VII. Learning and Conditioning

A vast amount of time and effort is spent on the business of learning, and any teacher or student will agree that learning is not always a simple matter. If a teacher tells a child to stay away from kids on the swings, the child may not always remember and obey—until a few collisions teach him his lesson. A kindergartener may need to watch her father tie his shoes dozens of times before she understands how to do it herself. Psychologists define learning as a change in behavior or knowledge that results from experience.

Three kinds of learning are of particular importance to psychologists. Classical conditioning is learning that depends on associations between events, such as learning to walk far from the swings to avoid collisions. Operant conditioning is learning that depends on the consequences of behavior, such as learning that getting a good night's sleep before an exam will help to earn a good grade. Observational learning involves learning by watching others, such as learning to tie shoelaces by watching someone else do it first.

A) Classical Conditioning

Russian physiologist **Ivan Pavlov** was the first to describe classical conditioning. In**classical conditioning**, also called "respondent conditioning" or "Pavlovian conditioning," a subject comes to respond to a neutral stimulus as he would to another, nonneutral stimulus by learning to associate the two stimuli.

Pavlov's contribution to learning began with his study of dogs. Not surprisingly, his dogs drooled every time he gave them food. Then he noticed that if he sounded a tone every time he fed them, the dogs soon started to drool at the sound of the tone, even if no food followed it. The dogs had come to associate the tone, a neutral stimulus, with food, a nonneutral stimulus.

Conditioned and Unconditioned Stimuli and Responses

Psychologists use several terms to talk about classical conditioning. In Pavlov's experiment, salivation was the **unconditioned response**, which is a response that occurs naturally. Food was the **unconditioned stimulus**, the stimulus that naturally evoked salivation. The tone was the **conditioned stimulus**, the stimulus that the dogs learned to associate with food. The **conditioned response** to the tone was salivation. The conditioned response is usually the same as, or similar to, the unconditioned response.

Example:

Suppose Adam has a psychology class with Professor Smith, who is determined to teach him about classical conditioning. In the first class, Professor Smith whips out a revolver and shoots it into the air. The revolver is loaded with blanks, but when Adam hears the loud bang, he cringes out of surprise. Professor Smith repeats this action several times during the class. By the end of the hour, Adam cringes as soon as she whips out the revolver, expecting a bang. He cringes even if she doesn't shoot. In this scenario, the unconditioned stimulus is the bang, the unconditioned response is cringing, the conditioned stimulus is the revolver, and the conditioned response is cringing.

Acquisition of Conditioned Responses

Subjects acquire a conditioned response when a conditioned stimulus is paired with an unconditioned stimulus. Conditioning works best if the conditioned stimulus appears just before the unconditioned stimulus and both stimuli end at about the same time. In the above example, Professor Smith's conditioning will work best if she displays the revolver right before firing and puts it away after shooting.

Extinction

After Adam has been conditioned to cringe at the sight of the revolver, Professor Smith comes into the next class and pulls out the revolver again. He cringes, but she doesn't shoot. If she pulls it out again and again on several occasions without shooting, Adam will soon stop cringing when she pulls it out. This process called **extinction** is the gradual weakening and disappearance of a conditioned response. Extinction happens when the conditioned stimulus appears repeatedly without the unconditioned stimulus.

Spontaneous Recovery

Suppose that by the end of the second class, Adam has completely stopped cringing when Professor Smith pulls out the revolver. His conditioned response has been extinguished. However, if Professor Smith comes into class later in the semester and pulls out the revolver again, Adam may still cringe, though maybe a little less than before. This is called spontaneous recovery. **Spontaneous recovery** is the reappearance of an extinguished conditioned response when the conditioned stimulus returns after a period of absence.

Stimulus Generalization

Now suppose Professor Smith conditions Adam again to respond to the revolver as she did in the first class. Soon he cringes every time she pulls out the revolver. While Adam is in this conditioned state, the professor pulls out a cell phone. Adam is likely to cringe at that too because of**stimulus generalization**—the tendency to respond to a new stimulus as if it were the original conditioned stimulus. Stimulus generalization happens most often when the new stimulus resembles the original conditioned stimulus.

Example:

*In the 1920s, the behaviorist **John Watson** and his colleague Rosalie Rayner did a famous study that demonstrated stimulus generalization. They gave a white rat to an eleven-month-old boy named Little Albert, who liked the rat and enjoyed playing with it. In the next stage of the experiment, the researchers repeatedly made a loud noise behind Albert while offering him the rat. Each time, Albert fell to the floor, frightened. When the researchers then offered the rat to him without making the noise, Albert showed fear of the rat and crawled away from it. The researchers were subsequently able to generalize Albert's fear to other furry, white stimuli, including a rabbit, a dog, a fur coat, a Santa Claus mask, and Watson's hair. This experiment is considered highly unethical by today's standards.*

Stimulus Discrimination

Suppose Professor Smith used a gray revolver to condition Adam. Once Adam is conditioned, if she pulls out a brown revolver, he'll initially cringe at that, too. But suppose Professor Smith never shoots when she pulls out the brown revolver and always shoots when she pulls out the gray one. Soon, Adam will cringe *only* at the gray revolver. He is showing **stimulus discrimination**—the tendency to lack a conditioned response to a new stimulus that resembles the original conditioned stimulus.

Higher-Order Conditioning

Now suppose that after Adam has been conditioned to cringe at the sight of the revolver, Professor Smith comes to class one day and pulls out the revolver while yelling, "Fire!" She does this many times. Each time, Adam cringes because he is conditioned to respond to the revolver. If she then yells, "Fire!" without pulling out the revolver, Adam will still cringe due to **higher-order conditioning**—the process by which a neutral stimulus comes to act as a conditioned stimulus by being paired with another stimulus that already evokes a conditioned response.

Phobias and Conditioning

A phobia is an intense, irrational fear that impairs a person's ability to function normally or participate in normal activities. Phobias, such as Little Albert's fear of rats and white, furry objects, may result from classical conditioning. For example, if someone has a near-drowning experience, he may become afraid of water in general.

B) Operant Conditioning

In the late nineteenth century, psychologist **Edward Thorndike** proposed the law of effect. The **law of effect** states that any behavior that has good consequences will tend to be repeated, and any behavior that has bad consequences will tend to be avoided. In the 1930s, another psychologist, **B. F. Skinner**, extended this idea and began to study operant conditioning. **Operant conditioning** is a type of learning in which responses come to be controlled by their consequences. Operant responses are often new responses.

Just as Pavlov's fame stems from his experiments with salivating dogs, Skinner's fame stems from his experiments with animal boxes. Skinner used a device called the Skinner box to study operant conditioning. A **Skinner box** is a cage set up so that an animal can automatically get a food reward if it makes a particular kind of response. The box also contains an instrument that records the number of responses an animal makes.

Psychologists use several key terms to discuss operant conditioning principles, including *reinforcement* and *punishment*.

Reinforcement

Reinforcement is delivery of a consequence that increases the likelihood that a response will occur. **Positive reinforcement** is the presentation of a stimulus after a response so that the response will occur more often. **Negative reinforcement** is the removal of a stimulus after a response so that the response will occur more often. In this terminology, positive and negative don't mean good and bad. Instead, *positive* means adding a stimulus, and *negative* means removing a stimulus.

Punishment

Punishment is the delivery of a consequence that decreases the likelihood that a response will occur. Positive and negative punishments are analogous to positive and negative reinforcement. **Positive punishment** is the presentation of a stimulus after a response so that the response will occur less often. **Negative punishment** is the removal of a stimulus after a response so that the response will occur less often.

Reinforcement helps to increase a behavior, while punishment helps to decrease a behavior.

Primary and Secondary Reinforcers and Punishers

Reinforcers and punishers are different types of consequences:

- **Primary reinforcers**, such as food, water, and caresses, are naturally satisfying.
- **Primary punishers**, such as pain and freezing temperatures, are naturally unpleasant.
- **Secondary reinforcers**, such as money, fast cars, and good grades, are satisfying because they've become associated with primary reinforcers.
- **Secondary punishers**, such as failing grades and social disapproval, are unpleasant because they've become associated with primary punishers.

- Secondary reinforcers and punishers are also called **conditioned reinforcers and punishers** because they arise through classical conditioning.

Is It Primary or Secondary?

To distinguish between primary and secondary reinforcers, people can ask themselves this question: "Would a newborn baby find this stimulus satisfying?" If the answer is yes, the reinforcer is primary. If the answer is no, it's secondary. The same idea can be applied to punishers by asking whether a baby would find the stimulus unpleasant.

Shaping

Shaping is a procedure in which reinforcement is used to guide a response closer and closer to a desired response.

Example:

Lisa wants to teach her dog, Rover, to bring her the TV remote control. She places the remote in Rover's mouth and then sits down in her favorite TV–watching chair. Rover doesn't know what to do with the remote, and he just drops it on the floor. So Lisa teaches him by first praising him every time he accidentally walks toward her before dropping the remote. He likes the praise, so he starts to walk toward her with the remote more often. Then she praises him only when he brings the remote close to the chair. When he starts doing this often, she praises him only when he manages to bring the remote right up to her. Pretty soon, he brings her the remote regularly, and she has succeeded in shaping a response.

Reinforcement Schedules

A **reinforcement schedule** is the pattern in which reinforcement is given over time. Reinforcement schedules can be continuous or intermittent. In **continuous reinforcement**, someone provides reinforcement every time a particular response occurs. Suppose Rover, Lisa's dog, pushes the remote under her chair. If she finds this amusing and pats him every time he does it, she is providing continuous reinforcement for his behavior. In **intermittent** or **partial reinforcement**, someone provides reinforcement on only some of the occasions on which the response occurs.

