MOVEMENTS & SENSATION

Lecture for students of the Faculty of Dentistry

lections.neurology@gmail.com

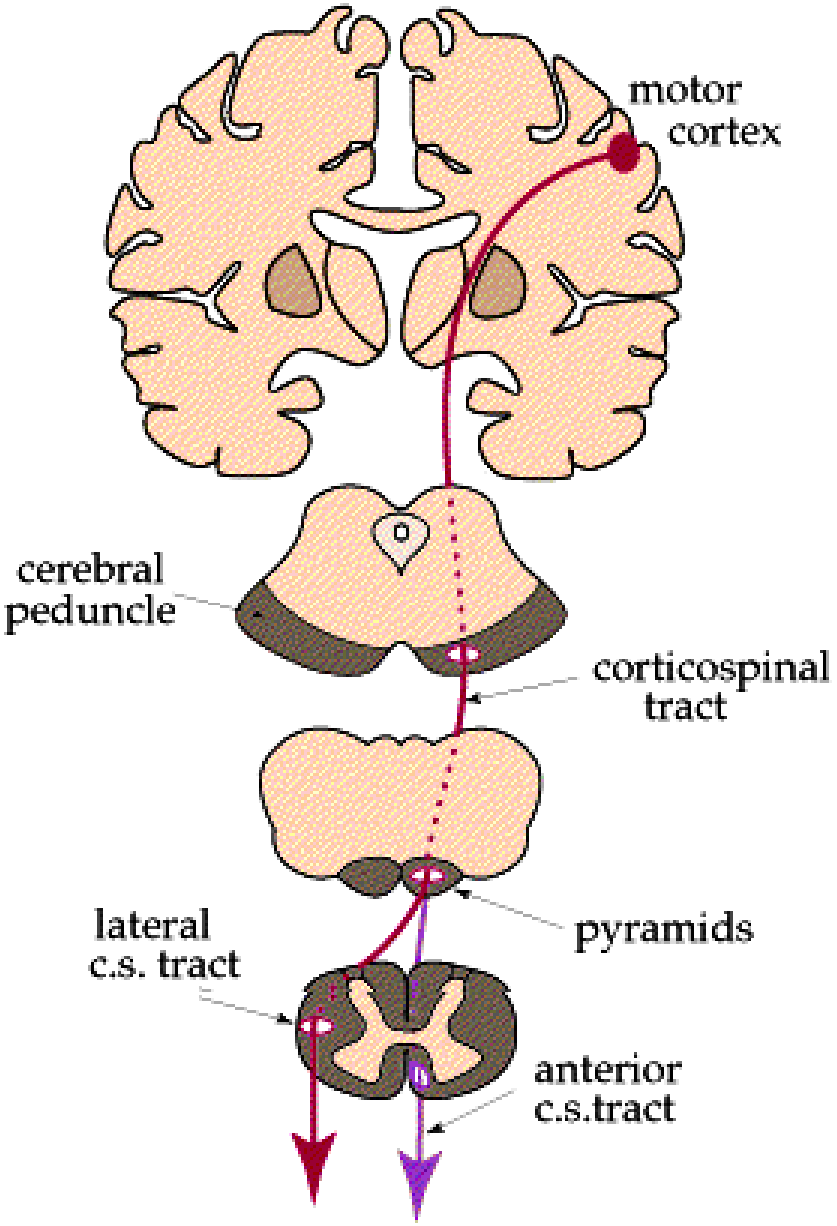
Plan

1. Voluntary movement system (paralysis)
2. Cerebellar impairment (ataxias)
3. Extrapyramidal system (Parkinson’s desease, hyperkinesia)
4. General sensation (pain & anesthesia)

Motor control systems

- **Corticospinal (pyramidal)**
  - Skilled, voluntary, strong and organised movements
- **Extrapyradimal system**
  - Automation and customization of movements, that the corticospinal system has generated
- **Cerebellum**
  - Consistency of movements, balance and stability

UMN & LMN

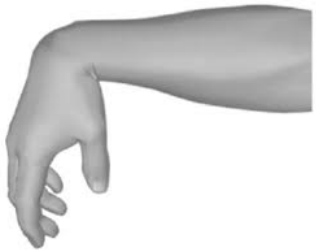

motor
cortex
cerebral
peduncle
corticospinal
tract
pyramids
lateral
c.s. tract
anterior
c.s.tract

Patterns of Weakness

MONOPLEGIA – weakness of a limb

Lesion: LMN at peripheral nerve

Causes: tumour, trauma of a nerve



HEMIPLEGIA – weakness of upper & lower limbs on same side

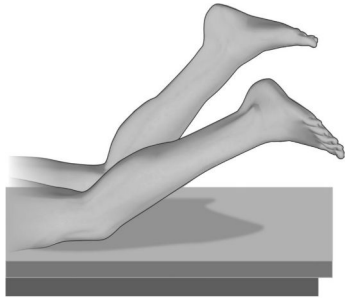
Lesion: UMN at cortex, internal capsule, brain stem

