MEDICINE
KING SAUD UNIVERSITY

تمت المراجعة
شوق الأحمري & عبدالعزيز العنقري

Physiology Team 436

CNS PHYSIOLOGY

- Text.
- Important
- Formulas
- Numbers
- Doctor notes
- Extra notes and explanation

Lecture No.21

« حسبنا الله، سيؤتينا الله من فضله، إنا إلى ربنا راغبون»

Physiology of Speech

Objectives:

1. Describe brain speech areas as Broca's, Wernicke's and insula.
2. Explain sequence of events in speech production.
3. Explain speech disorders as aphasia with its types, dysarthria, and acalculia.
4. Explain difference between aphasia and dysarthria.

Overview

- It is the highest function of the nervous system.
- Involves understanding of spoken & printed words.
- It is the ability to express ideas in speech & writing.
- Types of speech

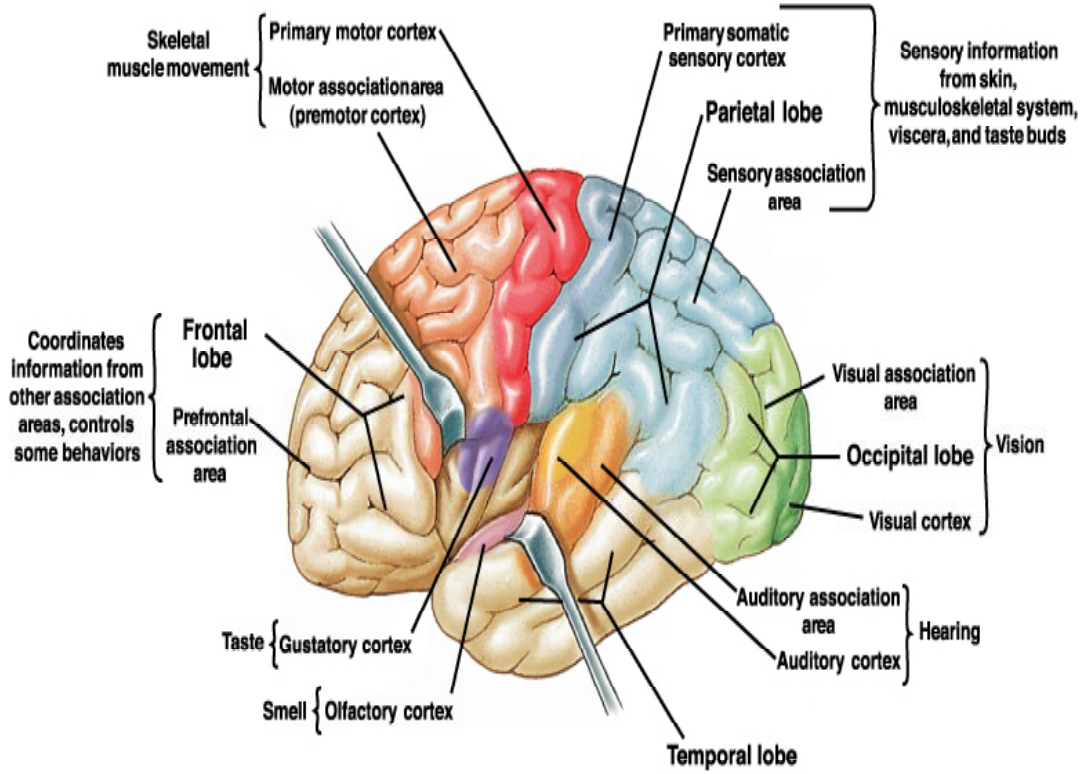
1. Spoken speech:

Understanding spoken words & expressing ideas in speech.

2. Written speech:

Understanding written words and expressing ideas in writing.

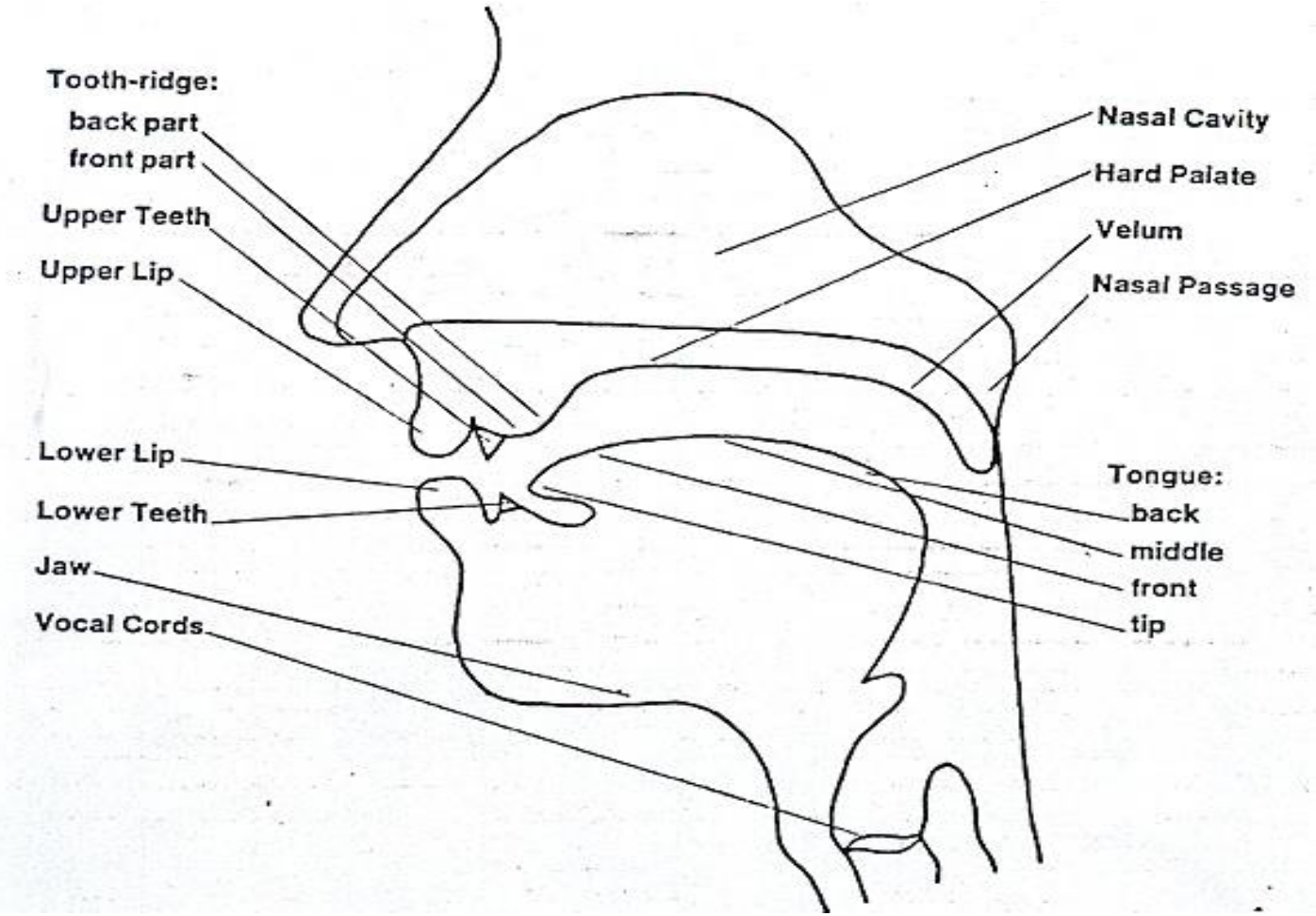
Extra picture



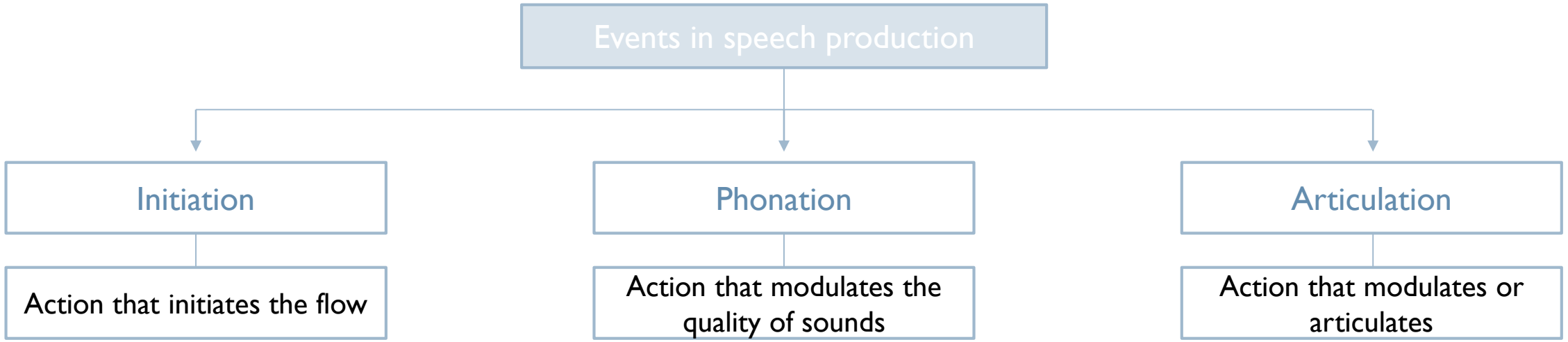
Speech

- Definition: speech may be defined as the means of communication between the two individual or group of individuals.

- Speech structures:
  - Oral Cavity.
  - Nasal Cavity.
  - Pharynx.
  - Larynx.



Basic events in speech production



Basic events in speech production (initiation)

- Setting the airstream in motion:
  - Creating airstream is an essential process of sound production.
  - Change in pressure.