Types of Intermittent Reinforcement Schedules

There are four main types of intermittent schedules, which fall into two categories: ratio or interval. In a **ratio schedule**, reinforcement happens after a certain number of responses. In an **interval schedule**, reinforcement happens after a particular time interval.

- In a **fixed-ratio schedule**, reinforcement happens after a set number of responses, such as when a car salesman earns a bonus after every three cars he sells.
- In a **variable-ratio schedule**, reinforcement happens after a particular average number of responses. For example, a person trying to win a game by getting heads on a coin toss gets heads every two times, on average, that she tosses a penny. Sometimes she may toss a penny just once and get heads, but other times she may have to toss the penny two, three, four, or more times before getting heads.
- In a **fixed-interval schedule**, reinforcement happens after a set amount of time, such as when an attorney at a law firm gets a bonus once a year.
- In a **variable-interval schedule**, reinforcement happens after a particular average amount of time. For example, a boss who wants to keep her employees working productively might walk by their workstations and check on them periodically, usually about once a day, but sometimes twice a day, or some-times every other day. If an employee is slacking off, she reprimands him. Since the employees know there is a variable interval between their boss's appearances, they must stay on task to avoid a reprimand.

Response Patterns

These different types of reinforcement schedules result in different patterns of responses:

- Partial or intermittent schedules of reinforcement result in responses that resist extinction better than responses resulting from continuous reinforcement. Psychologists call this resistance to extinction the **partial reinforcement effect**.
- Response rate is faster in ratio schedules than in interval schedules. Ratio schedules depend on number of responses, so the faster the subject responds, the more quickly reinforcement happens.
- A fixed-interval schedule tends to result in a **scalloped response pattern**, which means that responses are slow in the beginning of the interval and faster just before reinforcement happens. If people know when reinforcement will occur, they will respond more at that time and less at other times.
- Variable schedules result in steadier response rates than fixed schedules because reinforcement is less predictable. Responses to variable schedules also cannot be extinguished easily.

Extinction

As in classical conditioning, **extinction** in operant conditioning is the gradual disappearance of a response when it stops being reinforced. In the earlier example, Lisa's dog, Rover, started to put the remote under her chair regularly because she continuously reinforced the behavior with pats on his head. If she decides that the game has gone too far and stops patting him when he does it, he'll eventually stop the behavior. The response will be extinguished.

Stimulus Discrimination

If Lisa enjoys Rover's antics with the TV remote only in the daytime and not at night when she feels tired, Rover will put the remote under her chair only during the day, because daylight has become a signal that tells Rover his behavior will be reinforced. Daylight has become a discriminative stimulus. A **discriminative stimulus** is a cue that indicates the kind of consequence that's likely to occur after a response. In operant conditioning,**stimulus discrimination** is the tendency for a response to happen only when a particular stimulus is present.

Stimulus Generalization

Suppose Lisa's dog, Rover, began to put the remote under her chair not only during the day but also whenever a bright light was on at night, thinking she would probably pat him. This is called stimulus generalization. In operant conditioning, **stimulus generalization** is the tendency to respond to a new stimulus as if it is the original discriminative stimulus.

C) Biological Influences

Conditioning accounts for a lot of learning, both in humans and nonhuman species. However, biological factors can limit the capacity for conditioning. Two good examples of biological influences on conditioning are taste aversion and instinctive drift.

Taste Aversion

Psychologist John Garcia and his colleagues found that aversion to a particular taste is conditioned only by pairing the taste (a conditioned stimulus) with nausea (an unconditioned stimulus). If taste is paired with other unconditioned stimuli, conditioning doesn't occur.

Similarly, nausea paired with most other conditioned stimuli doesn't produce aversion to those stimuli. Pairing taste and nausea, on the other hand, produces conditioning very quickly, even with a delay of several hours between the conditioned stimulus of the taste and the unconditioned stimulus of nausea. This phenomenon is unusual, since normally classical conditioning occurs only when the unconditioned stimulus immediately follows the conditioned stimulus.

Example:

Joe eats pepperoni pizza while watching a movie with his roommate, and three hours later, he becomes nauseated. He may develop an aversion to pepperoni pizza, but he won't develop an aversion to the movie he was watching or to his roommate, even though they were also present at the same time as the pizza. Joe's roommate and the movie won't become conditioned stimuli, but the pizza will. If, right after eating the pizza, Joe gets a sharp pain in his elbow instead of nausea, it's unlikely that he will develop an aversion to pizza as a result. Unlike nausea, the pain won't act as an unconditioned stimulus.

An Evolutionary Adaptation

The combination of taste and nausea seems to be a special case. Researchers think that learning to quickly associate taste and nausea is an evolutionary adaptation, since this association helps people to know what foods to avoid in order to survive.

Instinctive Drift

Instinctive drift is the tendency for conditioning to be hindered by natural instincts. Two psychologists, Keller and Marian Breland, were the first to describe instinctive drift. The Brelands found that through operant conditioning, they could teach raccoons to put a coin in a box by using food as a reinforcer. However, they couldn't teach raccoons to put*two* coins in a box. If given two coins, raccoons just held on to the coins and rubbed them together. Giving the raccoons two coins brought out their instinctive food-washing behavior: raccoons instinctively rub edible things together to clean them before eating them. Once the coins became associated with food, it became impossible to train them to drop the coins into the box.

D) Cognitive Influences

Researchers once thought of conditioning as automatic and not involving much in the way of higher mental processes. However, now researchers believe that conditioning does involve some information processing.

The psychologist **Robert Rescorla** showed that in classical conditioning, pairing two stimuli doesn't always produce the same level of conditioning. Conditioning works better if the conditioned stimulus acts as a reliable signal that predicts the appearance of the unconditioned stimulus.

Example:

Consider the earlier example in which Adam's professor, Professor Smith, pulled out a revolver in class and shot it into the air, causing Adam to cringe. If Adam heard a gunshot only when Professor Smith pulled out her revolver, he would be conditioned to cringe at the sight of the revolver. Now suppose Professor Smith sometimes took out the revolver as before and fired it. Other times, she played an audio recording of a gunshot without taking out the revolver. The revolver wouldn't predict the gunshot sound as well now, since gunshots happen both with and without the revolver. In this case, Adam wouldn't respond as strongly to the sight of the revolver.

The fact that classical conditioning depends on the predictive power of the conditioned stimulus, rather than just association of two stimuli, means that some information processing happens during classical conditioning. Cognitive processes are also involved in operant conditioning. A response doesn't increase just because satisfying consequences follow the response. People usually think about whether the response caused the consequence. If the response did cause the consequence, then it makes sense to keep responding the same way. Otherwise, it doesn't.

E) Observational Learning

People and animals don't learn only by conditioning; they also learn by observing others.**Observational learning** is the process of learning to respond in a particular way by watching others, who are called models. Observational learning is also called "vicarious conditioning" because it involves learning by watching others acquire responses through classical or operant conditioning.

Example:

Brian might learn not to stand too close to a soccer goal because he saw another spectator move away after getting whacked on the head by a wayward soccer ball. The other spectator stopped standing close to the soccer goal because of operant conditioning—getting clobbered by the ball acted as positive punishment for standing too close. Brian was indirectly, or vicariously, conditioned to move away.

Bandura and the Bobo Dolls

The person best known for research on observational learning is psychologist Albert Bandura, who did some landmark experiments showing that children who watched adults behaving aggressively were more likely to behave aggressively themselves. His most famous experiment was the Bobo doll study. Bandura let a group of kindergarteners watch a film of an adult violently attacking an inflatable plastic toy shaped like Bobo the Clown by hitting it, sitting on it, hammering it, and so forth. He then let the children into a room with Bobo dolls. The children precisely imitated the adult's behavior, gleefully attacking Bobo. Their behavior was a type of observational learning.

VIII. Memory

Memory is just one of many phenomena that demonstrate the brain's complexity. On a basic level, memory is the capacity for storing and retrieving information, but memories are not simply recorded and neatly stored. Our memories are selected, constructed, and edited not just by us but by the world around us. We have an astounding, boundless capacity for memory, but our memories are also faulty, full of holes and distortions, and hampered by unreliable data retrieval systems.

Memory researchers explore the many mysteries of remembering. They examine why the name of a favorite elementary school teacher might leap easily to mind, while the time and place of a committee meeting prove maddeningly elusive. They try to explain why we have trouble remembering a person's name—only to recall it later, after the person is gone. We still have much to learn about how memories are made and what determines whether they last or fade away.

A) Memory Processes

Memory is essentially the capacity for storing and retrieving information. Three processes are involved in memory: encoding, storage, and retrieval. All three of these processes determine whether something is remembered or forgotten.

Encoding

Processing information into memory is called **encoding**. People automatically encode some types of information without being aware of it. For example, most people probably can recall where they ate lunch yesterday, even though they didn't try to remember this information. However, other types of information become encoded only if people pay attention to it. College students will probably not remember all the material in their textbooks unless they pay close attention while they're reading.

There are several different ways of encoding verbal information:

- **Structural encoding** focuses on what words look like. For instance, one might note whether words are long or short, in uppercase or lowercase, or handwritten or typed.
- **Phonemic encoding** focuses on how words sound.
- **Semantic encoding** focuses on the meaning of words. Semantic encoding requires a deeper level of processing than structural or phonemic encoding and usually results in better memory.

Storage

After information enters the brain, it has to be stored or maintained. To describe the process of storage, many psychologists use the three-stage model proposed by **Richard Atkinson** and **Richard Shiffrin**. According to this model, information is stored sequentially in three memory systems: sensory memory, short-term memory, and long-term memory.

