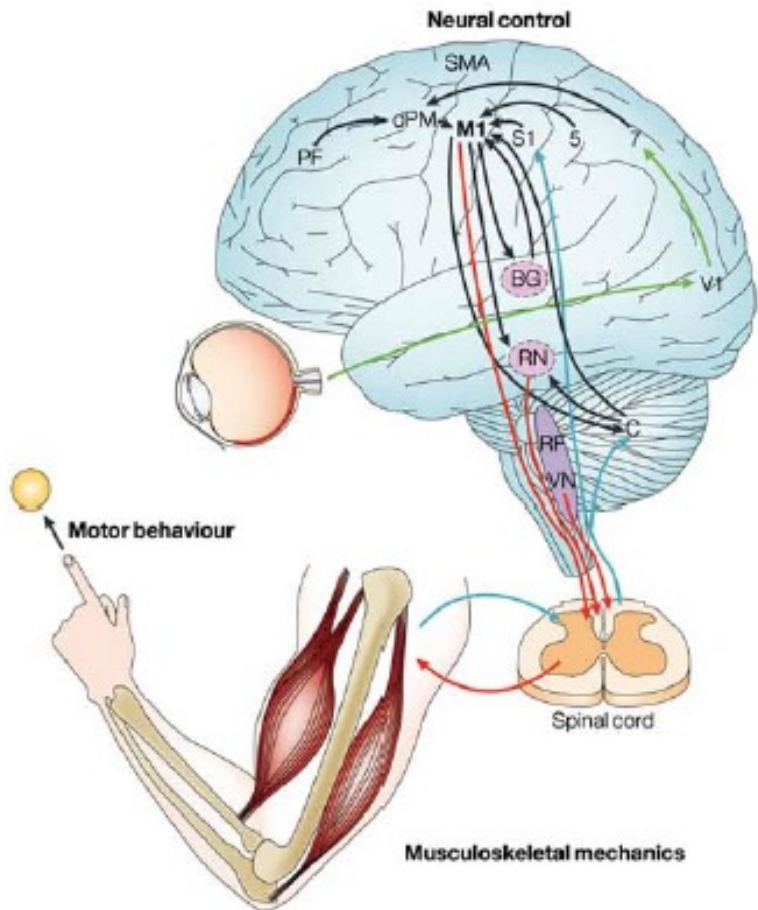


# BMD ENG 301 Quantitative Systems Physiology (Nervous System)

Upper Motor System  
2022\_v2

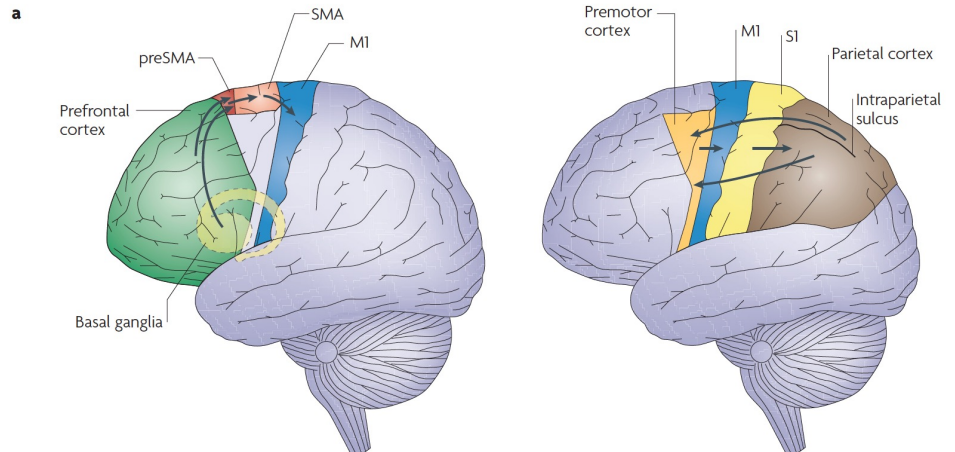
Professor Malcolm MacIver

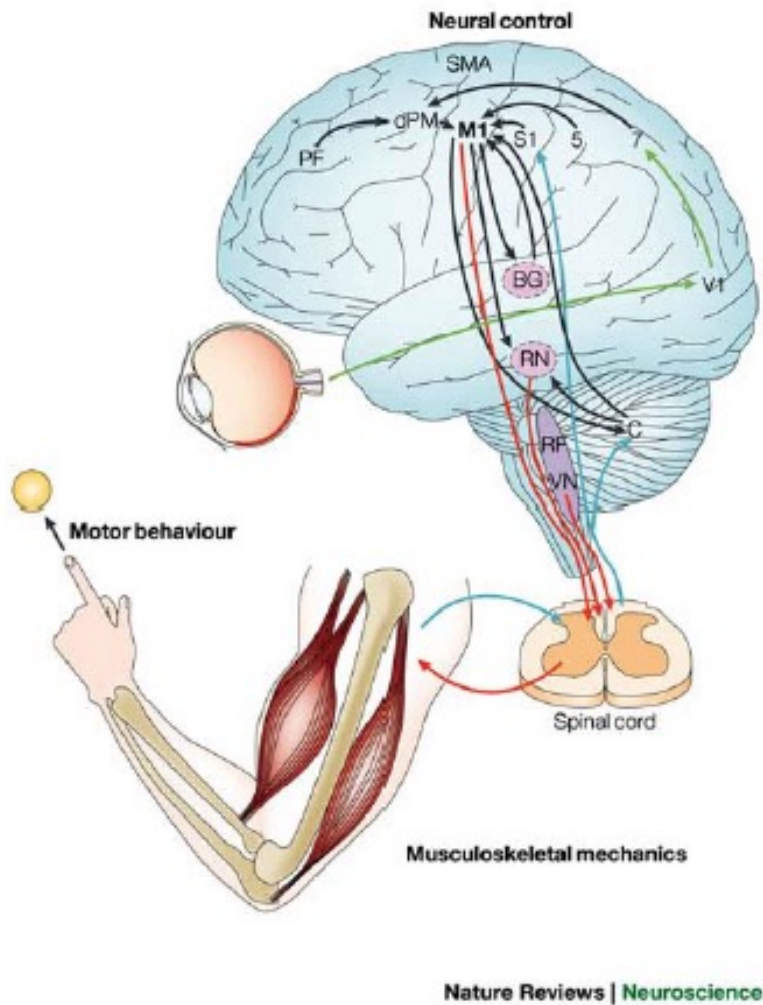


Nature Reviews | Neuroscience

Figure on right: Haggard 2001, 'Human volition'

- dPM: dorsal pre-motor cortex
- M1: primary motor cortex
- PF: prefrontal cortex
- SMA: supplementary motor area
- S1: primary somatosensory cortex
- V1: primary visual cortex
  
- BG: basal ganglia
- C: cerebellum
  
- RF: reticular formation
- RN: red nucleus
- VN: vestibular nucleus





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a

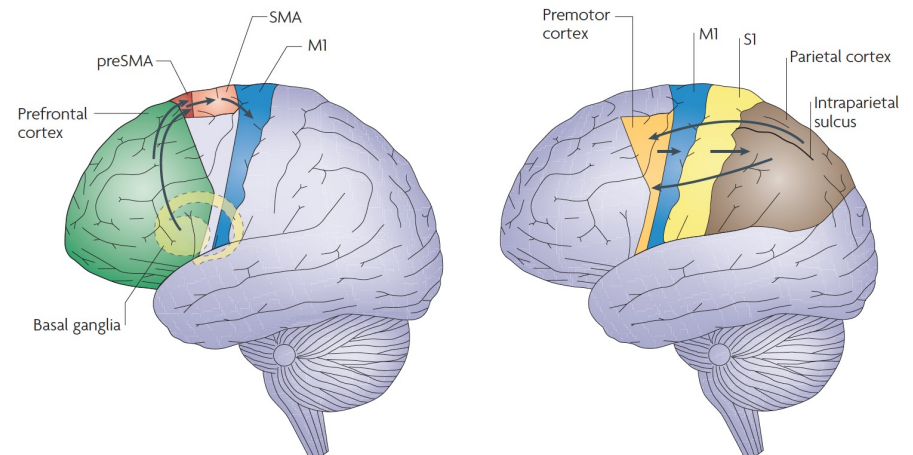
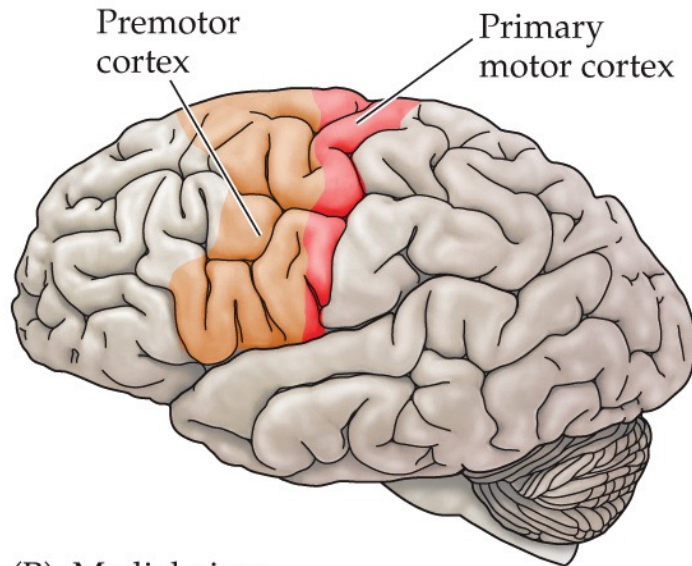
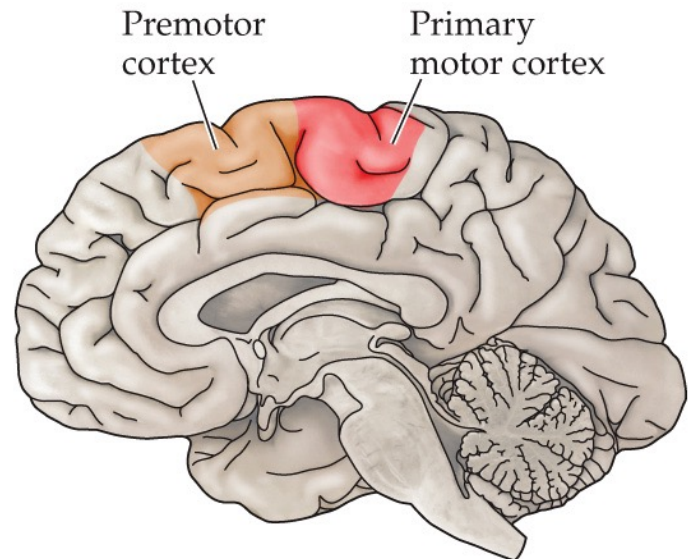


Figure on right: Haggard 200i,  
'Human volition'

