

Explorations of the Motor and Cognitive Changes Associated with Parkinson's Disease

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UNIVERSITY OF CALIFORNIA

Plan for Today

Part 1 Lab overview: What we do

Part 2 Today's team:

Overview of motor systems and the impact of PD on motor and cognitive function (Rich)

Sensorimotor learning



Elizabeth Cisneros

The Two Sides of Dopamine



Sabrina Abram

Part 3 How to get involved

CognAc: The Cognition and Action Lab

Department of Psychology



Campus Brain Imaging Center



Department of Neuroscience at UC
Berkeley



A Multidisciplinary Approach to Neuroscience

Team CognAc

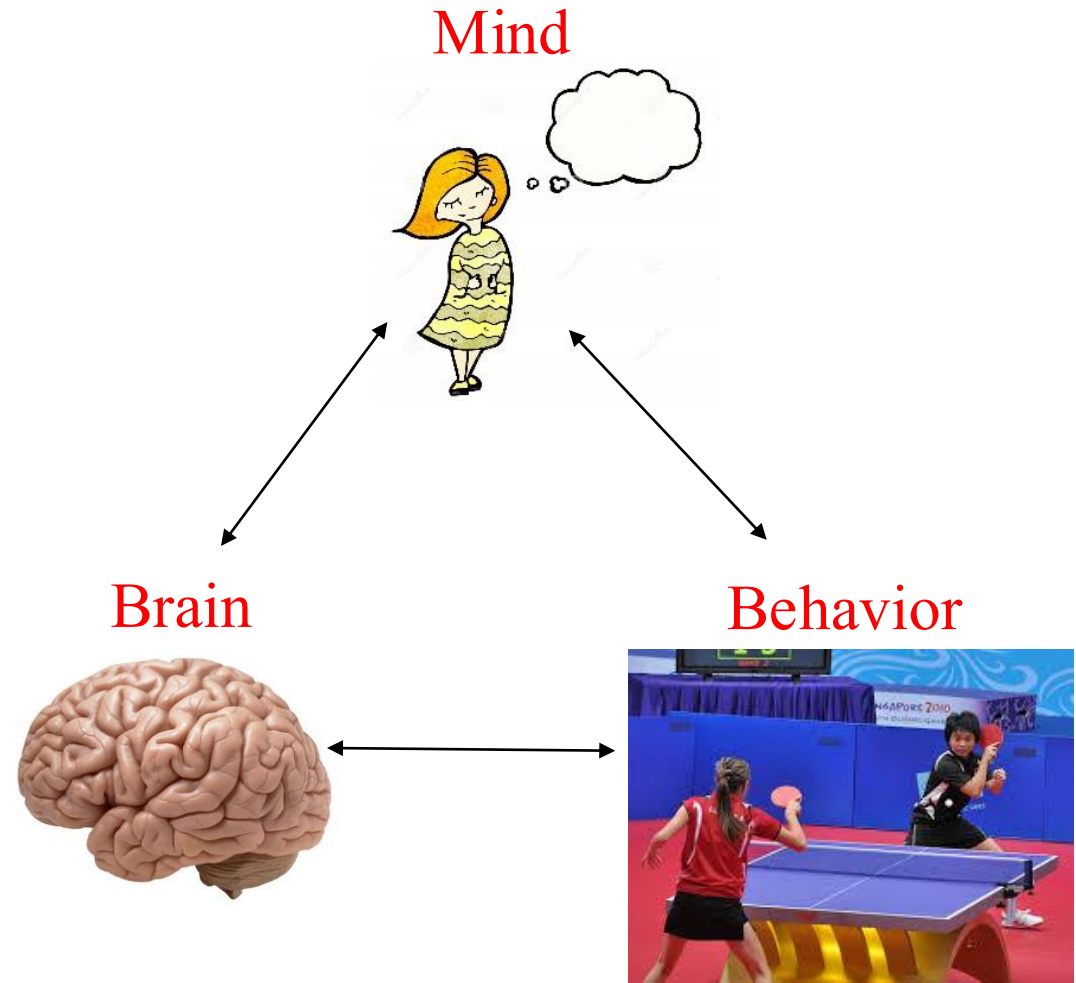


What We Do: Neuropsychological Research



"You told me I'm my own worst enemy. So I
got a restraining order against myself!"

Psychologist = Therapist



Cognitive Neuroscience:
The Biology of the Mind

Our Questions

- How do we produce and control movement?
- How do we acquire new motor skills?
- What is the relationship between skilled movement and skilled thought?
- What is the role of the basal ganglia and cerebellum in all of the above?
- How is movement and thought impacted by degenerative disorders of these structures?

Methods We Use

Behavior



EEG (brain waves)



Brain imaging (MRI)



Brain stimulation



Basic research program, not clinical trials

Methods We Use

Behavior



EEG (brain waves)



Brain imaging (MRI)



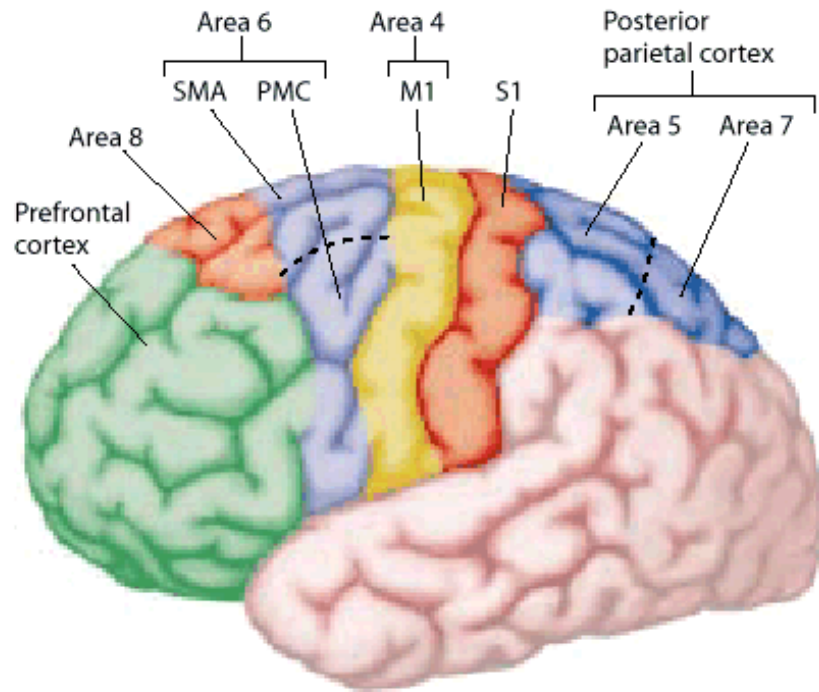
Brain stimulation



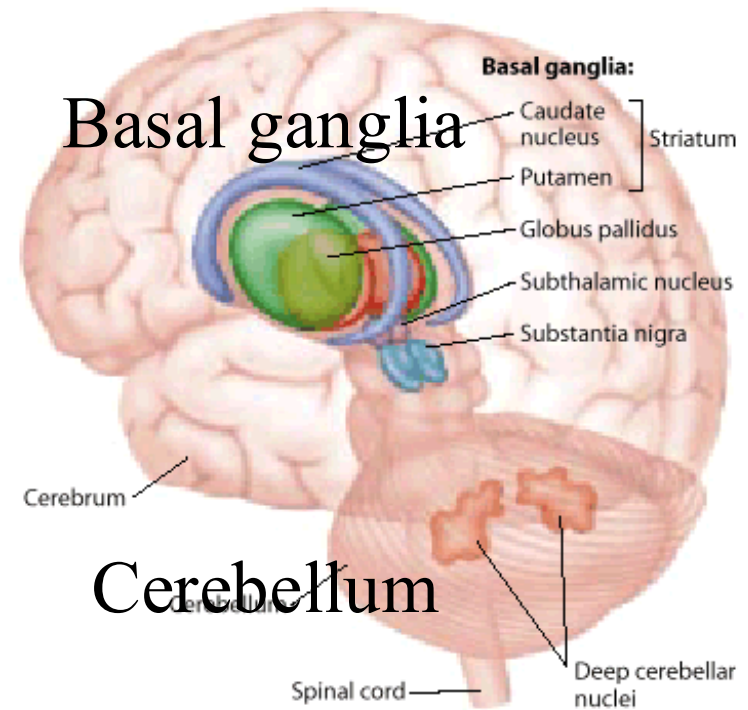
Basic research program, not clinical trials

