Learning
6
Questions to Consider:

How Did the Behavioral Study of Learning Develop?

How Does Operant Conditioning Differ from Classical Conditioning?

How Does Watching Others Affect Learning?

What Is the Biological Basis of Learning?
How Did the Behavioral Study of Learning Develop?

- Behavioral Responses Are Conditioned
- Phobias and Addictions Have Learned Components
- Classical Conditioning Involves More Than Events Occurring at the Same Time
- Critical Thinking Skill: Recognizing and Avoiding Inappropriate Association Effects in Reasoning
Learning Objective

Explain the types of learning that occur through conditioning.

Differentiate among UR, US, CS, and CR.

Describe the “Little Albert” experiment and explain how it is used as a model for understanding phobias.
How Did the Behavioral Study of Learning Develop?

- Learning is a relatively enduring change in behavior resulting from experience

- B.F. Skinner
  - Focused on the observable behaviors of pigeons and rats rather than the study of the mind through introspection
  - Skinner’s systematic studies led to many of the principles of learning we know today and have been influential in many areas from classrooms to clinics
Behavioral Responses Are Conditioned

- Psychologists study two types of conditioning: Classical or Pavlovian and operant or instrumental
  - John B. Watson
  - Ivan Pavlov
Behavioral Responses Are Conditioned

- Classical conditioning occurs when we learn that two types of events go together

- Operant conditioning occurs when we learn that a behavior leads to a particular outcome

- Pavlov believed that conditioning is the basis for how animals learn to adapt to their environments
Pavlov’s apparatus collected and measured a dog’s saliva.
Hypothesis: A dog can learn that a bell predicts food.

Research Method:

1. Food (unconditioned stimulus) causes the dog to salivate (unconditioned response).

A bell (neutral stimulus) does not cause the dog to salivate.

FIGURE 6.3 Scientific Method: Pavlov's Classical Conditioning
During conditioning trials, the ringing bell is presented to a dog along with the food. This combination is what we call conditioning (US: Unconditioned Stimulus).

Neutral stimulus:

During critical trials, the ringing bell (conditioned stimulus) is presented without the food, and the dog’s response is measured. This response is measured.

After conditioning:

Result: After conditioning, the ringing bell causes the dog to salivate (conditioned response).

Conclusion: The dog was conditioned to associate the bell with food.
- **Stimulus** – thing, item
- **Response** – behavior which occurs as a result of the stimulus
- **Unconditioned** – unlearned
- **Conditioned** - learned
- Unconditioned stimulus – stimulus that automatically produces a response (food)
- Unconditioned response – response that occurs automatically, without prior learning (salivation)
● Conditioned stimulus – stimulus that is associated with the unconditioned stimulus, producing the original response (bell)

● Conditioned response – response that occurs in reaction to the conditioned stimulus (salivation)
Behavioral Responses Are Conditioned

- Learning new behaviors (acquisition) depends on the contiguity (stimuli occurring close together in time) of the stimuli.

- Extinction occurs when the conditioned stimulus (CS) no longer predicts the unconditioned stimulus (US).
  - Spontaneous recovery
During acquisition, the CS-US pairings lead to increased learning such that the CS can produce the CR. If the CS is presented without the US, eventually the CR extinguishes. Later, if the CS is presented alone it will produce a weak CR, known as spontaneous recovery. This CR gets weaker and will extinguish if the CS is continually presented alone.

FIGURE 6.4 Extinction and Spontaneous Recovery
Behavioral Responses Are Conditioned

- Generalization is adaptive
  - In nature the CS is seldom experienced repeatedly in an identical fashion

- Stimulus discrimination:
  - Animals learn to differentiate between two similar stimuli if one is consistently associated with the UCS and the other is not
    - Second-order conditioning
**Stimulus Generalization**

- The CS of 1,000 Hz produces maximum salivation (CR).
- The closer a pitch gets to 1,000 Hz, the **stronger** the CR gets.
- The further a pitch gets from 1,000 Hz, the **weaker** the CR gets.

**Stimulus Discrimination**

- As the dog learns that even similar tones are not associated with the CS, it learns to discriminate more between the tones, such that only tones **very close** to 1,000 Hz yield a CR.

