

Learning and Memory

Learning

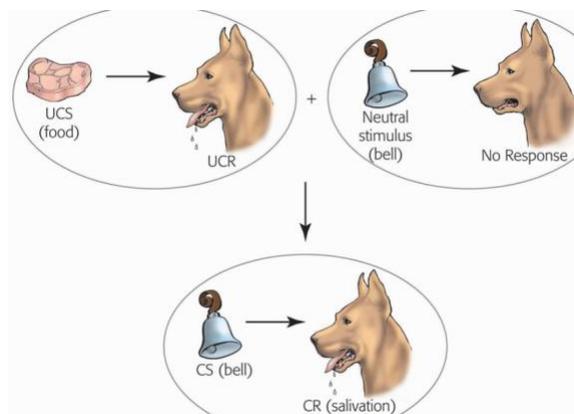
- Learning refers to the way in which we acquire new behaviors
- A **stimulus** is defined as anything to which an organism can respond
 - Combination of stimuli and responses serve as the basis for all behavioral learning
- Habituation: repeated exposure to the same stimulus may cause a decrease in response
- Dishabituation: recovery of a response to a stimulus after habituation has occurred.
 - I.e. – a second stimulus presented before the first habituation has fully occurred
 - Interrupts the habituation process and causes an increase in response to the original stimulus
 - Creates a new awareness of – and response – to the original stimuli
 - Always refers to changes in response of the original stimulus, not the new one
- Learning is the change in behavior that occurs in response to a stimulus

Associative Learning

- Creation of a pairing or association between two stimuli or between a behavior and a response
- Two types of this learning on the MCAT: Classical and operant Conditioning

Classical Conditioning I.e – Ivan Pavlov Experiments

- Takes advantage of biological & instinctual responses to create an association between two unrelated stimuli.
- Works because some stimuli cause an innate or reflexive physiological response
 - Unconditioned Stimulus: any event that brings about a reflexive response
 - Neutral Stimuli: do not produce a reflexive response
 - Referred to as **signaling stimuli** if the stimulus has the potential to be used as a conditioning stimulus
- Conditioned Stimulus: a normally neutral stimulus that now, through association, causes a reflexive response.
 - Conditioned Response: is the reflexive response caused by a conditioned stimulus
- Acquisition: the process that classical conditioning takes advantage of.
 - Process of taking advantage of a reflexive, unconditioned stimulus to turn a neutral stimulus into a conditioned stimulus



- **Extinction** may occur when a conditioned stimulus is presented without the unconditioned stimulus enough times.
 - Involves the habituation of the conditioned stimulus
 - However, even this is not always permanent. May still induce a weaker conditioned response at times. This is called **spontaneous recovery**
- Generalization: Broadening effect where a similar stimulus to the conditioned stimulus can also produce the conditioned response
- Discrimination: organisms learn to distinguish between two similar stimuli.
 - I.e. – the opposite of generalization

Operant Conditioning

- This links voluntary behaviors with consequences. Attempts to alter the frequency of those behaviors.
- B.F Skinner is considered the father of behaviorism: theory that all behaviors are conditioned.

Reinforcement

- Process of increasing the likelihood that an individual will perform a behavior. Can be divided into two categories:
 - Positive Reinforcers: increase a behavior by adding a positive consequence/incentive after the behavior is shown.
 - E.g. – Money
 - Negative Reinforcers: increase the frequency of a behavior by removing something unpleasant
 - E.g. – taking medicine to feel better when you are sick
- Negative Reinforcers can be split up further based on the timing of the unpleasant stimulus:
 - Escape Learning: role of behavior is to reduce the unpleasantness of something that already exists
 - Avoidance Learning: meant to prevent the unpleasantness of something that has yet to happen.
- Classical and operant conditioning can be used together
 - Primary Reinforcers: something that the organism would respond to naturally.
 - Conditioned or Secondary Reinforcer: a stimulus that would not normally cause a reinforcement
 - Discriminative Stimulus: indicates that the reward is potentially available
 - E.g. – Dolphin training: Fish is the primary reinforcer; clicking sounds that accompany the fish are considered the secondary reinforcer; trainer is a discriminative stimulus