A main goal of the lab:

Understanding how the ancient parts of the brain support movement and cognition

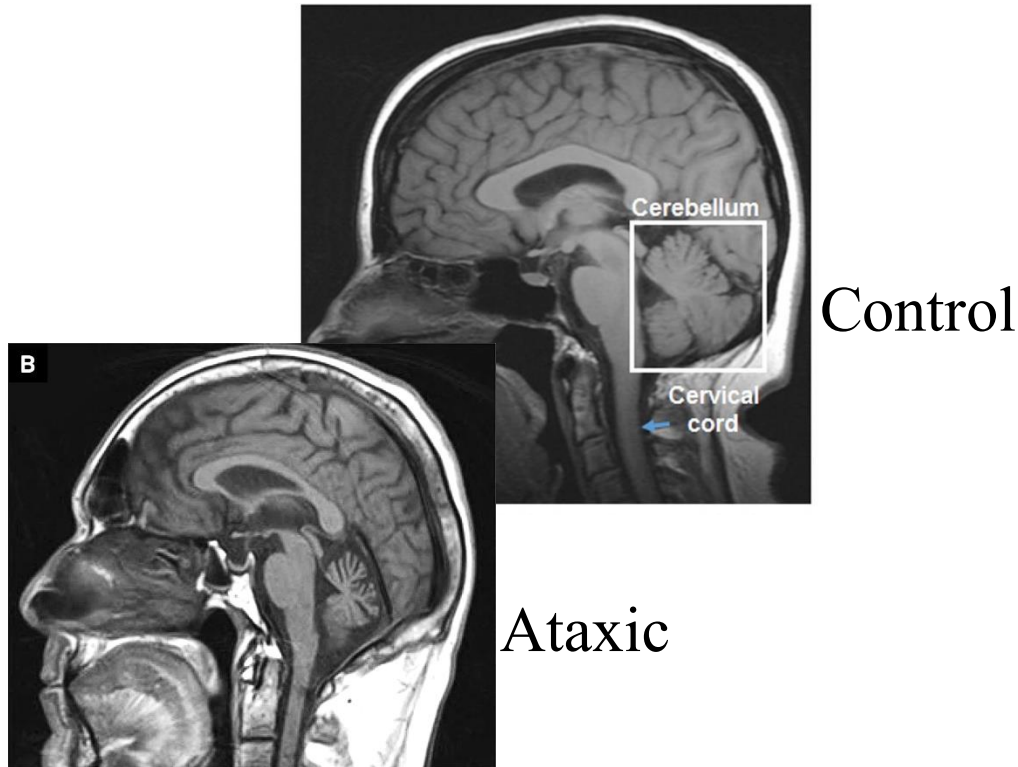


Motor regions of the cerebral cortex

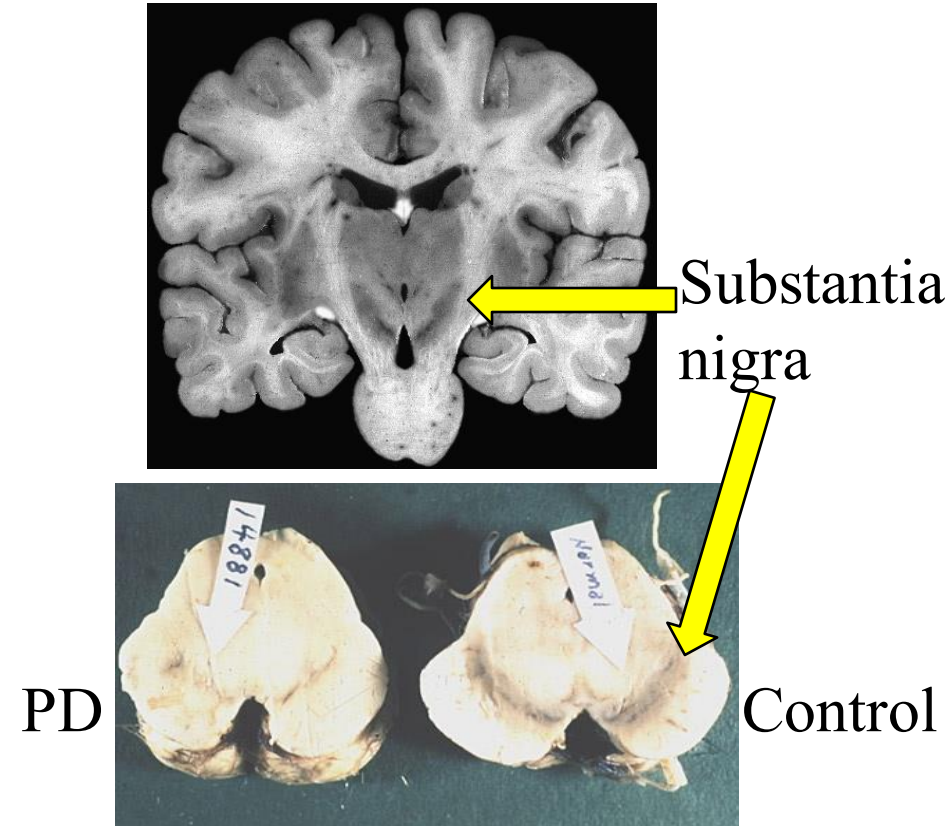


Prominent motor regions of the subcortex

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Atrophy of the
cerebellum (ataxia)



Atrophy of the substantia
nigra (Parkinson's disease)

