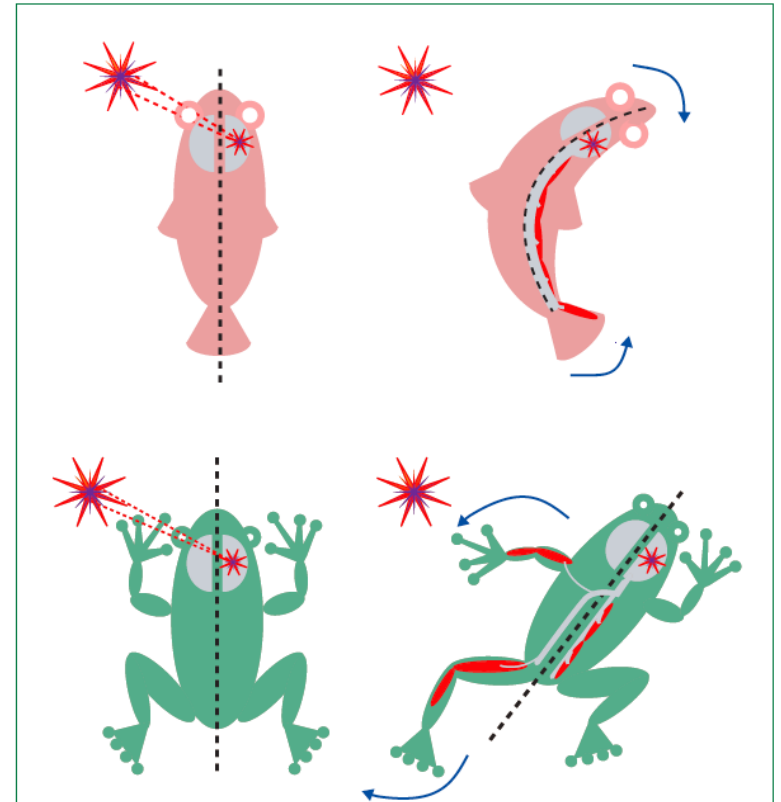
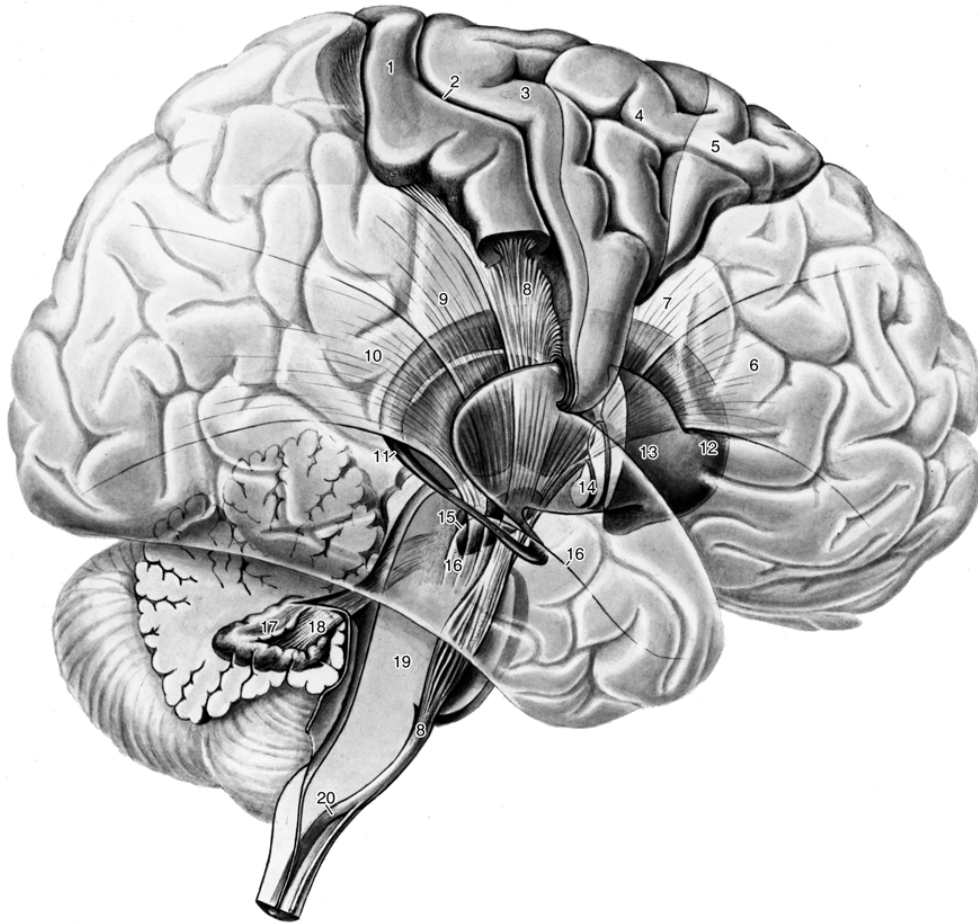


# Corticospinal Pathways



Virtual Neuroanatomy

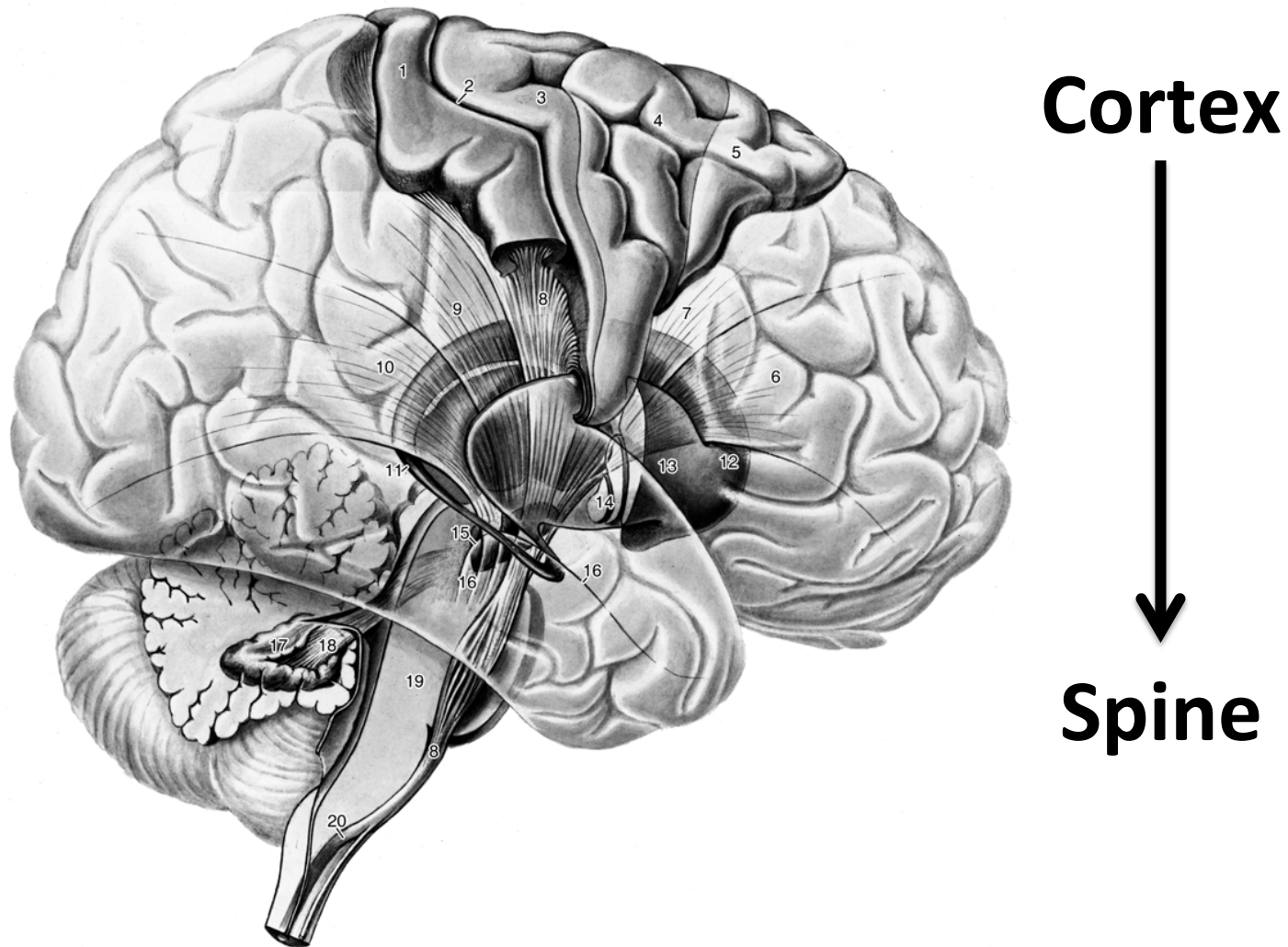
Lecture Date: 11/10/2014

# Outline

1. Background
2. Afferents & Efferents
3. Neurophysiology
4. Behavioral correlates
5. Physiological correlates
6. Neurochemical systems
7. Clinical Pathologies

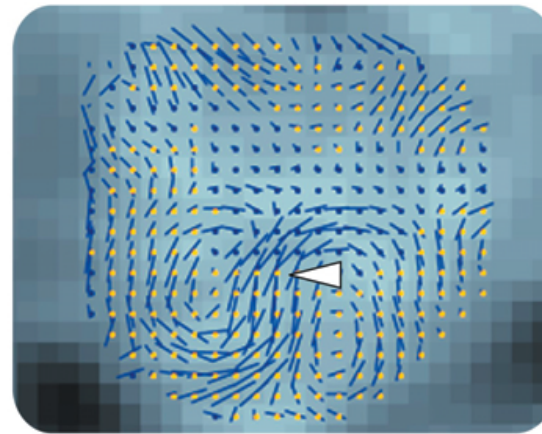
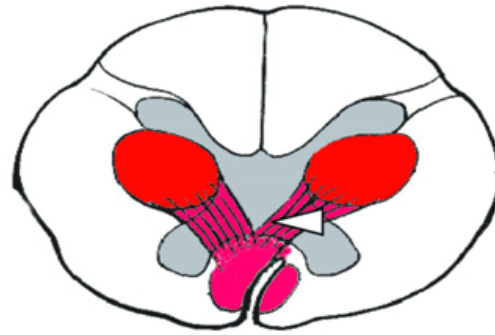
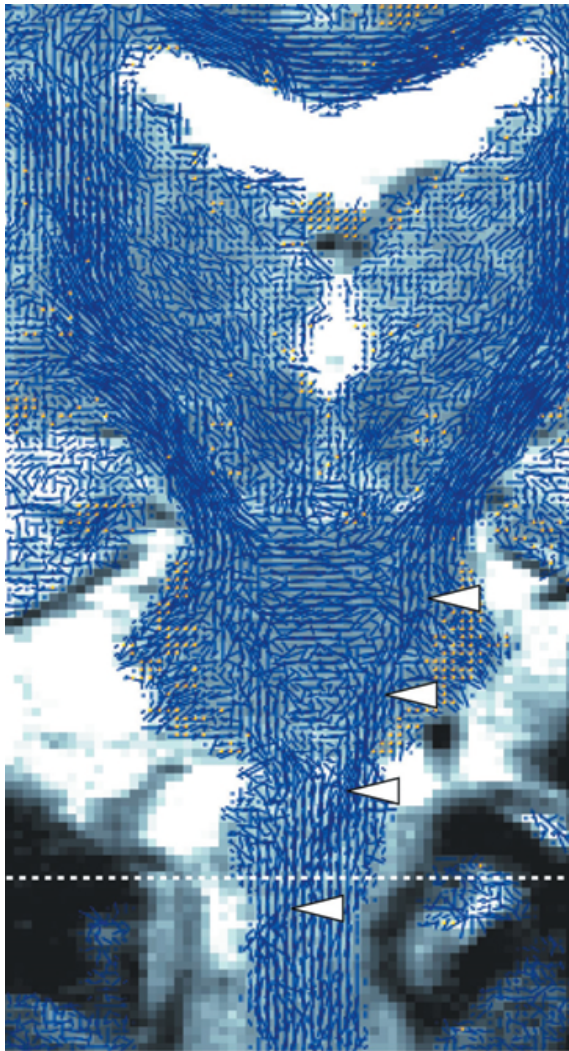
# 1) Background

