

The neurological examination

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Versie 1.0 20/04/2022



Koningin Mathilde
Moeder- en kindcentrum



Not an aim but a means

Based on

- History taking
- Clinical examination
- Differential diagnosis
- Additional investigations

We aim to understand

- The localisation of the lesion (central vs peripheral, focal vs multifocal)
- Diagnosis
- Treatment and Management

History

Essential and complementary to the neurological examination

- Onset: acute – subacute - progressive
- Progression: stable – progressive- intermittent
- Personal and family history
- Lifestyle
- Medication use

For children

- Pregnancy and delivery
- Developmental milestones
- Feeding
- Sleeping
- Context (home, daycare/school), important events
- Academic performance

Physical examination

- Vital signs
- Height – Weight – Head Circumference: PLOT!
- Skull shape (craniosynostosis, asymmetry...)
- Dysmorphic features
- Palate and uvula
- Skin changes (café au lait spots, hypomelanotic maculae...)
- Skeletal changes (kyphosis, scoliosis, high arched feet, clubfeet,...)
- Heart and lung auscultation
- Organomegaly?
- Genitalia

When to perform a neurological examination?

If the person has any of the following complaints:

- Dismorphic features
- Headaches
- Blurry vision
- Change in behavior
- Fatigue
- Change in balance or coordination
- Numbness or tingling in the arms or legs
- Decrease in movement of the arms or legs
- Injury to the head, neck, or back
- Fever
- Seizures
- Slurred speech
- Weakness
- Tremor
- ...

= ALWAYS!

Why perform a neurological examination?

Evaluates the function of the

- Cerebrum
- Basal ganglia
- Cerebellum and vermis
- Brain stem
- Medulla
- Plexus
- Peripheral nerves
- Neuromuscular junction
- Muscle

5 domains

1. Mental status
2. Cranial nerve testing
3. Motor/reflex examination
4. Coordination/gait
5. General sensory exam

Parts of the nervous system

Main Components of the Human Nervous System

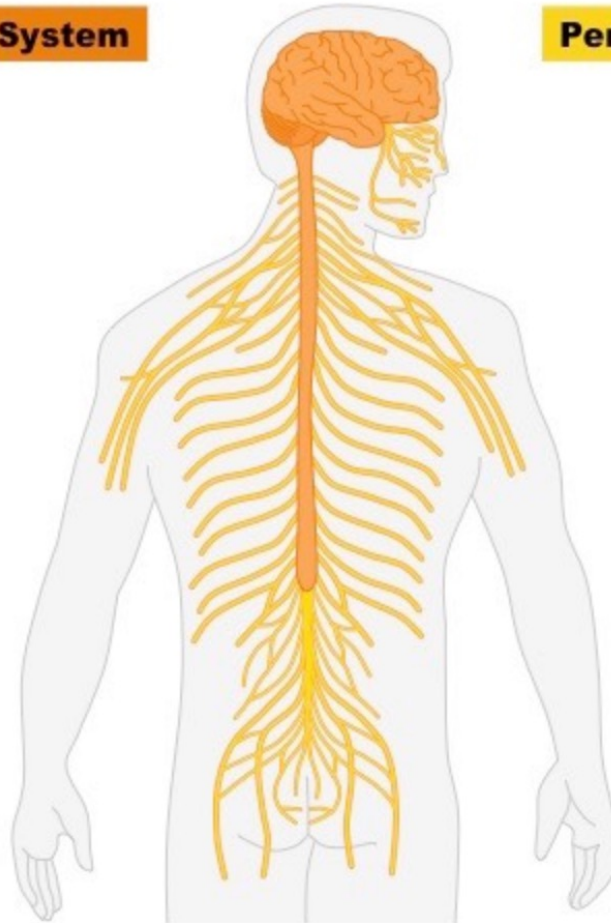
Central Nervous System

Composed of:

- Brain
- Spinal cord

Contains:

- Relay neurons (interneurons)



Peripheral Nervous System

Composed of:

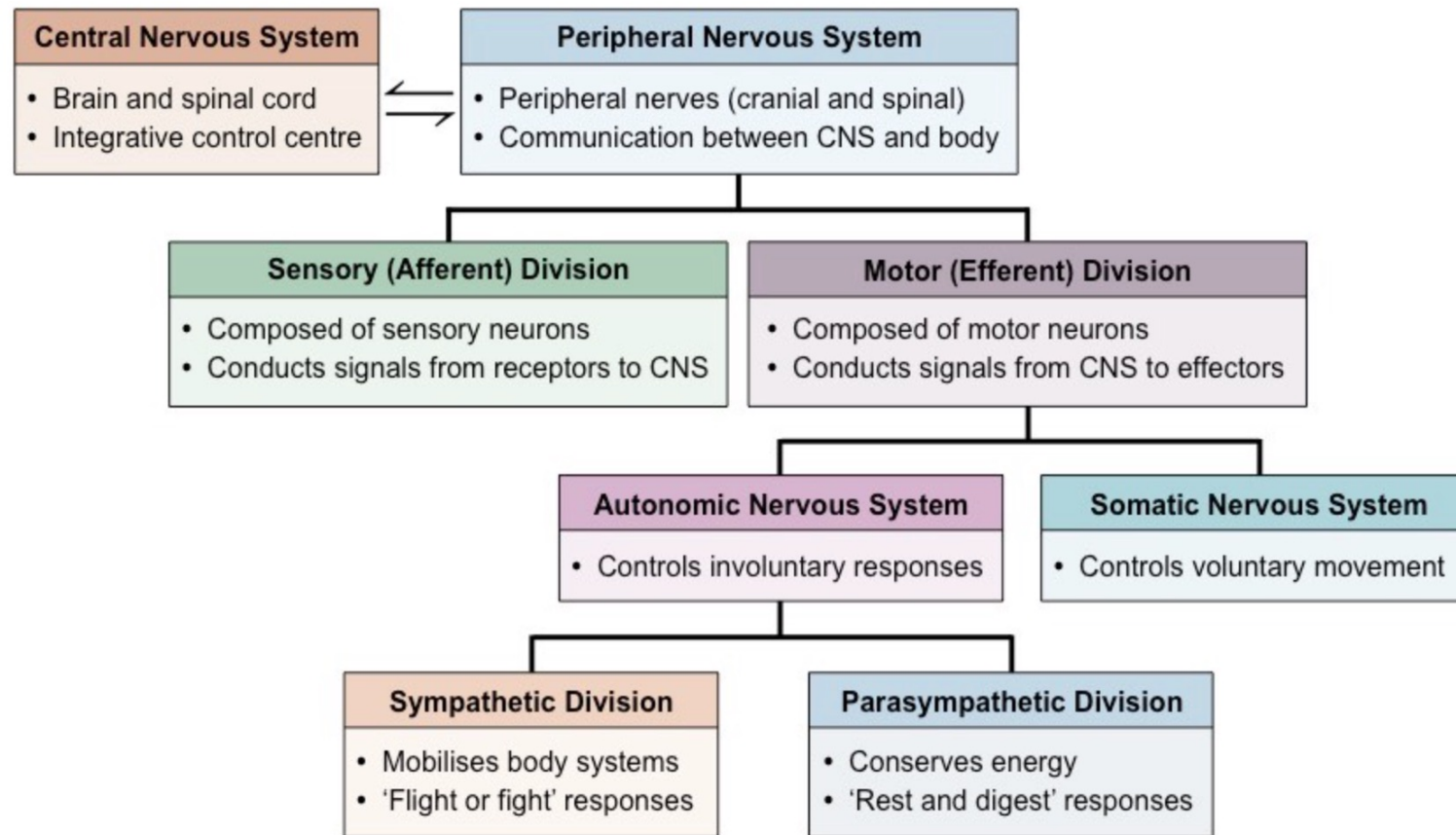
- Cranial nerves
- Spinal nerves
- Peripheral nerves