Sensory Memory

Sensory memory stores incoming sensory information in detail but only for an instant. The capacity of sensory memory is very large, but the information in it is unprocessed. If a flashlight moves quickly in a circle inside a dark room, people will see a circle of light rather than the individual points through which the flashlight moved. This happens because sensory memory holds the successive images of the moving flashlight long enough for the brain to see a circle. Visual sensory memory is called **iconic memory**; auditory sensory memory is called **echoic memory**.

Short-Term Memory

Some of the information in sensory memory transfers to **short-term memory**, which can hold information for approximately twenty seconds. Rehearsing can help keep information in short-term memory longer. When people repeat a new phone number over and over to themselves, they are rehearsing it and keeping it in short-term memory.

Short-term memory has a limited capacity: it can store about seven pieces of information, plus or minus two pieces. These pieces of information can be small, such as individual numbers or letters, or larger, such as familiar strings of numbers, words, or sentences. A method called chunking can help to increase the capacity of short-term memory. **Chunking**combines small bits of information into bigger, familiar pieces.

Example:

A person confronted with this sequence of twelve letters would probably have difficulty remembering it ten seconds later, because short-term memory cannot handle twelve pieces of information: HO TB UT TE RE DP OP CO RN IN AB OW L However, these letters can be easily remembered if they're grouped into six familiar words, because short-term memory can hold six pieces of information: HOT BUTTERED POPCORN IN A BOWL

Working Memory

Psychologists today consider short-term memory to be a **working memory**. Rather than being just a temporary information storage system, working memory is an active system. Information can be kept in working memory while people process or examine it. Working memory allows people to temporarily store and manipulate visual images, store information while trying to make decisions, and remember a phone number long enough to write it down.

Long-Term Memory

Information can be transferred from short-term memory to long-term memory and from long-term memory back to short-term memory. **Long-term memory** has an almost infinite capacity, and information in long-term memory usually stays there for the duration of a person's life. However, this doesn't mean that people will always be able to remember what's in their long-term memory—they may not be able to *retrieve*information that's there.

Organization of Memories

Imagine what would happen if a psychology textbook weren't organized by section, by chapter, or in any other way. Imagine if the textbook didn't have a table of contents or an index. If the textbook just contained lots of information in a random order, students would have difficulty finding a particular concept, such as "encoding of memory." They'd know the information was in there somewhere, but they'd have trouble retrieving it.

Long-term memory stores much more information than a textbook, and people would never be able to retrieve the information from it if it weren't organized in some way.

Psychologists believe one way the brain organizes information in long-term memory is by category. For example, *papaya* may be organized within the semantic category *fruit*. Categories can also be based on how words sound or look. If someone is struggling to remember the word *papaya*, she may remember first that it's a three-syllable word, that it begins with the letter *p*, or that it ends with the letter *a.*

Long-term memory organizes information not only by categories but also by the information's familiarity, relevance, or connection to other information.

Where Were You When . . .

Flashbulb memories are vivid, detailed memories of important events. Older people may have very clear memories of where they were and what they were doing when they heard President John F. Kennedy had been assassinated. Many people today may have a similar kind of memory of where they were when they heard the Pentagon and the World Trade Center had been attacked by terrorists.

Retrieval

Retrieval is the process of getting information out of memory. **Retrieval cues** are stimuli that help the process of retrieval. Retrieval cues include associations, context, and mood.

Lost Memories

The fact that people can often recall lost memories when hypnotized suggests that information in long-term memory is usually not lost — it may just be difficult to retrieve.

Associations

Because the brain stores information as networks of associated concepts, recalling a particular word becomes easier if another, related word is recalled first. This process is called **priming**.

Example:

If Tim shows his roommate a picture of sunbathers on a nude beach and then asks him to spell the word bear, the roommate may be more likely to spell bare because the picture primed him to recall that form of the word.

Context

People can often remember an event by placing themselves in the same context they were in when the event happened.

Example:

If a woman loses her car keys, she may be able to recall where she put them if she re-creates in her mind exactly what she did when she last came in from parking her car.

Mood

If people are in the same mood they were in during an event, they may have an easier time recalling the event.

B) Types of Memory

Psychologists often make distinctions among different types of memory. There are three main distinctions:

1. Implicit vs. explicit memory
2. Declarative vs. procedural memory
3. Semantic vs. episodic memory

Implicit vs. Explicit Memory

Sometimes information that unconsciously enters the memory affects thoughts and behavior, even though the event and the memory of the event remain unknown. Such unconscious retention of information is called **implicit memory**.

Example:

Tina once visited Hotel California with her parents when she was ten years old. She may not remember ever having been there, but when she makes a trip there later, she knows exactly how to get to the swimming pool.

Explicit memory is conscious, intentional remembering of information. Remembering a social security number involves explicit memory.

Declarative vs. Procedural Memory

Declarative memory is recall of factual information such as dates, words, faces, events, and concepts. Remembering the capital of France, the rules for playing football, and what happened in the last game of the World Series involves declarative memory. Declarative memory is usually considered to be explicit because it involves conscious, intentional remembering.

Procedural memory is recall of how to do things such as swimming or driving a car. Procedural memory is usually considered implicit because people don't have to consciously remember how to perform actions or skills.

Semantic vs. Episodic Memory

Declarative memory is of two types: semantic and episodic. **Semantic memory** is recall of general facts, while **episodic memory** is recall of personal facts. Remembering the capital of France and the rules for playing football uses semantic memory. Remembering what happened in the last game of the World Series uses episodic memory.

C) Forgetting

Memory researchers certainly haven't forgotten **Hermann Ebbinghaus**, the first person to do scientific studies of forgetting, using himself as a subject. He spent a lot of time memorizing endless lists of nonsense syllables and then testing himself to see whether he remembered them. He found that he forgot most of what he learned during the first few hours after learning it.

Later researchers have found that forgetting doesn't always occur that quickly. Meaningful information fades more slowly than nonsense syllables. The rate at which people forget or retain information also depends on what method is used to measure forgetting and retention. **Retention** is the proportion of learned information that is retained or remembered—the flip side of forgetting.

Forgetting Curve

A forgetting curve is a graph that shows how quickly learned information is forgotten over time. Ebbinghaus made use of forgetting curves to chart his research on memory.

Measures of Forgetting and Retention

Researchers measure forgetting and retention in three different ways: recall, recognition, and relearning.

Recall

Recall is remembering without any external cues. For example, essay questions test recall of knowledge because nothing on a blank sheet of paper will jog the memory.

Recognition

Recognition is identifying learned information using external cues. For example, true or false questions and multiple-choice questions test recognition because the previously learned information is there on the page, along with other options. In general, recognition is easier than recall.

Relearning

When using the **relearning** method to measure retention, a researcher might ask a subject to memorize a long grocery list. She might measure how long he has to practice before he remembers every item. Suppose it takes him ten minutes. On another day, she gives him the same list again and measures how much time he takes to relearn the list. Suppose he now learns it in five minutes. He has saved five minutes of learning time, or 50 percent of the original time it took him to learn it. His savings score of 50 percent indicates that he retained 50 percent of the information he learned the first time.

Causes of Forgetting

Everyone forgets things. There are six main reasons for forgetting: ineffective encoding, decay, interference, retrieval failure, motivated forgetting, and physical injury or trauma.

Ineffective Encoding

The way information is**encoded** affects the ability to remember it. Processing information at a deeper level makes it harder to forget. If a student thinks about the meaning of the concepts in her textbook rather than just reading them, she'll remember them better when the final exam comes around. If the information is not encoded properly—such as if the student simply skims over the textbook while paying more attention to the TV—it is more likely to be forgotten.

Decay

According to **decay theory**, memory fades with time. Decay explains the loss of memories from sensory and short-term memory. However, loss of long-term memories does not seem to depend on how much time has gone by since the information was learned. People might easily remember their first day in junior high school but completely forget what they learned in class last Tuesday.

Interference

Interference theory has a better account of why people lose long-term memories. According to this theory, people forget information because of interference from other learned information. There are two types of interference: retroactive and proactive.

- **Retroactive interference** happens when newly learned information makes people forget old information.
- **Proactive interference** happens when old information makes people forget newly learned information.

Retrieval Failure

Forgetting may also result from failure to **retrieve** information in memory, such as if the wrong sort of **retrieval cue** is used. For example, Dan may not be able to remember the name of his fifth-grade teacher. However, the teacher's name might suddenly pop into Dan's head if he visits his old grade school and sees his fifth-grade classroom. The classroom would then be acting as a context cue for retrieving the memory of his teacher's name.

Motivated Forgetting

Psychologist **Sigmund Freud** proposed that people forget because they push unpleasant or intolerable thoughts and feelings deep into their unconscious. He called this phenomenon **repression**. The idea that people forget things they don't want to remember is also called **motivated forgetting** or psychogenic amnesia.

Physical Injury or Trauma

Anterograde amnesia is the inability to remember events that occur after an injury or traumatic event. **Retrograde amnesia** is the inability to remember events that occurred before an injury or traumatic event.

D) Enhancing Memory

In spite of all these reasons for forgetting, people can still remember a vast amount of information. In addition, memory can be enhanced in a variety of ways, including rehearsal, overlearning, distributed practice, minimizing interference, deep processing, organizing information, mnemonic devices, and visual imagery.

Rehearsal

Practicing material helps people remember it. The more people **rehearse**information, the more likely they are to remember that information.

Overlearning

Overlearning, or continuing to practice material even after it is learned, also increases retention.

Distributed Practice

Learning material in short sessions over a long period is called **distributed practice** or the "spacing effect." This process is the opposite of cramming, which is also called**massed practice**. Distributed practice is more effective than cramming for retaining information.

Minimizing Interference

People remember material better if they don't learn other, similar material right before or soon after their effort. One way to minimize interference is to sleep after studying material, since people can't learn new material while sleeping.