# Corticospinal Pathways



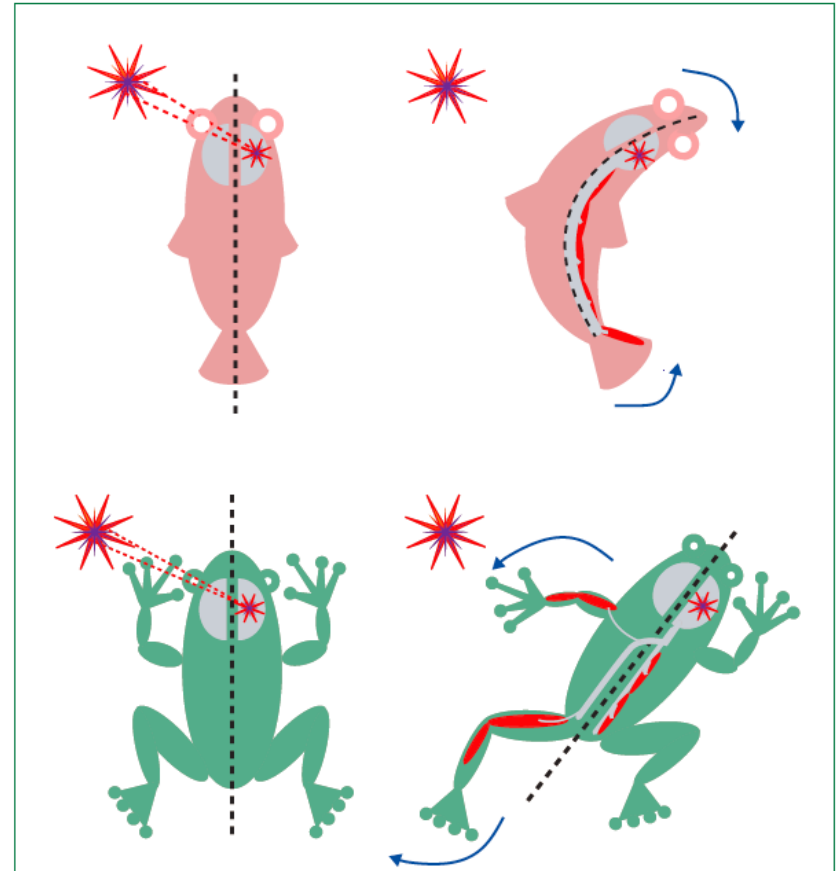
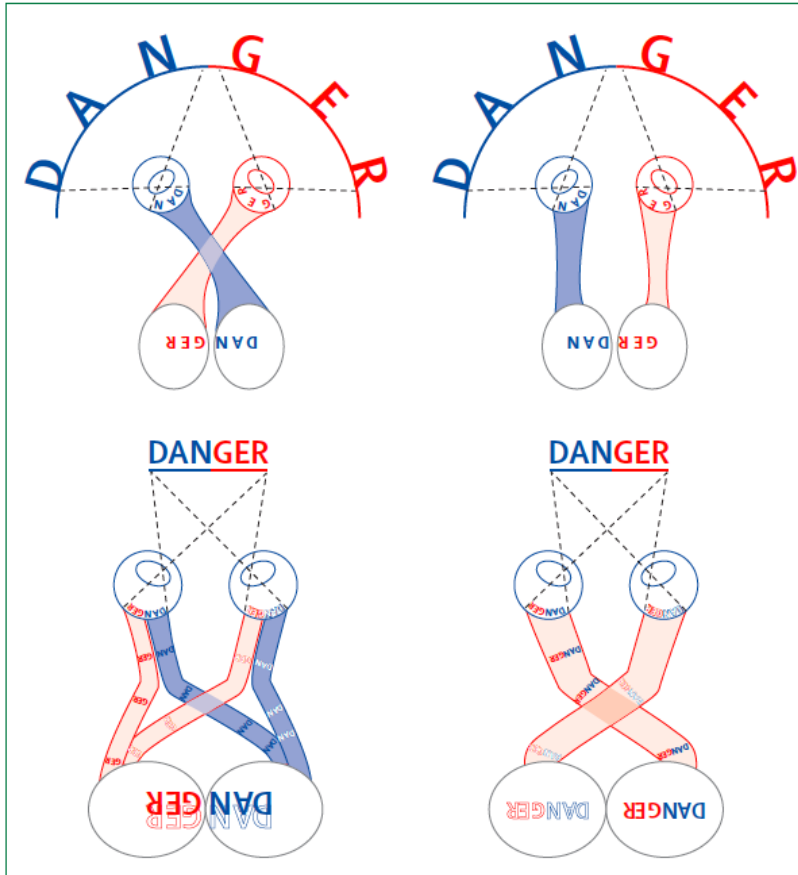
Direct link to spinal motor neurons from the cortex.

# Decussated projections cross the midline



(Vulliemoz et al. 2005)

# Why lateralized?

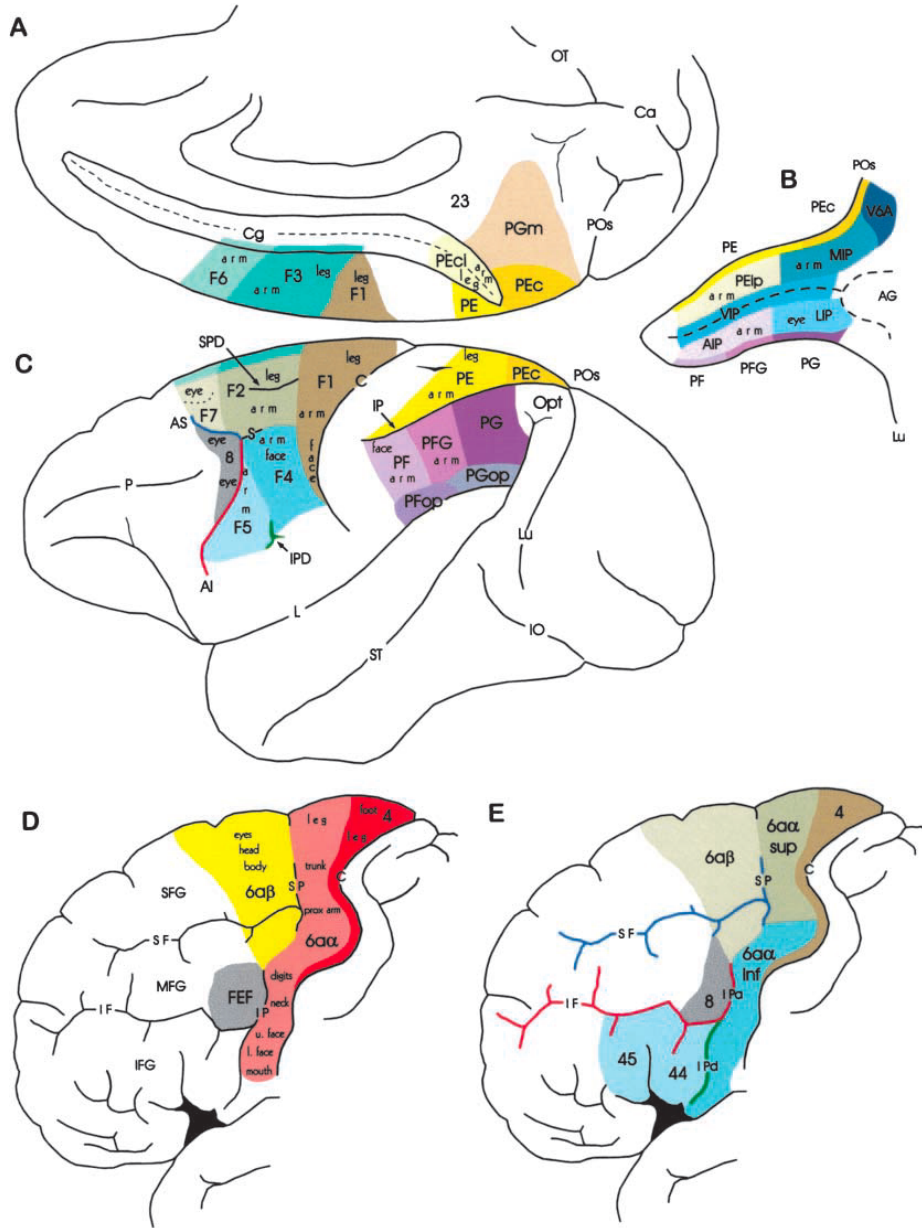


Ramon y Cajal's theory linked laterality of corticospinal projections to visual lateralization (Vulliemoz et al. 2005)

## 2) Afferents & Efferents

# Agranular cortex

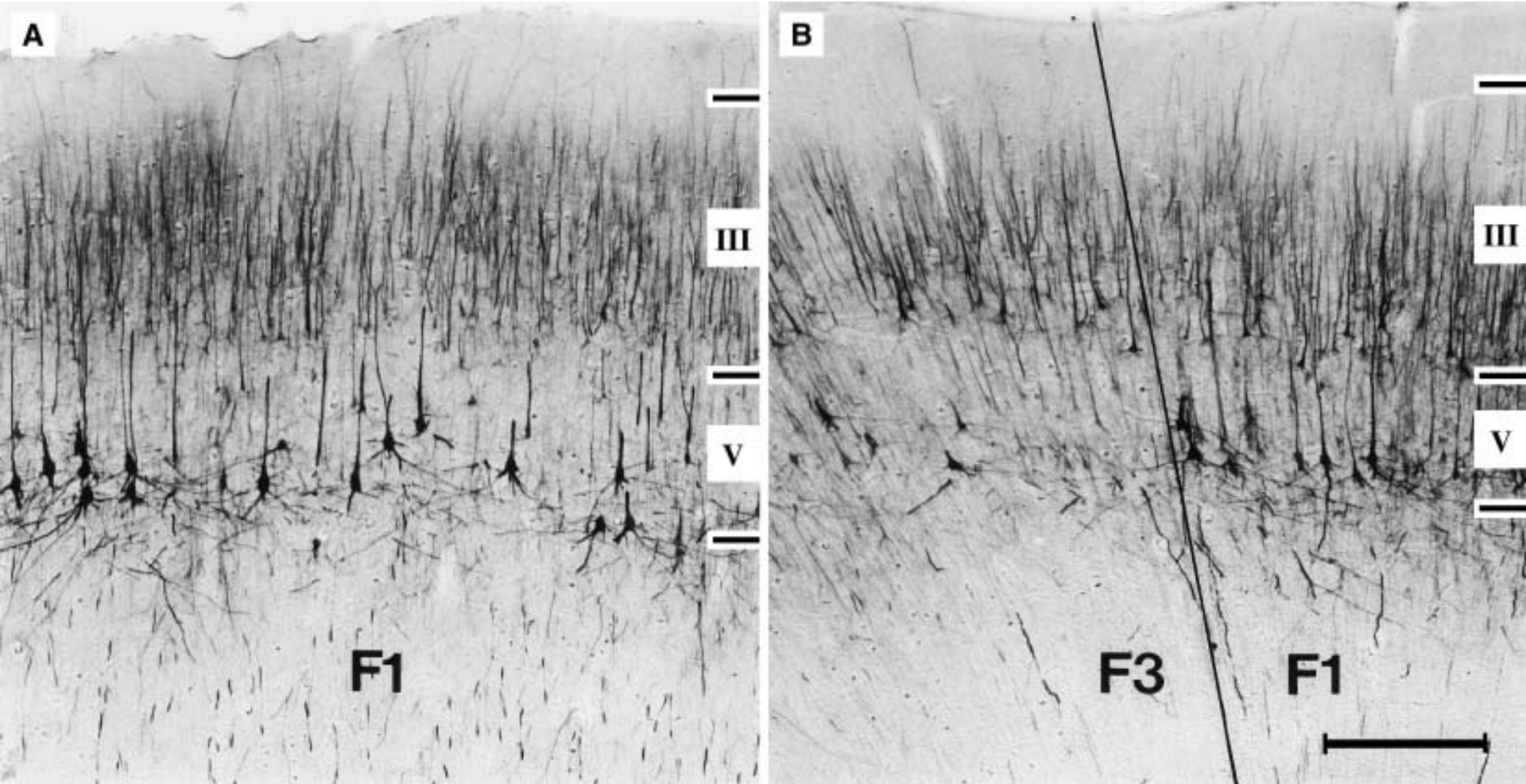
Corticospinal projections originate from the agranular cortex, a set of somatosensory and motor areas in the cortex.