- Three mechanisms of initiation:
  1. Pulmonic: pulmonic airstream mechanism via lungs
     95% of human speech sounds are produced in this way.
  2. Glottalic: airstream mechanism via glottis.
  3. Velaric: airstream mechanism via velum.

- Direction of air flow:

1. Egressive / pressure Sound

Exhalation: Deflation of lungs and consequent compression of the air (Hello…..Hello).

2. Ingressive / suction Sound

Inhalation: Sucking air into the lungs (Hi…..Hi).

ONLY IN MALES' SLIDES

Basic events in speech production (Phonation)

- Phonation is a process of changing air stream.
- Sound production by passage of air over the vocal cord.
- Produce speech sounds, air stream distorted in one way or another.
- Phonation is mainly achieved at larynx, vocal cord.

- Major components:
  - Vocal cords, Glottis, Epiglottis.
  - Three cartilages:
  1. Thyroid
  2. Arytenoid
  3. Cricoid

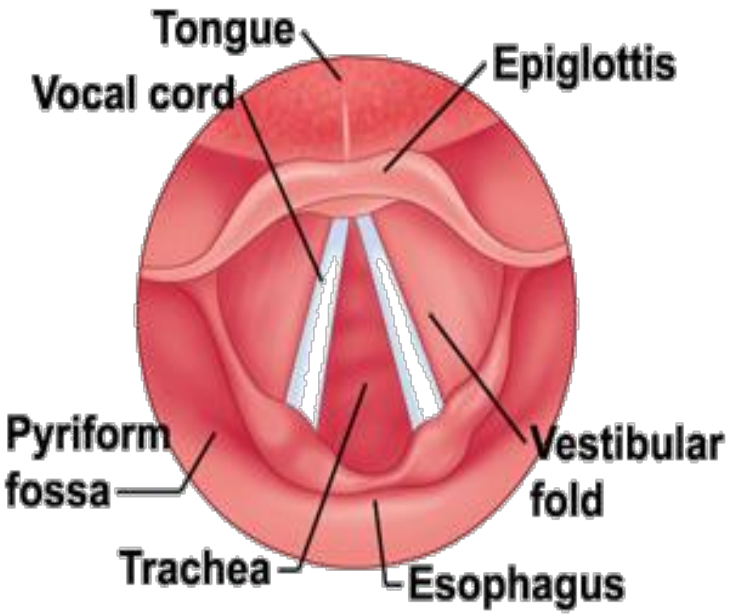
Basic events in speech production (Articulation)

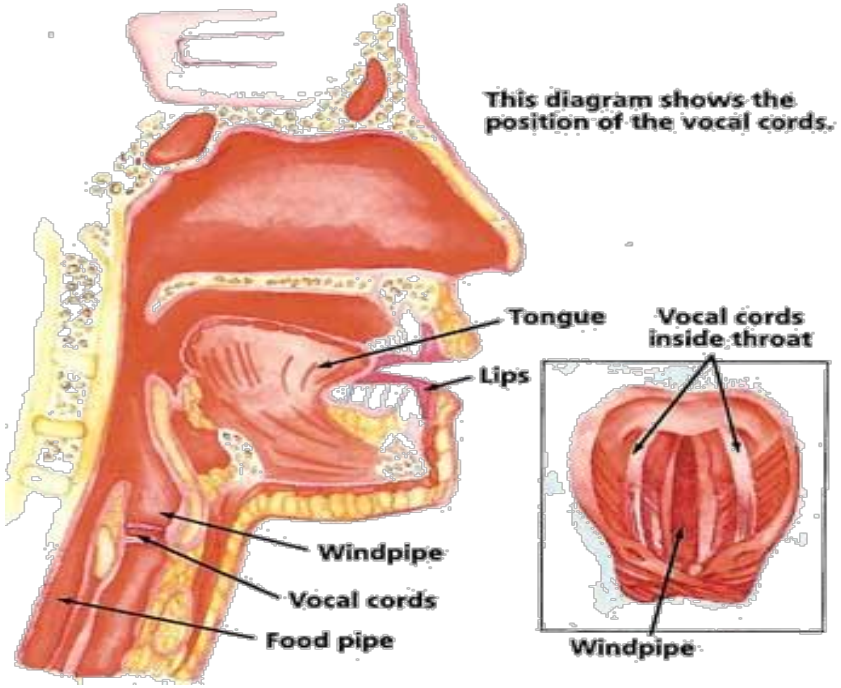
- Contribution by structures to shape airflow.
- A variety of speech sounds can be produced in terms of another way of air stream change – Articulation.
- Articulation is done mainly at vocal cord.
- An specific part of the vocal apparatus involved in the production of a speech sound.

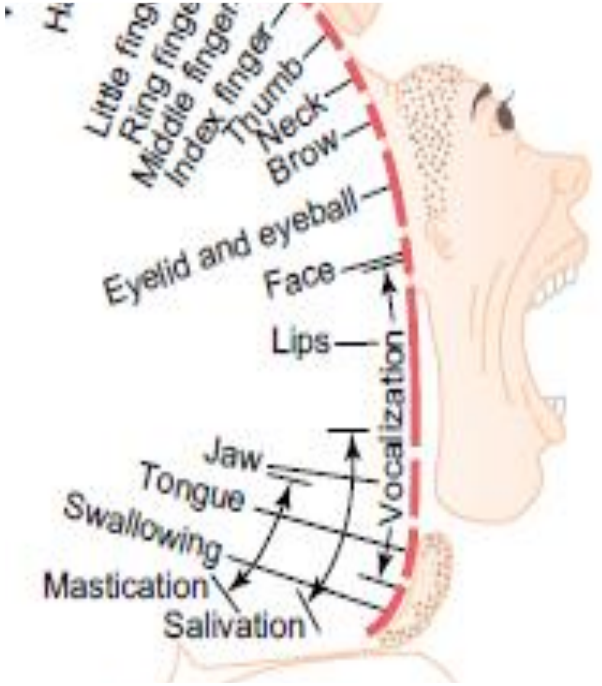
- Active articulators:
  1. Lips.
  2. Tongue.
  3. lower jaw.
  4. velum

Cont. Basic events in speech production (Articulation)

- Muscular movements of the mouth, tongue, larynx, vocal cords.
- Responsible for the intonations, timing, and rapid changes in intensities of the sequential sounds.

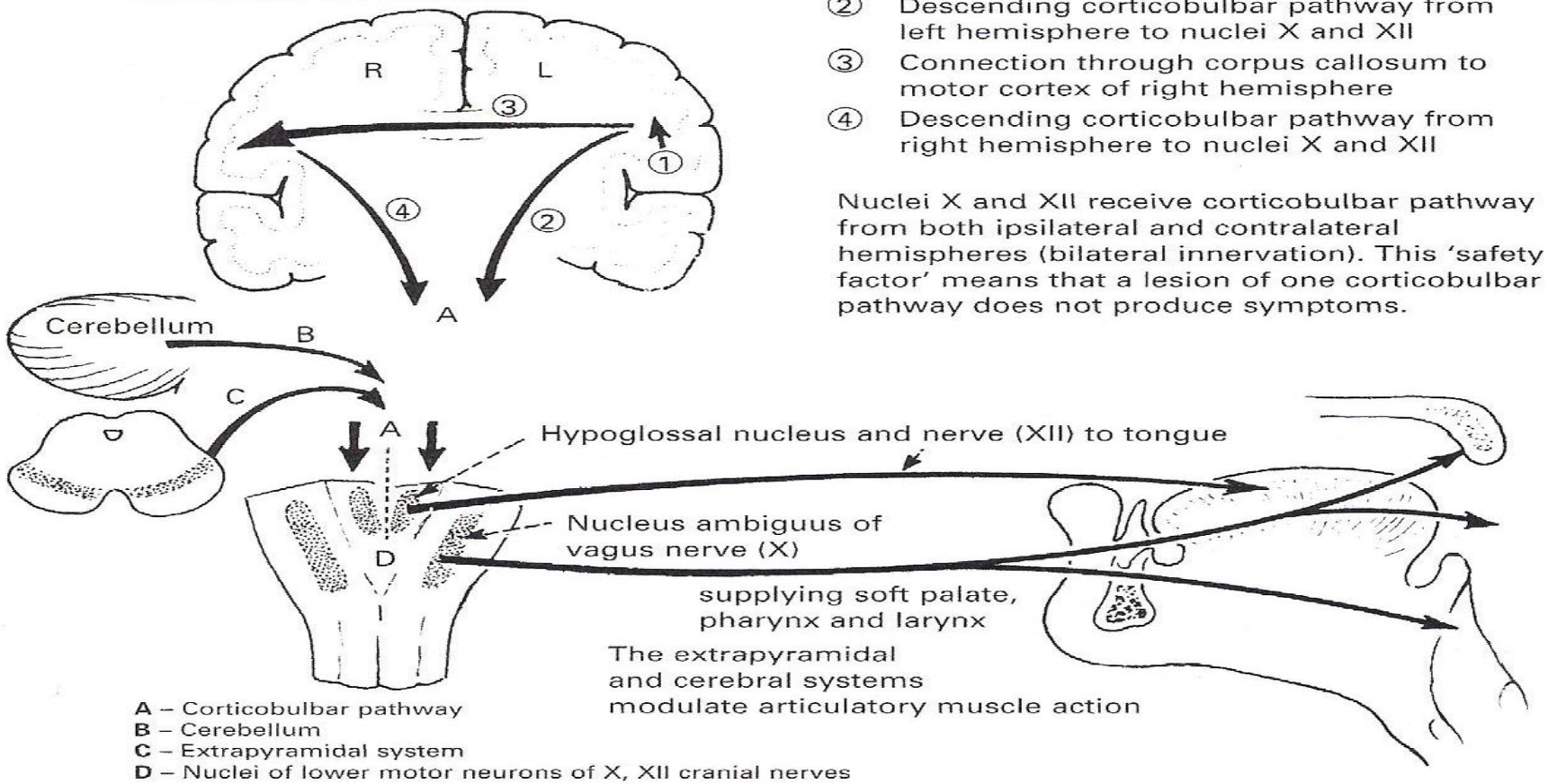






Mechanism of articulation

Mechanism of articulation



① Speech initiated
② Descending corticobulbar pathway from left hemisphere to nuclei X and XII
③ Connection through corpus callosum to motor cortex of right hemisphere
④ Descending corticobulbar pathway from right hemisphere to nuclei X and XII

