Introduction to Cognitive Neuroscience
Summer 2008

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).

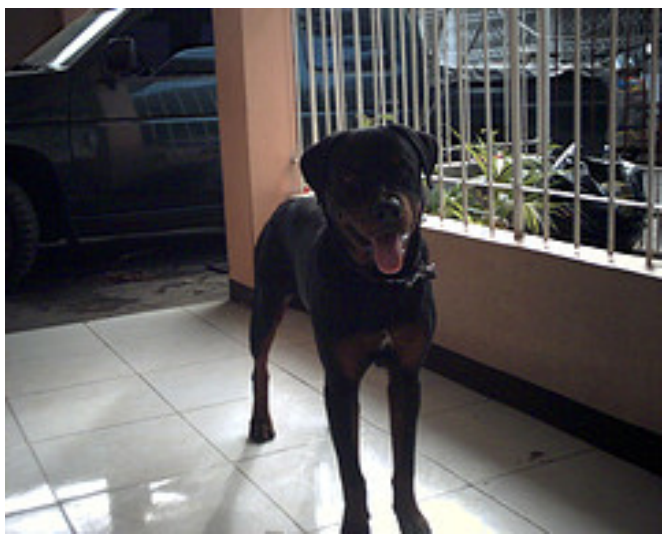


Image courtesy of Normski

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.

Follow the link to see a diagram of a Skinner Box

http://commons.wikimedia.org/wiki/Image:Skinner_box.png

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 peceptual experiences

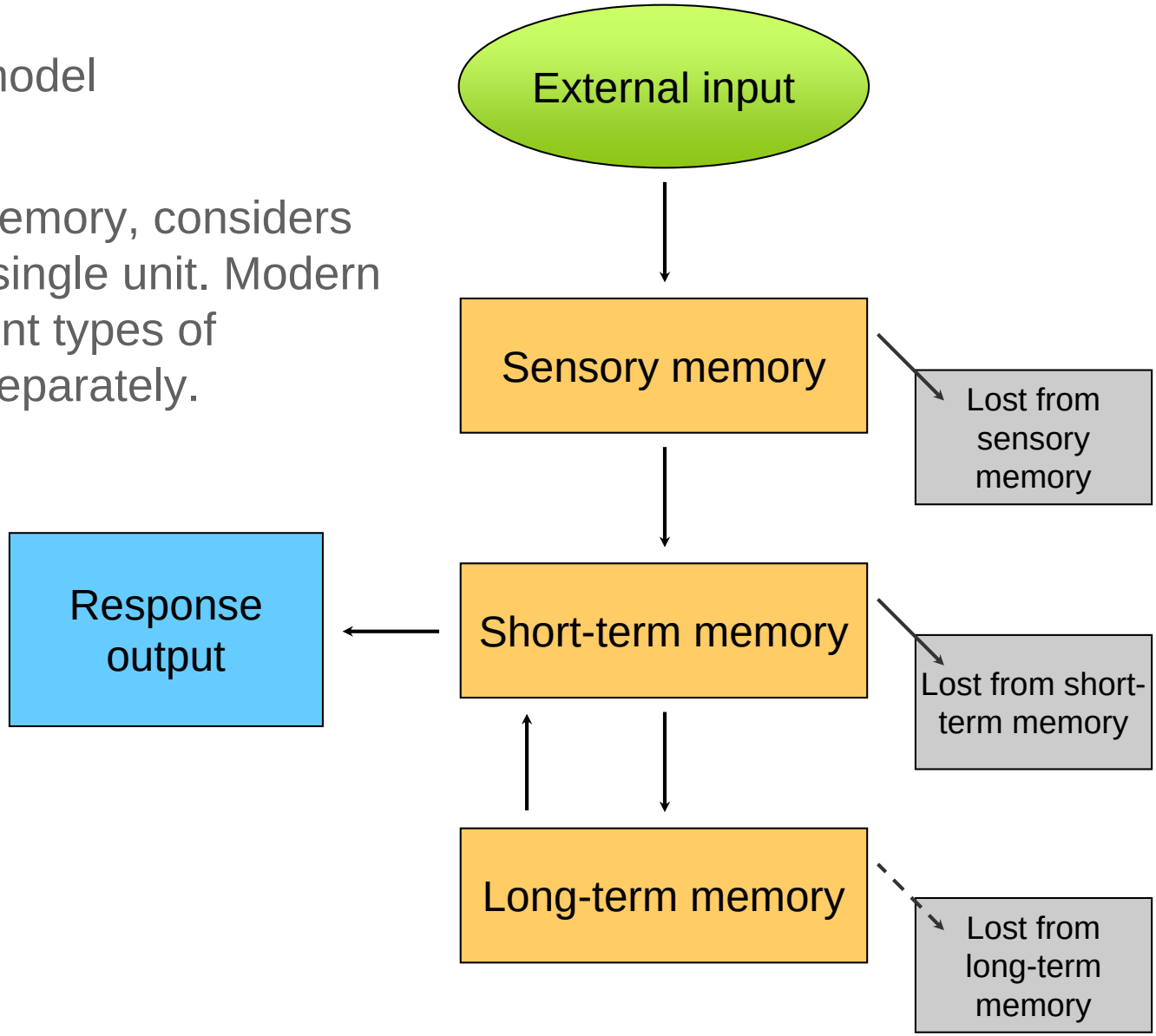
- Patient H.M. (who had most of his temporal lobes amputated in 1953 and could not form new memories) improved over several days on a mirror-tracing task.

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 w/ 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.