(from Geyers et al. 2000)



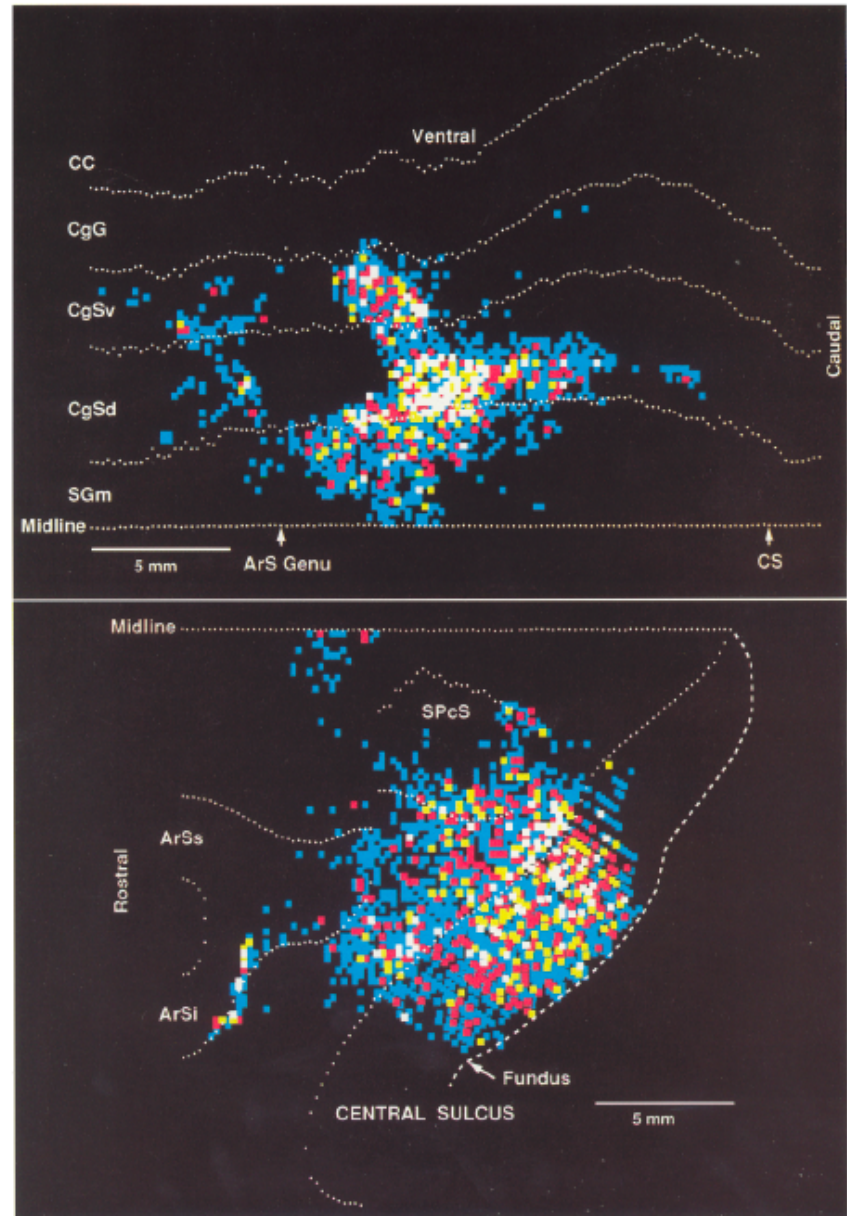
# Agranular cortex



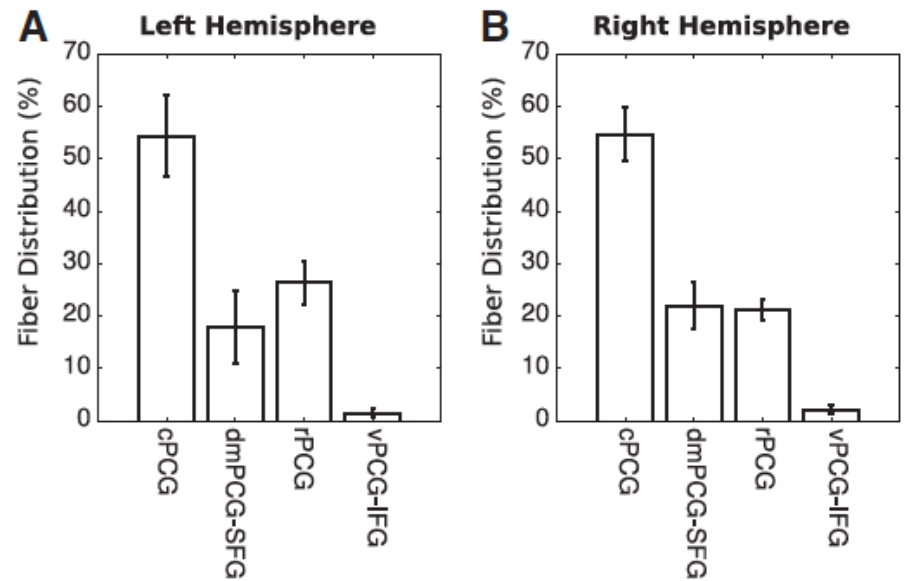
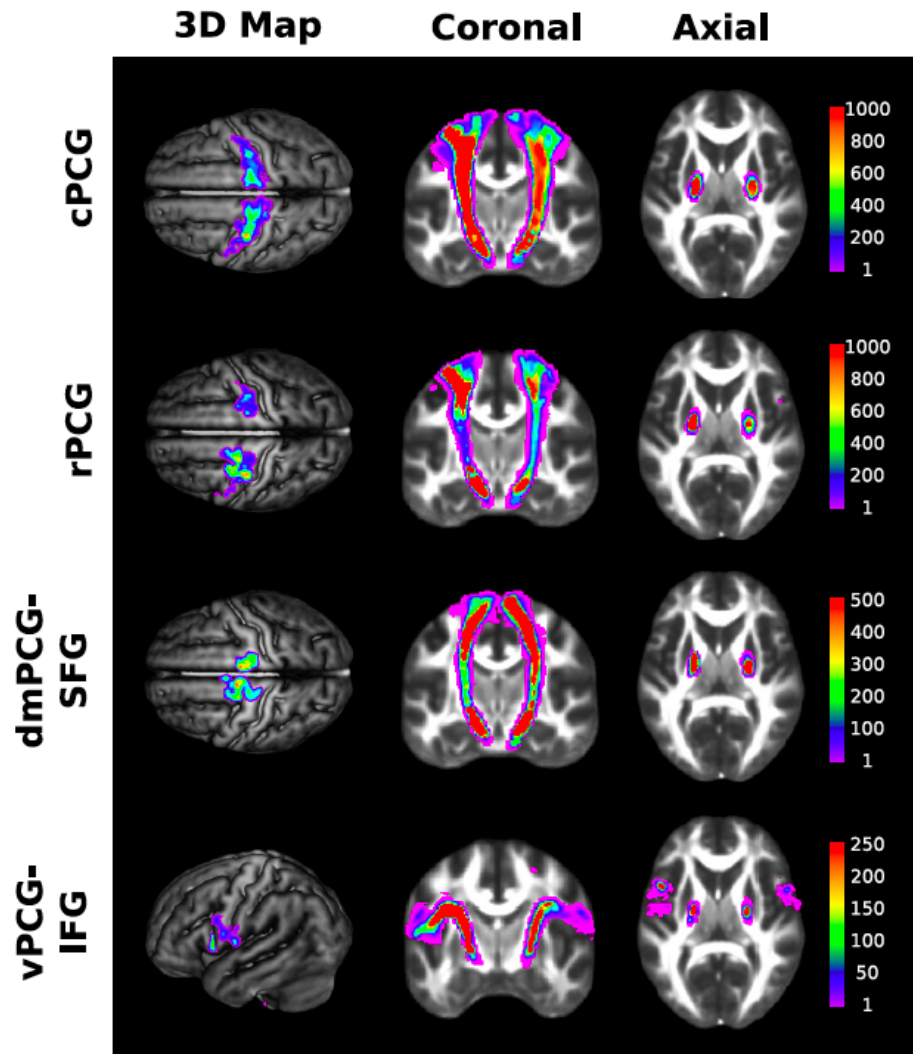
Large pyramidal cells (Betz cells) send descending projections to spine

# Cortical inputs to pyramidal neurons

Only 50% of the corticospinal projections originate from the primary motor cortex. The rest are fairly evenly distributed throughout the other premotor and somatosensory areas.



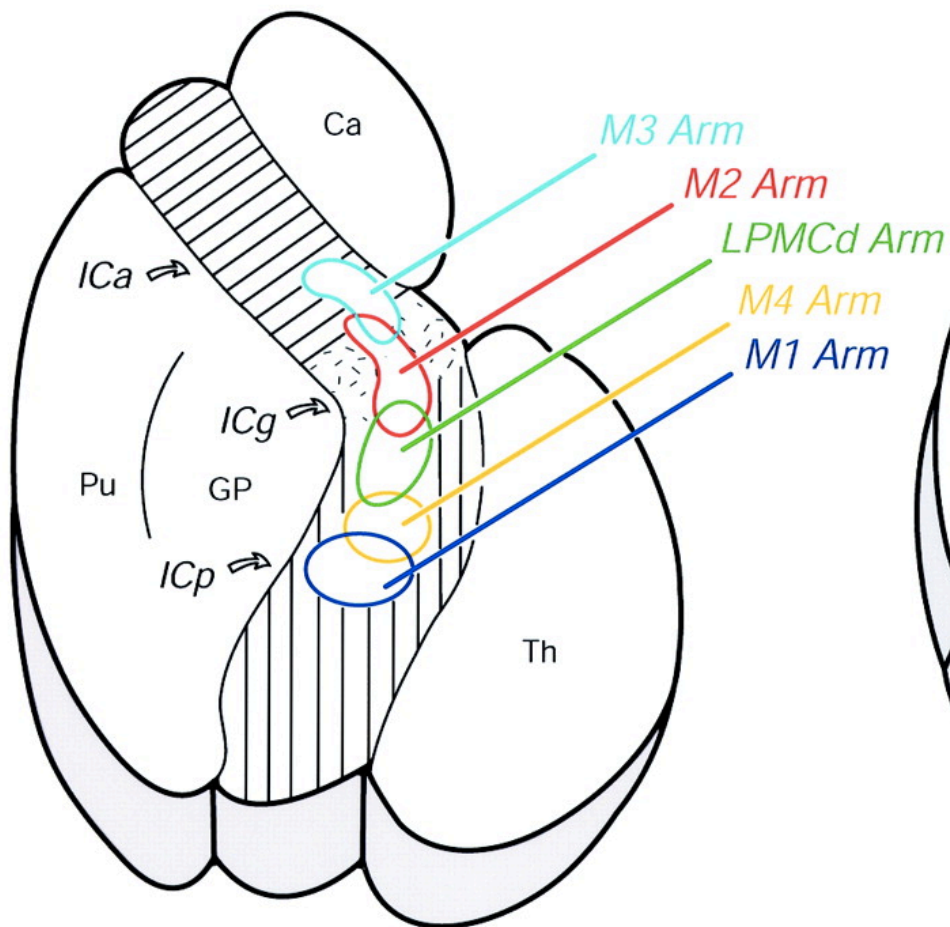
# Cortical inputs to pyramidal neurons



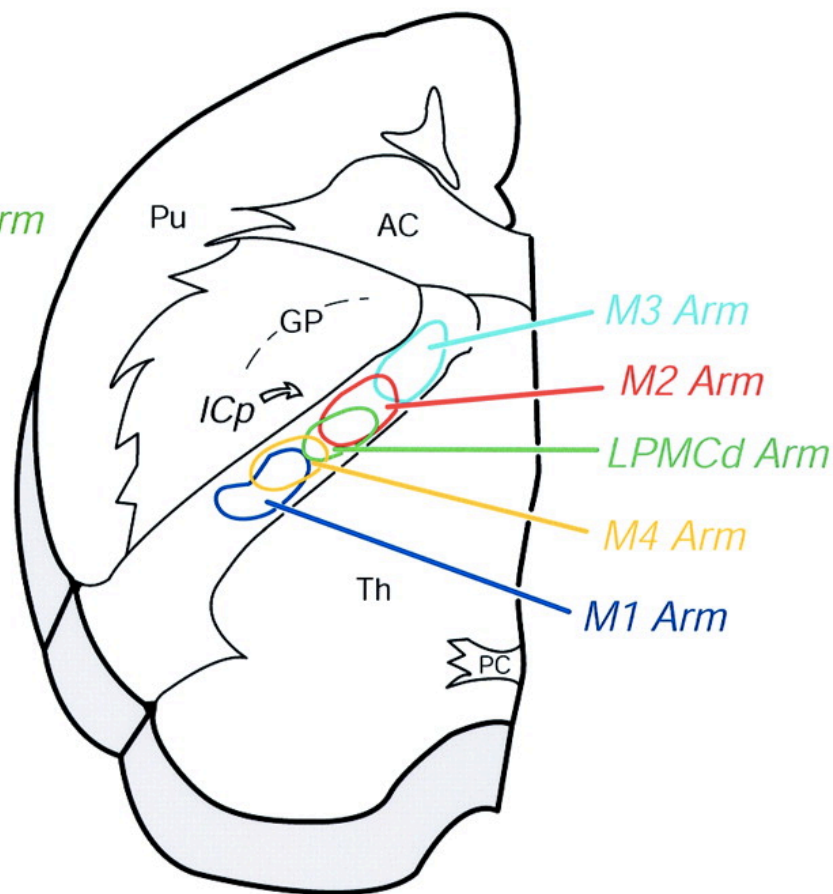
1. cPCG = M1
2. dmPCG-SFG = SMA
3. rPCG = Dorsal Premotor
4. vPCG-IFG = Ventral Premotor