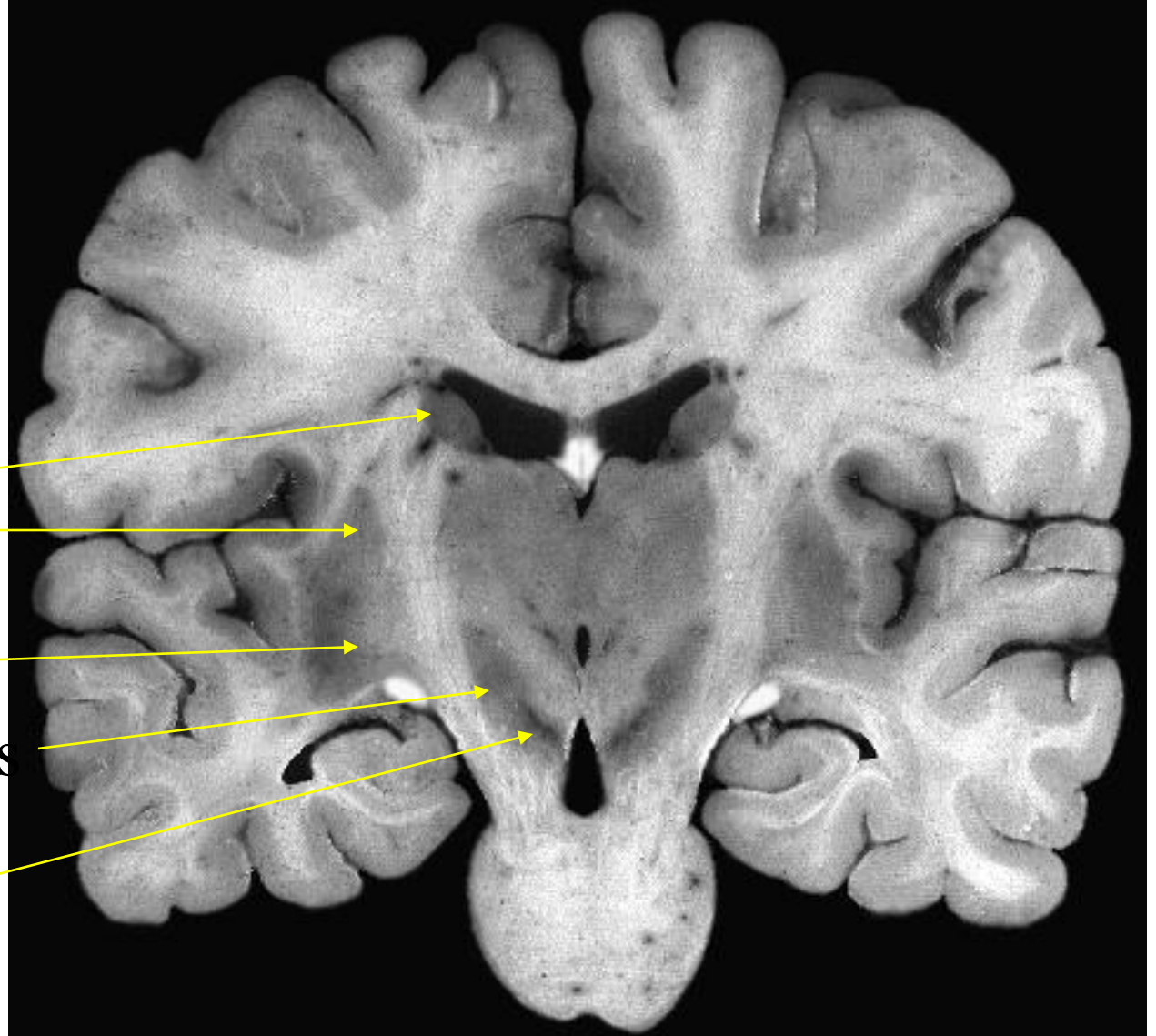
Components of the Basal Ganglia

Striatum

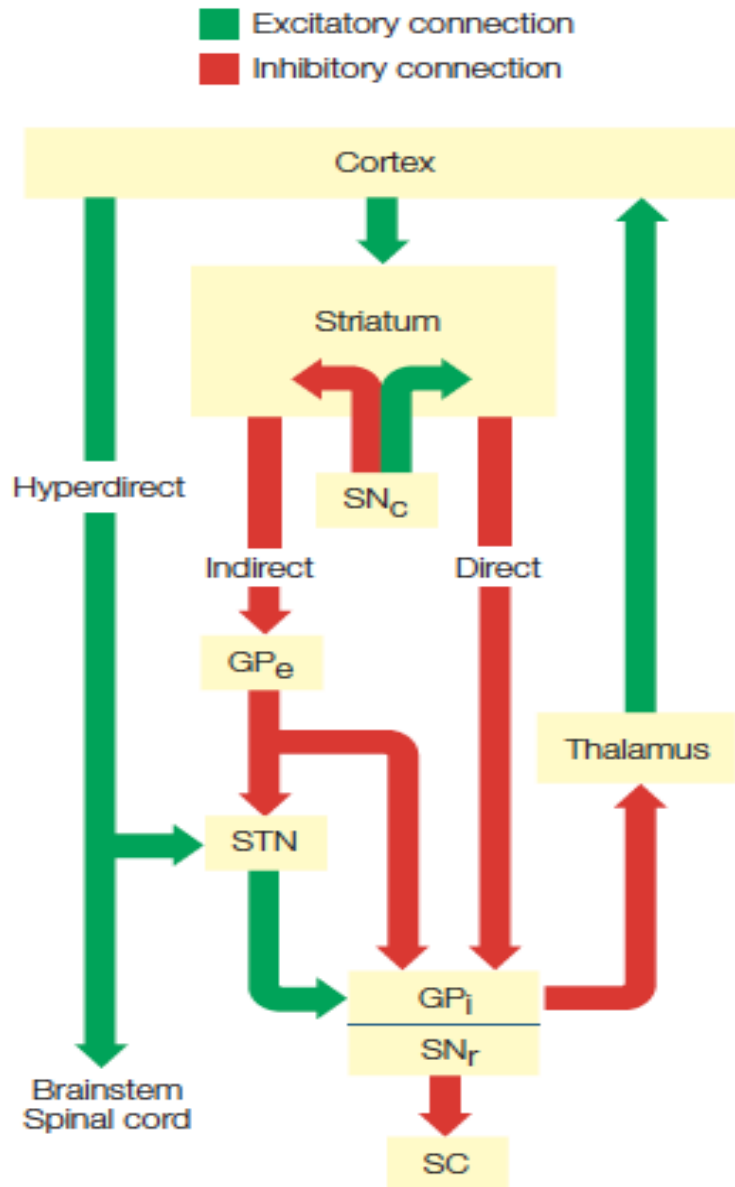
Globus Pallidus

Subthalamic nucleus

Substantia nigra



Anatomy and Physiology of the Basal Ganglia



Anatomy: Nuclei of the BG

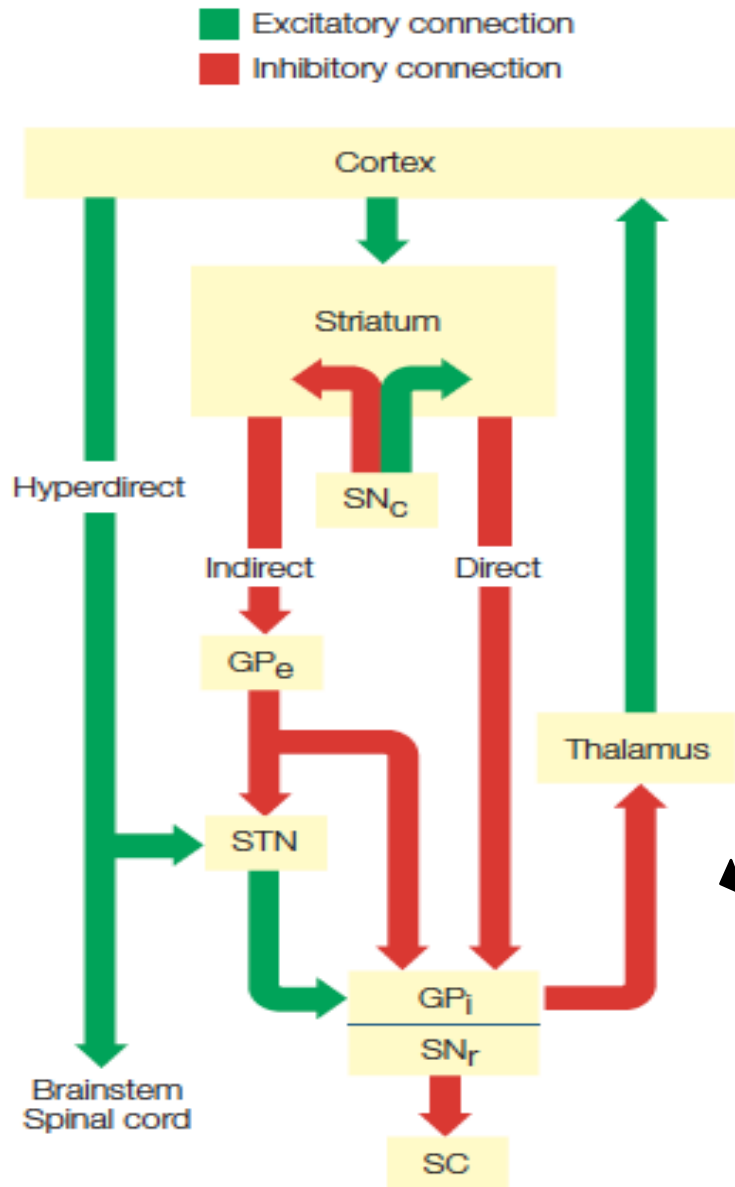
Striatum

GP: Globus Pallidus

SN: Substantia nigra

STN: Subthalamic nucleus

Anatomy and Physiology of the Basal Ganglia



Anatomy: Nuclei of the BG

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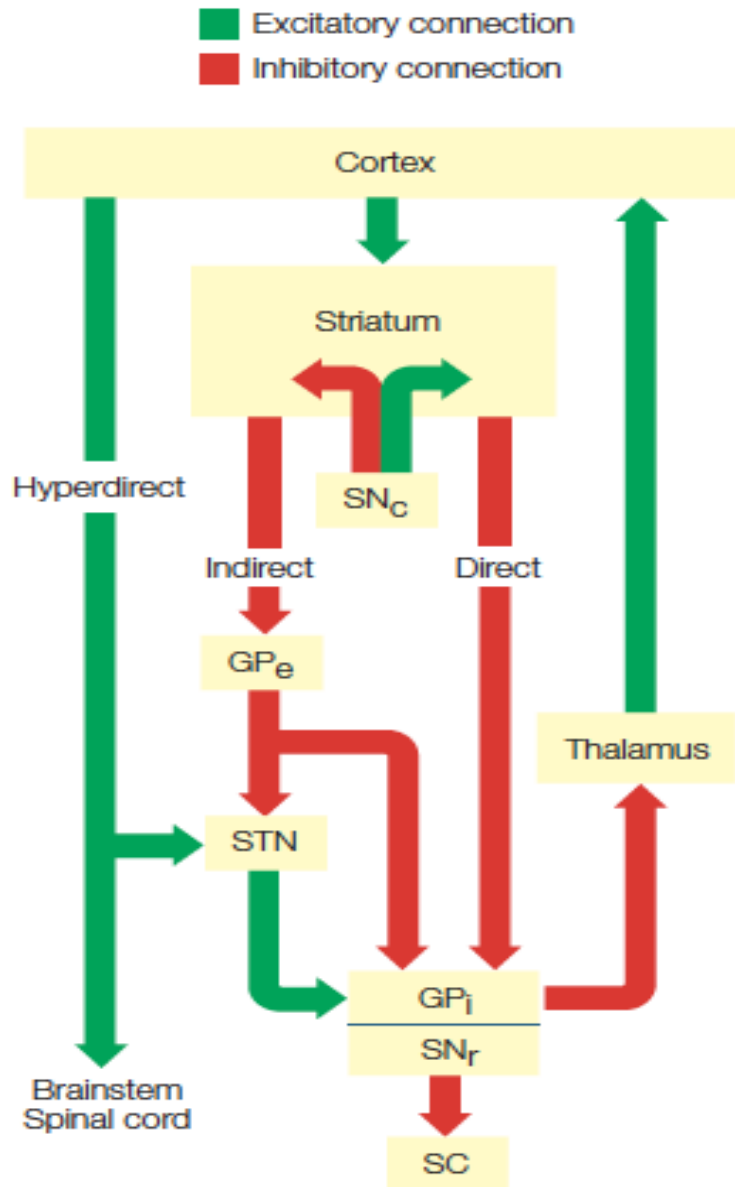
SN: Substantia nigra

STN: Subthalamic nucleus

Physiology:

Basal ganglia inhibits cortex.

Anatomy and Physiology of the Basal Ganglia



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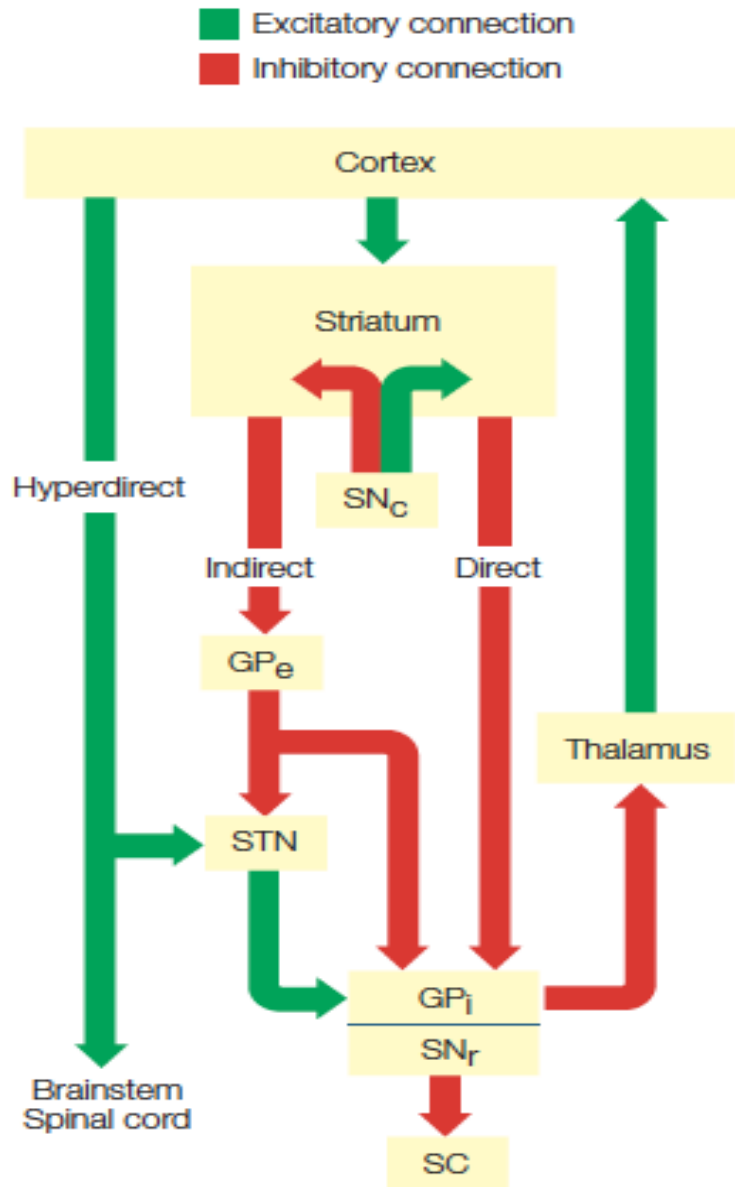
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Physiology:

Basal ganglia inhibits cortex.

When cortex excites BG:
inhibition of inhibition =>
disinhibition => movement

Anatomy and Physiology of the Basal Ganglia



Anatomy: Nuclei of the BG

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Double inhibition

Basal ganglia and movement initiation

Tonic inhibition of cortex:
Keep movement in check
during planning



Basal ganglia and movement initiation

Tonic inhibition of cortex:
Keep movement in check
during planning



Cortical input to BG:
Initiation by disinhibition
(release from inhibition)



Basal ganglia and movement initiation

Tonic inhibition of cortex:
Keep movement in check
during planning



Cortical input to BG:
Initiation by disinhibition
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A “dumb” selection mechanism

Disorders of the Motor System

Motor Cortex: Hemiplegia, Hemiparesis

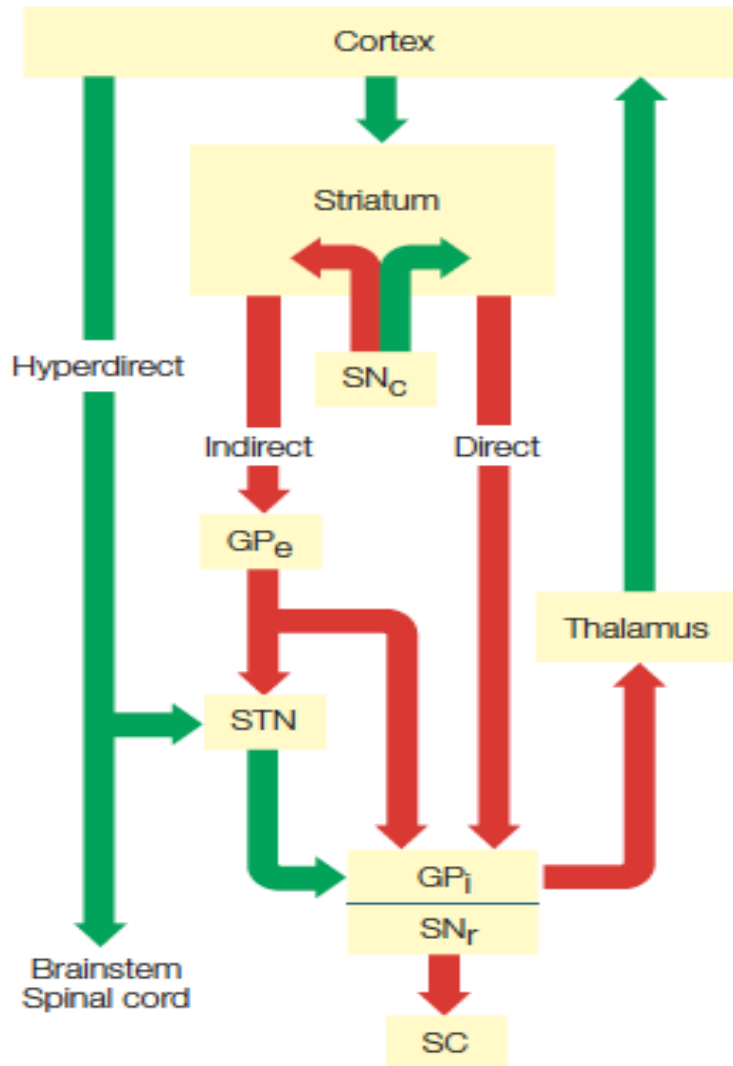
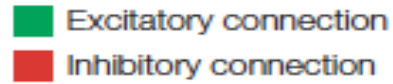
Secondary Motor Areas: Apraxia

