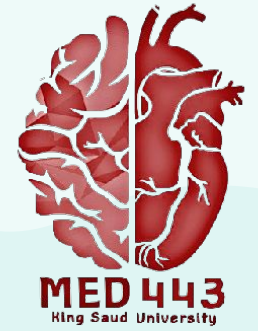
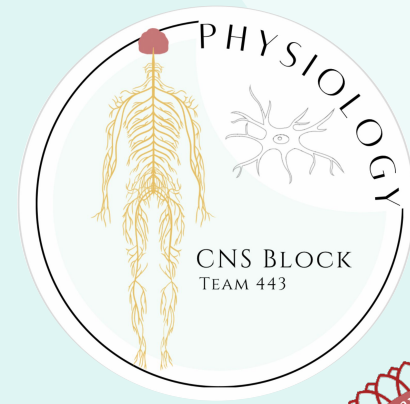


19



Physiology of speech



Color Index:

- Main text
- Important
- Girls Slides
- Boys Slides
- Notes
- Extra

Editing File



Objectives:

At the end of this lecture the student would be able to discuss :

- 1 Define speech, allied structures, types of communication
- 2 Describe brain speech areas as Broca's, Wernicke's and insula
- 3 Explain sequence of events in speech production
- 4 Role of higher centers in speech
- 5 Explain speech disorders as aphasia with its types, dysarthria, Dysphonia etc
- 6 Explain the difference between aphasia and dysarthria



Speech

Speech may be defined as the means of communication between the two individual or group of individuals.

It is the highest function of the nervous system.

It is the ability to express ideas in speech & writing.

It Involves understanding of spoken & printed words.

Language is the understanding of spoken and printed words and the expression of ideas in speech and writing. Human language functions depend more on one cerebral hemisphere than on the other.

Means of communication

Sensory communication types of speech

- **Auditory communication**
(Spoken Speech :understanding spoken words & expressing ideas in speech)
- **Visual communication.**
(Written Speech: understanding written words & expressing ideas in writing)

