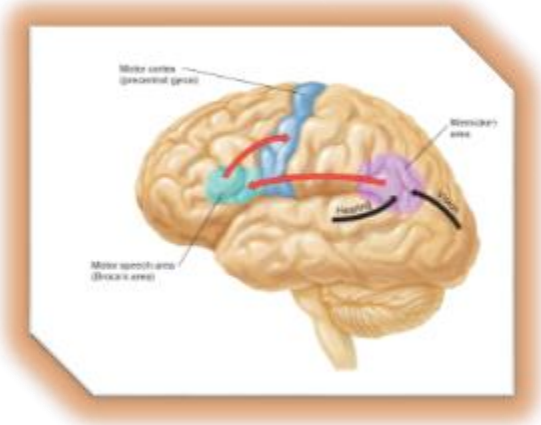
ORAL BIOLOGY AND PHYSIOLOGY

COURSE CODE: 1601106

2 credit Units



Physiology of Speech

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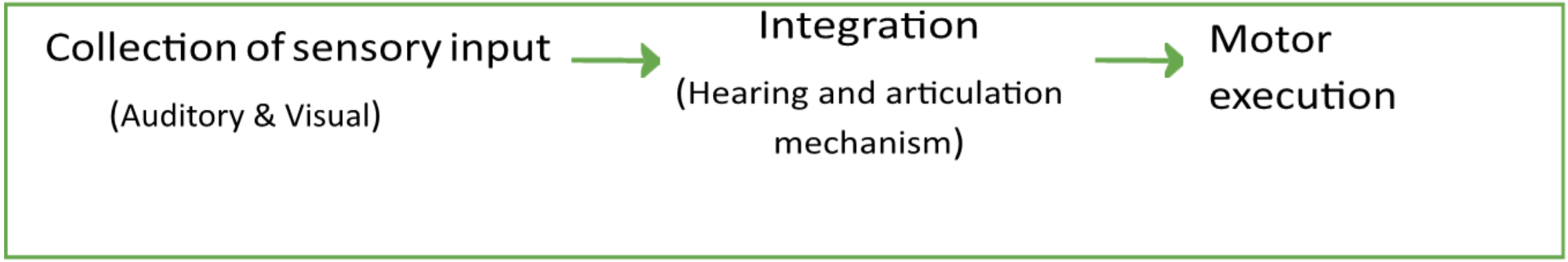
Week 6, Lecture 1

Intended Learning Outcomes

- To define speech and communication
- To understand the mechanisms of speech
- To understand the nervous control of speech (brain areas concerned with speech)
- Applied physiology of (speech disorders aphasia and dysarthria) speech

Communication

- Communication is the imparting or exchanging of information by speaking, writing, or using some other medium



- There are two means of communication:

- **Sensory Communication:** auditory & visual communication.
- **Motor Communications:** speech & writing

Speech

- Speech is defined as the expression of thoughts by the production of articulate sounds that have a definite meaning.
- Speech and other intellectual functions are especially well developed in humans:
  - It is the means of communication between individuals
  - 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