Deep Processing

People also remember material better if they pay attention while learning it and think about its meaning rather than memorize the information by rote. One way to process information deeply is to use a method called elaboration. **Elaboration** involves associating the material being learned with other material. For example, people could associate the new material with previously learned material, with an anecdote from their own lives, with a striking example, or with a movie they recently saw.

Organizing Material

Organizing material in a coherent way helps people to remember it:

- Organizing material hierarchically or in categories and subcategories can be particularly helpful. The way an outline is organized, for example, usually helps people to remember the material in it.
- Chunking material into segments is also helpful. People often remember long strings of numbers, such as social security numbers, by chunking them into two-, three-, or four-digit segments.

Mnemonics

Mnemonics are strategies for improving memory. Different kinds of mnemonics include acronyms, acrostics, the narrative method, and rhymes.

Acronyms

Acronyms are words made out of the first letters of several words. For example, to remember the colors of the spectrum, people often use the name ROY G. BIV, which gives the first letters of the colors red, orange, yellow, green, blue, indigo, and violet in the right order.

Acrostics

Acrostics are sentences or phrases in which each word begins with a letter that acts as a memory cue. For example, the rather strange phrase *Roses on yachts grow better in vinegar* also helps to remember the colors of the spectrum.

Narrative methods

Narrative methods involve making up a story to remember a list of words. For example, people could remember the colors of the rainbow in the right order by making up a short story such as this: *Red* Smith stood next to an *orange* construction cone and flagged down a *yellow* cab. He told the cabbie he was feeling very *green* and asked to be taken to a hospital. The cabbie took him to a hospital, where a nurse in a *blue* coat guided him to a room with *indigo* walls. He smelled a *violet* in a vase and passed out.

Rhymes

Rhymes are also good mnemonics. For example, the familiar rhyme that begins, "Thirty days has September . . ." is a mnemonic for remembering the number of days in each month.

Visual Imagery

Some well-known memory improvement methods involve using visual imagery to memorize or recall lists.

Method of Loci

When using the **method of loci**, people might picture themselves walking through a familiar place. They imagine each item on their list in a particular place as they walk along. Later, when they need to remember their list, they mentally do the walk again, noting the items they imagined along the path.

The Link Method

To use the **link method**, people associate items on a list with each other. For example, if a man wants to remember to buy bread, juice, and carrots at the store, he might try visualizing the peculiar image of himself eating a juice-and-bread mush using carrots as chopsticks.

Peg Word Method

When using the **peg word method**, people first remember a rhyme that associates numbers with words: one is a bun, two is a shoe, three is a tree, four is a door, five is a hive, six is sticks, seven is heaven, eight is a gate, nine is swine, ten is a hen. They then visualize each item on their list being associated with a bun, a shoe, a tree, and so on. When they need to remember the list, they first think of a bun, then see what image it's associated with. Then they think of a shoe, and so forth.

E) The Biology of Memory

Memory is a complicated phenomenon. Researchers still don't know exactly how it works at the physiological level. Long-term memory involves the hippocampus of the brain. Some researchers think the hippocampus binds together different elements of a memory, which are stored in separate areas of the brain. In other words, the hippocampus helps with memory organization. Other researchers think that the hippocampus helps with memory**consolidation**, or the transfer of information into long-term memory.

The brain area involved in processing a memory may determine where memories are stored. For example, memories of visual information probably end up in the visual cortex. Research suggests that there may be specific neural circuits for particular memories. Psychologists also think that memory relates to changes in neurotransmitter release from neurons, fluctuations in hormone levels, and protein synthesis in the brain.

Memories on Your Nerves

Long-term potentiation is a lasting change at synapses that occurs when long-term memories form. Synapses become more responsive as a result. Researchers believe long-term potentiation is the basic process behind memory and learning.

F) Distortions of Memory

Memories aren't exact records of events. Instead, memories are reconstructed in many different ways after events happen, which means they can be distorted by several factors. These factors include schemas, source amnesia, the misinformation effect, the hindsight bias, the overconfidence effect, and confabulation.

Schemas

A **schema** is a mental model of an object or event that includes knowledge as well as beliefs and expectations. Schemas can distort memory.

Example:

Suppose a high school junior visits her sister's college dorm room for the first time. She's never been to a dorm before, but she's seen dorms in movies, read about them, and heard her friends talking about them. When she describes the room to another friend after the visit, she comments on how many clothes her sister had and how many huge books were on her sister's desk. In reality, the books were hidden under the bed, not out in the open. The clothes were something she actually saw, while the books were part of her dorm-room schema.

Source Amnesia

Another reason for distorted memories is that people often don't accurately remember the origin of information.

Example:

After witnessing a car crash on the freeway, Sam later tells friends many details about what he saw. It turns out, however, that there is no way he could have actually seen some of the details he described and that he is, in fact, just reporting details he heard on TV about the accident. He isn't deliberately lying. He just may not be able to remember where all the different pieces of information came from.

This inaccurate recall of the origin of information is called **source amnesia**, source misattribution, or source monitoring error.

The Misinformation Effect

The **misinformation effect** occurs when people's recollections of events are distorted by information given to them after the event occurred. The psychologist **Elizabeth Loftus** did influential research on the misinformation effect that showed that memory reconstructions can affect eyewitness testimony.

Example:

A bank robber enters a crowded bank in the middle of the day, brandishing a gun. He shoots out the security cameras and terrifies everyone. He is taking money from a teller when one of two security guards approaches the robber, draws his own weapon, and shoots. Suddenly, another shot is fired from a different direction and the security guard falls to the ground, shot. Some of the customers see that the other security guard, who was approaching the robber from the other side, mistakenly shot his partner. Later, police ask the witnesses when the robber shot the guard, and they report that he shot after the guard fired on him. Even though they saw one guard shoot the other, they are swayed by the misinformation given by the police.

Stop or Yield

In one of Loftus's early experiments, she showed research subjects a film of a simulated automobile accident at an intersection with a stop sign. Afterward, she told half the subjects that there was a yield sign at the intersection. When asked later to describe the accident, those who had received the misleading suggestion tended to claim with certainty that there was a yield sign at the intersection, while those subjects who received no misleading suggestions had a more accurate recollection.

The Hindsight Bias

The **hindsight bias** is the tendency to interpret the past in a way that fits the present. For example, if Laura's boyfriend cheats on her, she may recall the boyfriend as always having seemed promiscuous, even if this is not true.

The Overconfidence Effect

The **overconfidence effect** is the tendency people have to overestimate their ability to recall events correctly.

Example:

Tina asks her father to tell her all about the day she was born: when her mother first went into labor, how long it took to get to the hospital, what time of day or night it was. Tina's father tells her a wonderful story about how he and her mother made a late night rush to the hospital the night of Thursday, the twelfth, and how Tracy's mother barely made it into the delivery room before Tracy emerged, and how the doctor kindly put 11:59 p.m. as the time of birth to avoid a Friday the thirteenth birthday. Years later, when glancing at an old calendar, Tracy discovers she was actually born on a Tuesday, not a Thursday.

Confabulation

Sometimes people claim to remember something that didn't happen or think that something happened to them when it actually happened to someone else. This phenomenon is **confabulation**.

Example:

Steve is in his early twenties, and he and a roommate have just moved to New York City. Steve has all sorts of interesting experiences. One night, he goes out to a local pub and meets Robert De Niro, who is just sitting there eating a hamburger. The two of them chat about baseball for a while and even shoot a game of pool. Later, Steve tells his roommate about the evening. Many years later, Steve and his old roommate get together to talk about old times, and the roommate relates the "De Niro story" as if it happened to him.

IX. Language and Cognition

Cognitive psychology concerns both language and thought and has been popular only since the 1950s. Before that, many psychologists believed that the scientific method could not be applied toward study of a process as private as thinking. From ancient Greek times, only philosophers and metaphysicians studied the nature of language and thought. The metaphysician René Descartes, for example, famously argued, “I think, therefore I am.”

Today, thanks to increasingly sophisticated tools for studying brain activity, cognitive psychology is a thriving science. Cognitive psychologists explore such questions as how language affects thought, whether it is possible to create a “thinking” machine, and why humans are motivated to create art.

A) The Structure of Language

Language is a system of symbols and rules that is used for meaningful communication. A system of communication has to meet certain criteria in order to be considered a language:

- A language uses **symbols**, which are sounds, gestures, or written characters that represent objects, actions, events, and ideas. Symbols enable people to refer to objects that are in another place or events that occurred at a different time.
- A language is meaningful and therefore can be understood by other users of that language.
- A language is **generative**, which means that the symbols of a language can be combined to produce an infinite number of messages.
- A language has rules that govern how symbols can be arranged. These rules allow people to understand messages in that language even if they have never encountered those messages before.

The Building Blocks of Language

Language is organized hierarchically, from phonemes to morphemes to phrases and sentences that communicate meaning.

Phonemes

Phonemes are the smallest distinguishable units in a language. In the English language, many consonants, such as *t*, *p*, and *m*, correspond to single phonemes, while other consonants, such as *c* and*g*, can correspond to more than one phoneme. Vowels typically correspond to more than one phoneme. For example, *o* corresponds to different phonemes depending on whether it is pronounced as in *bone* or *woman*. Some phonemes correspond to combinations of consonants, such as *ch*, *sh*, and *th*.

Morphemes

Morphemes are the smallest meaningful units in a language. In the English language, only a few single letters, such as *I* and *a*, are morphemes. Morphemes are usually whole words or meaningful parts of words, such as prefixes, suffixes, and word stems.

Example:

The word “disliked” has three morphemes: “dis,” “lik,” and “ed.”

Syntax

Syntax is a system of rules that governs how words can be meaningfully arranged to form phrases and sentences.

