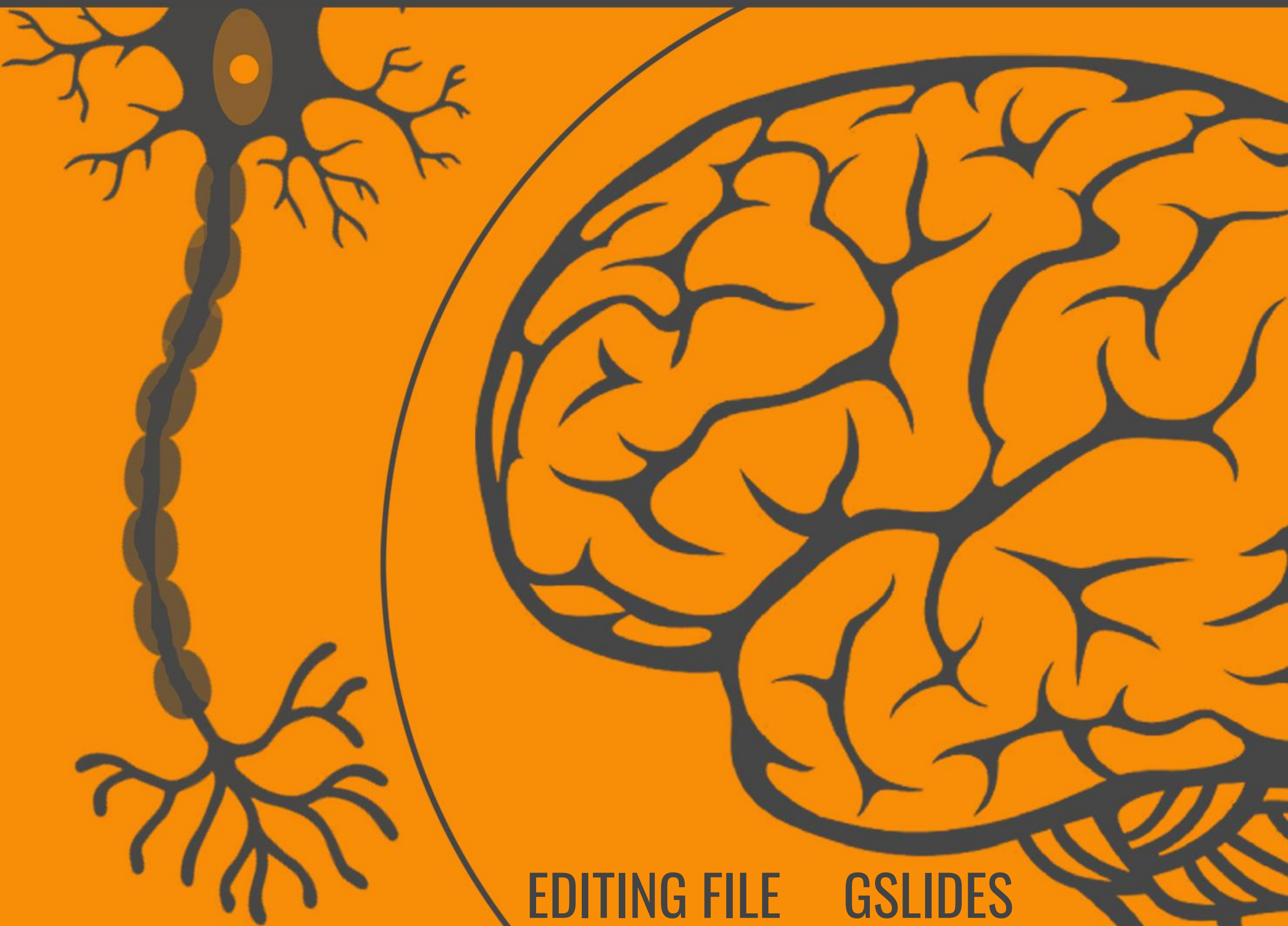


MEDICINE438's CNS PHYSIOLOGY

LECTURE 15: Physiology of Speech



EDITING FILE

GSLIDES

IMPORTANT

MALE SLIDES

EXTRA

FEMALE SLIDES

LECTURER'S NOTES

OBJECTIVES

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



SPEECH

It's the means of communication between the individuals. Speech and other intellectual functions are especially well developed in humans—the animal species in which the neocortical mantle is most highly developed.

- 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 & Writing.
 - 2- Written speech: understanding written words and expressing ideas in writing.

STEPS OF COMMUNICATION:



THERE ARE TWO MEANS OF COMMUNICATION

- **Sensory Communication** : Auditory communication & Visual communication.
- **Motor Communications** : speech & write

BRAIN AREAS CONCERNED WITH SPEECH & LANGUAGE :



