Lecture 22 -- Introduction to Motor Systems -- Martin

Lecture plan

1) Basic principles of movement control
2) Sensory control of movement
3) Components of the motor systems
4) Descending motor pathways

Hierarchical organization of movements

Reflexes

monosynaptic (knee jerk) and polysynaptic (withdrawal) reflexes
spinal cord

Postural adjustments

feed forward and feedback control
vestibular control of balance
more flexible than simple reflexes, yet more constrained than voluntary movements
brain stem, cerebellum and spinal cord

Voluntary control-prehension

motor equivalence
very context-specific
greater flexibility than afforded by simple sensory representations, whether simple like the stretch reflex or complex, as for balance

Conclusions:

1. hierarchical organization of neural circuits underlying motor behavior
2. hierarchical organization of sensory-motor control, from stereotypy to flexibility
3. movement depends on internal representations of the sensory world as well as internal properties (e.g., muscle characteristics; mechanical properties of limbs)

An example of translating sensation into action: Visuo-Motor Control of Prehension

Prehension=reach and grasp

grasp=preshape hand during reach

Complex planning and execution stages

Motor program specifies:

•movement kinematics (the spatial characteristics of the movement; the angle through which the joints will move)

•movement dynamics (the forces that are required to move the joints)

"Circuit"

•Vision: **where** pathway to posterior parietal lobe
•Somatic sensory information (proprioception) integrated here
•Information transmitted to premotor areas, then to primary motor cortex
parallel paths for aiming the reach and preshaping the grasp

CONCLUSION:

•motor systems have selective access to sensory information
•hierarchical and parallel processing

Components of the motor systems

Bottom up view
- •Muscle, motor neurons and spinal premotor interneurons
- •Descending motor pathways from cortical motor areas and brain stem nuclei
  Hierarchical and parallel organization
- •Cerebellum and basal ganglia influence function of paths, via thalamus

Conclusion: parallel and hierarchically organized pathways

Descending motor pathways

Origins and spinal terminations
- Motor cortex→motor neuron
- Motor cortex→interneuron→motor neuron
- Motor cortex→brain stem nucleus→interneuron→motor neuron
- ETC

Proximal-distal rule of spinal organization

Medio-lateral organization
- •medial pathways for posture control
- •lateral pathways for goal-directed limb control

Brain stem tracts

Medial
- •Tectospinal (from superior colliculus)
- •Reticulospinal (from reticular formation)
- •Vestibulospinal (from vestibular nuclei)

Lateral
- •Rubrospinal (from magnocellular division of red nucleus)

Cortical tracts

Primary motor cortex; premotor cortical areas
- •Lateral corticospinal tract
- •Ventral corticospinal tract

Relevant reading: ch. 33 in "Principles"