Contains:

- Sensory neurons
- Motor neurons

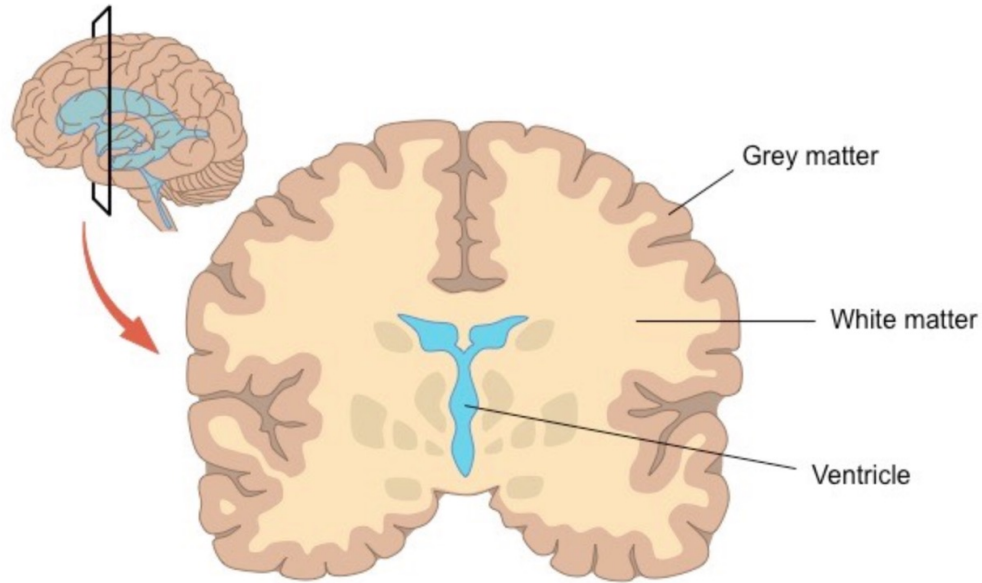
Parts of the nervous system

Schematic of the Nervous System Divisions

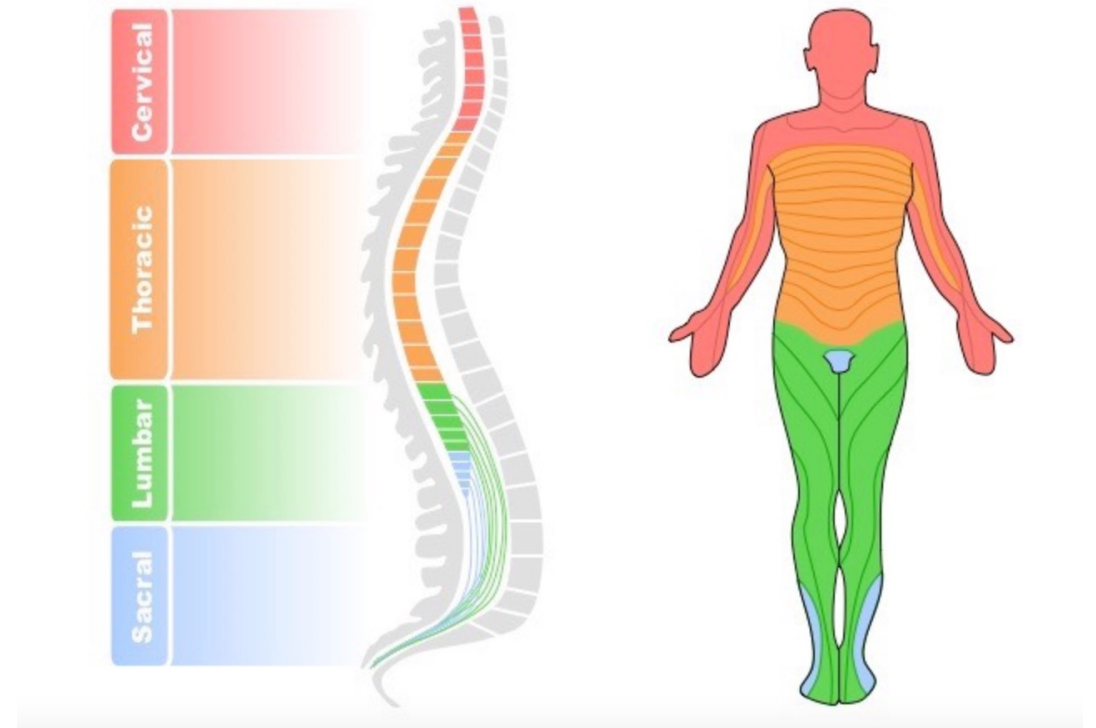


Parts of the nervous system

Cross Section of the Human Brain



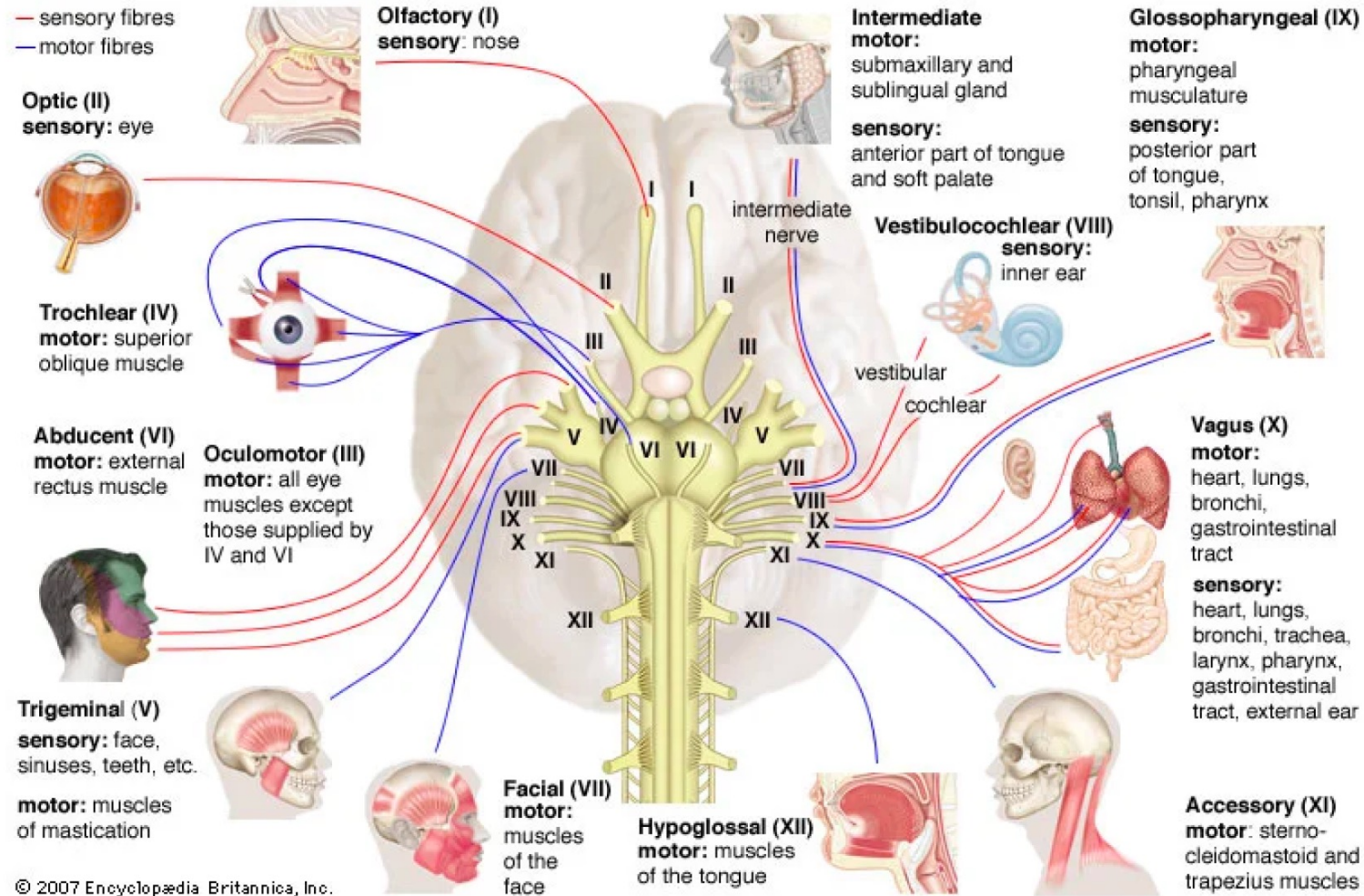
Organisation of the Peripheral Nervous System (Dermatome)