SPEECH STRUCTURES

- Oral Cavity
- Nasal Cavity
- Pharynx
- Larynx

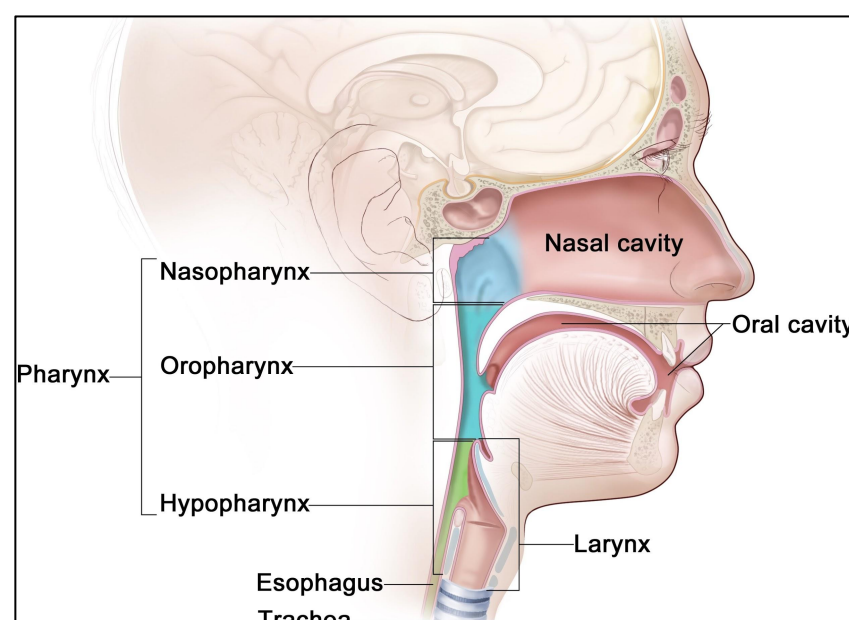


Figure 15-1

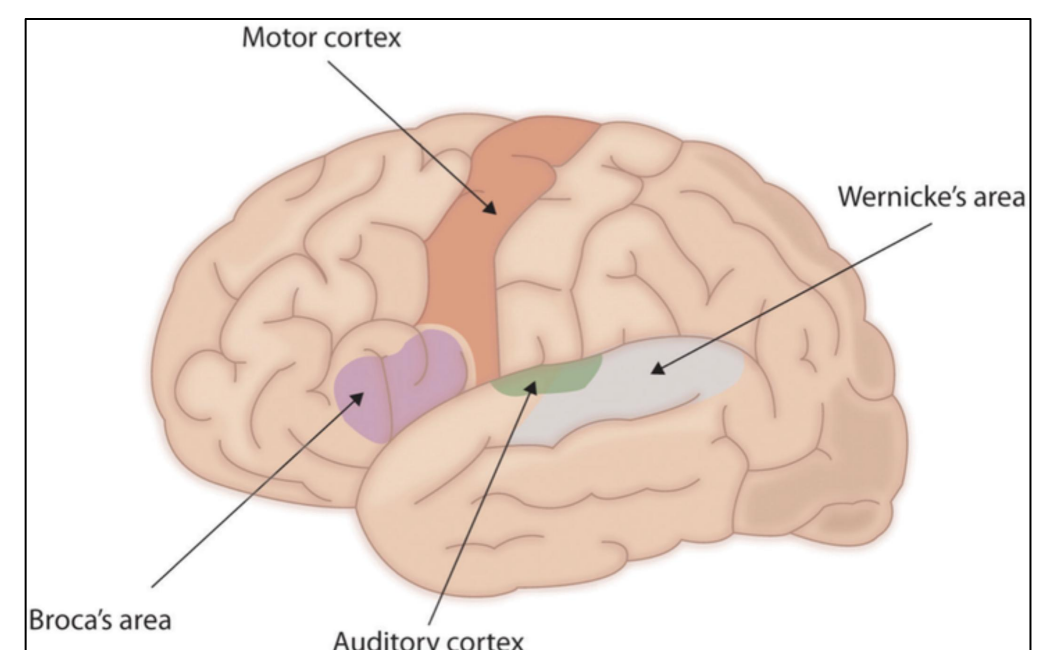


Figure 15-2

SPEECH PRODUCTION

1 INITIATION

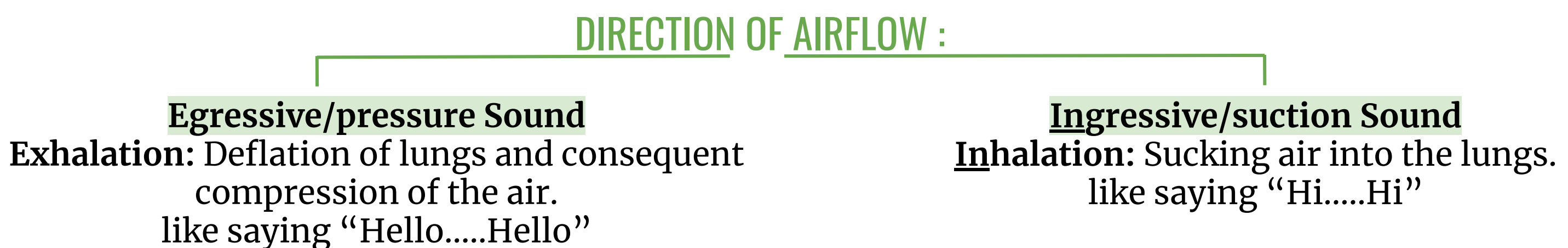
Initiation will set the airstream in motion, creating airstream is an essential process of sound production due to Change in pressure.

THREE MECHANISMS OF INITIATION

Pulmonic: Pulmonic airstream mechanism: Lungs 95% of human speech sounds are produced in this way.

Glottalic: Airstream mechanism via glottis.

Velaric: Airstream mechanism via velum.



2 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 cords** .