# Midbrain trajectory

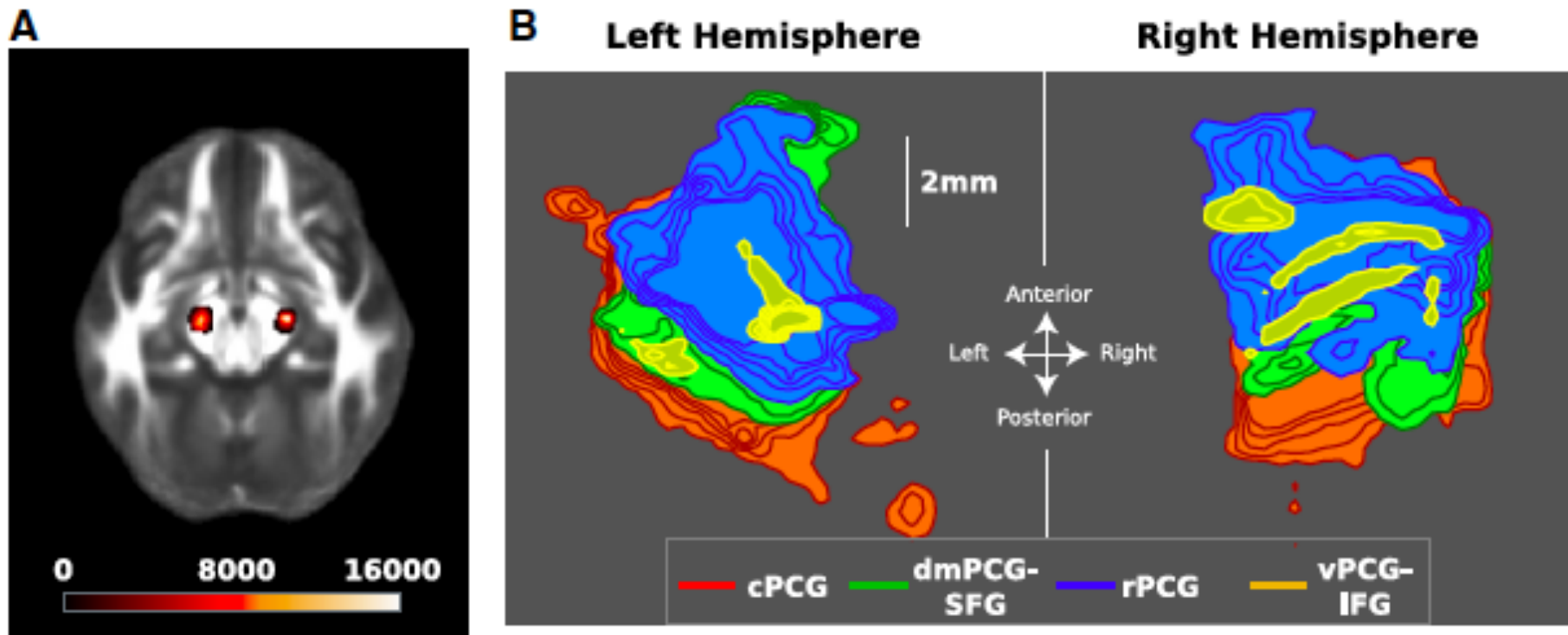
Superior internal capsule



Inferior internal capsule



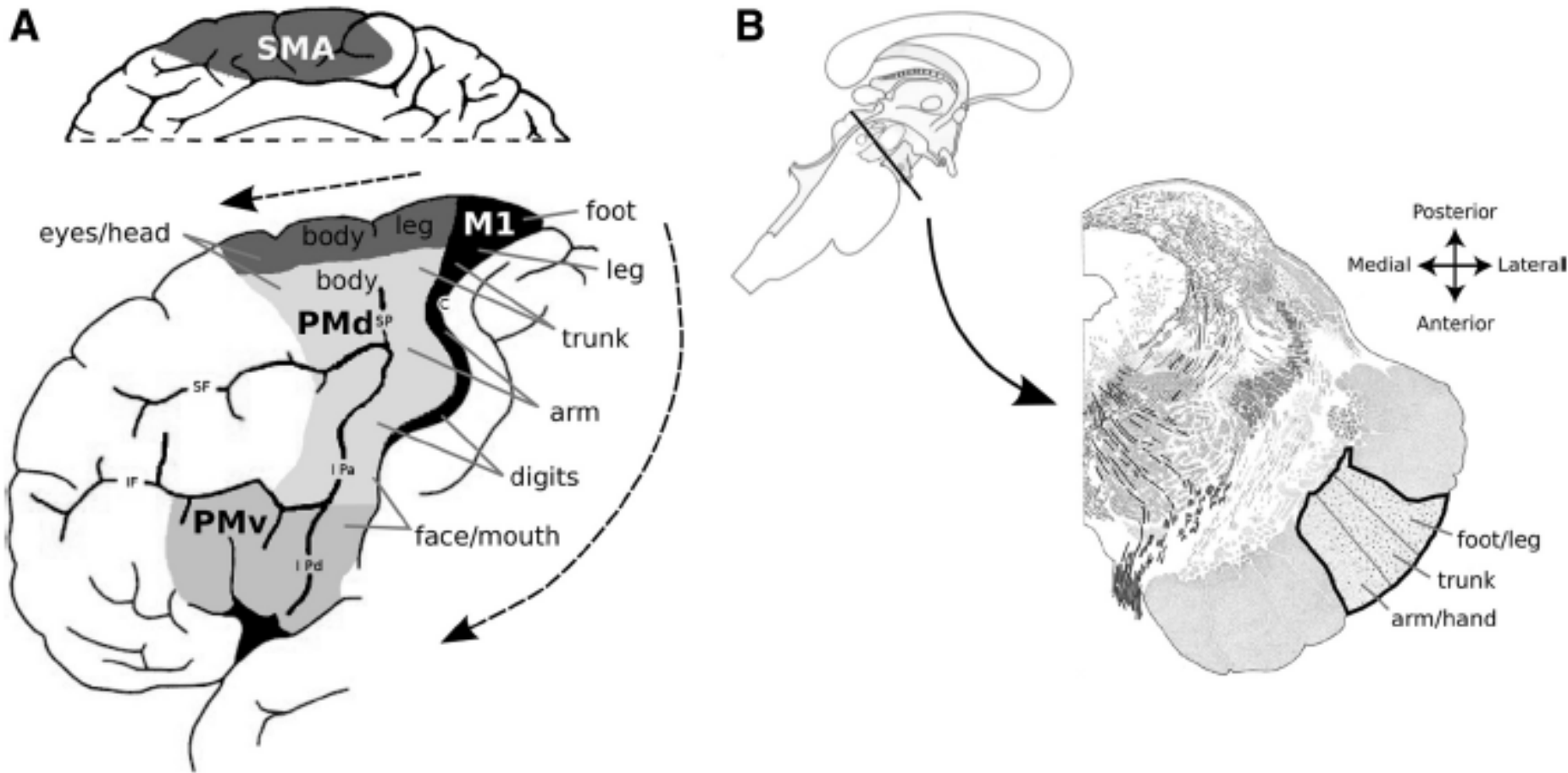
# Midbrain Trajectory



Projections continue through the middle part of the cerebral peduncle below the thalamus.

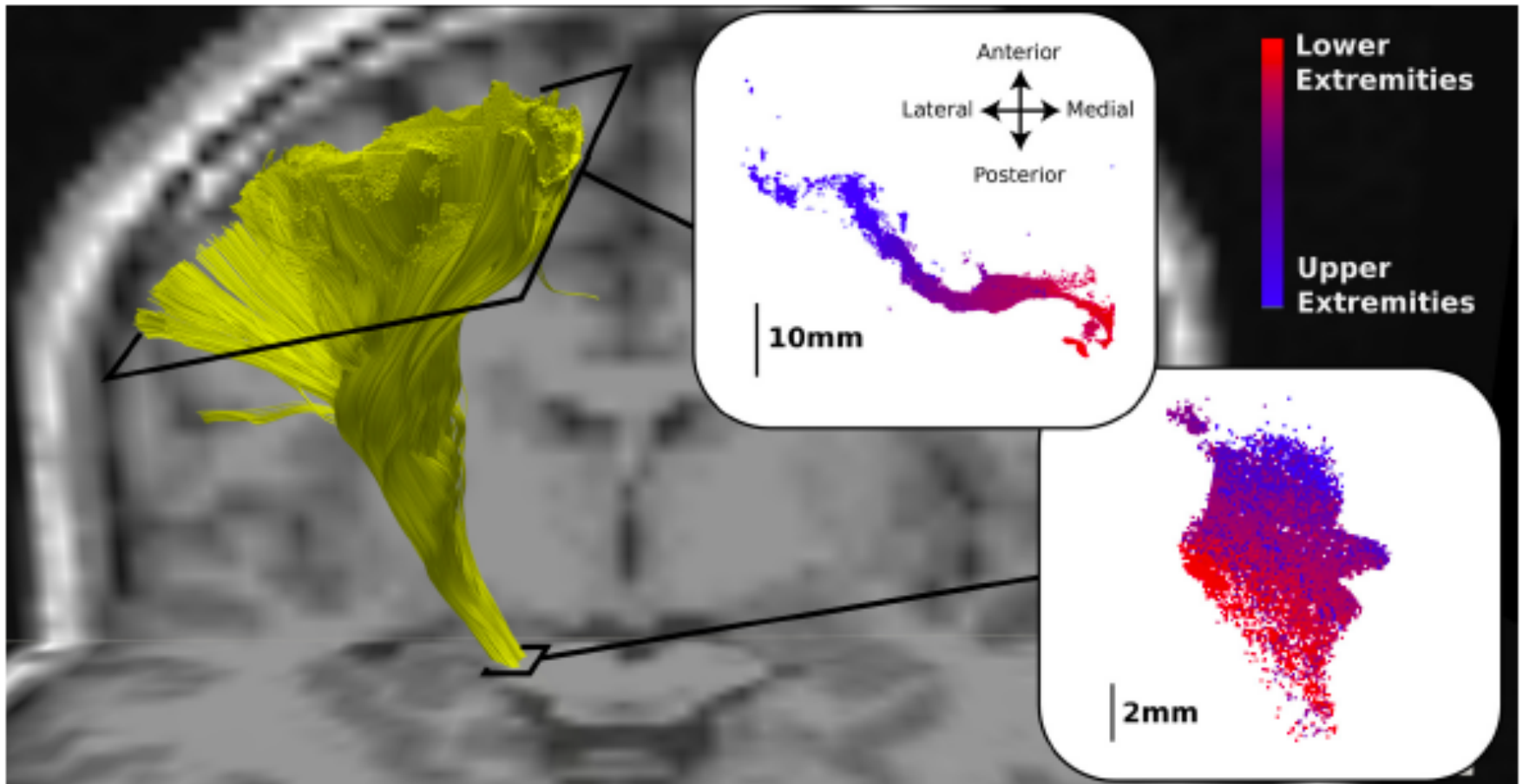
1. cPCG = M1
2. dmPCG-SFG = SMA
3. rPCG = Dorsal Premotor
4. vPCG-IFG = Ventral Premotor

# Midbrain Trajectory



Mediopontine pathway maintains motor somatotopy.