Causes: stroke, tumour, trauma

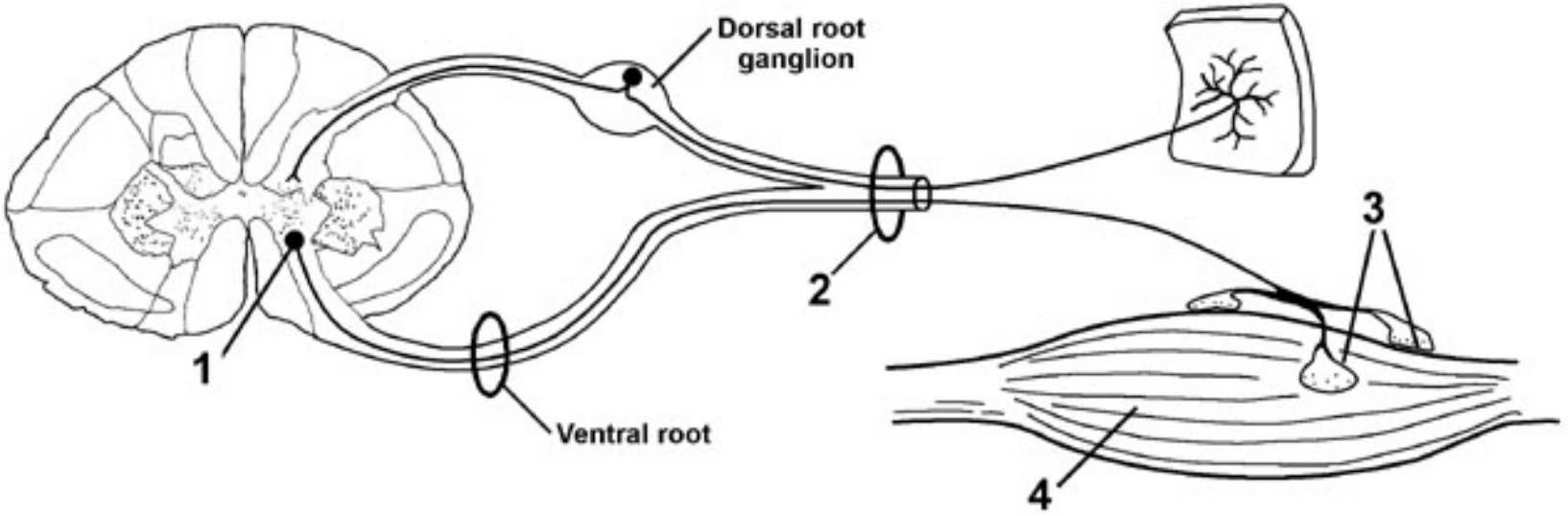
PARAPLEGIA – weakness of both lower limbs

Lesion: UMN or LMN in SC (myelitis, spinal injury)

LMN in PN (polyneuritis)



LMN & reflex arc



PERIPHERAL PARALYSIS FEATURES (LMN)

1. **A**reflexia (violation of the efferent link of the reflex arc).
2. **A**tonia (violation of reflex support of tone).
3. **A**trophy of the muscles.
4. **A**MR > CMR (reaction of degeneration, violation of electroexcitation).
5. Fibrillar or fascicullar twitchings (front horns or roots).
6. Limited paralysis.

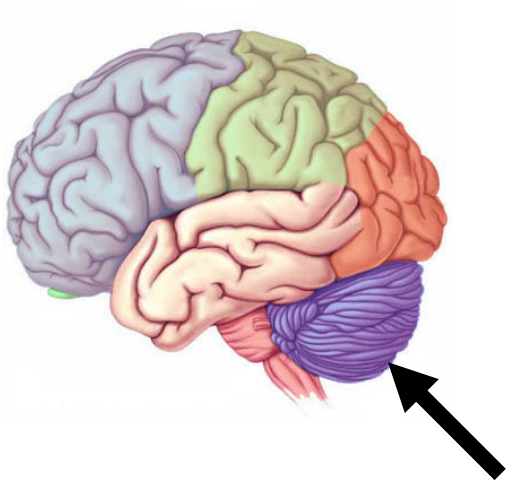
SIGNS OF CENTRAL PARALYSIS

1. Elevated deep reflexes (hyperreflexia)
2. Increased muscle tone (spastic tone)
3. Clones of feet and kneecaps
4. Decrease or prolapse of abdominal and foot reflexes
5. Pathological reflexes (oral and foot).
6. Diffuse paralysis

The Cerebellum: where is it and what does it do?

Thought to be involved in:

- Balance
- Coordinating movement
- Timing of movements
- Timing of discontinuous movements
- Motor learning - acquiring and maintaining