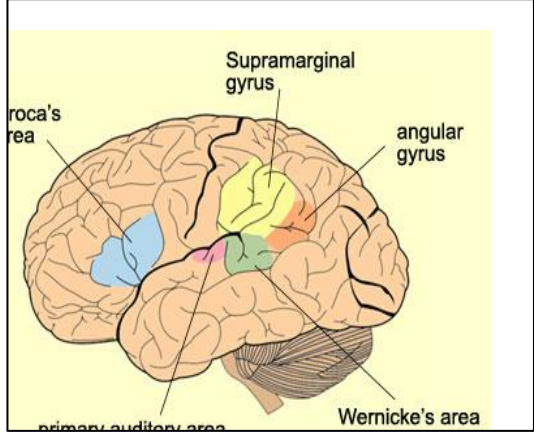
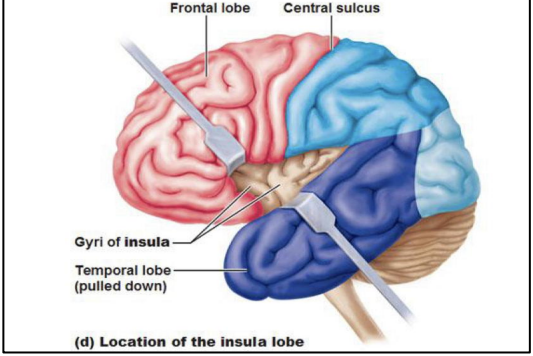
Major components : Vocal cords, Glottis, Epiglottis.

Three cartilages : Thyroid, Arytenoid, Cricoid.

3 ARTICULATION :

- Contribution by structures to shape airflow, A variety of speech sounds can be produced in terms of another way of airstream change Articulation.
- Specific part of the vocal apparatus involved in the production of a speech sound **active articulators** : **Lips** , **tongue** , **lower jaw** , **velum**.
- Muscular movements of the mouth, tongue, larynx, vocal cords .
- Responsible for the intonations, timing, and rapid changes in intensities of the sequential sounds.

SPEECH CENTERS

	Wernicke's Area	Broca's Area	Angular Gyrus	Insula
Location	At the posterior end of the superior temporal gyrus .	In the frontal cortex at the lower end of premotor area.	Behind Wernicke's area fused posteriorly into the visual cortex.	A portion of the cerebral cortex folded deep within the lateral sulcus.
Function	<ul style="list-style-type: none"> - Concerned with comprehension of auditory and visual information. - Interpretations of sensory experience. - Formation of thought in response to sensory experience. - Receive information from both auditory & visual areas - Closely associated with primary and secondary auditory areas (this close relation probably results from the fact that the first introduction to language is by way of hearing) - Choice of words to express thoughts. 	<ul style="list-style-type: none"> - Process information received from Wernicke's Area into detailed & co-ordinated pattern for vocalization. - Provides the neural circuitry for word formation. - Plans and motor patterns for expressing individual words or even short phrases are initiated and executed here. 	<p>Interpretation of information obtained from reading from visual cortex.</p>  <p style="text-align: center;">Figure 15-3</p>	<ul style="list-style-type: none"> - Hand and eye motor function.  <p style="text-align: center;">Figure 15-4</p>
Course	It projects information via the arcuate fasciculus to Broca's area (area 44)	Then project it to motor cortex to initiate the appropriate movement of the lips & larynx to produces speech. <ul style="list-style-type: none"> - If writing is concerned, then information is processed in the arms and hand region of the motor cortex » initiation of necessary muscle movement in the hand & arms required for writing a particular word. 	_____	_____
Damage	Wernicke's Aphasia: "sensory aphasia": <ul style="list-style-type: none"> - Unable to interpret the thought. - Meaningless words with loss of comprehension - Fluent 	Motor Aphasia: <ul style="list-style-type: none"> - Non fluent - Normal comprehension but voice production is defective 	<ul style="list-style-type: none"> - Anomic: the patient is unable to name objects. - Dyslexia "Word blindness" 	Motor Aphasia: <ul style="list-style-type: none"> - Progressive - non fluent + normal comprehension

It is interesting that in individuals who learn a second language in adulthood, MRI reveals that the portion of **Broca's area** concerned with it is adjacent to but separate from the area concerned with the native language. However, in children who learn two languages early in life, only a single area is involved with both languages. It is well known, of course, that children acquire fluency in a second language more easily than adults.

BOX 15-1: GUYTON AND HALL

The Angular Gyrus Area Is Needed for Initial Processing of Visual Language (Reading).

A visual association area that feeds visual information conveyed by words read from a book into Wernicke's area, the language comprehension area. It is needed to make meaning out of the visually perceived words. In its absence, a person can still have excellent language comprehension through hearing but not through reading.

- Lying immediately behind Wernicke's area and fusing posteriorly into the visual areas of the occipital lobe as well. If this region is destroyed while Wernicke's area in the temporal lobe is still intact, the person can still interpret auditory experiences as usual, but the stream of visual experiences passing into Wernicke's area from the visual cortex is mainly blocked.
- Therefore, the person may be able to see words and even know that they are words but not be able to interpret their meanings. This condition is called dyslexia, or word blindness.

