<table>
<thead>
<tr>
<th>Telencephalon</th>
<th>Striatum</th>
<th>Pallidum (globus pallidus)</th>
<th>Habenula</th>
<th>Subthalamic Nucleus</th>
<th>Substantia Nigra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>External internal</td>
<td></td>
<td></td>
<td>reticulate</td>
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<tr>
<td></td>
<td></td>
<td>GPe</td>
<td></td>
<td></td>
<td>compact</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GPi</td>
<td></td>
<td></td>
<td>dopamine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hb</td>
<td></td>
<td>STN</td>
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<td></td>
<td></td>
<td>SNr</td>
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<td></td>
<td></td>
<td>SNC</td>
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<td>Diencephalon</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Midbrain</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
TELENCEPHALON

hippocampus
neocortex

stria
tal
ridge

pallidal
ridge

thalam
cic
e
eminence

hypothalamus

DIENCEPHALON

E13 rat embryo
transverse section
through forebrain vesicle
basal ganglia I: sequential control of action

classical basal ganglia of neocortex

core ganglia (forebrain) telencephalon

striatum (aka dorsal or neo-striatum)

caudate
putamen

globus pallidus (aka pallidum)

external segment GPe
internal segment GPi

associated ganglia (midbrain)/

substantia nigra

pars compacta SNC
pars reticulata SNr

subthalamic nucleus STN

habenula (diencephalon) Hb

epithalamus = pineal + habenula
Loop

1. somato-motor
2. occulo-motor
3. dorsolateral PFC
4. lateral orbitofrontal
5. anterior cingulated

Function
- simple movements
- tasks at hand
- primary drives
Thomas Willis (1664)

corpus striatum for myelinated axons passing through

receives most cortical inputs into the BG

dorsal striatum receives from entire neocortex except A1, V1

rough topographic map for frontal cortex
<table>
<thead>
<tr>
<th>Cortex</th>
<th>Neocortex</th>
<th>Allocortex</th>
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</thead>
<tbody>
<tr>
<td>Striatum</td>
<td>Caudate</td>
<td>Nucleus Accumbens</td>
</tr>
<tr>
<td></td>
<td>Putamen</td>
<td>Olfactory Tuber Cle</td>
</tr>
<tr>
<td>Pallidum</td>
<td>Dorsal</td>
<td>Ventral Pallidum</td>
</tr>
<tr>
<td>Midbrain</td>
<td>Substantia Nigra</td>
<td>Ventral Tegmental Area</td>
</tr>
<tr>
<td>Dopamine Neurons</td>
<td>Compacta</td>
<td>VTA</td>
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</tbody>
</table>
Huntington's Disease, HD
George Huntington (1872)
involuntary movements
chorea
athetosis
voluntary movements
slowed
rigidity
Huntington's Disease (HD)

George Huntington (1872) presents in midlife as dementia (severe cognitive impairment), depression, personality change. Next, hyperkinetic defects appear:

- Frequent, well-coordinated, and natural but in voluntary movements called chorea, dance
- Also, writhing or squirming movements with facial grimaces called athetosis

Voluntary movements themselves are slower than normal, progressing to rigidity.

Death 5-20 years after onset of AD mutation in Huntington gene, selective death of striatal neurons.
Corpus striatum [Latin stria (striations, furrows)] for striped appearance from myelinated axons passing through it. Thomas Willis (1664) receives most cortical inputs into the basal ganglia. Receives input from entire neocortex except A1, V1. Rough topographic map from cortex to basal ganglia (to thalamus to cortex).

Diagram:

```
PFC <-> SMA <-> PM <-> M1
```

caudate
putamen
OCD, obsessive-compulsive disorder
recurring intrusive thoughts
ritualistic behavior

Tourette disease
motor, phonetics
compound stereotypies

Ventral striatum ← caudate ← putamen

life plans ← complex behaviors ← simple actions

? ← OCD ← Tourette
Tourette disease

Phonic tic, e.g. "disgusting"
patient can suppress a tic
but like not scratching an
itch, it is unpleasant

↑ BOLD in putamen
treatment SSRI s
obsessive-compulsive disorder, OCD
anxiety disorder, classified as recurrent intrusive thoughts and ritualistic behavior
thoughts of violence fear of contamination
onset late childhood/early adult
4 BOLD in orbital cortex & caudate
4 BOLD under stimulus (forced to touch dirty objects)
treatments SSRI's
behavioral therapy (response prevention)
Tourette disease
motor and phonic tics/stereotypies
  e.g., "disgusting"
compare choreas and tics
chorea non-stereotyped
tic repeat same pattern
chorea no premonit

over →
<table>
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<tr>
<th>pattern</th>
<th>choreas</th>
<th>compulsiones</th>
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<tbody>
<tr>
<td>premonitory urge</td>
<td>non-stereotyped</td>
<td>stereotyped</td>
</tr>
<tr>
<td>sense of relief</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>upon completion</td>
<td>no</td>
<td>yes</td>
</tr>
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Patient can suppress a tic but like not scratching an itch, it is unpleasant.

4 BOLD in putamen (Tourette's) treatment SSRIs

(caudate, putamen)

Complex actions $\rightarrow$ Simple actions

OCD $\rightarrow$ Tourette disease
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