



PHYSIOLOGY OF SPEECH



Prof. Sultan Ayoub Meo
MBBS, Ph.D, M Med Ed (Dundee), FRCP (London,
FRCP (Dublin), FRCP (Glasgow), FRCP (Edinburgh)
Professor and Consultant, Department of Physiology
College of Medicine, King Saud University



SPEECH

Lecture 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, Dysphonia etc
- Explain difference between aphasia and dysarthria.

SPEECH

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

Means of communications:

Sensory Communication

Auditory communication

Visual communication

Motor Communications:

Talking

Writing



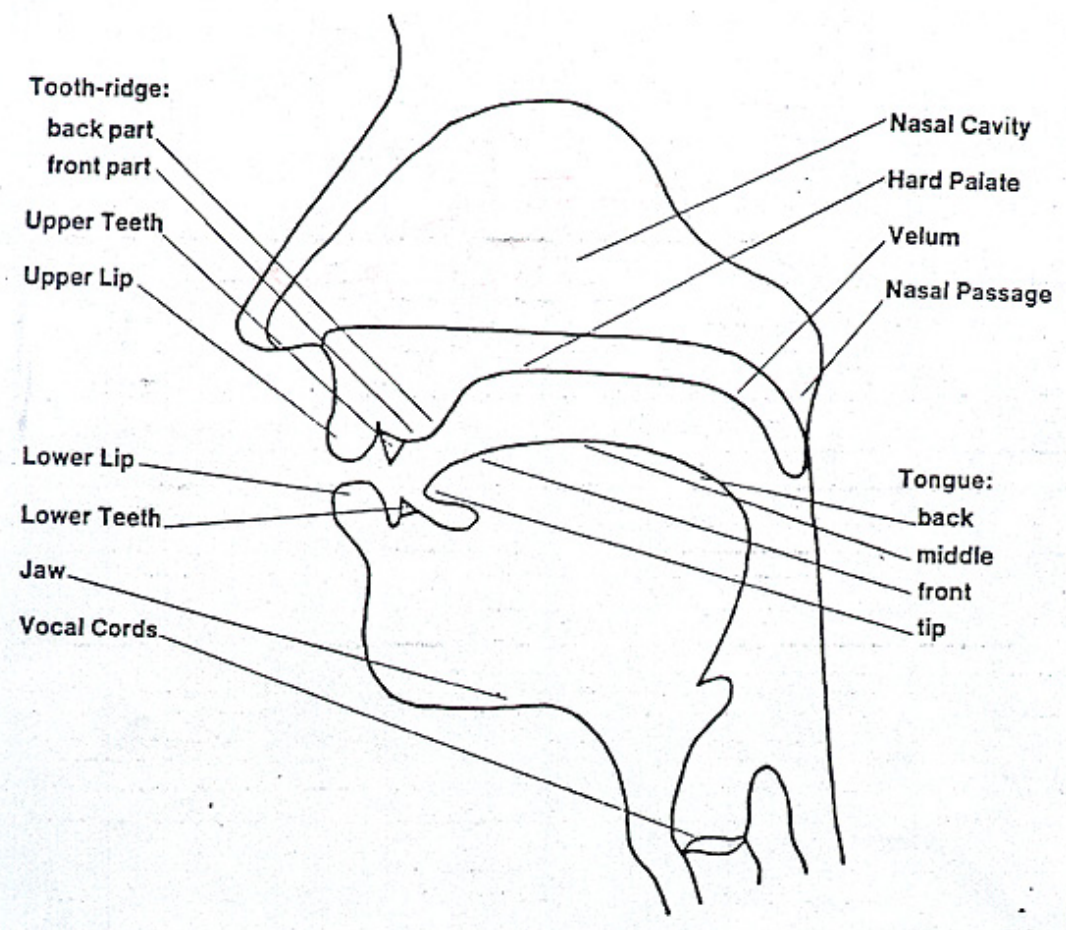
SPEECH STRUCTURES

Oral Cavity

Nasal Cavity

Pharynx

Larynx





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

1. INITIATION

Setting the airstream in motion

Creating airstream is an essential process of sound production

Change in pressure

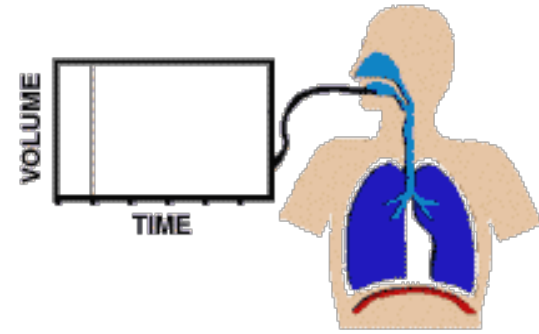
Three mechanisms of initiation

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

Glottalic: Airstream mechanism via glottis

Velaric: Airstream mechanism : Velum

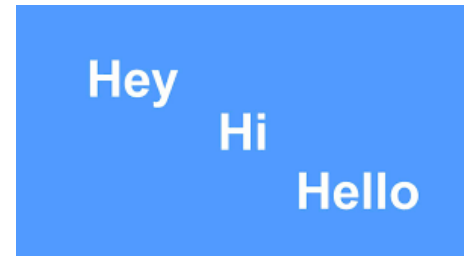
BASIC EVENTS IN SPEECH PRODUCTION



1. INITIATION: DIRECTION OF AIR FLOW

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.....



