

Results of the Graf et al. (1985)



(a) The results of the recall test indicate that the amnesic patients (AMN) did poorly on the test compared to the medical inpatients (INPT) and the alcoholic controls (ALC). (b) The results

of the implicit memory test, in which the task was to complete three-letter word stems, shows that the amnesic patients performed as well as the other patients.

Implicit Memory in Everyday Experience:

- Effect of advertisement exposure.
- Perfect and Askew (1994), had participants scan articles and not pay attention to advertisements, they gave higher ratings to the ones they had been exposed to than to other advertisements that they had never seen.

The Propaganda Effect

Participants more likely to rate statements they have read or heard before as being true, because they have been exposed to them before. This effect can occur even when the person is told that the statements are false when they first read or hear them (Begg et al., 1992). Involves implicit memory because it can operate even when people are not aware that they have heard a statement before, and may even have thought it was false when they first heard it.

Eyewitness to crime

Implicit memory can lead to memory errors; eyewitnesses to crimes have identified people as having been at the crime scene not because they were actually there, but because the eyewitnesses had seen them somewhere else at another time, so they seemed familiar.

Lecture 27

COGNITIVE PROCESSES

Knowledge and Semantic Memory

We will learn in this module about how our previous knowledge can influence processes of memory such as visual and auditory recognition, how the senses gather stimuli from the outside world, and how these stimuli are then interpreted by our previous knowledge.

- Research has also looked at how these stimuli from the outside world are stored in memory.
- In everyday life we are paying attention to more than one message at a time. Our previous knowledge may influence which message we choose to process and which we choose to ignore.
- When our memory systems use techniques like chunking to store information, our previous knowledge helps in process of chunking.
- Our knowledge provides the kind of expertise that enhances long-term memory, and it can influence our memory for the events in our lives.
- Our knowledge can help us organize information in order to recall it more accurately.
- When we apply general principles such as the rotation heuristic and the alignment heuristic, our previous knowledge can distort our memories of spatial relationships, making them more regular than they actually are.

Knowledge and Semantic Memory

All these cognitive processes rely on general knowledge, demonstrating again that our cognitive processes are interrelated. An average English language speaker knows 20000 to 40,000 words Each of these words are associated with some knowledge about facts for example we know the words cat, car and tomato. we also know that cat has fur, car is a vehicle, tomato is a vegetable.

- Cities, names, history and general facts are all stored in a knowledge base in our system.
- Children acquire knowledge as they grow up, knowledge about environment, about moving objects about other people around them and huge amount of social knowledge.
- Wisdom is also acquired as we age. The wisdom comes with knowledge gathered through experience through learning from the experiences and through transmission of knowledge from elders and books.
- Semantic memory includes encyclopedic knowledge (“Allama Iqbal was born in…….)
- Lexical or language knowledge (e.g., “The word justice is related to the word equality”)

- Conceptual knowledge ("A square has four sides")
- Knowledge influences our cognitive activities; we determine locations, read sentences, solve problems, and make decisions.
- Categories and concepts are essential components of semantic memory.

Concepts and Categorization

Imagine that you find yourself in an unfamiliar town, where you have never been before. As you walk down the street, you notice that many things are not exactly the same as what you would encounter if you were in your own town. On the other hand, there are lots of things that seem familiar. Cars pass by, there are buildings on either side of the street and a gas station on the corner, and a cat dashes across the street and makes it safely to the other side. Luckily, you know a lot about cars, buildings, gas stations, and cats, so you have no trouble understanding what is going on. You know about the various components of this street scene because your mind is full of concepts.

A **concept** is a mental representation that is used for a variety of cognitive functions, including memory, reasoning, and using and understanding language (Solomon et al., 1999). Thus, when you think about cats, you are drawing on your concept, or mental representation, of cats, which includes information about what cats are, what they usually look like, how they behave, and so on.

By far the most commonly studied function of concepts is **categorization**, which is the process by which things are placed into groups called categories. For example, when you see vehicles in the street you can place them into categories such as cars, SUVs, jeeps, vans, Japanese cars, and local manufactured cars. Categories are not simply convenient ways of sorting objects. They are tools that are essential for our understanding of the world.

One of the most important functions of categories is to help us to understand individual cases we have never seen before. Categories have therefore been called "pointers to knowledge" (Yamauchi & Markman, 2000). Once you know that something is in a category, whether "cat," "gas station," or "impressionist painting," you know a lot of general things about it and can focus your energy on specifying what's special about this particular object (see Solomon et al., 1999; Spalding & Murphy, 1996).

Being able to place things in categories can also help us understand behaviours that we might otherwise find baffling. For example, you see three boys running on street with Pakistani flag painted on their faces, wearing green shirts and singing, if you know that a cricket match is going on in city and our national team is playing against a neighbour country, you will easily understand this behaviour. Dealing with new objects becomes easier and we can function more efficiently when we face new objects that can be placed in a previously known category.

The following points about this topic will help you prepare for exam questions and summarise your knowledge.

- A category is a set of objects that belong together; the category called "fruit" represents a certain category of food items; cognitive system treats these objects as being equivalent
- The term concept refers to our mental representations of a category (Wisniewski, 2002)
- Academic courses require us to form concepts, for example concept of intelligence in Psychology course, concept of words ending with 'ing' in English
- Semantic memory gathers similar but different objects under a category. This helps to reduce storage space, helps in making new inferences for example 'Food' concept, 'fruit' category; even child can infer that everything in fruit category is for eating.
- When we encounter new objects, it is easier to make inferences, understand and interpret if that object can be placed in a category. Let us look at concept of 'viruses. it can have many categories but talking about a new virus makes it easy to understand if we already have the concept of virus. Same can be said about concept of disease. there are viral diseases, infectious diseases and so on.
- The concepts expand knowledge beyond available information. We may not have all available information about a new virus but we know the concept of virus and that expands available information.
- According to an early theory, called the feature comparison model, concepts are stored in memory according to a list of necessary features or characteristics.
- According to an early theory, called the feature comparison model, concepts are stored in memory according to a list of necessary features or characteristics and people use a decision process to make judgments about these concepts.
- Defining features; those attributes that are necessary to the meaning of the item.
- Characteristic features; attributes that are merely descriptive but are not essential.
- Defining features of a parrot are; it is living, has feathers, is green, whereas characteristic features of a parrot are; it flies, perches in trees, is small in size.

An Exercise about Categories

- Feature comparison model; concepts stored in memory according to a list of necessary features or characteristics; people use a decision process to make judgments about these concepts.
- In the sentence verification technique, people see simple sentences, and they must consult their stored semantic knowledge to determine whether the sentences are true or false.

The Sentence Verification Technique

For each of the items below, answer as quickly as possible either "True" or "False."

1. A poodle is a dog.
2. A squirrel is an animal.
3. A flower is a rock.
4. A carrot is a vegetable.
5. A mango is a fruit.
6. A petunia is a tree.
7. A robin is a bird.
8. A rutabaga is a vegetable.

Research on Feature Comparison

- **The typicality effect**; people reach decisions faster when an item is a typical member of a category, rather than an unusual member. Carrot is a typical member, rutabaga is not. **Sloman** and **colleagues (**1998), asked college students, if they could they imagine an example of a concept that lacked a given characteristic, imagine a robin that didn't fly, didn't eat, didn't have feathers, and didn't have a red breast. The results showed that the participants did not believe that any specific feature is absolutely necessary in order to qualify for the category of "robin."

- **Problems with features model**; Research does not support that category membership is based on a specific list of necessary, defining features. it also does not explain how members of a category are related to each other. there are assumptions that features are independent and finally features are correlated for objects in nature; for example, objects with fur have legs, those with leaves, have no legs.

Placing Objects in Categories

- How do we decide which objects are similar? Objects in a given category are different from one another. Each of four approaches to semantic memory has a slightly different perspective on the nature of similarity. The feature comparison model is based on the similarity between an item and a list of features that are necessary for category membership. The prototype model is based on the similarity between an item and an idealized object that represents the category.

- Most theorists believe that each model may be at least partly correct. Each model can account for some aspect of semantic memory. In fact, it's unlikely that the wide variety of concepts would all be represented in the same way in our semantic memory.

- Look at these two pictures, a and b.

Picture a:

Picture b:

The picture a, is as you will say an example of a truck. Think about features that makes you place it in 'truck' category. Now look at picture b. you can guess it is not truck but closer to a rickshaw. what features made you place this in 'Rickshaw 'category?

Simpler organisms, such as animals and human infants, also have concepts (Mareschal, Quinn, & Lea, 2010). Squirrels may have a concept of predators, for example, that is specific to their own lives and experiences. However, animals likely have many fewer concepts and cannot understand complex concepts such as mortgages or musical instruments.

Influences of Typicality on Cognition
• **Typical items are judged category members more often** (Hampton, 1979).
• **Speed of categorization is faster for typical items** (Rips, Shoben, & Smith, 1973).
• **Typical members are learned before atypical ones** (Rosch & Mervis, 1975).
• **Learning a category is easier if typical examples are provided** (Mervis & Pani, 1980).
• **In language comprehension, references to typical members are understood more easily** (Garrod & Sanford, 1977).
• **In language production, people tend to say typical items before atypical ones (e.g., "apples and lemons" rather than "lemons and apples")** (Onishi, Murphy, & Bock, 2008).

Lecture 28

THE PROTOTYPE AND THE EXEMPLAR APPROACH

The Prototype Approach

Given the importance of categories, cognitive psychologists have been interested in determining the process involved in categorizing objects. According to the definitional approach to categorization, we can decide whether something is a member of a category by determining whether a particular object meets the definition of the category. Definitions work well for some things, such as geometric objects. Thus, defining a square as "a plane figure having four equal sides" works. However, for most natural objects (such as birds, trees, and plants) and many humans made objects (like chairs), definitions do not work well at all.

The philosopher Wittgenstein (1953) proposed the idea of family resemblance to deal with the problem that definitions often do not include all members of a category. Family resemblance refers to the idea that things in a particular category resemble one another in a number of ways. Thus, instead of setting definite criteria that every member of a category must meet, the family resemblance approach allows for some variation within a category. Chairs may come in many different sizes and shapes and be made of different materials, but every chair does resemble other chairs in some way.

According to the prototype approach to categorization, membership in a category is determined by comparing the object to a prototype that represents the category. A prototype is a "typical" member of the category. What is a typical member of a particular category? Elinor Rosch (1973) proposed that the "typical" prototype is based on an average of members of a category that are commonly experienced. For example, the prototype for the category "birds" might be based on some of the birds you usually see, such as sparrows, robins, and blue jays, but doesn't necessarily look exactly like a particular type of bird. High Prototypicality means that a category member closely resembles the category prototype (it is like a "typical" member of the category). Low Prototypicality means that the category member does not closely resemble a typical member of the category. Rosch (1975a) quantified this idea by presenting participants with a category title, such as "bird" or "furniture," and a list of about 50 members of the category. The participants' task was to rate the extent to which each member represented the category title on a 7-point scale, with a rating of 1 meaning that the member is a very good example of what the category is, and a rating of 7 meaning that the member fits poorly within the category or is not a member at all. the figure below shows results of his experiment. The 1.18 rating for sparrow reflects the fact that most people would agree that a sparrow is a good example of a bird (figure a). The 4.53 rating for penguin and 6.15 for bat reflects the fact that penguins and bats are not considered good examples of birds. Similarly, chair and sofa(rating = 1.04) are considered very good examples of furniture, but mirror(4.39) and telephone(6.68) are poor examples (Figure b). The idea that sparrows are a better example of "bird" than penguins or bats is not very surprising.

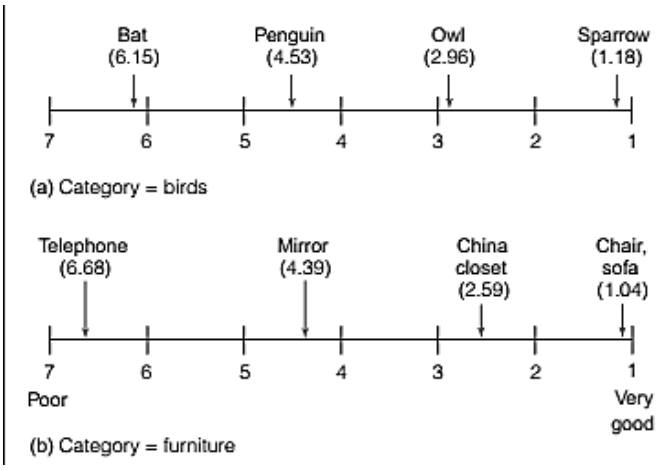


Figure 1.