1. MENTAL STATUS

- Alert and oriented to person, place and time
- Language functions: receptive, expressive and pragmatic language, reading
- Expressive functions: everyday actions (apraxia)
- Receptive functions: body perception, imagination and perceptive skills
- Memory
- Affective functions: mood, state of mind
- Conative functions: facial expressions, gestures, speech

2. CRANIAL NERVES

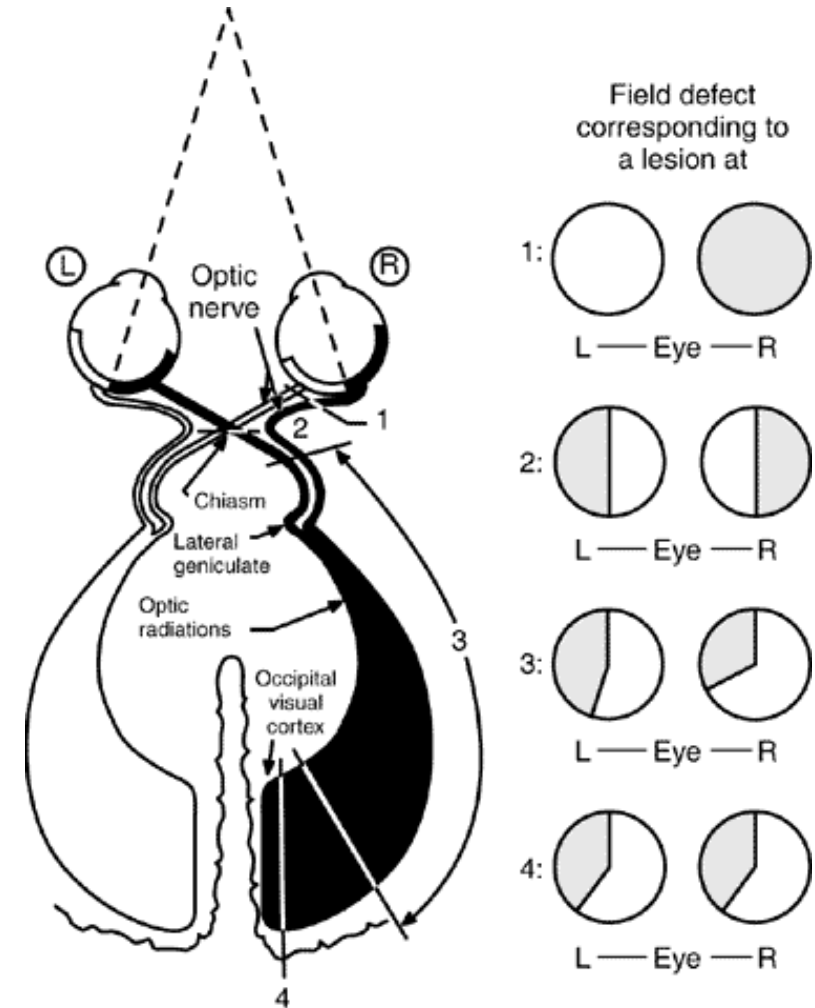


CRANIAL NERVES

- **Cranial nerve I (olfactory nerve).** This is the nerve of **smell**. The patient may be asked to identify different smells with his or her eyes closed. Often not tested unless frontal tumor is suspected.
- **Cranial nerve II (optic nerve).** This afferent nerve is assessed during **visual acuity, color vision, pupil testing** with the swinging flashlight test for afferent pupillary defect and **visual field** testing.
- **Cranial nerve III (oculomotor nerve).** This is routinely tested with extraocular motility. It innervates the levator palpebrae superioris (elevation of the upper eyelid) as well as four of the six extraocular muscles and is involved in **elevation, depression and adduction of the eye**. It is also involved in **pupillary constriction**.
- **Cranial nerve IV (trochlear nerve).** This is also routinely tested with extraocular motility. It innervates the superior oblique muscle involved in **depression of the adducted eye**, as well as **intorsion**.

Visual pathways and their injuries

- optic nerve injury : unilateral reduction of vision
- lesion chiasma: heteronymous bitemporal haemianopia
- lesion beyond the chiasma: contralateral homonymous haemianopia



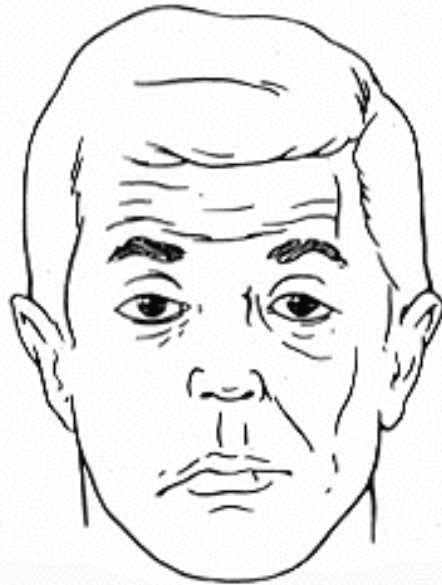
CRANIAL NERVES

- **Cranial nerve V (trigeminal nerve).** This nerve allows for many functions, including the ability to **feel the face, inside the mouth**, and move the muscles involved with **chewing**. The patient's healthcare provider may touch the face at different areas and watch the patient as he or she bites down. Reduced sensation in the distributions of V1 and V2 may indicate a cavernous sinus lesion, especially in cases of CN III, IV and/or VI dysfunction.
- **Cranial nerve VI (abducens nerve).** Routinely tested with extraocular motility, CN VI innervates the lateral rectus muscle which **abducts the eye**. Abduction deficits may be found in cases of increased intracranial pressure.
- **Cranial nerve VII (facial nerve).** This nerve is responsible for various functions, including the **movement of the face muscle** and **taste**. The patient may be asked to identify different tastes (sweet, sour, bitter), asked to smile, move the cheeks, or show the teeth. An upper motor neuron lesion of CN VII (such as a stroke) will spare the forehead and indicates damage in the cerebrum. A lower motor neuron will affect the entire half of the face.

Central vs peripheral CNVII palsy

II. Elevation of eyebrows

Patient can elevate both eyebrows



Unable to elevate eyebrow on right



CRANIAL NERVES

- **Cranial nerve VIII (acoustic nerve).** This nerve is the nerve of **hearing**. In a patient with an abduction deficit, it is important to test hearing due to the close relationship of cranial nerves VI, VII and VIII in the cerebellopontine angle. A patient with an abduction deficit and hearing loss on one side would localize to this region and would be concerning for a lesion such as an acoustic neuroma. CN VIII is also involved in the **vestibular system**, which is responsible for balance, proprioception and eye movements, including the vestibulo-ocular reflex. Disruption to this system can manifest clinically as nystagmus which may be seen in conditions such as Meniere's disease.
- **Cranial nerve IX (glossopharyngeal nerve)** and **Cranial nerve X (vagus nerve).** These nerves are involved with **taste and swallowing**. These are not examined separately; their close anatomic relationship rarely results in isolated lesions. Dysfunction of these nerves or the structures that they innervate may be indicated by dysphonia, dysphagia or dyspnea. The patient may be asked to swallow and a tongue blade may be used to elicit the **gag response**.