BASIC EVENTS IN SPEECH PRODUCTION

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 CORD**

Major components

Vocal cords, Glottis, Epiglottis

Three cartilages:

Thyroid

Arytenoid

Cricoid



BASIC EVENTS IN SPEECH PRODUCTION

3. 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

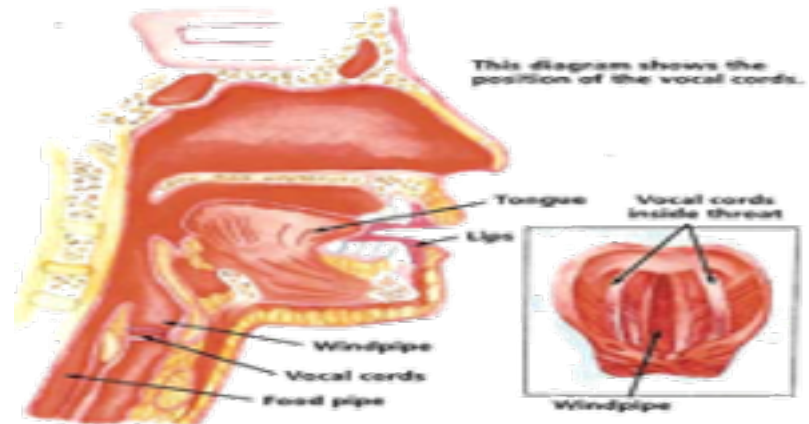
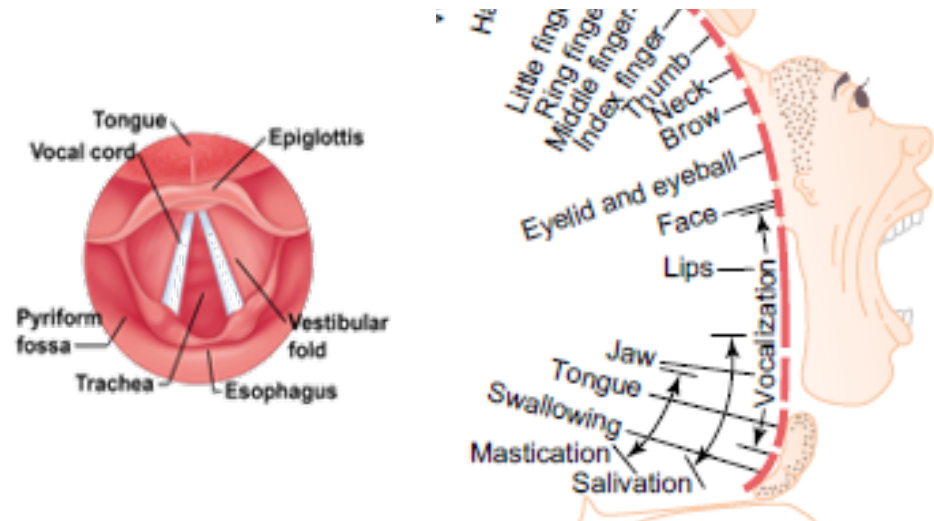
Active articulators

Lips, tongue, lower jaw, velum

BASIC EVENTS IN SPEECH PRODUCTION

3. ARTICULATION

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





SPEECH

Means of communications:

Sensory Communication

Auditory communication

Visual communication

Motor Communications:

Talking

Writing



STEPS OF COMMUNICATION

Steps of Communications

Collection of sensory input:

↓ Auditory and visual

Integration: Hearing and articulation mechanism

↓

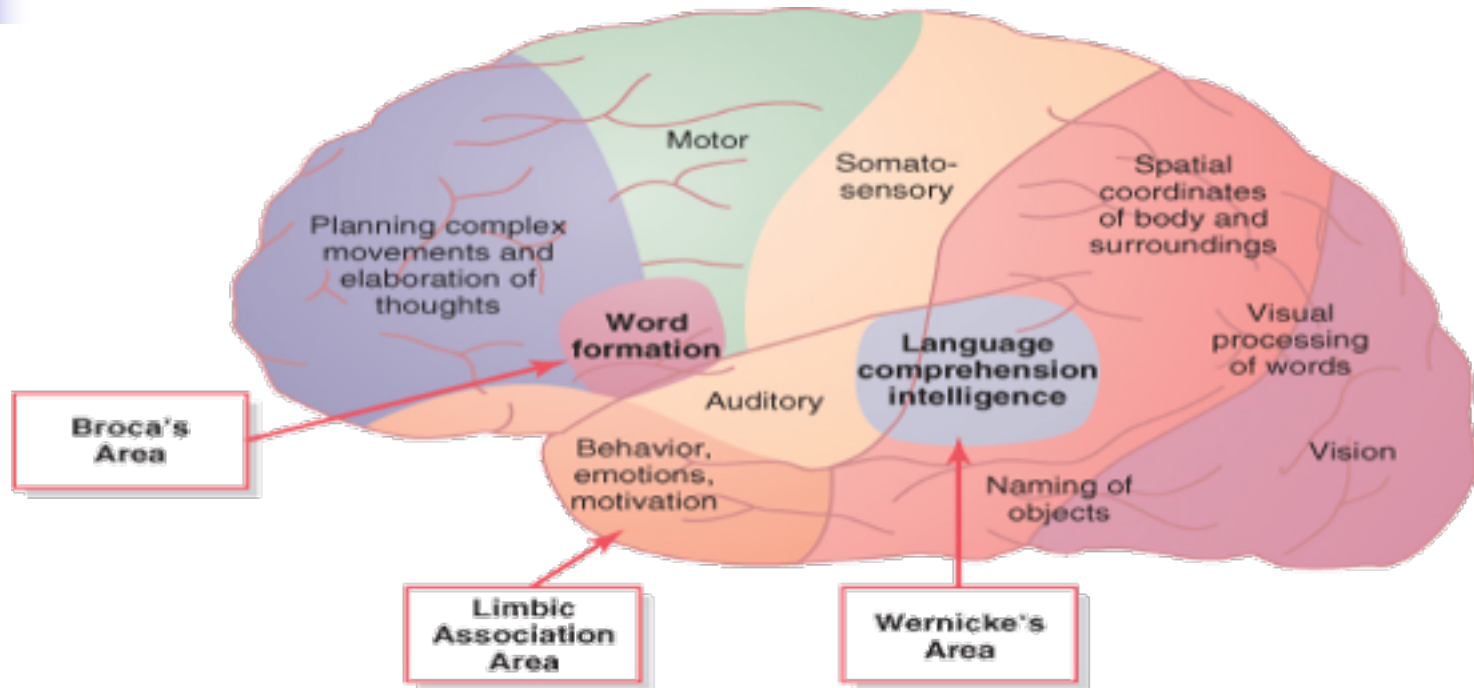
Motor execution



Brain Areas Concerned with Speech / Language

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

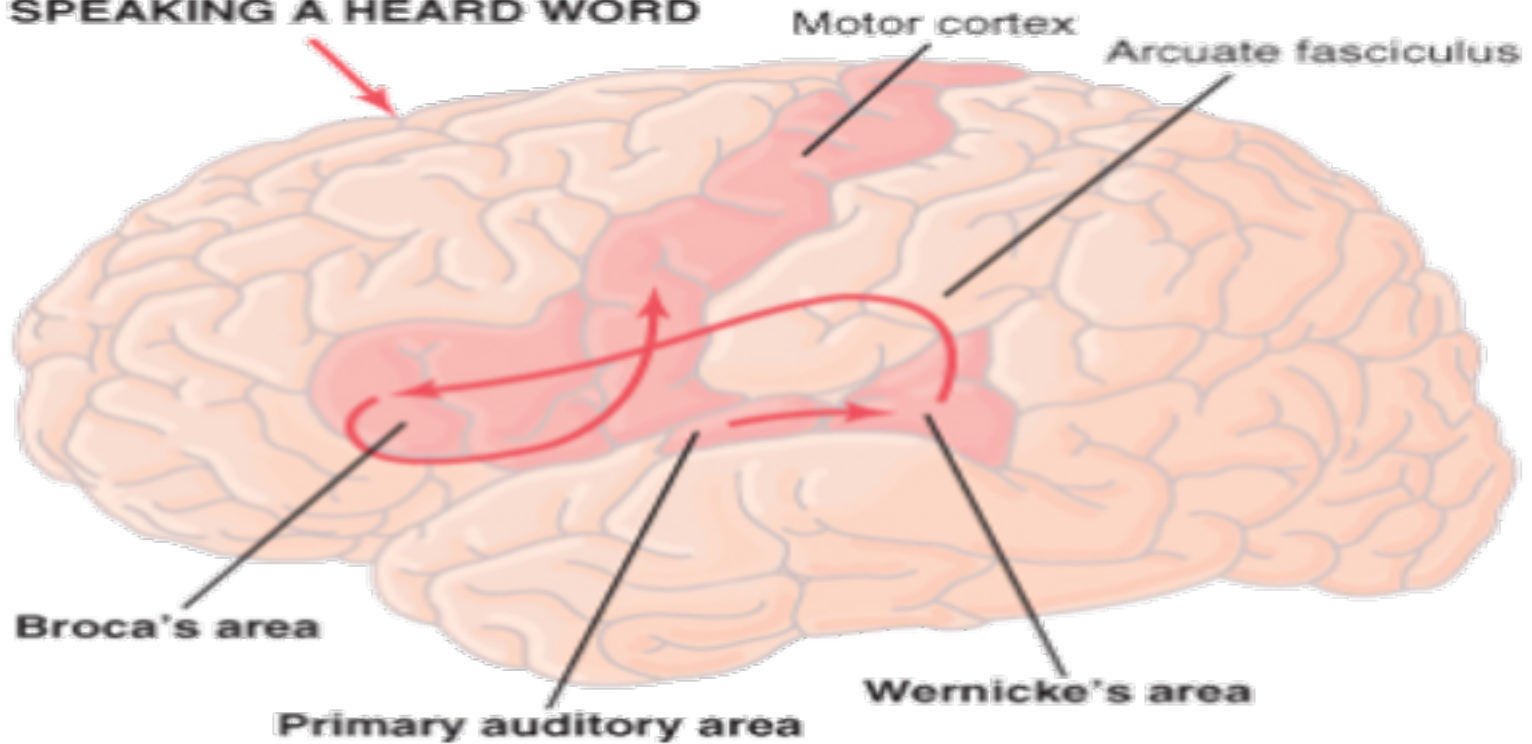
SPEECH CENTRES



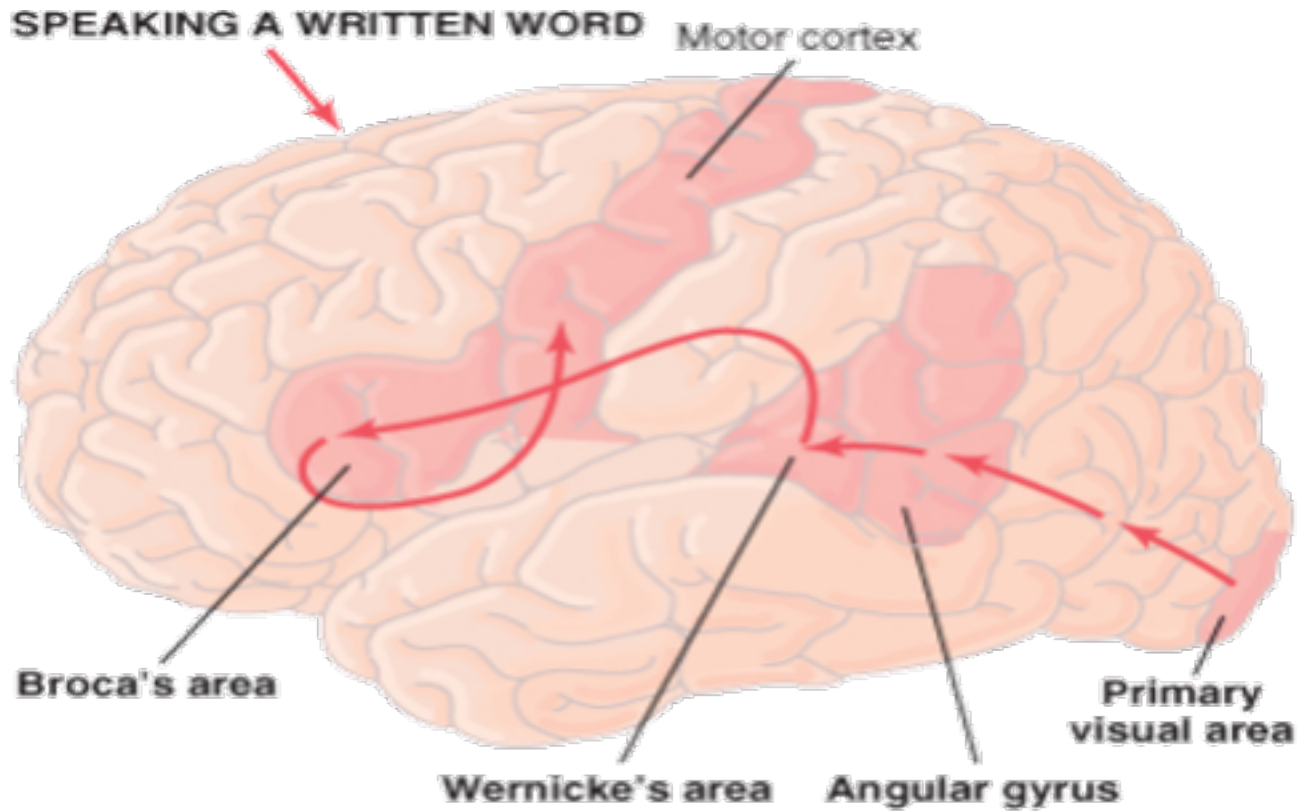
Broca's Area. A special region in the frontal cortex, called *Broca's area*, provides the neural circuitry for word formation. This area, is located partly in the posterior lateral prefrontal cortex and partly in the premotor area. It is here that plans and motor patterns for expressing individual words 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,

