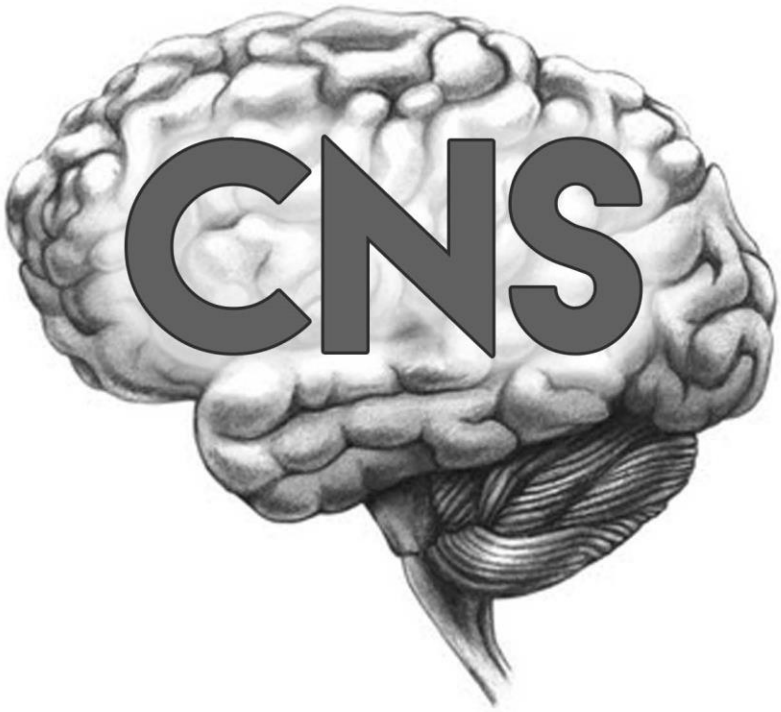

ANATOMY

☑ Sheet ○ Slide ○ Handout

Number

18

Subject

Cranial Nerves+ Language and Speech

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Date: 00/00/2016

Price:

Last lecture, we talked about the components of spinal and cranial nerves. We talked about the vagus and glossopharyngeal nerves. In this lecture, we will talk about the trigeminal and facial nerves.

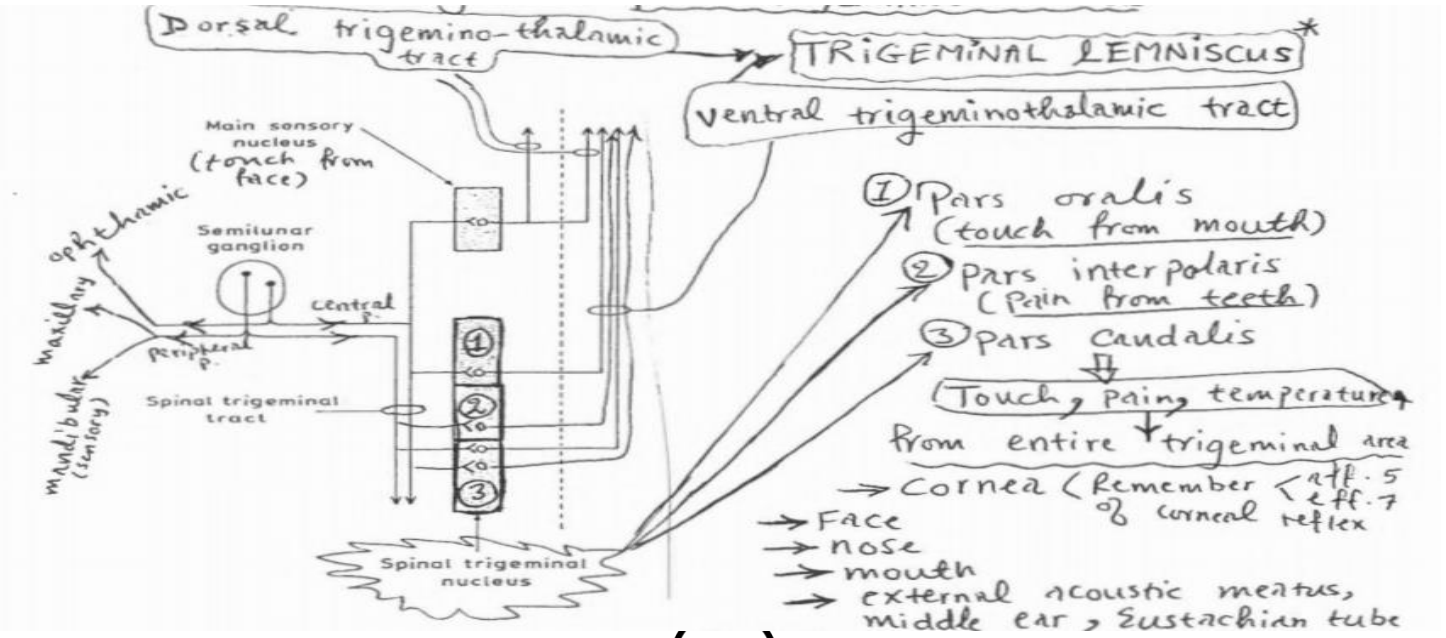
Trigeminal Nerve

-Trigeminal nerve is mainly sensory nerve. It has three divisions: ophthalmic, maxillary and mandibular. The ophthalmic and maxillary are purely sensory, and the maxillary is mixed (sensory + motor).
- Somatic sensation reaching the cortex can be either from the body (bringing sensation from the body through 1st, 2nd and 3rd order neurons via the spinal cord to the thalamus and then to the cortex) or from the face (bringing sensation from the face through 1st, 2nd and 3rd order neurons via the trigeminal nerve to the thalamus and then to the cortex).
- Both will reach the ventrobasal complex of the thalamus. Sensation from the body will go to the VPL and from the face to the VPM.

