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A Comprehensive Review Of Speech Physiology In Ayurveda

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ABSTRACT

Speech physiology delves into the intricate mechanisms of how human speech is produced, modified, and perceived, merging anatomical insights with functional dynamics. This review synthesizes contemporary research on the physiological processes underlying speech production, highlighting advancements in understanding the interaction between the respiratory, phonatory, articulatory, and resonatory systems.

The respiratory system initiates speech by providing the essential airflow, controlled by the diaphragm and intercostal muscles. The phonatory system, anchored in the larynx and comprising the vocal cords, transforms this airflow into sound through vibratory action. The articulatory system—encompassing the tongue, lips, teeth, and palate—plays a crucial role in shaping the produced sound into intelligible speech sounds.

Vaak pravritti is one of the highest human activities and suitable for expressing our thoughts and ideas on any subject. The process of speech begins with *Shira.* This order of thought is carried out from *Vata* to *Vagendriya*. *Udana Vayu* plays an important role in speech. *Mana* is the *Ubhayendriya* who guides all *Indriyas.* It plays an important role in thinking. Speech depends on the coordination of the centers and organs. The development of speech involves the integration of important areas of the brain such as Wernicke's area, Broca's area and the motor area of the main hemisphere. Various aspects of speech production are discussed in the article from Ayurvedic and modern perspectives.

Key words: Wernicke's Area, Resonatory, Articulatory, Broca's, Respiratory, *Vaak pravrutti*

INTRODUCTION

Speech is one of the example of skilled voluntary movement. It enables the communication of ideas from person to person. It is one of the most complex higher functions and is only well developed in human beings. Normally speech is produced on expiration by movement of vocal cords. So they are said to be superior when compared to animals.

Speech physiology is the study of the physical and biological processes involved in speech production and perception[1]. It explores the intricate mechanisms of the human body that enable us to communicate through spoken language. there are two means of communication which encompass language input(sensory) and language output(motor). Where language input in the brain understands the visual and auditory and express through either spoken or written language(motor).

Indriya resides in *Shirah Pradesh*[2] and being '*Vaagindriya*', which eventually is *Karmendriya* whose function is to speak[3] or *Vachana*. *Shirah* being one of the *trimarma*, thus any Injury to *Murdha* or *Shirah Pradesh* produces signs and symptoms like *Muka, Gadgada* and *Swarahani* which clearly indicates the involvement in the production of speech

DEFINITION

Speech is the Ability of a person to express himself in spoken or written words. It is a meaningful expression of thoughts and ideas in form of words and symbols for articulation of sound[4]. The function of *udana vata* is *Vaak Pravrutti* and the area of *Udana* is *Urah*. It wanders from *Nabhi* to *Nasa*. Thus, showing the connection in between *Shirah Pradesh* and *Urah Pradesh* with respect to the *Shabda Nirmana.*

SPEECH APPARATUS OR PERIPHERAL ORGANS OF SPEECH

It includes Muscles of Vocal cords, Larynx, Pharynx, Tongue, Palate, lips and teeth

BRAIN AREAS CONCERNED WITH SPEECH AND LANGUAGE

Includes Wernicke's area, Broca's area, Speech articulation Area in Insula, Exner's area, Dejerines's area and Auditory, visual association areas.

TYPES OF SPEECH

TWO TYPES - 1. SPOKEN SPEECH 2. WRITTEN SPEECH

- SPOKEN SPEECH – Means understanding the spoken words and expressing ideas in speech.
- WRITTEN SPEECH- Means understanding written words and expressing the ideas in writing.

Shabda the production of speech and there three types are as per production method[5].

a) Samyogaja Shabda- it is produced by conjunction of two things like stick or hands with drum.

b) *Vibhagaja Shabda*- it is produced by separating of two things like tearing of paper or splitting of bamboo-stick.

c) *Shabdaja Shabda*- it is produced from first one.