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**FIGURE 6.5 Stimulus Generalization and Stimulus Discrimination**
Phobias and Addictions Have Learned Components

- A phobia is an acquired fear out of proportion to the real threat
  - Fear conditioning
  - Little Albert
  - Counterconditioning can be used in treatment
Phobias and Addictions Have Learned Components

- With addiction, conditioned drug effects are common
  - The smell of coffee increases alertness in coffee drinkers
  - Presenting drug addicts with cues associated with drug ingestion leads to cravings and various physiological responses associated with withdrawal, such as changes in heart rate and blood pressure
  - Brain imaging studies
Phobias and Addictions Have Learned Components

- Tolerance
  - Influenced by situational factors
- Shepard Siegel
Cocaine addicts were shown videos of nature scenes and of cocaine cues. The cocaine-related videos sparked activation in brain regions associated with reward, such as the anterior cingulate and the amygdala. These areas would not have been activated by nature scenes alone. (Areas with greatest activation are shown in red.)
Classical Conditioning: More Than Events Occurring at the Same Time

- Pavlov thought conditioning was due to contiguity with the strength of the association determined by the strength of the CS or UCS

- Later research has identified exceptions to Pavlov’s understanding of this relationship
- Not all stimuli are equally effective in producing learning
  - Conditioned food aversions
Classical Conditioning: More Than Events Occurring at the Same Time

- Biological preparedness
  - Martin Seligman
  - Organisms are genetically prepared to fear certain objects
    - Humans are more likely to fear those who are different

- Gender differences in learning
  - Somewhat controversial
  - Wayfinding
Classical Conditioning: More Than Events Occurring at the Same Time

- Cognitive perspective of learning
  - Focuses on how expectations and prediction impacts classical conditioning.

- The Rescorla-Wagner model
  - Strength of the CS-UCS association is determined by the extent to which the UCS is unexpected
  - The blocking effect
Critical Thinking Skill

- If two events occur close together, people will form an association between them:
  - Guilt by association
  - Virtue by association

- Without additional evidence, these associations can be misleading
How Does Operant Conditioning Differ from Classical Conditioning?

- Reinforcement Increases Behavior
- Both Reinforcement and Punishment Can Be Positive or Negative
- Operant Conditioning Is Influenced by Schedules of Reinforcement
- Biology and Cognition Influence Operant Conditioning
- The Value of Reinforcement Follows Economic Principles
Learning Objectives

List the similarities and differences between operant and classical conditioning.

Explain how variable and ratio schedules of reinforcement combine with positive reinforcement, negative reinforcement, and punishment to affect behavior.
How Does Operant Conditioning Differ from Classical Conditioning?

- *Classical conditioning* is a passive associational process that does not take into account when organisms engage in instrumental behavior (to achieve some purpose)

- *Operant, or instrumental, conditioning* is the learning process in which an action’s consequences determine the likelihood that the action will be performed in the future
Thorndike used a primitive puzzle box, such as the one depicted here, to assess learning in animals.
By studying cats’ attempts to escape from a puzzle box, Thorndike was able to formulate his general theory of learning.

In early trials, Thorndike’s cats would try many random moves to escape from the box.

Through trial and error, the cats learned to more quickly repeat the successful behavior of pushing the lever.
Reinforcement Increases Behavior

- Operant Conditioning
  - Edward Thorndike
  - B.F. Skinner
    - A reinforcer is defined as a stimulus that occurs after a response and increases the likelihood that a response will be repeated
    - The Skinner box
FIGURE 6.13 Skinner Box
Reinforcement Increases Behavior

- Reinforcers can be grouped into two types:
  - Primary (those satisfying basic biological needs) and secondary (those that do not satisfy basic biological needs and are learned through classical conditioning)

- David Premack
  - The Premack principle suggests that more valued activities can be used to reinforce less valued activities
Both Reinforcement and Punishment Can Be Positive or Negative

- Reinforcement increases the probability of a behavior occurring in the future while punishment decreases the probability of a behavior occurring in the future
Both Reinforcement and Punishment Can Be Positive or Negative

- Positive reinforcement or positive punishment:
  - The administration of a stimulus leads to this increase or decrease

- Negative reinforcement or negative punishment:
  - The removal of a stimulus leads to increases or decreases in behavior
Punishment – anything that decreases a behavior

Reinforcement – anything that increases or maintains a behavior
- Negative – a stimulus is removed
- Positive – a stimulus is added
- **Negative reinforcement** – a stimulus is taken away and a behavior is increased (e.g., take away video games to increase studying)

- **Positive reinforcement** – a stimulus is administered and a behavior is increased (e.g., give a sticker and minding is increased)
- Negative punishment – a stimulus is removed so a behavior is decreased (e.g., take away a phone so a child stops staying out at night)

- Positive punishment – a stimulus is administered so a behavior is decreased (e.g., give a speeding ticket so speeding is decreased)
Both Reinforcement and Punishment Can Be Positive or Negative

- Parental punishment
  - Often applied ineffectively and may have unintended and unwanted consequences
    - Learning to avoid punishment rather than decreasing intended behavior
  - Can lead to negative emotions
  - May not be as strong as the reinforcing properties of the behavior itself
    - Spanking
FIGURE 6.15 Negative and Positive Reinforcement, Negative and Positive Punishment
Operant Conditioning Is Influenced by Schedules of Reinforcement

- Continuous reinforcement leads to rapid learning but is rare outside the laboratory.

