



- Speech is a learned process → if a baby is born deaf → he will never learn how to speak.
- Speech is composed of:
  - **Phonation:** it is the production of sounds by the vocal cords in the larynx (CN: IX & X).
    - ✓ Dysphonia/ aphonia: referring to any problem related to the production of sound.
  - **Articulation (CN: VII, IX, X, XI & XII):** it is the next step after phonation. It is the process which produces letters from sounds (by modifying the sound through: lips, tongue and soft palate).
    - ✓ Dysarthria/ anarthria: referring to conditions in which there is production of sound but articulation does not happen. Examples on these conditions are: myasthenia gravis and cerebellum defects.
  - **Language:** understanding words. It is occurring in higher cortical cognitive areas. It allows:
    - ✓ Comprehension (written and spoken words)
    - ✓ Repetition
    - ✓ Naming
    - ✓ Writing
- If someone is talking → the words will reach your ears as sound waves → and converted to action potentials which will travel to reach your auditory cortex → and then to an area known as Wernicke's area which allows you to understand the words → and therefore you can repeat the word which you heard.
  - **For this repetition** → a motor function is required → therefore, inputs from Wernicke's area will travel to Broca's area (which functions as a pre-motor area for programming each word and how it must be produced) → eventually, inputs will reach the primary motor cortex → resulting in speech.
- Notice that speech center is only present in one hemisphere and this is called (brain lateralization). Usually, it is the left hemisphere which has the speech center.
- Speech center has all the capabilities of communication with other people. It is composed of 2 main areas:
  - **Broca's area:** which is present in the frontal lobe (motor area).
  - **Wernicke's area:** which is present where parietal, occipital and temporal lobes meet (it functions in understanding words either written or spoken).
- If you show a person a paper with the written word "MONKEY" → if the paper is in his left visual field → it will be transmitted to the right side (contralateral side) of visual cortex → then a process of decoding will occur (in which you will imagine the picture of the word: you will imagine a monkey in this case) → input will cross to the left hemisphere → reaching angular gyrus (which is known as the naming center: it will tell you that the word which is written is MONKEY) → then input will travel to Wernicke's area (so you understand the word) → eventually reaching Broca's area (so the word can be spoken).
  - **Notice that Wernicke's area is connected to Broca's area through arcuate fasciculus.**
- Broca's area: it contains motor memories → which means that it has programs which guide you to pronounce each letter (these motor memories were gained by the process of learning).
  - **Babies cannot speak because there is still no learning process and their Broca's area is still not functioning.**
  - **If someone has a defect in Broca's area** → programming is lost and there will be not enough cells to produce speech → the patient will be treated by an approach known



as speech therapy in which he will be taught again to pronounce each letter and word (as if he is still a baby!!).

- **Broca's area is present in the left inferior pre-frontal cortex. A damage to Broca's area is known as expressive or motor aphasia:** in which the patient is unable to say the word but he can understand it. The patient will try to compensate for his condition by producing key words when he speaks, so people can understand what he says.
- **Wernicke's area** is present in the left temporal lobe. **Wernicke's aphasia:** in which the patient cannot understand what he hears, cannot make useful sentences, and produces sounds which people cannot understand (he talks a lot!!). So, Wernicke's aphasia is characterized by:
  - Neologisms (invention of new words and vocabulary!).
  - Fluent (the patient is talking a lot) but the speech has no information content.
  - Reading and writing skills are often severely impaired.
  - The patient is unaware of his deficit (he think that his speech is logical and that people are understanding him).
  - Physiological Wernicke's aphasia is occurring in babies (when they start to produce sounds with no meaning until they learn how to speak later when they grow up).
- **Global aphasia:**
  - There is a large lesion involving Sylvian fissure in which Broca's and Wernicke's areas are present.
  - **Dyslexia:**
    - ✓ It is a developmental condition.
    - ✓ Characterized by inability to read, or understand written words, or spell or write, or express themselves, or tell right from left, or find difficulty in structuring their thoughts, or suffering from troubles in finding the right word to say or struggle to understand.
    - ✓ Example: if there is a long word which is written on a board → and you ask a person to read it → if he tries to read it for 10 times or more and still fail on each time → then he is suffering from dyslexia.
  - **Alexia:**
    - ✓ It is an acquired dyslexia: in which a person used to be able to read but know he cannot because his angular gyrus was damaged.
- **Conductive aphasia:** occurring if there is a lesion to arcuate fasciculus (which is connecting Broca's area & Wernicke's area):
  - Patient can understand words.
  - Patient can produce speech.
  - But words don't make a sense and the **patient is aware of his deficit** (not like Wernicke's aphasia in which the patient in not aware of his deficit).