- The trigeminal nerve brings general sensation from the face → It has GSA.
- It also supplies special muscles (muscles derived from the 1st pharyngeal arch) → it has SVE.

The trigeminal nerve brings sensation from the face (general sensation not special sensation) → The sensory part of the trigeminal is GSA: general somatic afferent bringing sensation from the face, skin, muscles and joints.

- The other component of the mandibular is **SVE** (special visceral efferent) to special muscles. What are these special muscles? **Muscles of mastication**.



Now, we will focus on the sensory part of the trigeminal:

Any nerve containing a sensory part should have a ganglion. Within this ganglion we have the cell bodies of sensory fibers or 1st order sensory neuron. This cell has a peripheral process going to the receptor and a central process that enters the pons. The peripheral processes of this ganglion (also called trigeminal ganglion, semilunar ganglion, or gasserian ganglion) form the ophthalmic, maxillary, and sensory part of mandibular.

Now we want to follow the central processes:

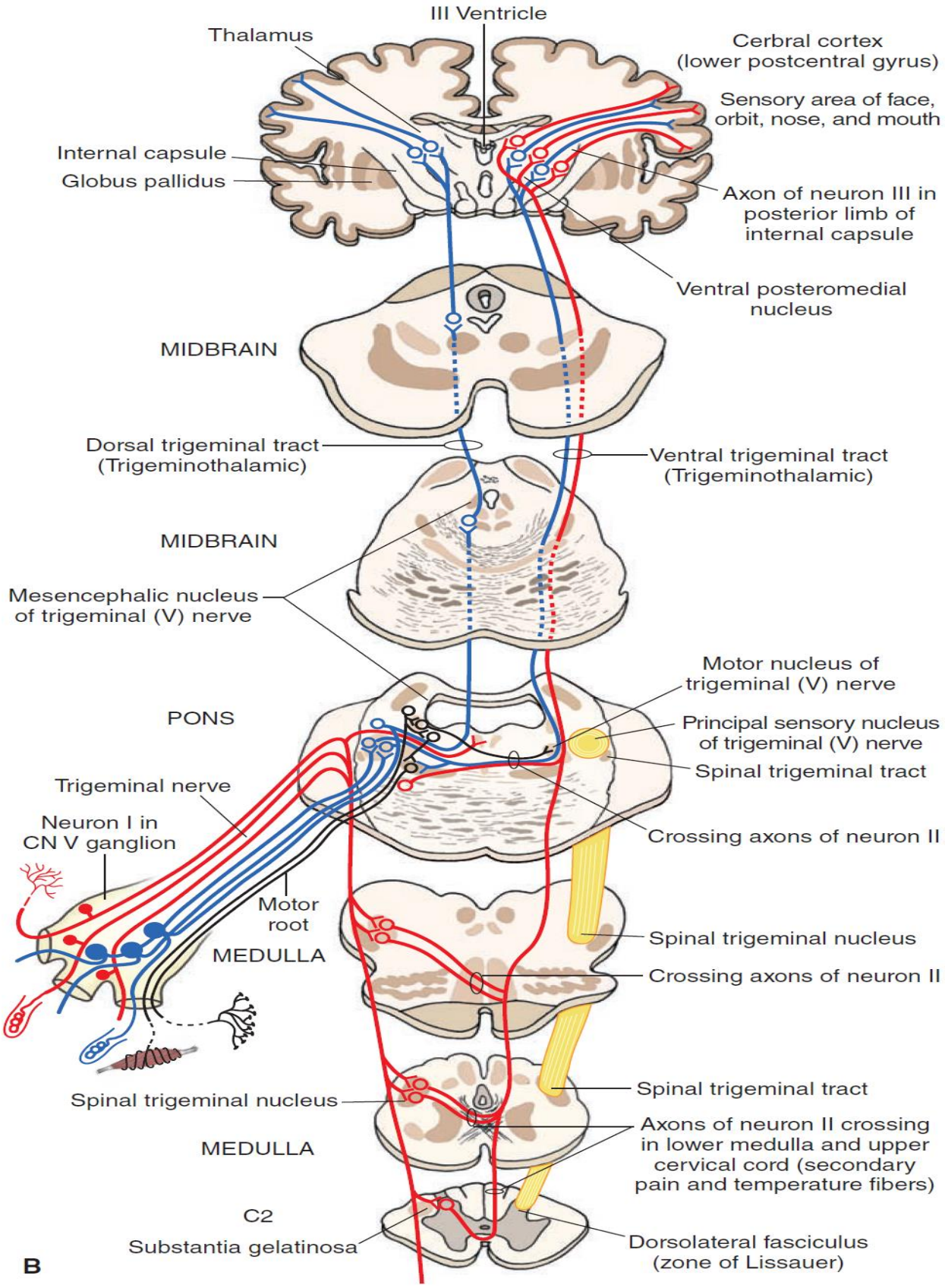
- First, fibers that enter the pons pass downwards to the medulla and up to the upper part spinal cord. We call these fibers the **spinal trigeminal tract**. They conduct pain and temperature sensation.
- Now we follow other fibers: they enter the pons and bifurcate into upper and lower, the lower fibers will follow the spinal trigeminal tract and the upper fibers go upward to the **main sensory nucleus**. These fibers that bifurcate carry touch from the face and they are the axons of first order neuron, the lower fibers synapse with second order neuron in a nucleus called spinal trigeminal nucleus.