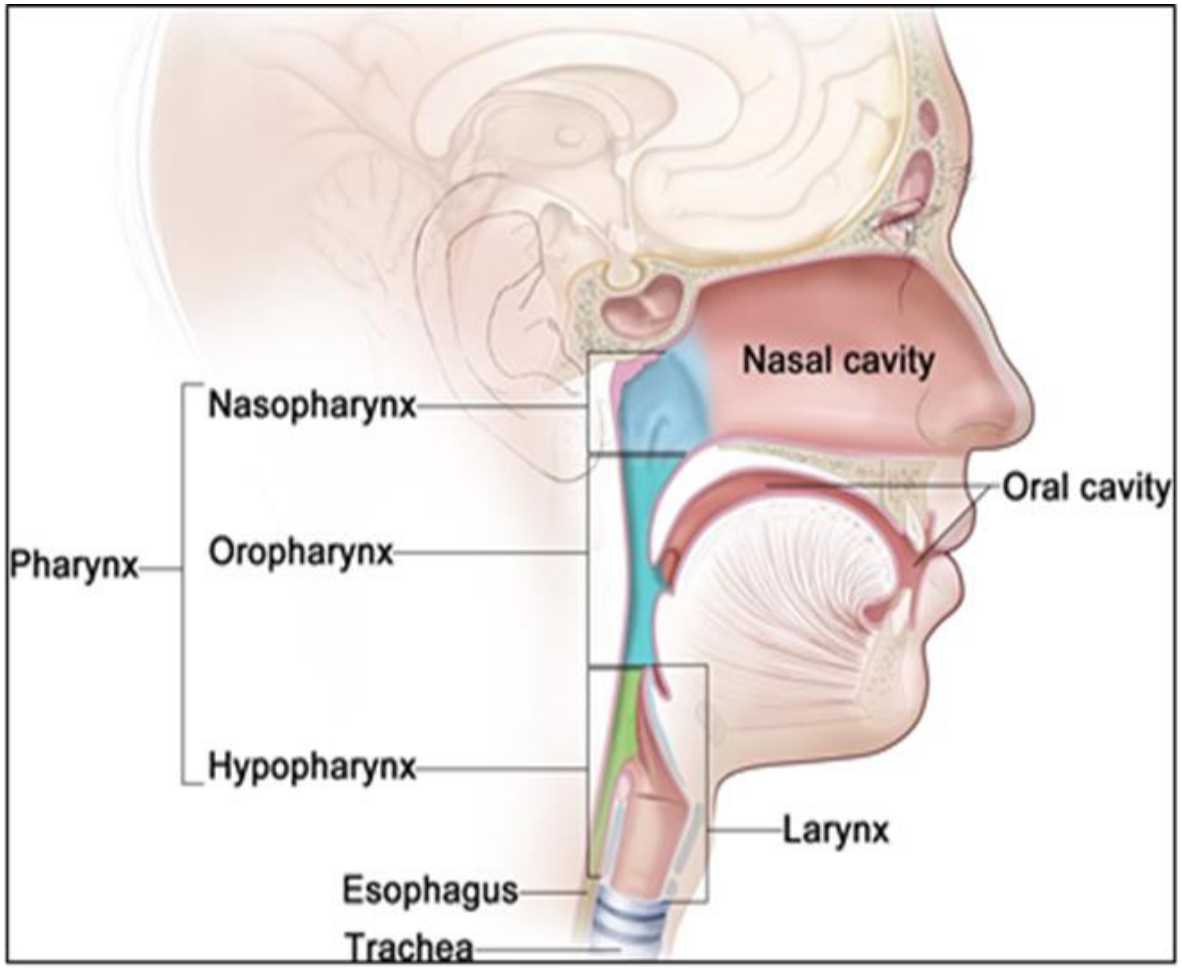
Types of Speech

- Spoken speech: understanding spoken words & expressing ideas in speech & writing.
- Written speech: understanding written words and expressing ideas in writing.

Mechanism of speech

- Speech depends upon the coordinated activities of the central speech apparatus and peripheral speech apparatus:
- The peripheral speech apparatus includes the larynx or sound box, pharynx, mouth, nasal cavities, tongue and lips.
- The central speech apparatus consists of higher centers, i.e. the cortical and subcortical centers

.It sends orders to the Peripheral speech apparatus



peripheral speech apparatus

Mechanism of speech-Speech production

- **Initiation**
- Initiation will set the airstream in motion which is an essential process in sound production due to change in pressure.

- Three mechanisms of initiation
  - Pulmonic airstream mechanism (lungs): 95% of human speech sounds are produced in this way.
  - Glottalic: airstream mechanism via the glottis.
  - Velaric: airstream mechanism via the velum.

Mechanism of speech-Speech production

- Direction of airflow :
- Egressive / pressure sound exhalation: deflation of the lungs and consequent compression of the air.
- Example: like when saying “Hello…..Hello”
- Ingressive/suction sound inhalation: sucking air into the lungs.
- Example: like saying “Hi…..Hi”

Mechanism of speech-Speech production

- **Phonation**
- Phonation is a process of changing air stream
  - Sound production by the passage of air over the vocal cords produces speech.
  - Sounds result from the air stream distorted in one way or another
  - Phonation is mainly achieved at by the larynx and vocal cords
  - Major components: vocal cords, glottis, epiglottis
  - Three cartilages: Thyroid, arytenoid, cricoid

Mechanism of speech-Speech production

- **Articulation** (contribution by structures to shape the airflow)