# Midbrain Trajectory

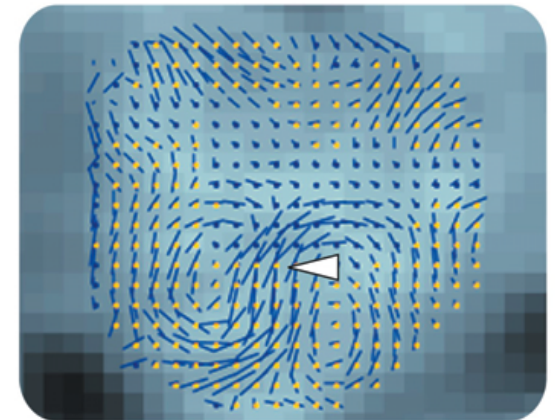
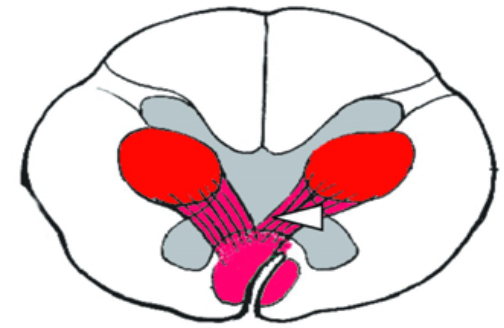
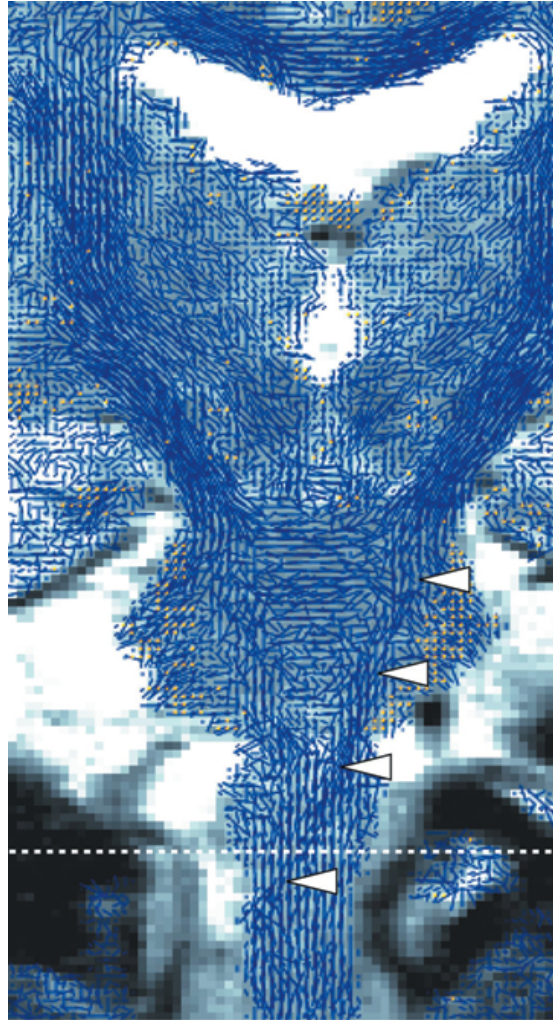


Mediopontine pathway maintains motor somatotopy.

# Pyramidal Decussation

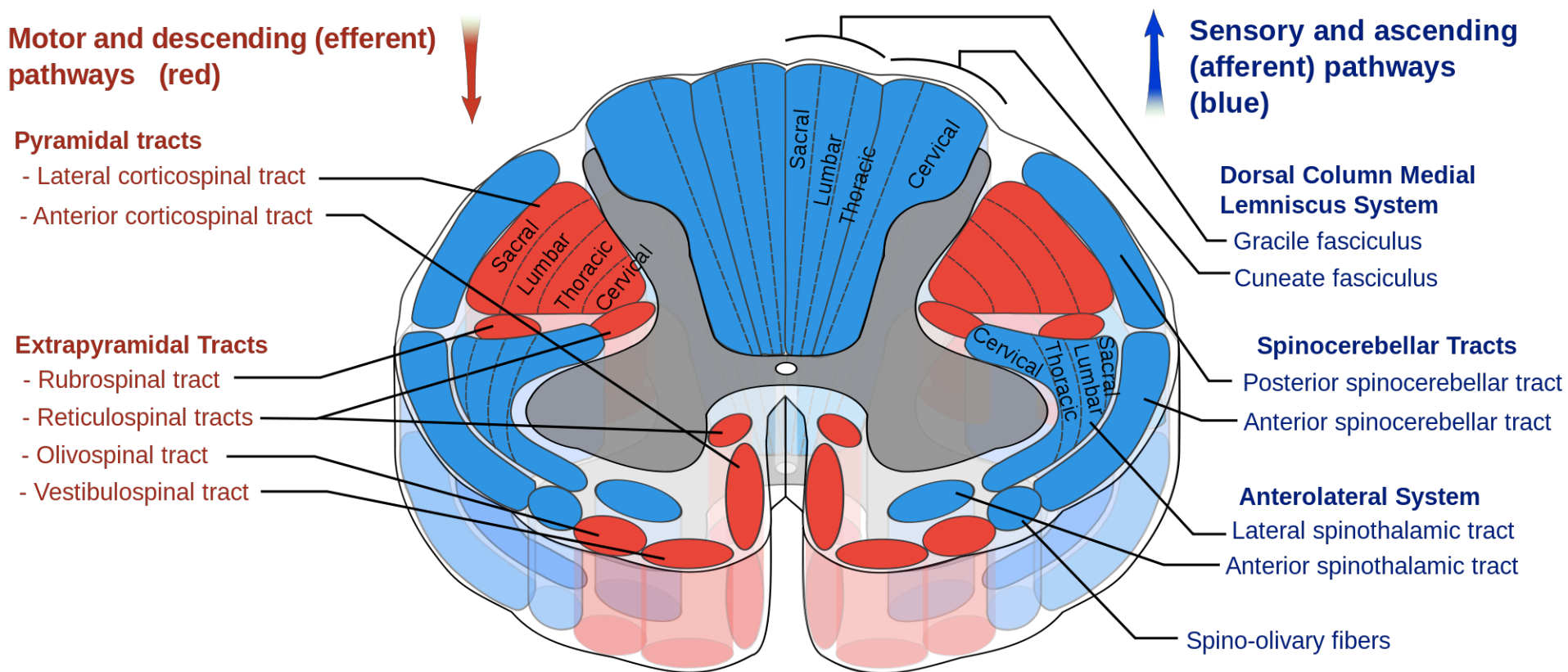
Projections to distal limbs cross the midline just below the pons.

~90% of distal projections cross the midline.



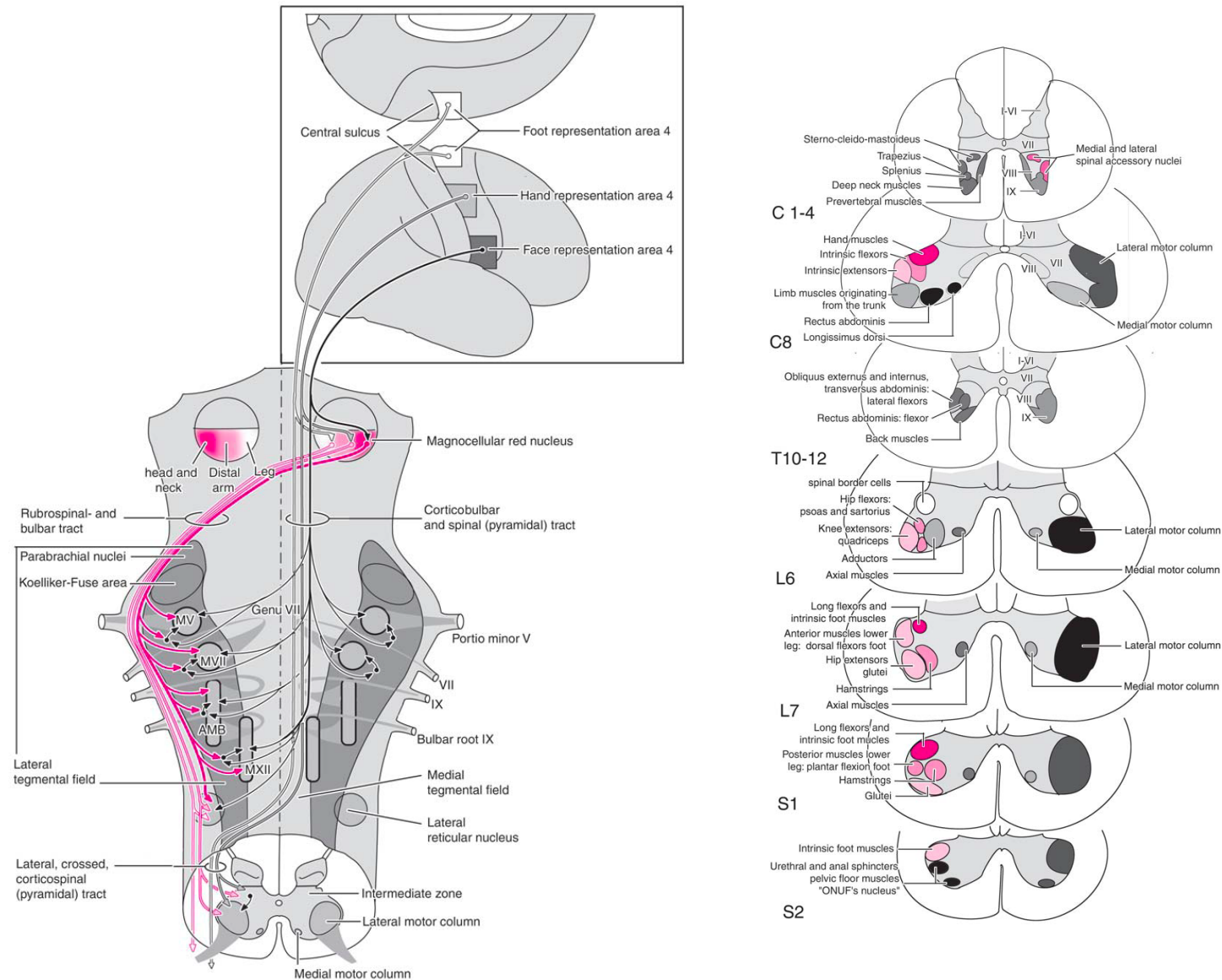


# Dorsal horn of the spine



Monosynaptic projections terminate on motor neurons in the dorsal horn of the spine.