So far we have two sensory nuclei belonging to the trigeminal nerve: spinal trigeminal nucleus and main sensory nucleus.

These are the second order neuron, now we follow them into the thalamus:

- The axons of the spinal trigeminal nucleus will cross the midline (this is characteristic of 2nd order neurons) forming **ventral trigeminothalamic tract** and ascend to the thalamus where they synapse on the third order neurons in the thalamus (in the VPM which is part of ventrobasal complex). This ventral trigeminothalamic tract is part of the **trigeminal lemniscus.**

Now we come to the second order neuron of the chief sensory nucleus of the trigeminal we follow its axons: they ascend ipsilaterally and well as contralaterally forming together the **dorsal trigeminothalamic tract** (the other part of the TG lemniscus).


III Ventricle
Thalamus
Cerbral cortex
(lower postcentral gyrus)
Sensory area of face,
orbit, nose, and mouth
Internal capsule
Globus pallidus
Axon of neuron III in
posterior limb of
internal capsule
Ventral posteromedial
nucleus
MIDBRAIN
Dorsal trigeminal tract
(Trigeminothalamic)
Ventral trigeminal tract
(Trigeminothalamic)
MIDBRAIN
Mesencephalic nucleus
of trigeminal (V) nerve
Motor nucleus of
trigeminal (V) nerve
PONS
Principal sensory nucleus
of trigeminal (V) nerve
Spinal trigeminal tract
Trigeminal nerve
Neuron I in
CN V ganglion
Crossing axons of neuron II
Motor
root
MEDULLA
Spinal trigeminal nucleus
Crossing axons of neuron II
Spinal trigeminal tract
Spinal trigeminal nucleus
Axons of neuron II crossing
in lower medulla and upper
cervical cord (secondary
pain and temperature fibers)
MEDULLA
C2
Substantia gelatinosa
Dorsolateral fasciculus
(zone of Lissauer)
B

- Thus the trigeminal lemniscus is formed of vental trigeminothalamic tract and dorsal trigeminothalamic tract. **Here we notice that touch sensation reaches both main sensory nucleus and spinal trigeminal nucleus and goes to the opposite side and to the same side.** What does it mean? This shows the significance of touch to face.
- -Where are the cell bodies of the ventral trigiminothalamic tract? spinal trigeminal nuclues
- -Where do we have the cell bodies of the dorsal trigiminothalamic tract? main sensory nucleus.

SPINAL TRIGEMINAL NUCLEUS IN DETAILS:

-Divided into 3 parts:

-**The rostral part** :الأعلى called pars oralis and receives touch from the mouth.

-**Par intercolaris**: pain from teeth

-**Most caudal part (very important)**: called pars caudalis and receives pain and temperature sensations from wide areas.

→

1. **Cornea** (remember the corneal reflex: if you touch the cornea with cotton bud there will be closure of the eyelid on the same eye AND on the other eye. This is a protective reflex. The afferent of this reflex is the trigeminal and efferent is the facial).
2. Skin of **face, nose**.
3. Skin of the **neck** through 2nd and 3rd cervical nerves.
4. **Dura mater**: and it is divided
   above tentorium cerebelli → supplied by ophthalmic
   belowe tentorium cerebelli → supplied by C2,3, and vagus.
5. **pharynx and esophagus**

- Pars caudalis, again, is the lower part of spinal TG nucleus.

HOW IS THE FACE REPRESENTED?

-Most superior part of pars caudalis receives afferents from the most anterior (lips). Look at the numbers in the figure below.

-The face is represented in layers sometimes called onion-like appearance.

Fig. 34-4 Representation of the face in the pars caudalis of the spinal nucleus of trigeminal nerve. (C1 often has no posterior nerve root.) (Adapted from Sears and Franklin, 1980.)

Other nuclei belonging to the TG: motor and mesencephalic nuclei.