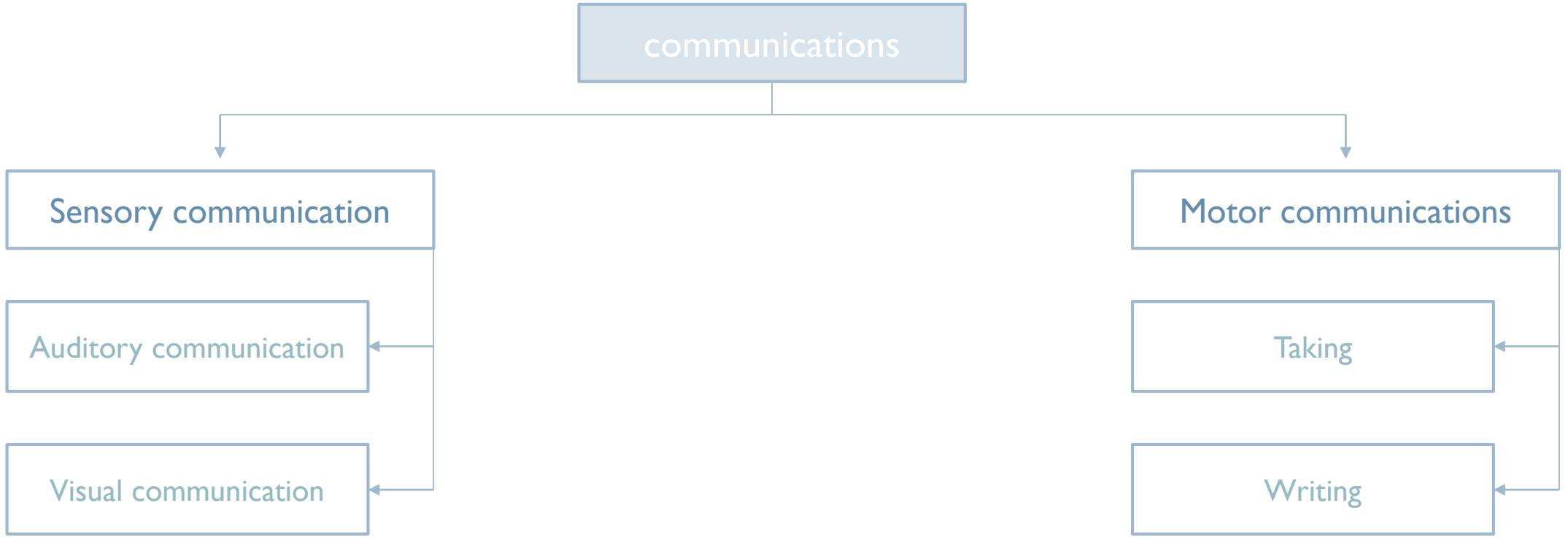
Nuclei X and XII receive corticobulbar pathway from both ipsilateral and contralateral hemispheres (bilateral innervation). This 'safety factor' means that a lesion of one corticobulbar pathway does not produce symptoms.

A – Corticobulbar pathway
B – Cerebellum
C – Extrapyramidal system
D – Nuclei of lower motor neurons of X, XII cranial nerves

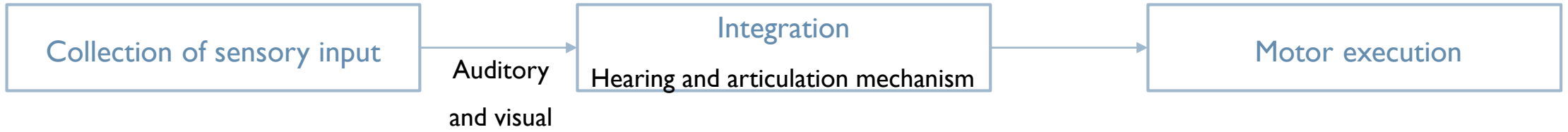
Muscles of expression, innervated by the facial nerve, play an additional role in articulation and weakness also results in dysarthria.

120

Communications



- Steps of communications:



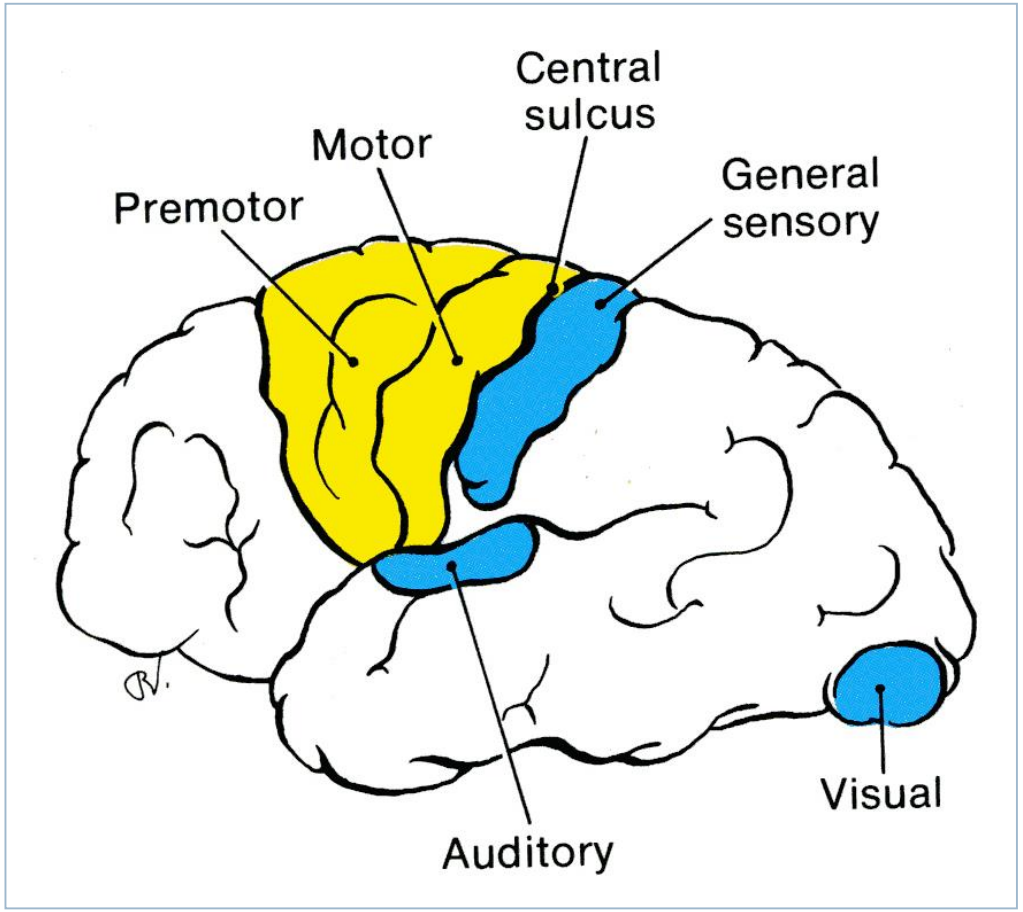
Main sensory areas of the cortex

The somatic sensory area is located in the parietal lobe posterior to the central sulcus.

Visual sensations are received in the visual area in the posterior lobe.

Auditory sensations are received in the temporal lobe close to the lateral sulcus.

Olfactory sensations are received deep inside the temporal lobe.



Brain areas concerned with language

- Wernick's area: understanding (comprehension) of speech.
- Broca'a area: motor area of speech , production of words.
- Speech articulation area → in insula.
- Motor cortex: controls muscles of speech production.
- Angular gyrus.
- Assoc Areas (only in male).
- Arcuate fasiculus (only in female).