- A variety of speech sounds can be produced by way of airstream change called articulation
- Specific parts of the vocal apparatus involved in the production of a speech sound are called active articulators: lips, tongue, lower jaw and the velum
- Muscular movements of the mouth, tongue, larynx, vocal cords
- Responsible for the intonations, timing, and rapid changes in intensities of the sequential sounds

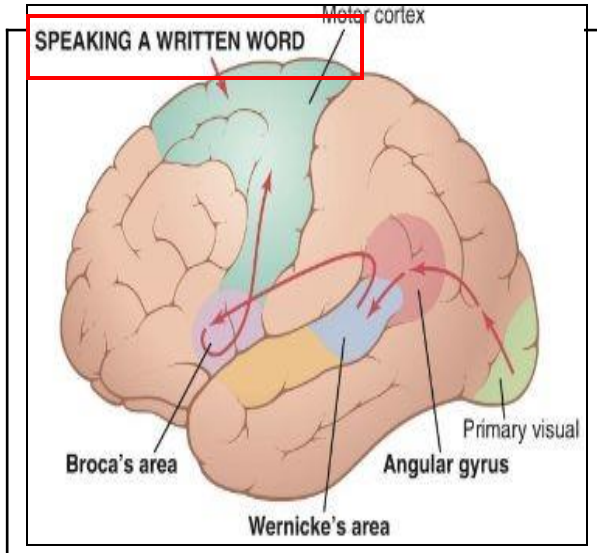
Mechanism of speech: the central apparatus

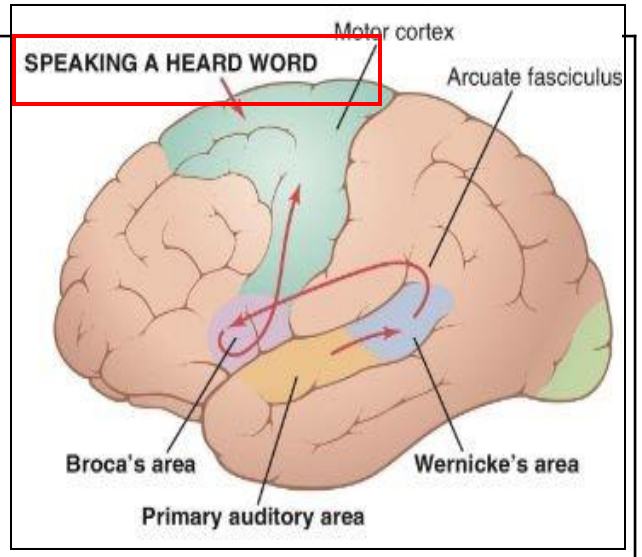
- Speech (in the central apparatus) involves two aspects:
  - Sensory: which involves formation in the mind of thoughts to be expressed and the choice of words.
  - motor control of vocalization and the act of vocalization.

- Formation of word, thought and choice of words is the function of the **Wernicke area**.
- **Broca area** controls the motor coordination required for speech.

Speech divides into two aspects

Sensory aspects





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 preservedby**Auditory** area

Motor aspects

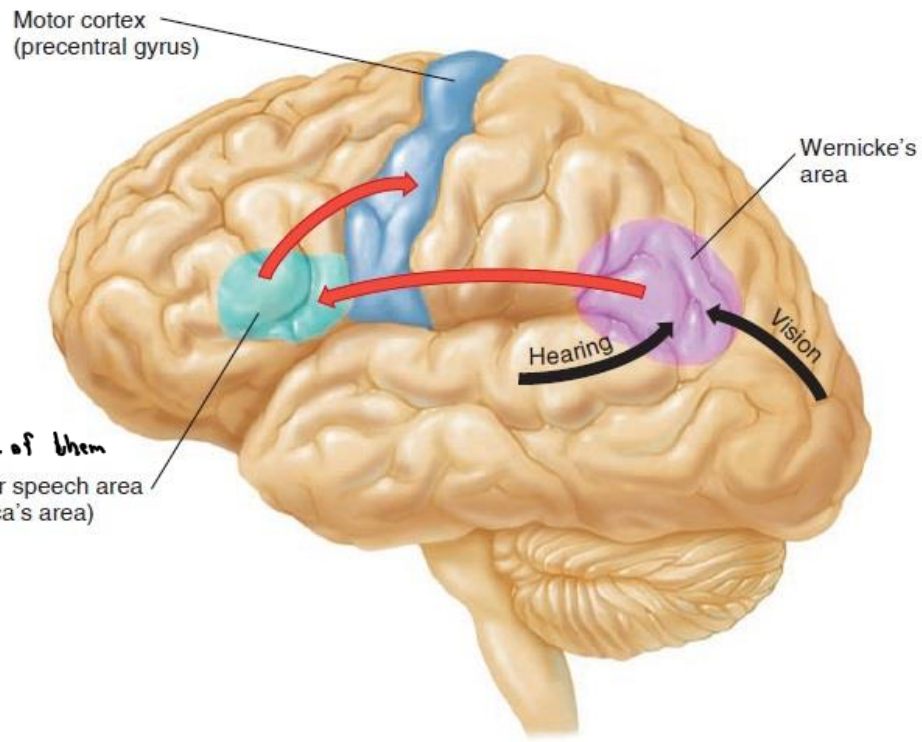
- Expression as well as choice of words to be used.
- Motor control of vocalization and the actual act of vocalization itself.