Demonstration

Family Resemblance; please carry out this demonstration.

Rosch and Mervis's (1975) instructions were as follows: For each of the following common objects, list as many characteristics and attributes that you feel are common to these objects. For example, for bicycles you might think of things they have in common like two wheels, pedals, handlebars, you ride on them, they don't use fuel, and so on. For dogs you might think of things they have in common like having four legs, barking, having fur, and so on. Give yourself about a minute to write down the characteristics for each of the following items: chair; sofa; mirror; telephone.

If you responded like Rosch and Mervis's participants, you assigned many of the same characteristics to chair and sofa. For example, chairs and sofas share the characteristics of having legs, having backs, you sit on them, they can have cushions, and so on. It is likely, however, that your list contains far less overlap for mirror and telephone, which are also members of the category "furniture" (see Figure 1. b). When an item's characteristics have a large amount of overlap with the characteristics of many other items in a category, this means that the family resemblance of these items is high; little overlap means the family resemblance is low. Rosch and Mervis showed that there was a strong relationship between family resemblance and prototypicality, because items high on prototypicality had high family resemblance. Thus, good examples of the category "furniture," such as chair and sofa, share many attributes with other members of this category; poor examples, like mirror and telephone, do not. In addition to the connection between prototypicality and family resemblance, researchers have determined the following connections between prototypicality and behavior.

- Statements about Prototypical objects are verified rapidly. Edward Smith and coworkers (1974) used a procedure called the sentence verification technique to determine how rapidly people could answer questions about an object's category.

Method

Sentence Verification Technique

The procedure for the sentence verification technique is simple. Participants are presented with statements and asked to answer "yes" if they think the statement is true and "no" if they think it isn't. They used the following two statements:

1. An apple is a fruit.
2. A pomegranate is a fruit.

When Smith and coworkers (1974) used this technique, they found that participants responded faster for objects that are high in Prototypicality (like apple for the category "fruit") than they did for objects that are low in prototypicality (like pomegranate). This ability to judge highly prototypical objects more rapidly is called the typicality effect. My guess is that if we used these two fruits, pomegranate will not have much difference in prototypicality as 'Anar' is a local Pakistani fruit and will be considered as prototypical as apple. As an assignment carry out this exercise with two vegetables that are more typical like potato and one that is less typical like French beans.

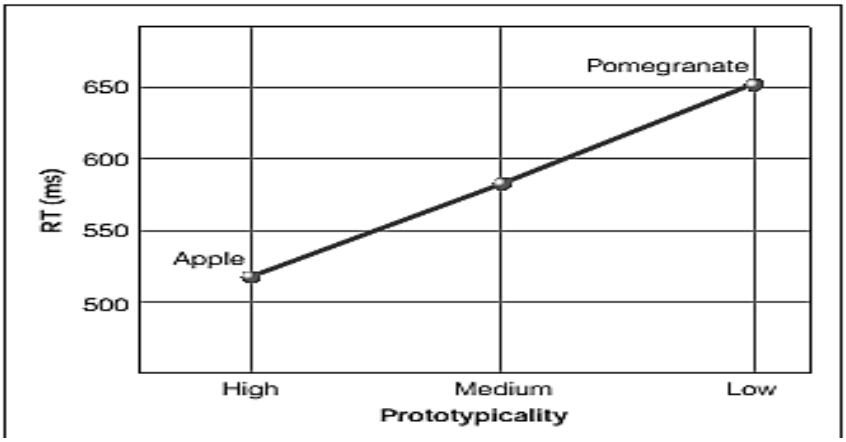


Figure 2; results of the experiment. Reaction times were faster for prototypical fruits.

- Prototypical objects are named first;
  When participants are asked to list as many objects in a category as possible, they tend to list the most prototypical members of the category first (Mervis et al., 1976). Thus, for "birds," sparrows would be named before penguins.

- Prototypical objects are affected more by Priming.

  Priming occurs when presentation of one stimulus facilitates the response to another stimulus that usually follows closely in time. Rosch (1975b) demonstrated that prototypical members of a category are affected by a priming stimulus more than are no prototypical members. The procedure for Rosch's experiment is shown in Figure 3. Participants first heard the prime,

which was the name of a color, such as "green." Two seconds later they saw a pair of colors side by side and indicated, by pressing a key as quickly as possible, whether the two colors were the same or different.

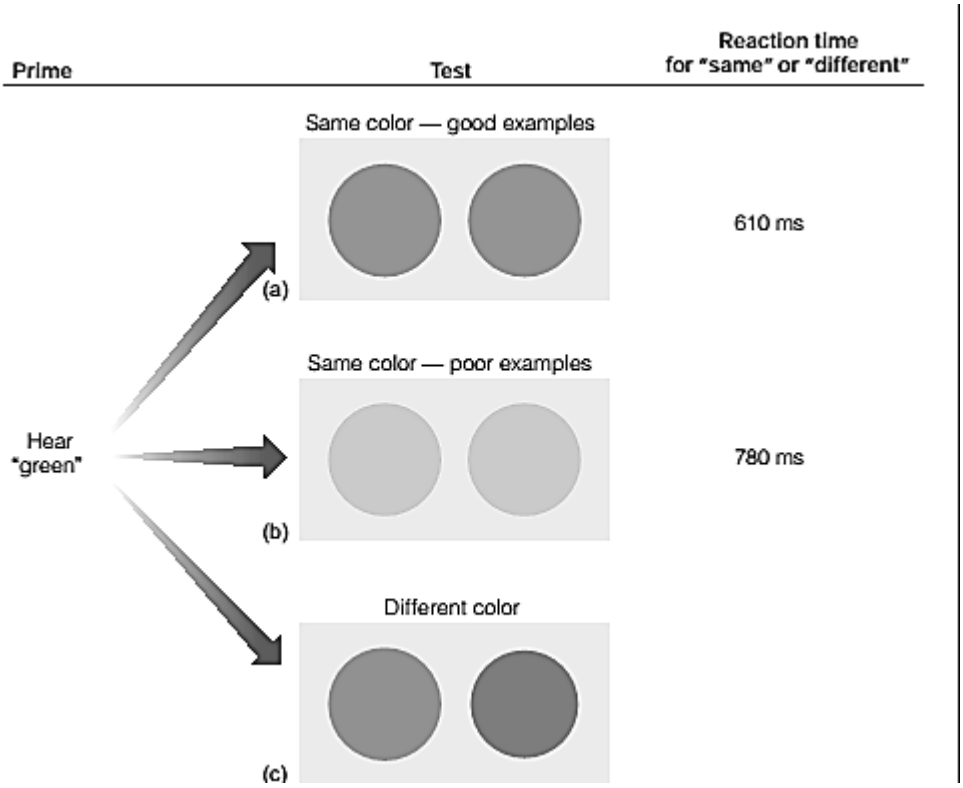


Figure 3; Procedure for Rosch's (1975b) priming experiment. Results for the conditions when the test colors were the same are shown on the right. (a) The person's "green" prototype matches the good green, but (b) is a poor match for the light green.

Eleanor Rosch; we organize each category on the basis of a prototype, the item that is most typical and representative of the category. We decide whether an item belongs to a category by comparing that item with a prototype. If the item is similar to the prototype, you include that item in the category. Robin is a bird because it matches ideal prototype for a bird. An example of an item sufficiently different from prototype, is a bee that is placed in category "insect".

A robin and a sparrow are very prototypical birds, whereas ostriches and penguins are no prototypes Think of prototypes for a student or for category furniture. Think of no prototypes. For example, characteristics of a "bachelor" are male and unmarried but you will probably not place your 85-year-old uncle as a typical member of that category although he is not married and is a male.

Table 1 shows ratings for words in 3 categories obtained in an experiment Consult text book for complete description

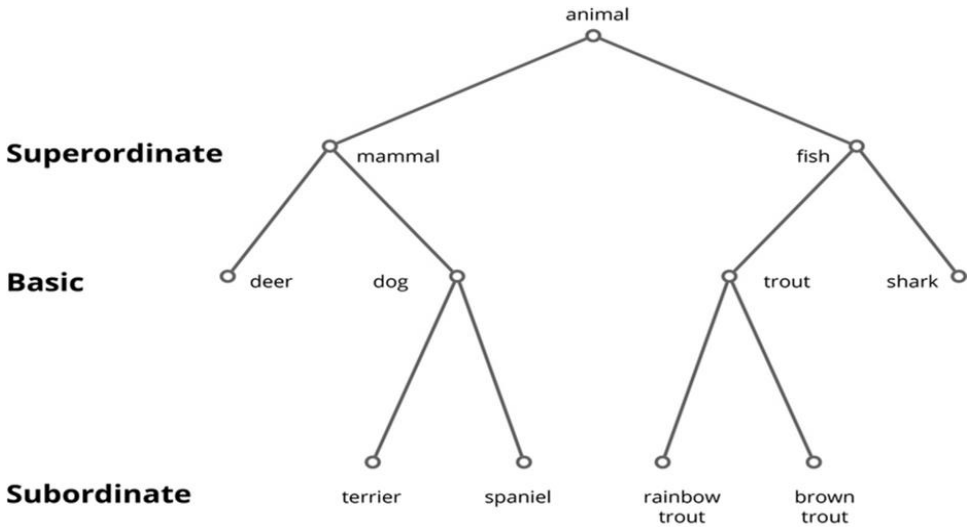
Prototype Ratings for Words in Three Categories.

Item	Vehicle	Vegetable	Clothing
1	Car	Peas	Pants
2	Truck	Carrots	Shirt
3	Bus	String beans	Dress
4	Motorcycle	Spinach	Skirt
5	Train	Broccoli	Jacket
6	Trolley car	Asparagus	Coat
7	Bicycle	Corn	Sweater
8	Airplane	Cauliflower	Underwear
9	Boat	Brussels sprouts	Socks
10	Tractor	Lettuce	Pajamas
11	Cart	Beets	Bathing suit
12	Wheelchair	Tomato	Shoes

Source: Rosch & Mervis, 1975.

Levels of Categorization

- Superordinate; higher-level or more general categories; furniture, sciences, tools
- Basic; Moderately specific, chair, biological sciences, screwdriver; more useful than either superordinate-level categories or subordinate-level categories
- Subordinate; lower-level or more specific categories, Desk chair, molecular genetics, Philips screw driver.



Different levels of categorization activate different regions of the brain

- **Superordinate terms** (e.g., Toy) are more likely than basic-level terms (e.g., doll) to activate part of the prefrontal cortex. And as you know, pre-frontal cortex plays an important role in reasoning and memory.
- **Subordinate terms** (e.g., rag doll) are more likely than basic-level terms (e.g., doll) to activate part of the parietal region of the brain.

- McCloskey and Glucksberg (1978) found that when people made repeated category judgments such as "Is an olive a fruit?" or "Is a sponge a kitchen utensil?" they changed their minds about borderline items—up to 22 percent of the time. So, not only do people disagree with one another about borderline items, they disagree with themselves! As a result, researchers often say that categories are *fuzzy*, that is, they have unclear boundaries that can shift over time.

Influences of Typicality on Cognition
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The Exemplar Approach

- The exemplar approach argues that we first learn some specific examples of a concept; then we classify each new stimulus by deciding how closely it resembles those specific examples.
- Each of those examples stored in memory is called an exemplar.
- Case studies of depression in Abnormal Psychology, a description of a woman with psychological problems fits depression cases but not anxiety cases.

Exemplars and Typicality

A. For the first part of this demonstration, write the numbers 1 through 7 in a column. Then, next to the appropriate number, write the first example that comes to mind for each of the following categories:

1. Amphibian

2. Bird
3. Fish
4. Insect
5. Mammal
6. Microorganism
7. Reptile

B. For the second part of the demonstration, look at each of the items you wrote. Rate how typical each item is for the category "animal." 1 = not at all typical, and 10 = very typical. For example, if you wrote barracuda on the list, supply a number between 1 and 10 to indicate the extent to which barracuda is typical of an animal.