Wernick's area

Wernick's area	
At the posterior end of the superior temporal gyrus. في كل منطقة يصير فيها lesion يصير عندنا disorder مختلف.	Closely associated with 1 & 2 auditory areas
Responsible about comprehension of auditory & visual information, then project it to Broca`s area via arcuat fasiculus.	Interpretations of sensory experience
Formation of thought in response to sensory experience. المنطقة مرتبطة بالسمع والفهم – اختيار الكلمات وترتيبها – التخطيط واختيار الردود.	Choice of words to express thoughts

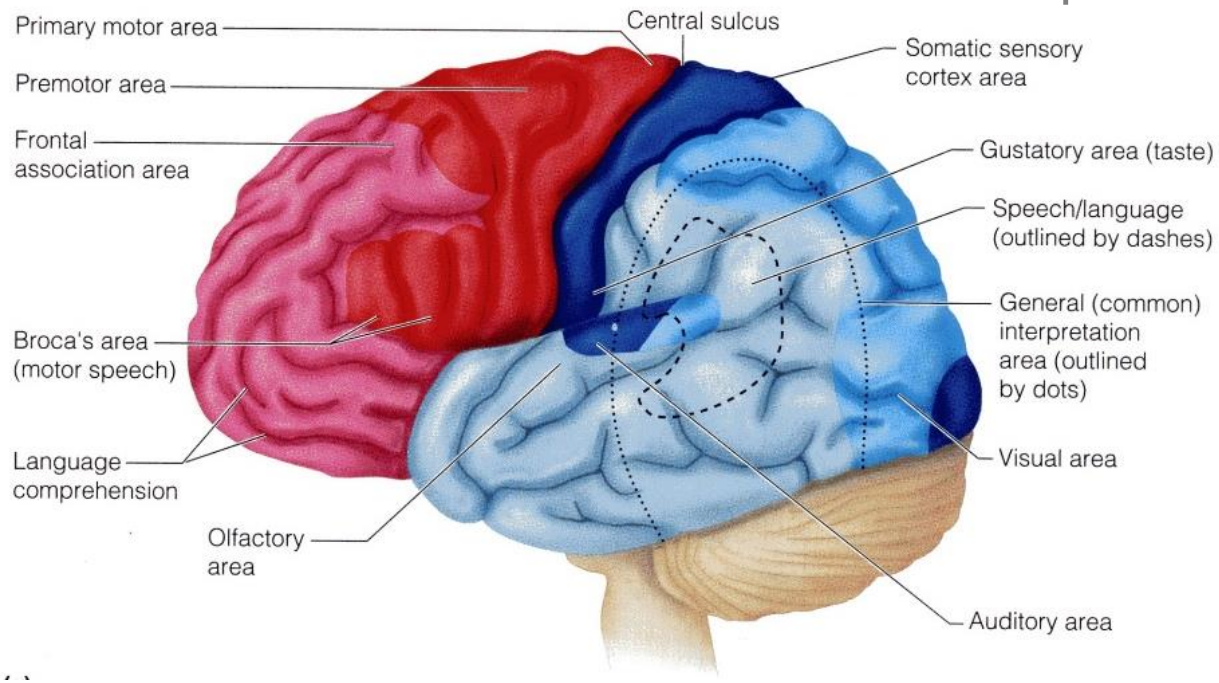
Broca's area

- At the lower end of premotor area.
- Process information received from W. Area into detailed & co-ordinated pattern for vocalization.
- Then project it to motor cortex to initiate the appropriate movement of the lips & larynx to produces speech.
- In adult who learn second language during adulthood. The MRI shows portion of Broca`s area concerned with it is adjacent to but separate from area concerned with the native language.

تتكون عندهم broca's area صغيرة في الدماغ «منطقة مرتفعة»

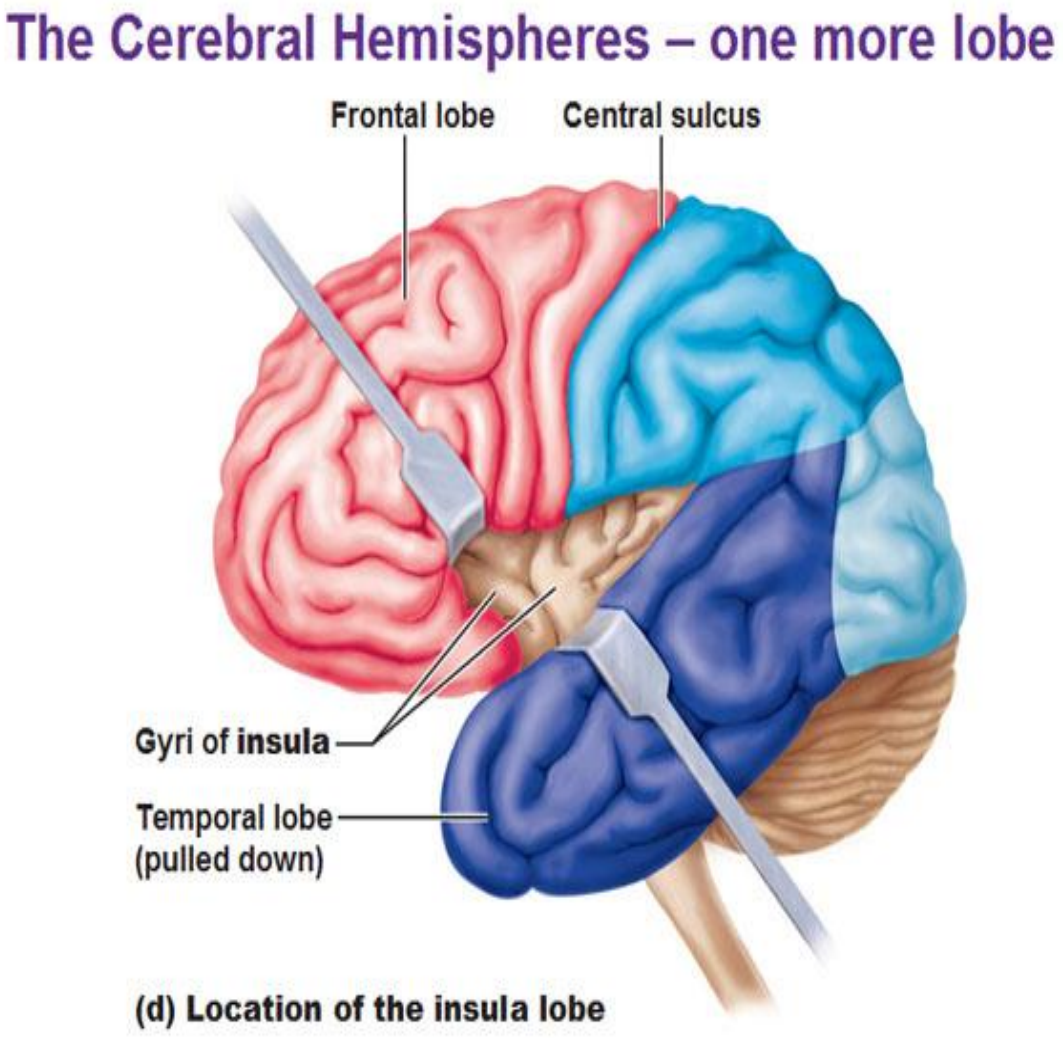
- But in children who learn second language early in life there is only single area involved for both languages, It'll diffuse in one area.

Extra picture



Agular gyrus and insula

- Agular gyrus:
  - Angular gyrus (brodmann area 39) → a region of the brain in the parietal lobe
  - Leis behind Wernikes area fused posteriorly into the visual cortex.
  - Function: interpretation of information obtained from reading from visual cortex.
- Insula:
  - It is a portion of the cerebral cortex folded deep within the lateral sulcus.
  - Hand and eye motor function.
  - It's important in motor execution.



Summary of the speech pathway

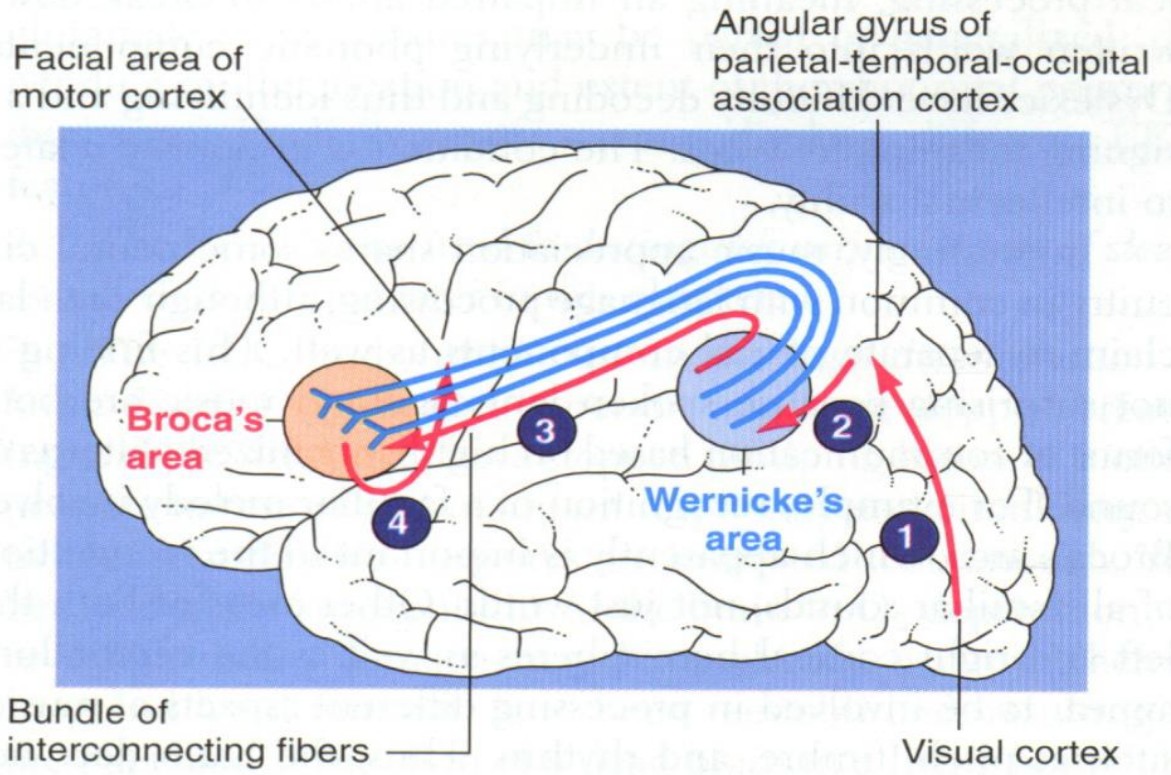
Wernick's area receive information from both auditory & visual areas.

