Cerebellum

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Cerebellar Signs

PNS Fig. 42-16

Research Points to Several Key Cerebellar Functions

- Comparison of intent and action (ie., errors) and generates corrective signals
- Motor learning and adaptation
- Plays a role in automating and optimizing behavior
- Motor cognition and general cognition & emotions (new evidence; controversial)

Goal: Cerebellar function

- Overview of motor system hierarchy
- Cerebellar anatomy
- Principal pathways out of the cerebellum—How the cerebellum impacts the motor pathways
- Experimental approaches to reveal:
  - Motor learning
  - Mental processes underlying movement control
  - Role in cognition and emotions

Motor Hierarchy

Cerebellar Functional Anatomy
Cerebellar Cortex

Deep Cerebellar Nuclei:
- Dentate
- Interposed
- Fastigial

Input-output Organization

Extrinsic inputs:
- mossy fiber
- climbing fiber

Cerebellar divisions

Spinocerebellum
- Vermis + Intermediate Hem.
- Control of limbs and trunk
- Cereblocerebellum
- (Lateral hemisphere)
- Planning of movement
- Vestibulo-cerebellum
- (Floculo-nodular lobe)
- Control of eye & head movements
- Balance

Cerebellar Cortex

Inputs
- Climbing fibers
  - from Inferior olive
- Mossy fibers
Output
- Purkinje neurons
Interneurons
- Granule neurons
- Stellate neurons
- Basket neurons
- Golgi neurons

Without inhibitory circuits
- Parallel fiber input to cerebellar cortex
With inhibitory circuits
- Inhibition reduces size of active Purkinje neurons
- Lateral inhibition
- Output more focused; more precise

Functional divisions of cerebellar cortex --> Deep nuclei
Functional divisions of cerebellar cortex --> Deep nuclei

Vermis
Intermediate hem
Cerebrocerebellum
Lateral hemisphere
Spinocerebellum
Vestibulo-cerebellum
Floculo-nodular lobe

Cerebrocerebellum
Intermediate hemisphere

Dentate

Interposed To lateral systems
Spinocerebellum
Vermis

Fastigial To medial systems
To frontal motor areas
Motor Planning +++
Motor execution
Eye mvt & balance

Motor Planning

NTA Fig. 10-2

Functions of the Cerebellum

- Motor learning/adaptation
- Non-motor functions:
  - Active tactile exploration
  - Higher brain functions (cerebellar cognitive-affective syndrome)

Non-motor Function

Passive stimulation
Discriminate roughness

Manipulate only
Manipulate + discriminate
Cerebellar Motor Functions
- Implemented via lateral and medial pathways, especially the corticospinal tract
- Incorporated into motor programs via frontal motor areas (SMA, premotor cortex…)
- Becomes part of motor strategy via prefrontal cortex

Cerebellar Cognitive Affective Disorder
- Lesions of the posterior cortex and vermis
- Impairment of executive functions
  - Planning, verbal fluency, abstract reasoning
- Difficulties with spatial cognition
  - Visuo-spatial organization, visual memory
- Personality changes
  - Blunting of affect, inappropriate behaviors
- Language disorders
  - Agrammatism

Conclusions
- Cerebellar lesions produce
  - Incoordination & errors not weakness
  - Lose ability to anticipate errors
  - Lose ability to correct
- Motor learning
  - Requires sensory awareness
  - Implemented via the descending cortical and brain stem pathways
- Cognitive and emotional disturbances
  - Anatomical connections to prefrontal and cingulate cortex (via thalamus)
- No single function
  - Clearly mostly motor; learning, optimizes
  - Functions may apply to cognitive and emotional behaviors