Motor communication

- Talking
- Writing

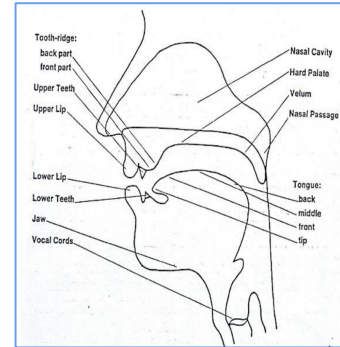
Speech Structures

Oral cavity

Nasal cavity

Pharynx

Larynx



Communication steps

Collection of sensory input:
Auditory & visual

Integration: Hearing and
articulation mechanism

Motor execution

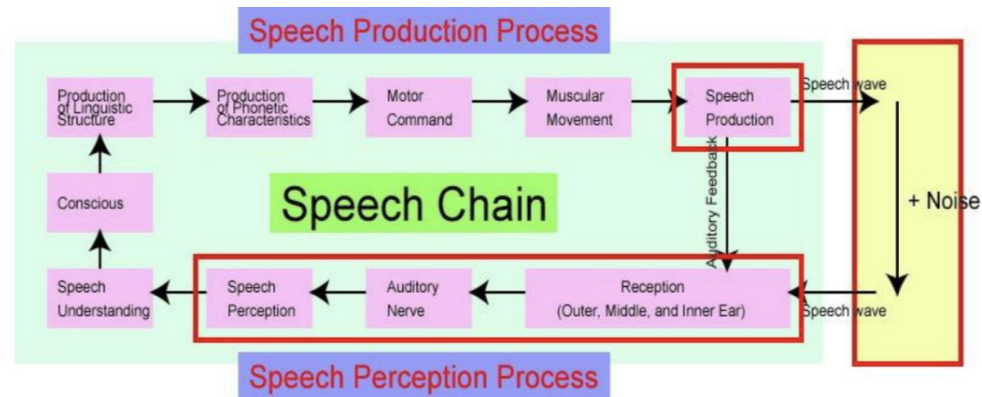
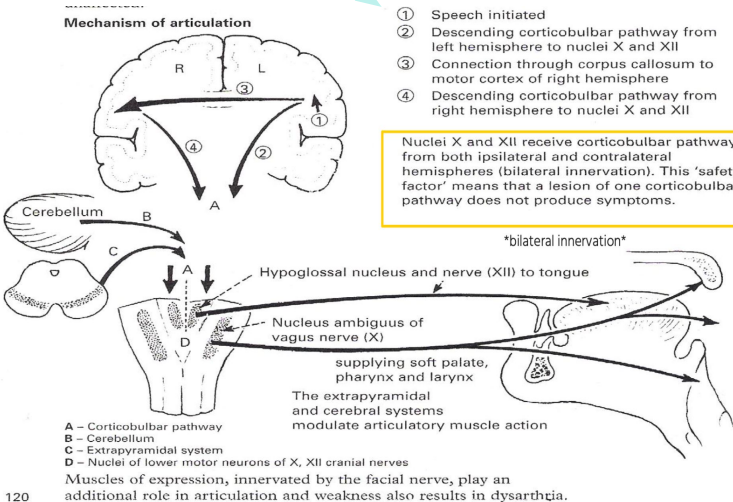
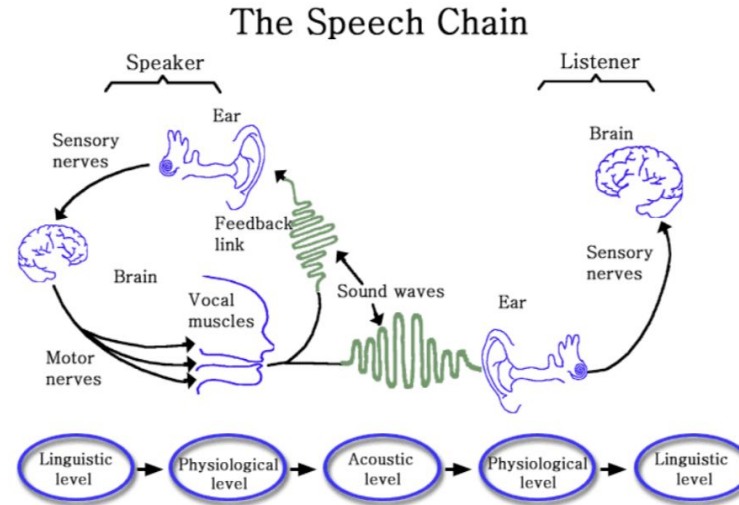


Basic Events In Speech Production

1 Initiation: Action that initiates the flow

2 Phonation: Action that modulates the quality of sounds

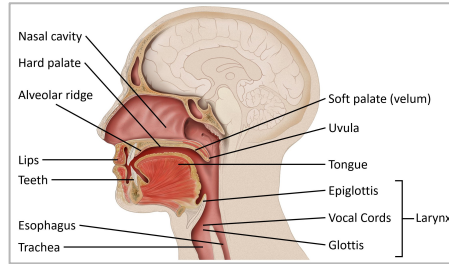
3 Articulation: Action that modulates or articulates





Basic Events In Speech Production

01) 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: Lungs 95% of human speech sounds are produced in this way.
- **2. Glottalic:** Airstream mechanism via glottis.
- **3. Velaric:** Airstream mechanism : Velum.

Direction Of Airflow:

- **Egressive/pressure Sound:**

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

- **Ingressive/suction Sound:**

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

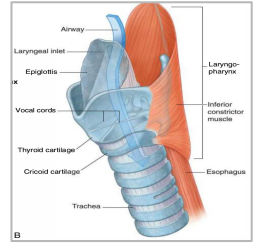
02) Phonation

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: Thyroid, Arytenoid and Cricoid.



03) Articulation

- **Muscular movements** of the mouth, tongue, larynx, vocal cords.
- Contribution by structures to shape airflow.
- A variety of speech sounds can be produced in terms of another way of airstream 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:** Lips, tongue, lower jaw, velum (structures of the mouth).
- Responsible for the intonations, timing, and rapid changes in intensities of the sequential Sounds.