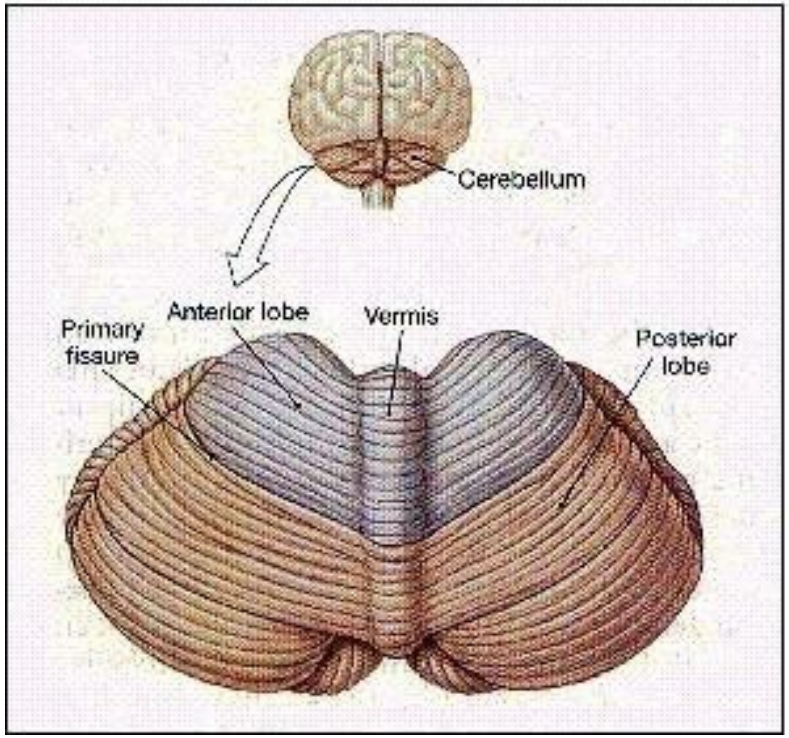


Sources of cerebellar injuries

Toxins (ethanol, chemotherapy, anticonvulsants, ethanol).
Autoantibodies (paraneoplastic cerebellar degeneration)
Structural lesions (strokes, MS, tumors, etc)
Inherited cerebellar degenerations (e.g. Freidreich's ataxia)

Cerebellum

- Midline – vermis
  - Dysarthia
  - Truncal titubation
  - Gait abnormalities
- Hemispheres
  - Double-crossed tracts, ipsilateral findings
  - Limb dysmetria
  - Ipsilateral veering while walking
  - Tremor
  - hypotonia



Functional Role of the Cerebellum

Participates in three systems:

1. Vestibular-cerebellar system modulating vestibular influences on posture & eye movement.

2. Spinal-cerebellar system regulating muscle tone, posture & locomotion.

3. Cerebro-cerebellar system regulating skilled movement.

Role of the Cerebellum

- Initiation & control of voluntary movement.
- Timing of movement/muscle action.
- Moment-to-moment correction of errors.
- Compensating for lesions of cerebral cortex.
- Motor learning & adaptive adjustments.

Ataxia

Ataxia

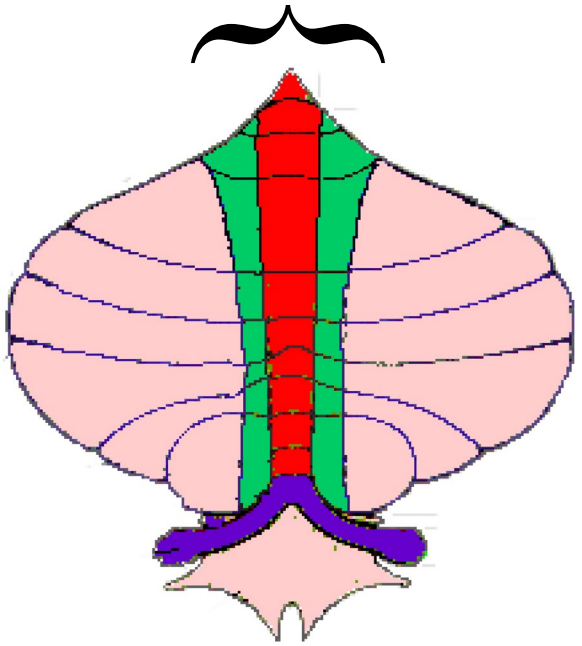
- Failure to produce smooth intentional movements