- **Summary:**

<b>Broca's aphasia</b>	<b>Non-fluent/ good comprehension/ poor repetition.</b>
<b>Wernicke's aphasia</b>	<b>Fluent/ poor comprehension/ poor repetition.</b>
<b>Conductive aphasia</b>	<b>Fluent/ good comprehension/ poor repetition.</b>

- **Other varieties of aphasia:**

- **Anomic aphasia:** persistent inability to name the objects they want to talk about.
- **Prosophenosia:** inability to recognize faces. The defect is in medial undersides of occipital and temporal lobes.
- **Stammering/stuttering:** normal speech interrupted involuntary by repetition and prolongation of sound syllabus and involuntary silent blocks. This condition occurs due to increase release of dopamine in basal ganglia.



- **Staccato:** it is an interrupted speech in which each syllabus is said separately as in music. This condition occurs if there is cerebellar lesion.

- Monkeys can be trained to use vocalization:

- This is done by stimulating areas which are producing speech in humans especially planum temporal (which is present in chimpanzees although they cannot speak!).

- The interconnection between the two cerebral hemispheres is known as corpus callosum:

- **If corpus callosum is cut** → the object which is seen in the left visual field → will go to the right visual cortex → but input will be unable to travel through corpus callosum to the left cerebral hemisphere (where Wernicke's and Broca's areas are present).

- ✓ But notice that emotional input can travel to the left hemisphere even with this cut through anterior commissure → so if a mother is shown a picture of her baby → she might say: "Oh my dear baby ☺" → but if you ask her to describe what is her baby wearing in the picture she cannot do that!

- Comparison between right and left cerebral hemispheres functions:

Left hemisphere functions	Right hemisphere functions
Analysis of right visual field	Analysis of left visual field
Stereognosis (right hand)	Stereognosis (left hand)
Lexical and syntactic language	Emotional coloring of language
Writing	Spatial abilities
Speech	Rudimentary speech

- People in whom right cerebral hemisphere is dominant are more romantic/emotional.
- **Right parietal lobe:** is producing emotional tone of speech.

- Sign language:

- A person who is aphasic by left hemisphere lesion: cannot learn sign language (because Broca's area is damaged).
- Aphasic deaf people can learn sign language (because language centers are intact).
- If a deaf person develops damage to Broca's area → he will lose his sign language ability.
- Aphasic deaf people with right cerebral hemisphere lesion have no emotional component associated with signs they make.

- Hemispheric lateralization and dominance:

• **Sequential Vs. random processing:**

- ✓ Left: list maker.
- ✓ Right: may flit from one task to another (arranging difficulty).

• **Symbolic Vs. concrete processing:**

- ✓ Left: no trouble processing symbols with linguistic and mathematical trials.
- ✓ Right: person wants to see, feel or touch the real object.

• **Logical Vs. intuitive processing:**

- ✓ Left: uses information piece by piece to solve a problem.
- ✓ Right: uses intuition (الحدس-البدئية).

• **Reality-based Vs. Fantasy-oriented processing:**

- ✓ Left: following rules.
- ✓ Right: no aware that there is anything wrong.

- **Note that color is analyzed by the right hemisphere.**