Example:

One rule of syntax is that an article such as “the” must come before a noun, not after: “Read the book,” not “Read book the.”

Language Development in Children

Children develop language in a set sequence of stages, although sometimes particular skills develop at slightly different ages:

- Three-month-old infants can distinguish between the phonemes from any language.
- At around six months, infants begin **babbling**, or producing sounds that resemble many different languages. As time goes on, these sounds begin to resemble more closely the words of the languages the infant hears.
- At about thirteen months, children begin to produce simple single words.
- By about twenty-four months, children begin to combine two or three words to make short sentences. At this stage, their speech is usually telegraphic.**Telegraphic speech**, like telegrams, contains no articles or prepositions.
- By about age three years, children can usually use tenses and plurals.
- Children’s language abilities continue to grow throughout the school-age years. They become able to recognize ambiguity and sarcasm in language and to use metaphors and puns. These abilities arise from **metalinguistic awareness**, or the capacity to think about how language is used.

Ambiguous Language

Language may sometimes be used correctly but still have an unclear meaning or multiple meanings. In these cases, language is ambiguous—it can be understood in several ways. Avoid biting dogs is an example of an ambiguous sentence. A person might interpret it as Keep out of the way of biting dogs or Don't bite dogs.

B) Theories of Language Acquisition

The nature vs. nurture debate extends to the topic of language acquisition. Today, most researchers acknowledge that both nature and nurture play a role in language acquisition. However, some researchers emphasize the influences of learning on language acquisition, while others emphasize the biological influences.

Receptive Language before Expressive Language

Children's ability to understand language develops faster than their ability to speak it. Receptive language is the ability to understand language, and expressive language is the ability to use language to communicate. If a mother tells her fifteen-month-old child to put the toy back in the toy chest, he may follow her instructions even though he can't repeat them himself.

Environmental Influences on Language Acquisition

A major proponent of the idea that language depends largely on environment was the behaviorist **B. F. Skinner**(see pages 145 and 276 for more information on Skinner). He believed that language is acquired through principles of conditioning, including association, imitation, and reinforcement.

According to this view, children learn words by associating sounds with objects, actions, and events. They also learn words and syntax by imitating others. Adults enable children to learn words and syntax by reinforcing correct speech.

Critics of this idea argue that a behaviorist explanation is inadequate. They maintain several arguments:

- Learning cannot account for the rapid rate at which children acquire language.
- There can be an infinite number of sentences in a language. All these sentences cannot be learned by imitation.
- Children make errors, such as overregularizing verbs. For example, a child may say *Billy hitted me*, incorrectly adding the usual past tense suffix *-ed* to *hit*. Errors like these can't result from imitation, since adults generally use correct verb forms.
- Children acquire language skills even though adults do not consistently correct their syntax.

Neural Networks

Some cognitive neuroscientists have created neural networks, or computer models, that can acquire some aspects of language. These neural networks are not preprogrammed with any rules. Instead, they are exposed to many examples of a language. Using these examples, the neural networks have been able to learn the language's statistical structure and accurately make the past tense forms of verbs. The developers of these networks speculate that children may acquire language in a similar way, through exposure to multiple examples.

Biological Influences on Language Acquisition

The main proponent of the view that biological influences bring about language development is the well-known linguist **Noam Chomsky**. Chomsky argues that human brains have a language acquisition device (LAD), an innate mechanism or process that allows children to develop language skills. According to this view, all children are born with a universal grammar, which makes them receptive to the common features of all languages. Because of this hard-wired background in grammar, children easily pick up a language when they are exposed to its particular grammar.

Evidence for an innate human capacity to acquire language skills comes from the following observations:

- The stages of language development occur at about the same ages in most children, even though different children experience very different environments.
- Children's language development follows a similar pattern across cultures.
- Children generally acquire language skills quickly and effortlessly.
- Deaf children who have not been exposed to a language may make up their own language. These new languages resemble each other in sentence structure, even when they are created in different cultures.

Biology and Environment

Some researchers have proposed theories that emphasize the importance of both nature and nurture in language acquisition. These theorists believe that humans do have an innate capacity for acquiring the rules of language. However, they believe that children develop language skills through interaction with others rather than acquire the knowledge automatically.

Language, Culture, and Thought

Researchers have differing views about the extent to which language and culture influence the way people think. In the 1950s, **Benjamin Lee Whorf** proposed the**linguistic relativity hypothesis**. He said language *determines* the way people think. For example, Whorf said that Eskimo people and English-speaking people think about snow differently because the Eskimo language has many more words for snow than the English language does.

Most subsequent research has not supported Whorf's hypothesis. Researchers do acknowledge, however, that language can *influence* thought in subtle ways. For example, the use of sexist terminology may influence how people think about women. Two ways that people commonly use language to influence thinking are **semantic slanting** and **name calling**.

Semantic Slanting

Semantic slanting is a way of making statements so that they will evoke specific emotional responses.

Example:

Military personnel use the term "preemptive counterattack" rather than "invasion," since "invasion" is likely to produce more negative feelings in people.

Name Calling

Name calling is a strategy of labeling people in order to influence their thinking. In anticipatory name calling, it is implied that if someone thinks in a particular way, he or she will receive an unfavorable label.

Example:

On the day a student buys a new desk, he might say, "Only a slob would pile junk on a desk like this." This might help ensure that his roommate keeps it free of junk.

Bilingualism

Although people sometimes assume that bilingualism impairs children's language development, there is no evidence to support this assumption. Bilingual children develop language at the same rate as children who speak only one language. In general, people who begin learning a new language in childhood master it more quickly and thoroughly than do people who learn a language in adulthood.

C) Language and Nonhuman Primates

Some researchers have tried to teach apes to use language. Because of the structure of their vocal organs, apes can't say words, but they can communicate using signs or computers. Using these means, apes can make requests, respond to questions, and follow instructions.

The Case of Washoe the Chimpanzee

Researchers at Central Washington University taught a chimpanzee named Washoe to use American Sign Language (ASL) to communicate. She could sign not only single words but also meaningful combinations of words. She could follow instructions and respond to questions given in ASL. Later, Washoe's foster child, Loulis, learned signs just by watching Washoe and other chimps that had been trained to use language. Some research even suggested that language-trained chimps may use signs spontaneously to communicate with each other or to talk to themselves, although this behavior is not thoroughly documented.

Skepticism about Ape Language

Critics of the idea that apes can learn and use language have maintained several arguments:

- Apes, unlike people, can be trained to learn only a limited number of words and only with difficulty.
- Apes use signs or computers to get a reward, in the same way that other animals can be taught tricks. But learning tricks is not equivalent to learning language.
- Apes don't use syntax. For example, they don't recognize the difference between*Me eat apple* and *Apple eat me*.
- Trainers may be reading meanings into signs apes make and unintentionally providing cues that help them to respond correctly to questions.

Clearly, communication in nonhuman animals differs drastically from language in humans. The spontaneity, uniqueness, and reflective content of human language remains unmatched.

Nonprimates Can Communicate

Researchers have taught nonprimate animals, such as parrots, to communicate meaningfully. Parrots that participated in language acquisition studies learned to identify dozens of objects, distinguish colors, and make simple requests in English. One famous example

is Alex the African gray parrot, owned by Irene Pepperberg from the University of Arizona. Alex can "speak" hundreds of words, but what makes him more unique is that he appears to do more than just vocalize. Though Pepperberg does not claim that Alex uses "language," she does believe that when Alex talks, he is expressing his thoughts, not just mimicking.

D) The Structure of Cognition

Cognition, or thinking, involves mental activities such as understanding, problem solving, and decision making. Cognition also makes creativity possible.

The Building Blocks of Cognition

When humans think, they manipulate mental representations of objects, actions, events, and ideas. Humans commonly use mental representations such as concepts, prototypes, and cognitive schemas.

Concepts

A **concept** is a mental category that groups similar objects, events, qualities, or actions. Concepts summarize information, enabling humans to think quickly.

Example:

The concept "fish" includes specific creatures, such as an eel, a goldfish, a shark, and a flying fish.

Prototypes

A **prototype** is a typical example of a concept. Humans use prototypes to decide whether a particular instance of something belongs to a concept.

Example:

Goldfish and eels are both fish, but most people will agree that a goldfish is a fish more quickly than they will agree that an eel is a fish. A goldfish fits the "fish" prototype better than an eel does.

Cognitive Schemas

Cognitive schemas are mental models of different aspects of the world. They contain knowledge, beliefs, assumptions, associations, and expectations.

Example:

People may have a schema about New York that includes information they've learned about New York in school, their memories of New York, things people have told them about New York, information from movies and books about New York, what they assume to be true about New York, and so on.

E) Theories of Cognitive Development

Cognitive development refers to the change in children's patterns of thinking as they grow older.

Jean Piaget's Stage Theory

The scientist best known for research on cognitive development is **Jean Piaget**(see pages 72–75), who proposed that children's thinking goes through a set series of four major stages. Piaget believed that children's cognitive skills unfold naturally as they mature and explore their environment.

Lev Vygotsky's Theory of Sociocultural Influences

Psychologist **Lev Vygotsky**believed that children's sociocultural environment plays an important role in how they develop cognitively. In Vygotsky's view, the acquisition of language is a crucial part of cognitive development. After children acquire language, they don't just go through a set series of stages. Rather, their cognitive development depends on interactions with adults, cultural norms, and their environmental circumstances.

Private Speech

Vygotsky pointed out that children use language to control their own behavior. After children acquire language skills and learn the rules of their culture, they start to engage in private speech. They first talk to themselves out loud, and then, as they grow older, silently, giving themselves instructions about how to behave.