(A) Lateral view

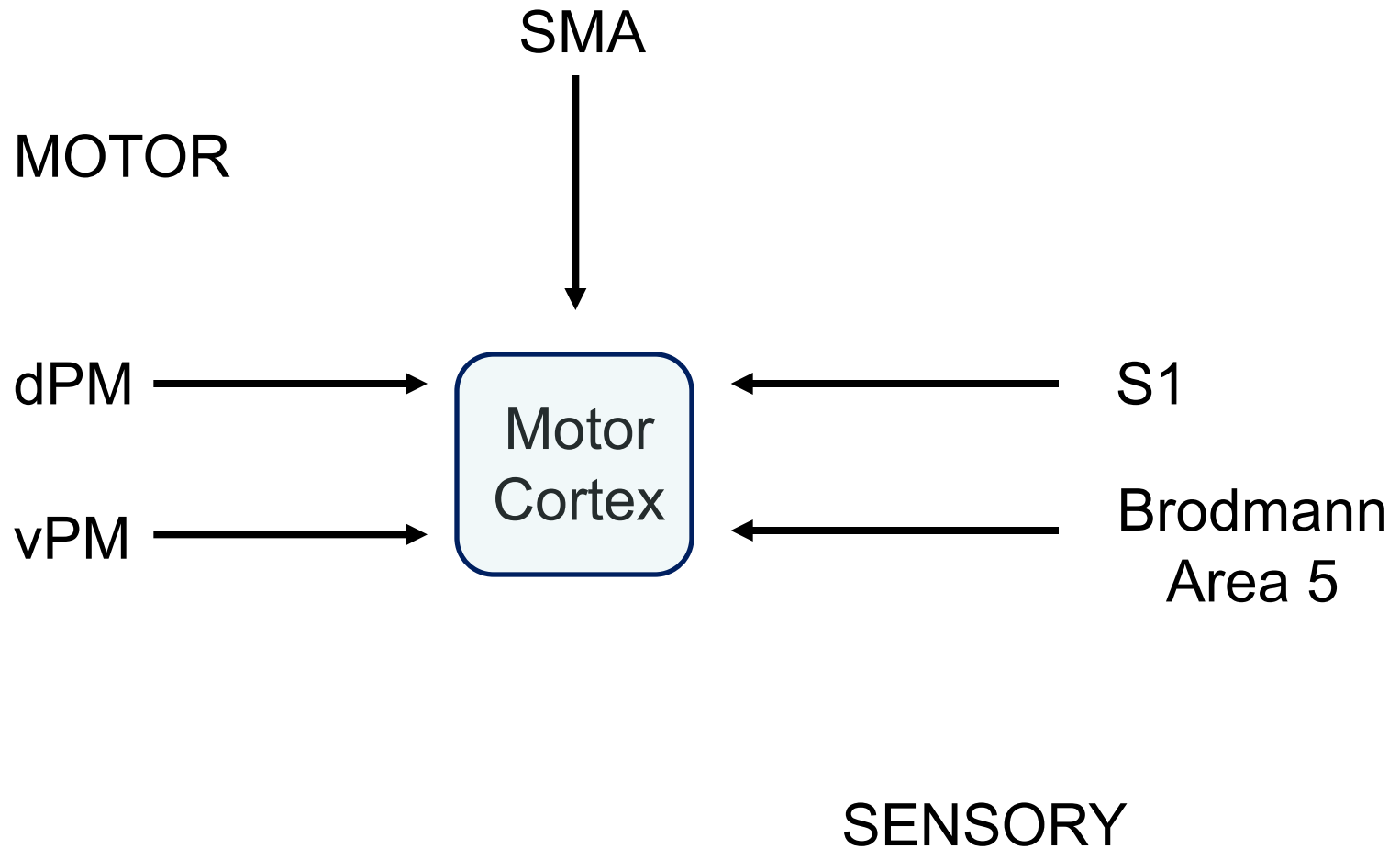


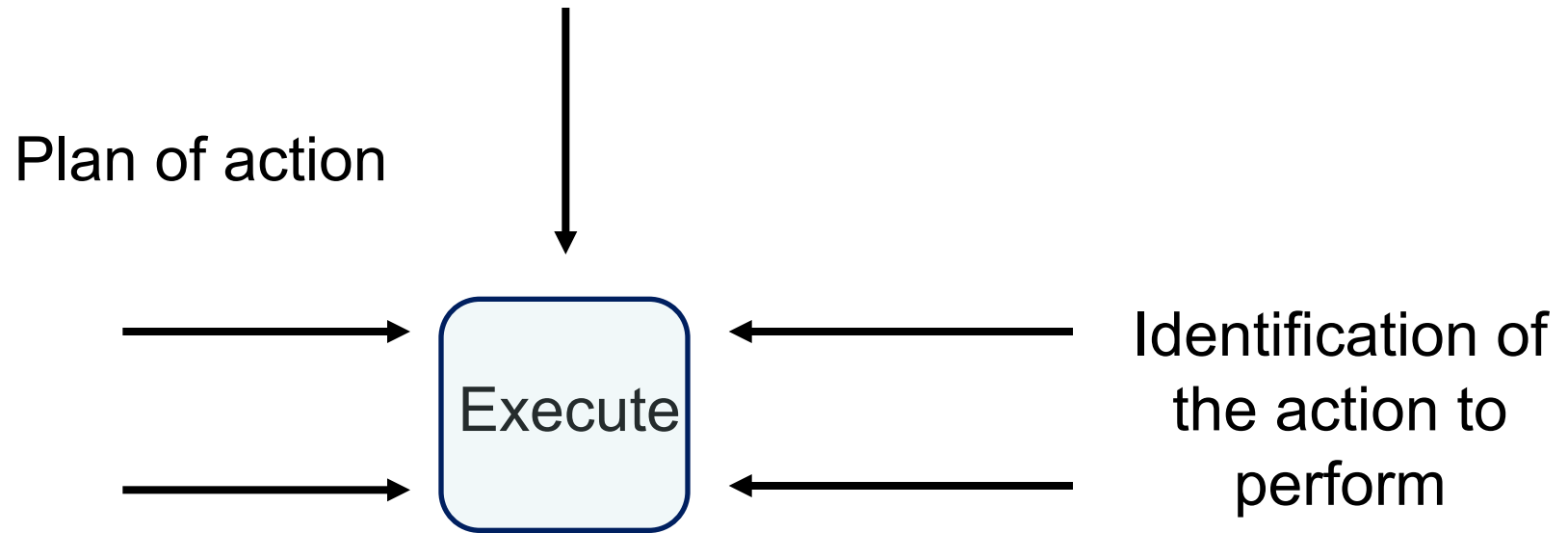
(B) Medial view

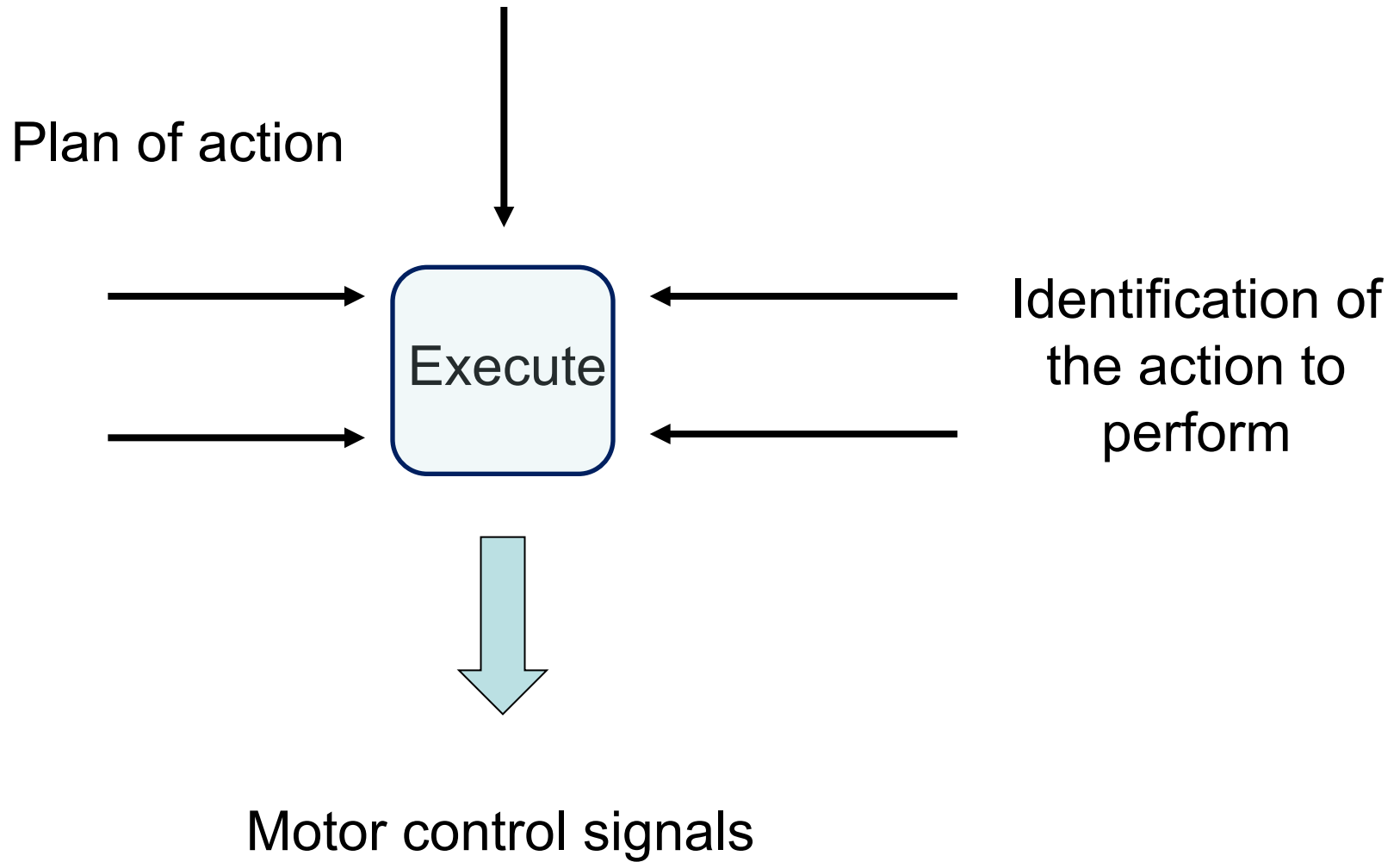


## CENTRAL MOTOR PROGRAM

- Identification of task to perform
- Plan of action - includes translation into the motor control program
- Execution of the plan