Brain Areas Concerned with Speech / Language

Brain areas:

Wernick's Area, Broca's area, speech articulation area in insula, motor cortex, Angular Gyrus, Aud assoc area

Association areas:

These areas receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from subcortical structures.

The most important associations areas:

Parieto-occipito-temporal association area:

Prefrontal association area.

Limbic association area.

Area for Naming Objects.

Area for Language Comprehension.
(Wernicke's area)

Analysis of the Spatial Coordinates of the Body.

Angular gyrus area: Area for initial processing of visual language (reading)

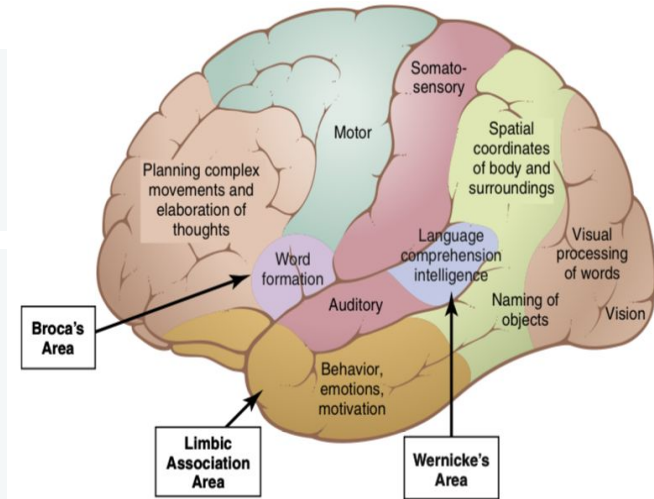


Figure 58-5. Map of specific functional areas in the cerebral cortex, showing especially Wernicke's and Broca's areas for language comprehension and speech production, which in 95% of all people are located in the left hemisphere.

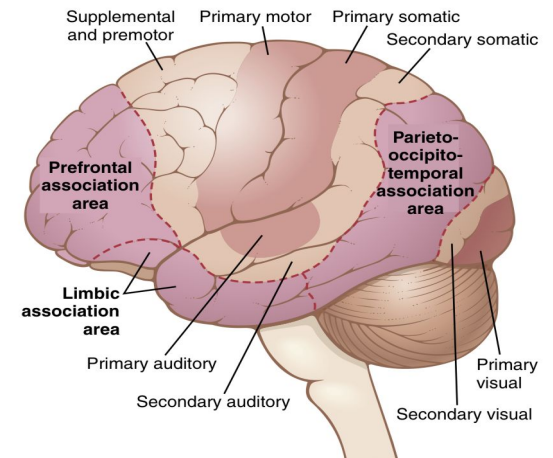


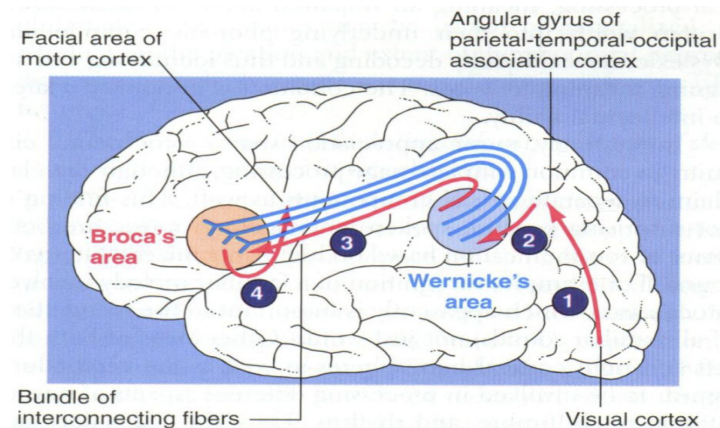
Figure 58-4. Locations of major association areas of the cerebral cortex, as well as primary and secondary motor and sensory areas.