THE ACT OF SPEECH DIVIDES INTO TWO ASPECTS

1 SENSORY ASPECTS OF COMMUNICATION:

2 MOTOR ASPECTS OF COMMUNICATION :

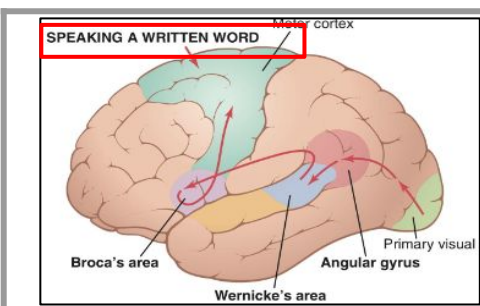


Figure 15-5

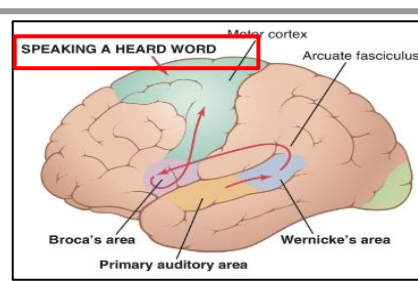


Figure 15-6

Visual Language Perception "Reading"	Auditory Language Perception "Hearing-Talking"
It will start with the primary visual cortex because the stimuli here is preserved by vision center	It will start with the primary Auditory area because the stimuli here is preserved by Auditory area center

(1) **Formation in the mind of thoughts** to be expressed, as well as choice of words to be used.

(2) **Motor control** of vocalization and the actual act of vocalization itself.

BOX 15-2: GUYTON AND HALL

THERE IS TWO PRINCIPAL PATHWAYS FOR COMMUNICATION:

- 1- Hearing and speaking response. 2- Reading and then speaking in response.

Auditory Language Perception "Hearing-Talking"	Visual Language Perception "Reading"
1) reception in the primary auditory area of the sound signals that encode the words	- The comparable steps in reading and then speaking in response.
(2) interpretation of the words in Wernicke's area	- The initial receptive area for the words is in the primary visual area rather than in the primary auditory area.
(3) determination, also in Wernicke's area, of the thoughts and the words to be spoken	- The information then passes through early stages of interpretation in the angular gyrus region and finally reaches its full level of recognition in Wernicke's area.
(4) transmission of signals from Wernicke's area to Broca's area by way of the arcuate fasciculus	- From here, the sequence is the same as for speaking in response to the spoken word.
(5) activation of the skilled motor programs in Broca's area for control of word formation	
(6) transmission of appropriate signals into the motor cortex to control the speech muscles.	

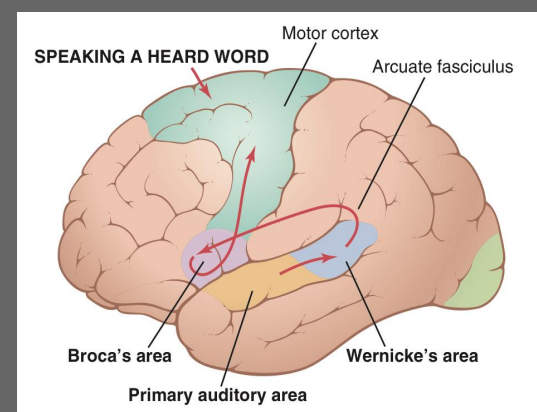


Figure 15-7

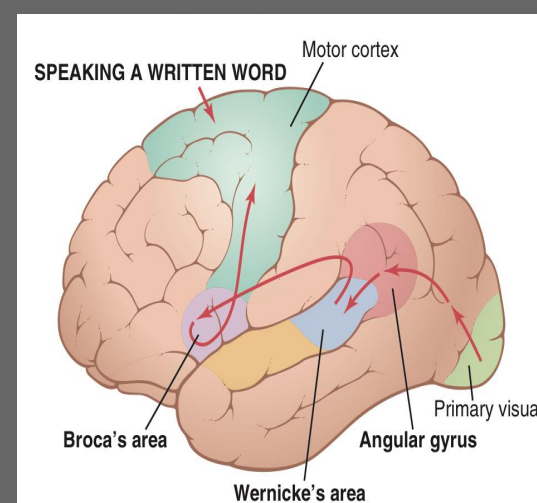
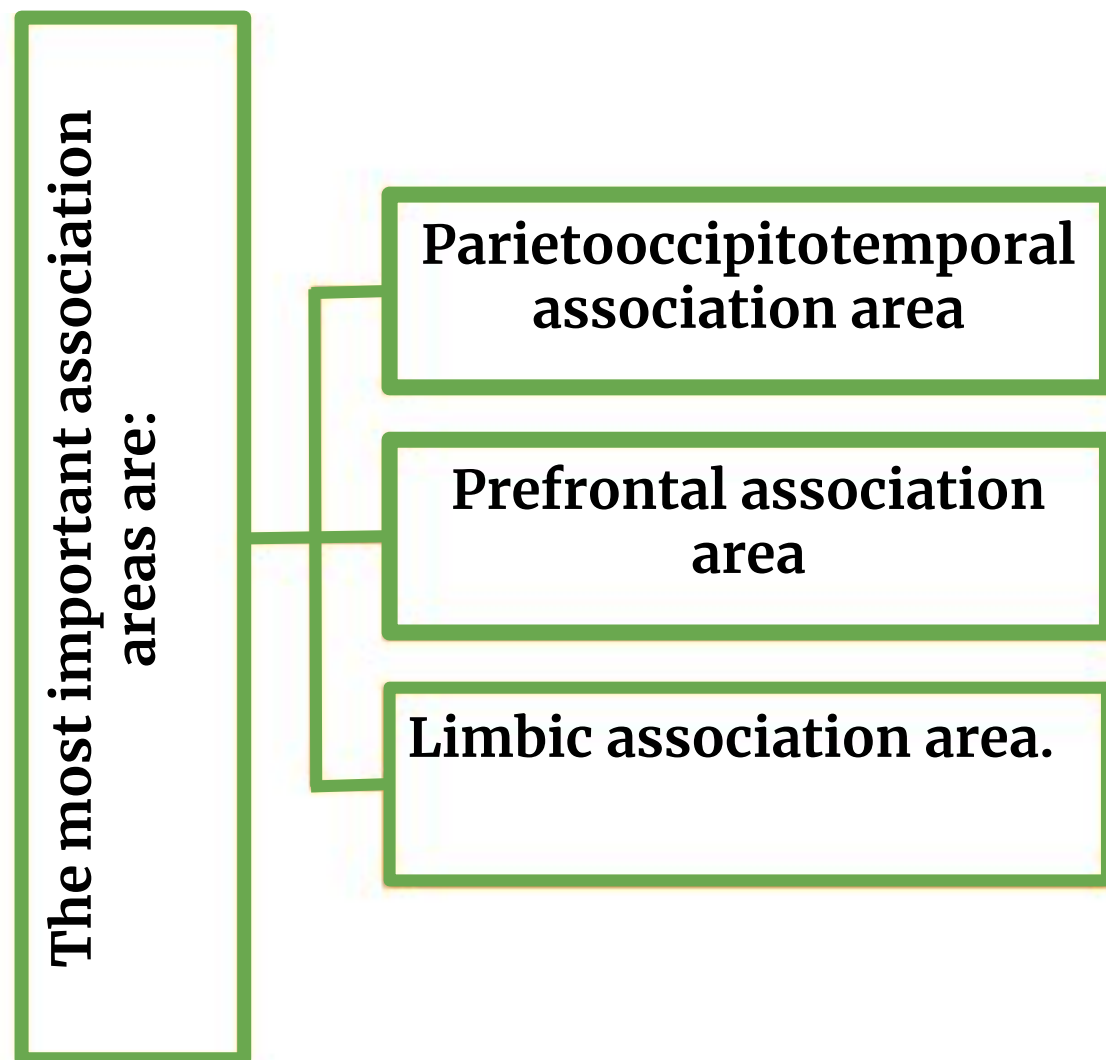