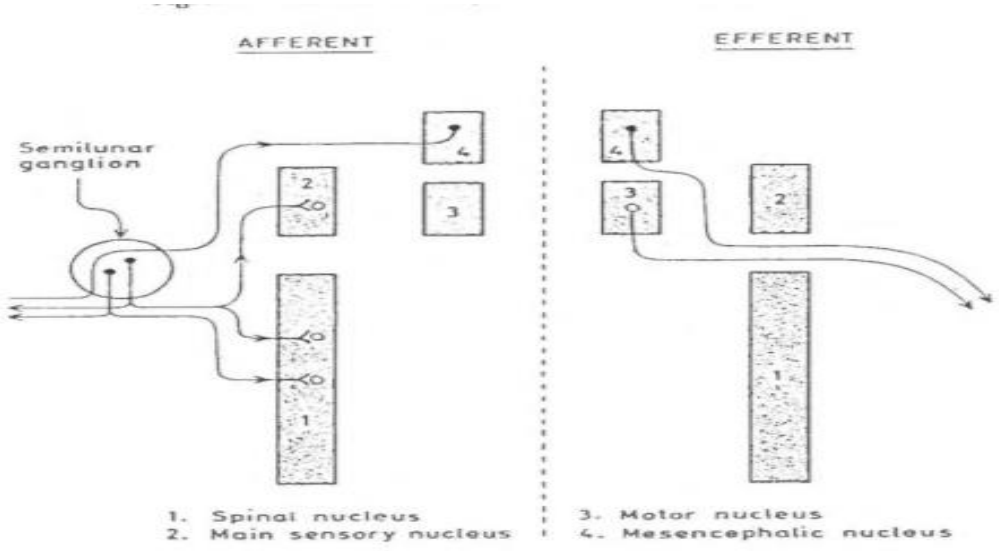
MESENCEPHALIC NUCLEUS

- Concerned with proprioception from the muscles of the face, tongue, and extra-ocular muscles.

- Number 4 in the figure below.

-What is peculiar to this nucleus is that it contains **pseudo-unipolar neurons** (bipolar neurons). The only nucleus that contains bipolar neurons is the mesencephalic nucleus which also reaches the midbrain. Since it is pseudo-unipolar it has peripheral and central processes. The peripheral processes go the spindles of muscles of tongue, extra-ocular muscles. Central processes go to the thalamus and cerebellum → **It carries both conscious and unconscious proprioception.**

-Sometimes called **nucleus of biting** because when you bite you activate the muscle spindles and all the muscles of mastication will contract.



SENSORY MAP OF THE FACE

- Draw a line from the external acoustic meatus going upwards, then from the chin to the external acoustic meatus, then from the angle of the mouth to the middle of the first line (the perpendicular one), then from the lateral angle of the eye to middle of the first line, then from the ala of the nose to the medial angle of the eye.

- Dorsum of the nose vs. ala of the nose:
  What is the difference? Dorsum of the nose receives sensation through the ophthalmic division of the TG nerve while the ala from the maxillary.

1. Upper eyelid: ophthalmic**.**
2. Lower eyelid, upper lip, upper teeth : maxillary
3. Lower lip, chin, lower teeth: mandibular

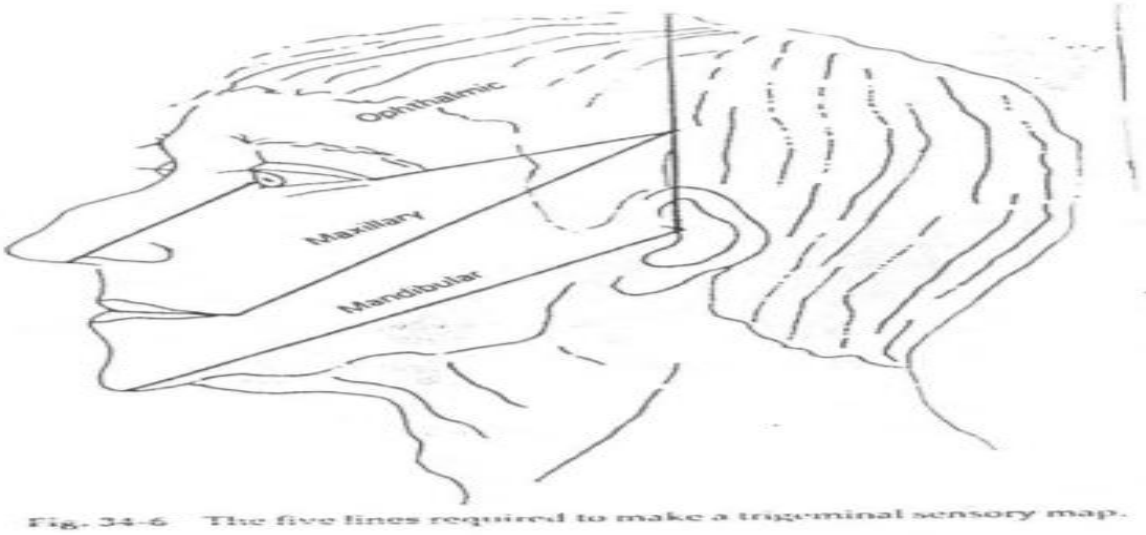


Fig. 34-6 The five lines required to make a trigeminal sensory map.

- Trigeminal neuralgia:
- The patient will come complaining of symptoms:
  severe pain when wind hits his/her face or severe pain when brushing teeth. Basically the patient complains of pain in the distribution of the ophthalmic, maxillary, or mandibular nerves. Therefore, it is important to memorize the map accurately.

MOTOR PART OF TRIGEMINAL

- It is the motor part of mandibular (remember the mandibular is mixed).

- Supplies muscles derived from the **first branchial arch** which are the muscles of mastication.

  - Temporalis, masseter, medial pterygoid, lateral pterygoid + other four
  - Tensor tympani, tensor palati, mylohyoid, and anterior belly of digastric.

- Lesions in the motor part are uncommon.

- **How may it be lesioned?**

  - Sometimes patients with TG neuralgia undergo surgery to cut the spinal trigeminal tract or the maxillary division and while doing so the mandibular nerve may get cut inadvertently.عن غير قصد

    Trigeminal neuralgia was treated surgically in the past.

    To test the lesion in thee mandibular:
    - Ask the patient to open his/her mouth: **it will deviate to the weak side under the effect of the lateral ptreygoid muscle.** If both the right and the left lateral pterygoid muscles are working, they will bring the lower jaw to the midline. If the lateral pterygoid is weakened, the lower jaw (not the angle of the mouth) will deviate to the weak side.