CRANIAL NERVES

- **Cranial nerve XI (accessory nerve).** This nerve is involved in the **movement of the shoulders and neck.** The patient may be asked to turn his or her head from side to side against mild resistance, or to shrug the shoulders.
- **Cranial nerve XII (hypoglossal nerve).** The final cranial nerve is mainly responsible for **movement of the tongue.** The patient may be instructed to stick out his or her tongue and speak. The tongue will deviate to the contralateral side of an upper motor neuron lesion and to the ipsilateral side with a lower motor neuron lesion. Tongue atrophy is a sign of a lower motor neuron lesion.

Mnemonics

On old Olympus' towering top a Finn and
German viewed some hops

- I **O**lfactorius
- II **O**pticus
- III **O**culomotorius
- IV **T**rochlear
- V **T**rigeminus
- VI **A**bducens
- VII **F**acialis
- VIII **A**cousticus/**V**estibulocochlear
- IX **G**lossopharyngeus
- X **V**agus
- XI **S**pinalis **a**ccessorius
- XII **H**ypoglossus

Some say marry money but my brother says big
brains matter more

- I **O**lfactorius **S**
- II **O**pticus **S**
- III **O**culomotorius **M**
- IV **T**rochlear **M**
- V **T**rigeminus **B**
- VI **A**bducens **M**
- VII **F**acialis **B**
- VIII **A**cousticus **S**
- IX **G**lossopharyngeus **B**
- X **V**agus **B**
- XI **S**pinalis **a**ccess **M**
- XII **H**ypoglossus **M**

3. MOTOR & REFLEX EXAMINATION

- Muscle strength
- Muscle tone
- Reflexes
 - Primitive reflexes
 - Tendon reflexes

Muscle strength

Testing segmental strength (per muscle/muscle group)

Medical Research Council Scale

Grade 5: Normal

Grade 4: Movement against gravity and resistance

Grade 3: Movement against gravity over (almost) the full range

Grade 2: Movement of the limb but not against gravity

Grade 1: Visible contraction without movement of the limb

Grade 0: No visible contraction

Muscle strength

Barré's sign

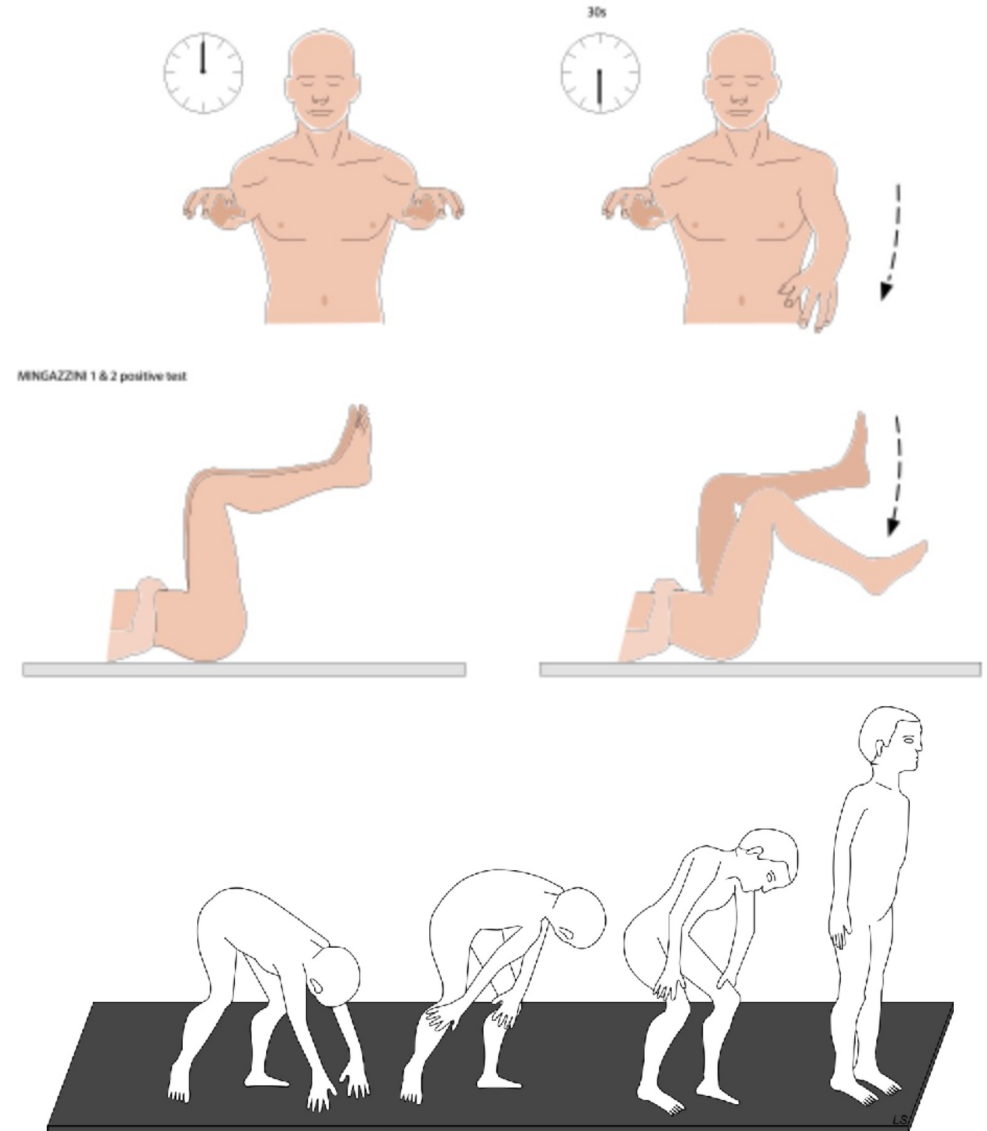
- Pronator drift points to (mild) upper motor neuron lesion

Mingazinni's test:

- The paretic thigh will lower

Gowers' sign

- Difficulty getting up from a chair or from supine position without arm support due to proximal muscle weakness



Muscle strength

Decrease in strength

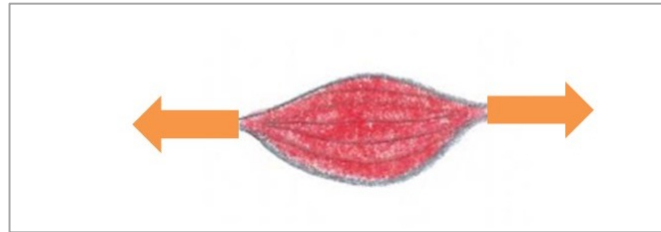
Paresis or paralysis (plegia)

- 1 limb = mono-paresis/plegia
- Upper and lower limb = hemi-paresis/plegia
- All 4 limbs = quadri- or tetra-paresis/plegia
- Both lower limbs = para- or diplegia

Muscle tone

Resistance given by a muscle to stretching forces

- Passive muscle tone = tone of the muscle at rest
- Active muscle tone = tone of the muscle under tension



- Most pronounced in muscles that keep the body straight, i.e. the anti-gravity muscles (flexors of the upper limbs, extensors of the lower limbs)