Figure 15-8

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.



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.

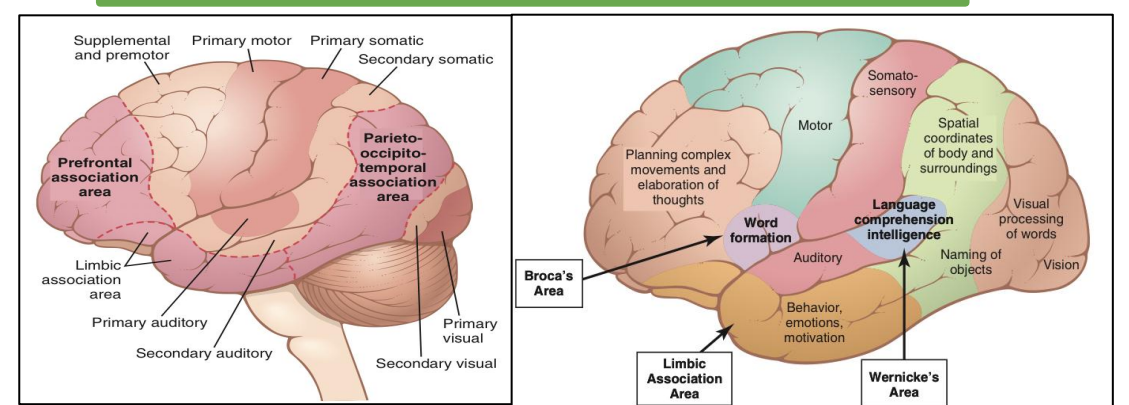


Figure 15-9

Figure 15-10

SPEECH CHAIN

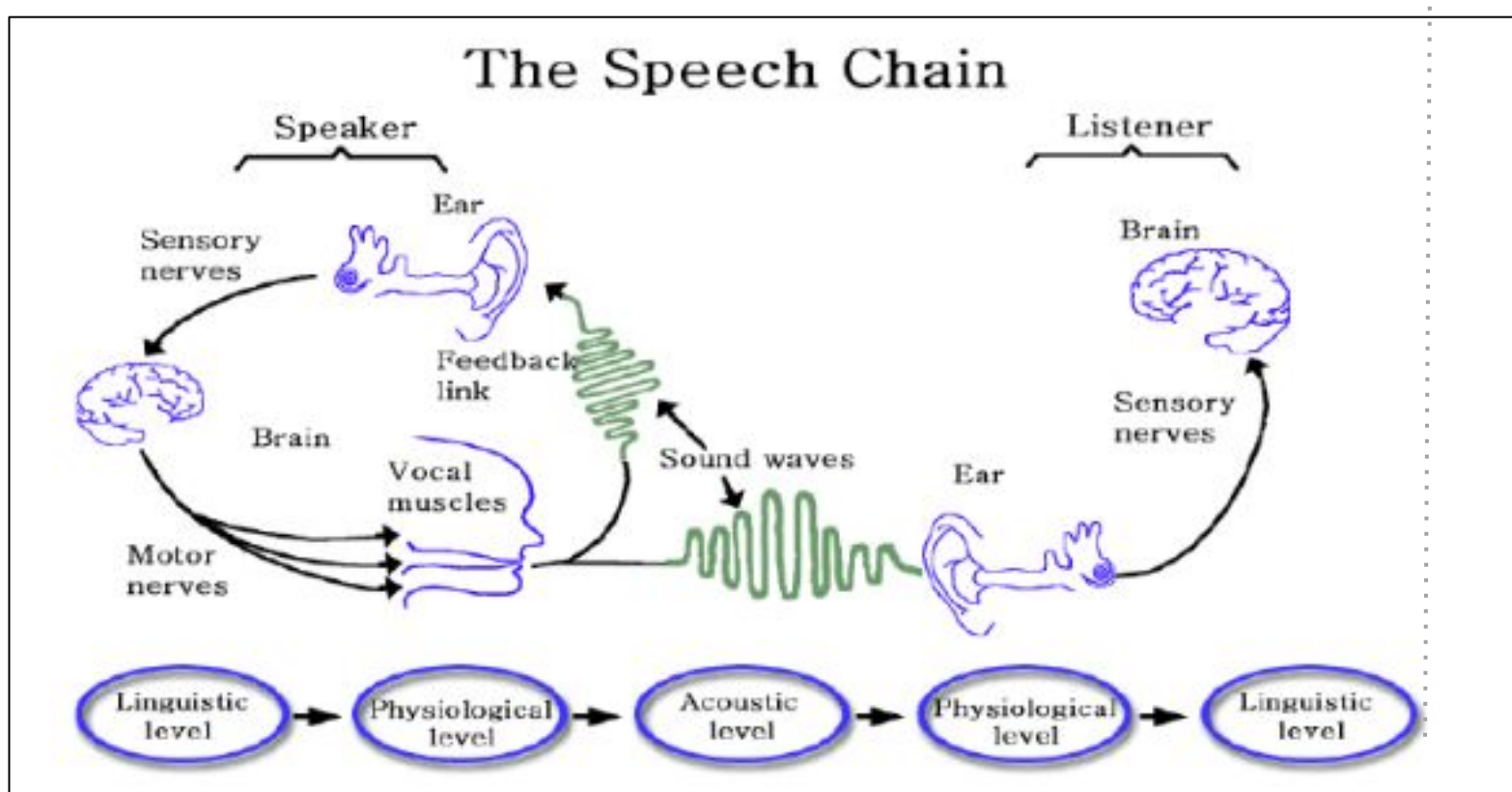


Figure 15-11

MECHANISMS OF ARTICULATION