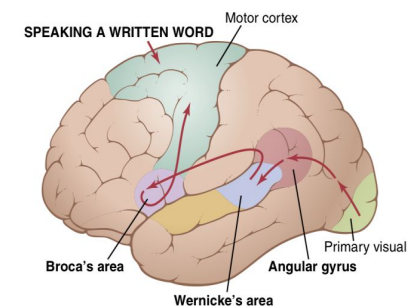
Brain Areas Concerned with Speech / Language

01) Wernicke's area:

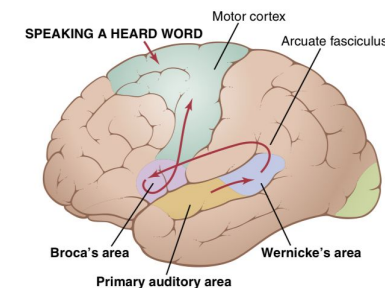
- At the posterior end of the **superior temporal gyrus**.
- Closely associated with 1 & 2 auditory areas.
- Responsible about comprehension of auditory & visual information, then projects it to Broca's area via arcuate fasciculus.
- Interpretations of sensory experience.
- Formation of thought in response to sensory experience.
- Choice of words to express thoughts.



Visual Language (Reading)



Auditory Language Perception



02) 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, at the lower end of 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.
- 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. But in children who learn second language early in life there is only single area involved for both languages.



Brain Areas Concerned with Speech / Language

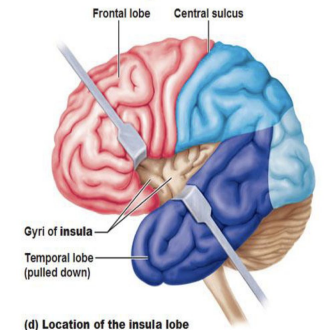
03) Arcuate fasciculus

04) Angular gyrus:

- Lies behind Wernicke's area fused posteriorly into the visual cortex.
- Function: interpretation of information obtained from reading from visual cortex.

- **Insula:**
 - is a portion of the cerebral cortex folded deep within the lateral sulcus
 - Hand and eye motor function.

The Cerebral Hemispheres – one more lobe



(d) Location of the insula lobe



Physiology of Speech

- **Wernicke's area receive information from both auditory & visual areas. (2)**
- Project it to Broca's areas via arcuate fasciculus. (3)
- **Broca's area process information received from Wernicke's area into detailed & co-ordinated pattern of vocalization & then project that pattern to the motor area/ cortex to initiate the appropriate movement of the lips & larynx to produces speech.**
- Initiation of movement of muscle of speech in tongue, larynx & lips. (4)
- If writing is concerned, then information received from W. 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. (4)

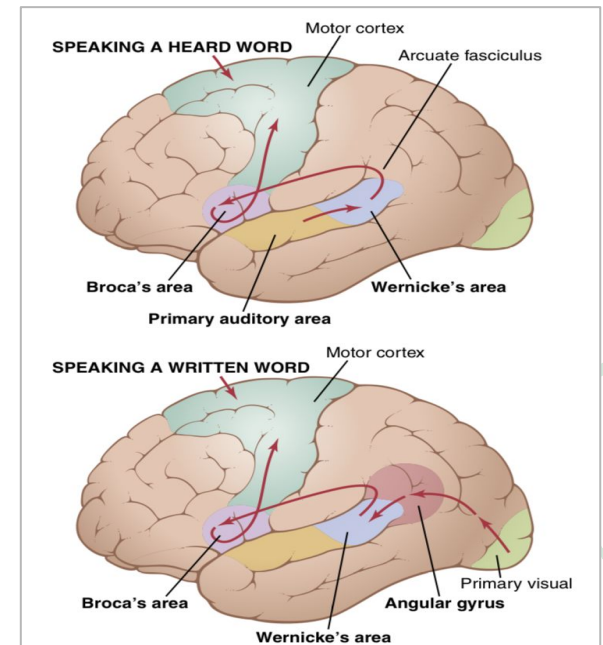


Figure 58-8. Brain pathways for (top) perceiving a heard word and then speaking the same word and (bottom) perceiving a written word and then speaking the same word. (Modified from Geschwind N: Specializations of the human brain. Sci Am 241:180, 1979.)