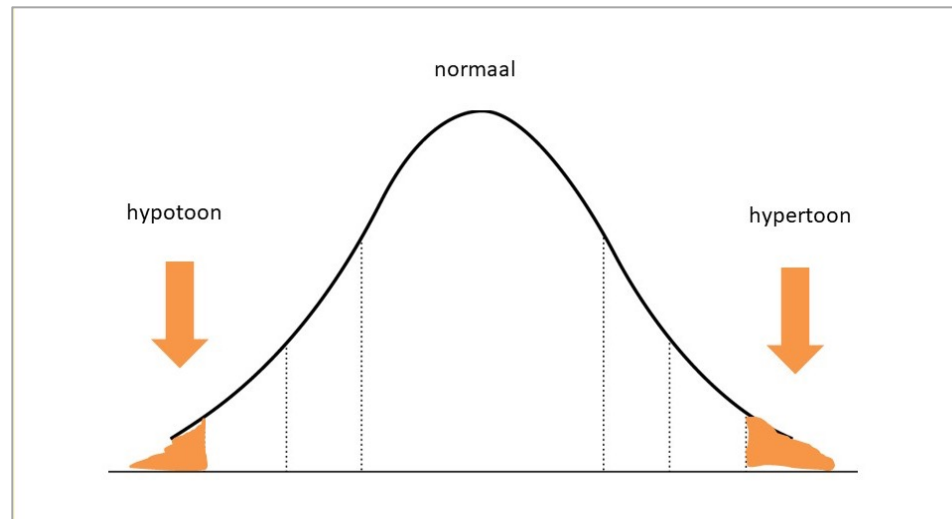
Muscle tone

Regulation of muscle tone

- Cooperation between central and peripheral nervous system

Abnormal muscle tone

- * hypotonia
- * hypertonia
- * dystonia

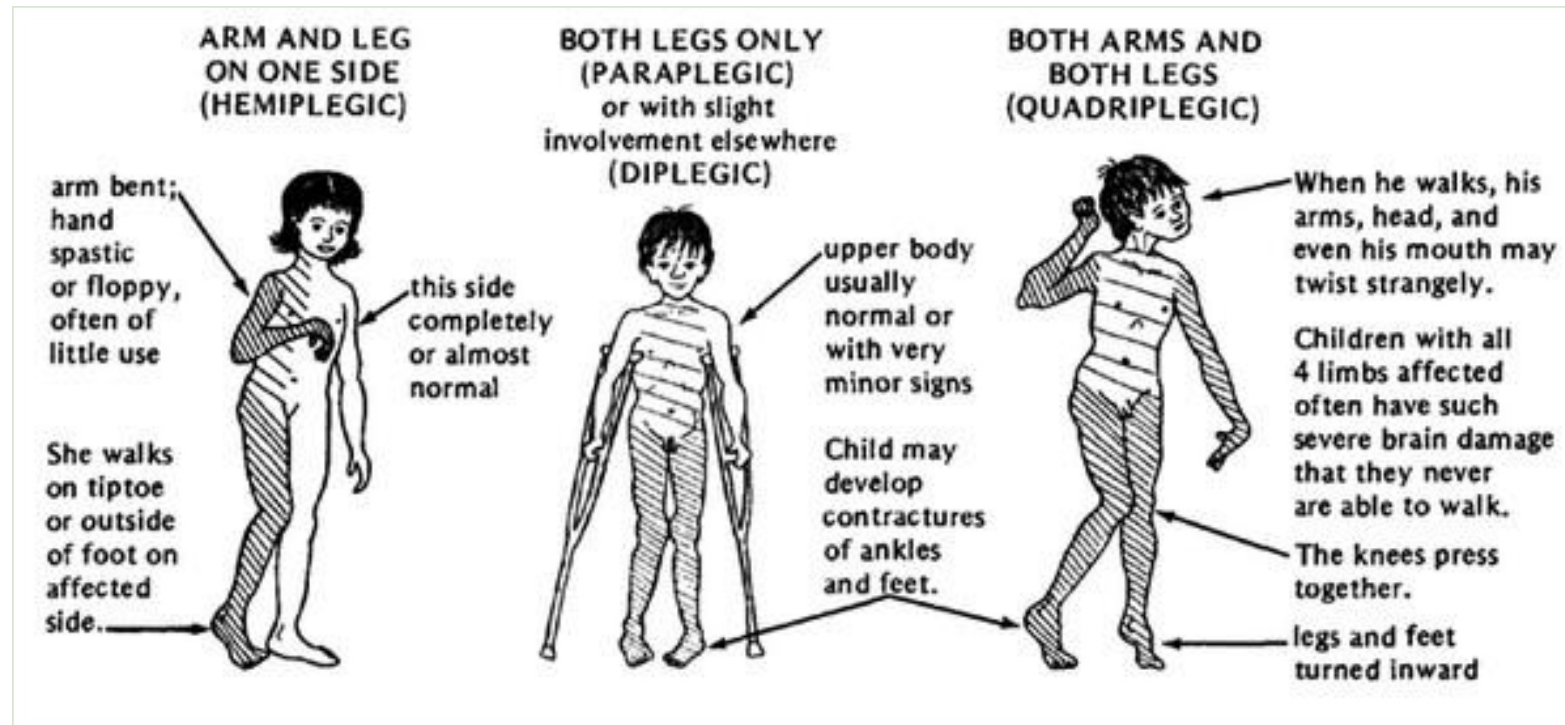


Abnormal tone

Spasticity

Upper motor neuron lesion – affects the pyramidal tract(s)

Affects opposing muscle groups to varying degrees



Abnormal tone

Rigidity (basal ganglia)

- affects opposing muscle groups equally
- the hypertonia is not tied to posture
- lead tube phenomenon: resistance is continuous
- cogwheel phenomenon (movement is intermittent, jerky) e.g. Parkinson's disease (tremor)

Spasticity versus Rigidity

Spasticity	Rigidity
Pyramidal tract lesion (internal capsule)	Basal ganglia lesion
Only one muscle group involved, either agonists or antagonists	Both agonists and antagonists involved
Clasp knife type	Leaden pipe or cogwheel type
Stretch sensitive	Not stretch sensitive

Tendon Reflexes

- Biceps tendon reflex: C5-C6 (n. musculocutaneus)
 - Percussion biceps tendon -> flexion forearm
- Radialis tendon reflex: C5-C6 (n. radialis)
 - Percussion at proc. styloideus radialis -> flexion and supination forearm
- Triceps tendon reflex: C6-C7 (n. radialis)
 - Percussion at triceps tendon above olecranon -> extension forearm
- Knee tendon reflex: L3-L4 (n. femoralis)
 - Percussion patellar tendon just below patella -> extension lower leg
- Achilles tendon reflex: S1-S2 (n. tibialis)
 - Percussion Achilles tendon -> plantar flexion foot



Afb 7-3-2-a
Bicepsreflex.



Afb 7-3-2-b
Tricepsreflex.



Afb 7-3-2-c
Kniespeesreflex bij zittende patiënt.



Afb 7-3-2-d
Kniespeesreflex bij liggende patiënt.



Afb 7-3-2-e
Achillespeesreflex bij knielende patiënt.