Auditory Language Perception

SPEAKING A HEARD WORD

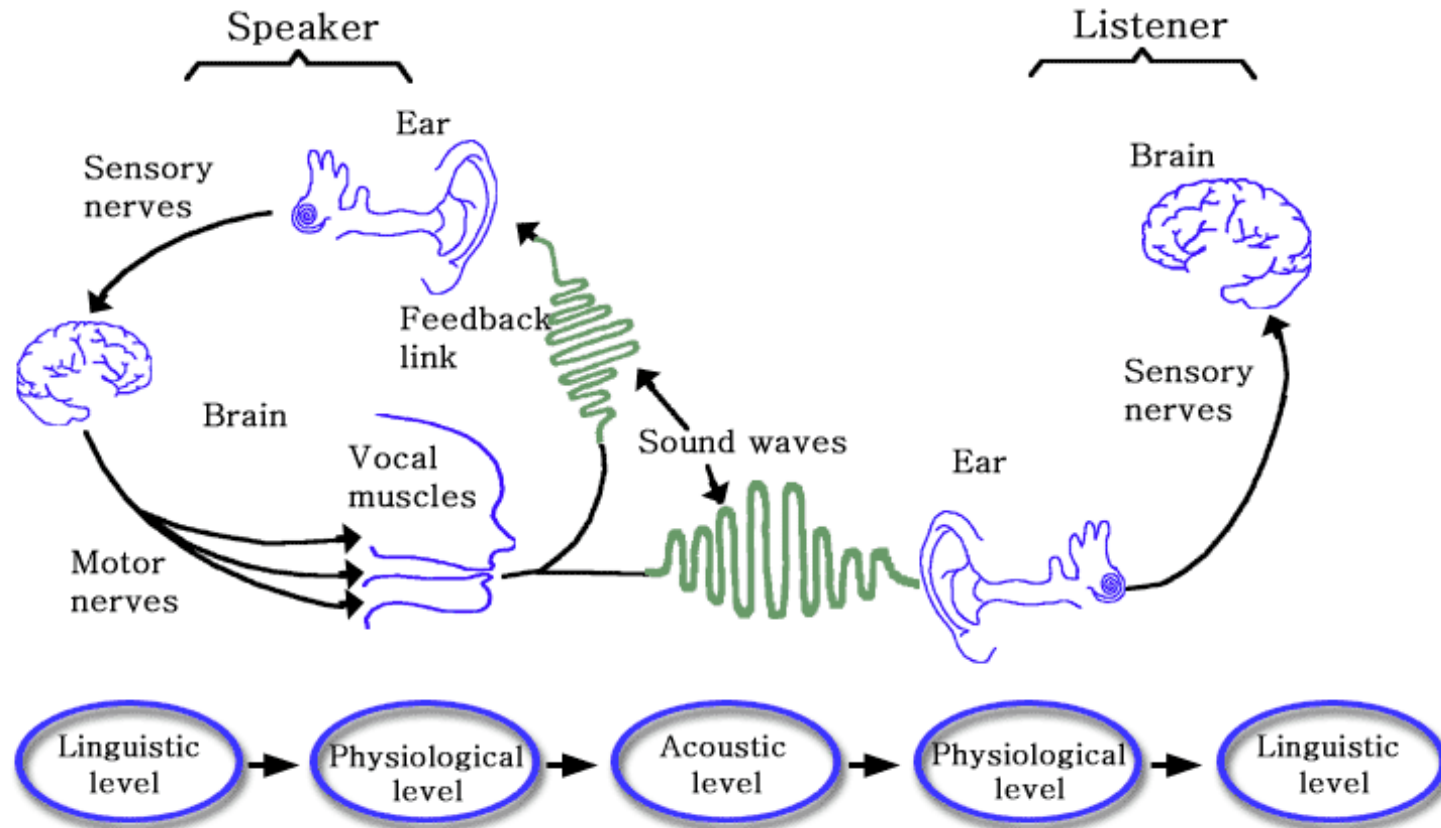


Visual Language (Reading)