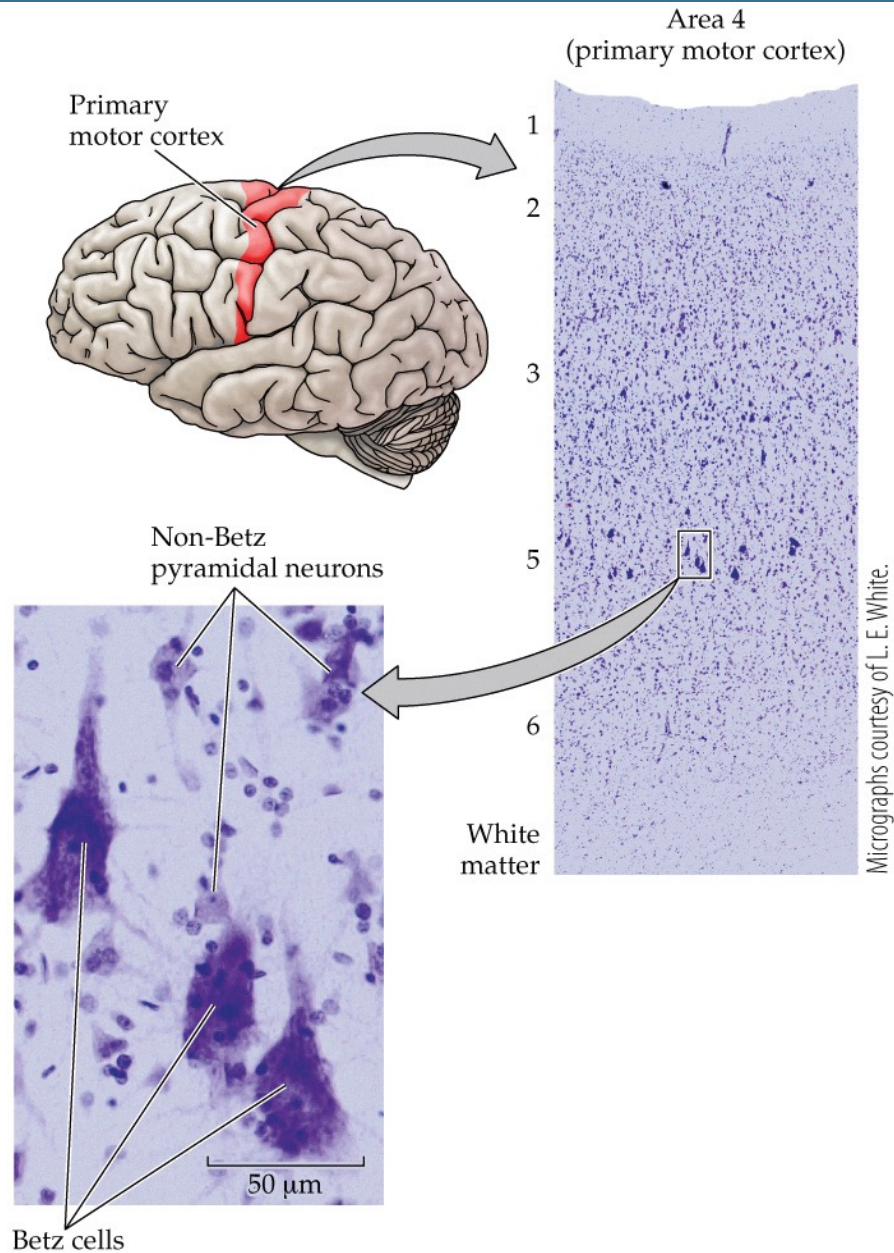






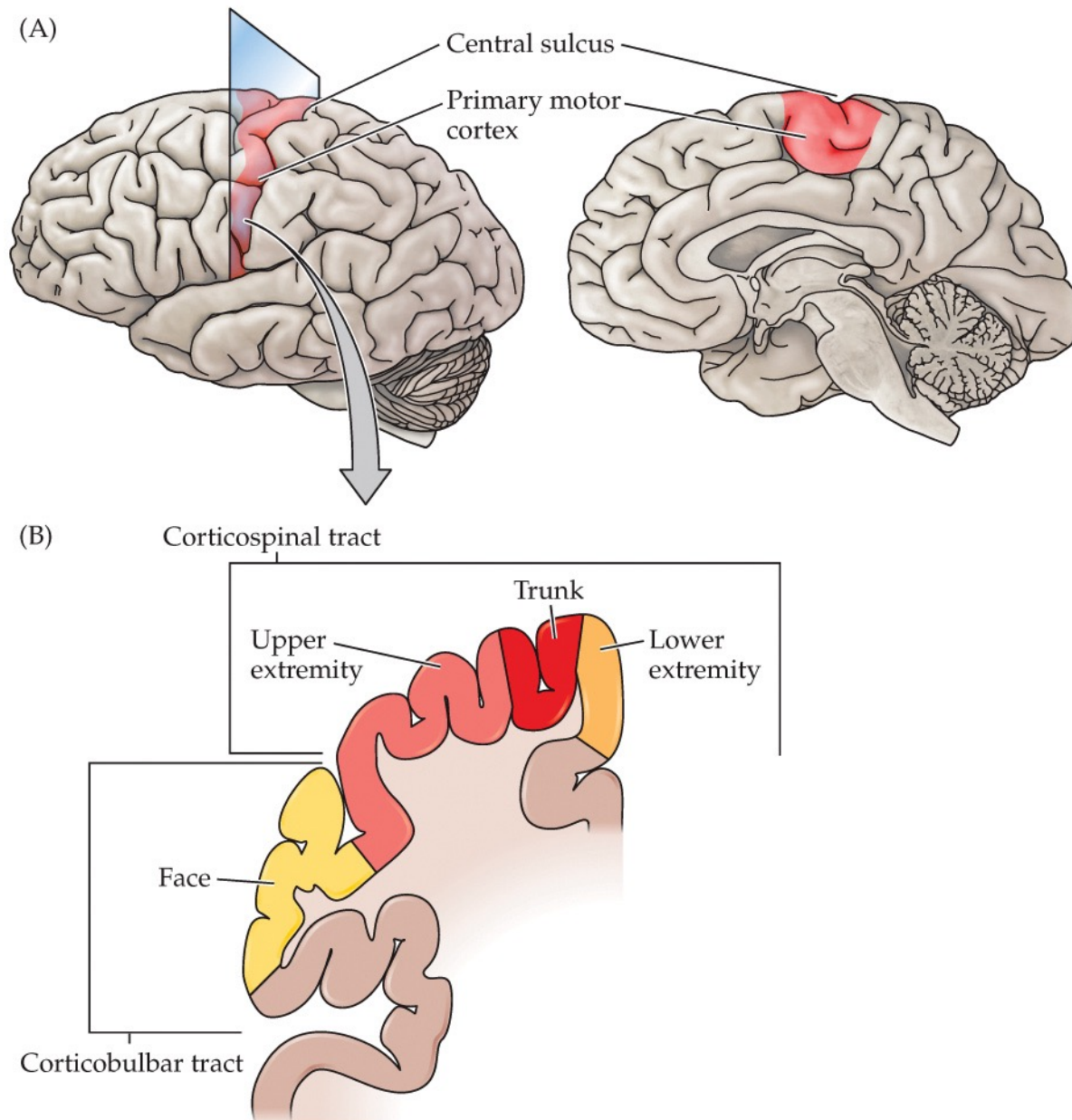


# Cytoarchitectonic appearance of the primary motor cortex in the human brain

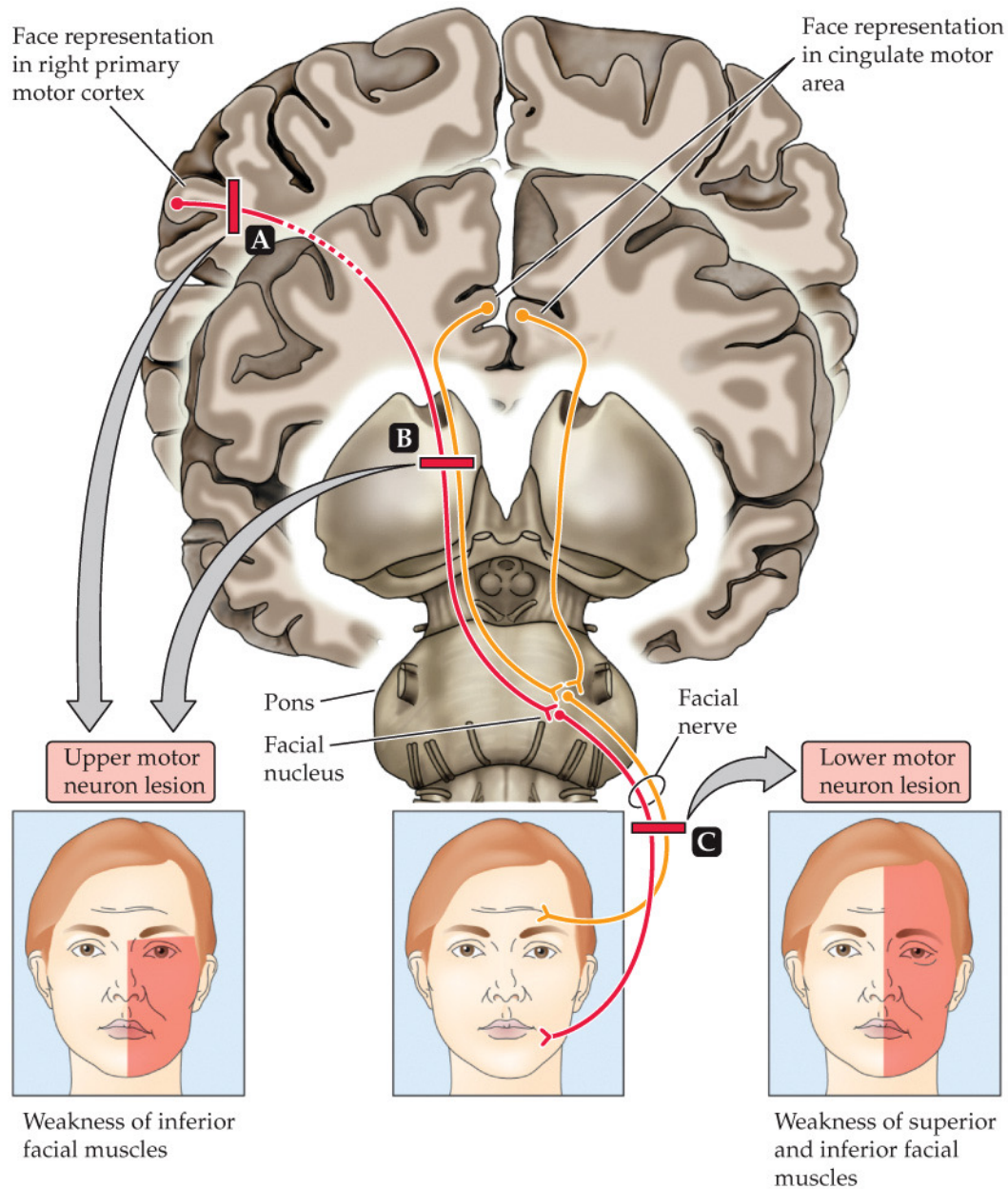




# Topographic map of movement in the primary motor cortex

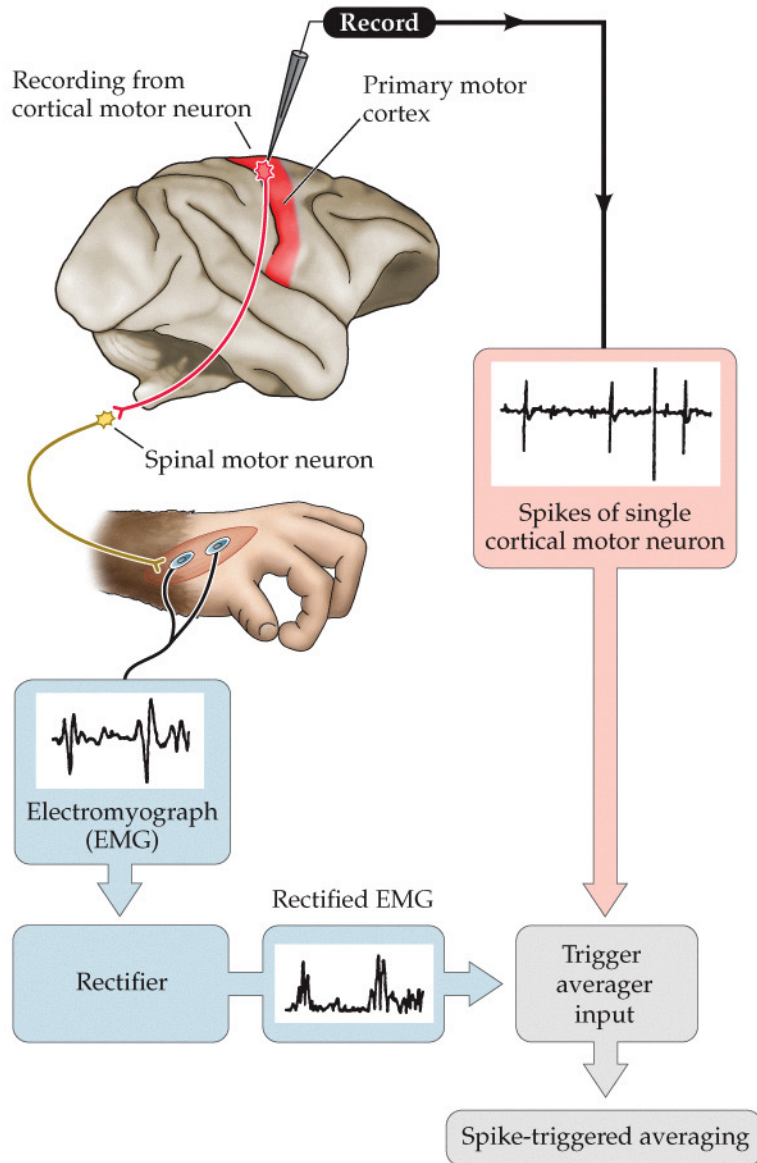


# Patterns of facial weakness and their importance for localizing neurological injury

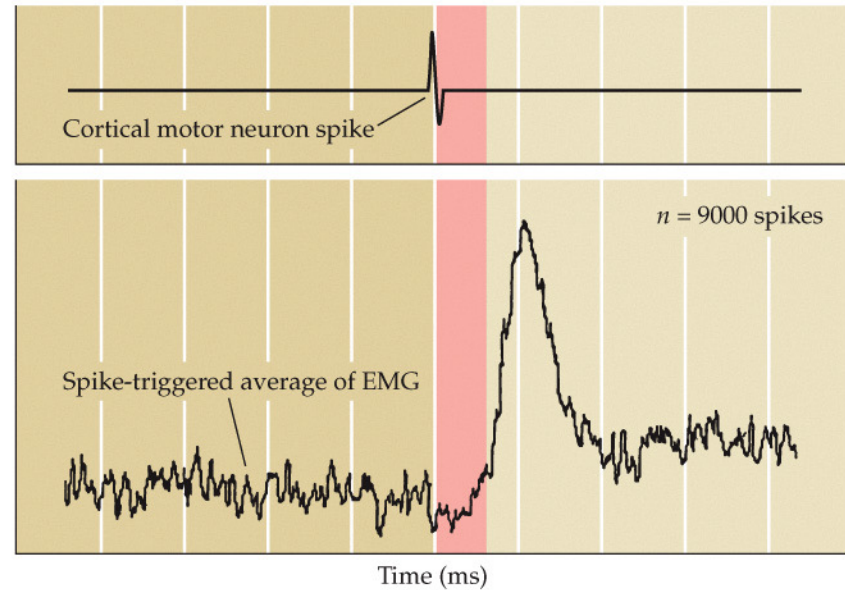


# The influence of single cortical upper motor neurons on muscle activity

(A) Detection of postspike facilitation