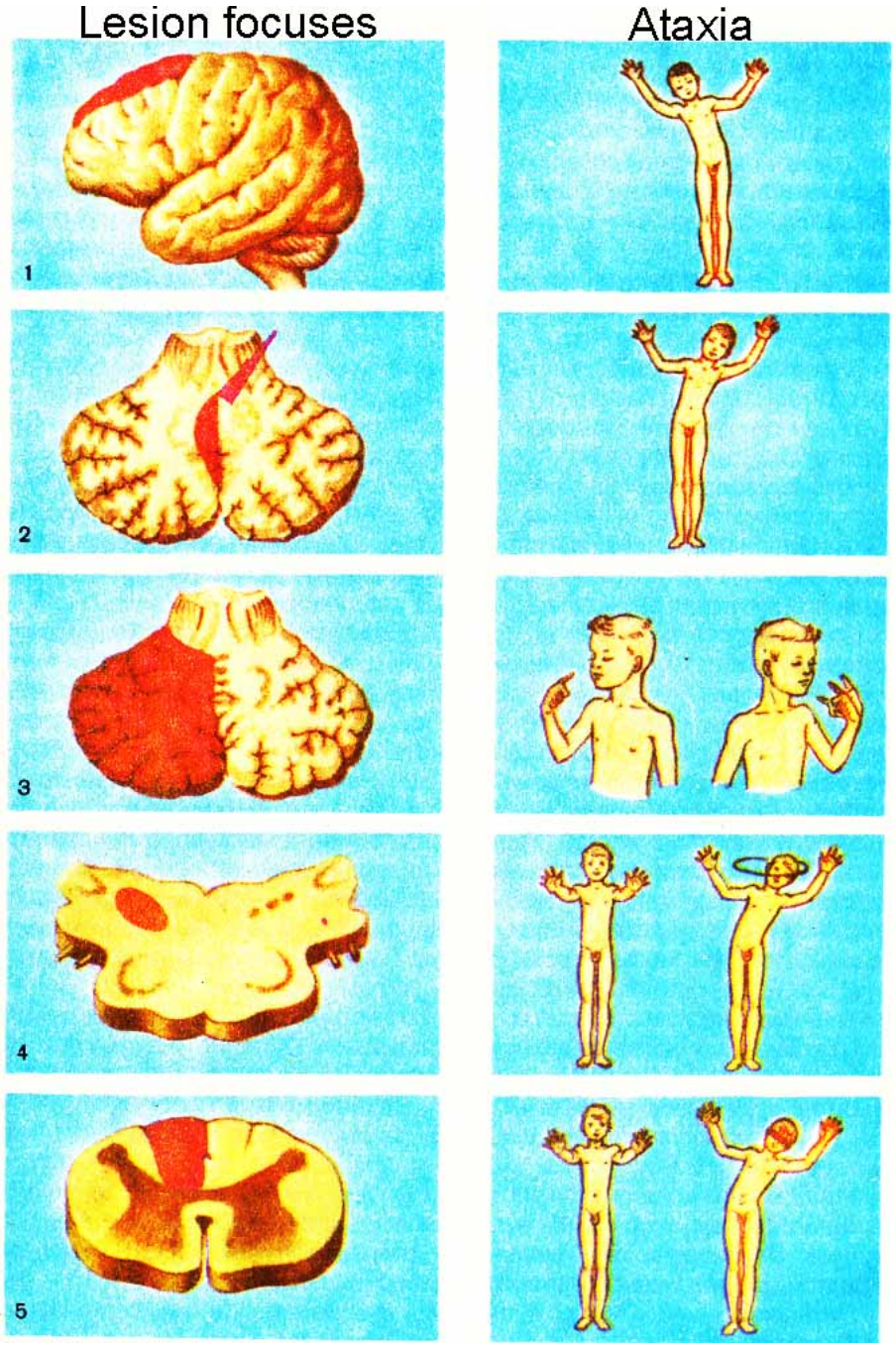
- **Motor Ataxia**
  - Caused by cerebellar disorders
- **Sensory Ataxia**
  - Failure of proprioceptive information to the CNS
  - May be due to disorders of spinal cord or peripheral nerves
  - Can be compensated for by visual inputs

Cerebellar Ataxia

Midline effects

Postural instability
e.g. fall to ipsilesional side
Truncal ataxia
Postural control and adjustment
e.g. Romberg sign
Gait ataxia
Extensor rigidity
Nystagmus
Eye deviation if unilateral





Types of ataxias

Clinical assessment, measurement & evaluation

Finger-to-finger & finger-to-nose

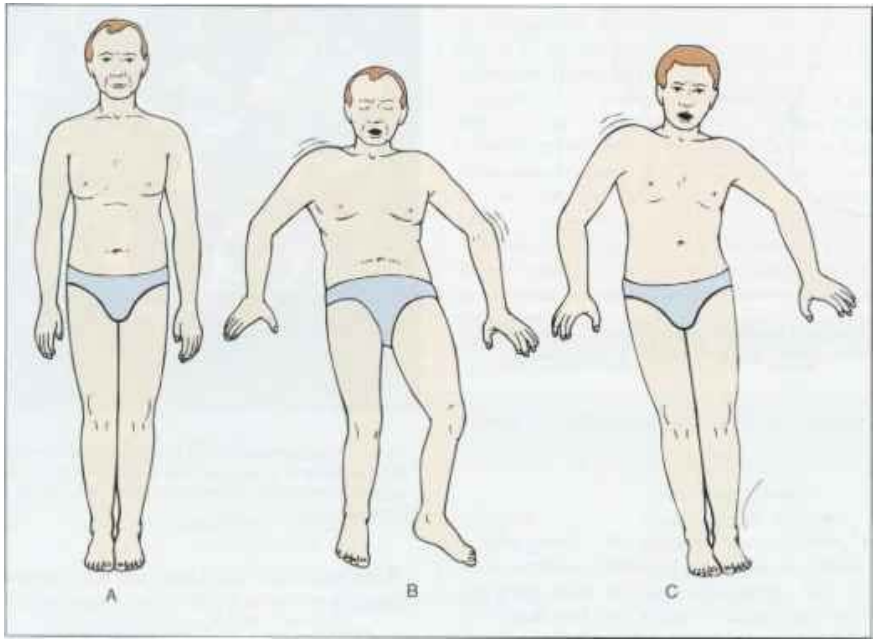
Heel-to-shin test

Rebound test

Rapid alternating movement

Romberg test for postural sway

Romberg test



-Sensory ataxia

-Pt can stand with feet together with eyes open, but not eyes closed.

-Cerebellar ataxia

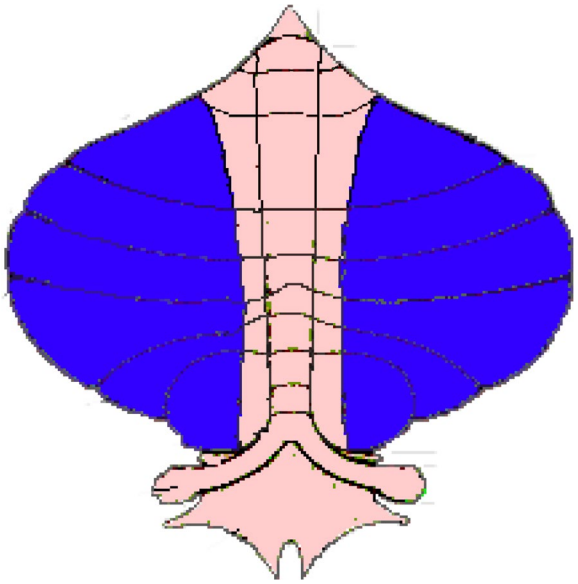
-Pt can not stand with feet together even with eyes open.

