9.03 Neural Basis of Learning and Memory: Lecture 2
Introduction to behavioral learning paradigms

Forms of behavioral learning

Instrumental conditioning

avoidance learning - receive an unpleasant stimulus when the animal fails to make a response

- 2-sided shock chamber

learned helplessness - inescapable shock results in freezing

- used in context dependent fear conditioning

reward training - receive reinforcement when response is made

- shaping

escape - inevitable unpleasant stimulus continued unless response is made

punishment - receive an unpleasant stimulus when a response is made

Classical conditioning

can be subdivided into *appetitive* conditioning when the unconditioned stimulus is rewarding, or *defensive* conditioning if the stimulus is aversive.

Examples of classical conditioning paradigms are

- eyeblink/nictitating membrane
- taste aversion
- GSR

Discrimination learning - positive and negative stimuli, must identify the positive stimulus

Serial learning

lists
sequences
mazes

Paired associates - positive and negative stimuli.

Spatial learning

radial maze

Biological constraints

Conditioning

- stimulus/response preferences - some stimuli are more easily associated with some responses
- easy to jump or bar press for food; hard to condition to grooming or scratching
- - shock produced fear easily paired with visual/auditory stimuli; difficult to pair with taste
- - illness easily associated with taste but not visual/auditory stimuli
- - avoidance of shock easily paired with barrier jumping but not bar pressing.

Discrimination learning

- - easy for dogs to associate voice tone but not location

Spatial memory

- - rats are good at radial maze but pigeons are poor, yet pigeons are good in open field tasks.
- - foraging patterns in rodents takes relative food quantity into consideration
- - instinctive drift observed in highly trained animals
- - imprinting

Ethology
- study of behavior in relation to the environment; innate behavior
neuroethology - the study of the neural basis of innate behavior

- - echolocation in bats
- - electroreception in fish
- - sound localization in owls

Biological mechanisms which may underlie learning and memory

- - activity dependent synaptic modification
- - presynaptic enhancement of release - facilitation/sensitization
- - presynaptic suppression of release - habituation
- - postsynaptic enhancement of response
- - alteration in membrane properties
- - enhancement of action potential transmission reliability
- - changes in neural excitability
- - structural changes

Techniques for studying the role of neural systems in learning and memory

1) pharmacological manipulation
    - agonists/antagonists
    - systemic/local infusion

2) electrophysiology
    - field potentials
    - multiple unit activity
    - single units
    - ensemble activity

3) lesions
    - resection/transection
    - electrolytic - focal
    - neurotoxic - selective (kill cells leaving fibers intact)

4) imaging
    - PET - detection of small quantities of labelled compounds. radiolabelled glucose utilization
    - MRI - differences in molecular composition - blood oxygenation
    - optical dyes - electrical neural activity
    - optical imaging of intrinsic signal - blood oxygenation

5) anatomy
    - staining
    - tracing
    - electron microscopy (EM)
    - metabolic labeling

6) genetic manipulation
    - inducible (invertebrates)
    - selective