(B) Postspike facilitation by cortical motor neuron



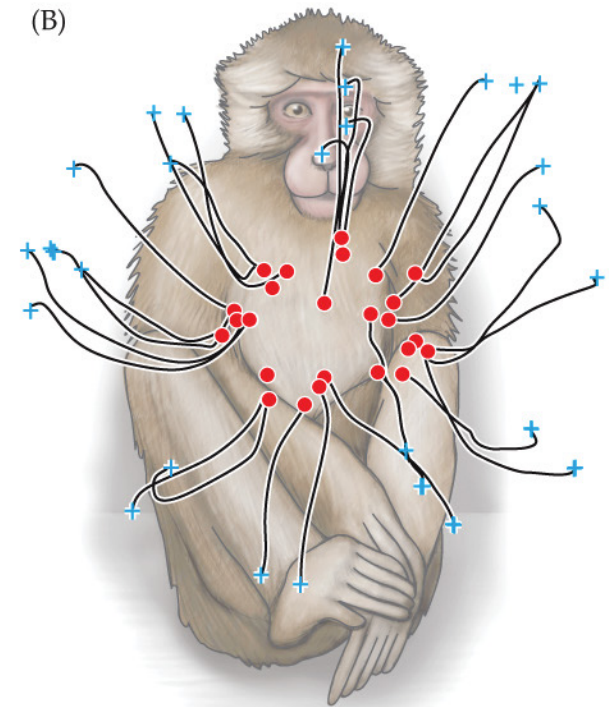
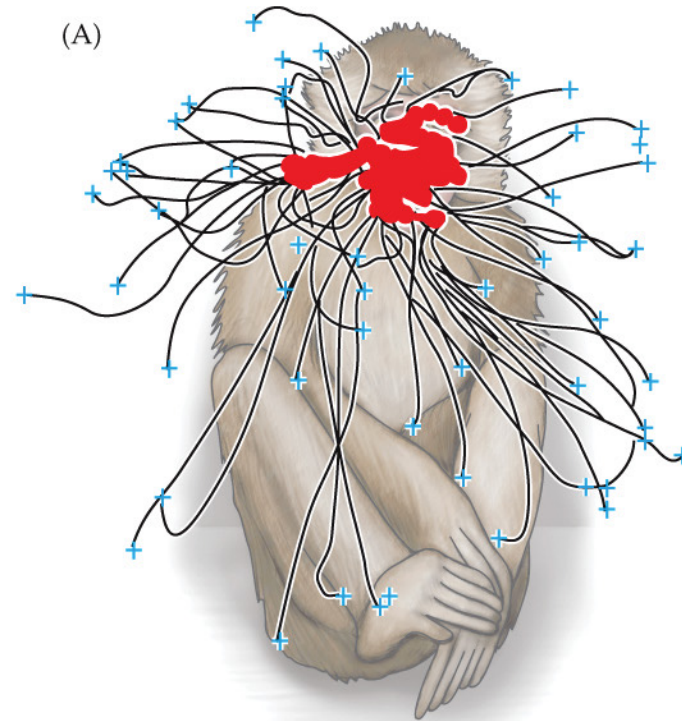
After Porter and Lemon (1993) Oxford: Oxford University Press.

**NEUROSCIENCE 6e, Figure 17.6**

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# Purposeful movements of the contralateral arm and hand in a macaque monkey

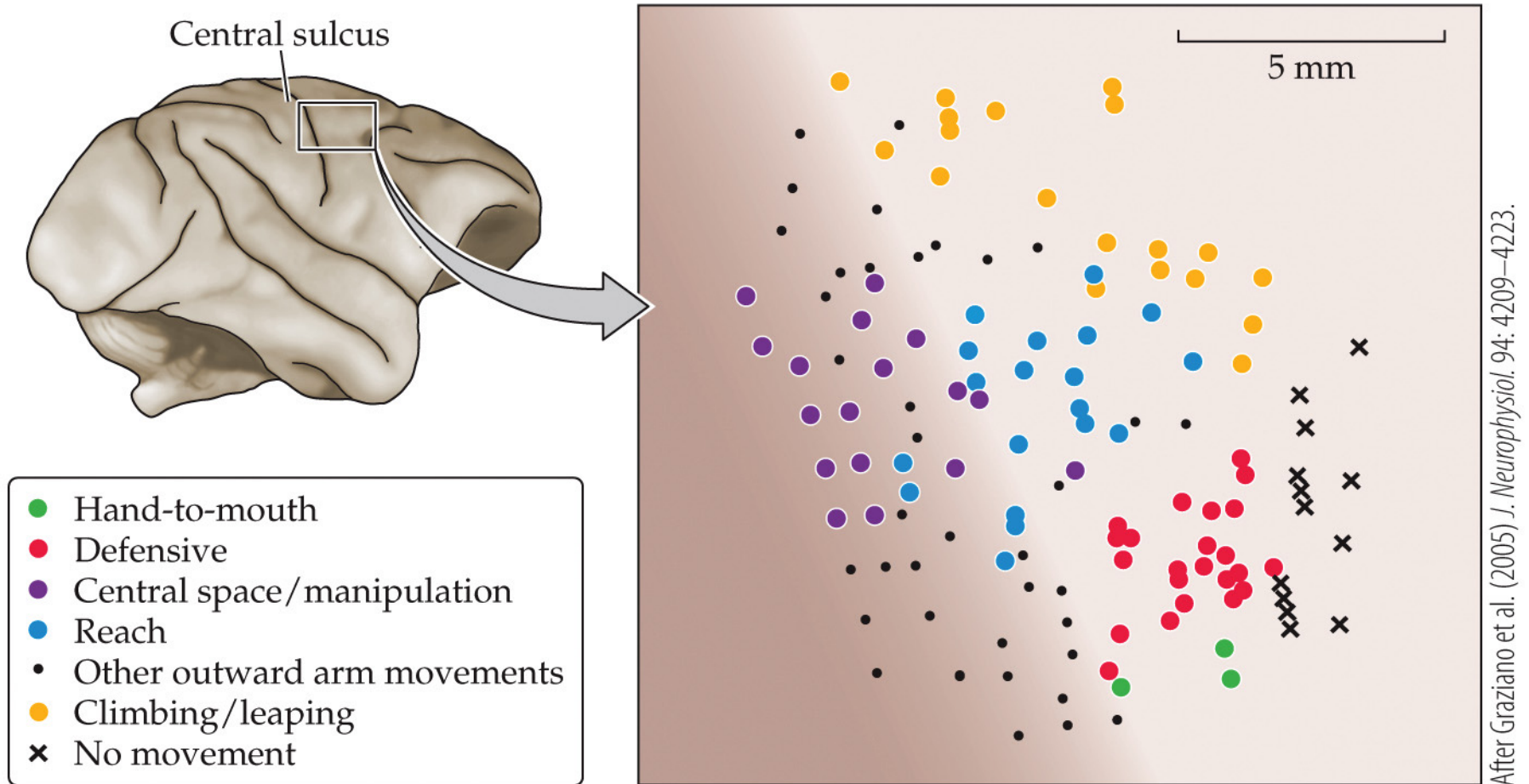


After Graziano et al. (2005) *J. Neurophysiol.* 94: 4209–4223.