-Positive romberg – imbalance with eyes closed

-Testing for **sensory ataxia.**

Cerebellar Ataxia

Hemispheric effects



Asynergia
Decomposition of movement

Dysarthia
Jerky speech pattern

Dysmetria
inability to stop a movement at desired point

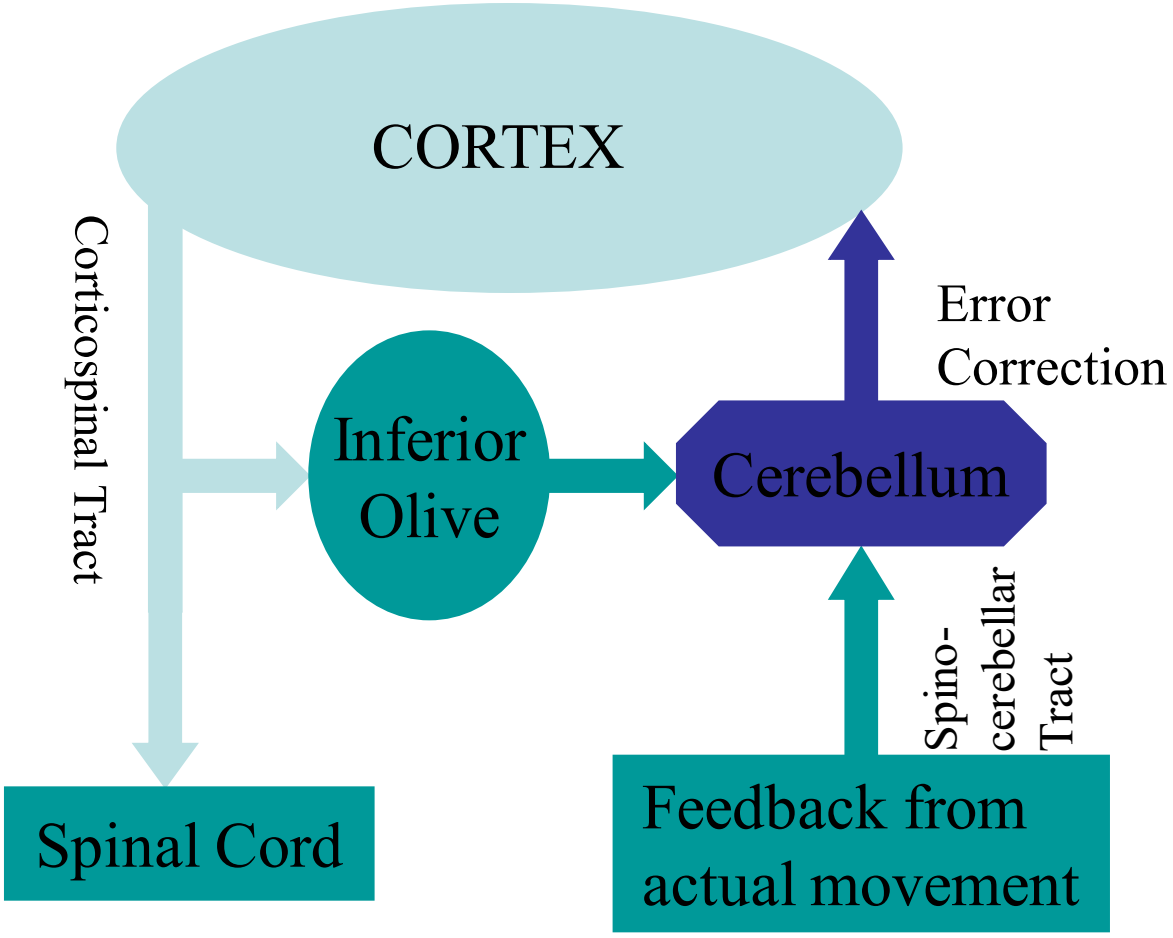
Dysdiadochokinesia
inability to perform rapidly alternating movements

Hypotonia
decreased muscle tone, pendular knee jerk

Intention Tremor
usually evident during powerful movements, but absent or diminished with rest (contrast basal ganglia disorders)

The Feedback Circuit:

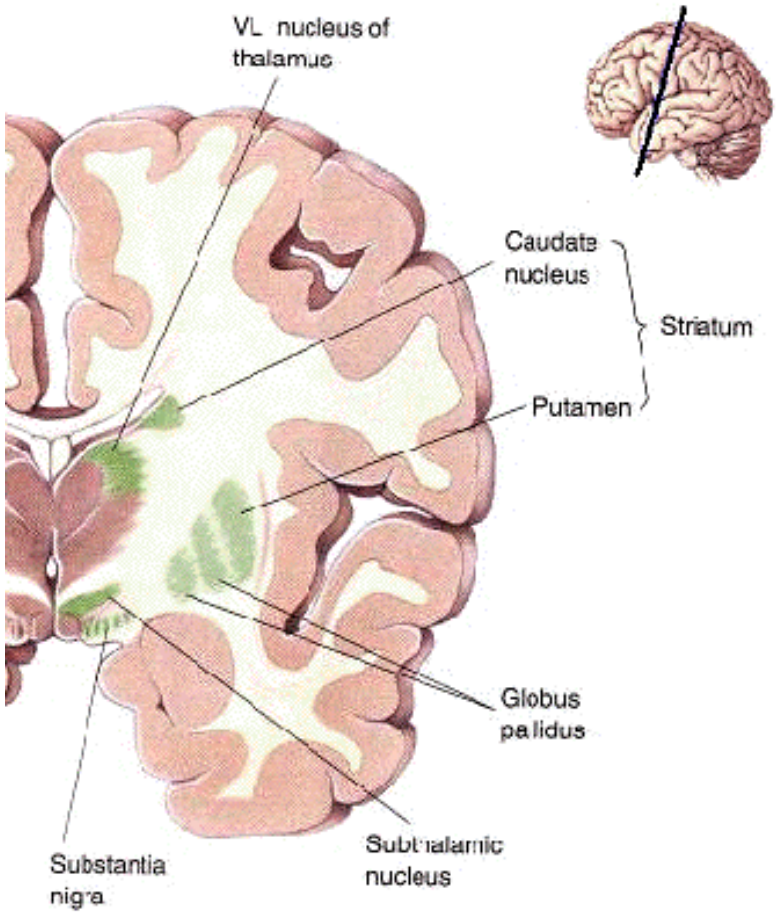
One theory of how the cerebellum might correct movement



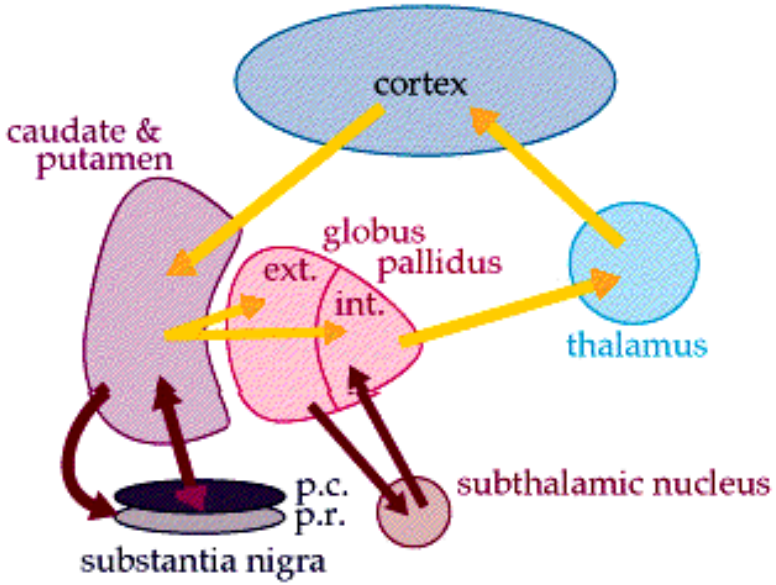
The basal ganglia

a collection of nuclei deep in the white matter of the cerebral cortex.

They include:
Caudate
Putamen
globus pallidus
substantia nigra
subthalamic nucleus



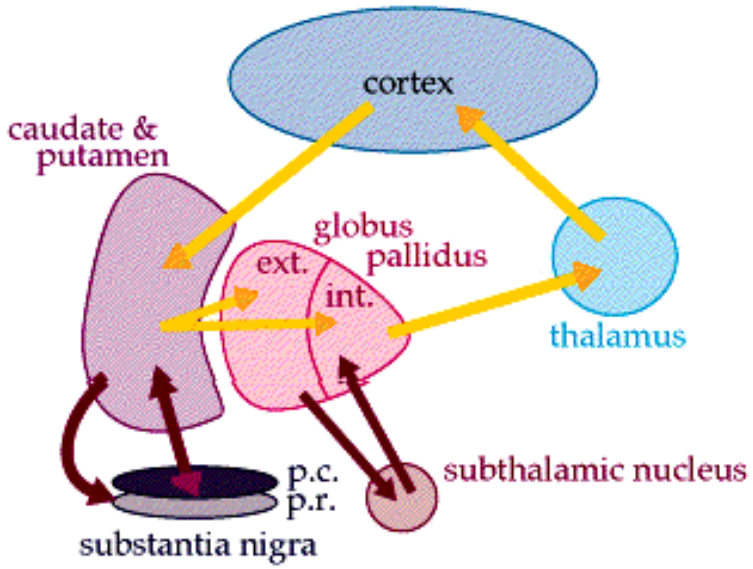
(the caudate nucleus and the putamen taken together all known as the striatum)



Lesions in specific nuclei tend to produce characteristic deficits.
the slow and steady loss of dopaminergic neurons in SNpc leads to:

Parkinson's disease,
3 symptoms usually associated with Parkinson's are:
Tremor (+ve) most apparent at rest
Rigidity (+ve) due to simultaneous contraction of flexors an extensors
Bradykinesia (ive) difficulty initiating voluntary movement

Akinesia illustrates intentional aspect of BG function



Whereas degeneration of the caudate and putamen (inhibitory) leads to:

Huntington's disease, or chorea, a hereditary disease of unwanted movements. produces continuous dance-like movements of the face and limbs

A related disorder is hemiballismus, flailing movements of one arm and leg, which is caused by damage (i.e., stroke) to the subthalamic nucleus.