# Dorsal horn of the spine



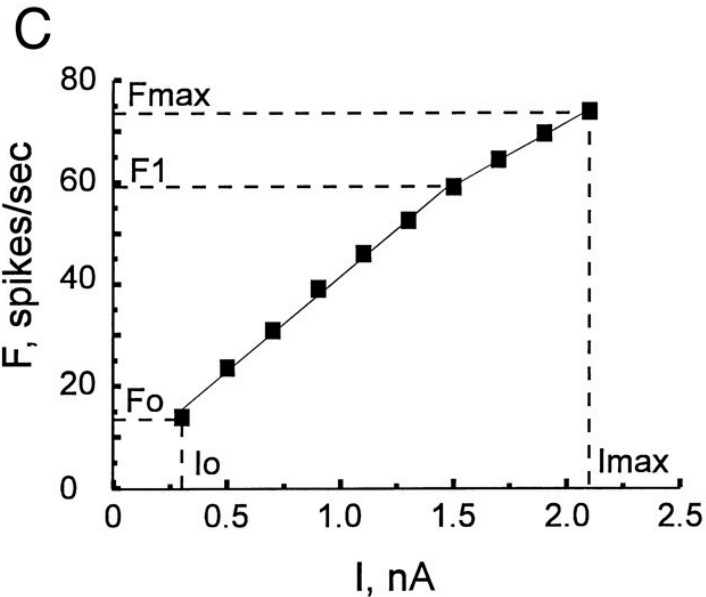
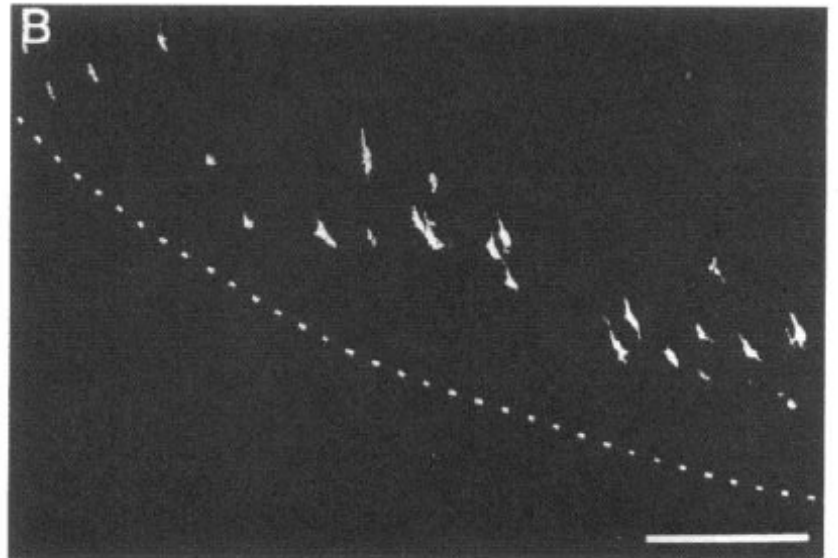
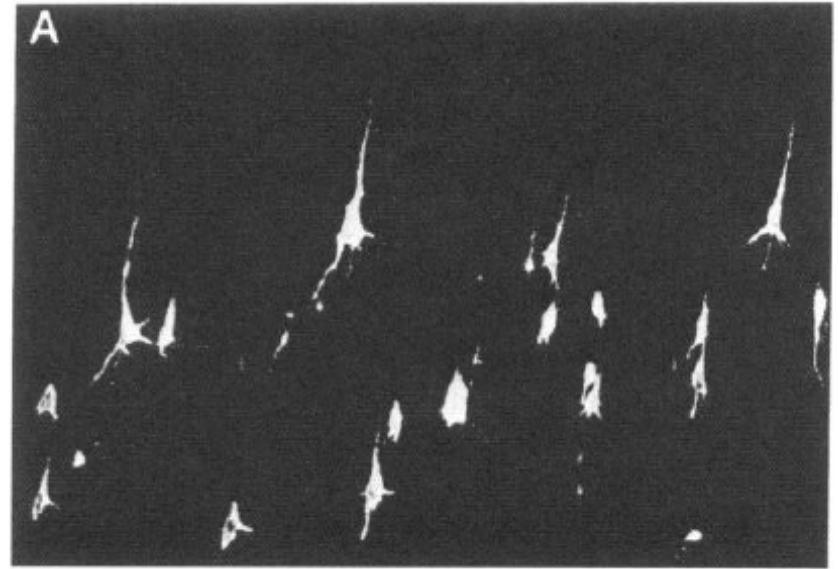
(from Nieuwenhuys, Voogd, & van Huijzen 2008)

# 3) Neurophysiology

# Betz Cells

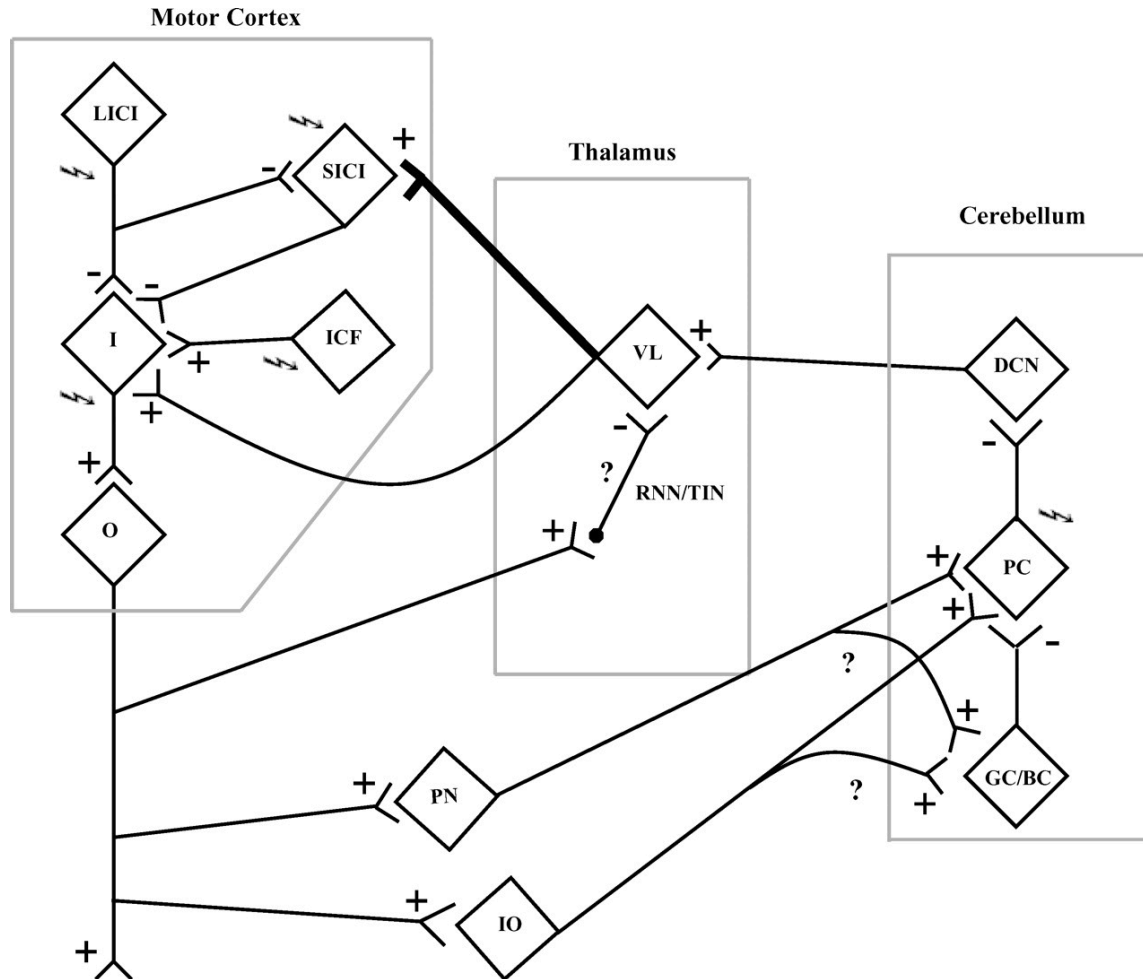
The pyramidal cells in layer V that project to the spine are relatively large.

Fairly linear relationship between input PSCs and firing rates.



(from Dum & Strick 1991; Schwindt et al. 1991)

# Inhibitory control

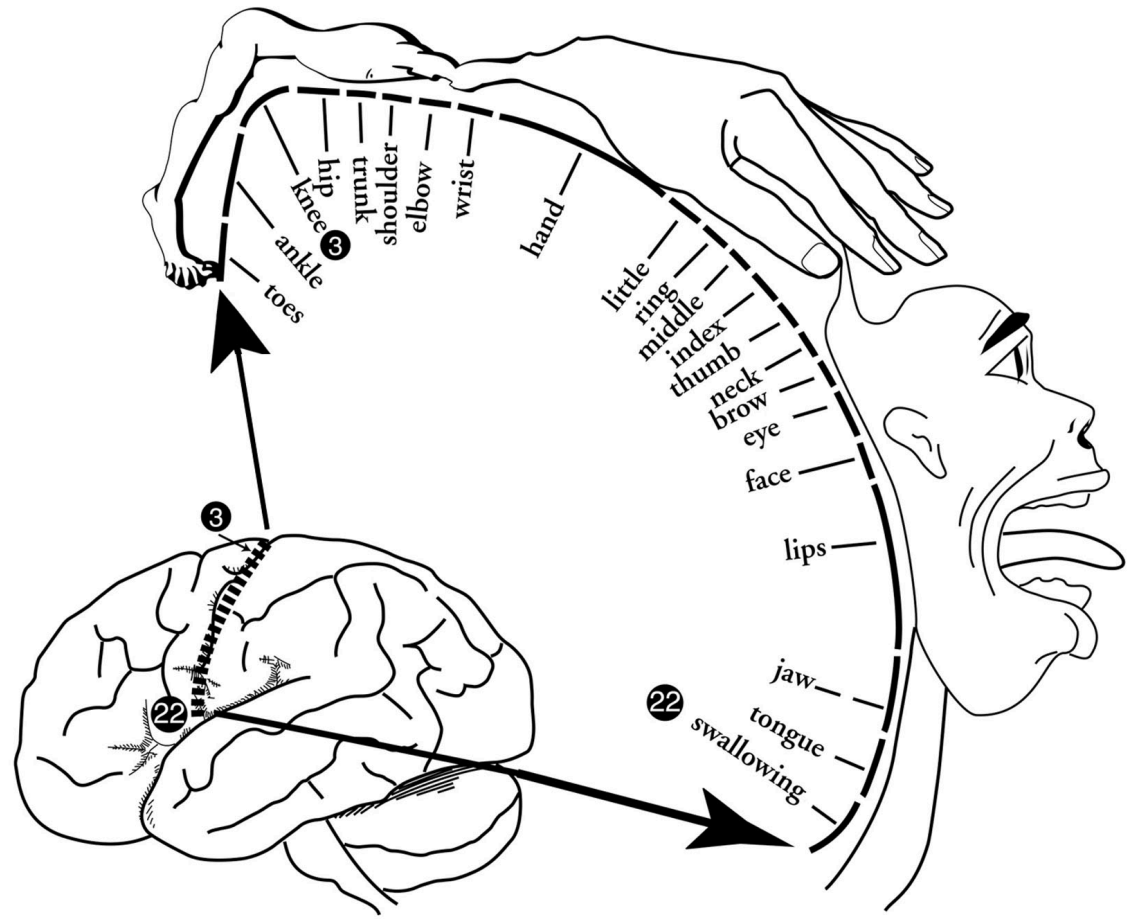


LICI = long interval intracortical inhibition  
SICI = short interval intracortical inhibition