C. Final part; rate each of the seven categories in Part A in terms of how typical each category is for the superordinate category "animal."

Use the same rating scale as in Part B.

Heit and Barsalou (1996) wanted to determine whether the exemplar approach could explain the structure of several superordinate categories, such as "animal." When people make judgments about animals, do they base these judgments on specific exemplars or general prototypes? Heit and Barsalou (1996) asked a group of undergraduates to supply the first example that came to mind for each of the seven basic-level categories in Part A of Demonstration 8.2. Then a second group of undergraduates rated the typicality of each of those examples, with respect to the superordinate category "animal." For instance, this second group would rate each example—such as frog or salamander—in terms of whether it was typical of the concept "animal." That second group also rated the seven basic-level categories. (To make the demonstration simpler—though not as well controlled—you performed all three tasks.) Heit and Barsalou (1996) wanted to see whether they could create an equation that would accurately predict—for the category "animal"- the typicality of the rating of the seven categories "amphibian," "bird," "fish," and so on based on the exemplars generated in a task like Task A of Demonstration. Specifically, they took into account the frequency of each of those exemplars. For example, the basic level category "insect" frequently produced the exemplar bee but rarely produced the exemplar Japanese beetle. They also took into account the typicality ratings, similar to those you provided in Task B of the demonstration. The information about exemplar frequency and exemplar typicality did accurately predict which of the seven categories were most typical for the superordinate category "animal" (Task C). In fact, the correlation between the predicted typicality and the actual typicality was $r = +.92$, indicating an extremely strong relationship. For example, mammals were considered the most typical animals, and microorganisms were the least typical.

The prototype approach suggests that our categories consider only the most typical items (Wisniewski, 2002). If this proposal is correct, then we can forget about the less typical items, and our categories would not be substantially changed. In another part of their study, Heit and Barsalou

(1996) tried eliminating the less typical exemplars from the equation. The correlation between predicted typicality and actual typicality decreased significantly.

Notice the implications of this study: Suppose that you are asked a question such as, "How typical is an insect, with respect to the category 'animal'?" To make that judgment, you don't just take into account a very prototypical insect—perhaps a combination of a bee and a fly. Instead, you also include some information about a caterpillar, a grasshopper, and maybe even a Japanese beetle.

"How typical is an insect, with respect to the category 'animal'?" To make that judgment, you don't just take into account a very prototypical insect—perhaps a combination of a bee and a fly. Instead, you also include some information about a caterpillar, a grasshopper, and maybe even a Japanese beetle.

Comparing two approaches

- The prototype approach says that this stored representation is a typical member of the category.
- In contrast, the exemplar approach says that the stored representation is a collection of numerous specific members of the category.
- Not features of depressed people or a typical depressed person.
- The exemplar approach argues that creating a list of characteristics or a prototypical person would force you to discard useful, specific data about individual cases.
- Problem with exemplar approach; too many examples to store, hence may be more suitable for categories with few members e.g., Tropical fruit.
- The prototype approach may be more suitable when considering a category that has numerous members; may be the most efficient approach for a large category such as "fruit" or animal."
- There may be individual differences among people in using these approaches; some may store as specific exemplars, some store as generic categories.

Lecture 29

PROBLEM SOLVING

Problem Solving

A problem occurs when there is an obstacle between a present state and a goal and it is not immediately obvious how to get around the obstacle (Lovett, 2002). A problem is difficult, and the solution is not immediately obvious.

There are many kinds of problems we have to solve. When students were asked about their problems they came up with following list;

- Completing assignments on time.
- Solving chemistry or statistics problems.
- Dealing with class fellows and colleague.
- Deciding which Courses to choose.
- Which career to choose?
- Paying fee on time.
- Learning to use a new software.

- Some problems are well defined as you can see in the above list. Well defined problems usually have a correct answer; certain procedures, when applied correctly, will lead to a solution such as mathematical problems.

- Some problems are ill defined. These occur frequently in our everyday life and do not necessarily have one "correct" answer, and the path to their solution is often unclear for example relationships dealing or choosing a career.

Gestalt approach to problem solving

As we know the Gestalt psychologists were primarily interested in perception. They did study other aspects of cognition like problem solving. When they studied other areas, they applied the perceptual approach. According to Gestalt approach the successful solution depends on how problem is represented in the brain. Therefore, the solution is obtained by first perceiving the object and then representing it in a different way. Problem solving, for the Gestalt psychologists, was about (1) how people represent a problem in their mind and (2) how solving a problem involves a reorganization or restructuring of this representation.

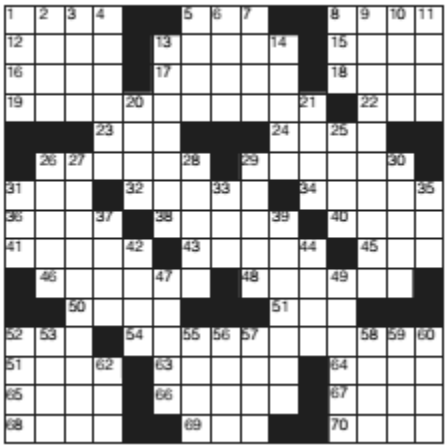
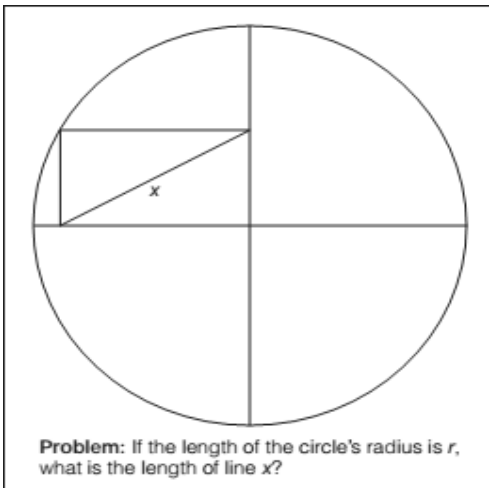


Figure 1

A cross word puzzle type of problem is represented on the page by a diagram and clues about how to fill in the open squares. How this problem is represented in the mind is probably different for different people, but it is likely to differ from how it is represented on the page. For example, as people try to solve this problem, they may choose to represent only a small part of the puzzle at a time. Some people might focus on filling in horizontal words and then use these words to help determine the vertical words. Others might pick one corner of the puzzle and search in their mind for both verticals and horizontals that fi t together. Each of these ways of going about solving the problem involves a different way of representing it in the mind.

One of the central ideas of the **Gestalt approach** is that success in solving a problem is influenced by how it is represented in the person's mind. This idea—that the solution to a problem depends on how it is represented—is illustrated by the problem in figure 2.

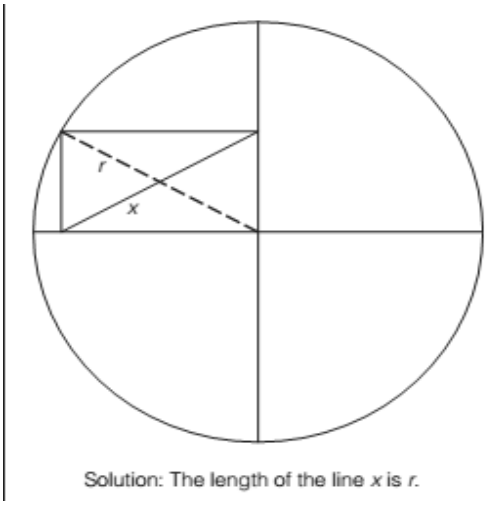


This problem, which was posed by Gestalt psychologist Wolfgang Kohler (1929), asks us to determine the length of the segment marked x if the radius of the circle has a length r.

One way to describe how this problem is represented on the page is "a circle with vertical and horizontal lines that divide the circle into quarters, with a small triangle in the upper left quadrant." The key to solving this problem is to change the last part of the representation to "a small rectangle in the upper left quadrant, with x being the diagonal between the corners." Once x is recognized as the diagonal of the rectangle, the representation can be reorganized by creating the rectangle's other diagonal (Figure 3). Once we realize that this diagonal is the radius of the circle, and that both diagonals of a rectangle are the same length, we can conclude that the length of x equals the length of the radius, r.

This solution does not require mathematical equations. Instead, the solution is obtained by first perceiving the object and then representing it in a different way. The Gestalt psychologists called the process of changing the problem's representation restructuring.

Figure 3



Solution: The length of the line *x* is *r*.

There will be some problems presented to you as part of your assignments.

The **Gestalt psychologists** also introduced the idea that restructuring is associated with insight—the sudden realization of a problem's solution. The Gestalt psychologists assumed that people solving their problems were experiencing insight because the solutions usually seemed to come to them all of a sudden.

Modern researchers have debated whether insight actually exists. Some point out that people often experience problem solving as an "Aha!" experience—at one point they don't have the answer, and the next minute they have solved the problem—which is one of the characteristics associated with insight problems (Bowden et al., 2005; Kounios et al., 2008). Other researchers have emphasized the lack of evidence, other than anecdotal reports, to support the specialness of the insight experience (Weisberg, 1995; Weisberg & Alba, 1981, 1982).

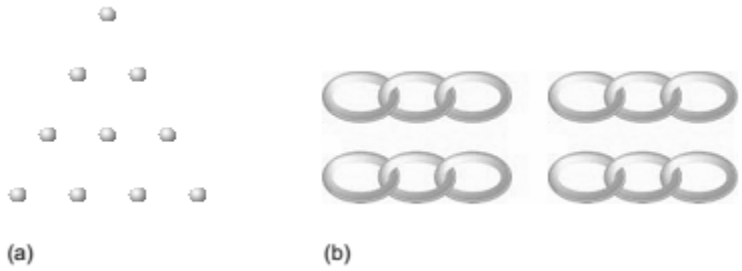


Figure 4

(a) Triangle problem and (b) chain problem for "Two Insight Problems" demonstration.

The triangle shown in Figure 4 points to the top of the page. Show how you can move three of the circles to get the triangle to point to the bottom of the page.

Chain problem

A woman has four pieces of chain. Each piece is made up of three links, as shown in Figure 4b. she wants to join the pieces into a single closed loop of chain. To open a link costs 2 cents and to close a link costs 3 cents. She has only 15 cents. How does she do it? For non-insight problems, Metcalfe and Wiebe used algebra problems like the following, which were taken from a high school mathematics text.

Solve for x: $(1/5)x + 10 = 25$
Factor $16y^2 - 40yz + 25z^2$

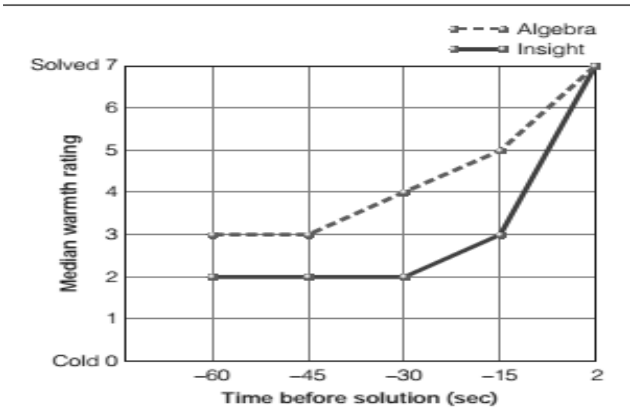
The results of their experiment are shown in Figure 5, which indicates the median warmth ratings for all of the participants during the minute just before they solved the two kinds of problems.

For the insight problems (solid line), warmth ratings remain low at 2 or 3 until just before the problem is solved. Notice that 15 seconds before the solution, the median rating is a relatively cold 3 for the insight problems. In contrast, for the algebra problems (dashed line), the ratings gradually increased until the problem was solved. Thus, Metcalfe and Wiebe demonstrated a difference between insight and non-insight problems. The solution for problems that have been called insight problems does, in fact, occur suddenly, as measured by people's reports of how close they feel they are to a solution.

The Gestalt psychologists believed that restructuring was usually involved in solving insight problems, so they focused on these types of problems. Their research strategy was to devise problems and situations that made it difficult for people to achieve the restructuring needed to

solve the problem. They hoped to learn about processes involved in problem solving by studying obstacles to problem solving.