Speech Disorders

I. Dysarthria:

- Means disorder/ disturbances in articulation e.g. **slurred speech**.
- **Abnormality in articulation (motor dysfunction)** Due to neurological conditions involving motor function (upper or lower motor neuron lesion).
- In some individuals who has no abnormality in the speech centre or in its pathways resulting in **stuttering speech**. مشاكل في النطق ، مخارج الحروف غير واضحة.

Ia. Slurred Speech:

Male slides

Language is intact, Paralysis, slowing or in coordination of muscles of articulation or local discomfort causes various different patterns of dysarthria.

- 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.

Examples:

- 'gravelly' speech of upper motor neuronal lesions of lower cranial nerves.
- jerky, ataxic speech of cerebellar lesions (Scanning Speech).
- the monotone of Parkinson's disease (Slurred).
- speech in myasthenia that fatigues and dies away. Many aphasic patients are also somewhat dysarthric.



Speech Disorders

My name is
Jo...jo...jo...jo..
John
Pe...pe..pe...pe
.... Peters

1b. 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.

2. Disordered Phonation:

- **Phonation:** Sound production by passage of air over the vocal cord.
- **Dysphonia:** Abnormal sound production due to problem in vocal cord e.g., paralysis, Cerebrovascular accident (CVA), other causes.
- **Causes:**
- - Paralysis of both vocal cord e.g whispering sound and inspiratory stridor. Stridor is a high-pitched, wheezing sound caused by disrupted airflow. Inspiratory stridor is one of the three types of stridor. In this type, you can only hear the abnormal sound when you breathe in. This indicates an issue with the tissue above the vocal cords.
- - Paralysis of left vocal cord: The voice becomes weak and cough bovine. **Mainly due to recurrent laryngeal palsy.**

3. Aphasia categorical hemisphere:



- Is loss of or defective language from damage to the speech centers within the left hemisphere
- **Please NOTE that :** There is no damage to vision, hearing or motor paralysis. The damage is in speech centers in categorical hemisphere.



Speech Disorders- types of aphasia

3- Dysphasia / Aphasia

- Abnormality of language function due to injury of language centres in cerebral cortex. Comprehension or expression of words will be affected. Due to thrombus or embolism of cerebral vessels, trauma.

Lesion area \ receptive	Expressive \ Type of aphasia
Wernicke's Area  Video	<u>Sensory or Wernicke's aphasia (fluent):</u> Broca's area receive unprocessed disorganized information from wernicke's area <ul style="list-style-type: none"> - Lesion of wernicke's area +/- arcuate fasciculus. - Loss of intellectual function - Failure to interprets meaning of written or spoken words - Meaningless words & excessive talk (in severe cases), with loss of \ Impaired comprehension / understanding
Broca's Area  Video	<u>Motor or Broca's aphasia (non fluent):</u> Projection to motor cortex is not working <ul style="list-style-type: none"> - Patient will understand spoken & written words but find it difficult to speak or to write (Understanding normal but Voice production defective) - Poorly articulated speech, slow with great effort & abnormal rhythm, In some cases speech may be limited to 2-3 words



Speech Disorders- types of aphasia

3- Dysphasia / Aphasia

Lesion area \ receptive	Expressive \ Type of aphasia
<p data-bbox="249 791 570 843">Angular Gyrus</p> <p data-bbox="183 865 264 918"></p> <p data-bbox="173 929 270 965">Video</p>	<p data-bbox="744 462 1105 515"><u>Anomic aphasia</u></p> <ul data-bbox="774 576 2440 868" style="list-style-type: none">- Lesion of angular gyrus, thus Broca's & Wernicke's are intact- Unable to name the objects- Speech & auditory comprehension is normal but visual comprehension is abnormal, due to visual information is not processed & not transmitted to wernicke's area.- Dyslexia (word blindness) interruption in the flow of visual experience into Wernicke's area from visual area <p data-bbox="835 876 2430 968">Depending on the extent of lesion in the angular gyrus ·major lesion or minor a specific letter or number will be affected</p> <p data-bbox="835 976 2372 1068">مثلاً ما راح يقدر يشوف حرف الألف فتكون مشوشة أو مقلوبة أو معوجة يحسبو عنده صعوبات تعلم ولكن هو ما يشوف الحرف</p> <p data-bbox="835 1076 2440 1176">They do well after special classes and training, finds it hard to differentiate between d,b and p,q</p>