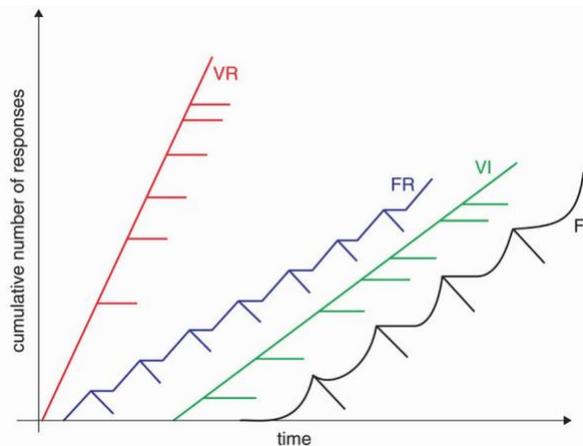
Punishment

- Uses conditioning to reduce the occurrence of a behavior.
- Positive Punishment: adds an unpleasant consequence in response to a behavior
- Negative Punishment: reduction of a behavior when a stimulus is removed
 - E.g. – taking away T.V from kids when they have done something bad

		Stimulus	
		Added	Removed
Behavior	Continues	Positive reinforcement	Negative reinforcement
	Stops	Positive punishment	Negative punishment

Reinforcement Schedules

- Rate at which desired behaviors are acquired is affected by the schedule being used to affect the behaviors
- **Fixed Ratio (FR) Schedules:** reinforce a behavior after a specific number of performances of that behavior.
 - **Continuous Reinforcement:** FR schedule where behavior is rewarded every time it is performed
- **Variable-ratio (VR) Schedules:** reinforce a behavior after a varying number of performances of that behavior
 - The average number of performances to receive a reward is relatively constant
- **Fixed-Interval (FI) Schedules:** reinforce the first instance of a behavior after a specified time period has elapsed.
- **Variable Interval (VI) Schedules:** reinforce a behavior for the first time that the behavior is performed after a varying time interval.
- Variable-ratio is the fastest and most extinction-resistant method



- VR has the fastest response rate: continuing producing stimuli in hope that the next iteration will be the “right one”
- FR and FI have brief moments of no response, learns what behavior is needed to receive the reinforcement.
- **Shaping:** process of rewarding increasingly specific behaviors
 - Associated mainly with operant conditioning

Cognitive and Biological Factors in Associative Learning

- Many factors have the ability to change the effects of associative learning
- Latent Learning: learning that occurs without a reward. But the stuff that is learned is spontaneously demonstrated when a reward is introduced.
- Problem Solving: Trial and error approach in which behaviors are tested until a reward is yielded.
 - Not a part of the standard behaviorist approach.
- Not all behaviors can be taught using operant conditioning techniques. Many organisms are predisposed to learn (or not to learn) simply based on their natural abilities and instincts.
 - Animals are most able to learn behaviors that coincide with their natural behaviors
 - Preparedness is the predisposition of learning certain behaviors more easily since they are related to an animal's natural tendencies.
- Instinctive Drift: difficulty in overcoming instinctual behaviors.

Observational Learning

- Process of learning a new behavior or gaining information by watching others
 - E.g. – Bobo Doll Experiment
- Can also be used to teach individuals to avoid behavior as well. So it is not simply a form of imitation.
- Mirror Neurons: neurons are located in the frontal and parietal lobes of the cerebral cortex
 - These fire when an individual performs an action or when an individual observes someone else performing an action
 - Mainly involved in motor neurons but may also be related to empathy and vicarious emotions (Seeing someone else feel the same emotion that you are)
- Modeling: important form of observational learning that determines an individual's behavior throughout their lifetime.
 - People learn what behaviors are acceptable by watching others perform them

Memory

Encoding

- Refers to the process of putting new information into memory.
- Automatic Processing: refers to the information that is gained without effort
 - E.g. – temperature, route taken
- Controlled (Effortful) Processing: active memorization that requires work to gain information
 - This can become automatic after practice
 - E.g. – learning a language
- Different ways of encoding the meaning of information:
 - Visual Encoding. This is the weakest type of encoding
 - Acoustic Encoding: store the way it sounds
 - Semantic Encoding: put it into meaningful context. This is the strongest type.