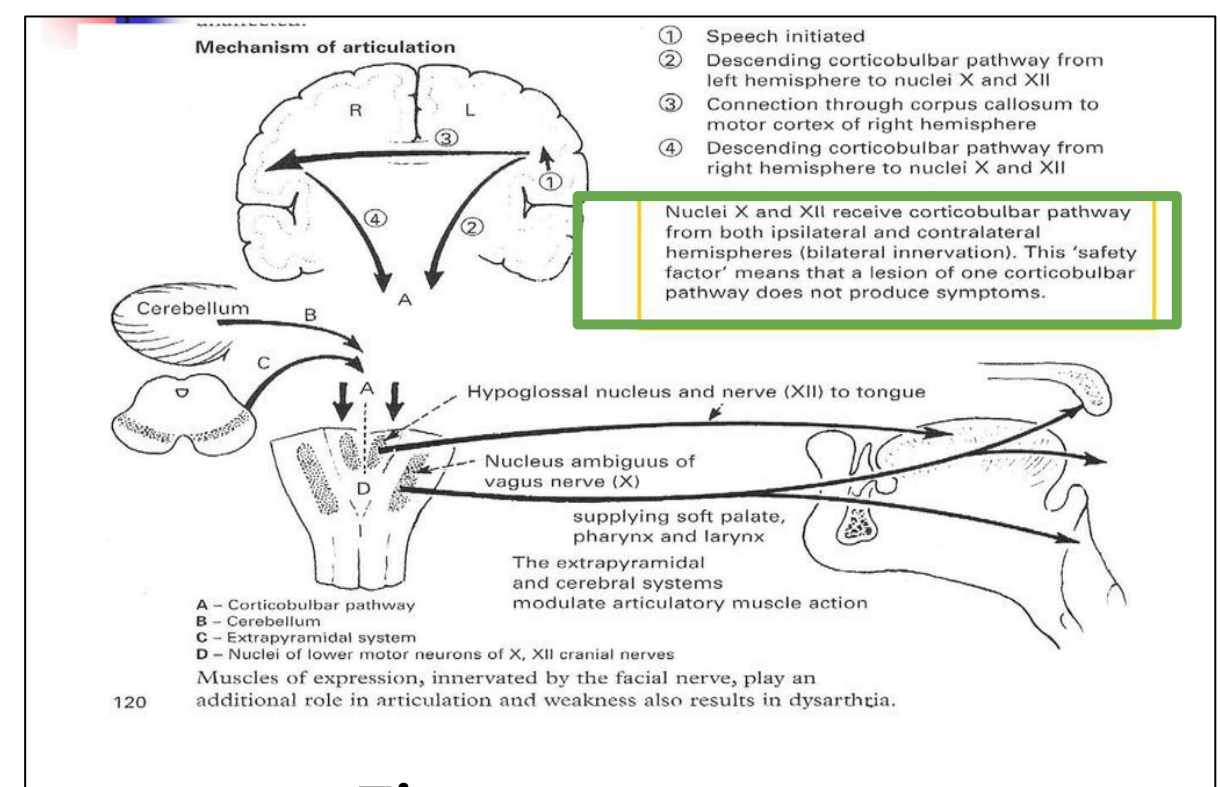


Figure 15-12

SPEECH DISORDERS

Area	Lesion feature
Auditory association areas	Word deafness
Visual association areas	Word blindness "dyslexia"
Wernicke's Aphasia	Unable to interpret the thought
Broca's Area Causes	Motor Aphasia
Global Aphasia	Unable to interpret the thought Motor Aphasia