Speech Disorders- types of aphasia

3- Dysphasia / Aphasia

Lesion area	Type of aphasia
Arcuate Fasciculus Female slides only	<u>Conductive aphasia (fluent):</u> <ul style="list-style-type: none">- Lesion of nerve fibres of arcuate fasciculus- Patient understand speech of others but can not repeat it, Meaningless speech.- Normal comprehension but the Transmission from wernicke's area to broca's area is disrupted.
Insula Female slides only	Insula damage: <u>Progressive non-fluent aphasia:</u> <ul style="list-style-type: none">- non fluent + normal comprehension- deterioration of normal language function, normal comprehension- Intact other non-linguistic cognition.- it's due to Degenerative disorders (such as Alzheimer's disease) or Atrophy of the left anterior insular cortex, associated with old age.- How is it differentiated from Broca's Aphasia? 1- It's progressive. 2- Degenerative disorder.
(mixture of all) Male slides only	<u>Global Aphasia (Central Aphasia):</u> <ul style="list-style-type: none">- 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.



Speech Disorders

3- Dysphasia

DISORDERS OF SPEECH – DYSPHASIA

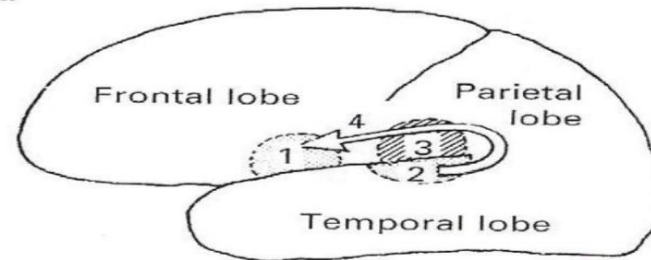
Dysphasia is an acquired loss of production or comprehension of spoken and/or written language secondary to brain damage.

Hand preference is associated with 'hemisphere dominance' for language. In right-handed people the left hemisphere is dominant; in left-handed people the left hemisphere is dominant in most, though 25% have a dominant right hemisphere.

The cortical centres for language reside in the dominant hemisphere.

1. Broca's area

Executive or motor area for the production of language – lies in the inferior part of the frontal lobe on the lateral surface of the cerebral hemisphere abutting the mouth of the Sylvian fissure.



2 and 3. Receptive areas

Here the spoken word is understood and the appropriate reply or action initiated. These areas lie at the posterior end of the Sylvian fissure on the lateral surface of the hemisphere.

The temporal lobe receptive area (2) lies close to the auditory cortex of the transverse gyrus of the temporal lobe. The parietal lobe receptive area (3) lies within the angular gyrus.

Receptive and expressive areas must be linked in order to integrate function. The link is provided by (4), the **arcuate fasciculus**, a fibre tract which runs forward in the subcortical white matter.

Dysphasia may develop as a result of vascular, neoplastic, traumatic, infective or degenerative disease of the cerebrum when language areas are involved.



Speech Disorders

4. Dyscalculia

Female slides

- Seen in developmental disorder.
- Difficulty in learning or comprehending arithmetic and Mathematics.
- **Not related to language function**

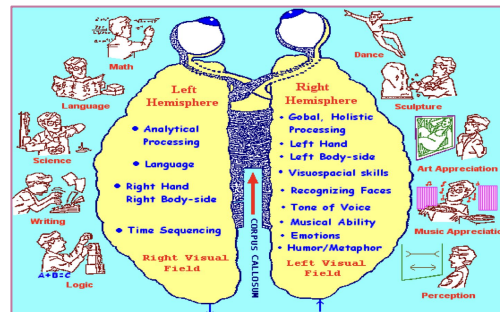
Male slides

Lesions of Different Areas in The Brain:

Area	Lesion Features
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

Female slides

<u>Right Hemisphere</u> (the representational hemisphere);	<u>Left Hemisphere</u> (the categorical hemisphere):
1. The right hemisphere controls the left side of the body.	1. The left hemisphere controls the right side of the body.
2. Controls Temporal and spatial relationships	2. Produce and understand language.
3. Analyzing nonverbal information.	3. understanding and manipulating language: recognition, use, and understanding of words and symbols.
4. Communicating emotion.	4. Speech.
5. Recognition of emotion.	5. Identification of objects by name.
6. Recognition of tunes, rhythms	6. Mathematics, logic, analysis.
7. Holistic problem solving.	



- Both are active they work together complement each other.
- depending on the function executed one hemisphere is active more than the other one.
- Mentioned before in 'cerebral hemisphere' lecture



Summary (EXTRA)

Aphasia :

loss of or defective language from damage to the speech center within the left hemisphere.

1. Wernicke's aphasia (fluent): Impaired **comprehension** + Meaningless words. (Sensory)

Broca's aphasia (non fluent): understand spoken & written words but find it **difficult to speak or to write** (motor).

3. Conductive aphasia (fluent): Normal comprehension but the Transmission from wernicke's area to broca's area is disrupted.

4. Anomic aphasia: **visual comprehension is abnormal**, due to visual information is not processed & not transmitted to wernicke's area.

5. Insula damage: Progressive non-fluent aphasia: deterioration of normal language function.

6. Global Aphasia: the **combination** of the expressive problems of Broca's aphasia and the loss of comprehension of Wernicke's.

Dysarthria

Abnormality in articulation (motor dysfunction) Due to neurological conditions involving motor function. e.g. :

2. Stuttering:

Talking with involuntary repetition of sounds, especially initial consonants.

1. Slurred Speech:

Language is intact, Paralysis, slowing or in coordination of muscles of articulation or local discomfort causes various different patterns of dysarthria

Dysphonia

Abnormal sound production due to problem in vocal cord.



TEST YOURSELF !

1- Which one of the following areas is responsible for word formation?

A) Wernicke's area

B) Broca's area

C) premotor cortex area

D) somatosensory cortex area

2- Which one of the following is the main function of Wernicke's area?

A) control the motor function of speaking

B) language comprehension and intelligence

C) somatosensory reception

D) articulation of words

3-Damage in which of the following area causes decrease in motor ability to speak?

A) Wernicke's area

B) somatosensory area

C) Broca's area

D) temporal lobe

4- which of the following describes dyslexia?

A) words can't be visualized visually

B) words aren't heard

C) slurred speech

D) a problem in motor aspect of communication



SAQ

From team 439

1- what are the Brain Areas Concerned with Speech / Language?

Wernicke's Area - Broca's Area - Speech articulation Area in Insula - Motor Cortex - Angular Gyrus - Aud Assoc Areas.

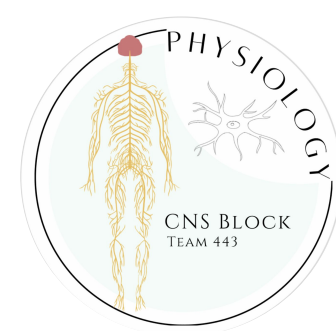
2- what are the The most important association areas?

Parieto-occipitotemporal association area - Prefrontal association area - Limbic association area.

3- What are the causes of dysphonia?

- Paralysis of both vocal cords.
- Paralysis of left vocal cord.

Team Leaders



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Huda bin Jadaan



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Salma Alkhlassi
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Sarah Alajajii
Sarah Alshahrani
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Ziyad Alsalamah
Omar Alamri
sultan almishrafi
Mohammad Alzahrani
Khalid Alanezi
sami Mandoorah
Abdullah alzamil
Mohammed Alqutub
Mohammed Bin Manee

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💡 Special Thanks to Physiology Team441
💡 Team logo and design was done by Rafan Alhazzani
💡 Thanks to ALEEN ALKULYAH for Helping with the design!

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