THE SPEECH CHAIN

The Speech Chain





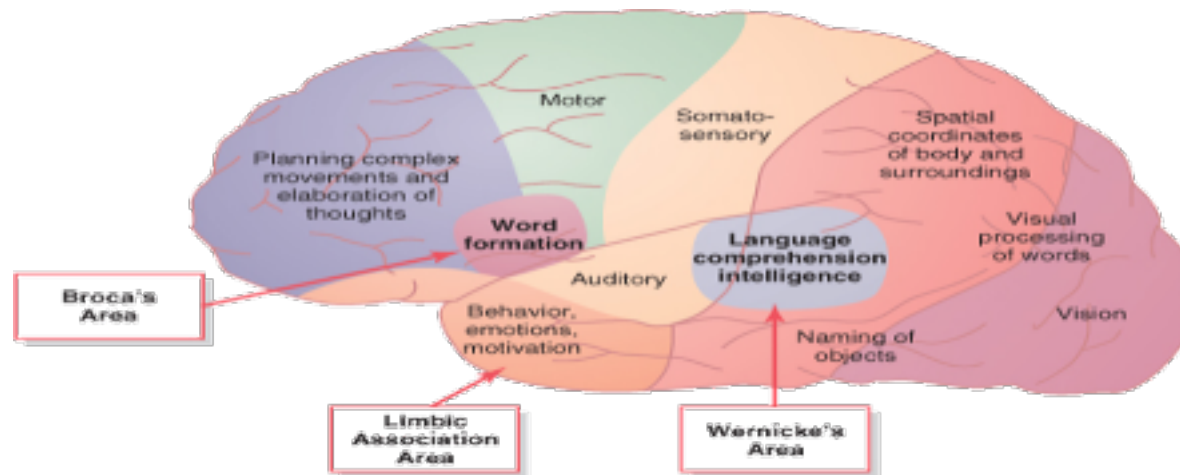
ASSOCIATION AREAS

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

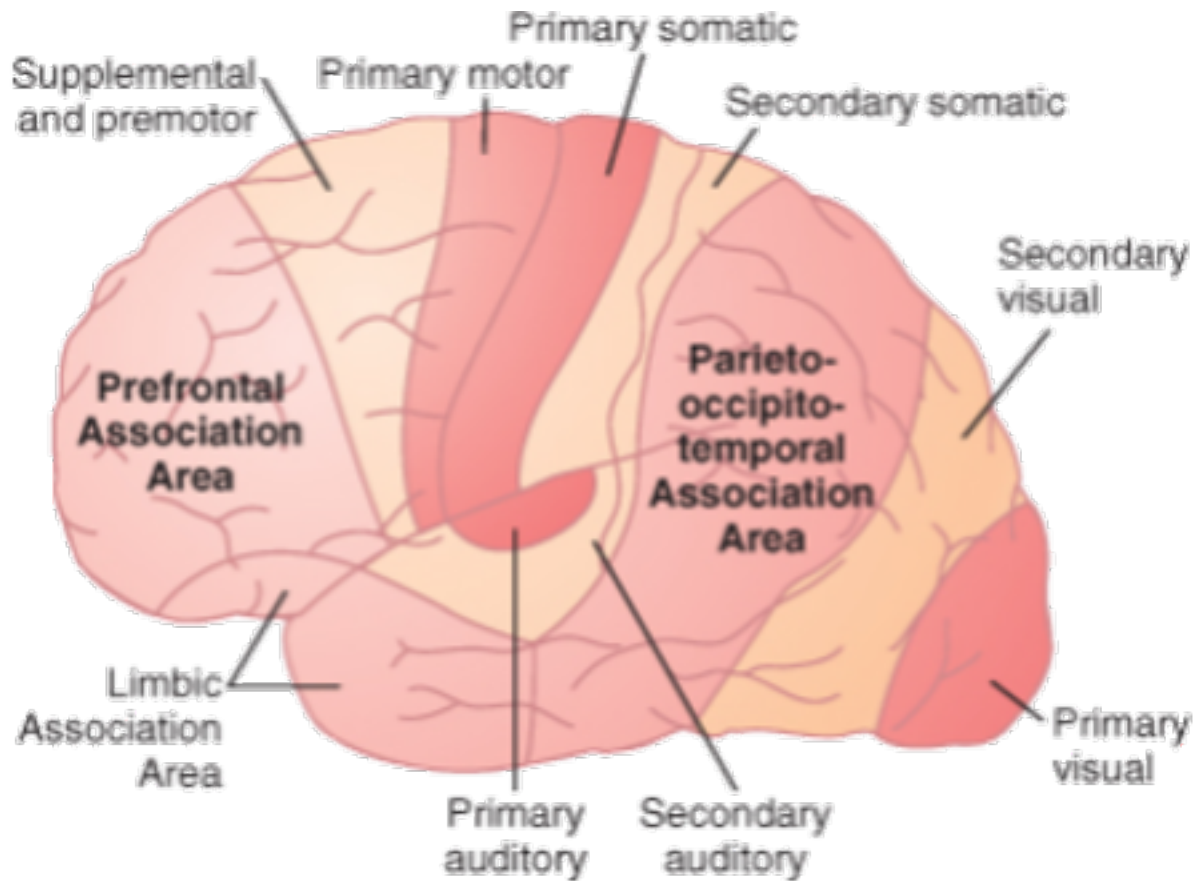
The most important association areas are
Parieto-occipitotemporal association area
Prefrontal association area
Limbic association area.