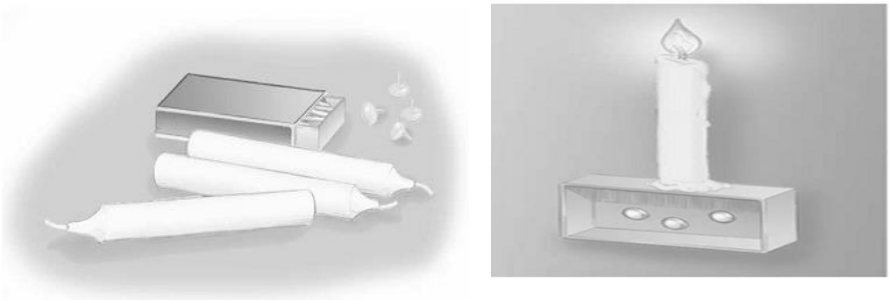
Figure 5



Obstacles to Problem Solving

- Fixedness; people's tendency to focus on a specific characteristic of the problem that keeps them from arriving at a solution.
- Functional fixedness; fixation on use of an object.

You are in a room with a corkboard on the wall. You are given the materials-some candles, matches in a matchbox, and some tacks, task is to mount a candle on the corkboard so it will burn without dripping wax on the floor.



Restricting the use of an object to its familiar functions is called functional fixedness (Jansson & Smith, 1991). The candle problem, first described by Karl Duncker (1945), illustrates how functional fixedness can hinder problem solving. In his experiment, he asked participants to use various objects to complete a task. The solution to the problem occurs when the person realizes that the matchbox can be used as a support rather than as a container. When Duncker did this experiment, he presented one group of participants with small cardboard boxes containing the materials (candles, tacks, and matches) and presented another group with the same materials, but outside the boxes, so the boxes were empty. When he compared the performance of the two groups, he found that the group that had been presented with the boxes as containers found the problem

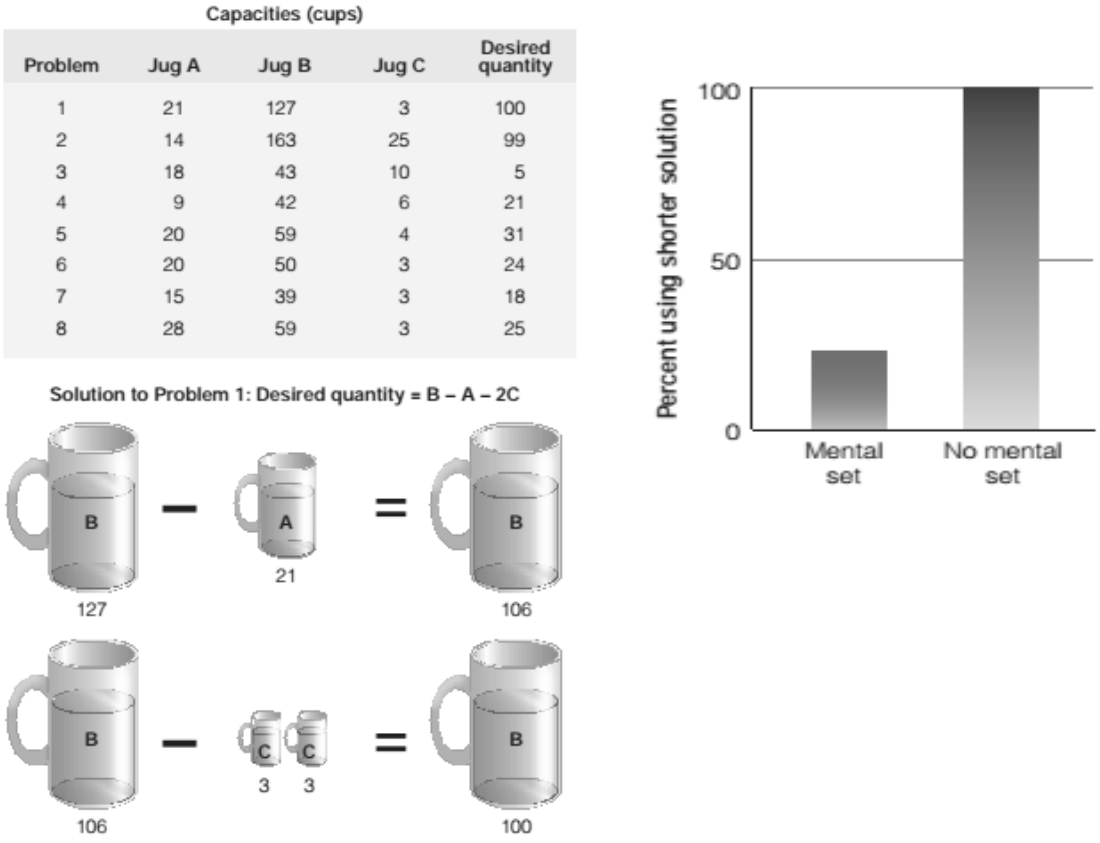
more difficult than did the group that was presented with empty boxes. Robert Adamson (1952) repeated Duncker's experiment and obtained the same result: Participants who were presented with empty boxes were twice as likely to solve the problem as participants who were presented with boxes that were used as containers.

Two string problem; a problem for you to solve; how can this person tie the two strings together. Both the candle problem and the two-string problem were difficult because of people's preconceptions about the uses of objects. These preconceptions are a type of mental set, a preconceived notion about how to approach a problem, which is determined by a person's experience or what has worked in the past. In these experiments mental set was created by people's knowledge about the usual use of objects.

The Gestalt psychologists also showed how mental set can arise out of the situation created as a person solves a problem. An example is provided by the Luchins water-jug problem, in which participants are given three jugs of different capacities and are required to use these jugs to measure out a specific quantity of water, as shown in Figure 7 (Luchins, 1942). Problem 1 is solved by first filling the 127-cup jug (B) and then pouring the water from B into A once and into C two times, thereby subtracting 27 cups and leaving 100 in jug B. This solution, which can be stated by the formula.

Desired quantity =B− A− 2C works for all of the problems. However, problems 7 and 8 can be solved more simply by using only jugs A and C. For problem 7: Pour A (15) and C (3) into a container to arrive at 18 (Desired quantity =A +C). For problem 8: Fill jug A (28) and then pour from A into C (3), to leave 25 in A (Desired quantity =A – C). A. S. Luchins (1942) had some

participants begin with problem 1 and do each problem in sequence through problem 8 (the mental set group), and had other participants solve only problems 7 and 8 (the no mental set group). Figure 8 compares the performance of the two groups. All of the participants in the no mental set group used the shorter solution for problems 7 and 8, whereas only 23 percent in the mental set group used this solution for these problems. Clearly, participants in the mental set group learned the procedure described by the formula B− A− 2C as they solved problems 1 to 6 and simply continued to apply that procedure to solve problems 7 and 8. The mental set created by solving problems 1 to 6 inhibited them from using the simpler solution for 7 and 8.



Capacities (cups)

Problem	Jug A	Jug B	Jug C	Desired quantity
1	21	127	3	100
2	14	163	25	99
3	18	43	10	5
4	9	42	6	21
5	20	59	4	31
6	20	50	3	24
7	15	39	3	18
8	28	59	3	25

Figure 8

The Gestalt psychologists were the pioneers of problem-solving research. Between about 1920 and 1950, they described problems and solutions illustrating how mental set can influence problem solving and how solving a problem often involves creating a new representation. This idea that problem solving depends on how the problem is represented in the mind is one of the enduring contributions of Gestalt psychology. Modern research has taken this idea as a starting point for the information processing approach to the study of problem solving.

Approaches to Problem Solving

- **Newell** and **Simon** (1972) saw problems in terms of an initial state-conditions at the beginning of the problem-and a goal state-the solution of the problem. A problem starts with an initial state, continues through a number of intermediate states, and finally reaches the goal state.
- The **initial state**, **goal state**, and all the possible intermediate states for a particular problem is called the **problem space**.

Demonstration; Tower of Hanoi problem

In addition to specifying initial and goal states of a problem, Newell and Simon also introduced the idea of operators—actions that take the problem from one state to another. For the Tower of Hanoi problem, the following rules specify which actions are allowed and which are not (see Figure 1)

1. Discs are moved one at a time from one peg to another.

2. A disc can be moved only when there are no discs on top of it.

3. A larger disc can never be placed on top of a smaller disc.

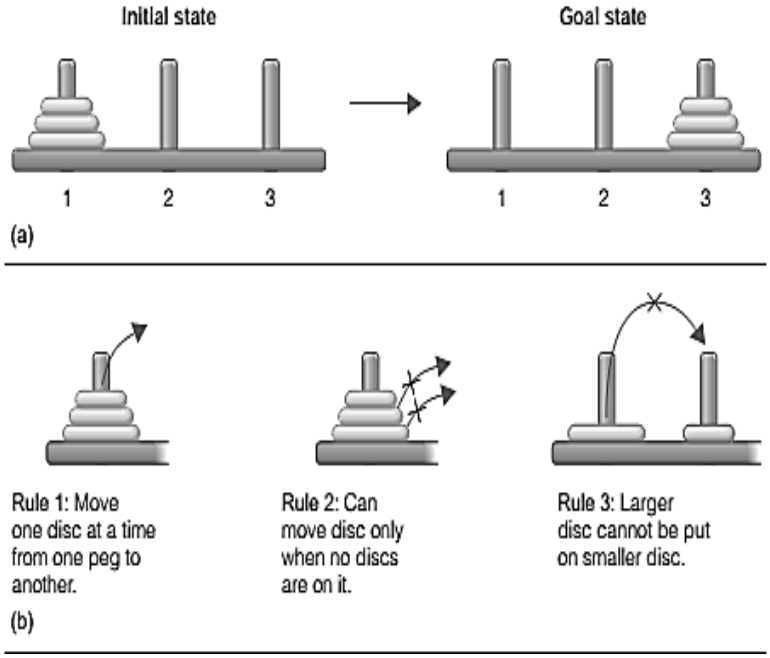


Figure 1

As you try solving this problem, count the number of moves it takes to get from the initial to the goal state. **See Figure 2**

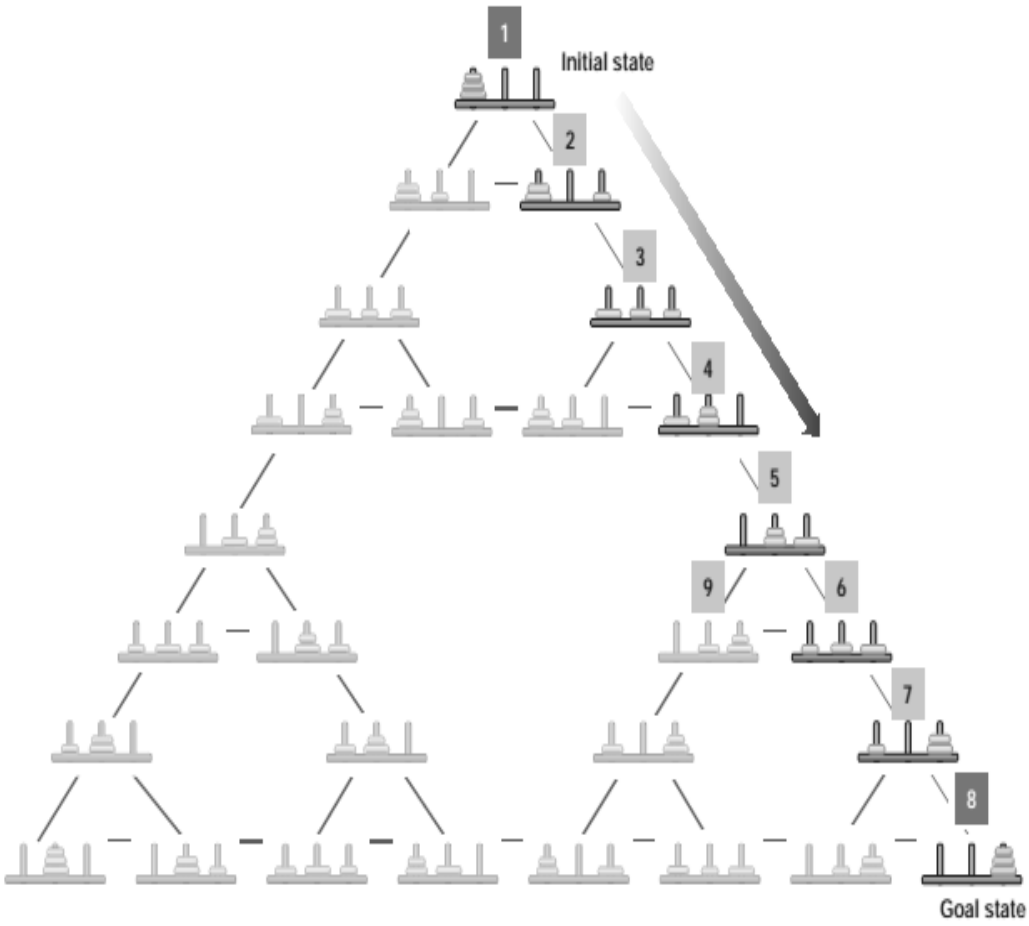


Figure 2

Newell and Simon conceived of problem solving as involving a sequence of choices of steps, with each step creating an intermediate state. Thus, a problem starts with an initial state, continues through a number of intermediate states, and finally reaches the goal state. The initial state, goal state, and all the possible intermediate states for a particular problem is called the problem space. (See Table 1 for a summary of the terms used by Newell and Simon.)