- Partial reinforcement is more common
  - Can be given in a fixed schedule, variable schedule, interval schedule, or ratio schedule
  - The schedule used impacts how persistent the behavior is.
The curves on this graph show a relative comparison of cumulative responses under different schedules of reinforcement over time. The steeper the line, the higher the response rate. Ratio reinforcement leads to the highest rate of response.

**Variable ratio:** A slot machine pays off on average every few pulls, but you never know which pull will pay.

**Fixed ratio:** You are paid each time you complete a chore.

**Variable interval:** You listen to the radio to hear your favorite song. You do not know when you will hear it.

**Fixed interval:** When quizzes are scheduled at fixed intervals, students study only when the quiz is to be administered (the grade is the reinforcer).

**FIGURE 6.16 Behavior and Reinforcement**

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Operant Conditioning Is Influenced by Schedules of Reinforcement

- The partial-reinforcement extinction effect
  - Greater persistence of behavior under partial reinforcement than under continuous reinforcement

- Behavior modification
  - The use of operant-conditioning techniques to eliminate unwanted behaviors and replace them with desirable ones
    - Token economies
Despite Skinner’s belief that all behavior could be explained by conditioning principles, the reality is that biology constrains learning and reinforcement does not always have to be present for learning to occur.
Biology and Cognition Influence Operant Conditioning

- **Biological Constraints**
  - Marian and Keller Breland
    - Conditioning is most effective if it is consistent with predispositions
  - Randy Gallistel
    - Various learning mechanisms have evolved to solve specific problems
Biology and Cognition Influence Operant Conditioning

- Acquisition/Performance Distinction
  - Edward Tolman
    - Reinforcement has more impact on performance than on learning
    - Cognitive map
  - Insight Learning
Hypothesis: Reinforcement has more impact on performance than on learning.

Research Method:

1. **One group of rats** is put through trials running in a maze with a goal box that never has any food reward as reinforcement.

2. **A second group of rats** is put through trials in a maze with a goal box that always has food reinforcement.

3. **A third group of rats** is put through trials in a maze that has food reinforcement only after the first 10 trials.

![Diagram of maze with rats and food boxes]

Results: Rats that were regularly reinforced for correctly running through a maze (blue) showed improved performance over time compared to rats that did not receive reinforcement (green). Rats that were not reinforced for the first 10 trials but were reinforced thereafter showed an immediate change in performance (red). Note that between days 11 and 12 the red group's average number of errors decreased dramatically.

Conclusion: Rats may learn a path through a maze but not reveal their learning, which is called latent learning, until it is reinforced. There is a distinction between acquisition and performance.
The Value of Reinforcement Follows Economic Principles

- At the heart of the behavioral economics approach are two ideas:
  - People and other animals often need to choose between reinforcers
  - A reinforcer’s worth is affected by the likelihood of its payoff and how long that payoff might take
    - Warren Bickel
    - Animals foraging
How Does Watching Others Affect Learning?

- Learning Can Be Passed On through Cultural Transmission
- Learning Can Occur through Observation
- Animals and Humans Imitate Others
- Critical Thinking Skill: Avoiding the Association of Events with Other Events That Occur at the Same Time
Learning Objectives

Provide an example of culture’s effect on learning.

Describe Bandura’s Bobo doll study and explain its significance.

Discuss mirror neurons’ role in learning.
How Does Watching Others Affect Learning?

- Learning through observation is very common and occurs in a wide variety of settings
Learning Can Be Passed On through Cultural Transmission

- Religious beliefs, values, and even things such as music preference are shaped by the culture in which we live.

