Intro to Cognitive Neuroscience

Learning and Memory
Starting with the behaviorists

• Learning - a relatively permanent change in an organism’s behavior due to experience

• Two types of conditioning that behaviorists discuss.
  
  • Classical conditioning (Pavlov etc) - a type of learning in which an organism learns to associate two stimuli.

  • Operant conditioning (Skinner etc) - a type of learning in which behavior is strengthened if followed by a reinforcer or diminished if followed by a punisher.
Classical conditioning

• A type of learning in which an organism learns to associate two stimuli.

• Pavlov’s dogs:
Classical conditioning

- Pavlov’s dogs:

  - Unconditioned stimulus (meat) triggers unconditioned response (drooling when meat is presented).
  
  - Pairing unconditioned stimulus (meat) with conditioned stimulus (tuning fork).
  
  - Eventually conditioned stimulus (tuning fork) alone can produce conditioned response (salivating when tuning fork is rung).

Image courtesy of Normski.
Classical conditioning

• Another example: Experimenter plays a tone right before delivering a puff of air at the eye. After two or three repetitions, subjects blink after just the tone is played.

  • What is the UCS? UCR? CS? CR?
Operant conditioning

• A type of learning in which behavior is strengthened if followed by a reinforcer or diminished if followed by a punisher.

• Shaping - procedure in which reinforcers guide behavior toward closer and closer approximation of a desired goal.
Operant conditioning

• Primary reinforcers = innately satisfying. Food, water, sex, etc.

• Secondary reinforcers = depend on association with primary reinforcers. Good grades, money, smiles from others, etc.

• Humans can handled delayed reinforcers, most other species can’t.

Image courtesy of the U.S. Government.
Operant conditioning

• Continuous reinforcement - reinforcer given every time. Learning occurs rapidly, extinction occurs rapidly.

• Fixed-ratio schedule - reinforce behavior after a set number of responses.

• Variable-ratio schedule - reinforce behavior after a varying number of responses.

• Fixed-interval schedule - reinforce first response after a certain amount of time.

• Variable-interval schedule - reinforce first response after a varying time interval.
Operant conditioning

• Punishment - reduces frequency or intensity of a behavior.

• Most effective (in humans, particularly) when combined with reinforcement of an alternative behavior.

Image removed due to copyright issues.
Some more modern perspectives

• Both classical and operant conditioning are (clearly) adaptive. Being able to associate two stimuli, or to associate behavior with outcomes, are good for your likelihood of reproducing.

• There seem to be biological constraints on classical conditioning - eg, eating a food and then getting sick.
Modern perspectives

• Evidence shows that “latent learning” - learning without reward or punishment - can occur.

• Promising people a reward for a task they already enjoy can backfire - overjustification effect.
Motor learning

• Procedural (aka non-declarative) memory is about motor procedures or perceptual experiences

• Patient H.M. (who had most of his temporal lobes amputated in 1953 and could not form new memories) improved over several days on a mirror-tracing task.
Types of memory

• Non-declarative - memory for perceptions or motor procedures

• Declarative - memory for things you can use words for
  
  • Episodic - memory for particular life events
  
  • Semantic - memory for facts, word meanings, and so on.
Types of memory

• Atkinson and Shiffrin’s model

• But, like with short-term memory, considers long-term memory as a single unit. Modern models show that different types of memories are handled separately.
Stages of memory

- Encoding - “putting information in”
- Storage - “retaining information”
- Retrieval - “getting information out”

• Remember this sentence (don’t write it down!): The angry artist hurled a palette at the window.
Encoding

• Automatic processing vs. effortful processing.

• Many memories form automatically. What did you do this afternoon? Did you put any effort into remembering those activities?

• Some memories require effort and attention. Studying = effortful processing.
Encoding - presentation of material

• Rehearsal increases recall, decreases time to re-learn material.

• Spacing effect - recall improves when rehearsal is spread over time. (IE, cramming is bad.)

• Expanding spaced recall - Thomas Landauer.

• Serial position effect - more likely to recall first or last items from a list.
Encoding

• We often encode verbal material’s meaning, rather than the material itself word-for-word.

• Craik and Tulving compared people’s recollection for words encoded visually, acoustically, or semantically.

• Bransford and Johnson asked students to recall a seemingly meaningless paragraph.
Storage

• Storage capacity of the brain has been estimated to be between a terabyte and a petabyte. (Not such a huge amount as it seemed in 1986.)

• Same team estimated that about a gigabyte of that storage is used.

• But how? Where? What does it mean to say a memory is “stored in the brain”? 
Storage

• Lashley (1950) trained rats to run a maze, then removed small sections of cortex.

• No matter which piece he removed, rats still retained some memory of the maze.

• Memories do not reside in single specific locations in cortex.
Storage

• Patients like H.M. show that forming declarative memory depends on hippocampus.

• Hippocampus also seems involved in forming spatial memories.

• Hippocampus seems to act as an area where brain temporarily stores memories before they move elsewhere.

• Classical conditioning seems to depend on processes in the cerebellum.
Retrieval

• How do we access stored information?

• Recall, recognition, and re-learning are all measures of memory used by psychologists.

• Need a cue of some sort to direct access to memory.
Retrieval

• Context matters.