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	– Concerned with the 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.	Processes information received from Wernicke's Area into detailed &coordinated 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.	Interpretation of information obtained from reading from visual cortex.	- Hand and eye motor function. -Hand skills.
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. 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.		

Dominant hemisphere

- **Human language** functions depend more on one cerebral hemisphere than on the other.
- This hemisphere is called the **dominant hemisphere.**
- The **non-dominant hemisphere is** related to other forms of sensory intelligence (music, sensory feelings).



·In most people → it's on the left hemisphere.
·Even left handed people, for most of them it's on the left hemisphere.

·If the w. area + B. area in the dominant hemispheres got destructed at a young age [below 7] → w. + B. areas can develop in the non dominant hemispheres.

Dominant hemisphere

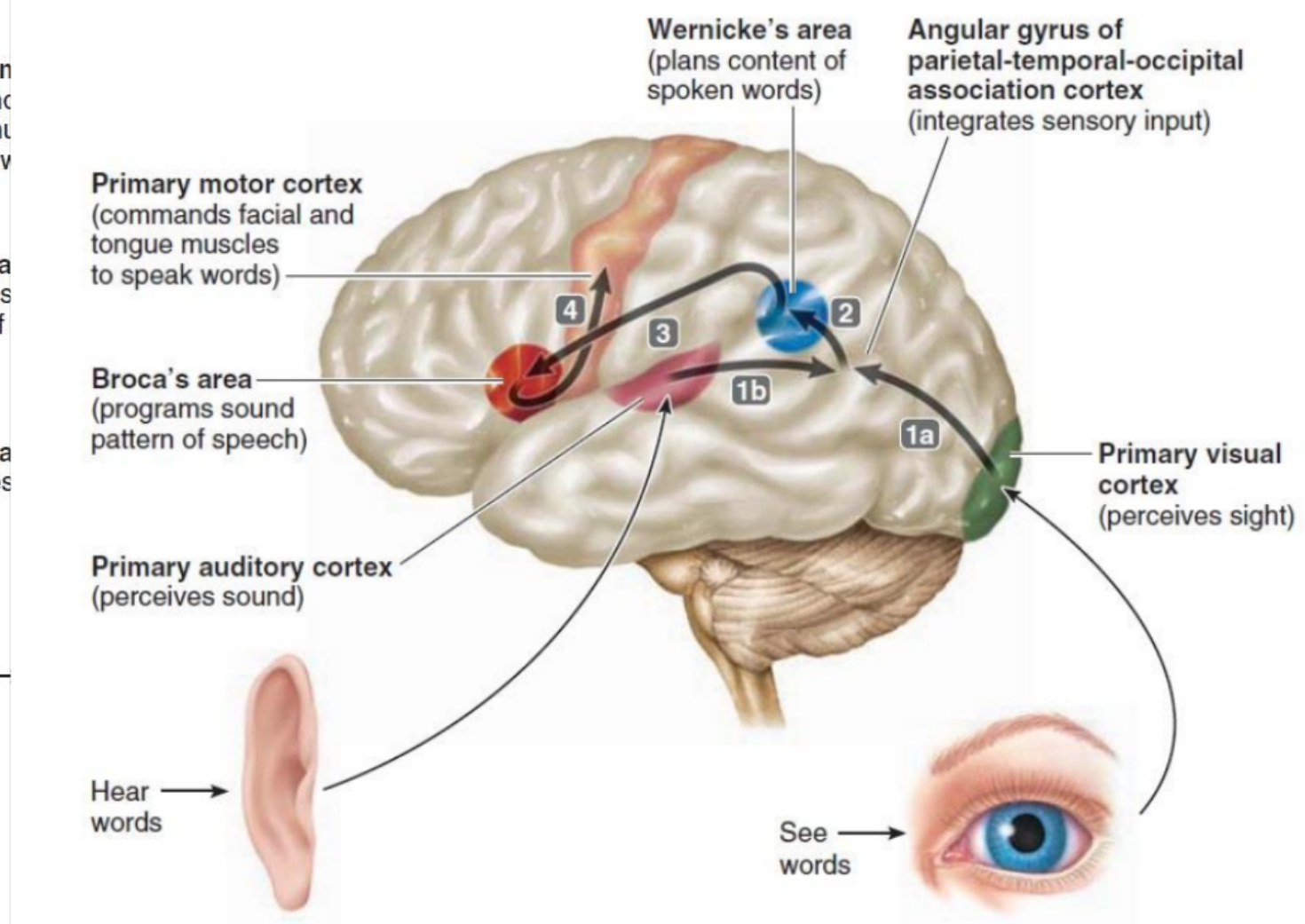
- Formation of word, thought and choice of words is a function of **Wernicke area**.
- **Wernicke area** is more developed in one hemisphere and is responsible for verbal symbolism and greatest related role in intelligence.
- **Wernicke area** can be as much as 50% larger in the dominant hemisphere.
- **Wernicke area** is where the somatic, visual and auditory fibers all meet in the posterior part of the superior temporal lobe