Basal Ganglia Parkinson's disease

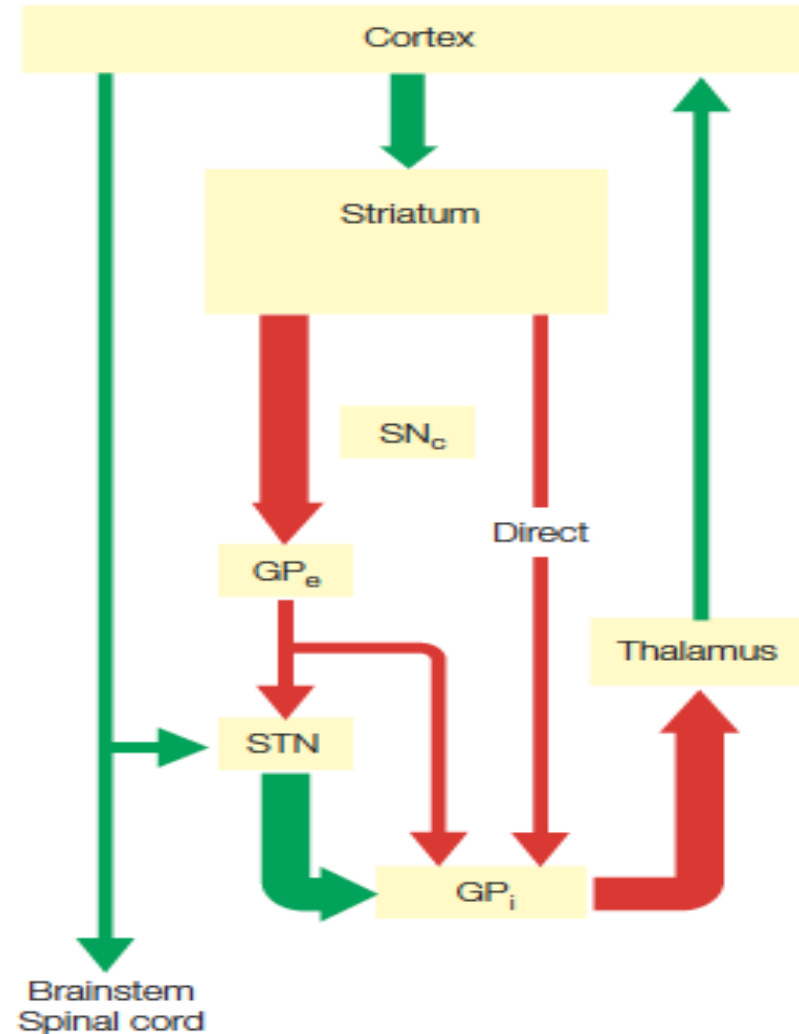
Primary features: Initiating movement, slowness, tremor

e-Clips:

1. PD_Walk3
2. PD_Walk1_rbi
3. PD_Walk2_rbi
4. Tremor

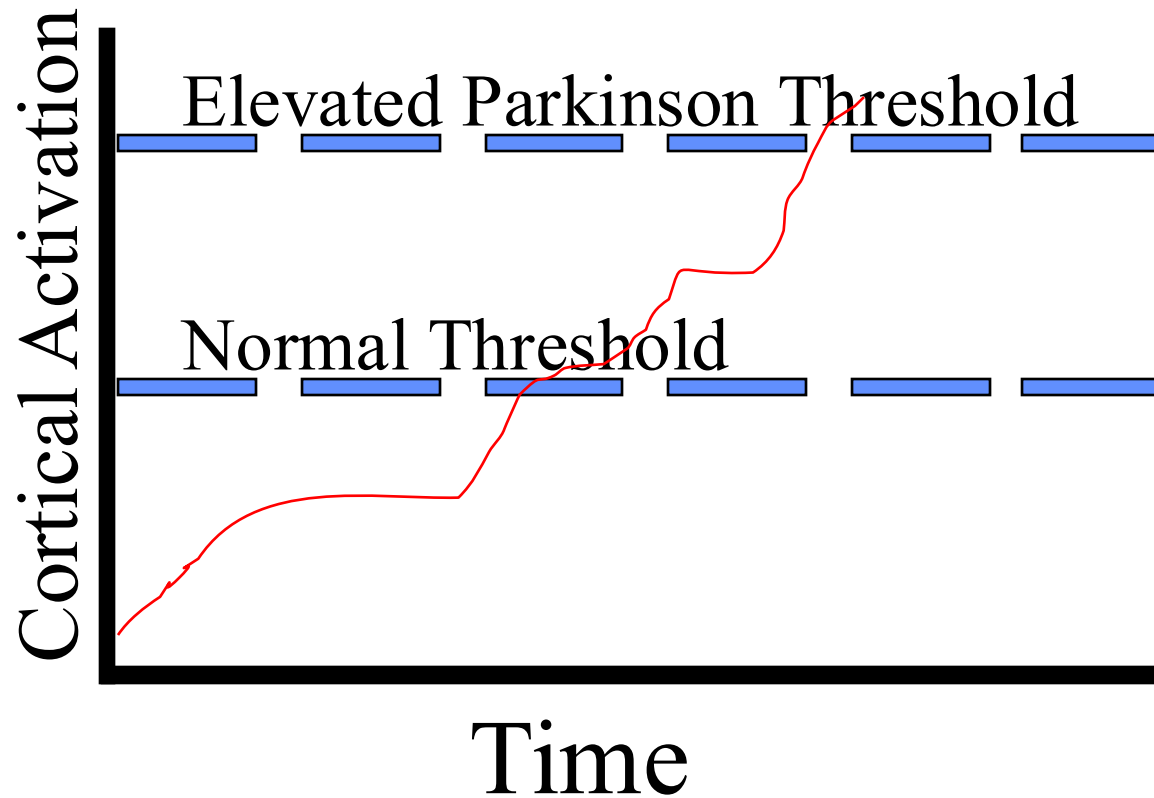


Parkinson's Disease

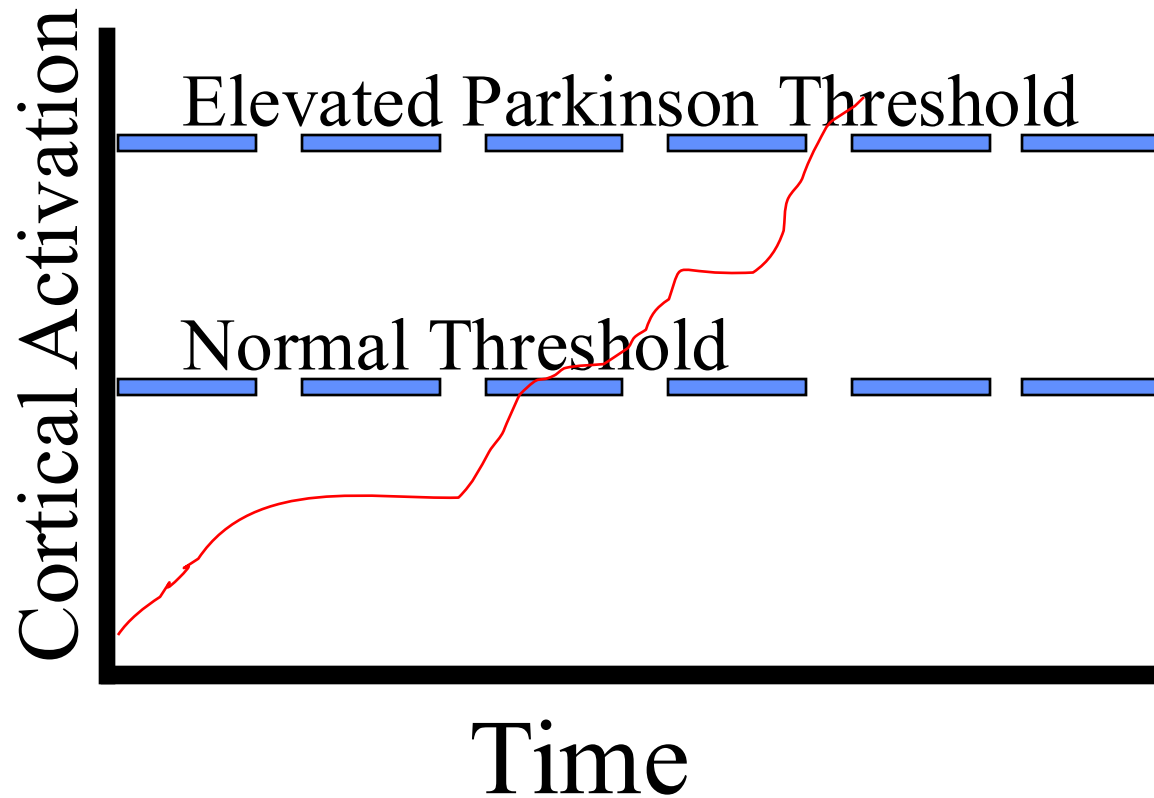


Loss of DA
 cells in SN_c
 =>
 Increased
 inhibition of
 cortex

Akinesia and bradykinesia: Symptoms of a “stuck gate”



Akinesia and bradykinesia: Symptoms of a “stuck gate”



Input pattern
(cortex) is
unchanged.

Stronger activation
required to trigger
movement

Ball toss example

Testing the Stuck Gate Hypothesis: Motor

Bradykinesia: Changing motor state

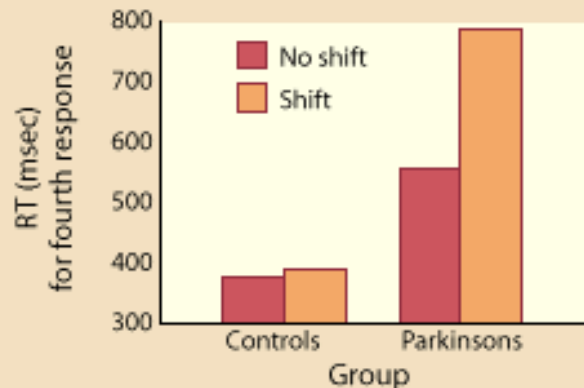
Motor shifting experiment

Learn sequence A:
Index-Ring-Middle (I-R-M)

Learn sequence B:
Index-Middle-Ring (I-M-R)



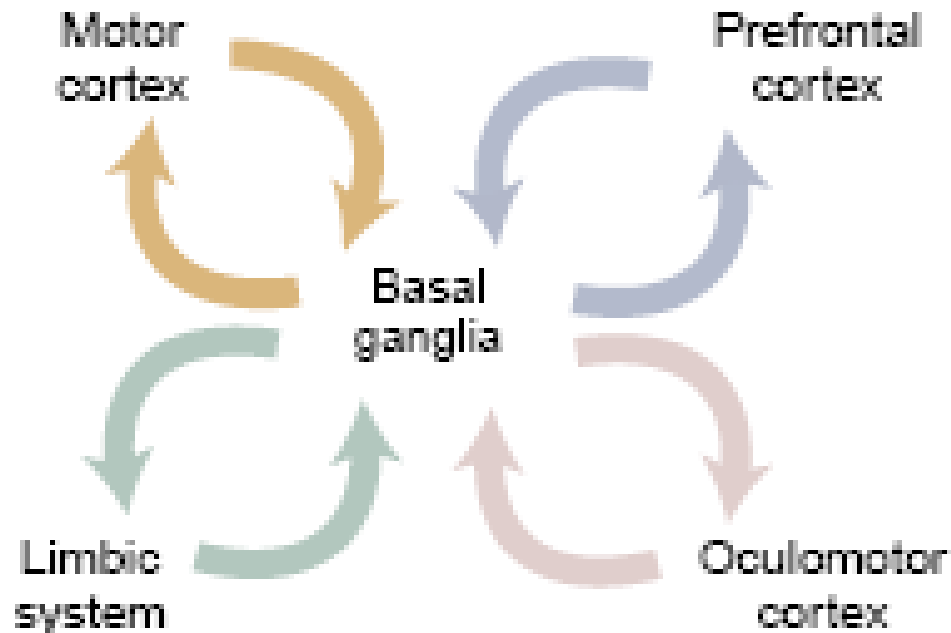
Condition	Stimulus	Response sequence
No shift	AA	I-R-M- I -R-M
Shift	BA	I-M-R- I -R-M



Testing the Stuck Gate Hypothesis: Beyond Motor

Anatomy suggests that basal ganglia function extends beyond motor systems

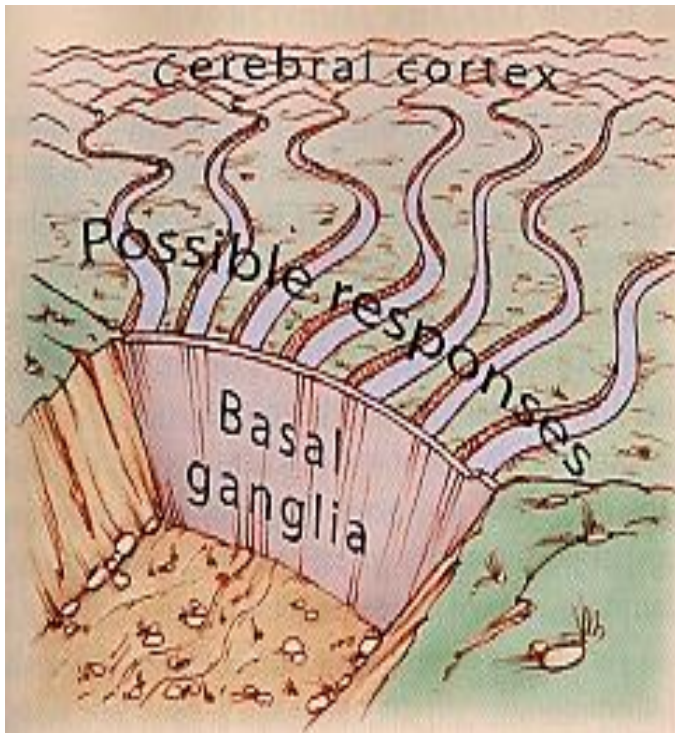
(b)