Dysphasia:	It is an acquired loss of production or comprehension of spoken and/or written language secondary to brain damage.
Dyscalculia	Difficulty in learning or comprehending arithmetic and mathematics, Seen in developmental disorder.
Dysarthria:	Abnormality in articulation (motor dysfunction) due to neurological conditions involving motor function (upper or lower motor neuron lesion). No abnormality in the speech centre or in its pathways results in stuttering speech.
Slurred Speech	<p>Language is intact. Paralysis, slowing or in coordination of muscles of articulation or local discomfort causes various different patterns of dysarthria.</p> <ul style="list-style-type: none"> -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 <p>Examples:</p> <ul style="list-style-type: none"> -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.
Stuttering	<ul style="list-style-type: none"> - 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.
Disordered phonation	
Dysphonia:	<p>Phonation: Sound production by passage of air over the vocal cord. Dysphonia: Abnormal sound production due to problem in vocal cord e.g. paralysis, CVA, and other causes.</p> <p>Causes:</p> <ul style="list-style-type: none"> -Paralysis of both vocal cord e.g whispering sound and inspiratory stridor. -Paralysis of left vocal cord: The voice becomes weak and cough bovine. Mainly due to recurrent laryngeal palsy

Aphasia

Abnormality of language function due to injury of language centres in cerebral cortex of left cerebral hemisphere.

- Comprehension or expression of words will be affected, due to thrombus or embolism of cerebral vessels or trauma.

TYPES OF APHASIA

Motor Aphasias	<p>Broca's aphasia (non fluent): Lesion of Broca's area.</p> <ul style="list-style-type: none"> - 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
	<p>Insula damage: Progressive non-fluent aphasia (in old patients)</p> <ul style="list-style-type: none"> - 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
Sensory Or Wernicke's Aphasia (Fluent)^{1,2}	<p>Lesion of wernicke's area +/- arcuate fasciculus</p> <ul style="list-style-type: none"> - <u>Impaired comprehension</u> - <u>Loss of intellectual function</u> - Failure to interprets meaning of written or spoken words - Meaningless & excessive talk (in severe cases)
Conductive Aphasia (Fluent)	<p>Lesion of nerve fibres of arcuate fasciculus</p> <ul style="list-style-type: none"> - Patient <u>understand speech</u> of others but can not repeat it - Meaningless speech
Anomic "Nominal" Aphasia	<p>Lesion of angular gyrus, thus Broca's & Wernicke's are intact</p> <ul style="list-style-type: none"> - 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
Global Aphasia "Central Aphasia"	<p>This means the combination of the expressive problems of Broca's aphasia and the loss of comprehension of Wernicke's.</p> <ul style="list-style-type: none"> - 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.

FUNCTIONS OF CEREBRAL HEMISPHERES

Right hemisphere (the representational hemisphere)	Left hemisphere (the categorical hemisphere)
<ul style="list-style-type: none"> ● The right hemisphere controls the left side of the body ● Temporal and spatial relationships ● Analyzing nonverbal information ● Communicating emotion ● recognition of emotion ● Recognition of tunes, rhythms ● Holistic problem solving 	<ul style="list-style-type: none"> ● 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

FOOTNOTES

1. After severe damage in Wernicke's area, a person might hear perfectly well and even recognize different words but still be unable to arrange these words into a coherent thought. Likewise, the person may be able to read words from the printed page but be unable to recognize the thought that is conveyed.
2. Damage to the Broca's area results in the inability to speak fluently despite having normal comprehension and vocal mechanisms. On the other hand, Wernicke's aphasia is the inability to understand or produce meaningful language even though they can speak fluently.