## 5) Behavioral correlates

# Motor Control

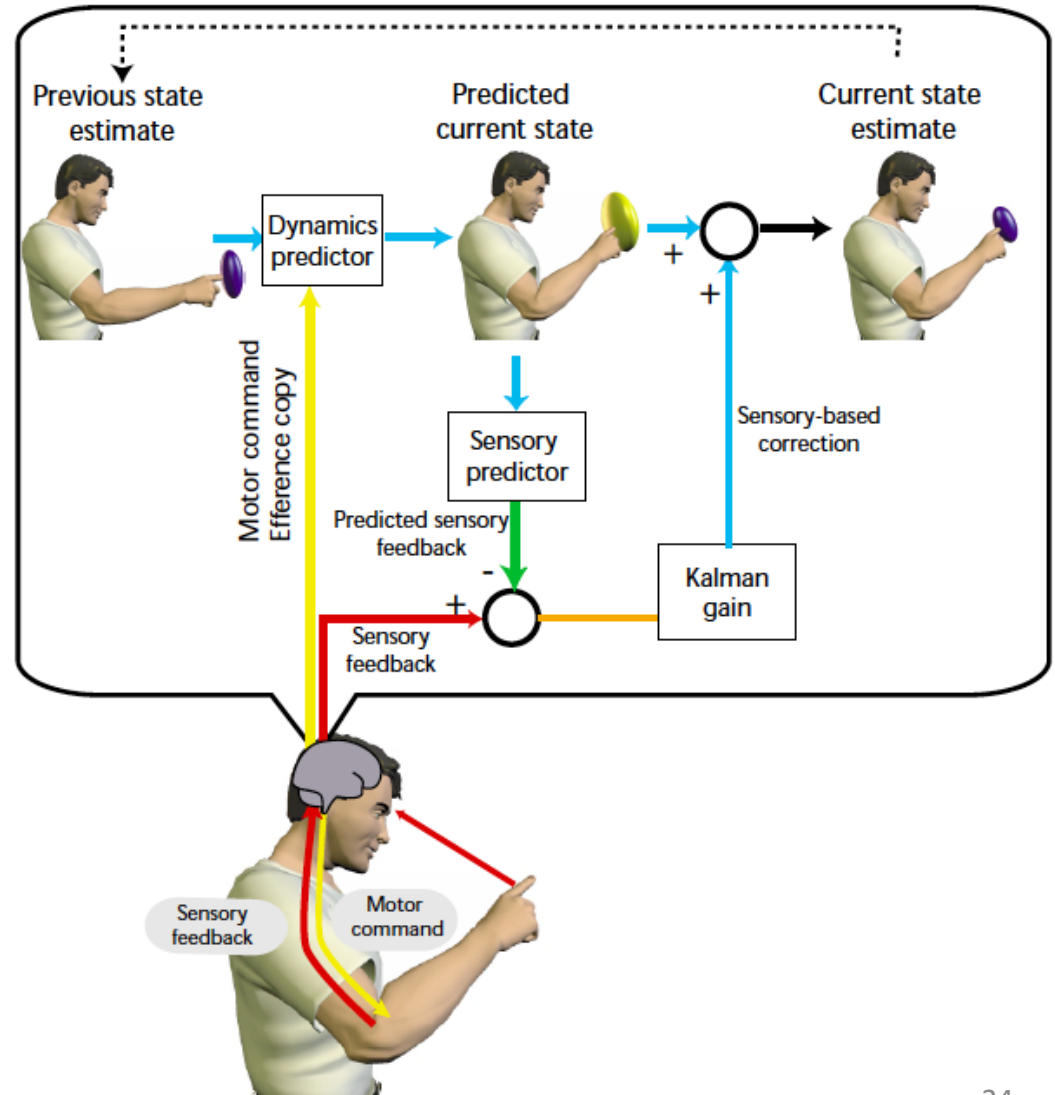
The primary goal of the corticospinal pathways are to regulate the control of voluntary movements via engagement of peripheral muscles



# Sensory Prediction

**Efference Copy (Corollary Discharge):**  
A forward model of expected sensory consequences of actions.

Believed to originate from motor execution areas.



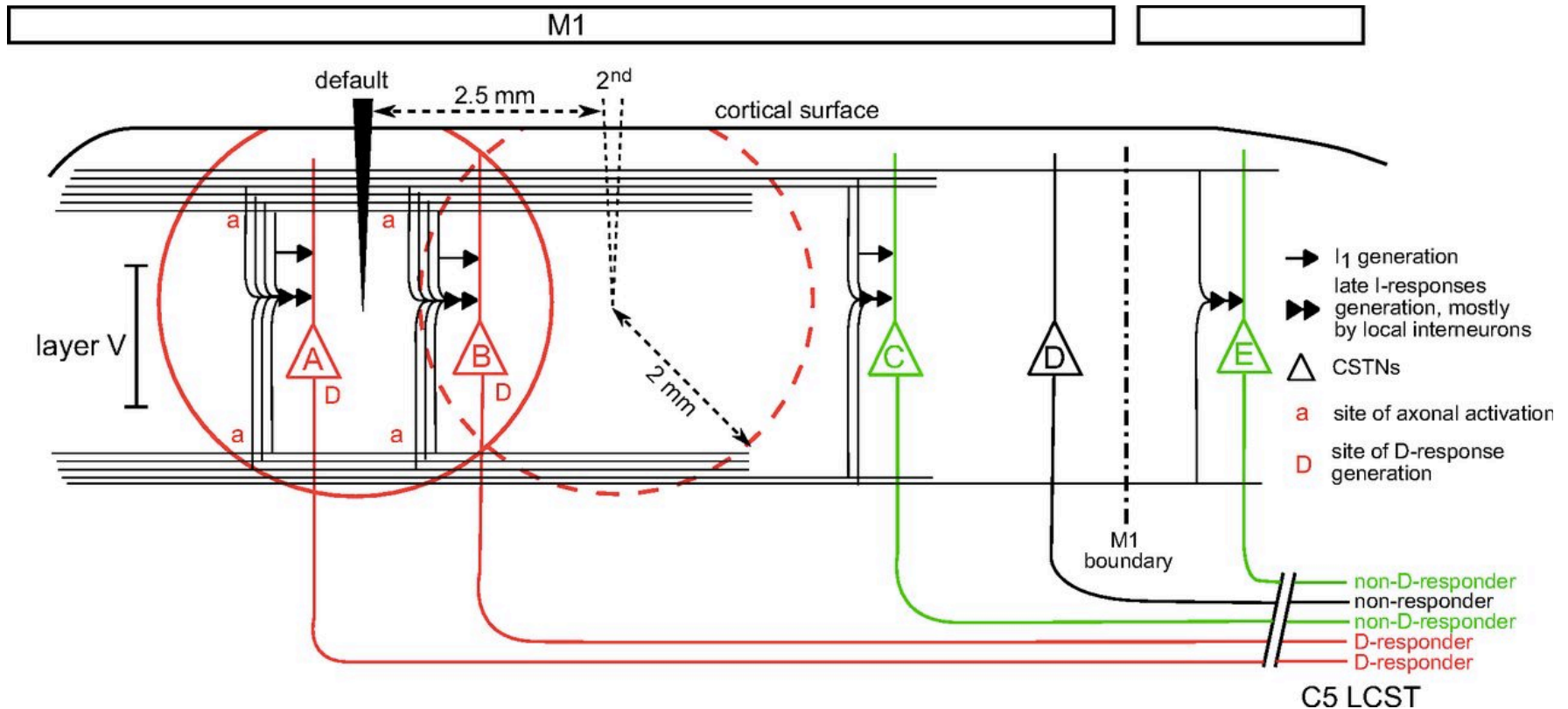


# 5) Physiological Correlates

(none that I could directly find)

## 6) Neurochemical systems

# Cell physiology



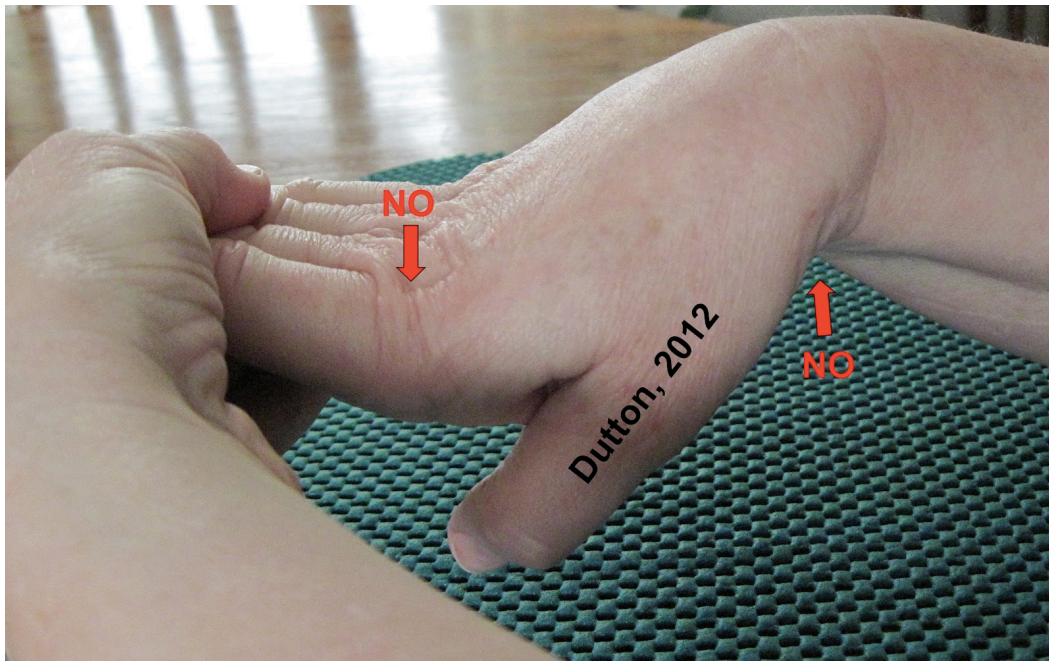
- Betz cells send excitatory projections to spinal motor neurons using glutamate.
- Local inhibitory control regulated by GABA-A and GABA-B interneurons.

(from Maier et al. 2013)

# 7) Clinical Pathologies

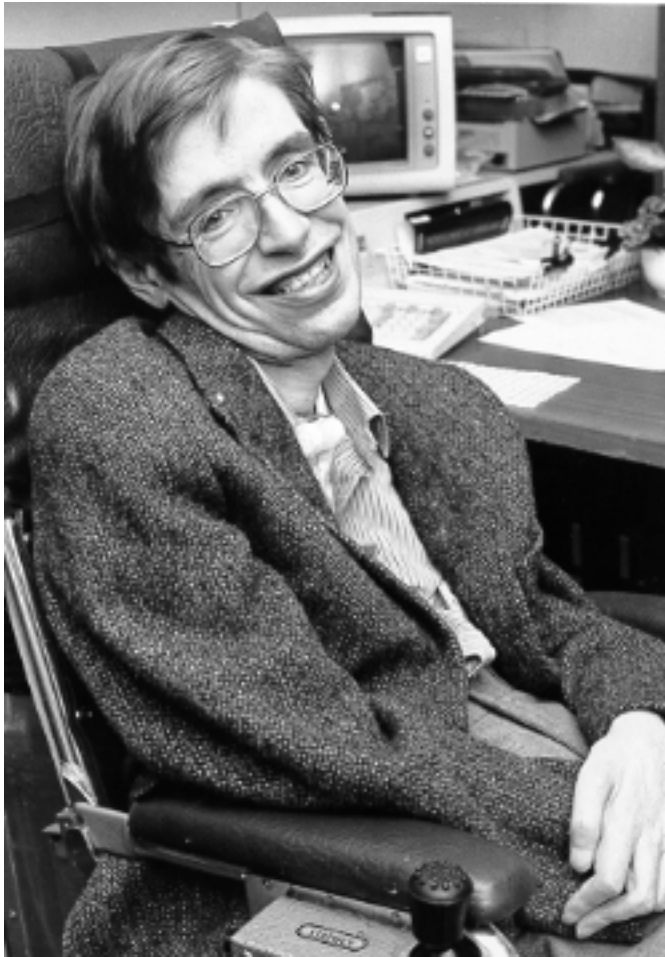
# Paralysis & Weakness

- **Hemiparesis:** Weakness of limbs on one side of the body
- **Hemiplegia:** Complete paralysis of limbs on one side of the body.