Current Research on Cognitive Development

Current research indicates that children have complex cognitive abilities at much younger ages than Piaget suggested. As early as four months of age, infants appear to understand basic laws of physics. For example, a four-month-old infant can recognize that solid

objects cannot pass through other solid objects and that objects roll down slopes instead of rolling up. At five months of age, infants can recognize the correct answers to addition and subtraction problems involving small numbers. These observations have led some researchers to speculate that humans are born with some basic cognitive abilities.

Critics argue that researchers who find these results are overinterpreting the behavior of the infants they study.

F) Problem-Solving

Problem-solving is the active effort people make to achieve a goal that cannot be easily attained.

Types of Problems

Three common categories of problems include **inducing structure**, **arranging**, and**transformation**.

Inducing Structure

Some problems involve finding relationships between elements.

Example:

"Pineapple is to fruit as cabbage is to ___." In this analogy problem, the answer, "vegetable," requires people to figure out the relationship between "pineapple" and "fruit" and apply a similar relationship to "cabbage."

Arranging

Other problems involve arranging elements in a way that fulfills certain criteria.

Example:

The answer to the problem "Arrange the letters in LEPAP to make the name of a fruit" is "APPLE."

Transformation

Other problems involve making a series of changes to achieve a specific goal, a process called **transformation**.

Example:

A familiar riddle describes a situation in which a man has to take his fox, his chicken, and his tub of grain across a river in a boat. The boat will hold only him and two of his possessions at any one time. He can't leave the fox and the chicken on the riverbank by themselves because the fox will eat the chicken, and he can't leave the chicken with the grain because the chicken will eat the grain. He also can't take the fox and the chicken in the boat together because the fox will eat the chicken when he's occupied with rowing the boat. The same goes for the chicken and the grain. How will he get all three across? First he takes the fox and the grain across. He leaves the fox on the opposite bank and takes the grain back with him. He then leaves the grain on the bank and takes the chicken across. He leaves the chicken on the opposite bank and takes the fox back with him to retrieve the grain.

Approaches to Problem Solving

There are many strategies for solving problems, included trial and error, algorithms, deductive reasoning, inductive reasoning, heuristics, dialectical reasoning, forming subgoals, using similar problems, and changing the way the problem is represented.

Trial and Error

Trial and error involves trying out different solutions until one works. This type of strategy is practical only when the number of possible solutions is relatively small.

Example:

It's dark, and a man is trying to figure out which button on the dashboard of his newly rented car switches on the headlights. He might press all the available buttons until he finds the right one.

Algorithms

Algorithms are step-by-step procedures that are guaranteed to achieve a particular goal.

Example:

A chocolate chip cookie recipe is an algorithm for baking chocolate chip cookies.

Deductive Reasoning

Deductive reasoning is the process by which a particular conclusion is drawn from a set of general premises or statements. The conclusion *has* to be true if the premises are true.

Example:

If the premises "All birds have wings" and "A penguin is a bird" are true, then the conclusion "A penguin has wings" must also be true.

Inductive Reasoning

Inductive reasoning is the process by which a general conclusion is drawn from examples. In this case, the conclusion is likely, but not guaranteed, to be true.

Example:

Given the premise "All the butterflies Fred has ever seen have wingspans of less than two inches," Fred might conclude, "All butterflies have wingspans of less than two inches."

Heuristics

A **heuristic** is a general rule of thumb that may lead to a correct solution but doesn't guarantee one.

Example:

A useful heuristic for finishing a timed exam might be "Do the easy questions first."

Dialectical Reasoning

Dialectical reasoning is the process of going back and forth between opposing points of view in order to come up with a satisfactory solution.

Example:

A student might use dialectical reasoning when she considers the pros and cons of choosing psychology as her college major.

Forming Subgoals

Forming subgoals involves coming up with intermediate steps to solve a problem. This is a way of simplifying a problem.

Example:

Susan is asked to solve the analogy problem "Prison is to inmate as hospital is to ____." Susan's subgoal could be to figure out the relationship between "prison" and "inmate." Once she achieves this subgoal, she can easily find the answer, "patient."

Using Similar Problems

A problem is often easier to solve if it can be compared to a similar problem.

Example:

Mike has to give his two-year-old daughter a bath, but she resists because she is afraid of the water. Mike remembers that he convinced her to get in the kiddie pool last week by letting her take her large plastic dinosaur toy with her for "protection." He gives her the toy again, and she agrees to get in the tub.

Changing the Way a Problem Is Represented

A problem may be easier to solve if it is represented in a different form.

Example:

If hundreds of guests at a banquet are trying to figure out where they are supposed to sit, written instructions might not be easy to follow. A seating chart, however, makes the seating arrangement easy to understand.

Obstacles to Effective Problem-Solving

Researchers have described many obstacles that prevent people from solving problems effectively. These obstacles include irrelevant information, functional fixedness, mental set, and making assumptions.

Irrelevant Information
Focusing on irrelevant information hinders problem-solving.

Example:

A familiar children's riddle goes like this: As I was going to St. Ives, I met a man with seven wives. Every wife had seven sacks, every sack had seven cats, every cat had seven kits. How many were going to St. Ives? People may think of this as a complicated math problem, but in reality, only one person, the "I," is headed to St. Ives. The seven wives and their respective entourages are headed the other way.

Functional Fixedness
Functional fixedness is the tendency to think only of an object's most common use in solving a problem.

Example:

Rachel's car breaks down while she is driving through the desert. She is terribly thirsty. She finds several soda bottles in the trunk but no bottle opener. She doesn't think of using the car key to open the bottles because of functional fixedness.

Mental Set
A **mental set** is a tendency to use only those solutions that have worked in the past.

Example:

When Matt's flashlight hasn't worked in the past, he's just shaken it to get it to work again. One day when it doesn't come on, he shakes it, but it still doesn't work. He would be subject to mental set if he keeps shaking it without checking whether it needs new batteries.

Making Assumptions
Making assumptions about constraints that don't exist prevent people from solving problems effectively.

Example:

Another familiar riddle goes as follows: A father and his son are driving on a highway and get into a terrible accident. The father dies, and the boy is rushed to the hospital with major injuries. When he gets to the hospital, a surgeon rushes in to help the boy but stops and exclaims, "I can't operate on this boy—he's my son!" How can this be? If people have a hard time answering, they may be making a false assumption. The surgeon is the boy's mother.

G) Decision-Making
Decision-making involves weighing alternatives and choosing between them.

People don't always make rational decisions. In the 1950s, economist Herbert Simon proposed that people's capacity to process and evaluate multiple alternatives limits their ability to make rational decisions. Because it is difficult to simultaneously evaluate all possible options, people tend to focus on only a few aspects of the available options. This can result in less than optimal decisions. Two types of decisions are decisions about preferences and risky decisions. People generally use a variety of different approaches when making these types of decisions.

Decisions about Preferences
Some decisions require people to make choices about what they would prefer.

Example:

Josh needs to choose which of two armchairs to buy. He must decide which one he likes better.

People may use additive or elimination strategies when making decisions about preferences.

Additive Strategies
When using an **additive strategy**, a person lists the attributes of each element of the decision, weights them according to importance, adds them up, and determines which one is more appealing based on the result.

Example:

To decide which armchair to buy, Josh may list the features he considers important in an armchair. For example, he might list attractiveness, comfort, and price. Then, for each armchair, he rates each feature on a scale from +5 to –5. He also weights each

feature according to its importance. For instance, if he considers comfort to be twice as important as price, he multiplies the ranking for comfort by 2. Josh then adds up the ratings for each armchair. The chair with the highest ranking wins.

Elimination Strategies

Another strategy for making decisions about preferences is called **elimination by aspects**, which involves eliminating alternatives based on whether they do or do not possess aspects or attributes the decision maker has deemed necessary or desirable. People often use this type of strategy when a large number of options and features have to be evaluated.

Example:

When using this strategy to choose his armchair, Josh sets a minimum criterion for each feature he thinks is important. For example, minimum criteria for attractiveness, comfort, and price of an armchair might be blue color, soft fabric, and under $300, respectively. He then compares the two armchairs according to these minimum criteria, starting with the most important criterion. An armchair that doesn't meet a criterion gets eliminated, and the remaining one wins.

Risky Decisions

When making choices about preferences, people select between known features of alternatives. In other types of decisions, however, they have to decide between unknown outcomes. This type of decision-making involves taking risks.

Example:

If Eric is trying to decide whether to buy a $5 raffle ticket, a risk is involved, since he has only a 1 in 1000 chance of winning a $500 prize.

People make risky decisions by judging the probability of outcomes. Strategies people use to make risky decisions include calculating expected value, estimating subjective utility, and using heuristics.

Expected Value

One strategy for making a risky decision is to calculate the **expected value** of the decision. People calculate the expected value by adding the value of a win times the probability of a win to the value of a loss times the probability of a loss.

Example:

For Eric, the value of a win is +$495 ($500 prize – $5 cost), and the value of a loss is –$5. The probability of winning is 1/1000 and the probability of losing is 999/1000. Therefore the expected value is –3.5. That means Eric can expect to lose $3.50 for every raffle ticket he buys.

Subjective Utility

Even when decisions have negative expected values, people still make such decisions. Some researchers believe that this occurs because people make some decisions by estimating **subjective utility**, or the personal value of a decision's outcome.

Example:

Eric may still buy the raffle ticket because having the ticket lets him dream about buying a stereo he's always wanted.

Availability Heuristic

People often use heuristics to estimate probabilities. One heuristic people frequently use is the **availability heuristic**. When people use this rule-of-thumb strategy, they estimate probability based on how readily they can remember relevant instances of an event. If people can quickly remember instances of some event, then they will estimate that event as being quite likely.

Example:

If Eric can think of several friends who have won raffles, he will judge that he is likely to win the raffle.

