

Learning

Intro Psychology
Georgia Tech
Instructor: Dr. Bruce Walker

Today

- What is Learning?
- Classical conditioning
- Operant conditioning

What is Learning?

- Depends on your purpose and perspective
- Could be changes in behavior
- Could be changes in potential for behavior
- Could be chemical changes

- Seems to always involve change (or does it?)

Learning

- Foundation of intelligent behavior

- Result of experience

- Inferred based on change in behavior as a result of previous experience

The Biological Basis

- At a neurobiological level...
- Learning is “stored” or “created” by changes to the connections (synapses) between neurons

Hebbian Learning in Neurons

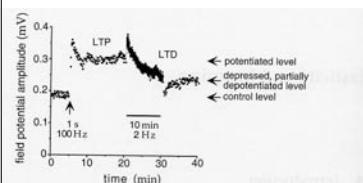


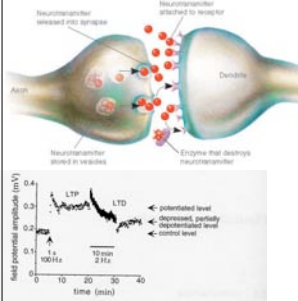
Figure 8.1 LTP and LTD at the Schaffer collateral inputs to the CA1 region of a rat hippocampal slice. The points show the amplitudes of field potentials evoked by constant amplitude stimulation. At the time marked by the arrow (at time 5 minutes), stimulation at 100 Hz for 1 s caused a significant increase in the response amplitude. Some of this increase decayed away following the stimulation, but most of it remained over the following 15 min test period, indicating LTP. Next, stimulation at 2 Hz was applied for 10 min (between times 20 and 30 minutes). This reduced the amplitude of the response. After a transient dip, the response amplitude remained at a reduced level approximately midway between the original and post-LTP values, indicating LTD. The arrows at the right show the levels initially (control), after LTP (potentiated), and after LTD (depressed, partially depotentiated). (Unpublished data of J. Fitzpatrick and J. Lisman.)

Stimulate a neuron, cause depolarization (i.e., it fires)

Next cell, even if it doesn't fire may become partially depolarized.

If this depolarization happens often close together in time, then cell may eventually fire.

Hebbian Learning in Neurons



- Why?
- Synapse gets stronger as cells activity gets more correlated.
- Change in synapses seems to be the basis of memory.

Figure 8.1 LTP and LTD at the Schaffer collateral inputs to the CA1 region of a rat hippocampal slice. The points show the amplitude of field potentials evoked by constant amplitude stimulation. At the time marked by the arrow (at time 5 min), brief stimulation at 100 Hz for 1 s caused a significant increase in the response amplitude. Some of this increase decayed away following the stimulation, but most of it remained over the following 10 min test period, indicating LTP. Next, stimulation at 2 Hz was applied for 10 min (between times 20 and 30 minutes). This reduced the amplitude of the response. After a transient dip, the response amplitude remained at a reduced level, approximately midway between the original and peak LTP values, indicating LTD. The arrows at the right show the levels initially (control), after LTP (potentiated), and after LTD (depressed, partially depotentiated). (Reprinted from J. Fitzpatrick and J. Lisman.)

The “Classic” Behavioral Basis

- We can also consider learning from a behavioral perspective, as compared to a biological perspective:
- Learning is about what you do and don't do as opposed to how your neurons change
- Outwardly observable
- Note: “Classical” learning theory predates tools to study neurobiology

Notes on Classical Learning Theory

- Classical learning theory can be abstract...
- Notational scheme doesn't help. I've kept it because the book uses it.
- Keep thinking: LEARNING IS THE FOUNDATION OF ALL KNOWLEDGE
- Some practical examples to convince you of both theoretical and practical significance.

Simplest Forms of Learning

- Associate two events, detection of co-occurrence
- Let go of a pencil, it drops
- Put hand on a hot surface, it hurts
- Drink too much, get sick.