The problem space for the **Tower of Hanoi problem** is shown in Figure 2. The initial state is marked 1 and the goal state is marked 8. All of the other possible configurations of discs on pegs are intermediate states. From the diagram, you can see that there are a number of possible paths for getting from the initial state to the goal state, but that one of these paths is shorter than the others. By choosing the path along the right side of the problem space (states 2, 3, 4, 5, 6, and 7), as indicated by the arrow, it is possible to reach the goal state by making just seven moves.

Given all of the possible ways to reach the goal, how can we decide which moves to make, especially when starting out? It is important to realize that the problem-solver does not have a picture of the problem space, like the one in Figure 2, when trying to solve the problem. According to Newell and Simon, the person has to search the problem space to find a solution, and they proposed that one way to direct the search is to use a strategy called means-end analysis. The primary goal of means-end analysis is to reduce the difference between the initial and goal states. This is achieved by creating sub-goals—intermediate states that are closer to the goal. Our overall goal in applying means-end analysis to the Tower of Hanoi problem is to reduce the size of the difference between initial and goal states. An initial goal would be to move the large disc that is on the left over to the peg on the right. However, if we are to obey the rules, we can't accomplish this in just one step, because we can move only one disc at a time and can't move a disc if another disc is on top of it. To solve the problem, we therefore set a series of subgoals, some of which may involve a few moves.

Sub goal 1: Free up the large disc so we can move it onto peg 3. Do this by (1) removing the small disc and placing it on the third peg (Figure 2.a; this is state 2 in the problem space in Figure 1). (2) Remove the medium disc and place it on the second peg (Figure 2.b; state 3 in the problem space). This completes the sub goal of freeing up the large disc.

Sub goal 2: Free up the third peg so we can move the large disc onto it. Do this by moving the small disc onto the medium one (Figure 2.c; state 4 in the problem space).

Sub goal 3: Move the large disc onto peg 3 (Figure 2.d; state 5 in the problem space). Now that we have reached state 5 in the problem space, let's stop and decide how to achieve sub goal 4, freeing up the medium-sized disc. We can move the small disc either onto peg 3 (state 9) or onto peg 1 (state 6). These two possible choices illustrate that to find the shortest path to the goal, we need to look slightly ahead. When we do this, we can see that we should not move the small disc to peg 3, because that blocks moving the medium disc there, which would be our next sub goal. Thus, we move the disc back to peg 1, which makes it possible to move the medium disc to peg 3(state 7), and we have almost solved the problem! This procedure of setting sub goals and looking slightly ahead often results in an efficient solution to a problem. The Tower of Hanoi problem illustrates means-end analysis, with its setting of sub goals, and this approach can be applied to real-life situations. For examples sometimes travelling to a destination with no direct flight connection may involve setting sub goals and doing mean end analyses.

Table 1; Key Terms for Newell-Simon Approach to Problem Solving

Term	Description	Example from Tower of Hanoi
Initial state	Conditions at the beginning of a problem.	All three discs on the left peg.
Goal state	Solution to the problem.	All three discs on the right peg.
Intermediate state	Conditions after each step is made toward solving a problem.	After moving the small disc to the right peg there are two other discus on left peg and the small one is on the right.
Operators	Actions that take the problem from one state to another. Operators are usually governed by rules.	Rule: A larger disc can't be placed on a smaller one.
Problem space	All possible states that could occur when solving a problem.	See Figure 1.
Means-end analysis	A way of solving a problem in which the goal is to reduce the difference between the initial and goal states.	Establishing subgoals, each of which moves the solution closer to the goal state
Sub goals	Small goals that help create intermediate states that are closer to the goal. Occasionally, a subgoal may appear to increase the distance to the goal state but in the long run can result in the shortest path to the goal.	Subgoal 4: To free up the medium-sized disc, need to move the small disc from the middle peg back to the peg on the left.

Method of Analogy and analogical transfer

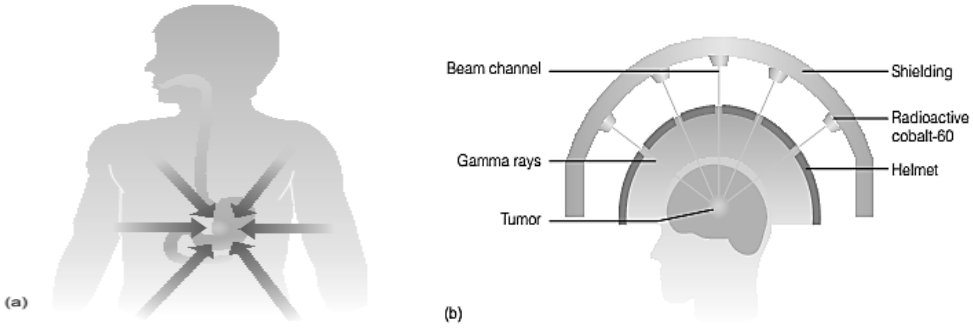
A person is faced with a problem and wonders how to proceed. Questions such as "What move should I make?" or "How should I begin thinking about this problem?" arise. One tactic that is sometimes helpful is to consider whether another problem that the person has solved before is similar to the new problem, and ask "Can I apply the same methods to solving this problem?" This technique of using the solution to a similar problem to guide solution of a new problem is called analogical problem solving.

A problem that has been widely used in research on analogical problem solving is Karl Duncker's radiation problem.

Demonstration

Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the ray reaches the tumor at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the ray passes through on the way to the tumor will also be destroyed. At lower intensities the ray is harmless to healthy tissue, but it will not affect the tumor either. What type of procedure might be used to destroy the tumor and at the same time avoid destroying the healthy tissue (Gick & Holyoak, 1980)? when Duncker initially posed this problem, only 10 percent of participants could arrive at solution. Solution is given in Figure 3a. The solution is to bombard the tumor with a number of low-intensity rays from different directions, which destroys the tumor without damaging the tissue the rays are passing through. The solution to this problem is actually the procedure used in modern radiosurgery, in which a tumor is bombarded with 201 gamma ray beams that intersect at the tumor, figure 3b.

Figure 3



Effect of Making Surface Features More Similar

The lightbulb problem is a problem with surface features similar to the radiation problem. The following is a shortened version of this problem.

Lightbulb Problem

In a physics lab at a major university, a very expensive light bulb, which would emit precisely controlled quantities of light, was being used in some experiments. One morning Ruth, the research assistant, came into the lab and found that the light bulb no longer worked. She noticed that the filament inside the bulb had broken into two parts. The surrounding glass bulb was completely sealed, so there was no way to open it. Ruth knew that the light bulb could be repaired if a brief, high-intensity laser beam could be used to fuse the two parts of the fi lament into one. However, a high-intensity laser beam would also break the fragile glass surrounding the filament. At lower intensities the laser would not break the glass, but neither would it fuse the filament. What type of procedure might be used to fuse the filament with the laser and at the same time avoid breaking the glass? (adapted from Holyoak & Koh, 1987).

Holyoak and Koh (1987) used the radiation problem as the source problem and the light bulb problem as the target problem. Participants in one group were taught about the radiation problem and its solution in an introductory psychology class, just prior to being given the light bulb problem. Participants in the control group did not know about the radiation problem. The result was that 81 percent of participants who knew about the radiation problem solved the light bulb problem, but only 10 percent of the participants in the control group solved it. Holyoak and Koh hypothesized that this excellent analogical transfer from the radiation problem to the light bulb problem occurred because of the high surface similarity between rays (radiation problem) and lasers (light bulb problem). Ruth's solution: Ruth placed several lasers in a circle around the lightbulb and administered low-intensity laser beams from several directions all at once. The beams all converged on the filament, where their combined effect was enough to fuse it. Because each spot on the surrounding glass received only a low-intensity beam from each laser, the glass was left intact.

Analogy in the real world

So far, our examples of analogy problems have involved laboratory research. But what about the use of analogy in the real world?

Many real-world examples of analogical problem solving illustrate what Kevin Dunbar (2001) has called the analogical paradox: Participants in psychological experiments tend to focus on surface features in analogy problems, whereas people in the real world frequently use deeper, more structural features. Dunbar reached this conclusion by using a technique called in vivo research. In vivo problem-solving research involves observing people to determine how they solve problems in real-world situations. This method has been used to study the use of analogy in a number of different settings, including laboratory meetings of a university research group and brainstorming sessions in which the goal was to develop a new product. Discussions recorded during these meetings have been analyzed for statements indicating that analogy is being used to help solve a problem. The advantage of the in vivo approach is that it captures thinking in naturalistic settings.

A disadvantage is that it is time-consuming, and, as with most observational research, it is difficult to isolate and control specific variables. When Dunbar and coworkers (Dunbar, 1999; Dunbar & Blanchette, 2001) videotaped molecular biologists and immunologists during their lab meetings, they found that researchers used analogies from 3 to 15 times in a 1-hour laboratory meeting. An example of an analogy from these laboratory meetings is the statement "If E. coli works like this, maybe your gene is doing the same thing." Similarly, when Bo Christensen and Christian Schunn (2007) recorded meetings of design engineers who were creating new plastic products for medical applications, they found that the engineers proposed an analogy about every 5 minutes. Thus, analogies play an important role both in solving scientific problems and in designing new products. When we discuss creativity later in this chapter, we will describe a famous example of how analogical thinking led to the development of a well-known product.

How Experts solve problems:

One factor that can sometimes make problem solving easier is practice or training. Some people can become very good at solving certain kinds of problems because they become experts in an area.

- Experts and novices solve problems differently
- Experts have more knowledge of the field.

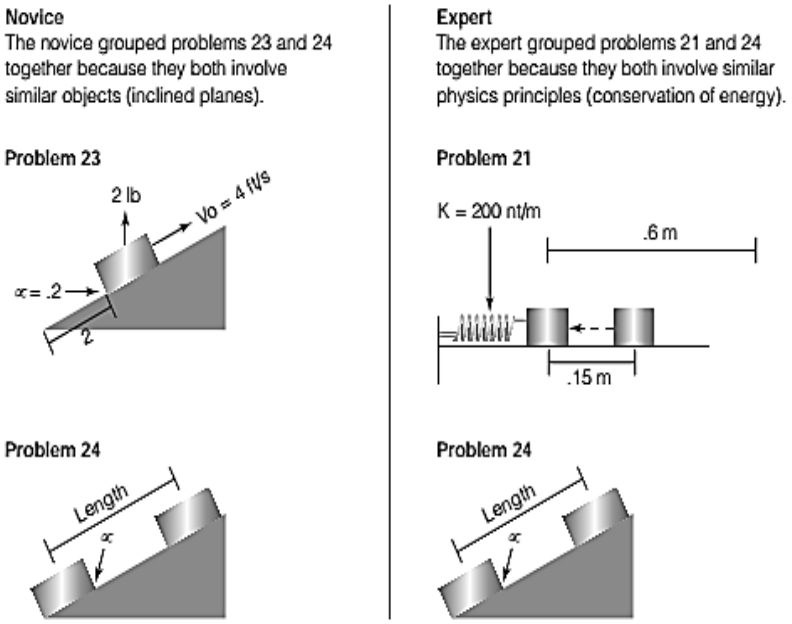
Chase and Simon's (1973a, 1973b) conducted research on how well chess masters and novices can reproduce positions on a chessboard that they have seen briefly. The results showed that experts excelled at this task when the chess pieces were arranged in actual game positions, but were no better than novices when the pieces were arranged randomly (see Figure 5.9). The reason for the experts' superior performance for actual positions is that the chess masters were able to recognize these specific arrangements of pieces. A chess master has about 50,000 patterns in his or her memory, compared to 1,000 patterns for a good player and few or none for a poor or beginning player (Bedard & Chi, 1992). But what is important for the purposes of problem solving is not just that the expert's mind contains lots of knowledge, but that this knowledge is organized so it can be accessed when needed to work on a problem.