JAW JERK

Fig. 8.31 Eliciting the jaw jerk.

- Present when there is **bilateral upper motor neuron lesion**. The patient quickly closes the mouth with great force. This is the same as the hyperreflexia we've seen in biceps or knee jerk.
- In this case the muscles raise the lower jaw upwards if it is bilateral. Why only occurs in bilateral but not in unilateral lesions? When you hit the lower jaw you contract the muscles (masseter, temporalis,..) on both sides and therefore the effect will be on both sides. If there was an UMN lesion on one side, the response will be weak.

FACIAL NERVE

- The facial nerve is the most frequently paralyzed of all the peripheral nerve.

- Its nucleus is in the **pons**, the nerve goes out from the pons and enters the **internal acoustic meatus** in the petrous part of temporal bone (an opening in the skull) accompanied by the **8th CN** and between them is a thin nerve called **nervus intermedius (**this nerve belongs to the facial nerve). NI contains taste fibers and parasympathetic fibers, this means that the facial is not only motor: it is motor, parasympathetic and sensory (taste).

- It passes above the vestibule of labyrinth (labyrinth = inner ear), then descends between the middle ear and the mastoid process in a canal sometimes called stylomastoid canal because it ends in the stylomastoid foramen.
- It goes out of the skull through the stylomastoid foramen. **BEFORE** leaving the skull it gives and branch to a muscle in the middle ear called the **stapedius**. The muscle limits the movement of the stapes.

What moves the stapes? Vibrations from the external ear.

If the stapes moves excessively you get **hyperacusis: hypersensitivity to sound due lesion in the facial nerve.**

COMPONENTS

- The ganglion of the nerve is found where the nerve changes its direction and it is called the geniculate ganglion. Once you hear geniculate ganglion remember that it is a ganglion related to the facial.

1. **SVE:**
   - Motor to the facial muscles (muscles of facial expression or mimetic muscles) why are they responsible for facial expression? Because they are inserted into the skin of the face. The facial nerve leaves through the stylomastoid foramen. However, before it leaves it gives a branch to the stapedius and after leaving it directly gives branches to the occipital belly, occipitofrontalis, stylohyoid and posterior belly of digastric and then enters the parotid gland where it divides into 6 branches: supplying upper and lower facial muscles.
   - Once the facial nerve leaves the skull it contains only motor fibers.
   Therefore, cancer in the parotid gland will only affect the motor function of the facial, the sensory and parasympathetic are not affected.
   - SVE is the only component that reaches the face, other components are given in the cranial cavity.

- The nucleus for SVE is present in the **principle motor nucleus at the pons.**

2- GVE or the parasympathetic part:
- the mother cells are in the superior salivatory nucleus and goes to **all glands of the face except the parotid (supplied by the 9th)** so it supplies: lacrimal gland, nasal gland, submandibular, sublingual, intralingual. Intralingual are salivary glands in the tongue that secrete saliva in between meals, while talking, however the others (submandibular and parotid) secrete saliva in response to food.

3- SVA or taste:
- mother cells are in the geniculate ganglion and bring taste from the anterior 2/3 of the tongue through a branch of the facial called the chorda tympani. Chorda tympani distributes with a branch of the trigeminal.

4- GSA:
- Brings afferents from outer ear and through the spinal trigeminal nucleus. So what are the nerves that reach the outer ear? 7,9, and 10.

- The vagus is the most important, because if stimulated significantly, there may be a significant bradycardia to the degree of shock.

FACIAL PALSY

- In patients with facial palsy, it is worthy to look into the external acoustic meatus, and if you see eruptions then the facial palsy is mainly caused by a viral infection. The facial palsy is severe in this case.

- Two things to ask to a facial palsy patient:

1. "Are you diabetic?" even if the patient said no, make sure to test the fasting blood glucose.

2- "Show me your ear" look for eruption

NERVOUS INTERMEDIUS

- Contains parasympathetic and taste fibers.

- **Parasympathetic**:
  Its cell bodies are present in the pons within superior salivatory nucleus.

  How is it distributed?
  - Through the greater petrosal and the chorda tympani. The parasympathetic before reaching the effector organ needs a ganglion (synapse) called PP or **pterygopalatine ganglion**, out of it comes nerves supplying lacrimal and nasal glands. The other nerve carrying parasympathetic, chorda tympani, its ganglion is the **submandibular ganglion** and goes to the submandibular salivary gland, sublingual, and intralingual glands.

- These two nerves are parasympathetic AND taste: activate impulse in two ways.