PARIETO-OCCIPITOTEMPORAL ASSOCIATION AREAS

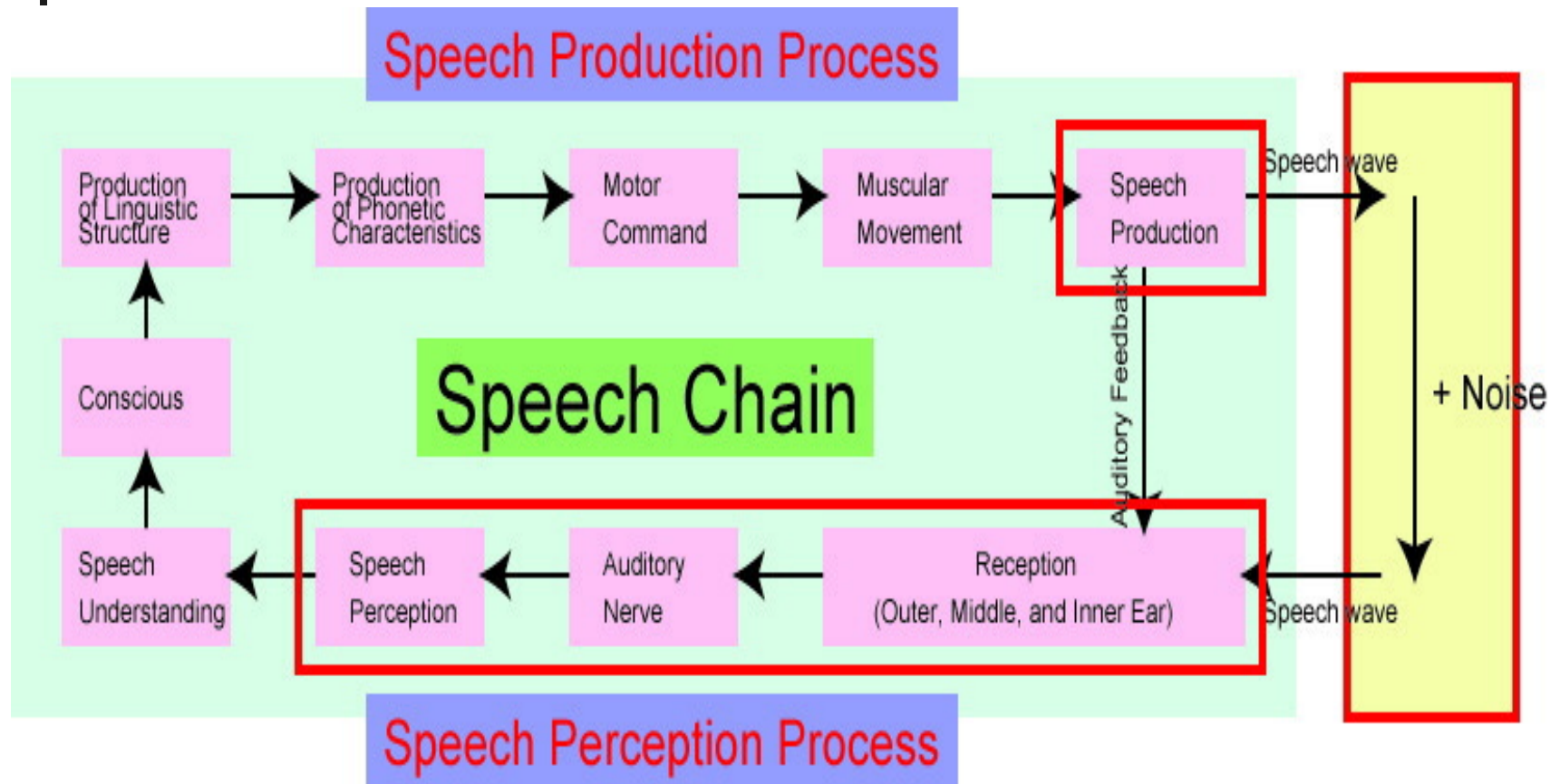
1. Analysis of the Spatial Coordinates of the Body.
2. Area for Language Comprehension.
3. Area for Initial Processing of Visual Language (Reading).
4. Area for Naming Objects.