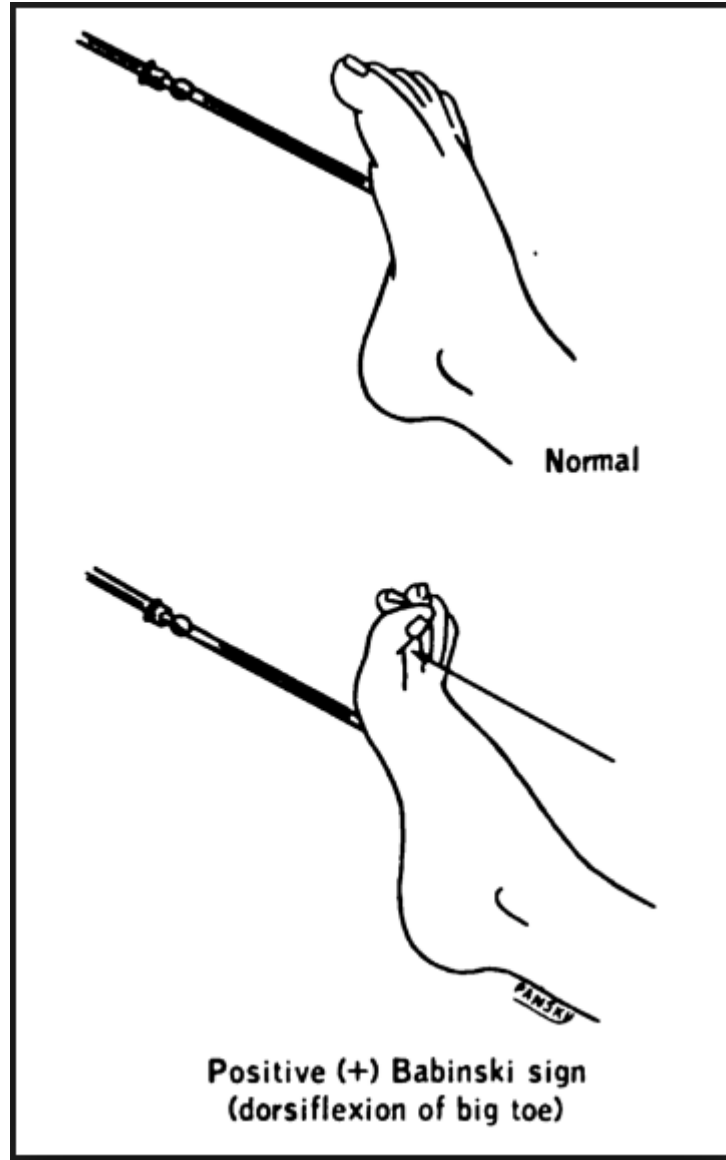
Afb 7-3-2-f
Achillespeesreflex bij liggende patiënt.



Superficial reflexes

Elicited by stimulation on certain skin or mucosa area causing muscle contraction

- **Abdominal wall reflexes**
 - Stroking with sharp end cotton swab from lateral to medial; abdominal muscle contraction towards navel
 - upper Th7-Th9 / middle Th9-Th11 / lower Th11- Th12
- **Cremaster reflex (L1-L2)**
 - Stroking along inner thigh: ipsilateral lifting of testicle by contraction of cremaster muscle
- **Anus reflex (S3-S4-S5) n. pudendus**
 - Stroking along perineum: contraction of sphincter
- **Sole of foot reflex (S1-S2) n. tibialis**
 - Pointing over lateral edge of foot from heel to big toe; plantar flexion toes.
 - Pathological: extension great toe and spreading other toes (Babinski sign)



4. GAIT & COORDINATION

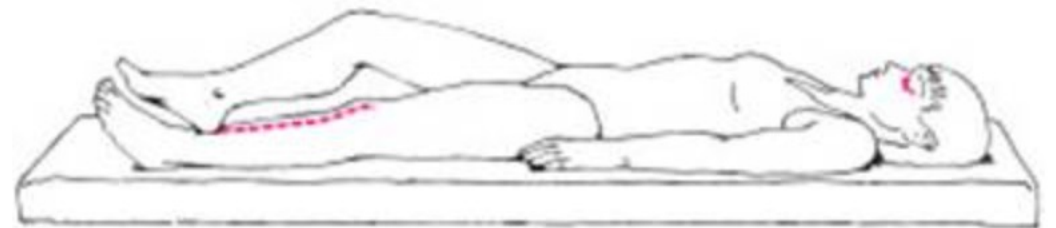
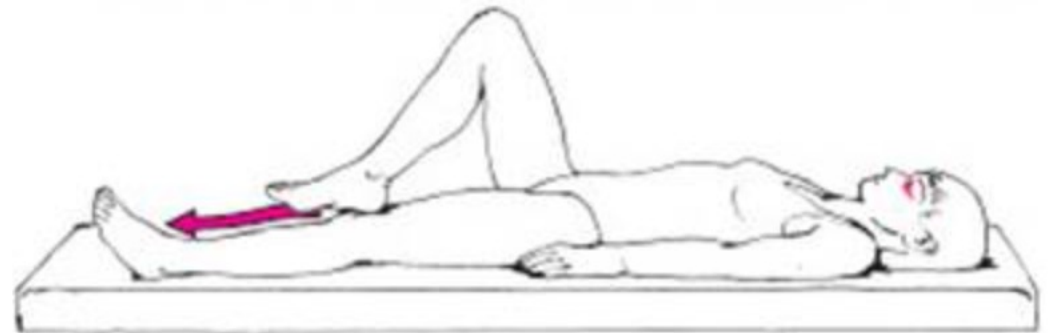
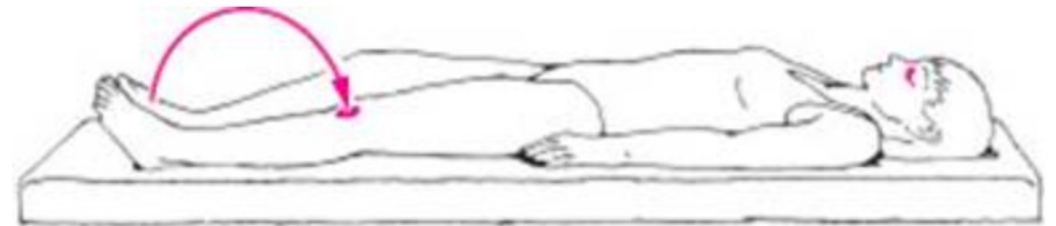
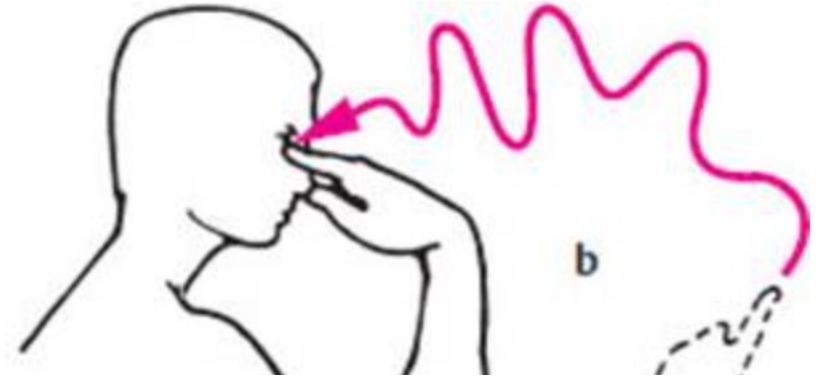
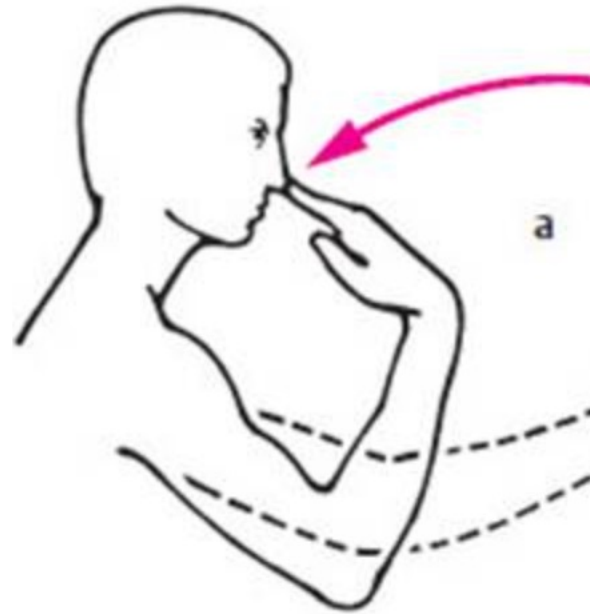
Normal gait, stance, and coordination require integrity of the motor, vestibular, cerebellar, and proprioceptive pathways. A lesion in any of the pathways causes characteristic deficits:

- Patients with cerebellar ataxia require a wide gait for stability.
- Footdrop causes a steppage gait (lifting the leg higher than normal to avoid catching the foot on surface irregularities).
- Pelvic muscle weakness causes waddling.
- Spastic leg causes scissoring and circumduction.
- Patients with impaired proprioception must constantly observe placement of their feet to avoid tripping or falling.