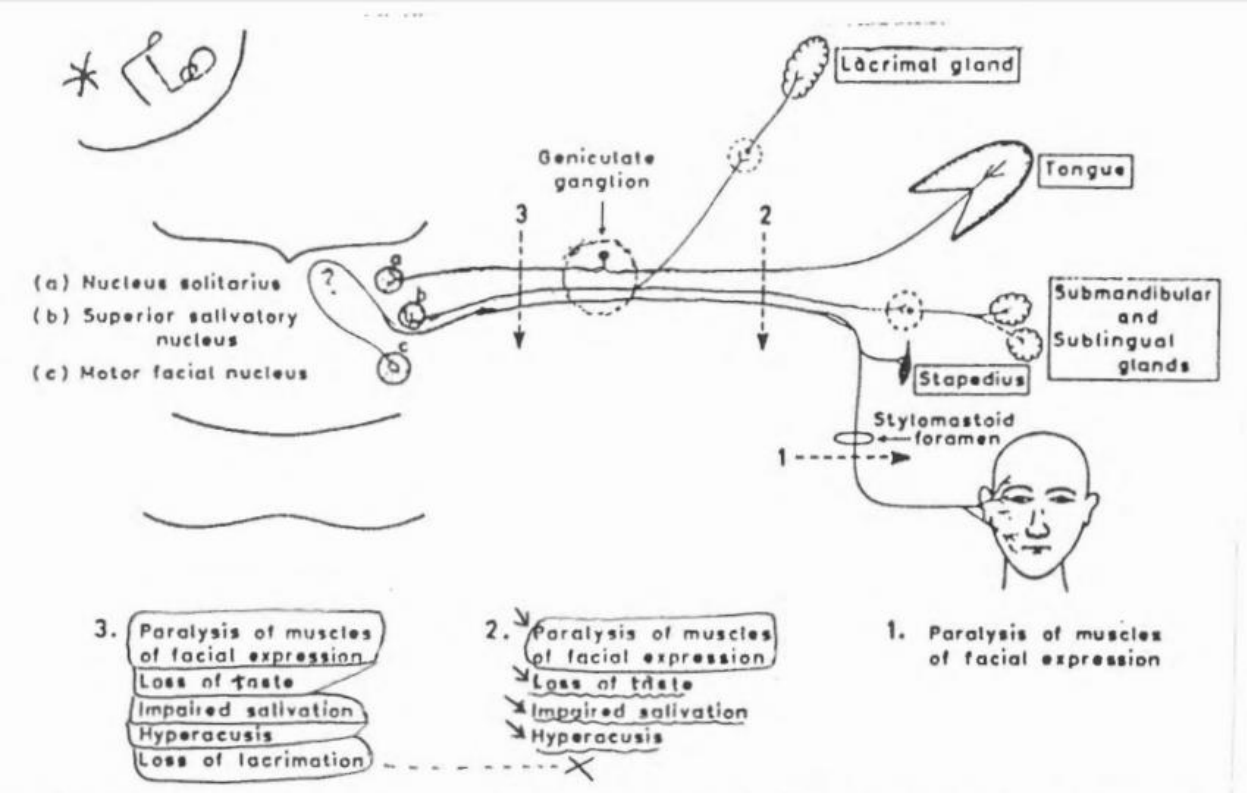
- PP: if stimulated excessively --> excessive lacrimation and excessive secretions of the nose. When you see this patient you might think that they have common cold however this might be allergic rhinitis.

- Allergic rhinitis may be caused by many allergens in the environment that activate PP.

Allergic rhinitis was called hay fever. Why?
Because it was thought that it's caused by hay and as the patients look red, they called it hay fever.

But now, it's believed that it may be caused by many allergens, so it's now called allergic rhinitis.

LESIONS IN THE FACIAL NERVE



1. **Lesion proximal to gengiculate ganglion**: all of the facial nerve parts are affected (the muscular part, parasympathetic and taste)
   - first symptom: paralysis of muscles of facial expression on the same side upper and lower parts of face. If lower alone then it is a stroke.
   - Other symptoms: loss of taste, impaired loss of salivation and not loss of salivation because the parotid is still working, hyperacusis and loss of lacrimation.
2. **Lesion distal to ganglion:** all symptoms mentioned above except lacrimation.
3. **Lesion after exiting the stylomastoid foramen**: ONLY paralysis of facial muscles upper and lower.
4. Facial muscles can be affected by UMNL by stroke—hemiplegia

MOTOR NUCLEUS OF FACIAL

- The part of facial nucleus that supplies the upper face receives contralateral as well as ipsilateral input.

- Patient has a stroke in the internal capsule: lesion in pyramidal and extrapyramidal corticospinal and corticobulbar--> the effect is contralateral hemiplegia and hemiface.

FACIAL PALSY

- If it is advanced:
- ask the patient to close eyes: the side which didn't close is the side of the lesion + mouth deviates to the opposite side, absence of nasolabial fold, no transverse creases, **can't whistle**, ask patient to show their teeth: the upper lip deviates to the healthy side.