- The word *meme* is used to refer to transmitted cultural knowledge.
Learning Can Be Passed On through Cultural Transmission

- Cultural Beliefs about Learning:
  - Asian children often perform better in school than their North American and European peers, especially in math and science.
  - The theory is that Asians are more likely to believe that learning is a function of working hard while Americans and Europeans may be more likely to believe that the ability to learn is innate.
Learning Can Occur through Observation

● Observational Learning
  ● The learning that occurs after watching another perform a behavior

● Albert Bandura
  ● Studies of violence using the Bobo doll suggested that observing media violence may increase aggression
Learning Can Occur through Observation

- Social Learning of Fear
  - Susan Mineka
  - Studies of monkeys found that the lab monkeys developed a fear of snakes after observing such fear in the wild-reared monkeys
  - Because we learn through observation, parents can teach their children complex skills simply by demonstration
Animals and Humans Imitate Others

- Modeling
  - Imitation of observed behavior is commonly called modeling
    - More likely to imitate the actions of models who are attractive, have high status, and are somewhat similar to ourselves
    - Only effective if the observer is physically capable of imitating the behavior
    - Typically we are unaware of the influence of models on our behavior
Animals and Humans Imitate Others

- Vicarious Reinforcement
  
  - Another factor that determines whether observers imitate a model is whether the model is reinforced or punished for performing the behavior

- Vicarious learning
Animals and Humans Imitate Others

- Mirror Neurons
  - When observing someone engage in a behavior, mirror neurons in the prefrontal cortex of the brain are activated
  - Debate exists as to whether mirror neurons lead to imitation learning, increased empathy, or human’s ability to communicate through language
    - Rizzolatti and Arbib
Animals and Humans Imitate Others

- Media and Violence

  - Media violence has been found to increase the likelihood of short and long-term aggressive and violent behavior as well as to lead to desensitization to violence.

  - However, problems exist with interpreting these findings, including generalization, outside the laboratory.
Critical Thinking Skill

- People, and animals, have a strong need to understand what causes or predicts events.
  - Superstitions
  - Pigeons

- Be aware of the tendency to associate events with other events that occur, perhaps simply by chance, at the same time.
What Is the Biological Basis of Learning?

- Dopamine Activity Underlies Reinforcement
- Habituation and Sensitization Are Simple Models of Learning
- Long-Term Potentiation Is a Candidate for the Neural Basis of Learning
Learning Objectives

Describe the neural basis of learning.
What Is the Biological Basis of Learning?

- Learning involves relatively permanent changes in the brain that result from exposure to environmental events.
Dopamine Activity Underlies Reinforcement

- Pleasure centers
  - The neural basis of this reinforcement is the release of the neurotransmitter dopamine

- Peter Milner and James Olds
  - Intracranial self-stimulation (ICSS)
  - Most psychologists believe that ICSS acts on the same brain regions as those activated by natural reinforcers, such as food, water, and sex
Dopamine Activity Underlies Reinforcement

- Nucleus Accumbens Activation

- Evidence suggests that dopamine serves as the neurochemical basis of positive reinforcement in operant conditioning

- Pleasure usually results from activation of dopamine neurons in the nucleus accumbens (part of the limbic system)
  - Drugs
  - Secondary reinforcers
FIGURE 6.26 Pleasure Centers of the Brain

Nucleus accumbens (with dopamine receptors)
Hypothalamus
Pituitary gland
Amygdala
Medial forebrain bundle
Hippocampus
Habituation and Sensitization Are Simple Models of Learning

- Richard Semon
  - Memories are stored through changes in the nervous system

- Donald Hebb
  - Learning results from alterations in synaptic connections
  - Hebb’s postulate can be summed up as “cells that fire, together wire together”
Habituation and Sensitization Are Simple Models of Learning

- Habituation is a decrease in behavioral response following repeated exposure to nonthreatening stimuli.
- Sensitization is an increase in behavioral response following exposure to a threatening stimulus.
  - Eric Kandel
  - For both types of simple learning, presynaptic neurons alter their neurotransmitter release.
Long-Term Potentiation: Candidate for Neural Basis of Learning

- Long-term potentiation (LTP) is the strengthening of the synaptic connection so that postsynaptic neurons are more easily activated.
  - LTP occurs when the intense electrical stimulation increases the likelihood that stimulating one neuron leads to an action potential in the second neuron.
  - Evidence supports the idea that LTP is the cellular basis for learning and memory.
1. When a presynaptic neuron is given a brief electrical pulse, there is a slight probability that the postsynaptic neuron will fire.

2. Applying intense and frequent pulses to the presynaptic neuron leads to a greater probability that the postsynaptic neuron will fire.

3. When a single brief pulse is applied subsequently, it produces the greatest probability that the postsynaptic neuron will fire.

**FIGURE 6.28 Long-Term Potentiation (LTP)**
Long-Term Potentiation: Candidate for Neural Basis of Learning

- LTP and the NMDA Receptor
  - In order for LTP to work, the NDMA receptor must be activated
  - Joseph Tsien
Long-Term Potentiation: Candidate for Neural Basis of Learning

- Fear Conditioning

- Although LTP originally was observed in the hippocampus, recent evidence indicates that fear conditioning may induce LTP in the amygdala.
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