Representativeness Heuristic

People also use the **representativeness heuristic** to estimate probability. The representativeness heuristic is a rule-of-thumb strategy that estimates the probability of an event based on how typical that event is. For example, if Eric the raffle ticket buyer lives in the United States, has several tattoos, and often wears dark sunglasses and a leather jacket, is it more likely that he owns a motorcycle or a car? If people use the representativeness heuristic, they may judge that Eric is more likely to own a motorcycle. This happens because the description of Eric is more representative of motorcycle owners.

Bias in Decision-Making

People often make flawed decisions. There are many biases that account for bad decision-making.

The Tendency to Ignore Base Rates

When using the representativeness heuristic, people frequently ignore the base rate, or the total number of events.

Example:

If people judged that Eric is more likely to be a motorcycle owner than a car owner because he has tattoos, they were subject to the tendency to ignore base rates. The total number of car owners in the United States far exceeds the number of motorcycle owners, so it is really more likely that Eric owns a car.

The Gambler's Fallacy

The representativeness heuristic can also make people susceptible to the gambler's fallacy. The **gambler's fallacy** is the false belief that a chance event is more likely if it hasn't happened recently. This belief is false because the laws of probability don't apply to individual independent events.

Example:

Mindy tosses a coin and get heads. Because of this, she believes that on her second toss, she'll get tails, since 50 percent of her tosses should yield tails. This belief is incorrect. Over a series of tosses, she can estimate that the probability of tails will be about 50 percent, but this logic can't be correctly applied to a single toss.

Overestimating the Improbable and Underestimating the Probable

Using the availability heuristic can cause people to overestimate improbable events. This happens because rare but memorable events come to mind easily.

Example:

Recalling a few dramatic TV reports of plane crashes could make people overestimate the likelihood of a plane crash.

Using the availability heuristic can also cause people to underestimate likely events. This can happen when events are hard to visualize and don't easily come to mind.

Example:

Beth may have unprotected sex because she doesn't think anyone she knows has a sexually transmitted disease (STD), and she doesn't know what the symptoms of an STD might be. In reality, the majority of the adult American population has contracted one or more STDs, and Beth has a very high chance of contracting one herself through unprotected sex.

Minimizing Risk

People sometimes make irrational decisions in an effort to minimize risk. An event is more likely to be chosen if it's framed in terms of winning rather than losing.

Example:

People are more likely to buy a raffle ticket if they hear they have a 1 in 1000 chance of winning than if they hear they have a 999 in 1000 chance of losing.

Confirmation Bias and Belief Perseverance

Confirmation bias is the tendency for people to look for and accept evidence that supports what they want to believe and to ignore or reject evidence that refutes their beliefs. When people reject evidence that refutes their beliefs, it can also be called**belief perseverance**, because rejecting contradicting evidence makes it easy for people to hold on to their beliefs.

Example:

If Carl is a believer in herbal nutritional supplements, he may willingly accept research that supports their benefits while ignoring or rejecting research that disproves their benefits.

The Overconfidence Effect

The **overconfidence effect** is the tendency for people to be too certain that their beliefs, decisions, and estimates are correct. People can minimize the effects of overconfidence by collecting a lot of information and evaluating it carefully before making a decision.

Example:

At the outset of the Civil War, young Southern men eagerly enlisted in the Confederate Army, believing their superior gallantry would help them make speedy work of the Union soldiers.

H) Creativity

Creativity is the ability to generate novel, valuable ideas. People need a minimum level of intelligence to be creative, but not all people who get high scores on intelligence tests are creative.

Divergent vs. Convergent Thinking

Creativity is characterized by**divergent thinking**. In divergent thinking, people's thoughts go off in different directions as they try to generate many different solutions to a problem. In**convergent thinking**, on the other hand, people narrow down a list of possibilities to arrive at a single right answer.

Example:

Cindy would have to use divergent thinking if her professor asked her to think of a hundred different uses for a fork. She uses convergent thinking when she considers the list of possibilities on a multiple-choice question and picks the one correct answer.

Characteristics of Creative People

Researchers have identified several characteristics that creative people share:

- **Expertise:** Creative people usually have considerable training, knowledge, and expertise in their field.
- **Nonconformity:** Creative people tend to think independently and have relatively little concern for what others think of them.
- **Curiosity:** Creative people tend to be open to new experiences and willing to explore unusual events.
- **Persistence:** Creative people are usually willing to work hard to overcome obstacles and take risks.
- **Intrinsic motivation:** Creative people tend to be motivated more by intrinsic rewards, such as a sense of accomplishment or satisfaction of curiosity, rather than by extrinsic rewards, such as money or social approval.

Environmental Influences on Creativity

People can best realize their creative potential if they are in circumstances that promote creativity. Families, organizations, and institutions promote creativity when they allow people to have control over problem solving and task completion, minimize judgment and evaluation of work, and encourage new ways of doing things.

X. Intelligence

Few people agree on exactly what "intelligence" is or how to measure it. The nature and origin of intelligence are elusive, and the value and accuracy of intelligence tests are often uncertain. Researchers who study intelligence often argue about what IQ tests really measure and whether or not Einstein's theories and Yo Yo Ma's cello playing show different types of intelligence.

Intelligence is a particularly thorny subject, since research in the field has the potential to affect many social and political decisions, such as how much funding the U.S. government should devote to educational programs. People who believe that intelligence is mainly inherited don't see the usefulness in special educational opportunities for the underprivileged, while people who believe that environment plays a large role in intelligence tend to support such programs. The importance and effects of intelligence are clear, but intelligence does not lend itself to easy definition or explanation.

A) Theories of Intelligence

A typical dictionary definition of **intelligence** is "the capacity to acquire and apply knowledge." Intelligence includes the ability to benefit from past experience, act purposefully, solve problems, and adapt to new situations. Intelligence can also be defined as "the ability that intelligence tests measure." There is a long history of disagreement about what actually constitutes intelligence.

Savant Syndrome

Savant syndrome, observed in some individuals diagnosed with autism or mental retardation, is characterized by exceptional talent in one area of functioning, such as music or math, and poor mental functioning in all other areas.

The G Factor

Charles Spearmanproposed a **general intelligence factor**, **g**, which underlies all intelligent behavior. Many scientists still believe in a general intelligence factor that underlies the specific abilities that intelligence tests measure. Other scientists are skeptical, because people can score high on one specific ability but show weakness in others.

Eight Types of Intelligence

In the 1980s and 1990s, psychologist **Howard Gardner** proposed the idea of not one kind of intelligence but eight, which are relatively independent of one another. These eight types of intelligence are:

1. **Linguistic:** spoken and written language skills
2. **Logical–mathematical:** number skills
3. **Musical:** performance or composition skills
4. **Spatial:** ability to evaluate and analyze the visual world
5. **Bodily-kinesthetic:** dance or athletic abilities
6. **Interpersonal:** skill in understanding and relating to others
7. **Intrapersonal:** skill in understanding the self
8. **Nature:** skill in understanding the natural world

Gardner believes that each of these domains of intelligence has inherent value but that culture and context may cause some domains to be emphasized over others. Critics of the idea of multiple intelligences maintain that these abilities are talents rather than kinds of intelligence.

Triarchic Theory of Intelligence

Also in the 1980s and 1990s, **Robert Sternberg** proposed a **triarchic theory of intelligence** that distinguishes among three aspects of intelligence:

- **Componential intelligence**: the ability assessed by intelligence tests
- **Experiential intelligence**: the ability to adapt to new situations and produce new ideas
- **Contextual intelligence**: the ability to function effectively in daily situations

Emotional Intelligence

Some researchers distinguish **emotional intelligence** as an ability that helps people to perceive, express, understand, and regulate emotions. Other researchers maintain that this ability is a collection of personality traits such as empathy and extroversion, rather than a kind of intelligence.

B) Intelligence Testing

The **psychometric approach** to intelligence emphasizes people's performance on standardized aptitude tests. **Aptitude tests** predict people's future ability to acquire skills or knowledge. **Achievement tests**, on the other hand, measure skills and knowledge that people have already learned.

Types of Tests

Intelligence tests can be given individually or to groups of people. The best-known individual intelligence tests are the Binet-Simon scale, the Stanford-Binet Intelligence Scale, and the Wechsler Adult Intelligence Scale.

The Binet-Simon Scale

Alfred Binet and his colleague Theodore Simon devised this general test of mental ability in 1905, and it was revised in 1908 and 1911. The test yielded scores in terms of mental age. **Mental age** is the chronological age that typically corresponds to a particular level of performance.

Example:

A ten-year-old child whose score indicates a mental age of twelve performed like a typical twelve-year-old.

The Stanford-Binet Intelligence Scale

In 1916, **Lewis Terman** and his colleagues at Stanford University created the Stanford-Binet Intelligence Scale by expanding and revising the Binet-Simon scale. The Stanford-Binet yielded scores in terms of intelligence quotients. The **intelligence quotient (IQ)** is the mental age divided by the chronological age and multiplied by 100. IQ scores allowed children of different ages to be compared.

Example:

A ten-year-old whose performance resembles that of a typical twelve-year-old has an IQ of 120 (12 divided by 10 times 100).

There are two problems with the intelligence quotient approach:

1. The score necessary to be in the top range of a particular age group varies, depending on age.
2. The scoring system had no meaning for adults. For example, a fifty-year-old man who scores like a thirty-year-old can't accurately be said to have low intelligence.