Gait



- Arms:
 - To assess **rapid alternation** of the hand on their leg repeatedly on their leg. In cerebellar disease.
 - **Finger-to-nose maneuver**
- Legs:
 - **Heel-to-shin maneuver**



5. SENSORY TESTING

- **The sense of touch (esthesia)** is tested with the patient's eyes closed. The examiner lightly touches various sites on the patient's body with a finger, a piece of tissue paper, or the like.
- **Two-point discrimination, stereognosis.** The epicritic component of the sense of touch (ultimately derived from Greek krites, “judge”) is tested on the pads of the fingers, e.g., by determining the patient's ability to discriminate two simultaneous stimuli located close together.
- **Vibration sense (pallesthesia)** is tested with a vibrating 64- or 124-Hz tuning fork solidly placed on various bony prominences of the body.
- **Position sense** is tested by passively moving some part of the patient's body and asking the patient in which direction it is being moved.

5. SENSORY TESTING

- **Temperature sense (thermesthesia)** should be tested particularly when a central lesion is suspected, because the pain and temperature pathways run separately from those of the other sensory modalities in the spinal cord and brainstem, and do not join them until the level of the thalamus.
- **The ability to feel pain (algnesia)** should be tested by pinching a fold of skin, never by pinprick.

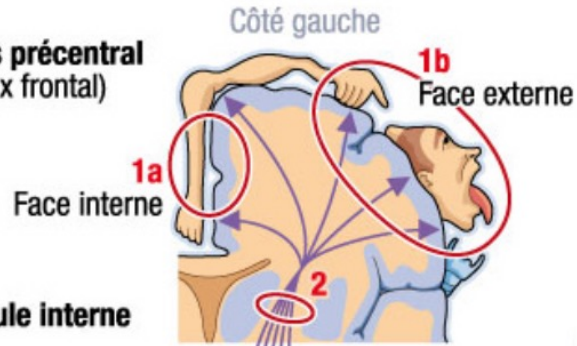
Upper motor neuron lesion	Lower motor neuron lesion
Lesion in the central nervous system which is above the anterior horn of the afferent pathways or above the motor nuclei of the efferent pathways.	Lesion in the peripheral nervous system
Reflexes: <ul style="list-style-type: none"> ● Pathological reflexes such as positive Babinski and Hoffman's sign present. ● Hyperreflexia or increased deep tendon reflexes present. 	Reflexes: Hyporeflexia or diminished reflexes present.
Strength: Hypertonia and spasticity.	Strength: Hypotonia, atrophy, reduced strength, flaccidity. Atrophy in distribution of peripheral nerve.
Sensation: Sensory deficits will be dependent on which part of the sensory tracts are impacted by the lesion. Dorsal column medial lemniscus pathway is responsible for our discriminatory sense: <ul style="list-style-type: none"> ● Two-point discrimination ● Vibration sense ● Proprioception ● Light touch Spinothalamic tract is responsible for our self-protective reactions in response to stimuli that are potentially harmful: <ul style="list-style-type: none"> ● Nociceptive information (pain) ● Temperature ● Tickle, itch and sexual sensations ● Crude touch (ability to identify the sensation of touch without localisation) 	Sensation: Sensory deficits will be dependent on the spinal nerve involved - creating a dermatomal loss of sensation or the cutaneous nerve involved, which would impact a patch of skin on the limb.

<https://www.raynersmale.com/blog/2015/1/17/sensation-testing-for-person-with-peripheral-lesion>

Pyramidal syndrome

- Decreased muscle strength, paresis
- Increased limb tone, spasticity, muscle contractures
- Increased reflexes – positive Babinski sign
- Flexion of the arm, extension of the leg
- Symmetry / asymmetry: hemiplegia, diplegia, quadriplegia

**1 Gyrus précentral
(Cortex frontal)**



2 Capsule interne

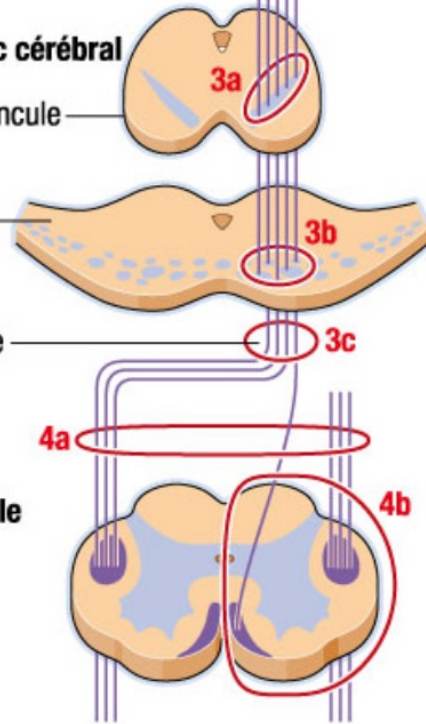
3 Tronc cérébral

Pédoncule

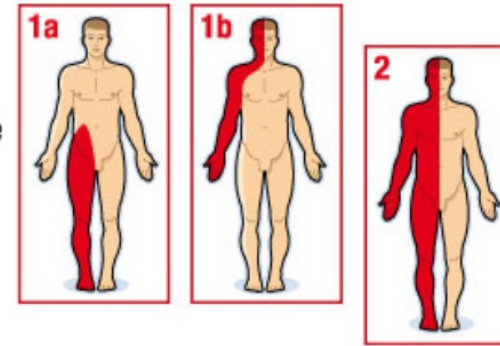
Pont

Bulbe

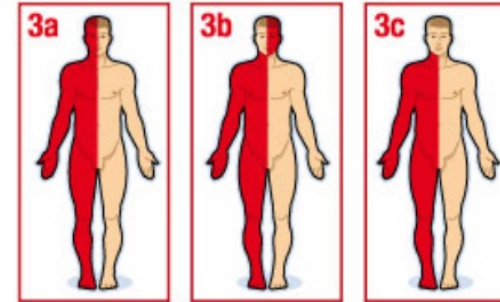
4 Moelle



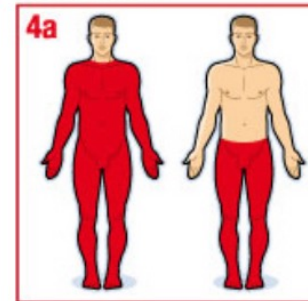
**Lésions unilatérales gauches
hémisphériques**



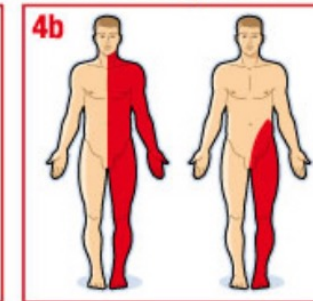
**Lésions unilatérales gauches
du tronc cérébral**



**Lésions médullaires
bilatérales**



**Lésions médullaires
unilatérales gauches**



Extrapyramidal syndrome

Association of hypotonia with variable rigidity of trunk and limbs 'plastic rigidity'

- **Dyskinesia:** several types of abnormal movements together
- **Chorea:** involuntary dance-like movement. Can affect any part of the body.
- **Athetosis:** slower writhing movements of the limbs, is often associated with chorea (choreoathetosis).
- **Dystonia:** Dystonia is a disorder of posture caused by simultaneous contraction of agonist and antagonist muscles.