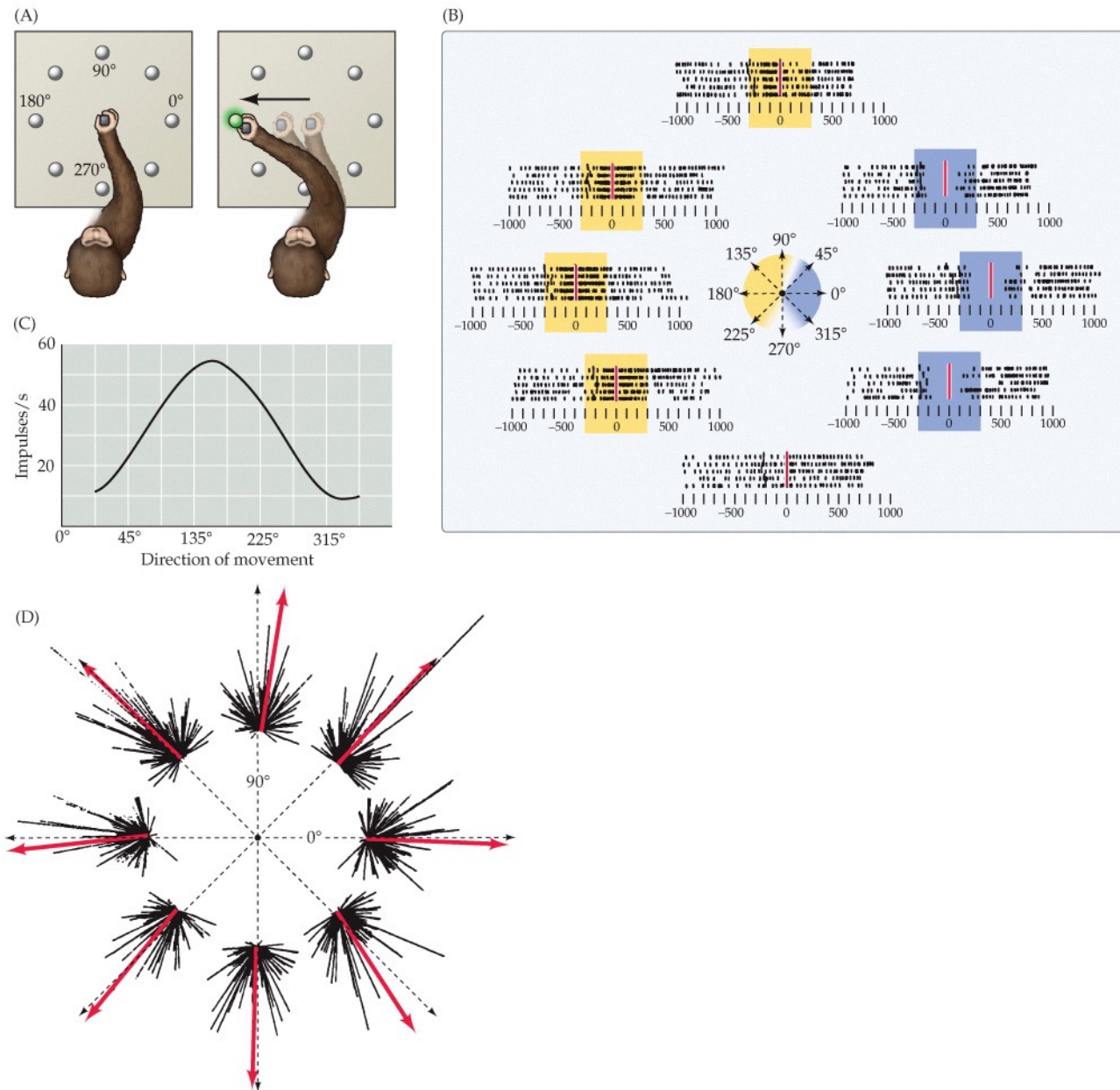
**NEUROSCIENCE 6e, Figure 17.7**

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# What do motor maps represent?



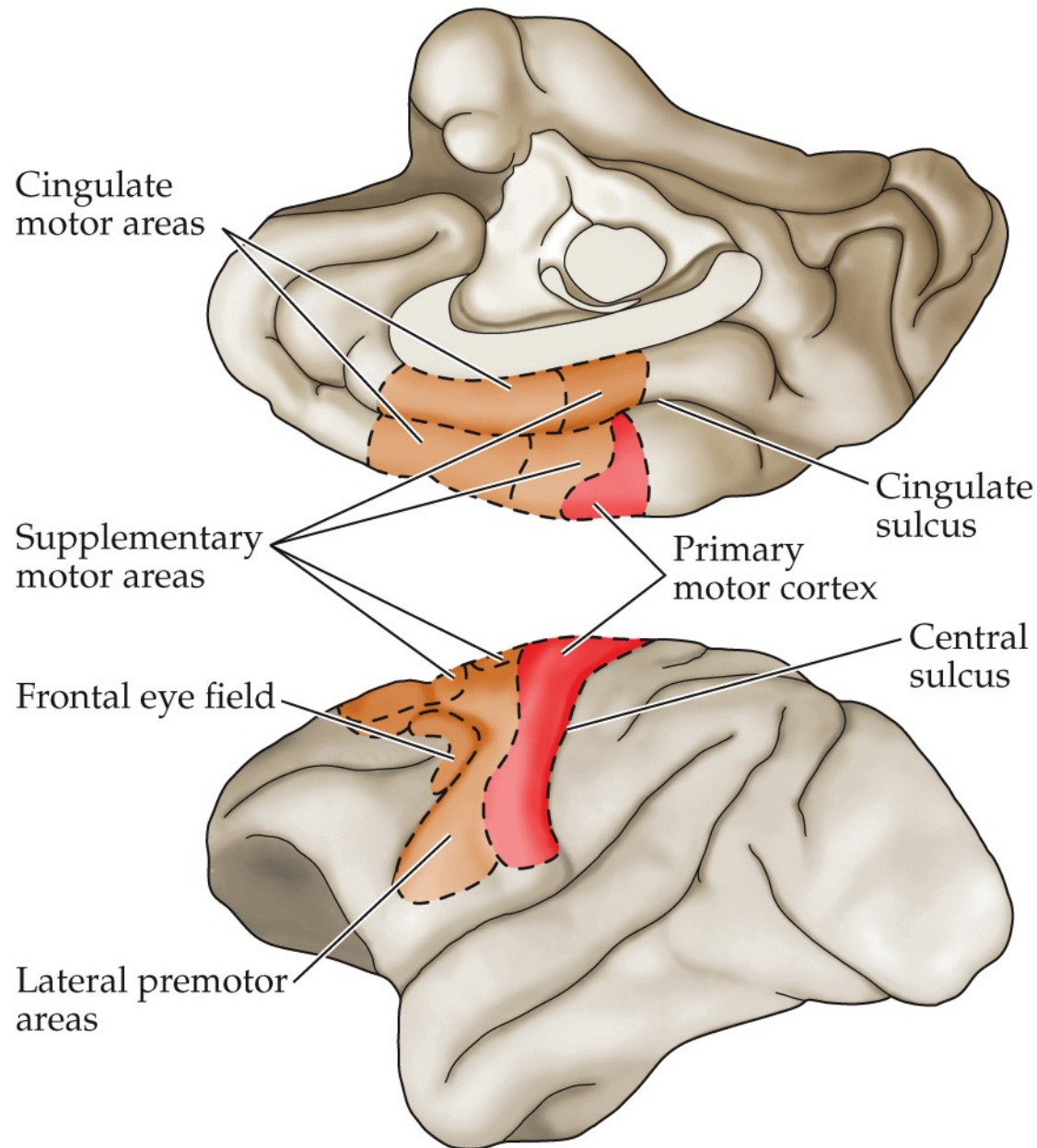
# Directional tuning of an upper motor neuron in the primary motor cortex



A–D after Georgopoulos et al. (1986) *Science* 233: 1416–1419.



# Divisions of the motor cortex in the macaque monkey brain

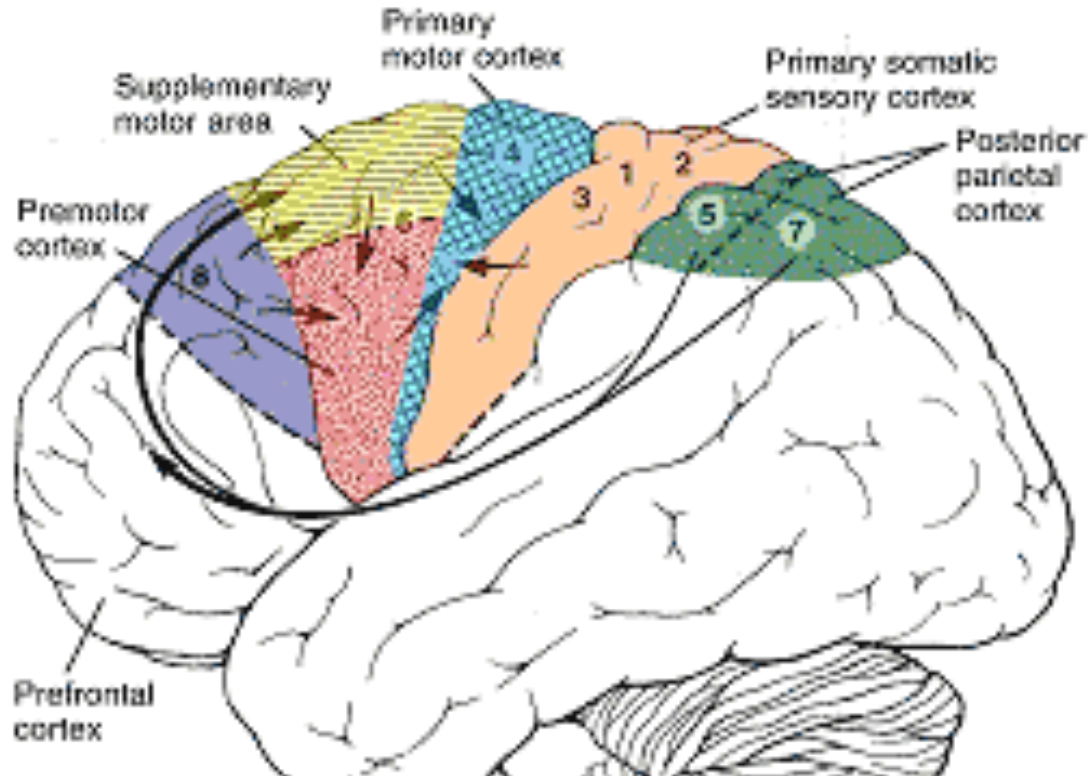


After Geyer et al. (2000) *Anat. Embryol.* 202: 443–474.