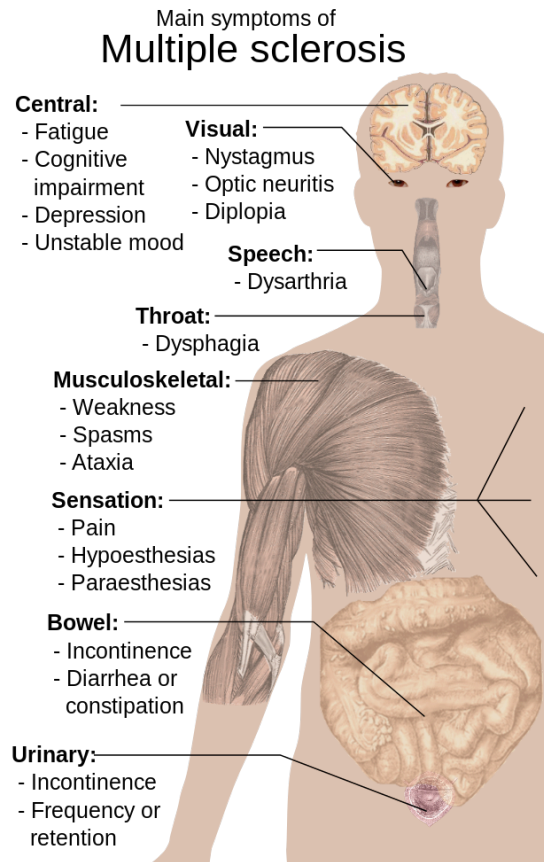
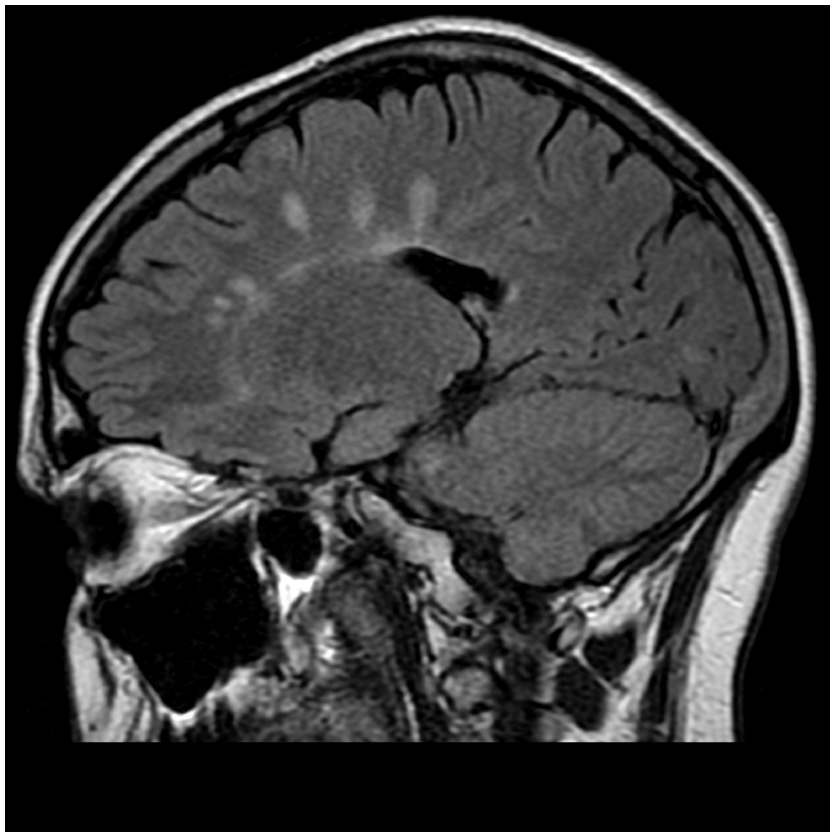
Usually arise from damage to the upper motor neurons in the corticospinal pathway (including cortical sources)

# Amyotrophic lateral sclerosis (ALS)



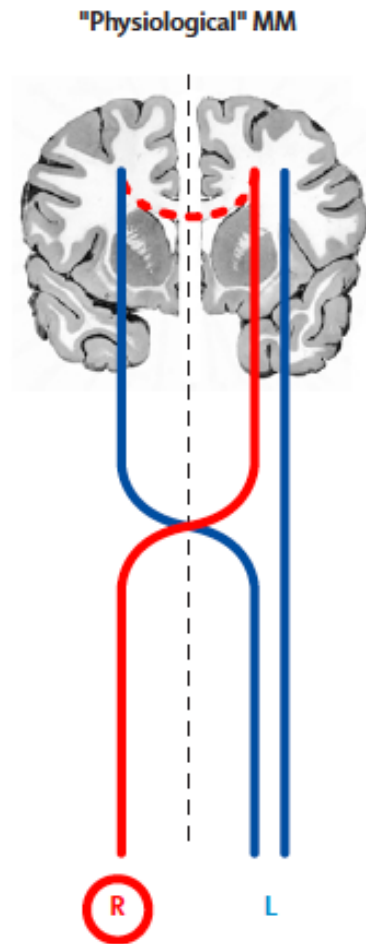
A progressive motor neuron disease characterized by whole-body weakness and paralysis due to degeneration of corticospinal white matter tracts

# Multiple Sclerosis



An inflammatory disease that causes demyelination of white matter pathways throughout the brain. Presenting symptoms usual start with motor or sensory deficits.

# Bimanual Synkinesis (Mirror Movements)

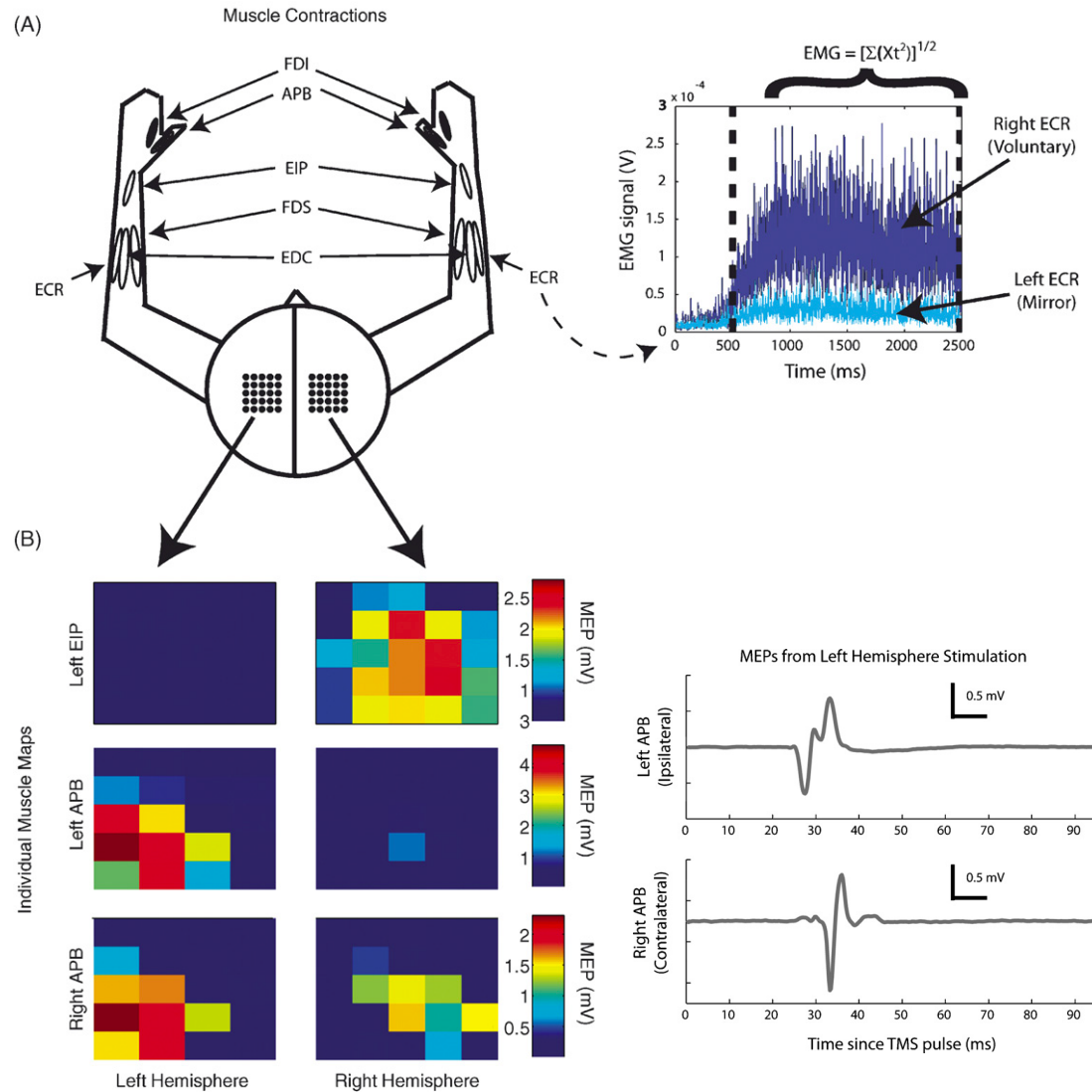


Involuntary, mirror-symmetric of one limb during the voluntary control of the contralateral limb.

(Vulliemoz et al. 2005)

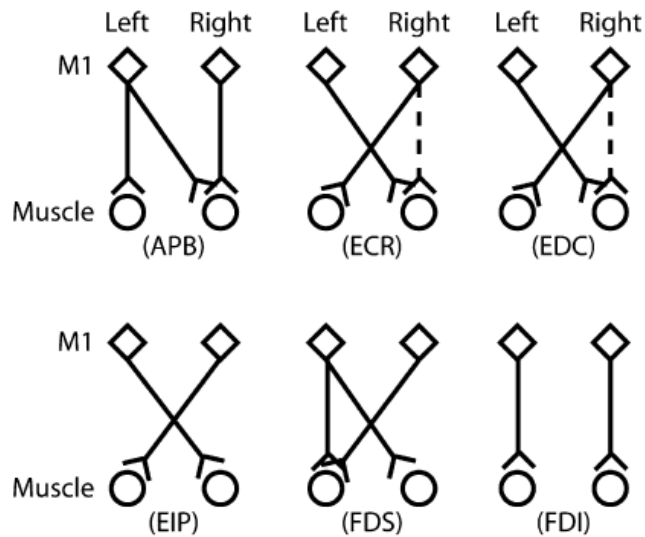


# Bimanual Synkinesis (Mirror Movements)

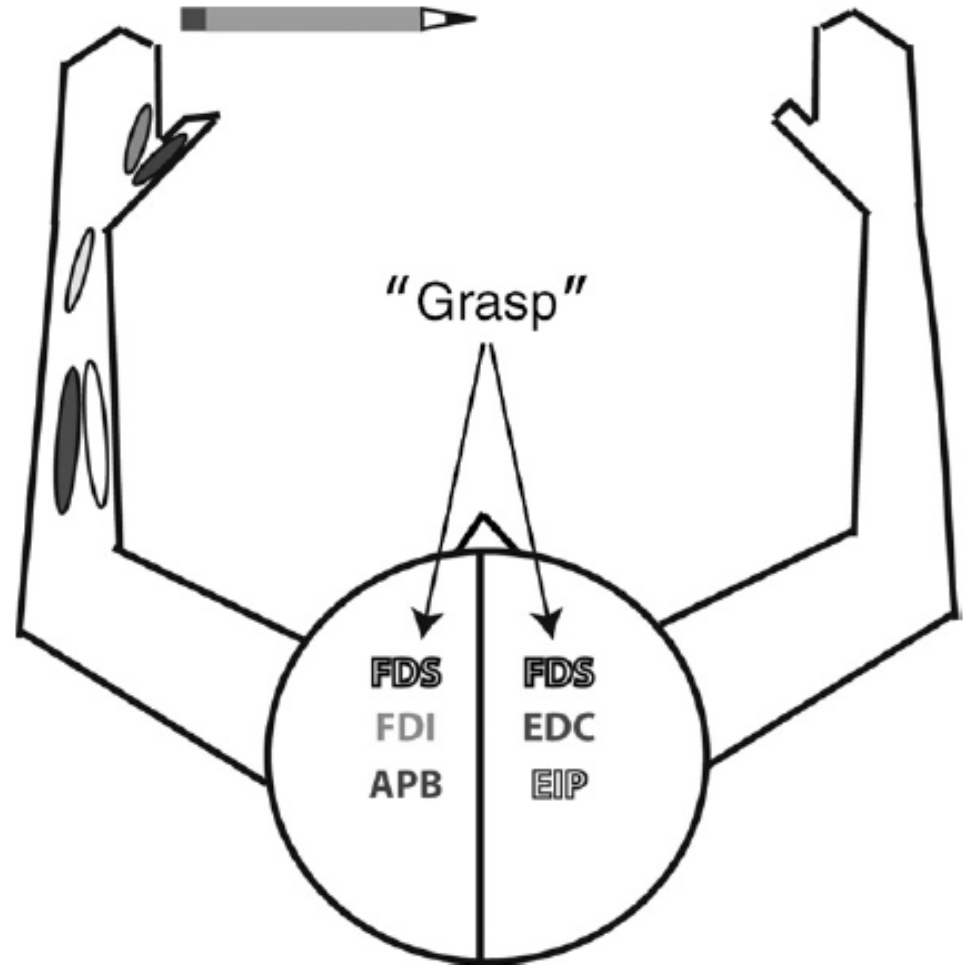


Origins of mirror movements remains controversial.

# Bimanual Synkinesis (Mirror Movements)



*T. Verstynen et al. / Neu*



Some evidence that they reflect a control strategy for overcoming abnormal decussation patterns in corticospinal pathways.

# Summary

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