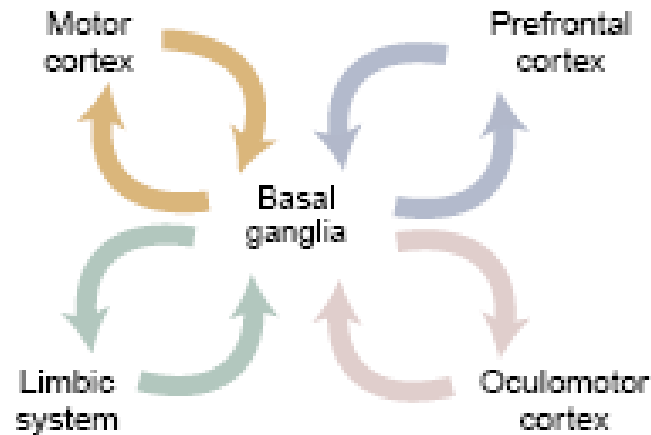
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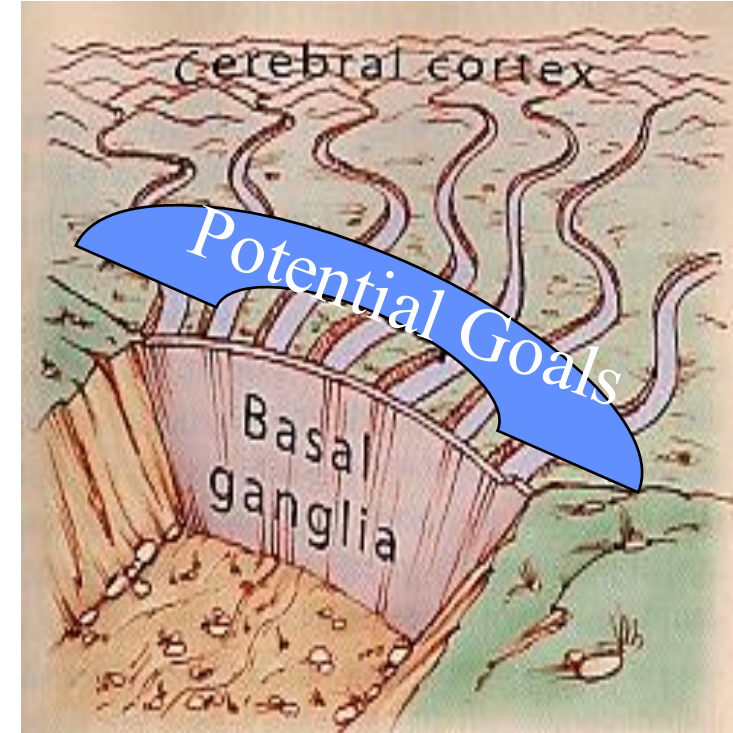
Motor Cortex



(b)