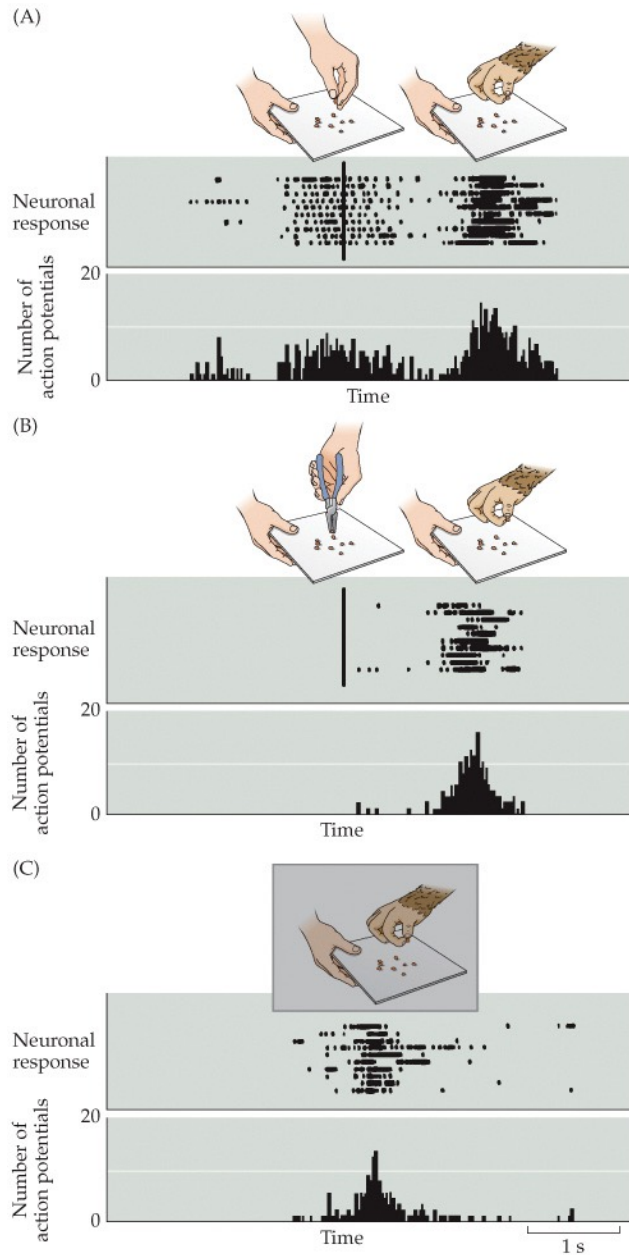


Multisensory information from the inferior and superior parietal lobules

Motivation and intention information from the rostral divisions of the frontal lobe

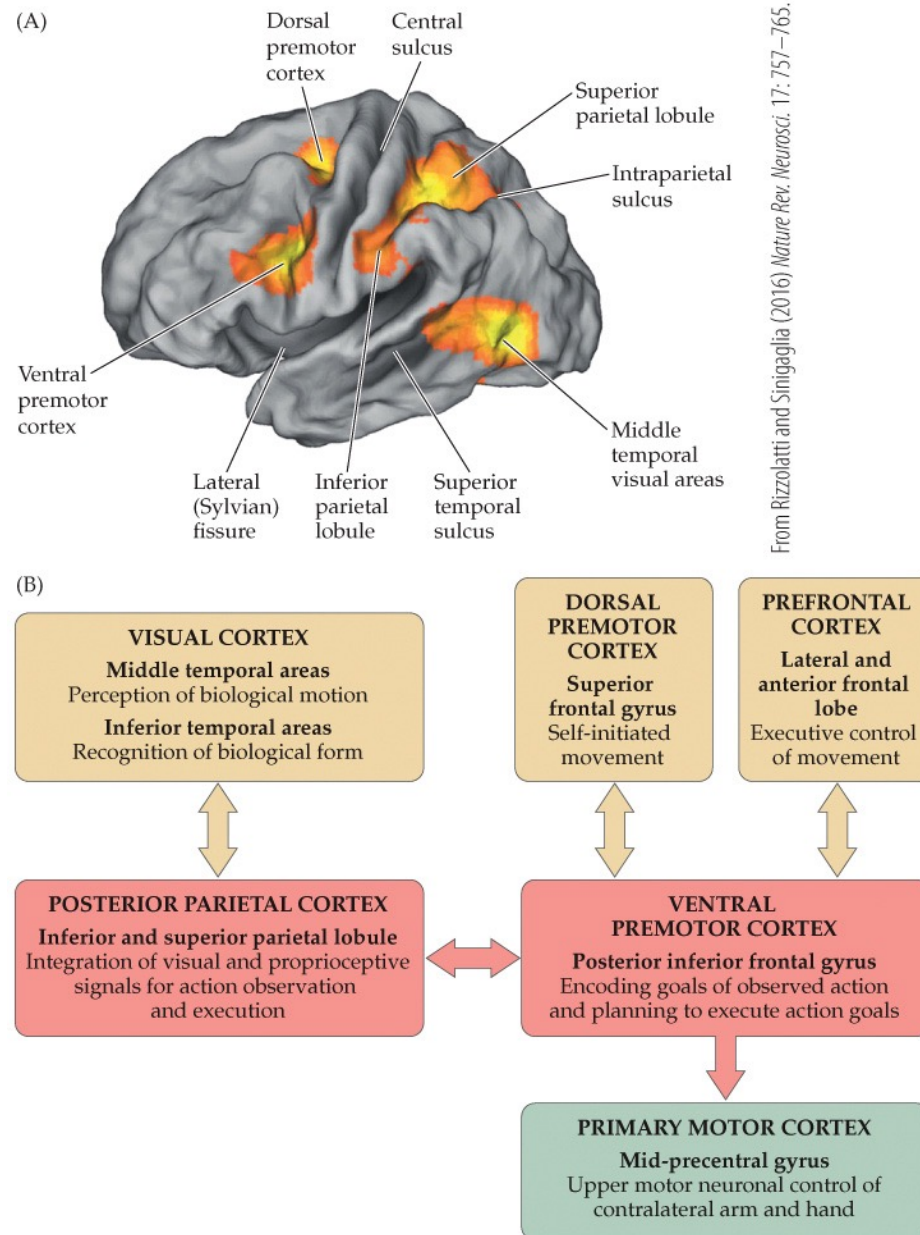


# Mirror motor neuron activity in a ventral-anterior sector of the lateral premotor cortex



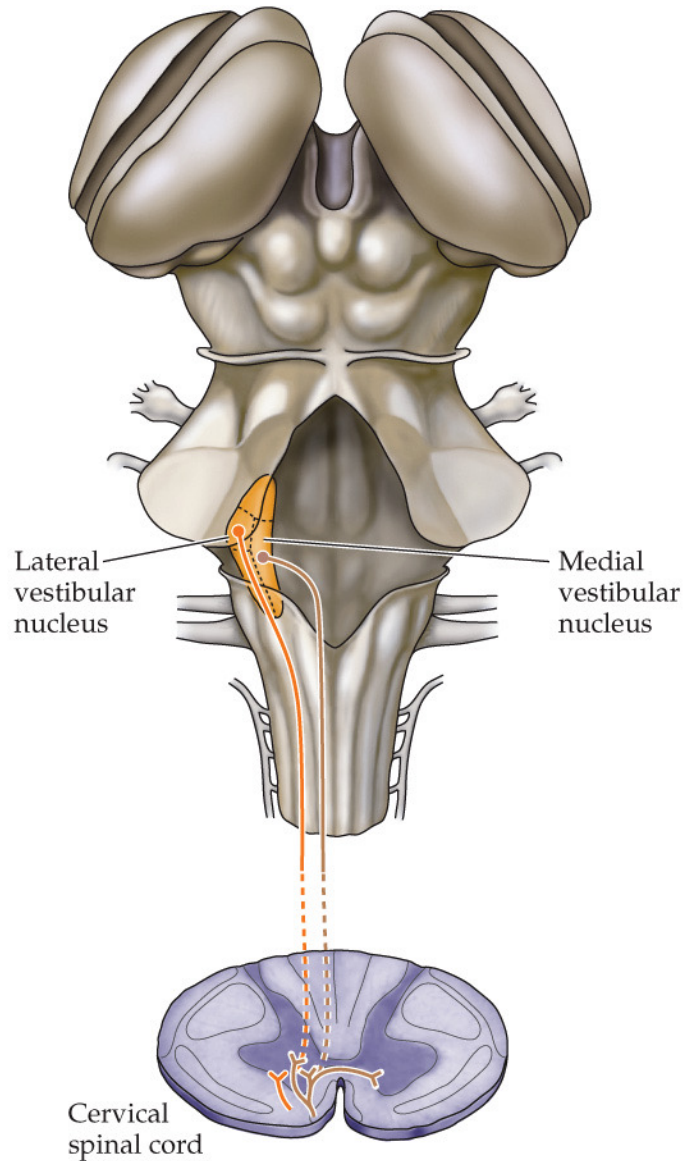
After Rizzolatti et al. (1996) *Cogn. Brain Res.* 3: 131–141.

