Lecture 5
The motor system

The neuromuscular junction
- Where a neuron meets a muscle
- Acetylcholine = the neurotransmitter used
  - Nicotinic receptors
    - Ionotropic (fast acting)
    - Small stimulation typically leads to an action potential

Myasthenia gravis
- Autoimmune disorder
- Results in the breakdown of acetylcholine (ACh) receptors on the muscle fiber
- Symptoms include extreme weakness, fatigue, droopy eyelids, slurred speech, difficulty swallowing and breathing
- Treatments include medications that suppress the immune system or inhibit acetylcholinesterase (AChE)

Nicotine
- An agonist to Acetylcholine (nicotinic) receptors
- Smokers report an increase in functioning capabilities
  - Increase in auditory capabilities
  - Memory functions
- Nicotine may be a substitute for ACh but it is not a very good one
- After longer use, nicotine actually deadens the receptors
  - Reduces reflexes
  - Fine tremors

Reflexes
- Monosynaptic reflexes
  - Involves only one synapse (two neurons: sensory and motor)
- Polysynaptic reflexes
  - Involves more than one synapse (and an interneuron)

Monosynaptic reflexes
- Sensory neuron from muscle to spinal cord
- Motor neuron from spinal cord to muscle
Polysynaptic reflexes

- Use an interneuron to coordinate action
- Reciprocal inhibition
  - When one muscle is voluntarily contracted, the other is automatically inhibited

Reciprocal inhibition

The Vestibular System

- Fluid filled cavities
- Semicircular canals
- Otoliths
  - Saccule
  - Utricle
- Found near the ear and auditory structures

How the vestibular system works

- Three semicircular canals
  - Near perpendicular to each other
  - Provide a 3D representation of head angles/movements
- Otoliths
  - Provide info about the passive position of the head relative to gravity
    - Acceleration of the head as well
    - One deals with horizontal movement
    - One deals with vertical movement

Brain structures involved in the motor system

- Brainstem
  - The cerebellum
  - The basal ganglia
- Cortical structures
  - Primary motor cortex
  - Supplementary motor area
  - Premotor area
  - Prefrontal cortex
What does the cerebellum do?
- Lesion studies
  - Posture and balance
  - Produce limb rigidity
  - Problems with the timing of rapid and automated movements
  - Saccadic eye movements
  - Dysarthria
  - Motor learning
- Imaging studies
  - Linguistic processing, attention, imagining movements, emotions

The Basal Ganglia
- Three main structures
  - Caudate nucleus, putamen, globus pallidus
- Damage leads to:
  - Tremors
  - Distorted movements and positions of the limbs
  - Lack of movement
  - Slow movement
  - Depression – subcortical dementia
  - Parkinson’s disease
  - Huntington’s disease

What do the basal ganglia do?
- Most areas don’t become active until after a movement has been initiated by the cortex
  - Provides adjustments to a movement
  - Might help sequence movements
    - Parkinson’s patients have problems with sequences of movements
  - Might be about allowing the right amount of force to occur
    - Damage can also lead patients to either have too strong of movements or too weak of movements

Cortical areas
- Primary motor cortex
- Organization

Cortical areas
Primary motor cortex

- Damage does not lead to paralysis
  - May lead to problems with fine movements
  - Other cortical areas send info to the spinal cord as well, so the primary motor cortex can be "bypassed"
  - Each point of primary motor cortex connects to many muscles

Other cortical areas

- Prefrontal cortex
  - Active when initiating tasks
  - Active during the learning of a motor task
  - Not active when the task is learned

SMA

- Involved in the planning of controlled movements
- Most active during tasks that can be executed without visual feedback

Premotor areas

- Involved in the planning of movements as well
  - Especially those that require sensory guidance
  - Juggling
  - The fine coordination needed comes from the cerebellum

The work of Benjamin Libet

- Found some interesting things about somatosensation
  - Stimulated somatosensory cortex
    - Only produced a feeling by the subject if the stimulus was .5 sec or longer
    - Concluded that consciousness lags by close to ½ second
  - Touched someone’s arm
    - Stimulation of the somatosensory cortex can block the feeling of the touch
    - This stimulation can lag up to .5 sec and still block the touch feeling

Libet’s motor work

- Found that subjects decided to move before they actually moved (duh!)
  - Found that the brain was active before subjects reported the “will to move”
  - Thus the brain prepares for movements before the subject consciously decides to move
  - Suggests that unconscious brain events start the process of voluntary action
  - Highly controversial