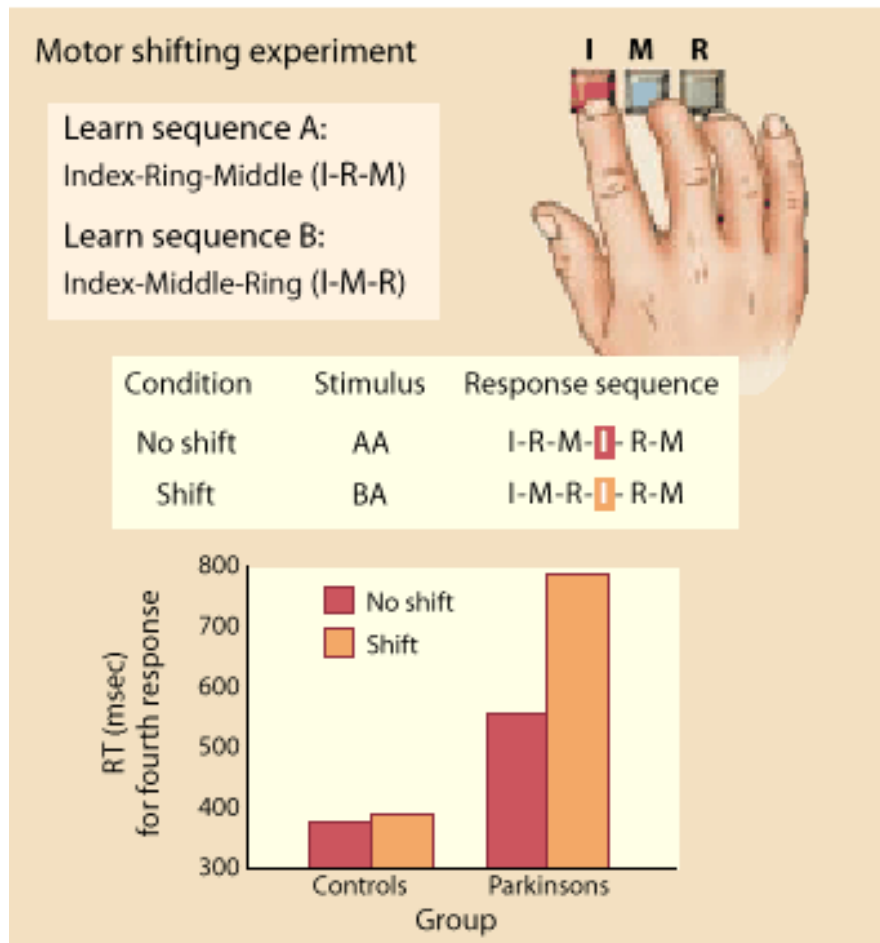


Prefrontal Cortex

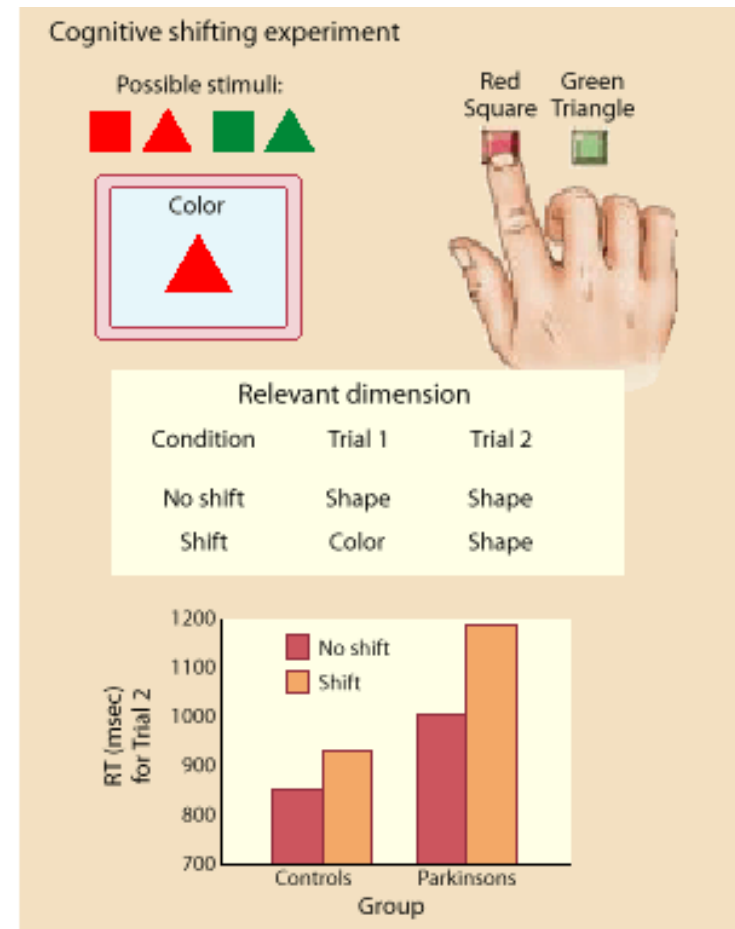


Testing the Stuck Gate Hypothesis: Beyond Motor

Bradykinesia:
Changing motor state



Bradyphrenia:
Changing cognitive state



Testing the Stuck Gate Hypothesis: Beyond Motor

Abstract cognition: Mathematics

2-number

$$2 + 1 = 3$$

$$8 + 3 = 13$$

$$6 + 8 = 14$$

$$8 + 3 = 11$$

3-number problem

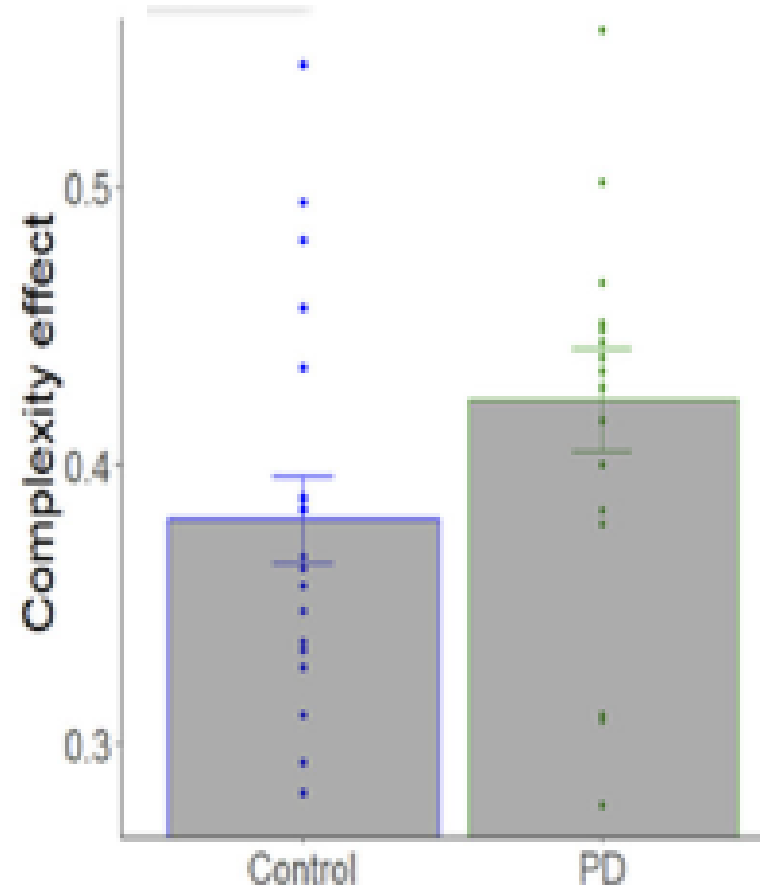
(changing state)

$$4 + 3 + 6 = 13$$

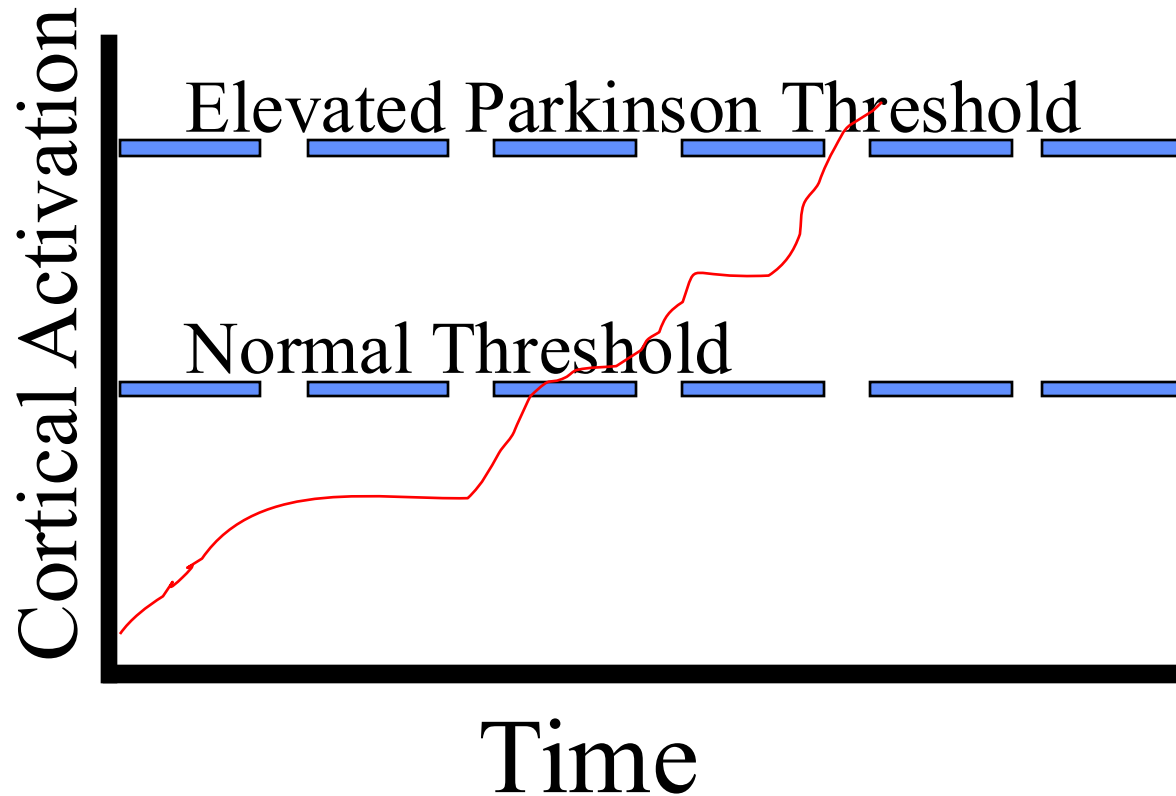
$$7 + 2 + 5 = 14$$

$$5 + 4 + 8 = 16$$

$$7 + 8 = 13$$



Stuck Gate Impact of Motor, Cognition, Emotion



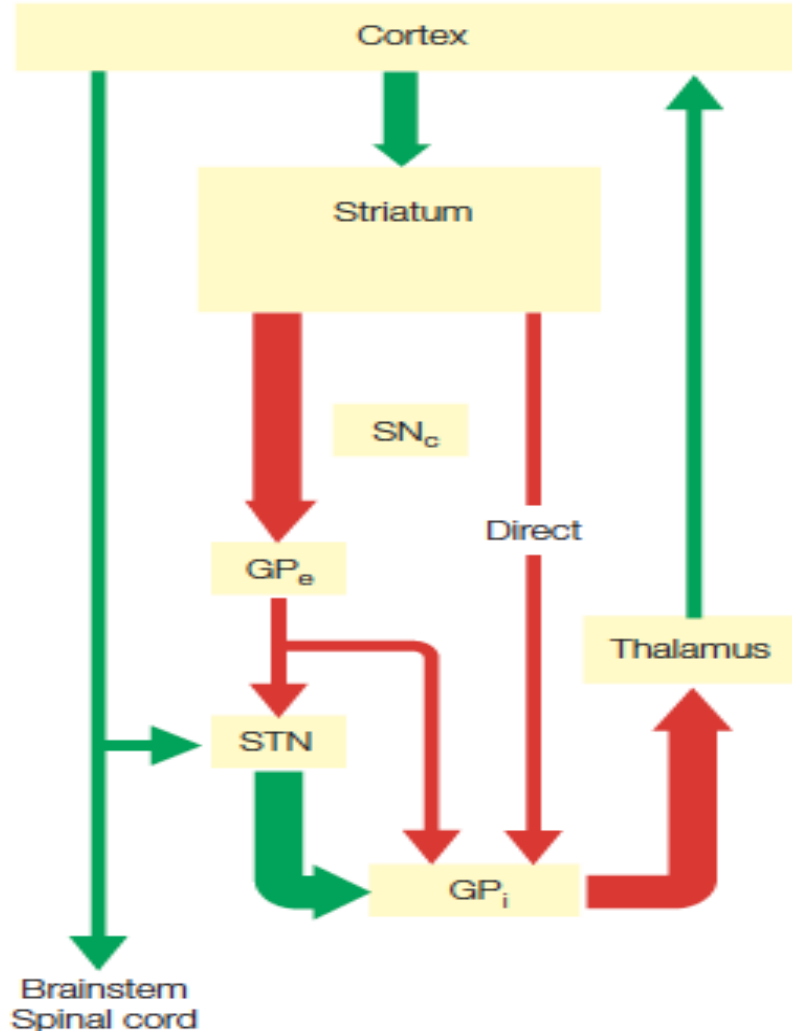
Slow to transition

-- movement states

-- mental states

-- emotion states

Parkinson's Disease



Fixing a stuck gate
medication
pallidotomy
DBS

Participating in CognAc Research

Lab Video: <http://ivrylab.berkeley.edu/participate.html>

Conducting both in-person studies and **on-line studies**

Join our on-line participant pool

<https://forms.gle/ktWtsLrJwy4DCSar8>^[P]_[SEP]

Minimal commitment

Single session/experiment (although many come back!)

Test from your home computer

Self-schedule— testing is at your convenience

Benefits

*** No clinical benefit ***

You are compensated for your time

You help us advance science