



Voluntary Movement

Brain and Spinal Systems

Psychology 372

Physiological Psychology

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Motor Control

- Is organized hierarchically and in parallel
- Lower – Reflexes and rhythmic motor patterns
- Higher – Give commands without having to specify the details of the motor system.
- Lots of overlap

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Have Three Levels of Control

- Cortex
 - Highest
 - Primary Motor Cortex (Area 4)
 - Lateral Premotor area (Area 6)
 - Supplementary Motor area (Also part of Area 6)
- Brain Stem
- Spinal Cord
- Other structures
 - Cerebellum
 - Basal Ganglia

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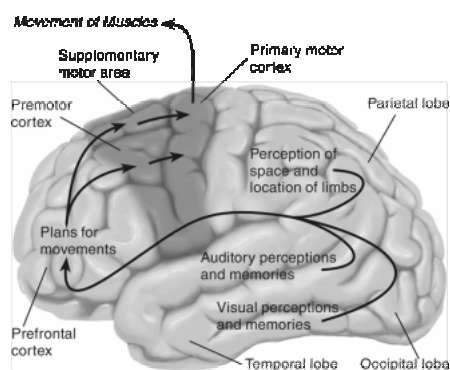
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Cortex

- Precentral Gyrus (Primary Motor Cortex)
- Premotor area (Superior and Middle Frontal Gyrus)
- Supplementary Motor area (Superior Frontal Gyrus)
- Tertiary Motor Areas (Middle and Inferior Frontal Gyrus)
- Issues commands that act on lower levels

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Cortex



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Precentral Gyrus Broadman's Area 4

- Is the Primary Motor Cortex
- Controls the major systems that control body movement.

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Precentral Gyrus
Broadman's Area 4

- Motor cortex is somatotopically organized (motor homunculus).
 - Most is taken up with the neck, mouth, face and hands.

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Precentral Gyrus
Receives Input From

- Premotor cortex
- Supplemental motor area
- Frontal association cortex
- Post Central Gyrus

Movement involves all of these structures

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Premotor Cortex and Supplementary Motor Cortex

- Broadman's areas 6 and 8
- Help coordinate and plan complex sequences of movement.
- Receives information from posterior and prefrontal association areas

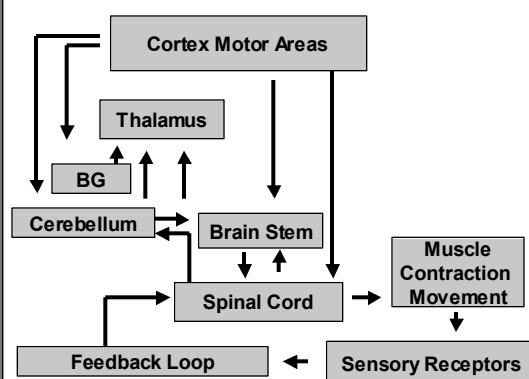
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Tertiary Motor Area

- Broadman's Areas 9, 10 11, 45, 46, 47
- More planning and thinking of movement
- 45, 46, 47 Involved with speech

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Cortex Motor Areas



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Descending Motor Pathways

- Axons from Area 4 descend to the spinal cord via two groups
- Lateral Group
- Ventromedial Group

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Lateral Group

- Generally controls independent limb movements
- Many Pathways
 - Corticospinal tract: hand/finger movements
 - Corticobulbar tract: movements of face, neck, tongue, eye
 - Rubrospinal tract: fore and hind-limb muscles

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Ventromedial Group

- Controls gross limb movements
 - Vestibulospinal tract: control of posture
 - Tectospinal tract: coordinate eye and head/trunk movements
 - Reticulospinal tract: walking, sneezing, muscle tone
 - Ventral corticospinal tract: muscles of upper leg/trunk

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Corticospinal Tract

- Neurons terminate on motor neurons within the gray matter of the spinal cord
- Begins in layer 5 of primary motor cortex
- Axons pass through the cerebral peduncles of the midbrain
- 80% cross over to the opposite side of the body (decussate) at the pyramidal decussation in the medulla
 - Becomes the Lateral Corticospinal Tract
- 20% remain ipsilateral
 - Becomes the Ventral Corticospinal Tract

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Corticospinal Tract

- Terminate onto internuncial neurons or alpha motor neurons of ventral horn
- Final common pathway
 - Efferent neurons to the muscle group

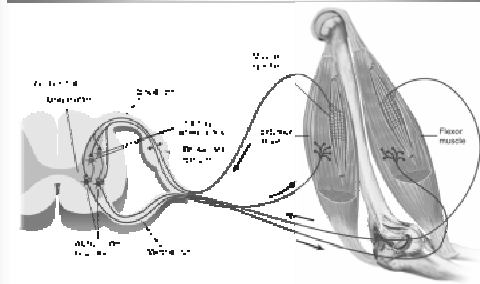
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Function

- Controls fine motor movements
- Destruction: loss of muscle strength, reduced dexterity of hands and fingers
- No effect of corticospinal lesions on posture or use of limbs for reaching
 - Uses different brain structures (BG, Cerebellum)

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Final Common Pathway



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Neuromuscular Junction

- The neuromuscular junction is the synapse formed between an alpha motor neuron and a muscle fiber
 - Each axon forms synapses with several muscle fibers (forming a motor unit).
 - The precision of muscle control is related to motor unit size.
 - Small: precise movements of the hand
 - Large: movements of the leg

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ACh

- Primary NT at the neuromuscular junction
- ACh release produces a large endplate potential
 - Voltage changes open Ca⁺⁺ channels
 - Ca⁺⁺ entry triggers myosin-actin interaction (rowing action)
 - Movement of myosin bridges shortens muscle fiber
 - Contraction occurs

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Golgi Tendon Organ Receptors

- Function to prevent over-contraction of striated muscle
- Are located within tendons
- Sense degree of stretch on muscle
- GTO activation inhibits the agonist muscle (via release of glycine onto alpha-motor neuron).

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Other Brain Structures Involved with Movement

- Basal Ganglia
- Cerebellum
- Spinal Cord

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