Hyperkinetic syndromes

- tremor
- chorea
- dystonia
- myoclonus
- tic

Sensation

- Input of sensory information
- Process of receiving, converting, and transmitting information from the outside world

General Senses

- Include somatic sensations (tactile, thermal, pain, and proprioceptive) and visceral sensations.
- Scattered throughout the body.
- Simple structures.

Special Senses

- Include smell, taste, vision, hearing and equilibrium.
- Concentrated in specific locations in the head.
- Anatomically distinct structures.
- Complex neural pathway.

Components of Sensation

1. Stimulation – Stimulus (change in the environment that can activate certain sensory neurons) occurs within the sensory neuron's receptive field (region that can respond to stimuli).

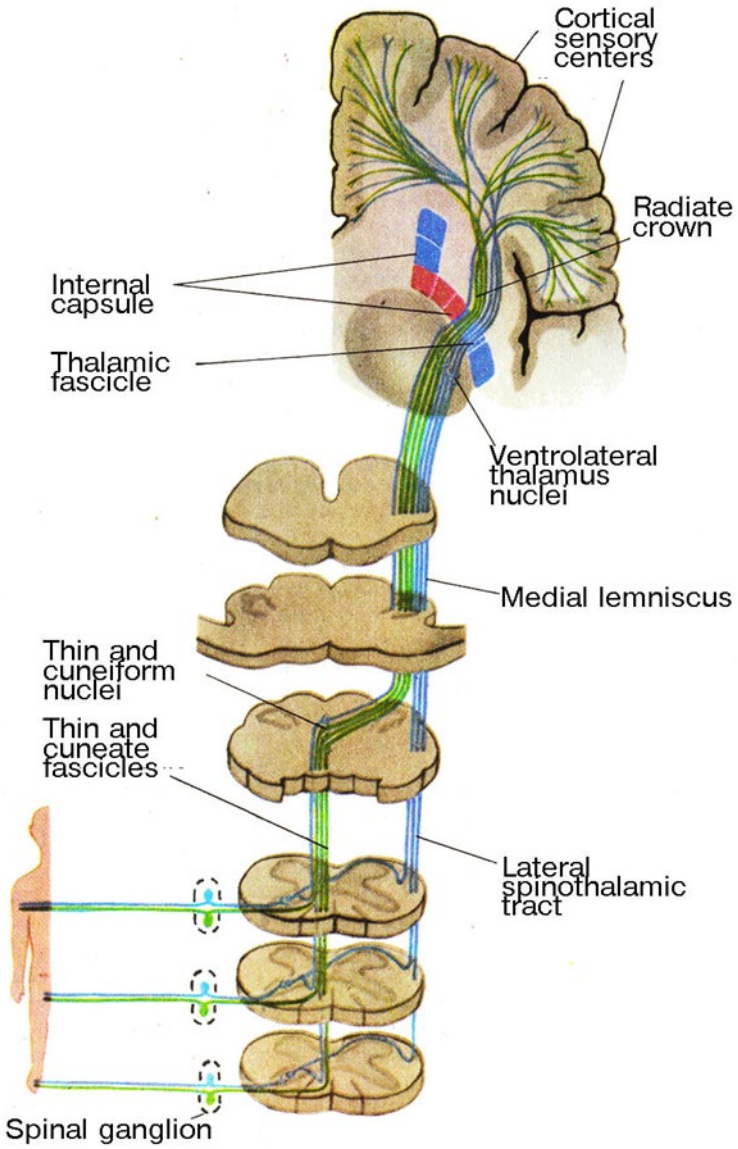
2. Transduction – A sensory receptor or sense organ must respond to the stimulus and transduce (convert it to a generator potential).

3. Impulse Generation and Conduction – When the generator potential reaches threshold, nerve impulses are sent.

First Order Neurons – Sensory neurons that send messages to the CNS.

4. Integration – A region of the CNS must receive and integrate the sensory nerve impulses into a sensation. Part of the cerebral cortex is involved with each type of sensation.