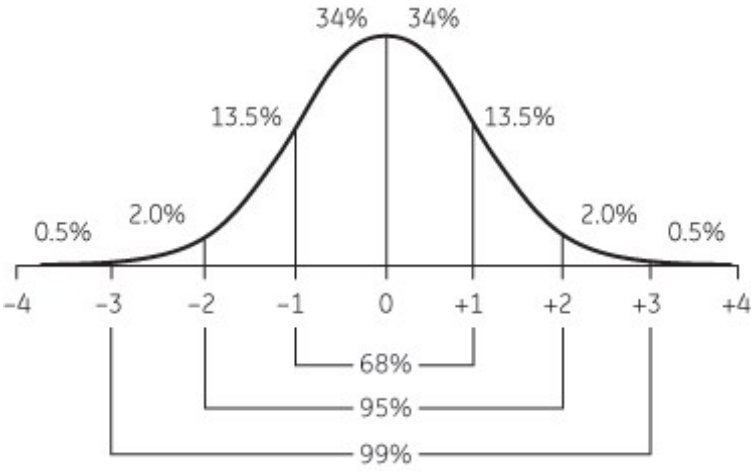
The Stanford-Binet was revised in 1937, 1960, 1973, and 1986.

Wechsler Adult Intelligence Scale

David Wechsler published the first test for assessing intelligence in adults in 1939. The Wechsler Adult Intelligence Scale contains many items that assess nonverbal reasoning ability and therefore depends less on verbal ability that does the Stanford-Binet. It also provides separate scores of verbal intelligence and nonverbal or performance intelligence, as well as a score that indicates overall intelligence.

The term *intelligence quotient*, or *IQ*, is also used to describe the score on the Wechsler test. However, the Wechsler test presented scores based on a normal distribution of data rather than the intelligence quotient. The**normal distribution** is a symmetrical bell-shaped curve that represents how characteristics like IQ are distributed in a large population. In this scoring system, the mean IQ score is set at 100, and the standard deviation is set at 15. The test is constructed so that about two-thirds of people tested (68 percent) will score within one standard deviation of the mean, or between 85 and 115.

On the Wechsler test, the IQ score reflects where a person falls in the normal distribution of IQ scores. Therefore, this score, like the original Stanford-Binet IQ score, is a relative score, indicating how the test taker's score compares to the scores of other people. Most current intelligence tests, including the revised versions of the Stanford-Binet, now have scoring systems based on the normal distribution. About 95 percent of the population will score between 70 and 130 (within two standard deviations from the mean), and about 99.7 percent of the population will score between 55 and 145 (within three standard deviations from the mean).



Group Intelligence Tests

Individual intelligence tests can be given only by specially trained psychologists. Such tests are expensive and time-consuming to administer, and so educational institutions often use tests that can be given to a group of people at the same time. Commonly used group intelligence tests include the Otis-Lennon School Ability Test and the Lorge-Thorndike Intelligence Test.

Biological Tests of Intelligence

Some researchers have suggested that biological indices such as reaction time and perceptual speed relate to intelligence as measured by IQ tests:

- **Reaction time:** the amount of time a subject takes to respond to a stimulus, such as by pushing a button when a light is presented.
- **Perceptual speed:** the amount of time a person takes to accurately perceive and discriminate between stimuli. For example, a test of perceptual speed might require a person to determine which of two lines is shorter when pairs of lines flash very briefly on a screen.

The Influence of Culture

Many psychologists believe that cultural bias can affect intelligence tests, for the following reasons:

- Tests that are constructed primarily by white, middle-class researchers may not be equally relevant to people of all ethnic groups and economic classes.
- Cultural values and experiences can affect factors such as attitude toward exams, degree of comfort in the test setting, motivation, competitiveness, rapport with the test administrator, and comfort with problem solving independently rather than as part of a team effort.
- Cultural stereotypes can affect the motivation to perform well on tests.

Characteristics of IQ Tests

Some characteristics of IQ tests are standardization, norms, percentile scores, standardization samples, reliability, and validity.

Standardization

Intelligence tests are **standardized**, which means that uniform procedures are used when administering and scoring the tests. Standardization helps to ensure that people taking a particular test all do so under the same conditions. Standardization also allows test takers to be compared, since it increases the likelihood that any difference in scores between test-takers is due to ability rather than the testing environment. The SAT and ACT are two examples of standardized tests.

Norms and Percentile Scores

Researchers use norms when scoring the tests. **Norms** provide information about how a person's test score compares with the scores of other test takers. Norms allow raw test scores to be converted into percentile scores. A **percentile score** indicates the percentage of people who achieved the same as or less than a particular score. For example, if someone answered twenty items correctly on a thirty-item vocabulary test, he receives a raw score of 20. He consults the test norms and finds that a raw score of 20 corresponds with a percentile score of 90. This means that he scored the same as or higher than 90 percent of people who took the same test.

Standardization Samples

Psychologists come up with norms by giving a test to a standardization sample. A**standardization sample** is a large group of people that is representative of the entire population of potential test takers.

Reliability

Most intelligence tests have good reliability. **Reliability** is a test's ability to yield the same results when the test is administered at different times to the same group of people. For more on reliability, see page 14.

Validity

Validity is a test's ability to measure what it is supposed to measure. For more on validity, see page 14. Although intelligence tests cannot be considered good measures of general intelligence or general mental ability, they are reasonably valid indicators of the type of intelligence that enables good academic performance.

Critical Views on Intelligence Testing

Critics of widespread intelligence testing point out that politicians and the public in general misuse and misunderstand intelligence tests. They argue that these tests provide no information about how people go about solving problems. Also, say the critics, these tests do not explain why people with low intelligence scores can function intelligently in real-life situations. Advocates of intelligence testing point out that such tests can identify children who need special help, as well as gifted children who can benefit from opportunities for success.

C) The Influence of Heredity and Environment

Today, researchers generally agree that heredity and environment have an interactive influence on intelligence. Many researchers believe that there is a **reaction range** to IQ, which refers to the limits placed on IQ by heredity. Heredity places an upper and lower limit on the IQ that can be attained by a given person. The environment determines where within these limits the person's IQ will lie.

Despite the prevailing view that both heredity and environment influence intelligence, researchers still have different opinions about how much each contributes and how they interact.

Hereditary Influences

Evidence for hereditary influences on intelligence comes from the following observations:

- Family studies show that intelligence tends to run in families.

- Twin studies show a higher correlation between identical twins in IQ than between fraternal twins. This holds true even when identical twins reared apart are compared to fraternal twins reared together.
- Adoption studies show that adopted children somewhat resemble their biological parents in intelligence.

Family studies, twin studies, and adoption studies, however, are not without problems. See pages 36-–38 for more information about the drawbacks of such studies.

Heritability of Intelligence

Heritability is a mathematical estimate that indicates how much of a trait's variation in a population can be attributed to genes. Estimates of the heritability of intelligence vary, depending on the methods used. Most researchers believe that heritability of intelligence is between 60 percent and 80 percent.

Heritability estimates apply only to groups on which the estimates are based. So far, heritability estimates have been based mostly on studies using white, middle-class subjects. Even if heritability of IQ is high, heredity does not necessarily account for differences *between* groups. Three important factors limit heritability estimates:

1. Heritability estimates don't reveal anything about the extent to which genes influence a single person's traits.
2. Heritability depends on how similar the environment is for a group of people.
3. Even with high heritability, a trait can still be influenced by environment.

Environmental Influences

Evidence for environmental influences on intelligence comes from the following observations:

- Adoption studies demonstrate that adopted children show some similarity in IQ to their adoptive parents.
- Adoption studies also show that siblings reared together are more similar in IQ than siblings reared apart. This is true even when identical twins reared together are compared to identical twins reared apart.
- Biologically unrelated children raised together in the same home have some similarity in IQ.
- IQ declines over time in children raised in deprived environments, such as understaffed orphanages or circumstances of poverty and isolation. Conversely, IQ improves in children who leave deprived environments and enter enriched environments.
- People's performance on IQ tests has improved over time in industrialized countries. This strange phenomenon, which is known as the **Flynn effect**, is attributed to environmental influences. It cannot be due to heredity, because the world's gene pool could not have changed in the seventy years or so since IQ testing began.

Possible Causes of the Flynn Effect

The precise cause for the Flynn effect is unclear. Researchers speculate that it may be due to environmental factors such as decreased prevalence of severe malnutrition among children, enhancing of skills through television and video games, improved schools, smaller family sizes, higher level of parental education, or improvements in parenting.

Cultural and Ethnic Differences

Studies have shown a discrepancy in average IQ scores between whites and minority groups in the United States. Black, Native American, and Hispanic people score lower, on average, than white people on standardized IQ tests. Controversy exists about whether this difference is due to heredity or environment.

Hereditary Explanations

A few well-known proponents support hereditary explanations for cultural and ethnic differences in IQ:

- In the late 1960s, researcher Arthur Jensen created a storm of controversy by proposing that ethnic differences in intelligence are due to heredity. He based his argument on his own estimate of about 80 percent heritability for intelligence.
- In the 1990s, researchers Richard Herrnstein and Charles Murray created a similar controversy with their book, *The Bell Curve*. They also suggested that intelligence is largely inherited and that heredity at least partly contributes to ethnic and cultural differences.

Environmental Explanations

Many researchers believe that environmental factors primarily cause cultural and ethnic differences. They argue that because of a history of discrimination, minority groups comprise a disproportionately large part of the lower social classes, and therefore cultural and ethnic differences in intelligence are really differences among social classes. People in lower social classes have a relatively deprived environment. Children may have:

- Fewer learning resources
- Less privacy for study

- Less parental assistance
- Poorer role models
- Lower-quality schools
- Less motivation to excel intellectually

Some researchers argue that IQ tests are biased against minority groups and thus cause the apparent cultural and ethnic differences.

However, not all minority groups score lower than whites on IQ tests. Asian Americans achieve a slightly higher IQ score, on average, than whites, and they also show better school performance. Researchers suggest that this difference is due to Asian American cultural values that encourage educational achievement.