PRIMARY, SECONDARY AND ASSOCIATION AREAS

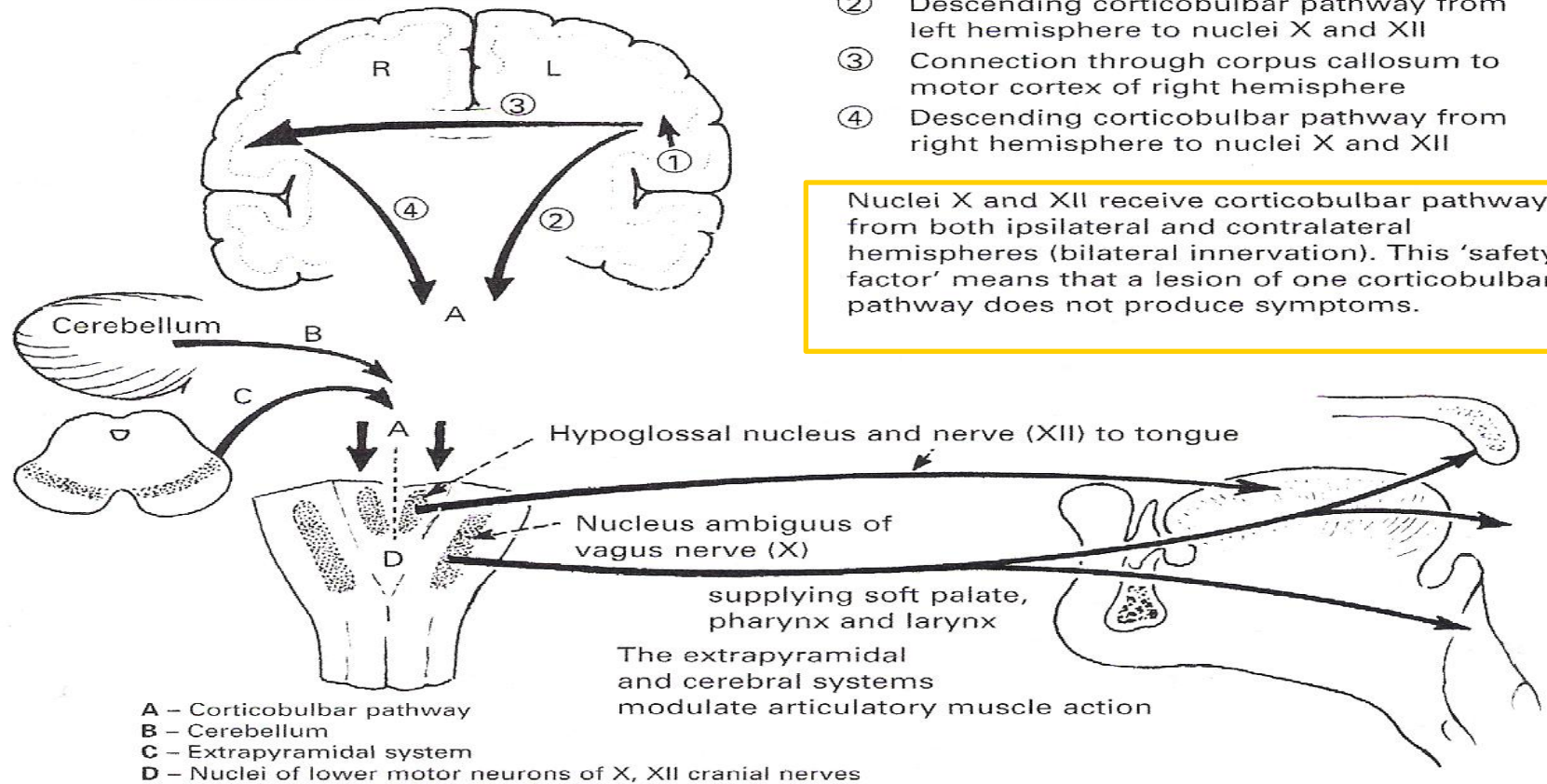


SPEECH PRODUCTION PROPCESS



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.

APHASIA

CATEGORICAL HEMISPHERE

APHASIA IS LOSS OF OR DEFECTIVE LANGUAGE FROM DAMAGE TO THE SPEECH CENTRES WITHIN THE LEFT HEMISPHERE.

PLEASE NOTE THAT

IN APHASIA THERE IS NO DAMAGE TO VISION, HEARING OR MOTOR PARALYSIS. THE DAMAGE IS IN SPEECH CENTERS IN CATEGORICAL HEMISPHERES

APHASIA

EXPRESSIVE

NON FLUENT
Understanding normal but
Voice production defective

FLUENT: Meaningless words
with loss of comprehension /
understanding

ANOMIC: Unable to name
the objects

GLOBAL: Mixture of all

RECEPTIVE

BROCA'S AREA

WERNICK'S AREA
CONDUCTION APHASIA

ANGULAR GYRUS

WIDESPREAD DAMAGE TO
SPEECH AREAS



SPEECH DISORDERS

AREA	LESION FEATURES
Auditory association areas	Word deafness
Visual association areas	Word blindness called dyslexia teapot tɛpɔt tɛpɔt tɛpɔt tɛpɔt tɛpɔt tɛpɔt tɛpɔt tɛpɔt tɛpɔt
Wernicke's Aphasia	Unable to interpret the thought
Broca's Area Causes	Motor Aphasia
Global Aphasia	Unable to interpret the thought Motor Aphasia

SPEECH DISORDERS: DYSPHASIA

DISORDERS OF SPEECH – DYSPHASIA

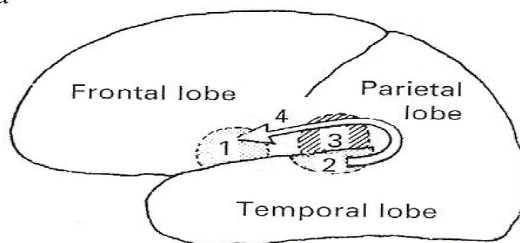
Dysphasia is an acquired loss of production or comprehension of spoken and/or written language secondary to brain damage.

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: DYSARTHRIA

DYSARTHRIA: MEANS DISORDER IN ARTICULATION

e.g., 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

"Slurred" 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



SPEECH DISORDERS: DYSARTHRIA

DISORDERED 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 (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: STUTTERING



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

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.



SPEECH DISORDERS:

DISORDERED PHONATION

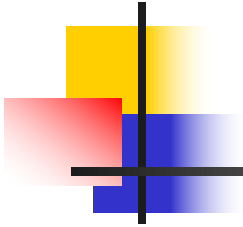
- Sound production by passage of air over the vocal cord.
- **Dysphonia:** Abnormal sound production due to problem in vocal cord e.g., paralysis, CVA, other causes
- Causes: Paralysis of both vocal cord e.g. whispering sound and inspiratory strider
- **Paralysis of left vocal cord:** The voice becomes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



GLOBAL APHASIA (CENTRAL APHASIA)

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.



THANK YOU