The Cerebellum
Gordon Holmes
(1876-1966)
Cerebellar Signs

Ataxia (incoordination)
- Overshooting, past-pointing (dysmetria, intention tremor)
- Decomposition of complex movements
- Dysdiadochokinesia – inability to perform alternating patterns of movements
- Explosive or staccato speech (dysarthria)
- Megalographia

Other signs
- Abnormal nystagmus
- Pendular knee jerks
- No deficit in conscious sensation
- Not affected by closing the eyes / blindfolding
  - in contrast to sensory ataxia, wherein blindfolding will cause unsteadiness “Romberg’s sign”
Effects of cerebellar inactivation on muscle coordination

Vilis and Hore, 1977

Normal

Inactivate cerebellar outputs
Readjustment of eye hand coordination during adaptation to prism glasses

Prisms displace optic path to the right

Subject looks left to see straight ahead

Initial overshoot to left

Learn to compensate

Glasses off, overshoot to right
Pattern of cerebellar inputs and outputs
The **cerebellar peduncles** connect the cerebellum to the rest of the brain and spinal cord.
Cerebellar cortex, white matter & deep nuclei

- Vermis
- Cortex
- Fastigial nuc.
- Interpositus nuc.
- Dentate nuc.
- White matter

Cerebellar cortex, white matter & deep nuclei (globus & emboliform)
Cerebellar cortex
Functional Cerebellar Topography

- Vestibular system (primary afferents and vestibular nuclei)
- Contralateral cortical inputs via pontine nuclei
- Vestibular nuclei
- Ventro-medial brainstem pathway (vest.)

Output Nuclei
- Dentate nucleus
- Interpositus nuclei
- Fastigial nucleus
- Vestibular nuclei

Projection
- Primary motor cortex and premotor cortex via VL nucleus of thalamus
- VL (cortex), red nucleus (lateral brainstem pathway)
- Vento-medial brainstem pathway (vest.)
- Vento-medial brainstem pathway

Proprioceptive input from trunk & vestibular system
- Vermis
- Spino-cerebellum
- Intermediate zones
- Spino-cerebellar, corticopontine input about girdle and limb

Flocculo-nodular lobe
- Vestibulo-cerebellum
- Vestibular system (primary afferents and vestibular nuclei)
Double Cerebellar Decussations

Unilateral cerebellar damage results in *ipsilateral* neurological signs
**Intrinsic circuitry**

*Purkinje cell* dendrites are oriented transverse to long axis of folia.

*Parallel fibers* (axons of granule cells) run parallel to long axis.

*Inputs*

- **Climbing fibers** surround individual Purkinje cells.
- **Mossy fibers** synapse onto granule cells.
- (Contralateral Inferior Olive)
- (All other inputs)
Cerebellar Microcircuitry

Parallel fibers

Golgi cell

Purkinje cell

Granule cells

Deep Cerebellar Nucleus

Climbing fiber

Mossy fiber

Output

Input

Stellate cell

Basket cells
Cerebellar Processing Loop

Motor control circuits

Cerebral Cortex
Spinal cord
Red nucleus
Reticular formation
Vestibular nuclei

Cerebellar Cortex

Processing

Purkinje cell

Inputs

Outputs

Deep Cerebellar Nuclei
Purkinje Cell “Stencil”

Cerebellar Cortex

Input from cerebral cortex

Cells in a deep cerebellar nucleus

Input from brainstem and spinal cord

To brainstem and cerebral cortex (via the thalamus)

Cell inhibited

Time