Dominant hemisphere

- **Broca area** controls the motor coordination required for speech.

- It is also called the speech center. /Motor area of speech.
- It is situated in lower part of the lateral surface of the prefrontal cortex.
- This area controls the movements of structures concerned with vocalization.

Central mechanisms of speech



1a To speak about something seen, the brain transfers the visual information from the primary visual cortex to the angular gyrus of the parietal-temporal-occipital association cortex, which integrates inputs such as sight, sound, and touch.

1b To speak about something heard, the brain transfers the auditory information from the primary auditory cortex to the angular gyrus.

2 The information is transferred to Wernicke's area, where the choice and sequence of words to be spoken are formulated.

3 This language command is then transmitted to Broca's area, which translates the message into a programmed sound pattern.

4 This sound program is conveyed to the precise areas of the primary motor cortex that activate the appropriate facial and tongue muscles for causing the desired words to be spoken.

Angular Gyrus—Interpretation of Visual Information

- The *angular gyrus* is the most inferior portion of the posterior parietal lobe, lying immediately behind Wernicke's area and fusing posteriorly into the visual areas of the occipital lobe as well.
- If it 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.

Speech disorders

- Aphasia is the loss or impairment of speech.
- It is due to damage of speech centers which occurs during stroke, head injury, cerebral tumors, brain infections and degenerative diseases like Parkinson's disease.

- ***Classification of aphasia***
  - *Verbal aphasia:* Disability in the formation of words.
  - *Syntactical aphasia:* Inability to arrange words in proper sequence.
  - *Semantic aphasia:* Inability to recognize the significance of words.
  - *Nominal aphasia:* Difficulty in naming objects due to failure to recognize the meaning of words

Speech disorders

- Dysarthria or anarthria is difficulty or inability to speak because of paralysis of muscles involved in articulation.
- Spoken and written words are understood.
- It is caused by damage to brain areas or the nerves that control muscles involved in speech.
- It occurs in conditions like stroke, brain injury and degenerative disease.

Speech disorders

- Dysphonia is a voice disorder characterized by hoarseness and a sore or dry throat.
- Hoarseness means the difficulty in producing sound while trying to speak or a change in the pitch or loudness of voice.
- It occurs due to diseases of vocal cords or larynx

Speech disorders

- Stammering or shuttering is a speech disorder in which the normal flow of speech is disturbed by repetitions or stoppage of sound and words.
- It is associated with some unusual facial and body movements.
- Stammering is due to genetic factors, brain damage, neurological disorders or anxiety.

Useful links

- https://www.youtube.com/watch?v=DwVfCjbIJQI
- https://www.youtube.com/watch?v=nA_7SwMbZK0