→ Project it to Broca's areas via arcuat fasiculus.

→ Broca`s area process information received into co-ordinated pattern of vocalization & then project that pattern to the motor area.

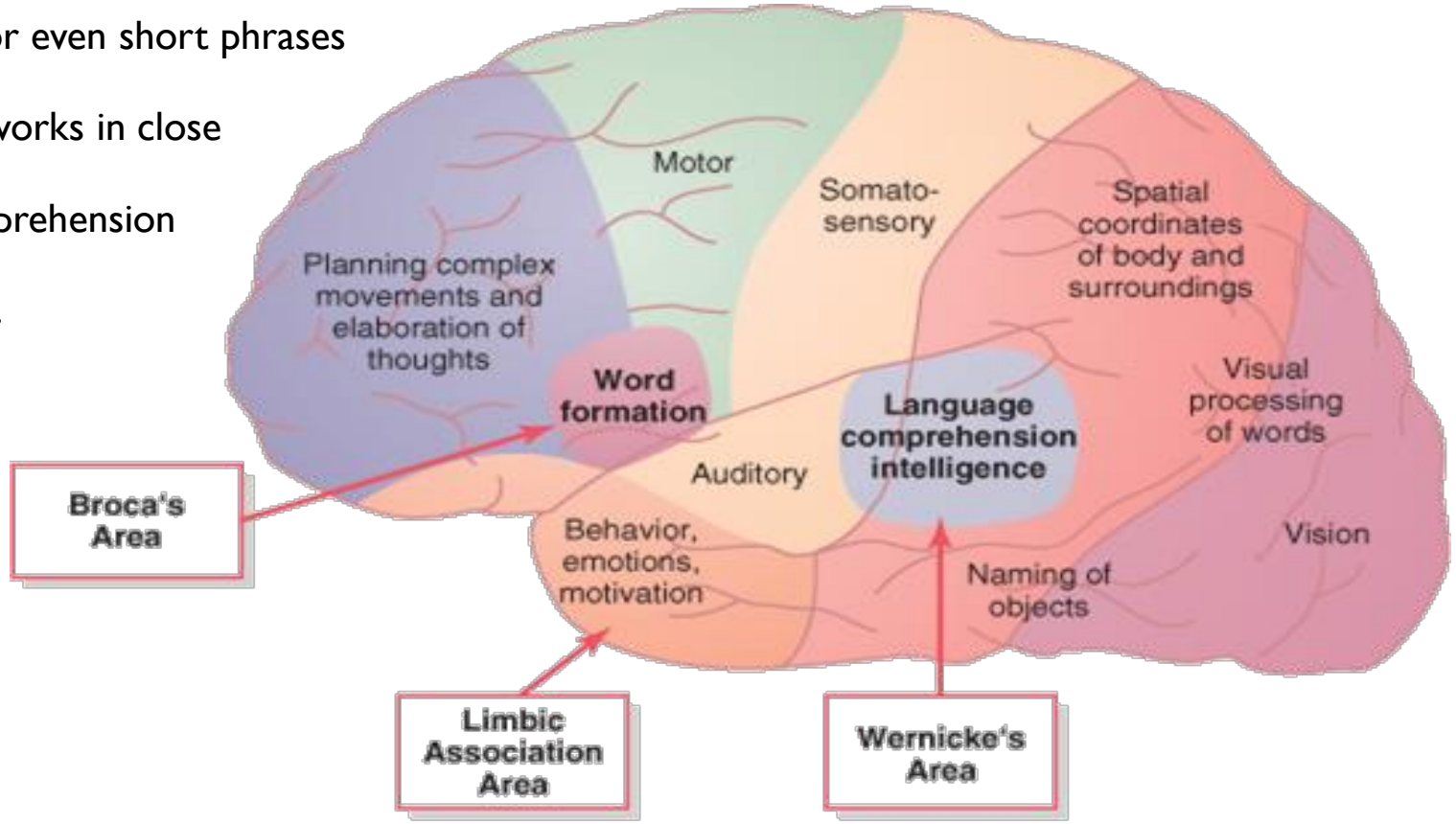
→ Initiation of movement of muscle of speech in tongue, larynx & lips.

- If writing is concerned, then information received from wernick's area is processed in the area of hand skills.
- Co-ordinated pattern of muscle movement projected to the arms & hand region of the motor cortex.
- Initiation of necessary muscle movement in the hand & arms required for writing a particular word.



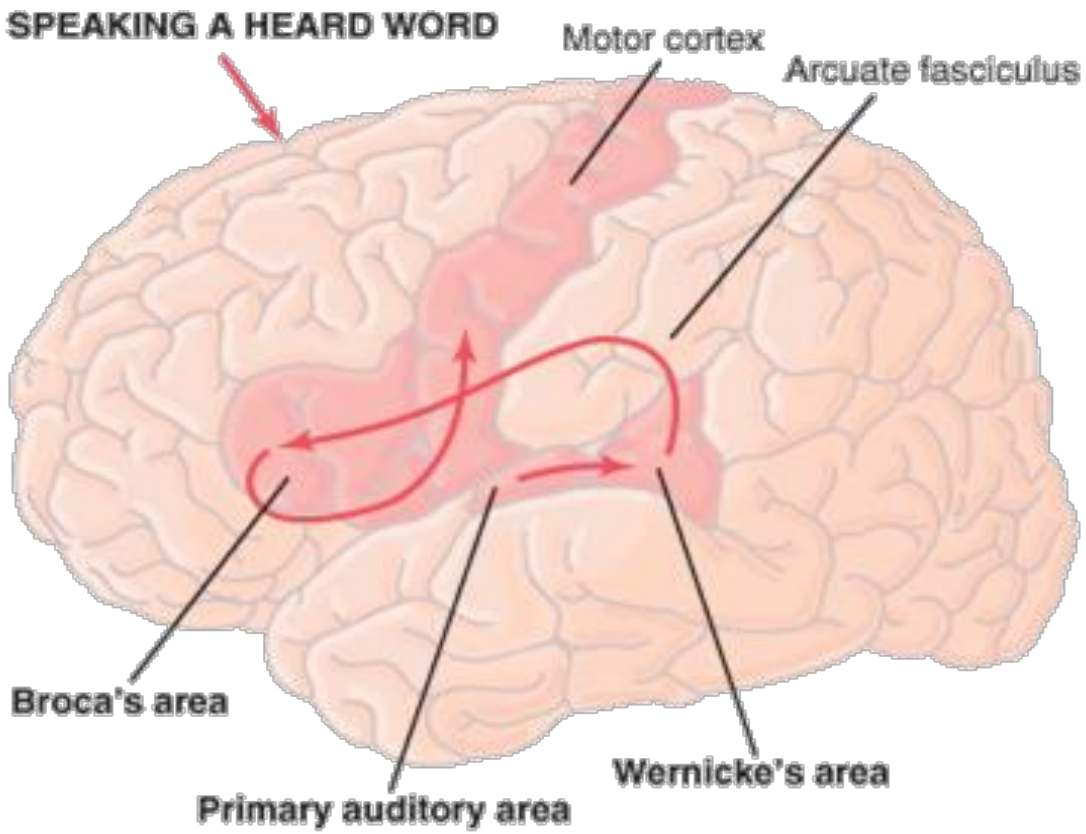
Speech centres

- Broca's Area. A special region in the frontal cortex, called Broca's area, provides the neural circuitry for word formation. This area, is located partly in the posterior lateral prefrontal cortex and partly in the premotor area. It is here that plans and motor patterns for expressing individual words or even short phrases are initiated and executed. This area also works in close association with Wernicke's language comprehension center in the temporal association cortex.