There are two types of *Shabda* - according to form of produced word

a) *Dhawnya Aatmaka Shabda* (in form music)

b) *Varnya Aatmaka Shabda* (in the form of alphabet)

PHYSIOLOGY OF SPOKEN AND WRITTEN SPEECH

SPOKEN WORDS

⬇

DETECTED BY EAR AND TRANSFORMED AS ACTION POTENTIAL ALONG PATHWAY

⬇

AREA 41 AND 42 PERCIEVES WITHIN WORDS

⬇

AREA 22 UNDERSTAND SPOKEN WORDS

⬇

WERNICKES AREA UNDERSTANDS THE MEANING OF WRITTEN WORDS AND RESPOND TO THEM

⬇

BROCAS AREA FOR WORD VOCALIZATION

⬇

CORTICOBULBAR TRACT TO SPEECH MUSCLES

⬇

RESPOND TO SPOKEN WORDS

WRITTEN WORDS

⬇

DETECTED BY THE EYES AND TRANSFORMED AS ACTION POTENTIAL ALONG THE PATH WAY

⬇

AREA 17 PERCIEVES WRITTEN WORDS

⬇

AREA 18,19 UNDERSTAND THE WRITTEN WORDS

⬇

WERNICKES AREA UNDERSTAND THE MEANING OF WRITTEN WORDS AND RESPOND TO THEM

⬇

EXNERS AREA FOR EXPRESSION OF SPEECH BY WRITING

⬇

PYRAMIDAL AND EXTRAPYRAMIDAL TRACTS TO HAND MUSCLES

⬇

RESPOND BY WRITTEN WORDS

SPEECH CENTRES AND ITS FUNCTIONS

WERNICKE'S AREA

AREA NO 22-SENSORY

It's a highest seat for Language based intelligence responsible for interpretation of complicated meanings of different sensory experience and Present In parietotemporal occipital association area.

FUNCTIONS –

1) Understand the meaning of spoken or written words.
2) Beginning the response to these words (i.e., express thoughts in words and choice of words)
3) It is connection between motor and sensory speech centers

DEJERINE'S AREA

AREA NO 39- SENSORY

Located In the angular gyrus behind Wernicke's area anterior to visual area.

FUNCTION-

Generation of thoughts and ideas in response to the written language

BROCA'S AREA

WORD FORMATION AREA-MOTOR AREA NO 44

Located in Frontal lobe in front of inferior end of motor cortex.

FUNCTION-

- Process information from wernicke's area into detailed and coordinated pattern for vocalization
- Provides the control for word information
- Plans the motor patterns for expressing individual words or short phrases

EXNER'S AREA

MOTOR AREA- AREA NO 45

Located in middle frontal gyrus that is pre motor cortex

FUNCTION-

Process information from Broca's area along with motor cortex and initiate muscle movements of hands and fingers to produce written speech

DISCUSSION

According to Ayurveda,

Vaak Nirmitee is the Process of *Vaak* or *Shabda Nirmitee* starts from higher center i.e. from brain.*Vaak Pravrutti* is the process which is completed at *jivha* through *Urah Pradesh* by *Udana.* The

process of speech production is basic function performed through *Gnyanendriya* with coordination of *Karmendriya.*

Role of *Buddhi* in production of speech:

Buddhi is produced by *Sannikarsha Sambandha* of *Indriya* (sense organs), *Indriya Artha* (sensory inputs), *Satva* (mind) and *Aatma* (soul). For any type of perception, *Aatma* gets connected with mind, mind with *Indriya*, *Indriya* with *Indriyartha*[6]. *Indriya* perceives the sensory inputs and by *Sannikarsha* with *Buddhi* creates/develops intellect (*Gnyana*). This intellect or *Buddhi* is of two types – *Kshanika* (temporary perception) and *Nishchayatmika*[7].So when the process of speech production starts, the nature of words, meanings sentences are defined & decided first.

Sometimes it happens consciously and sometimes subconsciously. These *Indriya* because of *Atiyoga, Mithyayoga* and *Heenayoga* to their sensory inputs or sense objects in association with mind are the reason for *Upaghata* of their *Buddhi. Buddhi* in *Sannikarsha* with *Mana* is the reason for the proper perception of their individual sensation.