Classical Conditioning

- First decent laboratory method for studying this simple form of learning
- Ivan Pavlov
 - Russian physiologist studying digestive system
 - Ideas fit nicely with emerging socio-political philosophy of communism



Classical (Pavlovian) Conditioning

- Principal observation was that salivation was triggered by food, sight of food, sight of laboratory assistant that fed dogs.
- Obvious why food causes salivation, but why and how does sight of lab assistant cause this?
- Learning of some sort...

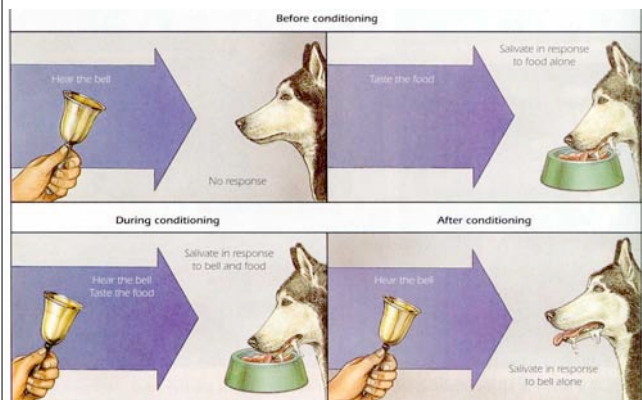
Classical (Pavlovian) Conditioning

- Unconditioned **stimulus**
 - Event that regularly elicits (leads to) a certain response (e.g., food)
- Unconditioned **response** (reflex)
 - Response elicited by the unconditioned stimulus (US) (e.g., salivation)
- Food (US) naturally, automatically, without learning, leads to salivation (UR)

Classical (Pavlovian) Conditioning

- Conditioned stimulus
 - Previously neutral stimulus that elicits no response (until learning takes place) (e.g., lab technician)
- Conditioned response
 - Response to the CS after learning (e.g., drool when lab tech arrives)

Classical (Pavlovian) Conditioning



Classical (Pavlovian) Conditioning

- Conditioned response does not have to (and typically doesn't) equal the unconditioned response.
- UR and CR generally are different quantitatively or qualitatively (you'll see why in a minute)

Classical (Pavlovian) Conditioning

- What's happening here?
 - Prediction – the conditioned stimulus is associated with an upcoming event.
 - Prediction comes from the association between the conditioned stimulus and the unconditioned stimulus
 - Two forms of association – US to CS, and CS to CR.
- [Video of Pavlov]

Sidebar: John B. Watson

Born Jan 9, 1878

- 1920 - Little Albert
 - Experiments in conditioning, along with Rosalie Rayner
- 1924 - Innovations in advertising



Classical (Pavlovian) Conditioning

- What's so important?
 - This learning presents in a whole range of organisms – from Aplysia (sea slugs) to humans.

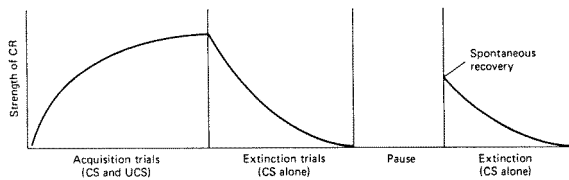


Classical (Pavlovian) Conditioning

- What's so important?
 - This learning presents in a whole range of organisms – Aplysia (sea slugs) to humans.
 - Huge amount of useful information is contained in these simple associations.
 - Basic building block in learning the structure of the environment.

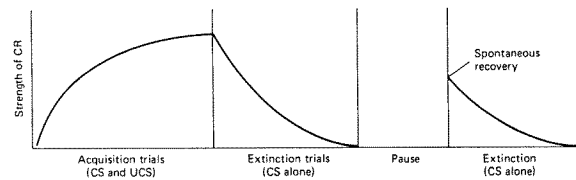
Classical (Pavlovian) Conditioning

- Seems simple but there are some interesting complications...