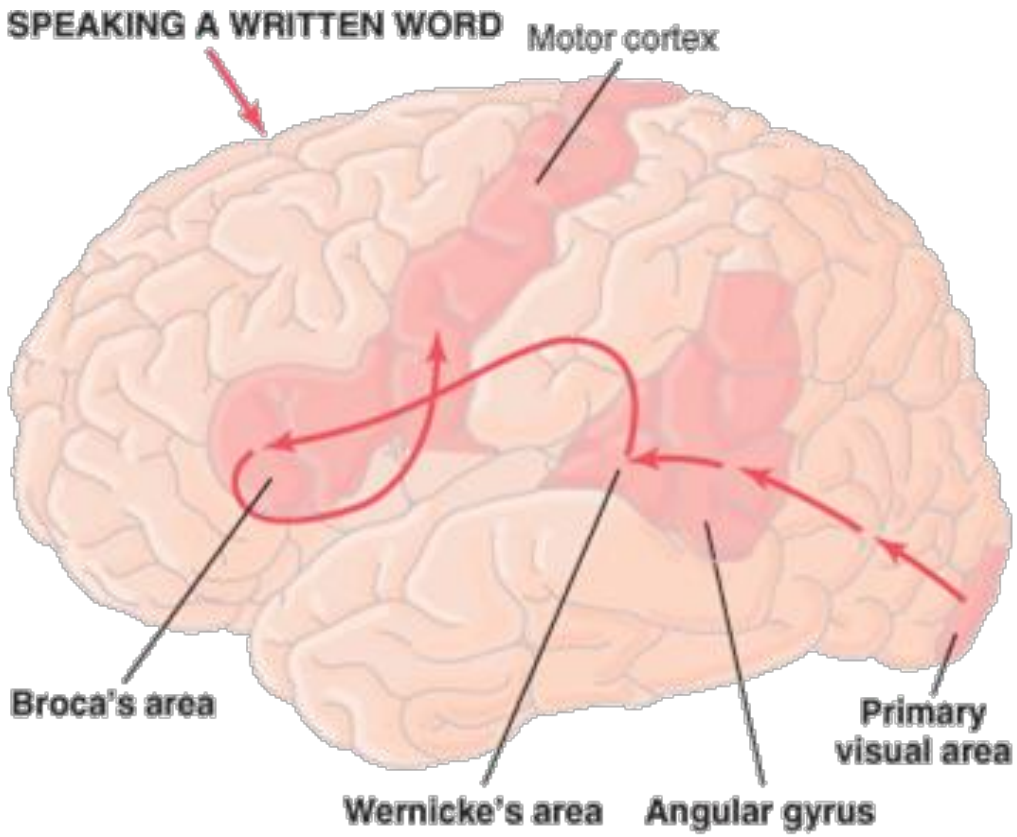


ONLY IN MALES' SLIDES

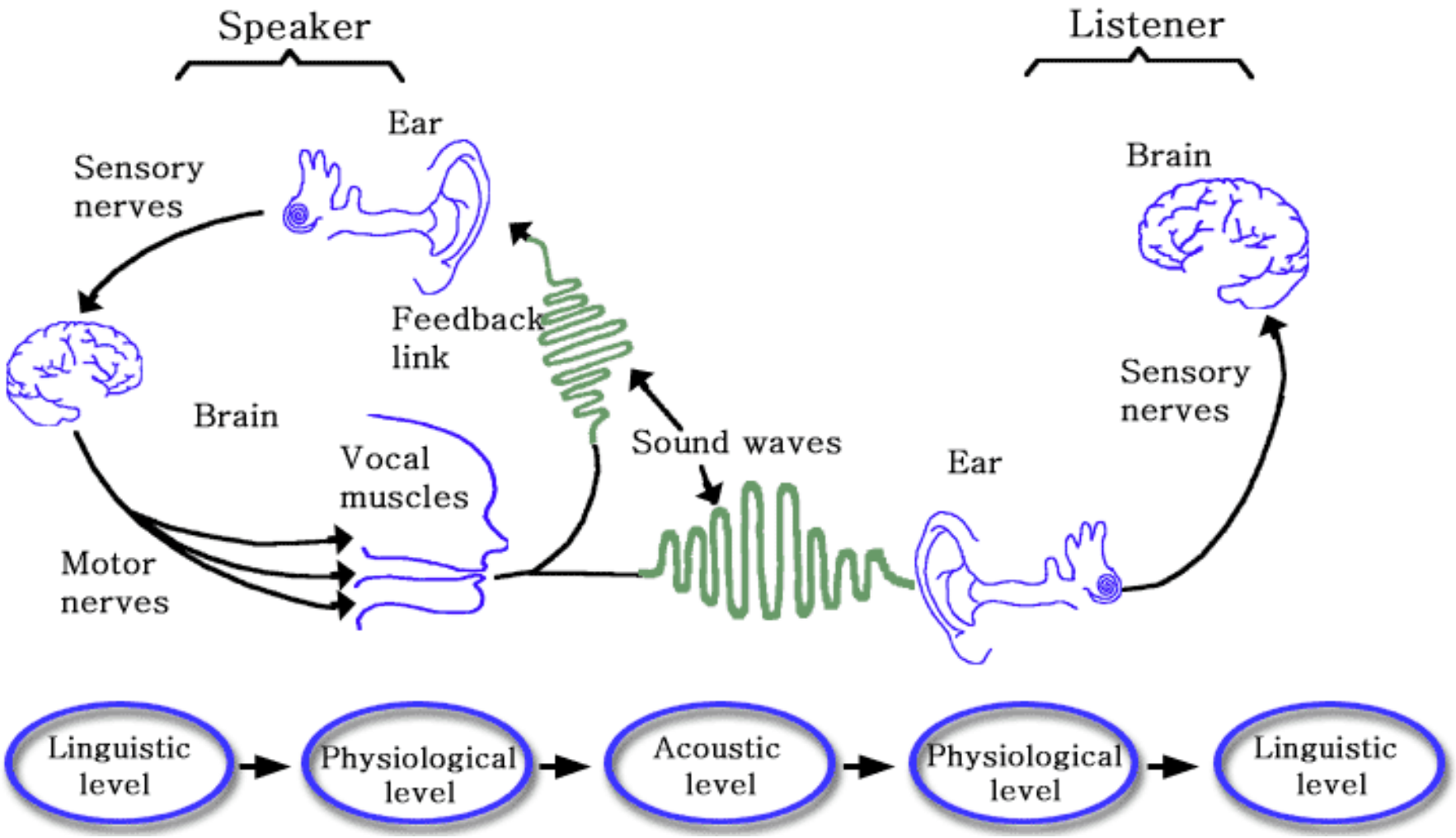
Auditory language perception



Visual Language (Reading)



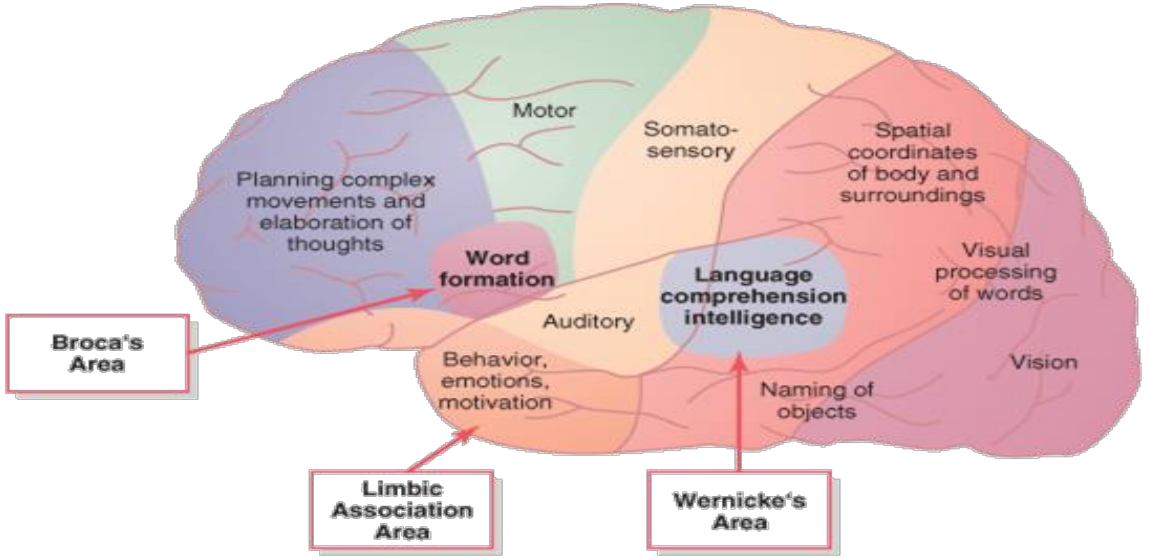
The speech chain



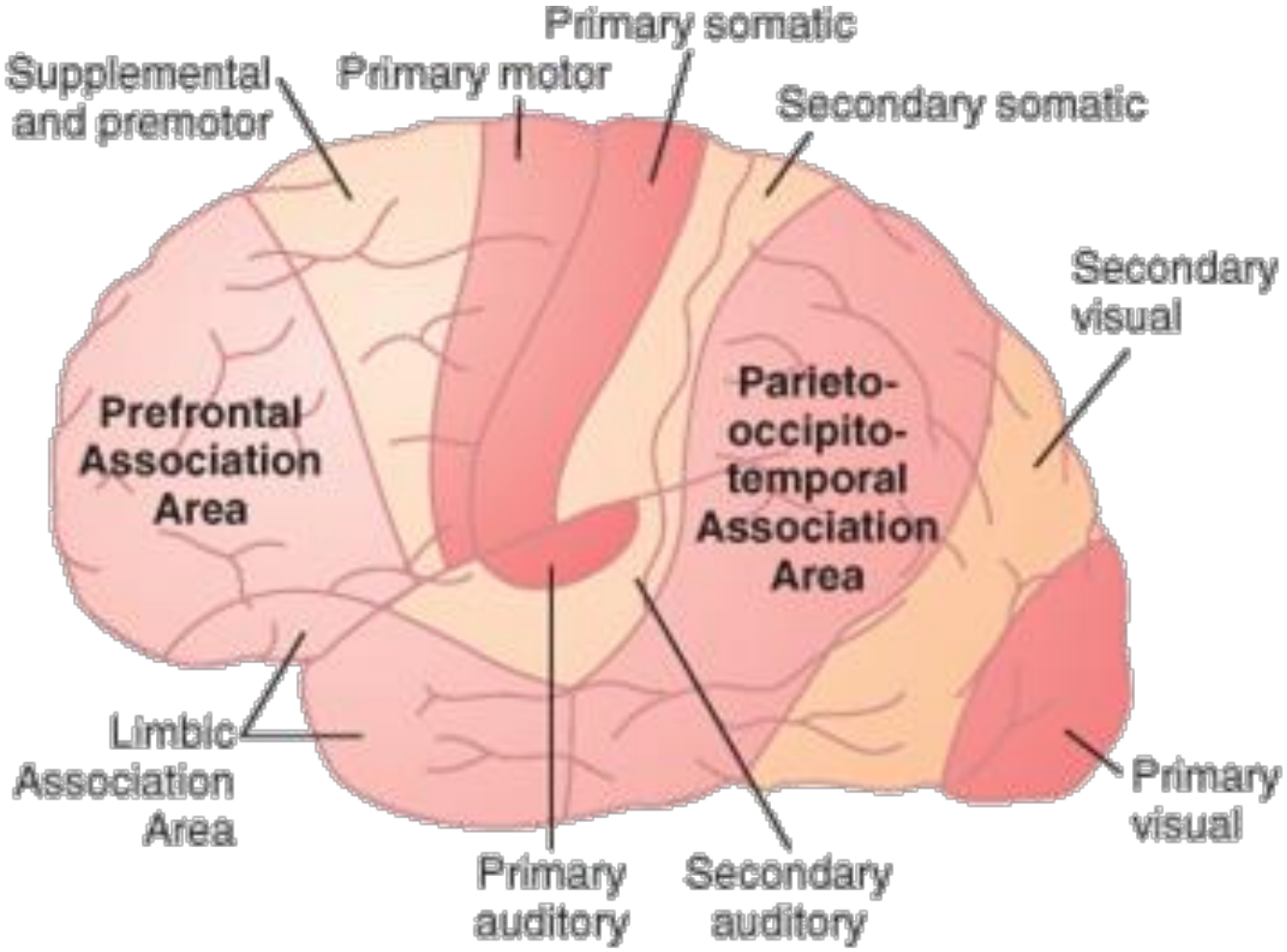
Association areas

- These areas receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from sub-cortical structures.
- The most important association areas are parieto occipitotemporal association area prefrontal association area limbic association area.