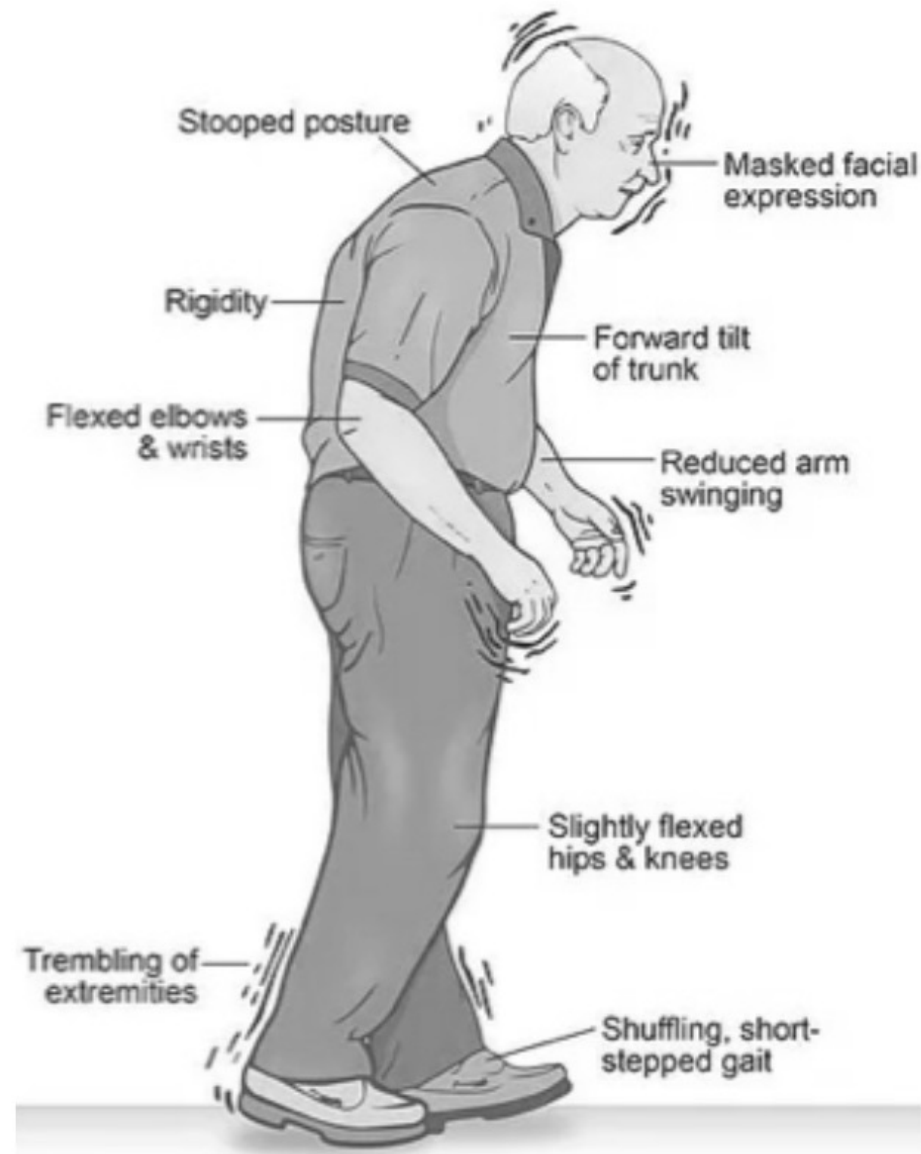


Figure 2

synagile.com/parkinson-s-disease.html

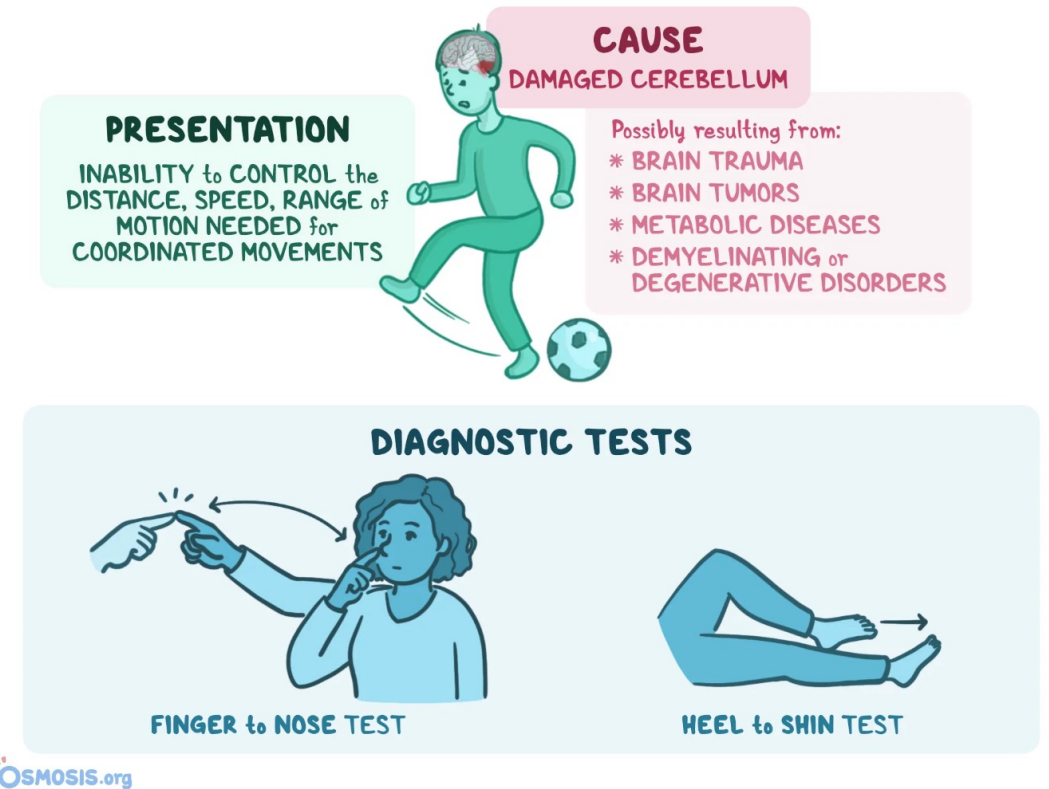
Cerebellar syndrome

Cerebellar signs

- Ataxic gait
- Trunc ataxia
- Dysmetria
- Dysdiadochokinesis

- Dysarthria

- Saccadic eye movements
- Nystagmus



Useful resources

Detailed chapter

- <https://doctorlib.info/neurology/fundamentals-neurology/3.html>

In Dutch

- <https://www.youtube.com/watch?v=HneZ5sjdRi8>
- <https://www.youtube.com/watch?v=LfzFjn8ppFQ>
- <https://www.youtube.com/watch?v=MsNb02dwVPA>
- <https://www.youtube.com/watch?v=JVe3rh8QC0A>
- <https://www.youtube.com/watch?v=N-MRRmDNyPU>

In English

<https://www.youtube.com/watch?v=PEJJv3gJh74>

Useful resources

Detailed chapter

- <https://doctorlib.info/neurology/fundamentals-neurology/3.html>

In English

- https://neurologicexam.med.utah.edu/adult/html/home_exam.html
- <https://www.youtube.com/watch?v=PEJJv3gJh74>

In Dutch

- <https://www.youtube.com/watch?v=HneZ5sjdRi8>
- <https://www.youtube.com/watch?v=LfzFjn8ppFQ>
- <https://www.youtube.com/watch?v=MsNb02dwVPA>
- <https://www.youtube.com/watch?v=JVe3rh8QC0A>
- <https://www.youtube.com/watch?v=N-MRRmDNyPU>

Thank you!



Versie 1.0 20/04/2022



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