- **Experts organize knowledge differently, spend more time analyzing.**

The difference in organization between experts and novices is illustrated by an experiment by Michelene Chi and coworkers (1982; also see Chi et al., 1981). They presented 24 physics problems to a group of experts (physics professors) and a group of novices (students with one semester of physics) and asked them to sort the problems into groups based on their similarities. Figure 4 shows diagrams of problems that were grouped together by an expert and by a novice. We don't need a statement of the actual problems to see from the diagrams that the novice sorted the problems based on surface characteristics such as how similar the objects in the problem were. Thus, two problems that included inclined planes were grouped together, even though the physical principles involved in the problems were quite different. The expert, in contrast, sorted problems based on structural features, such as general principles of physics. The expert perceived two

problems as similar because they both involved the principle of conservation of energy, even though the diagrams indicate that one problem involved a spring and another an inclined plane. Thus, novices categorized problems based on their surface features (what the objects looked like) and the experts categorized them based on their deep structure (the underlying principles involved). Experts' ability to organize knowledge has been found to be important not only for chess masters and physics professors, but for experts in many other fields as well Egan & Schwartz, 1979; Reitman, 1976).

Figure 4



- **Expertise is an advantage in expert's specialty only**

When **James Voss** and **coworkers** (1983) posed a real-world problem involving Russian agriculture to expert political scientists, expert chemists, and novice political scientists, they found that the expert political scientists performed best and that the expert chemists performed as poorly as the novice political scientists. In general, experts are experts only within their own field and perform like anyone else outside of their field (Bedard & Chi, 1992). This makes sense when we remember that the superior performance of experts occurs largely because they possess a larger and better organized store of knowledge about their specific field.

It should be pointed out that being an expert is not always an advantage. One disadvantage is that knowing about the established facts and theories in a field may make experts less open to new ways of looking at problems. This may be why younger and less experienced scientists in a field are often the ones responsible for revolutionary discoveries (Kuhn, 1970; Simonton, 1984). Thus, it has been suggested that being an expert may be a disadvantage when confronting a problem that requires flexible thinking—a problem whose solution may involve rejecting the usual procedures in favor of other procedures that might not normally be used (Frensch & Sternberg, 1989).

Lecture 30

REASONING

Reasoning

- Reasoning has been defined as the process of drawing conclusions (Leighton, 2004) and as the cognitive processes by which people start with information and come to conclusions that go beyond that information (Kurtz et al., 1999).
- Reasoning is bases of decision making often in many real-world settings such as study, career, relationships, health practices, monetary decisions like investments, even good deeds like helping the needy or going for Haj or pilgrimage.
- Reasoning is also involved in many other situations besides making decisions. For example, we might use reasoning to help solve problems like the ones we studied in topic of problem solving.
- Reasoning is also involved in reading, as we make inferences about what is happening in a story based on what we know has happened earlier in the story.

Deductive and Inductive Reasoning

- Deductive reasoning is based on drawing conclusion from statements for example K.E.M.U requires an applicant to pass an entry test, Usman is studying in K.E.M.U, Usman must have passed the entry test.

- Inductive reasoning, in which we arrive at conclusions about what is probably true, based on evidence. Thus, if we know that Richard attended State U. for 4 years and that he is now the vice president of a bank, we might conclude it is likely that he graduated. Notice, however, that in this example, we cannot say that he definitely graduated (maybe he never completed all the requirements, and his mother, who is president of the bank, made him a vice president). Thus, we can make definite conclusions based on deductive reasoning and probable conclusions based on inductive reasoning. Studying both kinds of reasoning provides insights both about how the mind works and about everyday thinking.

Aristotle is considered the father of deductive reasoning because he introduced the basic form of deductive reasoning called the syllogism. A syllogism includes two statements, called premises, followed by a third statement, called the conclusion. We will first consider categorical syllogisms, in which the premises and conclusion describe the relation between two categories by using statements that begin with all, no, or some.

An example of a categorical syllogism is the following:

Syllogism 1

Premise 1: All birds are animals.

Premise 2: All animals eat food.

Conclusion: Therefore, all birds eat food.

This is an example of good reasoning which means the conclusion follows from the two premises and it is also true as both premises are true.

Validity and truth in syllogisms

The word valid is often used in everyday conversation to mean that something is true or might be true. For example, saying "Susan has a valid point" could mean that what Susan is saying is true, or possibly that it should be considered further. However, when used in conjunction with categorical syllogisms, the term validity has a very specific meaning: A syllogism is valid when its conclusion follows logically from its two premises.

Let's now consider another syllogism that has exactly the same form as the first one:

Syllogism 2

All birds are animals. (All A are B)

All animals have four legs. (All B are C)

All birds have four legs. (All A are C)

Whereas the conclusion is derived from two premises so can be called valid, you may notice that something is wrong here. How can Syllogism 2 be valid when it is obvious that the conclusion is wrong, because birds don't have four legs?

The answer is that validity and truth are two different things. Validity depends on the form of the syllogism, which determines whether the conclusion follows from the two premises. Truth, on the other hand, refers to the content of the premises, which have to be evaluated to determine whether they are consistent with the facts. The problem with Syllogism 2 is that the statement "All animals have four legs" is not true; that is, it is not consistent with what we know about the world. It is no coincidence, then, that the conclusion, "All birds have four legs," is not true either, even though the syllogism is valid.

The difference between validity and truth can make it difficult to judge whether reasoning is "logical" or not. Not only can valid syllogisms result in false conclusions, but syllogisms can be invalid even though each of the premises and the conclusion seem reasonable. For example, consider the following syllogism, in which each of the premises could be true and the conclusion could be true:

Syllogism 3

- All of the students are tired.

- Some tired people are irritable.

Some of the students are irritable. To understand why the conclusion does not logically follow from the two premises, consider ● Figure 13.1. All of the students are tired (Premise 1) and are sitting in the student section of the stadium. Some tired people, who are sitting across the fi eld from the student section, are irritable (Premise 2). The fact that the tired and irritable people are sitting across the field from the students is consistent with the second premise because this premise just says some tired people are irritable, without mentioning students. Thus, just because the students are tired, and some tired people are irritable, the conclusion that some of the students are irritable does not follow. Because this conclusion does not logically follow from the premises, this syllogism is not valid.

The detailed study of determining validity and truth of syllogisms falls in domain of Logic and is studied in courses of Logic or Philosophy. However, from this topic important lesson is that good reasoning" and "truth" are not the same thing. This can have important implications for examples of reasoning that you might encounter. Consider following example of reasoning;

'All members of Sindh parliament are in favor of lifting lock down. Some members who are in favor of lifting lockdown are taking money from traders. What this means is that some members of Sindh parliament are taking money'.

What is wrong with this argument? It happens to have exactly the same form as Syllogism 3, and as with Syllogism 3, it doesn't logically follow that just because all of the members are against the lockdown (or all students are tired), and some members who are against the lockdown are taking money from special interest groups (or some people who are tired are irritable), that some members of parliament are taking money from special interest groups (or some students are irritable). Thus, even though syllogisms may seem "academic," people often use syllogisms to "prove" their point, often without realizing that their reasoning might be invalid. It is therefore important to realize that even conclusions that might sound true are not necessarily the result of good reasoning.

Conditional syllogisms

Conditional syllogisms have two premises and a conclusion, like the ones we have been discussing, but the first premise has the form **"If ... then...."** This kind of deductive reasoning is common in everyday life. For example, let's say that you lent your friend Sami Rs.200, but he has never paid you back. Knowing Sami, you might say to yourself that you knew this would happen. Stated in the form of a syllogism, your reasoning might look like this: If I lend Sami Rs. 200, then I won't get it back. I lent Sami 200. Therefore, I won't get my 200 back.

The four major types of conditional syllogisms are listed in Table 1. They are presented in abstract form (using p and q) and also in the form of a concrete "everyday" example. For conditional syllogisms, the notations p and q are typically used instead of the A and B used in categorical syllogisms. The symbol p, the first or "if" term, is called the antecedent, and q, the second or "then" term, is called the consequent.

Table 1

First premise of all syllogisms:
If *p*, then *q*. (abstract version)
If I study, then I'll get a good grade. (concrete example)

Syllogism	Second Premise	Conclusion	Is It Valid?	Judged Correctly?
Syllogism 1: Affirming the antecedent	*p* (abstract) I studied. (concrete)	Therefore, *q* Therefore, I'll get a good grade.	Yes	97%
Syllogism 2: Denying the consequent	Not *q* I didn't get a good grade.	Therefore, not *p* Therefore, I didn't study.	Yes	60%
Syllogism 3: Affirming the consequent	*q* I got a good grade.	Therefore, *p* Therefore, I studied.	No	40%
Syllogism 4: Denying the antecedent	Not *p* I didn't study.	Therefore, not *q* Therefore, I didn't get a good grade.	No	40%

Syllogism 1 is called **affirming the antecedent** because the antecedent, p (If I study), is affirmed in the second premise (I studied). The conclusion of this syllogism (I got a good grade) is valid. Syllogism 2 is called denying the consequent because the consequent, q(I'll get a good grade) is negated in the second premise (I didn't get a good grade). The conclusion of this syllogism (I didn't study) is valid.

Syllogism 3 is called **affirming the consequent** because q is affirmed in the second premise (I got a good grade). The conclusion of this syllogism (I studied) is invalid, because even if you didn't study, it is still possible that you could have received a good grade. Perhaps the exam was easy, or maybe you knew the material because it was about your job experience. If that explanation is not convincing, consider the following syllogism, with "studying" and "good grade" in Syllogism 3, replaced by "robin" and "bird."

- If it's a robin, then it's a bird.
- It's a bird.
- Therefore, it's a robin.

When stated in this way, it becomes more obvious that the affirming the consequent form of the syllogism is invalid. Syllogism 4 is called denying the antecedent because p is negated in the second premise (I didn't study). The conclusion of this syllogism (I didn't get a good grade) is not valid. As in Syllogism 3, you can probably think of situations that would contradict the conclusion, in which a good grade was received even though the person didn't study.

Again, the fact that this syllogism is invalid becomes more obvious when restated in terms of birds and robins:

- If it's a robin, then it's a bird.
- It's not a robin.
- Therefore, it's not a bird.

How well can people judge the validity of these syllogisms? The results of many experiments, shown in the far-right column of Table 1, indicate that most people (close to 100 percent in most experiments) correctly judge that Syllogism 1 is valid, but performance is lower on Syllogism 2, which is also valid, and 3 and 4, which are not valid. These percentages are the average results from many studies in which the syllogisms were stated abstractly, using the letters p and q for the antecedent and the consequent. In the next section we will describe a reasoning problem that has been studied both when stated in abstract form and also in terms of specific real-world examples.