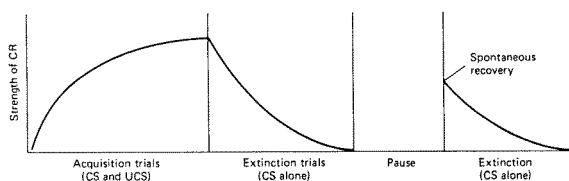
Classical (Pavlovian) Conditioning

- Extinction – repeated presentation of CS w/o US (e.g., bell w/o food), CS is no longer predictive, response goes down.



Classical (Pavlovian) Conditioning

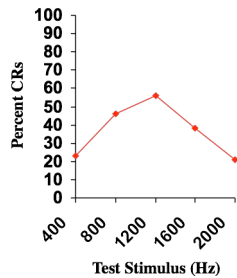
- Spontaneous recovery – pause can cause a rebound in activity.
- One run shouldn't get rid of everything.



Stimulus Generalization

- Conditioned responses (CRs) occurring to stimuli other than the CS used for training
- The more similar the second stimulus is to the CS the more generalization will occur
- Generalization is a critical feature of learning because we rarely encounter the exact same stimulus twice
 - Consider drug-sniffing dogs learning a range of smells (different drug samples)

Generalization Gradient



- From Moore, 1972
- Eyeblink conditioning in Rabbits
- CS+ = 1200 Hz Tone
UCS = mild Shock
Hundreds of trials
- Generalization test in extinction

Stimulus Generalization Along Non- Physical Dimensions

- In language-using animals (e.g., humans) generalization to words with a similar meaning may occur
- Called Semantic Generalization
- Razran (1949) found that after training with the word “day”, human subjects showed about 20% generalization to the word “may”, but 40% generalization to the word “week”
- Razran also found an “opposites” effect: more generalization from “day” to “night”

Second-Order Conditioning

- Phase 1:
 - Pair CS₁ → UCS until learning occurs
- Phase 2:
 - Pair a new stimulus (CS₂) as the CS with the first one (CS₁) as the UCS
 - CS₂ → CS₁
- Because CS₁ reliably elicits a CR, the new stimulus, CS₂ that is paired with it, will begin to elicit the CR as well

Second-Order / Higher-Order Conditioning

- The number of second-order trials is important
- Higher-order conditioning is possible as well (although weaker)
- Rizley & Rescorla (1972) also found that if CS₁ is extinguished (separately), it has no effect on the ability of CS₂ to elicit CRs

Conditioning and Drug Tolerance

- Shepard Siegel (McMaster Univ)
 - Drug as unconditioned stimulus
 - Context immediately before taking drug as conditioned stimulus
 - CS evokes a CR aimed at maintaining homeostatic balance, opposite of drug effect.
 - “Tolerance” is partly the increase in CR response counteracting drug effects



Conditioning and Drug Tolerance

- Shepard Siegel (McMaster Univ)
 - Prediction: drug effect should be greater in absence of CS (context)
 - Evidence: Siegel (1982) interviewed addicts that had experienced overdose, suggested that OD more likely in different unfamiliar context (but problems with observational studies...)



Conditioning and Drug Tolerance

- Shepard Siegel (McMaster Univ)
 - Prediction: drug effect should be greater in absence of CS (context)
 - Evidence: Siegel (1983) showed that rats' drug tolerance was lower in different, unfamiliar cages compared to same familiar cages.
 - Support for conditioning locus for at least part of acquisition of drug tolerance.