# Descending projections from the brainstem to the spinal cord

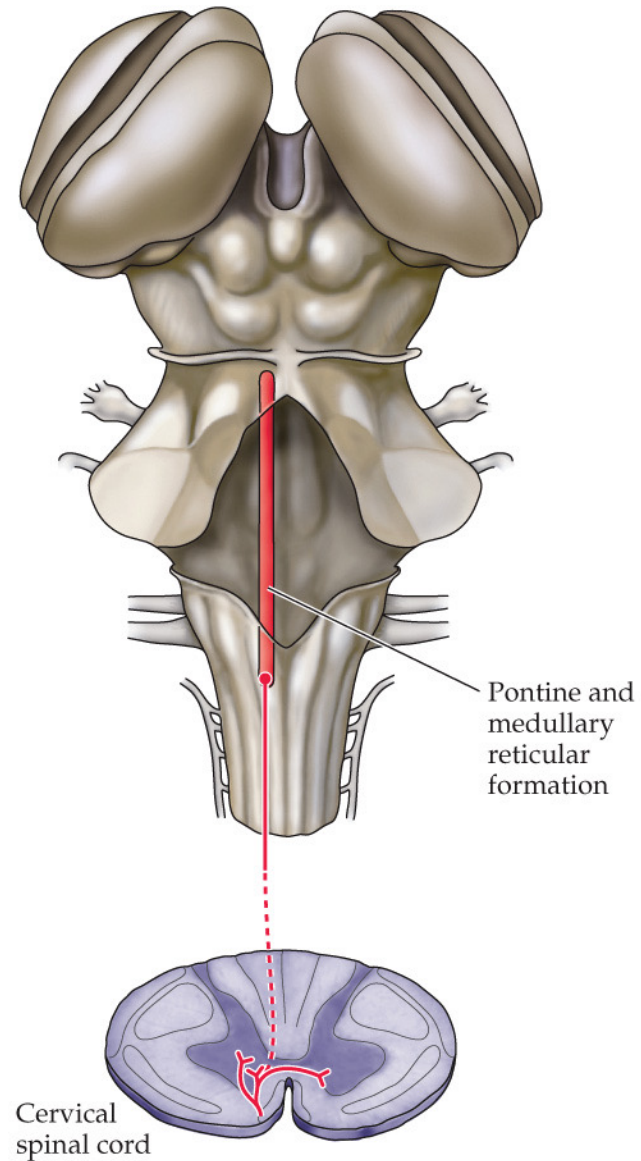


# Descending projections from the brainstem to the spinal cord

(A) Lateral and medial vestibulospinal tracts

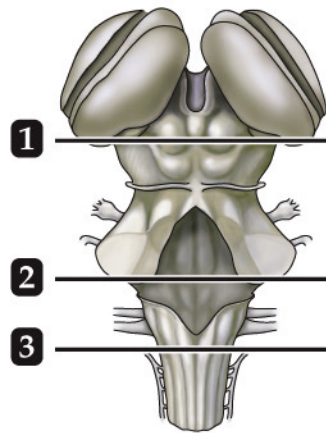


(B) Reticulospinal tract

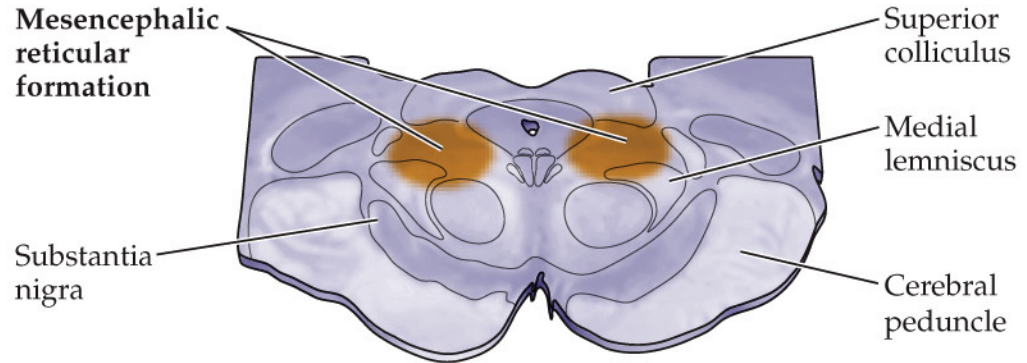




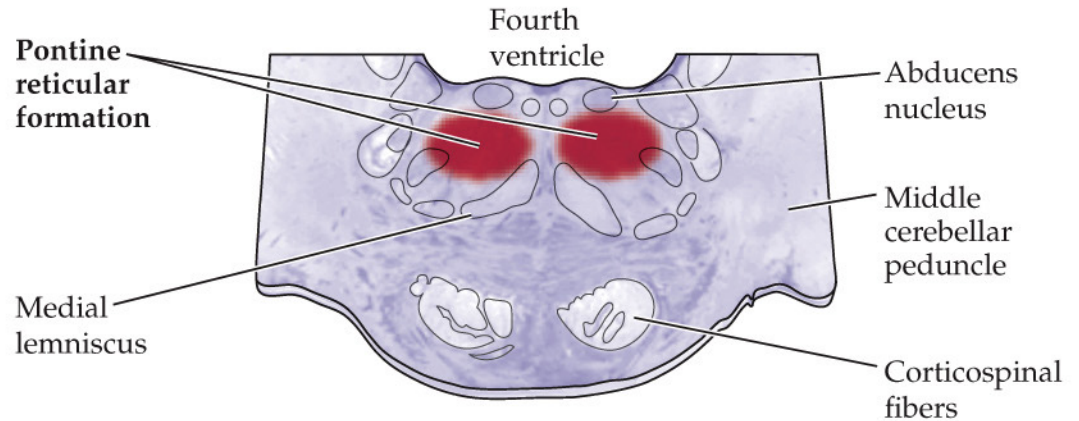
# Location of the reticular formation



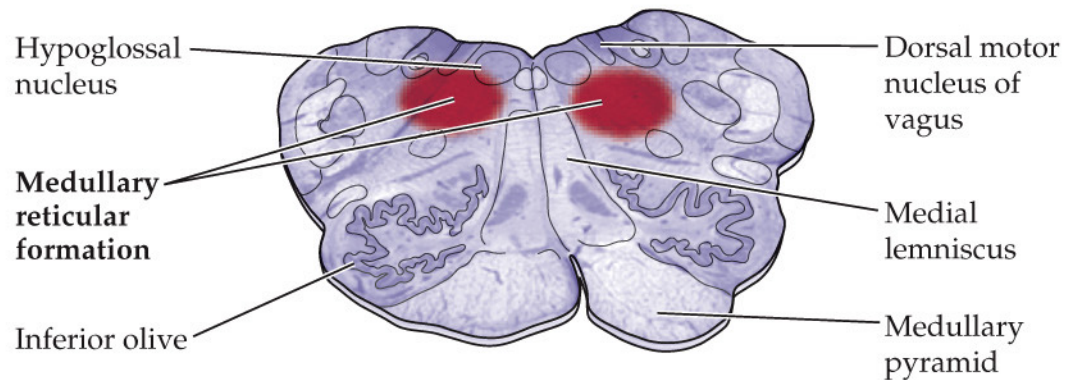
## 1 Midbrain



## 2 Lower pons

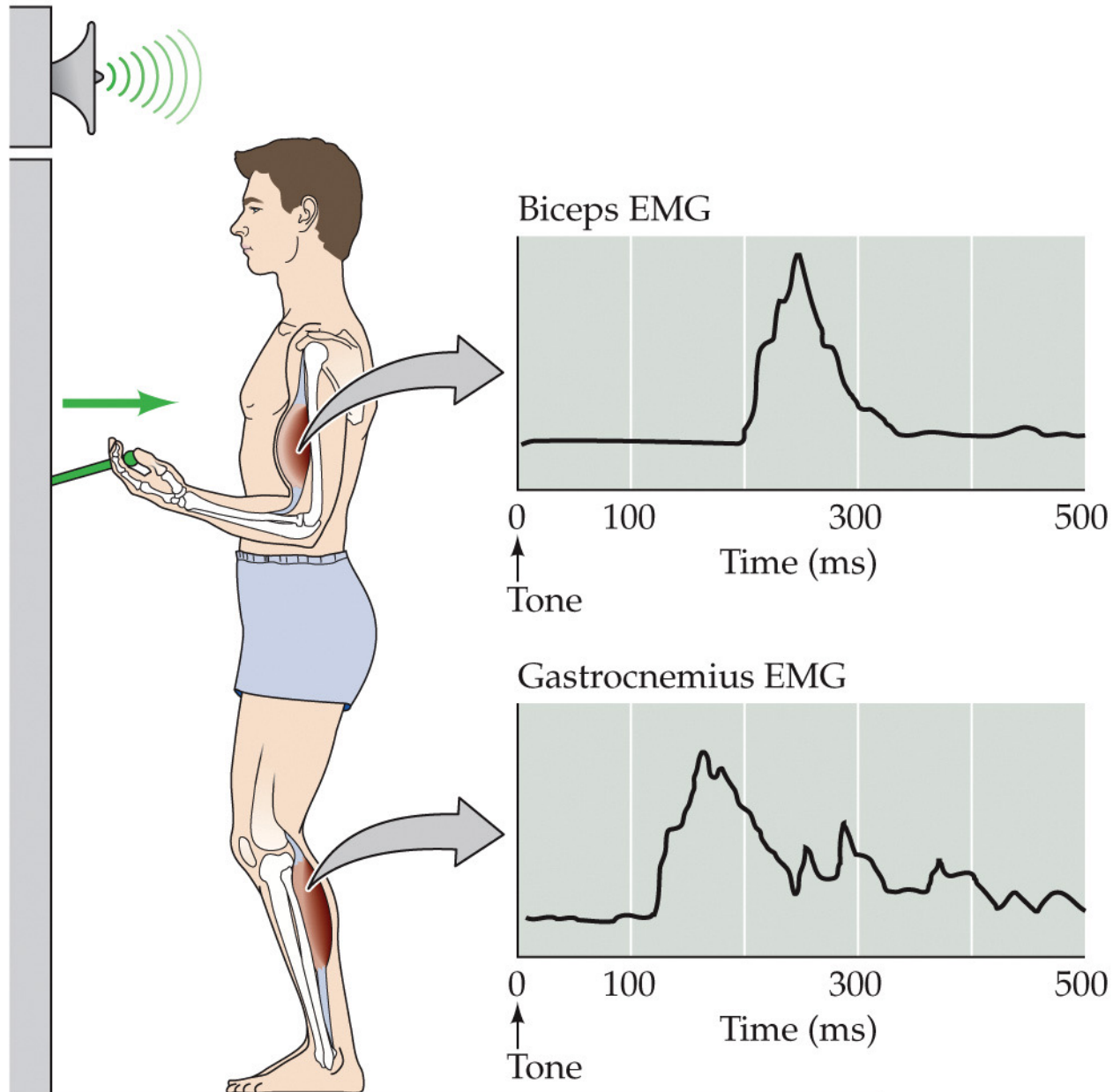


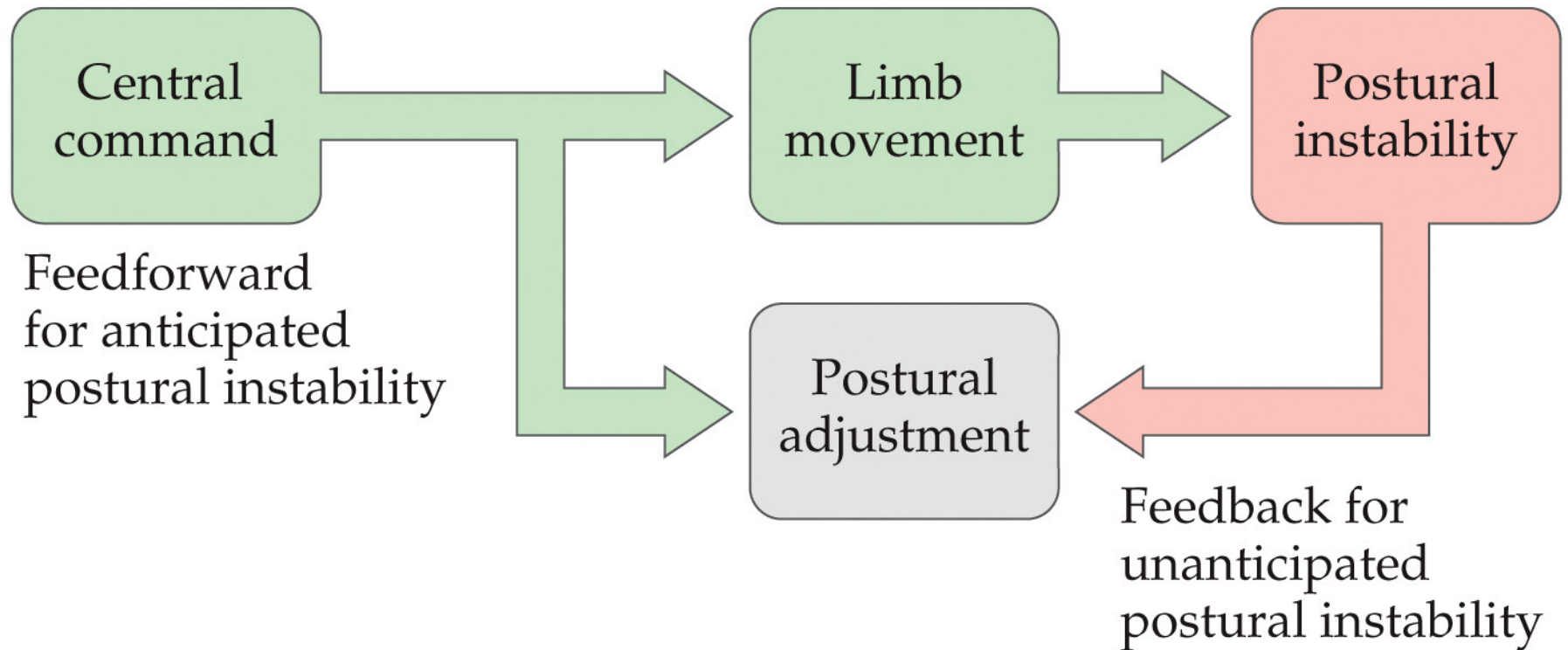
## 3 Middle medulla



# Anticipatory maintenance of body posture

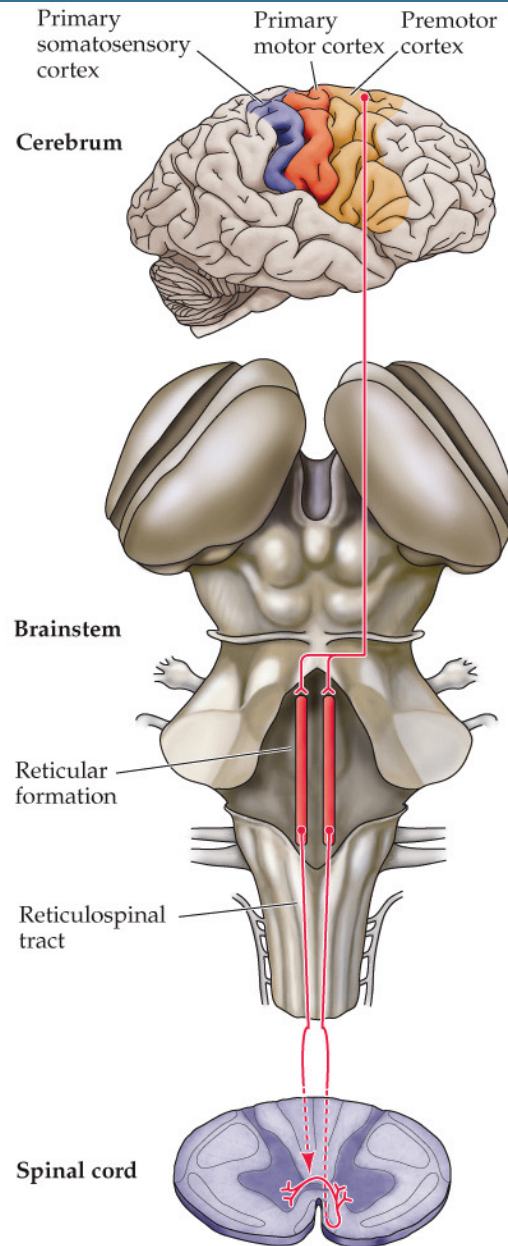
After Nashner (1979) *Brain Research*: 177–184.



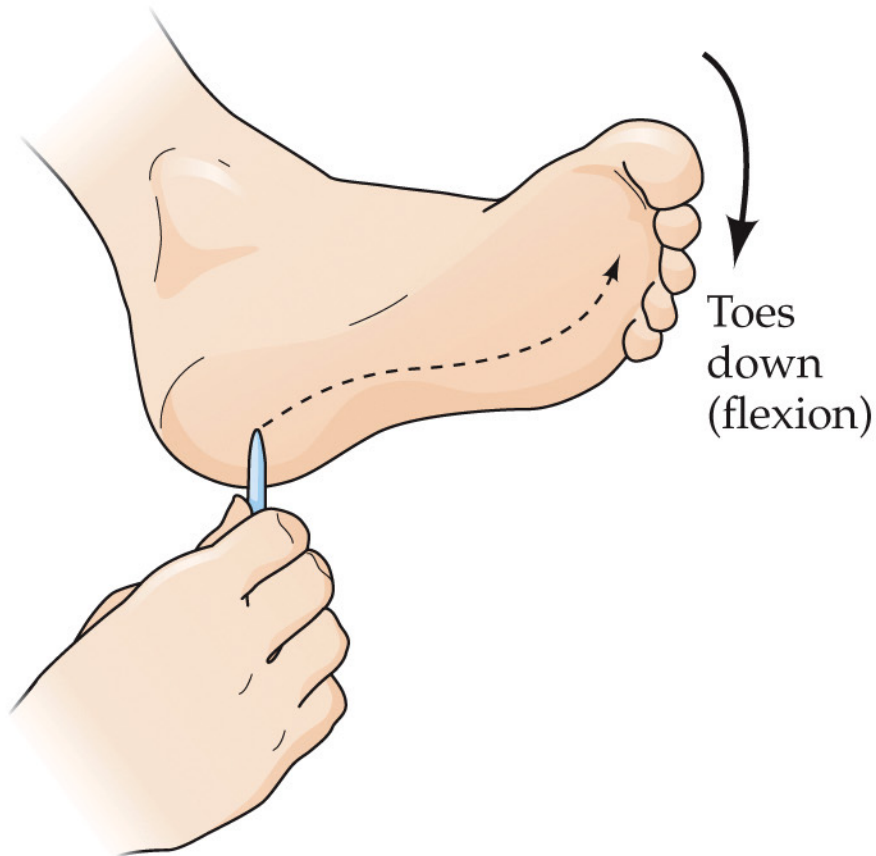




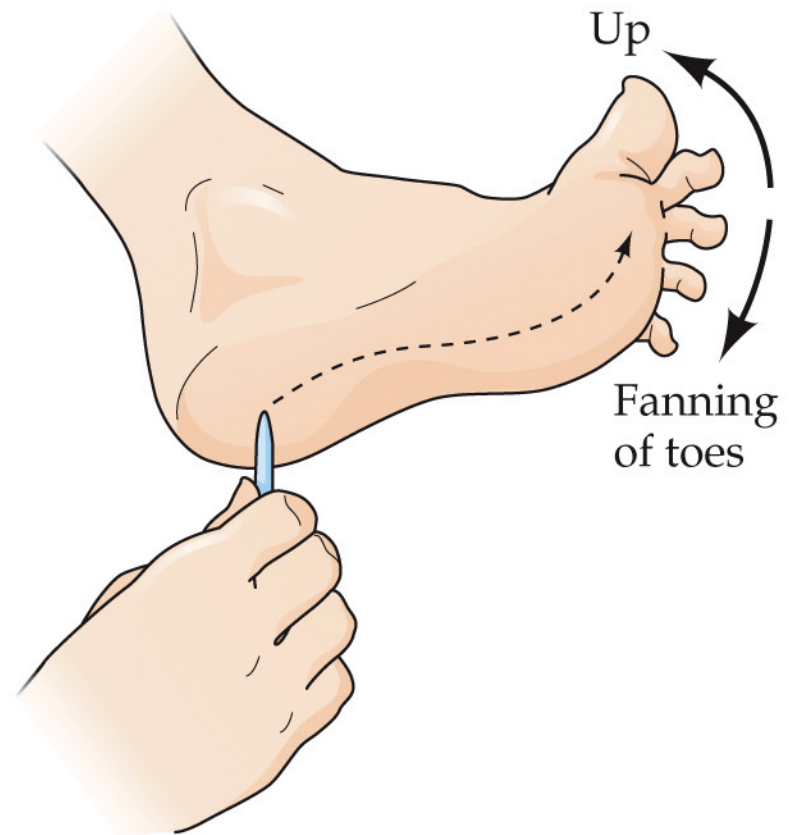
# Indirect pathways from the motor cortex to the spinal cord



(A) Normal plantar response



(B) Extensor plantar response (Babinski sign)



**TABLE 17.1 ■ Signs and Symptoms of Lower and Upper Motor Neuron Lesions**

	<b>Lower motor neuron syndrome</b>	<b>Upper motor neuron syndrome</b>
<b>Strength</b>	Weakness or paralysis	Weakness
<b>Muscle bulk</b>	Severe atrophy develops	Mild or no atrophy develops
<b>Reflexes</b>	Hypoactive superficial and deep reflexes	Hyperactive deep reflexes after initial period of spinal shock
<b>Special signs and symptoms</b>	Initial signs and symptoms persist	Initial period of spinal shock, then spasticity ensues
	Fasciculations and fibrillations	Babinski's sign and clonus
	Geographic distribution of impairment (reflecting distribution of affected spinal segments, cranial nuclei, or spinal/cranial nerves)	More widespread (nongeographic) distribution of impairment in body regions
	Impairments of reflexive and gross and/or fine voluntary movements	Impairment of fine voluntary movements; gross movements relatively unimpaired