



24rd Lecture

Physiology of Speech

PHYSIOLOGY TEAM – 430

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Physiology of speech and language

- It is the highest intellectual function of the nervous system, because almost all such intellectual functions are language based.
- It involves the integration of three distinct capabilities:
 - ✓ **Expression:** Ability to express ideas in speech and writing
 - ✓ **Comprehension:** Understanding of spoken and printed words, each of which is related to a specific area of the cortex. The primary areas of cortical specialization for language are Broca's area and Wernicke's area
 - ✓ **Motor aspect of communication**
- Function of the Brain in Communication- Language Input and Language Output:
Sensory Aspects of Communication → Integration → Motor aspects of communication → Articulation

• **Articulation**

- Means the arrangement and coordination of muscular movements of the mouth, tongue, larynx, vocal cords and lips
- Responsible for the intonations, timing, and rapid changes in intensities of the sequential sounds
- The facial and laryngeal regions of the motor cortex activate these muscles, and the cerebellum, basal ganglia, and sensory cortex all help to control the sequences and intensities of muscle contractions

• **Three types of areas in the brain:**

- 1- **Primary areas:** Responsible for sensory input or motor output
- 2- **Secondary areas:** Responsible for integration (translation)
- 3- **Association areas:** Associates different areas together to come up with a final thought

• **Three aspects of sensory communication participate in speech:**

- 1- **Auditory perception** (If someone asks you what's your name you will answer)
- 2- **Visual perception** (If someone asks you what are you seeing you will answer)
- 3- **Somatosensory perception** (If someone puts something in your hand and asks you tell me what's that with closed eyes you will answer)

• **Association areas in the brain:**

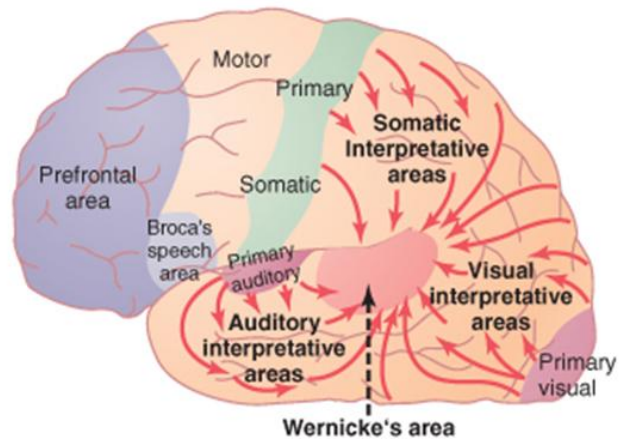
- These areas receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from subcortical structures
- **Types:**
 - 1) **Prefrontal association area:** Responsible for personality and planning
 - 2) **Parieto-Occipito-Temporal association areas:** Responsible for thinking, intelligence and decision making
 - 3) **Limbic association area:** Responsible for emotion

- **Speech Production:**

1) Wernicke's area:

Location: At the junction of parietal, occipital and temporal lobes, associated with auditory, visual and somatic interpretive areas

Function: The major area for language comprehension and interpretation



1. Responsible for comprehension of auditory and visual information, it plays a critical role in understanding both spoken and written messages.

It receives input from:

- **Visual cortex in the occipital lobe** (important in reading comprehension and in describing objects seen)
 - **Auditory cortex in the temporal lobe** (important in understanding spoken words)
 - **Somatosensory cortex** (important in the ability to read Braille "the way blind people use to read")
2. Interpretations of sensory experience
 3. Formation of thought in response to sensory experience
 4. Choosing the right words to express:

It means when someone asks you what's your pin code for your ATM card you will not tell him, but when he asks what's your car it's ok to say it

2) Broca's area

Location: At the lower end of premotor area in the frontal lobe (at the base of precentral gyrus), in close association with the motor areas of the cortex that control the muscles necessary for articulation.

Function: Makes words from information received via arcuate fasciculus from Wernicke's area, then passes it to the motor cortex to initiate the appropriate movement of the lips and larynx

3) Arcuate fasciculus

Function: responsible for transmission of signals from Wernicke's area to Broca's area

4) Angular gyrus

Location: lies immediately behind Wernicke's area and fused posteriorly into visual areas of the occipital lobe as well.

