Medical Neuroscience | Tutorial Notes

Upper Motor Neuronal Control—Premotor Cortex

Map to Neuroscience Core Concepts[1]

NCC1. The brain is the body's most complex organ.

NCC3. Genetically determined circuits are the foundation of the nervous system.

NCC4. Life experiences change the nervous system.

Learning Objectives

After study of the assigned learning materials, the student will:

1. Discuss the neural centers that give rise to lateral and medial descending projections to lower motor neurons.
2. Discuss the organization of the motor cortex and its contributions to the control of volitional movement.

Tutorial Outline

I. Motor Control Centers in the Cerebral Cortex: lateral projections for volitional motor control

"Motor cortex" refers to the mosaic of cortical areas in the posterior frontal lobe that are mainly concerned with the planning and execution of volitional movements; these include the **primary motor cortex** and the **premotor cortex** (see **Figure 17.2**[2])

- A. each of these divisions of the motor cortex gives rise to descending projections to lower motor neuronal circuits in the brainstem and spinal cord
- B. collectively, the motor cortex receives input from the motor nuclei of the thalamus (**ventral anterior/ventral lateral complex**) and somatic sensory and visual input from somatic sensory and visual cortical areas ("where" pathway) in the parietal lobe
- C. premotor cortex
  - 1. changing premotor concepts
    - a. traditionally thought to function at a "higher plane" in a functional hierarchy of motor control by providing input to the primary motor cortex that, in turn, commands volitional movements … *this view is no longer accepted!*
    - b. comprises a mosaic of cortical areas that organize movement sequences required to interact with objects and persons (e.g., reaching, grasping,

[1] Visit **BrainFacts.org** for *Neuroscience Core Concepts* (©2012 Society for Neuroscience) that offer fundamental principles about the brain and nervous system, the most complex living structure known in the universe.

[2] Figure references to Purves et al., *Neuroscience, 5th Ed.*, Sinauer Assoc., Inc., 2012. [click here]

writing, gesturing, talking), as well as to express movements that convey meaning (e.g., music performance, dance, emotive posturing)

c. mainly concerned with planning and expressing skilled movements in "extrapersonal" space (see **Box 17B**)

2. includes areas just anterior to the precentral gyrus on the dorsal-lateral convexity and the paracentral lobule in the medial aspect of the hemisphere, and a set of areas in the depths of cingulate suclus (see **Figures 17.2 and 17.9**)

3. contributes axons to descending corticospinal (pyramidal) tract, but also projects to brainstem reticular formation

4. for simplicity, consider medial and lateral divisions of premotor cortex:

   a. medial premotor areas

      (i) includes "cingulate motor areas" that contribute to the expression of emotional behavior (see below)

      (ii) some areas play a role in organizing complex movements, especially movements that require bilateral hand coordination

      (iii) other areas are involved in the organization of self-initiated movements that are not triggered by sensory cues (e.g., front eye fields, which shift gaze toward a desired visual target; see **Figures 20.11** & **20.12**)

   b. lateral premotor areas

      (i) includes areas that play a role in organizing movements that are guided by sensory information (conditioned motor responses)

      (iii) another (Broca's area in the left inferior frontal gyrus) is specialized for the production of speech

      (iv) others are involved in imitation learning (see **Figure 17.10**)

      - inferior-anterior areas contain **mirror neurons** that fire when the hand reaches and grasps an object *and* when the same action is performed by another is observed

      - such neurons may encode the *intentions* of others

STUDY QUESTION

Consider what you would do should you be driving a motor vehicle and you approach a typical, international 3-color traffic light, and the light changes from **green** to **yellow**. I trust that the well-practiced motor response in this circumstance is a gentle application of the brake (not the accelerator!) so that you come to a stop in advance of the anticipated change in color from yellow to red. With this scenario in mind, here's the question: which division of the premotor cortex was chiefly engaged with planning to execute the appropriate motor response given the color change in the traffic light?

A. the medial division of the premotor cortex

B. the lateral division of the premotor cortex