Reinforcement Learning

Instrumental Conditioning:
- Basal Ganglia
  - Transcortical: ‘instruction’ learning
  - Basal Ganglia: automatic behaviors
  - Behaviors initially use the transcortical pathway → then later use the Basal Ganglia pathway
  - Parkinson’s Disease: Basal Ganglia deficit → problems with implicit memory

Reinforcement Learning:
- Involves reinforcing or punishing ‘signals’ → context dependent
- Reinforcement signal is information poor, but motivation rich
- Involves ‘basic’ brain structures that do not ‘process’ information
  - Ex. of reinforcement learning: Drug addiction: deficit in the control of the reinforcing value

Reinforcement Learning (pt. 2):
- Reinforcement: The Ventral Tegmental Area
  - Self stimulation studies. Rats will work to exhaustion
  - Self stimulation is a form of instrumental conditioning (no perceived reward)

- Meso-Limbic System
  - Nucleus Accumbens: neural substrate of drug addiction
  - Both stimulation of VTA and natural rewards (sugar, food, sex…) increase dopamine levels in Nucleus Accumbens
  - Lever Press → stimulation of VTA → increase in dopamine in nucleus accumbens

Dopamine in Nucleus Accumbens: Sex Chamber
- Hedonic value of Dopamine: natural stimulation
- Dopamine is also released in response to the anticipation of rewards

Reinforcement Learning:
- Meso-Cortical System
  - VTA → primary/secondary association cortex → & hippocampus → & frontal cortex
  - Frontal cortex: working memory. Reinforcement of current plans and strategies
- So: what controls the VTA
  - LH: hunger…
  - Amygdala: emotional stimuli
  - PFC: planning, strategies
- Lateral hypothalamus → VTA
- Amygdala → VTA
- Prefrontal cortex → VTA

## Memory III

### Memory: Neural structures
- **Sensory cortices: Long term memory**
  - The what (ventral) and where (dorsal pathways. Association cortex
- **Prefrontal cortex: working memory**
  - Delayed match-to-sample task
  - Delayed non-match-to-sample tasks
    - The monkey moves the sample object to obtain food from the well beneath it
    - A screen is lowered in front of monkey during delayed period
    - The monkey is confronted with the sample object and an unfamiliar object
    - The monkey must remember the sample object and choose the object correctly from memory
  - Different kinds of working memories
- **Basal Ganglia, cerebellum: Motor memory**
  - Instrumental conditioning
- **Hippocampus: short term memory**
  - Classical conditioning
  - Hippocampus: spatial learning and spatial memory
  - Right hippocampus is primarily activated
  - Ex. right hippocampus is larger in (London) taxi drivers

### Spatial Learning: The Rat Mazes
- Uses positive reinforcements
- **Hippocampus and the milk-maze:**
  - Hippocampus involved in relational learning, but not (much) in S-R tasks
- **WaterMaze: Cortex vs. Hippocampus:**
  - Hippocampus involved in acquisition and consolidation of new memories. Cortex involved in storage of long-term memories
- **Memory reconsolidation:**
  - A reminder of a consolidated memory ‘moves’ the memory back to the hippocampus
  - New memories are stores ‘relative’ to old memories
Hippocampal memories are susceptible to interferences

**Learning in hippocampus**

*Behavioral evidences:*
- Watermaze: lesion studies, temporary inactivation studies
- Reconsolidation: long term memories can be changed

*Neurophysiological evidences:*
- Rats: place cells and spatial receptive fields
- Monkeys: Spatial view cells: cells that respond to places currently being viewed

**Memory: damages and deficits**

*Amnesia: Anterograde & Retrograde*

- **Retrograde:**
  - inact emotional memory, impaired motor memory
  - Cannot remember events prior to brain damage

- **Anterograde:**
  - inact motor memory
  - Cannot later remember events that occur after brain damage

**Anterograde amnesia**

- Anterograde amnesia due to *neurochemical damage*: Korsakoff’s syndrome.
  - Alcoholism and thiamine (vitamin B1) deficiency
- Anterograde amnesia due to *temporal lobe damage*: patient H.M.
  - Inact perceptual, sensory-motor, motor learning. No consolidation
- You don't need the hippocampus as long as you keep a continuous string of perception.
  - Ex. a guy with anterograde amnesia gets a brain scan, but he does not forget he is in the machine after 2 mins because he has not looked away from the machine, the perception of getting a brain scan in a machine continues.