Chapter highlights: Movement (Ch 5)

The purpose of “chapter highlights” is to offer a framework in which to think about the specific information discussed in each Brain Facts chapter. These highlights draw upon information in the chapter and on the new Brain Facts web site (http://www.brainfacts.org) and occasionally, on our own knowledge of neuroscience that may not be discussed in Brain Facts. Questions for Brain Bee will come from Brain Facts (new 2012 publication) and entries from the new Brain Facts web site that have “brainfacts.org” in the URL. Some but not all relevant entries are cited below.

Movement (http://www.brainfacts.org/sensing-thinking-behaving/movement/)

- Things to know about skeletal muscles
  - Skeletal muscles get their name because they attach to and move the skeleton
    - Exception: some attach to and move soft tissue (e.g., tongue)
  - Muscles do work (move bones) by contracting
  - Muscles contain two types of fibers: extrafusal and intrafusal
    - Extrafusal muscle fibers do the work of moving bones/tissue and are innervated by alpha motoneurons located in the spinal cord and brain stem
    - Intrafusal fibers are part of the sensory system conveying information back to the brain and spinal cord about muscle stretch and are innervated by gamma motoneurons located in the spinal cord and brain stem
  - Each skeletal muscle contains many muscle fibers
    - each fiber is innervated by only one motoneuron whereas each motoneuron innervates many muscle fibers
      - a motoneuron and the muscle fibers it innervates is called a motor unit

- Things to know about motor movement
  - There are two basic types of movement: involuntary (such as reflexes) and voluntary
    http://www.brainfacts.org/sensing-thinking-behaving/movement/articles/2012/involuntary-movements/
    - Reflexes involve local circuits mediated by neurons at the level of the spinal cord and brain stem whereas voluntary movements require signals from higher up in the brain (e.g., cortex)
    - The simplest reflex is the stretch reflex (knee jerk reflex): sensory to motoneuron to muscle
• Muscle stretch (or passive lengthening of the muscle) is sensed by muscle spindles (stretch receptors associated with the intrafusal fibers)

• The sensitivity of muscle spindles is regulated by small gamma motoneurons in the spinal cord and brain stem (the more active the gamma motoneuron is, the more sensitive to stretch the muscle spindle is)

  ▪ Another peripheral regulator of muscle contraction are the golgi tendon organs located in the tendons (which attach muscle to bone) that sense the amount of force exerted by individual muscles

  ▪ They help to protect muscles and tendons from damage by inhibiting muscle contraction

  o Some reflexes involve simultaneous activation of neurons on one side of the spinal cord or brain stem and inhibition of comparable neurons contralaterally (e.g., withdrawal crossed extension reflex)

  o Coordinated movement, both voluntary and reflexive, involves the coordinated activation and inhibition of both agonists and antagonist muscles

    ▪ Agonist and antagonist muscles work to move the skeleton in opposing directions to start and stop movement in a controlled manner.

  o Maintaining a pose, like lifting a leg and holding it, requires activation of both agonist and antagonist muscles, thereby stiffening the joint

  o Voluntary movement can involve many parts of the brain, including the cortex, thalamus, basal ganglia and cerebellum http://www.brainfacts.org/sensing-thinking-behaving/movement/articles/2012/bfttb-the-activation-sequence-for-the-motor-areas/

For info on complex movements, see ...


  ▪ neurons in the primary motor cortex (adjacent to the somatosensory cortex) extend very long axons that directly and indirectly synapse on and activate alpha motoneurons in the spinal cord to cause movement http://www.brainfacts.org/sensing-thinking-behaving/movement/articles/2012/bfttb-movement-and-sense/
- The cerebellum plays an important role in fine motor control (e.g., force needed for lifting full vs empty cup) and learned, highly skilled movements (e.g., learning to play the piano).

- The role of particular brain areas in movement are exemplified by various movement disorders:
  - Neurons in the motor cortex degenerate in **amyotrophic lateral sclerosis** (ALS), a motoneuron disease which is associated with a progressive loss in the ability to produce voluntary movement. [Link](http://www.brainfacts.org/diseases-disorders/diseases-a-to-z-from-ninds/als-amyotrophic-lateral-sclerosis/)
  - Depletion of the neurotransmitter dopamine in neurons of the substantia nigra causes the movement disorder known as **Parkinson’s disease**. [Link](http://www.brainfacts.org/diseases-disorders/diseases-a-to-z-from-ninds/parkinson-s-disease/)
  - Degeneration of neurons in the basal ganglia causes **Huntington’s disease**, another movement disorder. [Link](http://www.brainfacts.org/diseases-disorders/diseases-a-to-z-from-ninds/huntington-s-disease/)
  - Degeneration of Purkinje neurons in the cerebellum causes a movement disorder known as **cerebellar ataxia** (there are several such types with distinct genetic causes). [Link](http://www.brainfacts.org/diseases-disorders/diseases-a-to-z-from-ninds/ataxias-and-cerebellar-or-spinocerebellar-degeneration/)

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**Sources:**
- [Brain facts](http://www.brainfacts.org)
- [NINDS](http://www.ninds.nih.gov)