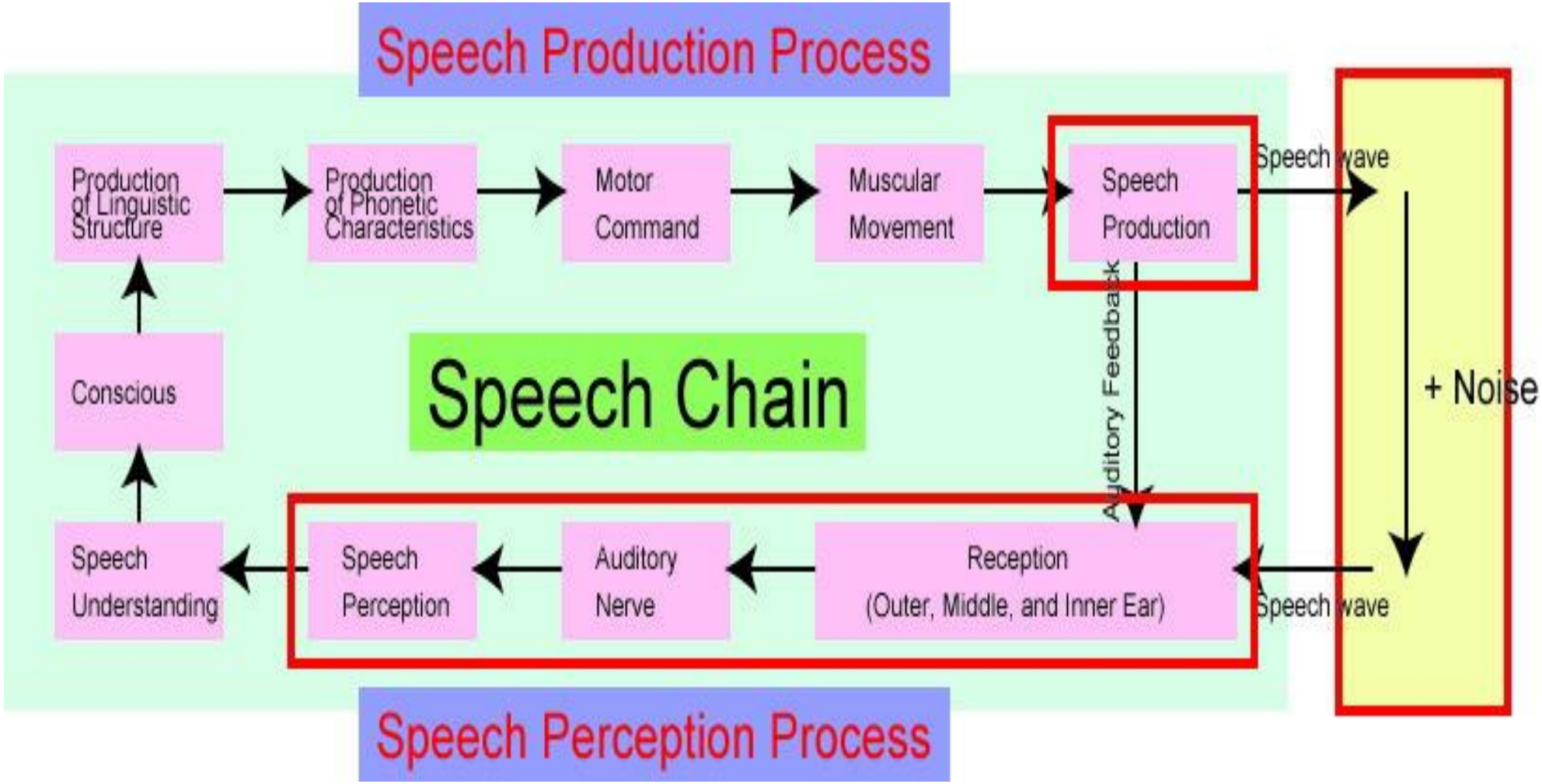
- Parieto-occipitotemporal association areas:
  1. Analysis of the Spatial Coordinates of the Body.
  2. Area for Language Comprehension.
  3. Area for Initial Processing of Visual Language (Reading).
  4. Area for Naming Objects.



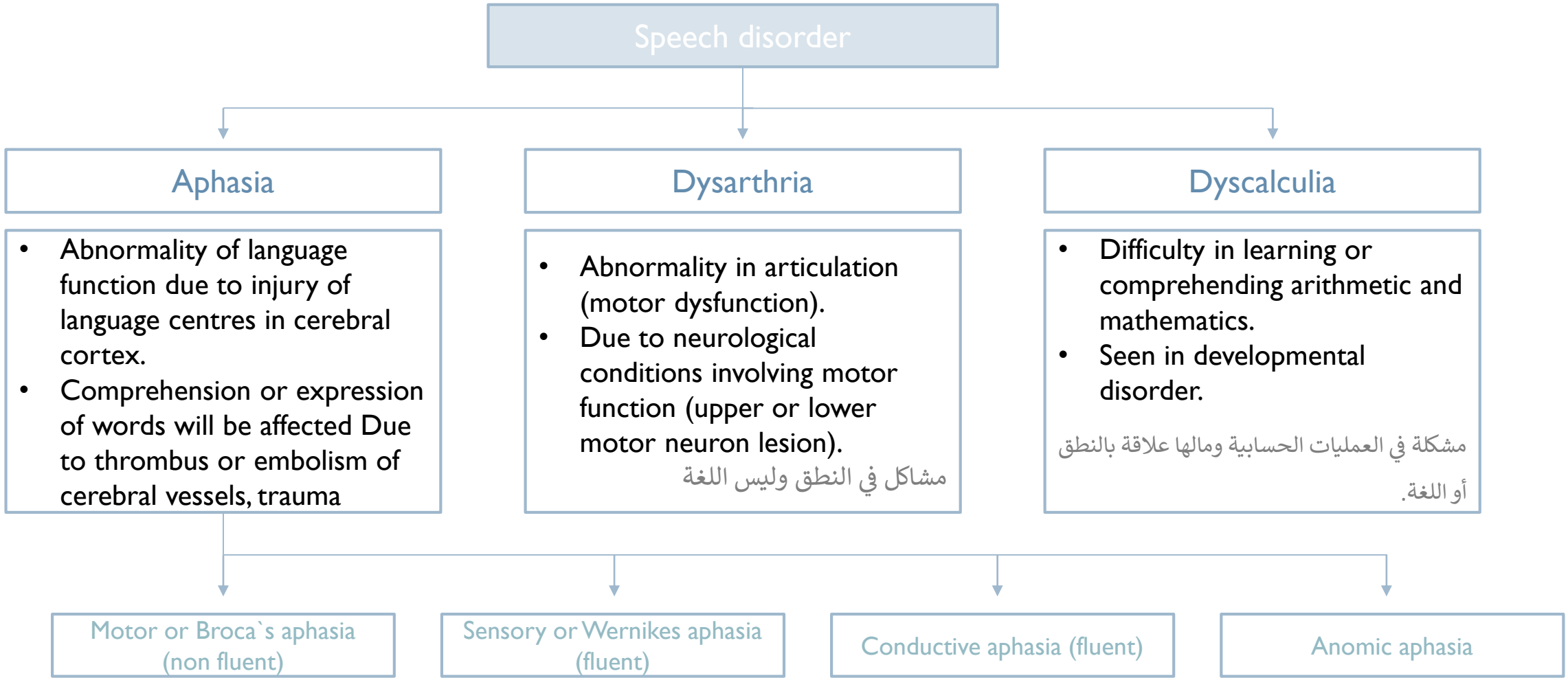
Primary, secondary and association areas



Speech production propcess



Speech disorder



Aphasia types

- Motor or Broca`s aphasia (non fluent):
  - Lesion of Broca`s area.
  - Patient will understand spoken & written words but find it difficult to speech or to write.
  - Poorly articulated speech, slow with great effort & abnormal rhythm.
  - In some cases speech may be limited to 2-3 words.

- Insula damage:
  - Progressive non-fluent aphasia.
  - deterioration of normal language function.
  - non fluent + normasl comprehension.
  - Intact other non-linguistic cognition.
  - Degdegenerative disorders.

الفهم والادراك طبيعيان فقط الكلام والكتابة تأثروا

- Degdegenerative disorders:
  - Atrophy of the left anterior insular cortex.

Cont.