Conditional reasoning:

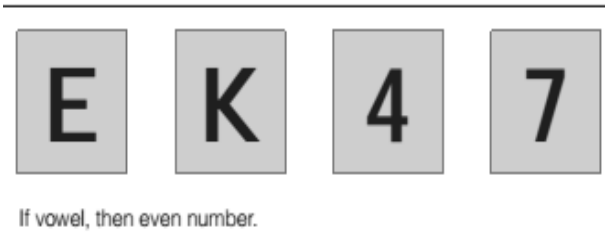
The Wason Four-Card Problem

If reasoning from conditional syllogisms depended only on applying rules of formal logic, then it wouldn't matter whether the syllogism was stated in terms of abstract symbols, such as p and q, or in terms of real-world examples, such as studying or robins. However, research shows that people are often better at judging the validity of syllogisms when real-world examples are substituted for abstract symbols. As we look at this research, we will see that some real-world examples are better than others. Our main goal, however, is not simply to show that stating a problem in real-world terms makes it easier, but to consider how researchers have used various ways of stating a problem to propose mechanisms that explain why the real-world problems are easier. Many researchers have used a classic reasoning problem called the Wason four-card problem.

Demonstration

Four cards are shown in Figure 1. Each card has a letter on one side and a number on the other side. Your task is to indicate which cards you would need to turn over to test the following rule: If there is a vowel on one side, then there is an even number on the other side.

Figure 1



When Wason (1966) posed this task (which we will call the abstract task), 53 percent of his participants indicated that the E must be turned over. This is correct because turning over the E directly tests the rule. (If there is an E, then there must be an even number, so if there is an odd

number on the other side, this would prove the rule to be false.) However, another card needs to be turned over to fully test the rule. Forty-six percent of Wason's participants indicated that in addition to the E, the 4 would need to be turned over. The problem with this answer is that if a vowel is on the other side of the card, this is consistent with the rule, but if a consonant is on the other side, turning over the 4 tells us nothing about the rule, because having a consonant on one side and a vowel on the other does not violate the rule. As shown in Figure 2. an only 4 percent of Wason's participants came up with the correct answer—that the second card that needs to be turned over is the 7. Turning over the 7 is important because revealing a vowel would disconfirm the rule. The key to solving the card problem is to be aware of the falsification principle: To test a rule, it is necessary to look for situations that would falsify the rule. As you can see from Table 2, the only two cards that have the potential to achieve this are the E and the 7.

Figure 2

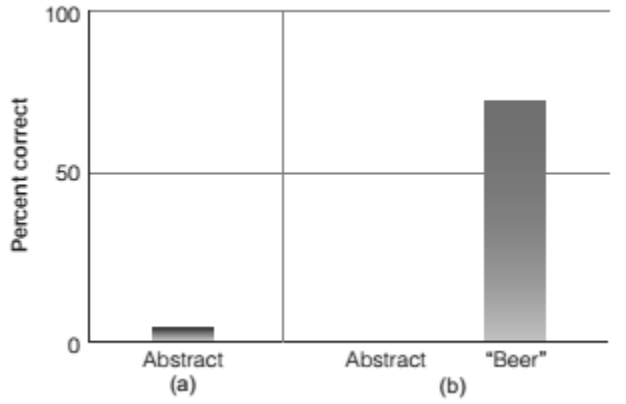


Table 2

The rule:
If there is a vowel on one side,
then there is an even number on the other side.

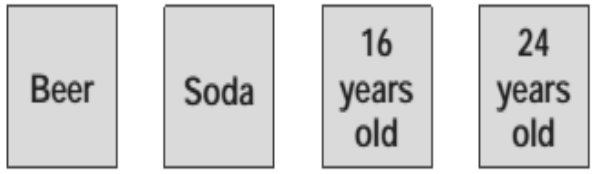
If turn over...	And the result is...	Then this _____ the rule
E	Even	confirms
E	Odd	**falsifies**
K	Even	is irrelevant to *
K	Odd	is irrelevant to
4	Vowel	confirms
4	Consonant	is irrelevant to
7	Vowel	**falsifies**
7	Consonant	is irrelevant to

The Wason task has generated a great deal of research. One reason for the degree of interest in this problem is that it is a conditional reasoning task. (Note that the problem is stated as an "If . . . then . . ." statement.) But the main reason researchers are interested in this problem is that they want to

determine if there are general reasoning mechanisms that are responsible for the improved performance when the task is stated in real-world terms. In one of these real-world experiments, Richard Griggs and James Cox (1982) stated the problem as follows:

Four cards are shown in Figure 13.4. Each card has an age on one side and the name of a beverage on the other side. Imagine you are a police officer who is applying the rule "If a person is drinking beer, then he or she must be over 19 years old." (The participants in this experiment were from Florida, where the drinking age was 19 at the time.) Which of the cards in Figure 3 must be turned over to determine whether the rule is being followed?

Figure 3; The beer/drinking-age version of the four card problem. (Source: Based on R. A. Griggs & J. R. Cox, "The Elusive Thematic-Materials Effect in Wason's Abstract Selection Task," British Journal of Psychology, 73, 407–420, 1982.)



If drinking beer, then over 19 years old.

This beer/drinking-age version of Wason's problem is identical to the abstract version except that concrete everyday terms (beer, soda, and ages) are substituted for the letters and numbers. Griggs and Cox found that for this version of the problem, 73 percent of their participants provided the correct response: It is necessary to turn over the "beer" and the "16 years" cards. In contrast, none of their participants answered the abstract task correctly (Figure 2.b). Why is the concrete task easier than the abstract task? Apparently, being able to relate the beer task to regulations about drinking makes it easier to realize that the "16 years" card must be turned over.

Patricia Cheng and Keith Holyoak (1985) took the Wason task a step further by proposing the concept of pragmatic reasoning schemas. A pragmatic reasoning schema is a way of thinking about cause and effect in the world that is learned as part of experiencing everyday life. An example is the permission schema that states that if a person satisfies condition A (such as being the legal age for drinking), then he or she gets to carry out action B (being served alcohol). The permission schema "If you are 19, then you get to drink beer" is something that most of the participants in this experiment had learned, so they were able to apply that schema to the card task.

This idea that people apply a real-life schema like the permission schema to the card task makes it easier to understand the difference between the abstract version of the card task and the beer/drinking-age version. With the abstract task, the goal is to indicate whether an abstract statement about letters and numbers is true. But in the beer/drinking-age task, the goal is to be sure that a person has permission to drink alcohol. Apparently, activating the permission schema helps people focus attention on the card that would test that schema. Participants' attention is attracted

to the "16 years old" card because they know that "beer" on the other side would be violating the rule that a person must be 19 years old to drink.

To test the idea that a permission schema may be involved in reasoning about the card task, Cheng and Holyoak (1985) ran an experiment with two groups of participants who both saw the cards in Figure 4 One of the groups was read the following directions:

You are an immigration officer at the International Airport in Manila, capital of the Philippines. Among the documents you have to check is a sheet called Form H. One side of this form indicates whether the passenger is entering the country or in transit, and the other side of the form lists names of tropical diseases. You have to make sure that if the form says "Entering" on one side, the other side includes cholera among the list of diseases. * Which of the following forms would you have to turn over to check? Indicate only those that you need to check to be sure. [*The asterisk is explained in the text that follows.]

Sixty-two percent of the participants in this group chose the correct cards, "Entering" and "Typhoid, Hepatitis." (If it isn't clear why "Typhoid, Hepatitis" is the second card, remember that "Entering" on the other side would disconfirm the rule.) Participants in the other group saw the same cards and heard the same instructions as the first group, but with the following changes: Instead of saying that the form listed tropical diseases, the instructions said that the form listed "inoculations the travelers had received in the past 6 months." In addition, the following sentence was added where indicated by the asterisk (*): "This is to ensure that entering passengers are protected against the disease." The changes in the instructions were calculated to achieve a very important effect: Instead of checking just to see whether the correct diseases are listed on the form, the immigration officer is checking to see whether the travelers have the inoculations necessary to give them permission to enter the country. These instructions were intended to activate the participants' permission schema, and apparently this happened, because 91 percent of the participants in this condition picked the correct cards (Figure 5).

Figure 4

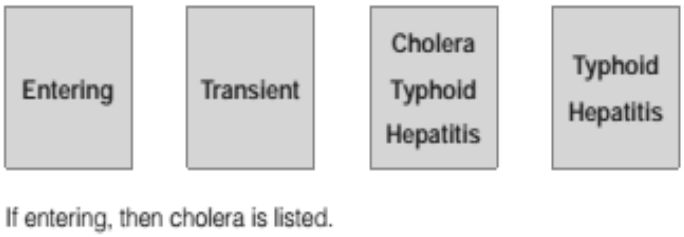
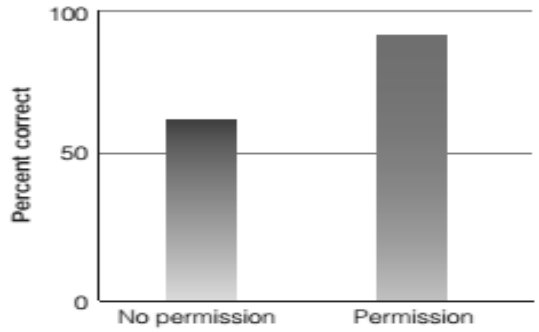


Figure 5



Heuristics

Inductive Reasoning: Reaching Conclusions from Evidence

- In inductive reasoning, conclusions are suggested, with varying degrees of certainty, but do not definitely follow from premises. This is illustrated by the following two inductive arguments:

  Observation 1; all the crows I have seen in Lahore are black; when I visited a village, all crows were black there too. Conclusion; pretty good bet that all crows are black

Observation 2: Here in Tucson, the sun has risen every morning. Conclusion: The sun is going to rise in Tucson tomorrow.

- When people use past experience to guide present behavior, they often use shortcuts to help them reach conclusions rapidly

- We don't have the time or energy to stop and gather every bit of information that we need to be 100 percent certain that every conclusion we reach is correct.

- A number of factors can contribute to the strength of an inductive argument. Among them are the following:

- **Representativeness of observations**: How well do the observations about a particular category represent all of the members of that category? Clearly, the crows example suffers from a lack of representativeness because it does not consider crows from other parts of the country. If there are rare blue crows in Kaghan, then the conclusion is not true.
- **Number of observations**: The argument about the crows is made stronger by adding the Rawalpindi observations to the Lahore observations. Adding more observations would strengthen it further. The conclusion about the sun rising in Tucson is extremely strong because it is supported by a very large number of observations.
- **Quality of the evidence**: Stronger evidence results in stronger conclusions. For example, although the conclusion "The sun will rise in Tucson" is extremely strong because of the number of observations, it becomes even stronger when we consider scientific descriptions of how the earth rotates on its axis and revolves around the sun. Thus, adding the observation

"Scientific measurements of the rotation of the earth indicate that every time the earth rotates the sun will appear to rise" strengthens the conclusion even further.

Although our examples of inductive reasoning have been "academic" in nature, we often use inductive reasoning in everyday life, usually without even realizing it. For example, Sarah has observed, from a course she took with Professor X, that he asked a lot of questions about experimental procedures on his exams. Based on this observation, Sarah concludes that the exam she is about to take in another of Professor X's courses will probably be similar. In another example, Sam has bought merchandise from mail order company Y before and gotten good service, so he places another order based on the assumption that he will continue to get good service. Thus, anytime we make a prediction about what will happen based on our observations about what has happened in the past, we are using inductive reasoning.

It makes sense that we make predictions and choices based on past experience, especially when predictions are based on familiar situations such as studying for an exam or buying merchandise by mail. However, we make so many assumptions about the world, based on past experience, that we are using inductive reasoning constantly, often without even realizing it. For example, did you run a stress test on the chair you are sitting in to be sure it wouldn't collapse when you sat down? Probably not. You assumed, based on your past experience with chairs, that it would not collapse. This kind of inductive reasoning is so automatic that you are not aware that any kind of "reasoning" is happening at all. Think about how time-consuming it would be if you had to approach every experience as if you were having it for the first time. Inductive reasoning provides the mechanism for using past experience to guide present behavior.

Heuristics

When people use past experience to guide present behavior, they often use shortcuts to help them reach conclusions rapidly. After all, we don't have the time or energy to stop and gather every bit of information that we need to be 100 percent certain that every conclusion we reach is correct. These shortcuts take the form of heuristics— "rules of thumb" that are likely to provide the correct answer to a problem, but are not foolproof.

The Availability Heuristic

- The availability heuristic states that events that are more easily remembered are judged as being more probable than events that are less easily remembered (Tversky & Kahneman, 1973).

The following demonstration introduces the availability heuristic.

Answer the following questions.