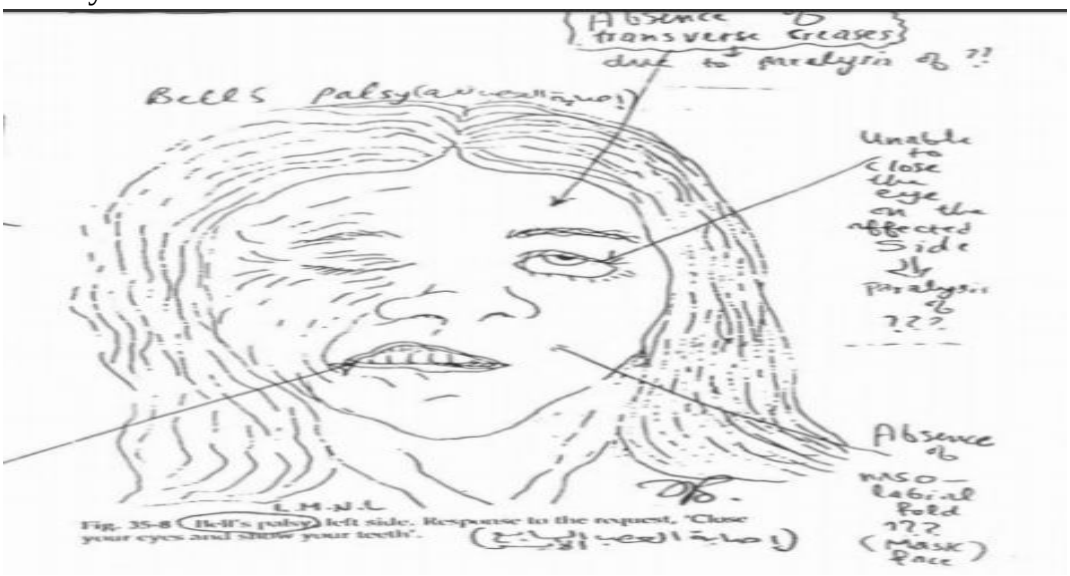


Fig. 35-8 Bell's palsy, left side. Response to the request, 'Close your eyes and show your teeth'.

MOTOR NUCLEUS OF FACIAL RECEIVES INPUT FROM:

1. Bilateral corticobulbar fibers to that part of the nucleus which supplies the upper facial muscles and only contralateral to that part of the nucleus that innervates lower facial (perioral muscles).

2. Basal ganglia: supported by the fact that if a patient with weakness in the lower facial muscle was emotionally involved can whistle and use the muscles normally. What activated the nucleus in this case?
Mostly the limbic cortex passing through the basal ganglia. In other words, this means that the facial nucleus doesn't only receive corticobulbar input but also from limbic system.


Fig. 35-4 A, supranuclear lesion of the left facial nerve. B, the patient can smile spontaneously.

3. Superior olive: part of hearing tract, explains the grimacing of the facial muscles that occurs in response to loud noises.

4.Trigeminal system: Underlies the blinking of the eyelids in response to corneal stimulation.

Corneal Reflex:
Touching the cornea with a cotton wisp elicits a bilateral blink response. The afferent limb of this reflex is the nasociliary branch of the ophthalmic nerve, and the efferent is the facial.

Touching the cornea sends impulses through the ophthalmic → Then the facial sends motor branches to the palpebral part of the orbicularis oculi muscle.

SPEECH AND LANGUAGE

Involves:

- Understanding spoken and printed words

- Expression of ideas: by speaking or writing (if you are literate)

- Aphasia: اضطراب الكلام could be:

  - **fluent (sensory)**: instead of saying "I cut with a knife" the patient says "I cut with a fork" or patient may say "I use a bife and a dork" instead of "knife and fork" سمعه طبيعي و عضلات الكلام مش مشلولة speaks fluently but his ideas are nonsense.
  - **or non-fluent (motor)**
    In both types there are NO defects in vision, hearing and muscles.

- The left cerebral hemisphere is dominant in more than 95% of people, centers for speech are present in the left area. Broca's area is present in the frontal lobe in the left inferior frontal gyrus.

- Wernick's: sensory speech area present in the posterior part of area 22 (association auditory area).

- Left hemishephere: is dominant for speech

- Right hemisphere: analytical, recognition of faces, music.

-**Both hemispheres comprehend but only the left hemisphere talks**.

- For example: If I put a key in your left hand, where do you feel it? On the right hemisphere where you understand what you are touching. For you to say that you felt the key in your left hand the signal must be sent from the right side to the left side.الجزء المتكلم من الدماغ In other words, if you cut the corpus callosum, you understand that you have a key in your left hand but you're unable to talk, why?

  The signal from your left hand goes to the sensory cortex on the right, to be able to speak the signal must go from the right side to the left side through the corpus callosum which is cut in this case. This is called **split syndrome**: the brain is cut into half. From the outside the patient looks normal but if you do tests you find disturbances.

-Again, both hemispheres comprehend, but to express and to talk the signal must reach the left cerebral hemisphere.

COMMUNICATION BY LANGUAGE

SPOKEN LANGUAGE

- If someone spoke to you
- First thing: you hear what that person said, what are the parts of the brain responsible for hearing and responding?

  Primary auditory area. It receives impulses from the ear and sends them to the association auditory area (area 22) next to it and from the association auditory area (there are 6 parts) and mainly from its posterior part called the Wernick's sensory speech area comes out a bundle of fibers called arcuate fasciculus and it goes to Broca motor speech area which contains speech programs which are executed these through muscles of speech (muscles of larynx, palate, tongue, lips).

- What connects the motor speech area to area 4? A tract between them.
- And from the motor areas comes out the corticobulbar and moves the muscles of speech.

