



Basal Ganglia

Psychology 372
Physiological Psychology
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Basal Ganglia

- Does not have direct input or output to the spinal cord
- Receives information from the cortex
- Sends output to
 - Brain stem via the thalamus
 - Cortex

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Past

- Had specific systems involved with movement
- Pyramidal
- Extrapyramidal
- Corticospinal
- Other structures including BG

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Today

- Many more parts are involved
- Movement problems can also occur with problems in the
 - Brain stem
 - Red Nucleus
 - Cerebellum

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Consists of Four Principal Nuclei

- Striatum
- Globus Pallidus (Pallidum)
- Substantia Nigra
- Subthalamic Nucleus

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Striatum

- Has three important subdivisions
 - Caudate Nucleus
 - Putamen
 - Ventral Striatum (Includes Nucleus Accumbens)
- Mostly divided by the internal capsule
 - Are fibers that go from the cortex to the thalamus in both directions.

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Striatum

- Receives most of the fibers from the
 - Cortex
 - Thalamus
 - Brain Stem Structures
- Sends fibers to
 - Globus Pallidus
 - Substantia Nigra

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Striatum

- All areas of the cortex send excitatory (glutamatergic) fibers to the striatum.
- Also gets dopaminergic projections from the midbrain
- Finally gets serotonergic input from the Raphe Nuclei
- Contains mostly GABA neurons
- Has two separate parts (called patches)
 - Matrix
 - Striosome
- Both are separate and have different types of receptors

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Globus Pallidus (Pallidum)

- Lies medial to the Putamen
- Has two segments
 - External
 - Internal
- Use GABA as a NT.

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Substantia Nigra

- Lies in the midbrain on medial side of the internal capsule
- Has a compact zone (pars compacta)
 - Is a distinct nucleus
 - Contains
 - Many Dopamine neurons
 - Oxidized pigment from Dopamine
 - Neuromelanin (makes the structure dark)
 - Increases with age

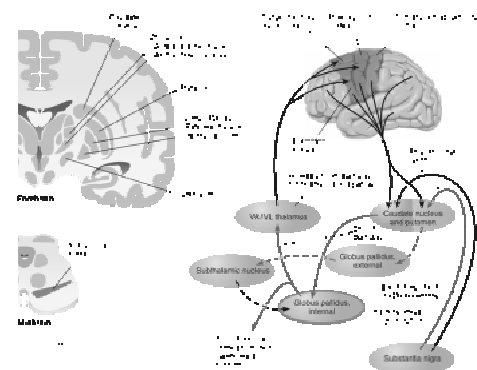
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Subthalamic Nucleus

- Lies below the thalamus
- Lies above the substantia nigra
- Is closely connected to
 - Parts of the Globus Pallidus
 - Substantia Nigra
- Uses glutamatergic neurons
 - Are the only excitatory neurons in BG.
 - All others are inhibitory

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Subthalamic Nucleus



Subthalamic Nucleus

- Input to the basal ganglia is from the
 - Primary motor cortex
 - Substantia Nigra
- Output of the basal ganglia is to
 - Primary motor cortex
 - Supplemental motor area
 - Premotor area
 - Brainstem motor nuclei (ventromedial pathways)
- Cortical Basal Ganglia Loop
 - Frontal, parietal, temporal cortex send axons to caudate/putamen
 - Caudate/putamen sends axons to the globus pallidus
 - Globus pallidus sends information to the motor cortex via thalamic nuclei

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Functions

- Past - Only motor related functions
- Today
 - Motor
 - Cognitive
 - Emotional
 - Motivated behavior

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Output from the BG

- Output is very important
- Output neurons discharge at high frequency
- Structures
 - Internal Pallidal Segment
 - Pars Reticulata of Substantia Nigra
 - Both tonically inhibit target nuclei in the thalamus and Brain Stem
- Modulated by two parallel pathways
 - Indirect Pathway
 - Direct

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Indirect

- Is purely Gabainergic
 - Goes first to external Pallidal Segment
 - Then goes to subthalamic nucleus
 - Finally goes to output nuclei in subthalamic nucleus
- Contains excitatory glutaminergic neurons

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Direct

- Striatum to Pallidum
- When activated shuts down the tonically active neurons
- Permits the thalamus and cortex to be activated

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Comparisons

- Direct
 - Provides positive feedback
 - Activation disinhibits the Thalamus
 - Increases thalamus/cortical activity
 - Facilitates movement
- Indirect
 - Provides negative feedback
 - Activation inhibits the thalamus
 - Has opposing effect
 - Shuts down movement

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Dopamine

- Is very important
- Direct are D1 receptors are excitatory
- Indirect are D2 receptors are inhibitory
- Synaptic actions are different
 - Both decrease inhibition of thalamocortical neurons
 - Thus both facilitate movement
- Decrease dopamine in the striatum
 - Activity increases output nuclei increases
 - Output nuclei then inhibit thalamocortical neurons
- Movement decreases

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Disorders

- Many different types
- Parkinson's syndrome/disease
- Huntington's Disease
- Most involve some sort of motor functioning problem.

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