Function: it is a visual association area that interprets visual information into wernicke's area (making meanings out of words and objects seen)

- **Parieto-Occipito-Temporal association areas:**

Area	Site	Function
Analysis of the coordinates of the body	beginning in the posterior parietal cortex and extending into the superior occipital cortex	computes the coordinates of the visual, auditory, and body surroundings
Area for Language Comprehension	Wernicke's area, lies behind the primary auditory cortex in the posterior part of the superior gyrus of the temporal lobe	higher intellectual function
Area for Initial Processing of Visual Language (Reading)	angular gyrus area	make meaning out of the visually perceived words
Area for Naming Objects	angular gyrus area	naming objects

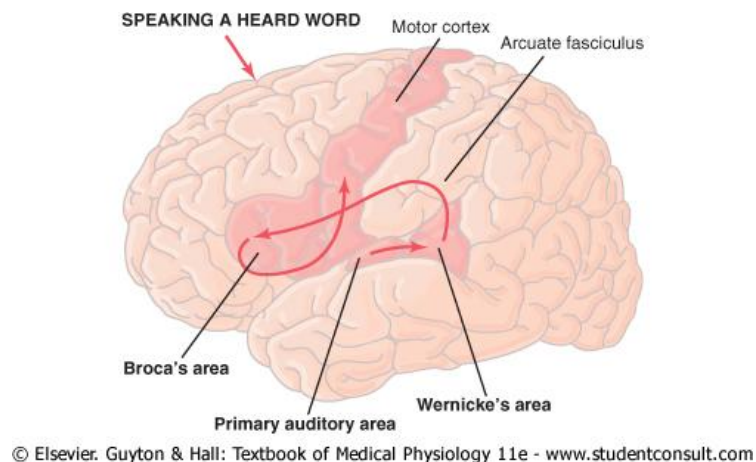
- **Facial recognition area:**

- Medial undersides of both occipital lobes and along the medioventral surfaces of the temporal lobes
- If this area is damaged the disorder is known "Prosopagnosia"
- This area has big representation in the cerebral cortex

Note:

The reason why you sometimes remember faces of people but you forget their names is that the facial recognition area is separated from the naming area (it happens a lot !!)

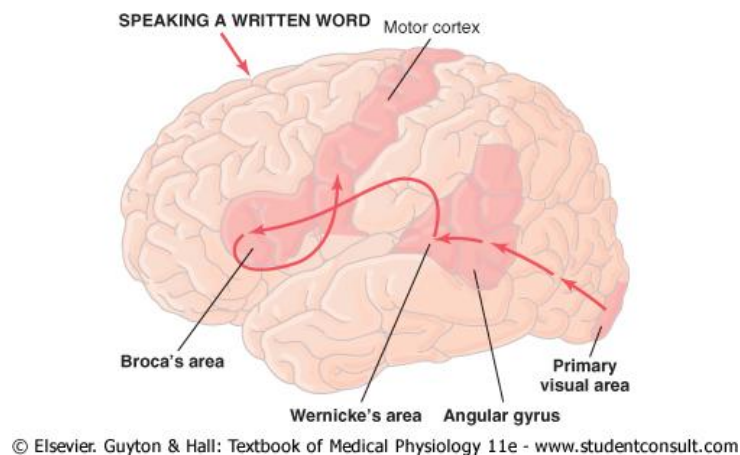
- **Speaking a heard word:**



Primary auditory area → interpretation in Wernicke's area → Arcuate fasciculus → Broca's area → Motor cortex → Speech muscles

If the **auditory association area** is damaged, the person will have **Word Deafness**, which means he can hear very well but he won't be able to understand what you are saying

- **Speaking a written word:**



Primary Visual area → Angular Gyrus → interpretation in Wernicke's area → Arcuate fasciculus → Broca's area → Motor cortex → Speech muscles

If the **visual association area** is damaged, the person will have **Word Blindness**, which means he can see very well but he won't be able to recognize what is in front of him

Note:

The difference between the auditory pathway and the visual pathway is that the visual pathway before reaching Wernicke's area it passes through the Angular Gyrus but the Auditory doesn't

- **Speech Disorders**

- **Aphasia in general:**

There are three types:

Expressive (The person understands but can't make words)

Receptive (The person can't understand, but can make words)

Global (Both expressive and receptive, so the person neither understands nor can make words)

1) Dysarthria:

It occurs in many places (Could be caused by paralysis of any muscle which is involved in articulation) and represented by: Disordered articulation or Slurred speech (**Not considered a speech disorder**)

2) Broca's aphasia (Motor Aphasia):

Patient understands but can't make words

3) Wernicke's aphasia (Sensory Aphasia):

Unable to understand, but no problems with word formation

4) Conduction aphasia:

Broca's and Wernicke's are ok, but the conduction between them is damaged (Arcuate Fasciculus), mostly the repetition is affected (repetition means saying one word many times)

5) Anomic aphasia:

Unable to name things (If you show him a car and ask him what is this, he will say "I drive it, I fill it with gas.." but he won't be able to name it)

6) Global aphasia:

Both Broca's + Wernicke's are affected, Person neither understands nor can make words

7) Dyslexia:

Word Blindness (Damage in Visual Association Area)

8) Prosopagnosia:

Loss of the ability to recognize faces (Damage in the facial recognition area)

9) Achromatopsia:

Inability to recognize colors

10) Stuttering (تأتأة):

Over activity in the cerebral cortex and cerebellum with timing disturbance, because MANY muscles participate to produce one word (**Not considered a speech disorder**)