Instrumental Conditioning: Thorndike

- How our behavior controls the environment and how the environment controls our behavior
- Key is that we are active participants in learning



Edward L. Thorndike

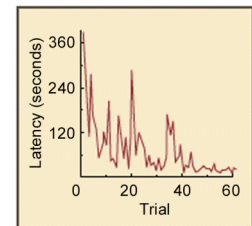
Thorndike: Puzzle Box

- Puzzle box – animal learned to perform a simple action to attain some reward (escape box, food)



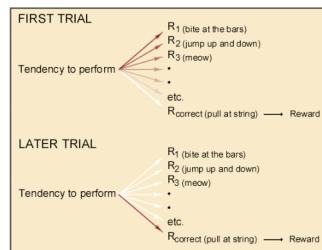
Thorndike: Learning

- Learning can be seen by the decrease in time to escape the box as a function of number of trials



Thorndike: Learning

- “Law of effect”
Behaviors that are followed by a “satisfying state” (e.g., rewarded) will be strengthened, those that are followed by no reward or punishment are weakened.

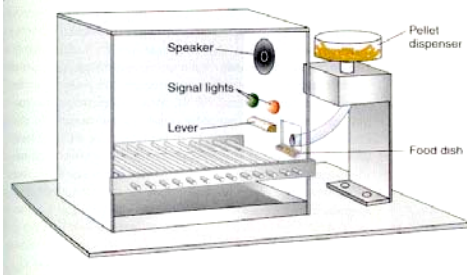


B. F. Skinner



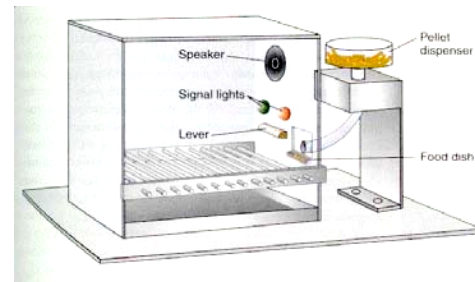
Skinner's Box (Operant Chamber)

- Tool for measuring how behavior is shaped by different types of rewards and different ways of presenting rewards.



Skinner's Box

- Reinforcers and Punishments



Schedules of Reinforcement

- Ratio Schedules – produce some specific amount of behavior for reward
 - Fixed
 - Variable
- Interval Schedules – rewards based on intervals of time
 - Fixed
 - Variable

Schedules of Reinforcement

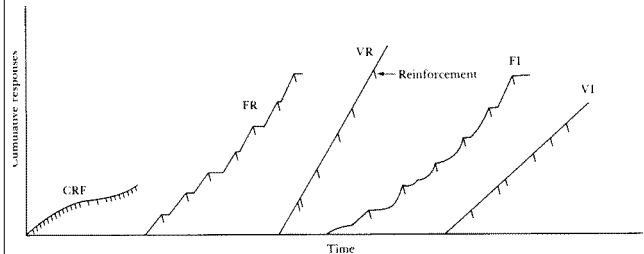
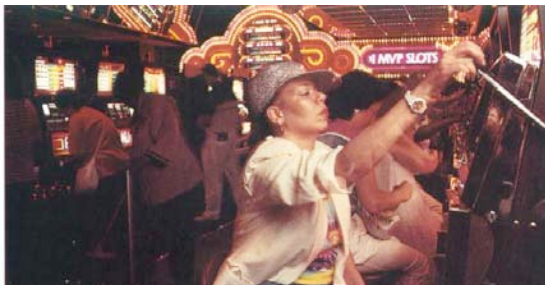


FIGURE 6.1. Sample cumulative records of lever pressing on various simple reinforcement schedules. Horizontal displacements in the records indicate passage of time. Vertical displacements indicate cumulative responses. Hatch marks indicate times when the reinforcer is delivered. CRF is continuous reinforcement; FR, fixed ratio; VR, variable ratio; FI, fixed interval; and VI, variable interval. (Hypothetical data.)

Schedules of Reinforcement: Which One?



Humans

- Same basic principles apply but other complications
 - Rewards and punishments get more complicated (e.g., prestige, embarrassment)
 - Attitudes and decision processes intervene
 - Effects of rewards

Upcoming

- Sensation & Perception
- Exam 1