Aphasia types	
Sensory or wernikes aphasia (fluent)	Lesion of wernikes area +/- arcuate fasucul. Impaired comprehension. Loss of intellectual function. loss of cognitive function يقدر يقرأ ويسمع لكن عنده Failure to interprets meaning of written or spoken words. Meaningless & excessive talk (in sever cases). loss of planning / choice making – وما يفهمون الأوامر – كلامهم مخربط
Conductive aphasia (fluent)	• Lesion of nerve fibres of arcuate fasiculus. • Patient understand speech of others but can not repeat it. • Meaningless speech. Difference between wernick's and conductive aphasia: Wernick's = loss of intellectual Conductive = patient can understand
Anomic aphasia	• Lesion of angular gyrus, thus B. & W.Are intact, (Where visual information are processed). • Speech & auditory comprehension is normal but visual comprehension is abnormal, due to visual information is not processed & not transmitted to w.Area.السمع سليم لكن فهم الصور والرسومات غير موجود • Dyslexia (word blindness) interruption in the flow of visual experience into W.Area from visual area*.

*في حالة ال word blindness نفترض أنه عندنا طفل في أولى ابتدائي يتعلم حرف الباء ولكن هو مايقدر يشوفه فلما يعطونه كلمة زي بابا هوا يشوفها ا ا أو يشوف الباء مقلوبة فبالتالي ما يستطيع يتعلم ويرسب ويحسبونه صعوبات تعلم ولكن في الحقيقة هو اساسا ما يشوف الحرف. نفس الشي ممكن يكون بدل الحرف رقم ما يقدر يشوفه.

Speech disorders

Area	Lesion faetures
Auditory association areas	Word deafness
Visual association areas	Word blindness called dyslexia
Wernicke's aphasia	Unable to interpret the thought
Broca's area causes	Motor aphasia
Global aphasia	Unable to interpret the thought Motor aphasia

Aphasia

- Aphasia is loss of or defective language from damage to the speech centres within the left hemisphere.
- In aphasia there is no damage to vision, hearing or motor paralysis. The damage is in speech centers in categorical hemispheres.

Aphasia	
Expressive	Receptive
• Non fluent. • Understanding normal but voice production defective.	Broca's area
Fluent: meaningless words with loss of comprehension / understanding.	Wernick's area conduction aphasia
Anomic: unable to name the objects.	Angular gyrus
Global: mixture of all.	Widespread damage to speech areas

- This means the combination of the expressive problems of Broca's aphasia and the loss of comprehension of Wernicke's.
- The patient can neither speak nor understand language. It is due to widespread damage to speech areas and is the commonest aphasia after a severe left hemisphere infarct. Writing and reading are also affected.

Dysarthria

- Dysarthria: means disorder in articulation ex: slurred speech.
- Dysarthria disturbances of the articulation. In some individuals who has no abnormality in the speech centre or in its pathways results in stuttering speech.
- Speaking softly or barely able to whisper.
- Slow rate of speech.
- Rapid rate of speech with a "mumbling" quality.
- Limited tongue, lip, and jaw movement.
- Abnormal intonation (rhythm) when speaking.
- Changes in vocal quality ("nasal" speech or sounding "stuffy").
- Hoarseness.

Disorder articulation

- Slurred speech.
- Language is intact,.
- Paralysis, slowing or in coordination of muscles of articulation or local discomfort causes various different patterns of dysarthria.
- Examples:
- Gravelly' speech of upper motor neuronal lesions of lower cranial nerves.
- Jerky, ataxic speech of cerebellar lesions (scannimg speech).
- The monotone of parkinson's disease (slurred).
- Speech in myasthenia that fatigues and dies away. Many aphasic patients are also somewhat dysarthric.

Stuttering

- Stuttering affects the fluency of speech.
- Talking with involuntary repetition of sounds, especially initial consonants.
- It begins during childhood and, in some cases, lasts throughout life.
- The disorder is characterized by disruptions in the production of speech sounds, also called 'disfluencies'.
- Have right cerebral dominance and widespread overactivity in the cerebral cortex and cerebellum. This includes increased activity of the supplementary motor area.

- Sound production by passage of air over the vocal cord.
- Dysphonia: Abnormal sound production due to problem in vocal cord e.g., paralysis, CVA, other causes.
- Causes:
- Paralysis of both vocal cord e.g whispering sound and inspiratory strider.
- Paralysis of left vocal cord: The voice becomes week and cough bovine. Mainly due to recurrent laryngeal palsy.

Right hemisphere (the representational hemisphere)

لا يوجد dominant and non dominant كلهم شغالين بس على حسب المهمة اللي الشخص يبغى يسويها أي واحد يشتغل أكثر.

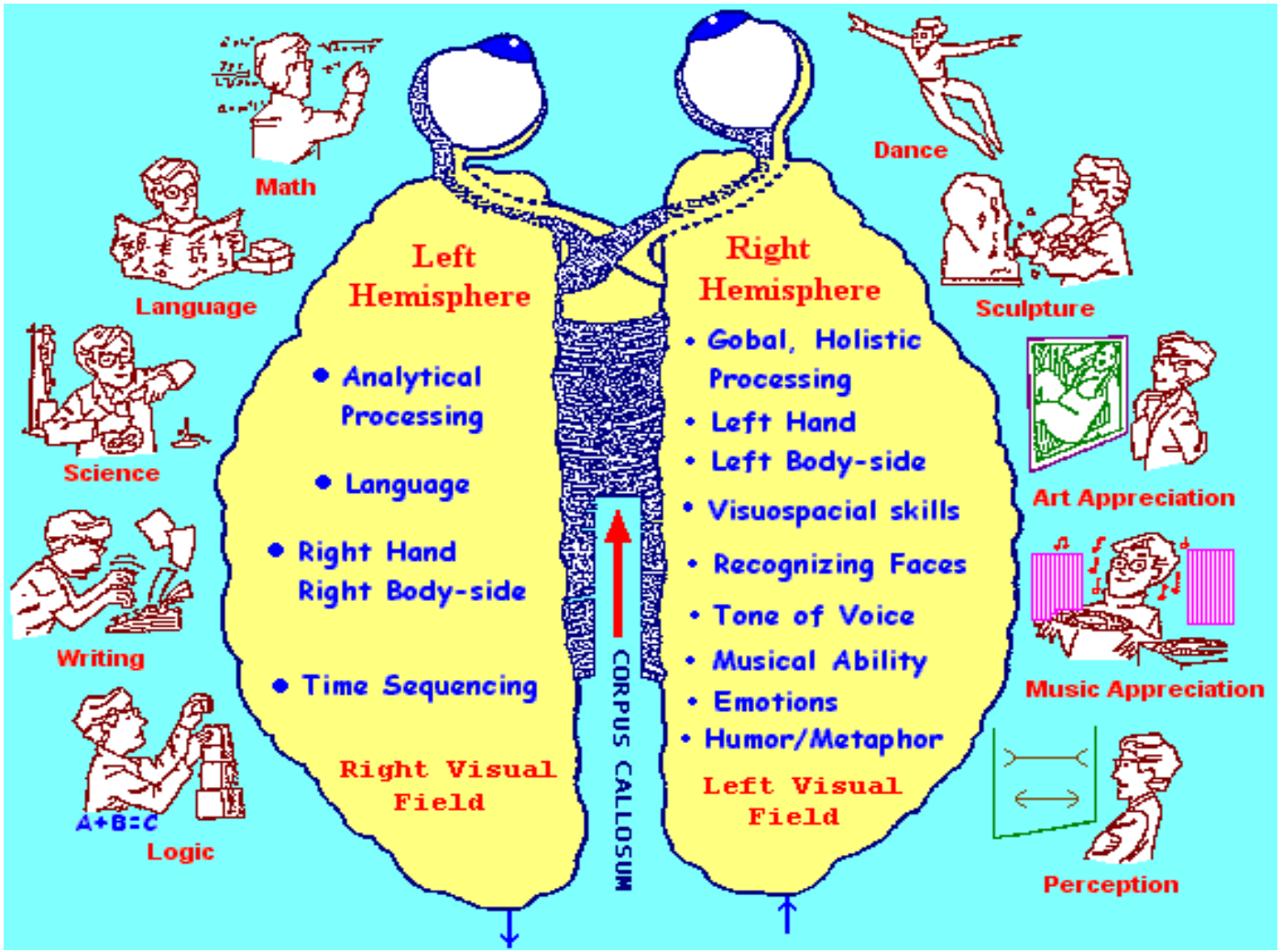
The right hemisphere controls the left side of the body	Temporal and spatial relationships*	Analyzing nonverbal information مثل لغة الجسد
Communicating emotion	recognition of emotion مرتبط بالمشاعر والجوانب الروحانية أكثر.	Recognition of tunes, rhythms
	Holistic problem solving	

*عادة الأشخاص اللي يستخدمون اليد اليسار في حياتهم اليومية يبدعون كمهندسين ومصممين ديكور لأن عندهم تصور للعلاقات بين الأشياء من ناحية المسافات وغيرها.

Left hemisphere (the categorical hemisphere)

The left hemisphere controls the right side of the body	Produce and understand language	understanding and manipulating language: recognition, use, and understanding of words and symbols
Speech	Identification of objects by name	Mathematics, logic, analysis

Summary of right & left hemisphere



Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمعة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

The Physiology 436 Team:

Females Members:

Lama Alfawzan

Zaina Alkaff

Males Members:

Hassan Alshammari

Abdulaziz Alseffay

Team Leaders:

Lulwah Alshiha

Laila Mathkour

Mohammad Alayed

Contact us:

QUIZ

اقتراحات وشكاوي

References:

- Females' and Males' slides.
- Guyton and Hall Textbook of Medical Physiology (Thirteenth Edition.)