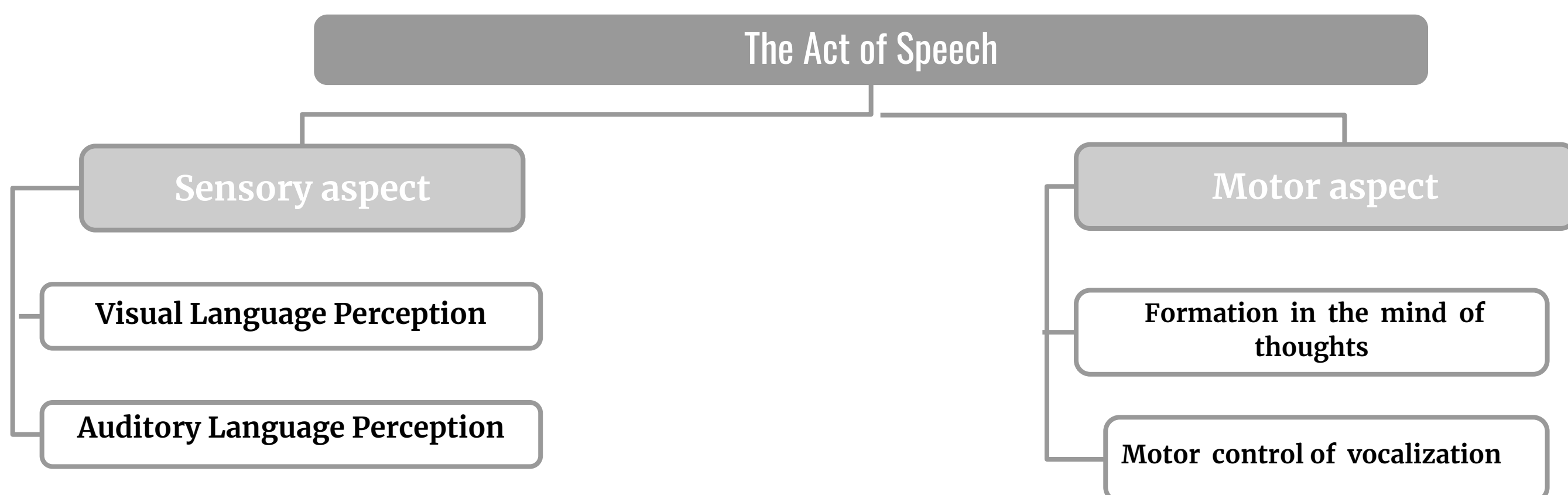
SUMMARY

Speech Production

1. Initiation	Action that initiates the flow of air which is achieved by the Lung and glottis and velum .
2. Phonation	Action that modulates the quality of sounds which is achieved by the larynx and vocal cords .
3. Articulation	Action that modulates or articulates which is achieved by the structures of the mouth .

Speech Centers

	Wernicke's	Broca's	Angular gyrus	Insula
Function	Interpretations of sensory experience	provides the neural circuitry for word formation	Interpretation of information obtained from reading from visual cortex	Contains Speech articulation area
Damage	Wernicke's Aphasia "sensory aphasia"	Motor Aphasia	-Anomic -Dyslexia "Word blindness"	Motor Aphasia: -Progressive non fluent + normal comprehension



Three Important Association Areas

Parietooccipitotemporal association area	Prefrontal association area	Limbic association area.
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QUIZ



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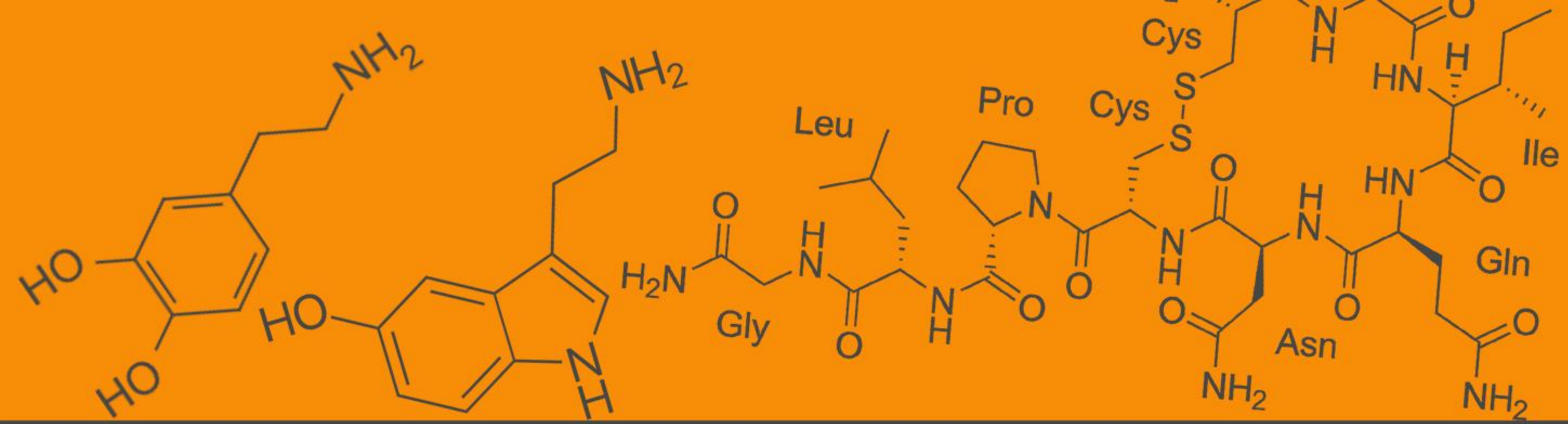
1. Which of the speech centers initiates the movement of the lips, tongue, and larynx to produce speech?
 - A) Wernicke's area
 - B) Broca's area
 - C) Insula
 - D) Angular gyrus
2. Action that modulates the quality of sounds which is achieved by the larynx and vocal cords?
 - A) Articulation
 - B) Phonation
 - C) Initiation
 - D) Modulation
3. Which speech center damage will cause motor aphasia?
 - A) Wernicke's area
 - B) Broca's area
 - C) Insula
 - D) Angular gyrus
4. Which speech disorder affects the fluency of speech?
 - A) Stuttering
 - B) Dysphonia
 - C) Dysphasia
 - D) Global aphasia
5. Which of the following is NOT a function of the Parietooccipitotemporal association area?
 - A) Area for Language Comprehension
 - B) Area for Initial Processing of Visual Language (Reading)
 - C) Area for Naming Objects
 - D) Hand and eye motor function

SHORT ANSWER QUESTIONS

1. What are the most important association areas?
 - Parietooccipitotemporal association area
 - Prefrontal association area
 - Limbic association area
2. What are the causes of dysphonia?
 - Paralysis of both vocal cords
 - Paralysis of left vocal cord
3. Define central aphasia?

The combination of the expressive problems of **Broca's aphasia** and the loss of comprehension of **Wernicke's**.

ANSWER KEY: C, B, B, A, D



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REFERENCES

- Guyton and Hall Textbook of Medical Physiology
- Ganong's Review of Medical Physiology