Somatic Sensory Pathways



1. First-Order Neurons

Carry signals from the receptor to the brain stem or spinal cord

2. Second Order Neurons

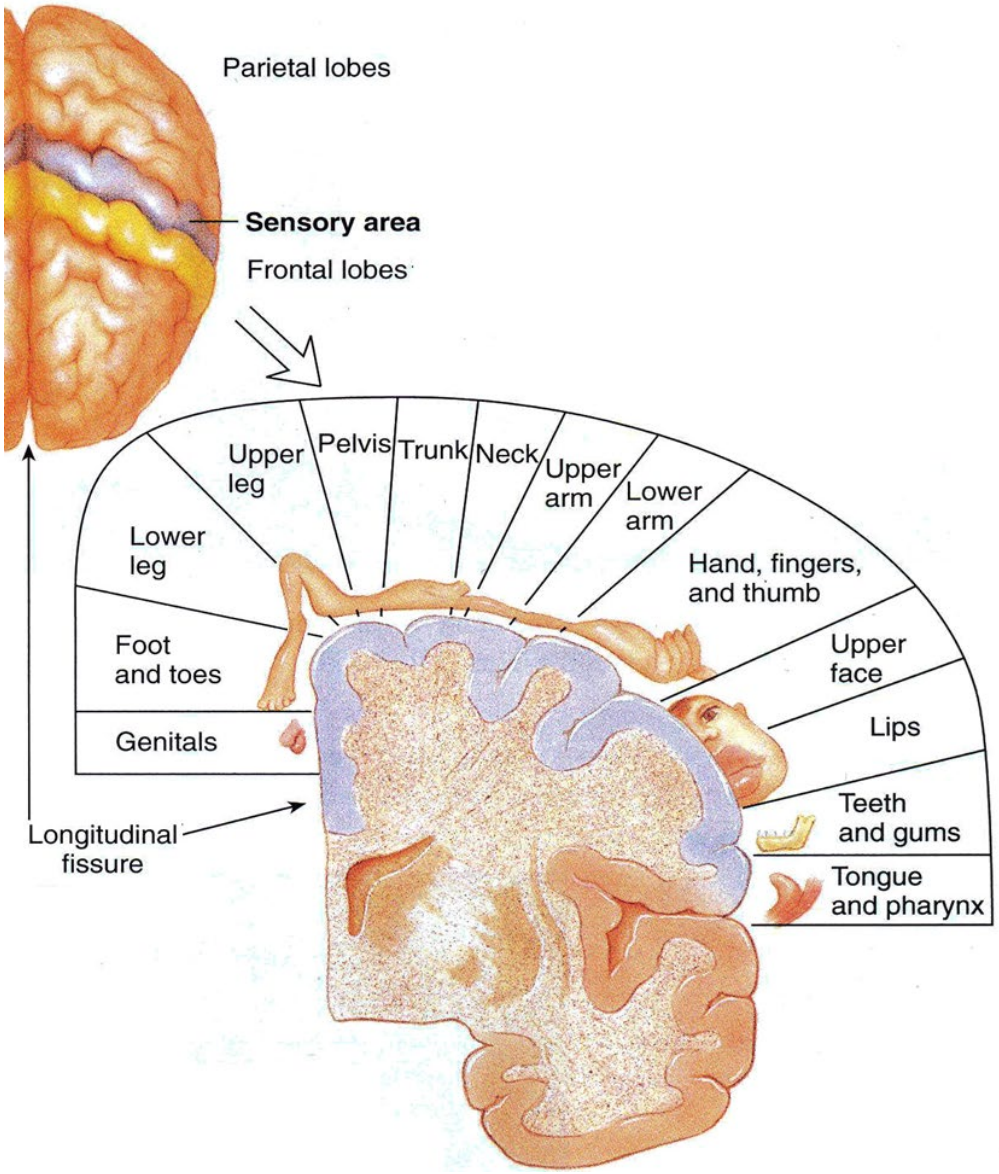
Carry signals from the spinal cord or brain stem to the thalamus

Second order neurons cross over from right to left and vice versa before ascending to the thalamus

3. Third Order Neurons

Run from the thalamus to the primary somatosensory area of the cerebral cortex where conscious perception of sensations result

Localization of general sensitivity in the cerebral cortex



Subjective violations:

- Pain
- Paresthesia: sensation of creeping crawling, itching, cold, numbness, burning;
- Causalgia: painful sensations of burning on a background of intense pain;
- Phantom pains - a sensation of pain in the missing part of the limb.

Objective violations:

- Hypoesthesia: decreased sensitivity;
- Anesthesia: lack of sensitivity;
- Hyperesthesia: increased sensitivity;
- Dysaesthesia: perverted perception
- Topanesthesia: no sense of localization;
- Hyperpathy: unpleasant fuzzy localized pain at high pain threshold

The peripheral type includes:

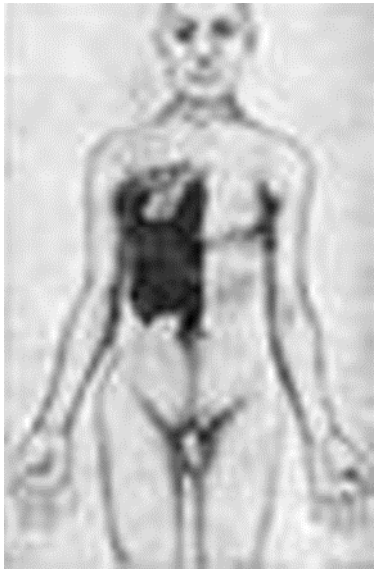
1. Mononeuritic - when affected peripheral nerve (pain, hypoesthesia all kinds of sensitivity).

2. Polyneuritis – plural affection of peripheral nerves (pain, sensitivity disorder in the form of "gloves" and "socks" in distal segments of the extremities.

Segmental disorders include:

1. Radicular segmental lesion posterior sensitive roo spinal cord (pain, loss of all types of sensitivity in the corresponding segments);

2. Segment-dissociated type when the posterior horn of the dorsal brain loss of pain and temperature sensitivity at preserved deep in the zone of segments



Discriminative Touch - The ability to recognize the exact location of a light touch and to make two-point discriminations

Stereognosis - The ability to recognize by feel the size, shape and texture of an object. Examples are reading braille or identifying (with eyes closed) a paperclip put in your hand

Proprioception - The awareness of the precise position of body parts, and kinesthesia, the awareness of direction of movement

Weight Discrimination - The ability to assess the weight of an object

Vibratory Sensations - The ability to sense rapidly fluctuating touch