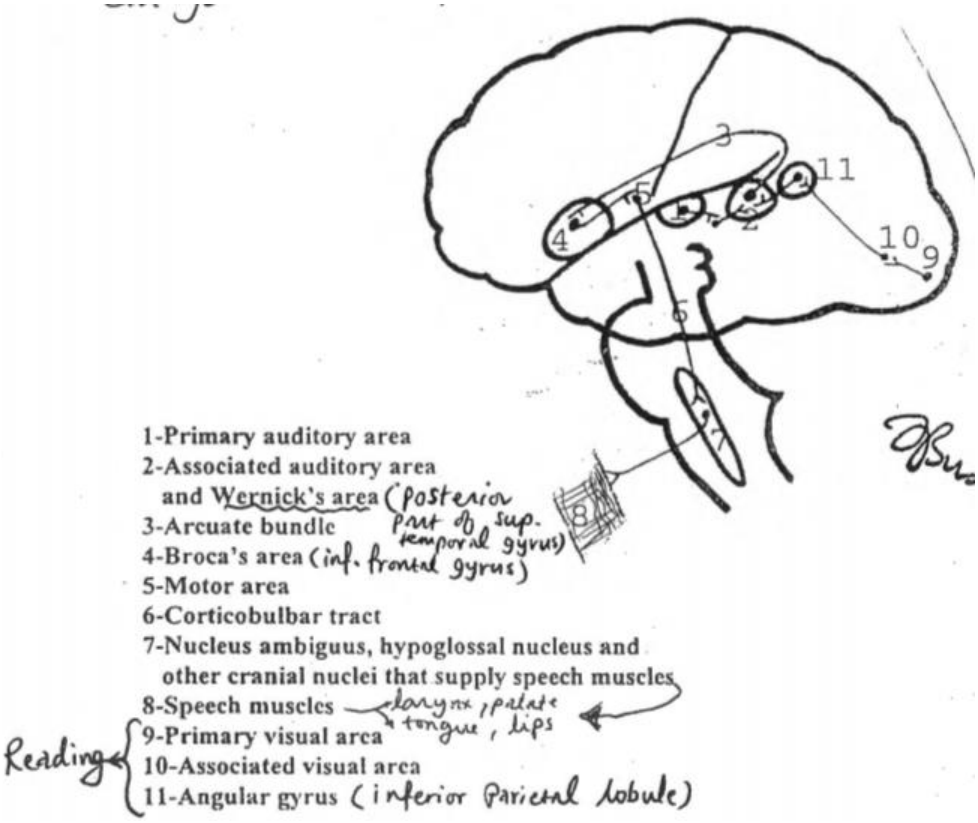
To communicate through speech we needed:

1. Auditory sensory area

2. Association area (Wernicke's)

3. A tract between Wernick's and Broca

4. Then broca sent the speech program to muscles of speech through the corticobulbar which moved the larynx, tongue muscles and lips.



COMMUNICATION BY WRITTEN LANGUAGE (READING)
you need:

1. Primary visual area

2. Association area 17,18, and then to **39: Angular gyrus (very very very important)** and from here signals go to the

3.Wernicke's to Broca

من المسؤول عن التحول من الصورة المرئية للصورة المسموعة؟
left angular gyrus

- If a child is born with a disturbance in the left angular gyrus? Reads but cannot understand what he/she just read.

COMMUNICATION BY WRITING

Left hemisphere is dominant for writing.

Wernicke's sensory speech area is important to understand spoken words coming from the auditory and then it to Broca--> corticobulbar-->speech.

Sorry for any mistake.

2. A 60-year-old man was admitted to the local hospital after complaining that, for the past few months, he has had difficulty in swallowing and his voice has become increasingly hoarse and, at times, little or no voice could be produced. The patient was given a neurologic and general medical examination, and a magnetic resonance imaging scan (MRI) was done. The examinations revealed deviation of the uvula to one side and significant reduction of gastric fluids. The MRI revealed the presence of a growing tumor. The location of this tumor is in the:
   a. Ventromedial medulla
   b. Dorsolateral pons
   c. Internal acoustic meatus
   d. Jugular foramen
   e. Hypoglossal canal

4. A patient displays ipsilateral medial gaze paralysis coupled with contralateral hemiplegia. The lesion is located in the:
   a. Medulla
   b. Caudal pons
   c. Rostral pons
   d. Midbrain
   e. Diencephalon

5. During a routine examination, a physician attempted to elicit a gag reflex response in a patient by stroking the posterior pharynx with a cotton-tipped probe. This reflex is initiated primarily by activating the sensory endings of:
   a. Cranial nerve V
   b. Cranial nerve VII
   c. Cranial nerve IX
   d. Cranial nerve XI
   e. Cranial nerve XII

2. Answer: **d**

The jugular foramen contains fibers of cranial nerves (CN) IX and CN X. In particular, damage to fibers associated with CN X could account for both the somatomotor and autonomic effects described in this case. Because CN X innervates the intrinsic muscles of the larynx, damage to the nerve would affect swallowing and speech (producing hoarseness). Reduction in gastric secretions is due to damage to the parasympathetic inputs to the stomach from the vagus nerve. The other choices are not appropriate because none of them contain any fibers or cell bodies associated with CN X.

4. Answer: **d**

Medial gaze is governed by the action of the oculomotor (cranial nerve [CN] III) nerve. This nerve passes close to the crus cerebri en route to exiting the brain. Therefore, a lesion located in the ventromedial aspect of the midbrain can quite easily affect both the root fibers of CN III as well as the descending fibers of the corticospinal tract. Such a lesion would produce paralysis of the limbs on the contralateral side of the body, due to the disruption of the corticospinal tract, and ipsilateral third nerve paralysis. This constellation of deficits is called Weber's syndrome.

5. Answer: **c**

The afferent (sensory) limb of the gag reflex involves somatic afferent fibers (i.e., general somatic afferent) of the glossopharyngeal (cranial nerve [CN] IX) nerve that enter the brainstem and make a synapse with special visceral motor fibers of CN X, whose axons comprise the efferent (motor) limb of the reflex that innervates pharyngeal muscles. The other cranial nerves are not involved in this reflex.