- Works best when the context is more vivid
 - Self-reference effect: information is best recalled when it is put into the context of one's own life.
- Maintenance rehearsal: repetition of a piece of information to keep it within working memory or to store it in short-term and eventually long-term memory
- Mnemonics: Acronyms or rhyming phrases that provide an organization of information
 - Method of Loci: associating each item in a list with a location along the route of an already memorized building route.
 - Peg Word System: associates numbers with items that rhyme with or resemble the numbers
- Chunking (Clustering): takes individual elements of a large list and groups them together into elements with the related meanings.

Storage

- Information from encoding must be stored if it needs to be remembered

Sensory Memory

- Consists of **ionic** (visual) and **echoic** (auditory) memory
- Lasts only a very short amount of time (less than a second), but eyes take in a very detailed representation of surrounds
- These memories are maintained by the major projection areas of each sensory system:
 - Occipital lobes for vision
 - Temporal lobes for hearing
- Information fades very quickly and will be forgotten unless it is attended to.

Short-Term Memory

- Sensory information that is paid attention to.
- Fades quickly (approximately 30 seconds)
 - Duration can be increased by using maintenance rehearsal
- Also limited by capacity of approximately seven items (**7±2** rule)
 - Capacity can be increased by clustering information
- This type of memory is housed in the **hippocampus**
 - Also responsible for consolidation of short term memory into long-term memory

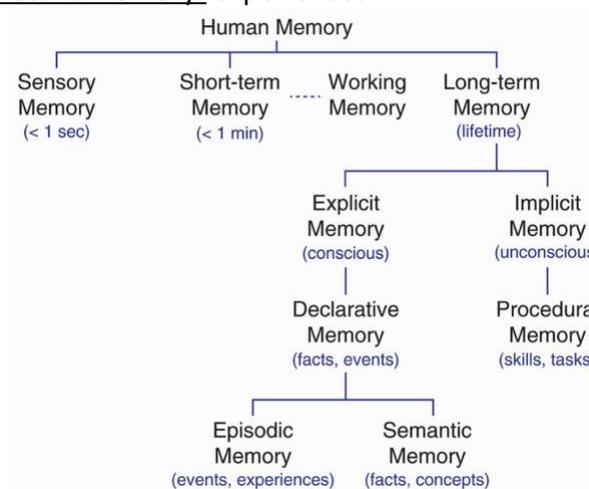
Working Memory

- Supported by hippocampus and is related to short-term memory
- Enables us to keep a few pieces of information in our consciousness and simultaneously manipulate that information
- Integrates short-term memory, attention and executive function
 - As such, frontal and parietal lobes are involved
- Allows us to do simple math in our head

Long-Term Memory

- Information moves from short-term to long-term memory with rehearsal
- This is essentially a limitless warehouse for knowledge that we are then able to recall on demand

- Elaborative Rehearsal: association of the information to knowledge that is already stored in long-term memory
 - Closely related to **self-reference effect**: ideas that are relatable to one's own life are more likely to be transferred into long-term memory
- Primarily controlled by the hippocampus, but memories are moved back to the cerebral cortex, over time.
- Two types of long-term memories:
 - Implicit (non-declarative or procedural) memory: skills and conditioned responses
 - Explicit (declarative) memory: those memories that require conscious recall
 - Semantic Memory: facts that we know
 - Episodic Memory: experiences



Retrieval

- Process of demonstrating that something that has been learned has been retained
 - Associated with **recall**: the retrieval and statement of previously learned info
 - Also demonstrated by recognizing or quickly relearning information
- Recognition: identifying a piece of information that was previously learned
 - This is far easier than recall
- Relearning: Ability to rememorize information much more quickly than the first iteration
 - Spacing Effect: the longer the amount between sessions of relearning, the greater the retention of information later on
- The brain organizes ideas into a **semantic network**
 - Concepts are linked together based on similar meaning
 - A way for the brain to organize information so that it can take advantage of environmental cues
 - Spreading Activation: when one node of a semantic network is activated, the other linked concepts around it are also unconsciously activated.
- Priming: spreading activation is the heart of this retrieval cue
 - Recall is aided by first being presented with a word or phrase that is close to the desired semantic memory.