- Which are more prevalent in English, words that begin with the letter r or words in which r is the third letter?

- Some possible causes of death are listed below in pairs. Within each pair, which cause of death do you consider to be more likely for people in the United States? That is, if you randomly picked someone in the United States, would that person be more likely to die next year from cause A or cause B?

Cause A	Cause B
Homicide	Appendicitis
Auto-train collision	Drowning
Botulism	Asthma
Asthma	Tornado
Appendicitis	Pregnancy

When faced with a choice, we are often guided by what we remember from the past. The availability heuristic states that events that are more easily remembered are judged as being more probable than events that are less easily remembered (Tversky & Kahneman, 1973). Consider, for example, the problems we posed in the demonstration. When participants were asked to judge whether there are more words with r in the first position or the third, 70 percent responded that more words begin with r, even though in reality three times more words have run the third position (Tversky & Kahneman, 1973; but see also Gigerenzer & Todd, 1999).

Table 1 shows the results of experiments in which participants were asked to judge the relative prevalence of various causes of death (Lichtenstein et al., 1978). For each pair, the more likely cause of death is listed in the left column (compare these to your answers in the demonstration above). The number in parentheses indicates the relative frequency of the more likely cause compared to the less likely cause. For example, 20 times more people die of homicide than die of appendicitis. The number on the right indicates the percentage of participants who picked the less likely alternative. For example, 9 percent of participants thought it was more likely that a person would die from appendicitis than as a result of homicide. In this case, therefore, a large majority of people, 91 percent, correctly picked homicide as causing more deaths. However, for the other causes of death, a substantial proportion of participants misjudged their relative likelihood. In these cases, large numbers of errors were associated with causes that had been publicized by the media. For example, 58 percent thought that more deaths were caused by tornados than by asthma, when in reality, 20 times more people die from asthma than from tornados. Particularly striking is that finding that 41 percent of participants thought botulism caused more deaths than asthma, even though 920 times more people die of asthma.

The explanation for these misjudgments appears linked to availability. When you try to think of words that begin with r or that have r in the third position, it is much easier to think of words that

begin with r (run, rain, real) than words that have r in their third position (word, car, arranged). When people die of botulism or in a tornado, it is front-page news, whereas deaths from asthma go virtually unnoticed by the general public (Lichtenstein et al., 1978).

Table 1; Experiment asking about likely causes of death in USA

More Likely	Less Likely	Percent Picking Less Likely
Homicide (20)	Appendicitis	9
Drowning (5)	Auto-train collision	34
Asthma (920)	Botulism	41
Asthma (20)	Tornado	58
Appendicitis (2)	Pregnancy	83

Adapted from Lichtenstein et al., 1978.

- Heuristics can mislead us into reaching the wrong conclusion when less frequently occurring events stand out in our memory. There are many situations, however, in which we remember events that do occur frequently. For example, you might know from past observations that when it is cloudy and there is a certain smell in the air, it is likely to rain later in the day. Or you may have noticed that your boss is more likely to grant your requests when he or she is in a good mood.

Illusory correlation; fooling ourselves

Although observing correlations between events can be useful, sometimes people fall into the trap of creating illusory correlations. Illusory correlations occur when a correlation between two events appears to exist, but in reality, there is no correlation or it is much weaker than it is assumed to be. Illusory correlations can occur when we expect two things to be related, so we fool ourselves into thinking they are related even when they are not. These expectations may take the form of a stereotype—an oversimplified generalization about a group or class of people that often focuses on the negative. A stereotype about the characteristics of a particular group may lead people to pay particular attention to behaviors associated with that stereotype, and this attention creates an illusory correlation that reinforces the stereotype. This phenomenon is related to the availability heuristic because selective attention to the stereotypical behaviors makes these behaviors more "available" (Chapman & Chapman, 1969; Hamilton, 1981).

- Stereotypes as illusory correlation.

We can appreciate how illusory correlations reinforce stereotypes by considering the stereotype that gay males are effeminate. A person who believes this stereotype might pay particular attention to effeminate gay characters on TV programs or in movies, and to situations in which they see a person who they know is gay acting effeminate. Although these observations support a correlation

between being gay and being effeminate, the person has ignored the large number of cases in which gay males are not effeminate. This may be because these cases do not stand out or because the person chooses not to pay attention to them. Whatever the reason, selectively taking into account only the situations that support the person's preconceptions can create the illusion that a correlation exists, when there may be only a weak correlation or none at all.

The Representative Heuristic

- Is related to the idea that people often make judgments based on how much one event resembles another event.

A randomly picked person, Robert wears glasses, speaks softly and reads a lot- farmer or librarian? When Amos Tversky and Daniel Kahneman (1974) presented this question in an experiment, more people guessed that Robert was a librarian. Apparently, the description of Robert as wearing glasses, speaking quietly, and reading a lot matched these people's image of a typical librarian (see illusory correlations, above). Thus, they were influenced by the representativeness heuristic into basing their judgment on how closely they think the characteristics used to describe Robert (A in our definition of the representativeness heuristic) match those of a "typical" librarian (class B). However, they were ignoring another important source of information—the base rates of farmers and librarians in the population. The base rate is the relative proportion of different classes in the population. In 1972, when this experiment was carried out, there were many more male farmers than male librarians in the United States, so it is much more likely that Robert was a farmer (remember that he was randomly chosen from the population). One reaction to the farmer–librarian problem might be that perhaps the participants were not aware of the base rates for farmers and librarians, so they didn't have the information they needed to make a correct judgment. The effect of knowing the base rate has been demonstrated by presenting participants with the following problem:

In a group of 100 people, there are 70 lawyers and 30 engineers. What is the chance that if we pick one person from the group at random that the person will be an engineer?

Participants given this problem correctly guessed that there would be a 30 percent chance of picking an engineer. However, for some participants, the following description of the person who was picked was added:

Jack is a 45-year-old man. He is married and has four children. He is generally conservative, careful, and ambitious. He shows no interest in political and social issues and spends most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles.

Adding this description caused participants to greatly increase their estimate of the chances that the randomly picked person (Jack, in this case) was an engineer. Apparently, when only base rate information is available, people use that information to make their estimates. However, when any descriptive information is available, people disregard the base rate information, and this can potentially cause errors in reasoning. Note, however, that the right kind of descriptive information can increase the accuracy of a judgment. For example, if the description of Jack also noted that his

last job involved determining the structural characteristics of a bridge that was being built, then this would greatly increase the chance that he was, in fact, an engineer. Thus, just as it is important to pay attention to base rate information, the information provided by descriptions can also be useful if it is relevant. When such information is available, then applying the representativeness heuristic can lead to correct judgments.

Conjunction rules

The following demonstration illustrates another characteristic of the representativeness heuristic.

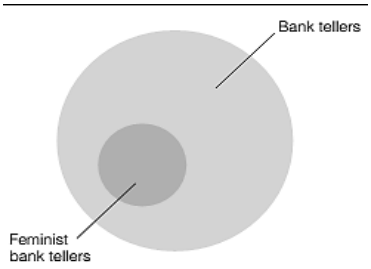
Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations. Which of the following alternatives is more probable?

1. Linda is a bank teller.

2. Linda is a bank teller and is active in the feminist movement.

The correct answer to this problem is that Statement 1 has a greater probability of being true, but when Tversky and Kahneman (1983) posed this problem to their participants, 85 percent picked Statement 2. They were influenced by the representativeness heuristic, because the description of Linda fits people's idea of a typical feminist. However, in doing this they violated the conjunction rule, which states that the probability of a conjunction of two events (A and B) cannot be higher than the probability of the single constituents (A alone or B alone). For example, the probability that you have a black cat cannot be greater than the probability that you have a cat, because the two constituents together (cat and black) define a smaller number of cars than one constituent (Cat) alone. Similarly, there are more bank tellers than feminist bank tellers; stating that Linda is a bank teller includes the possibility that she is a feminist bank teller (Figure 1). People tend to violate the conjunction rule even when it is clear that they understand it due to the representativeness heuristic. In the example just cited, the participants saw Linda's characteristics as more representative of "feminist bank teller" than "bank teller."

Figure 1



Incorrectly assuming that small samples are representative:

People also make errors in reasoning by ignoring the importance of the size of the sample on which observations are based. The following demonstration illustrates the effect of sample size.

Demonstration

A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower. For a period of 1 year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?

• The larger hospital?

• The smaller hospital?

• About the same

When participants were asked this question in an experiment (Tversky & Kahneman, 1974), 22 percent picked the larger hospital, 22 percent picked the smaller hospital, and 56 percent stated that there would be no difference. The group that thought there would be no difference was presumably assuming that the birthrate for males and females in both hospitals would be representative of the overall birthrate for males and females. However, the correct answer is that there would be more days with over 60 percent male births in the small hospital. We can understand why this result would occur by considering a statistical rule called the law of large numbers, which states that the larger the number of individuals that are randomly drawn from a population, the more representative the resulting group will be of the entire population. Conversely, samples of small numbers of individuals will be less representative of the population. Thus, in the hospital problem it is more likely that the percentage of boys born on any given day will be near 50 percent in the large hospital and farther from 50 percent in the small hospital. To make this conclusion clear, imagine that there is a very small hospital that records only one birth each day. Over a period of a year there will be 365 births, with about 50 percent being boys and 50 percent being girls. However, on any given day, there will be either 100 percent boys or 100 percent girls—clearly percentages that are not representative of the overall population. People often assume that representativeness holds for small samples, and this results in errors in reasoning. (See Gigerenzer & Hoffrage, 1995; Gigerenzer & Todd, 1999, for additional perspectives on how statistical thinking and heuristics operate in reasoning.)

Confirmation bias

One of the major roadblocks to accurate reasoning is the confirmation bias, our tendency to selectively look for information that conforms to our hypothesis and to overlook information that argues against it. This effect was demonstrated by Wason (1960), who presented participants with the following instructions:

You will be given three numbers which conform to a simple rule that I have in mind.… Your aim is to discover this rule by writing down sets of three numbers together with your reasons for your choice of them. After you have written down each set, I shall tell you whether your numbers

conform to the rule or not. When you feel highly confident that you have discovered the rule, you are to write it down and tell me what it is.

After Wason presented the first set of numbers, 2, 4, and 6, the participants began creating their own sets of three numbers and receiving feedback from Wason. Note that Wason told participants only whether the numbers they proposed fit his rule. The participants did not find out whether their rule was correct until they felt confident enough to actually announce their rule. The most common initial hypothesis was "increasing intervals of two." Because the actual rule was "three numbers in increasing order of magnitude," the rule "increasing intervals of two" is incorrect even though it creates sequences that satisfy Wason's rule. The secret to determining the correct rule is to try to create sequences that don't satisfy the person's current hypothesis, but do satisfy Wason's rule. Thus, determining that the sequence 2, 4, 5 is correct, allows us to reject our "increasing intervals of two" hypothesis and formulate a new one. The few participants whose rule was correct on their first guess followed the strategy of testing a number of hypotheses themselves before announcing their rule, by creating sequences that were designed to disconfirm their current hypothesis. In contrast, participants who didn't guess the rule correctly on their first try tended to keep creating sequences that confirmed their current hypothesis.

The confirmation bias acts like a pair of blinders—we see the world according to rules we think are correct and are never dissuaded from this view because we seek out only evidence that confirms our rule. The confirmation bias is so strong that it can affect people's reasoning by causing them to ignore relevant information. Charles Lord and coworkers (1979) demonstrated this in an experiment that tested how people's attitudes are affected by exposure to evidence that contradicts those attitudes. By means of a questionnaire, Lord identified one group of participants in favor of capital punishment and another group against it. Each participant was then presented with descriptions of research studies on capital punishment. Some of the studies provided evidence that capital punishment had a deterrent effect on murder; others provided evidence that capital punishment had no deterrent effect. When the participants reacted to the studies, their responses reflected the attitudes they had at the beginning of the experiment. For example, an article presenting evidence that supported the deterrence effect of capital punishment was rated as "convincing" by proponents of capital punishment and "unconvincing" by those against capital punishment. This is the confirmation bias at work—people's prior beliefs caused them to focus only on information that agreed with their beliefs and to disregard information that didn't.

Your course is completed

Hope you enjoyed the learning experience

Best wishes for continued learning and best outcomes