

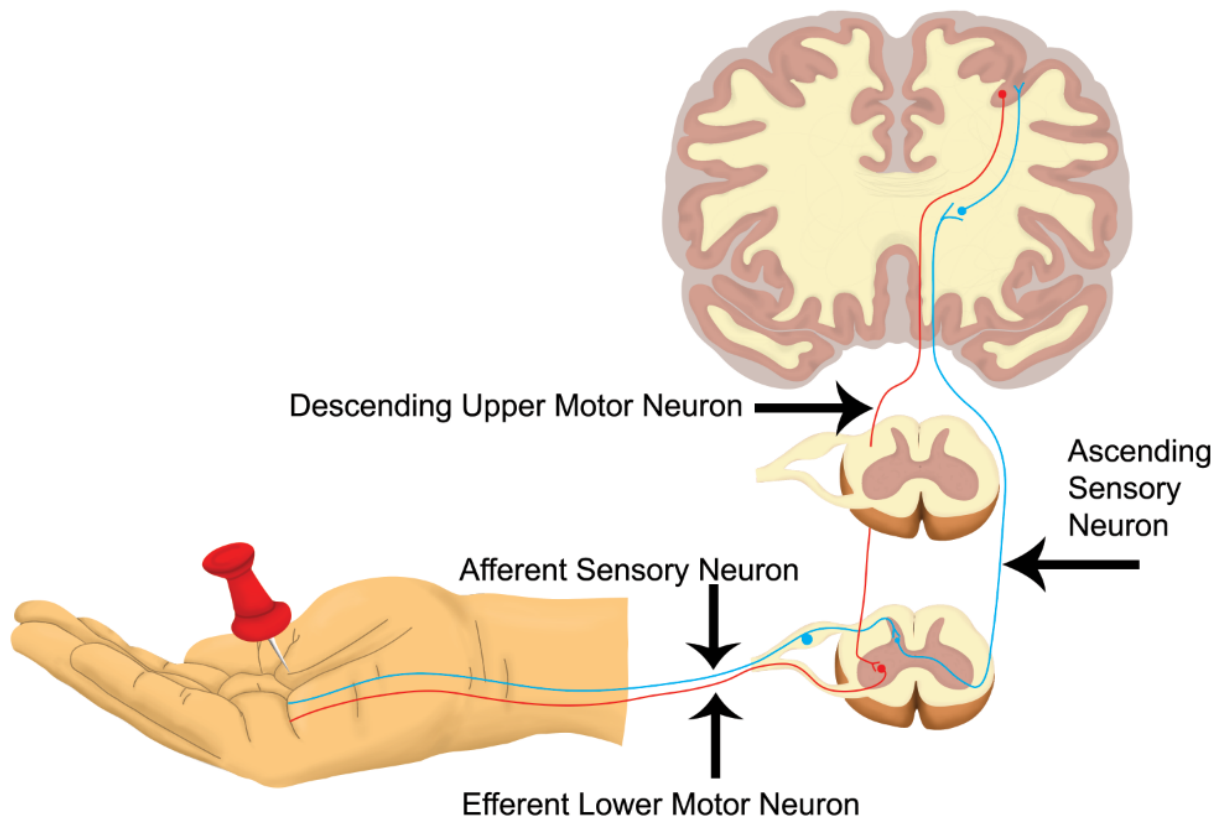
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Voluntary Control of Muscle

In order to understand reflexes and unconscious movement, we must first examine how voluntary movements are controlled. Voluntary movements, such as walking upright, are rather complex involving multiple areas of the central nervous system (CNS) and peripheral nervous system (PNS). It is no wonder that it takes time to learn to walk or ride a bike. Once learned, these movements are consciously initiated and then carried out almost automatically. Why are we taught that practice makes perfect? It is because the more we practice a skill the more automatic it becomes. We commonly refer to this phenomenon as "muscle memory."

Voluntary control of movement depends on **upper motor neurons** (UMN) and **lower motor neurons** (LMN). The cell bodies of upper motor neurons are found in the cerebral cortex, where planning, initiation, and coordination of movement occur. Upper motor neurons then synapse with lower motor neurons in the spinal cord. The lower motor neurons then leave the spinal cord and synapse with skeletal muscles at the neuromuscular junction. It is this single neuron system from the spinal cord to the muscle that we refer to as the somatic nervous system. To summarize, upper motor neurons initiate movement by sending impulses to lower motor neurons which then relay that information to the skeletal muscle.

In contrast to voluntary control, involuntary or **reflexive** control of skeletal muscle starts within the muscle, rather than the brain, and sends signals back to the spinal cord to modify movement of the muscles. Thus you can say that voluntary movement comes from the top down and reflexes come from the bottom up. The synapse between the upper motor neuron and the lower motor neuron in the spinal cord is where modulation of both voluntary and reflexive movement takes place.



Withdrawal Reflex: An example of Involuntary Movement that uses sensory and motor neurons of the central and peripheral nervous system. Image by BYU-I student Becky T. 2018

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