- Context Effects: memory is aided by being in the physical location where encoding took place
 - E.g. – a person will score better when they take an exam in the same room in which they learned the information
- State-Dependent Memory (effect): A person's mental state also affects recall
 - E.g. facts learned while drunk will be recalled better when intoxicated again as compared to recalling the facts while sober.
 - E.g. – recollection of negative or positive memories will lead to the persistence of the mood.
- Serial position effect: retrieval cue that appears while learning lists
 - Primacy Effect: tendency to remember early items
 - Recency Effect: tendency to remember later items
 - Primacy effect are stronger than recency effects and they last longer.

Forgetting

Brain Disorders

- Alzheimer's disease: degenerative brain disorder thought to be linked to a loss of acetylcholine in neurons that are linked to the hippocampus.
 - Marked by progressive **dementia** and memory loss along with brain atrophy
 - Memory loss tends to proceed in retrograde fashion
 - Loss of recent memories before distant memories
 - Under the microscope, **neurofibrillary tangles** and **β -amyloid plaques** are found
 - Sundowning: increase in dysfunction in the late afternoon and evening.
- Korsakoff's Syndrome: memory loss caused by thiamine deficiency in the brain
 - Marked by retrograde amnesia (loss of previously formed memories) & anterograde amnesia (inability to form new memories)
 - Confabulation: process of creating vivid but fabricated memories
- Agnosia: loss of the ability to recognize objects, people or sounds (usually only one)
 - Caused by physical damage to the brain

Decay

- Memories are simply lost naturally over time
 - Neurochemical trace of a short-term memory fades
- Curve of Forgetting: for a day or two after learning a list, the recall falls sharply but then levels off.

Interference (interference effect)

- Retrieval error that is caused by the existence of other, usually similar, information.
- Proactive Interference: old information is interfering with new learning
 - Each subsequent list or thing learned is harder since there is an increase of interference
- Retroactive Interference: new information causes forgetting of old information
 - E.g. – teachers learning a new set of students names find it difficult to recall old student's names.
 - Can be prevented by reducing the number of interfering events
 - E.g. – studying right before going to sleep

Aging and Memory

- Aging does not necessarily lead to significant memory loss
- Pivotal events in old people's lives are usually most vividly recalled from when they are in their teens and twenties. This indicates that this time period is the peak period for encoding in a person's life.
- Do not demonstrate as much degradation in recognition or skill-based memory as they age.
- Semantically meaningful material can be easily learned and recalled
 - I.e. – older individuals have a larger semantic networks
- Prospective Memory: remembering to perform a task at some point in the future
 - Remains intact when it is event-based
 - Time based memory tends to decline (e.g. – remembering to take meds at certain time everyday)

Memory Construction

- Memories are heavily influenced by thought and feeling during the actual event and during recall.
- Confabulation: gaps in memories that are filled. This can cause the memory to be altered significantly from its original event.
 - Example of **false memories**
- Misinformation Effect: recollection of events or information can be heavily influenced by outside sources.
 - Effect can also be seen at the point of recall
 - E.g. – changing the language of a question to change the recollection of a thought
- Source-Monitoring error: confusion between semantic and episodic memory
 - A person remembers the details of an event, but confuses the context under which those details were gained
 - E.g. – person hears a story of something that happened to someone else, but later recalls the story as having happened to themselves.

Neurobiology of Learning and Memory

- Neuroplasticity: neural connection form rapidly in response to stimuli
 - Very prominent in newborns since they are born with many more neurons than are actually needed
 - Adult brains display nowhere near the plasticity as that of children. Only a small degree of plasticity is retained.
- Synaptic Pruning: Weak neural connections tend to degrade as one gets older, while the stronger connections are bolstered.
 - This is done to increase the efficiency of the brain's ability to process information
- Long-Term potentiation: strengthening of memories through more efficient release of neurotransmitters from neurons.
 - Also involves an increase in receptor sites on the other side of the synapse.

- A memory begins as a sensory memory that is located in the projection area of a given sensory modality. This memory is brief unless it is maintained by the consciousness and moved into the hippocampus.
 - Moving of the sensory memory to the hippocampus requires the conversion of the memory to short-term memory.
 - Memory can then be manipulated in the hippocampus through the use of working memory and can also be stored in the hippocampus for later use.
 - Over longer periods of time, memories are gradually moved from the hippocampus to the cerebral cortex