Role of *Mana* in speech production[8]

Understanding of things occur due to *Sannikarsha* of *Mana* with *Indriya. Anutwa* and *Ekatva* are considered to be these two characteristics. *Chintya, Vicharya, Uhya, Dheya and Sankalpa* are the objects of mind. Control of sense organs, self-restraint, hypothesis and consideration represent the action of mind. Beyond that, flourishes the domain of intellect.

Process of perception: The objects are perceived with the help of sense organs together with mind. The intellect which determines the specific properties of object impels an individual to speak or act intelligently.

Role of *Vayu* in speech production[9]:

Vayu is said to be the prime reason behind the speech production. It is said to be promoter and producer of speech (*Pravartako Vachah*). It is the resource of two main special properties (*Vishesha Guna*), i.e. *Sparsha* and *Shabda* (*Prakruti Sparsh Shabdayoh*). The other factors responsible for speech like mind and *Indriya* (*Karmendriya - Vaak*) are also controlled by *Vata.*

Role of *Prana* and *Udana Vayu*

Prana is situated in *Murdha Sthana* and regulates the functions of *Indriya* (*Gnyanendriya* and *Vagindriya*)[10]. When it gets provoked and produces *Sarvendriyanam Shunyatvam*[11] and thus causes *Jada, Gadgad* and *Mukata* when encircled by *Samana.* It regulates the functions of *Buddhi*. So, *Prana* with help of *Buddhi* decides to express the thoughts into sounds. *Vayu* is the controller and initiator of mind (*Niyanta* and *Praneta*)[12]. The production of thought is the function which is controlled and regulated by *Vata* with help of mind.

Process of initiation of sound production and role of *Samana Vayu:*

Prana Avrutta Samana has characters like *Gadgada* and *Mukatva. In Samanavruta Vyana Vata* there are symptoms similar to Pralapa. Therefore, when *Samana* is afflicted speech production is inhibited,

weakened or lost. The opposite can be seen when *Samana* surrounds another *Vayu* or remains provoked. Therefore, *Samana* has an important role in voice production. Now, at *Nabhi/* stomach level it created or initiates the process of sound creation. Transformation of the sense of sound and speech by *Prana*: The cause of *Vaak Pravrutti* is said to be *Udana Vayu*.[13] Even if *Kaphavruta vata* is surrounded by *Udana,* it will create *Vaakgrah*. Therefore, *Udana Vayu* through the moment of abdominal muscles helps in formation of sound and speech. But here the sound produced is low and is incomprehensible. This lower sound is then transmitted to throat via *Vyana Vayu* and radiates through the higher sound to navel region

Effect of *Dhatus* [14]

Rasa Dhatu is related with *Shabda Asahishnutwa*. So, perception of *Shabda* is related to *Rasa Dhatu*

Saarata and *Swara*

MedaSara: Swara Visheshatah Sneha, MajjaSara: Snigdha Swara, Shukrasara: Prasanna Snigdha Swara, Sarvasara: Saanunada, Snigdha Gambhira and Mahaswara.

Role of *Prakruti* and *Swara*[15]

Vatapradhana Prakruti Swara Lakshana are- *Ruksha, Kshama, Sannaa, Sakta, Jarjara Swara* due to *Ruksha Guna* of *Vata. Pittapradhana prakuti Swara lakshana* is - *Bhuryucchara. Kaphapradhana Prakruti Lakshana* of *Swara* is *Prasanna Snigdha Swara* due to *Accha Guna* of *Kapha*.

Role of *Oja* in speech production[16]

Pralapa is the sign in *Ojo Kshaya*. "Unmeaning, incoherent speech are the meanings of *Pralapa*. Thus, it can be said that physiologically*, Pralapa* is disorganized, disoriented, uncontrolled speech. It occurs when the limbic system, Wernicke's area and other centres related to speech get disorganized. When *Oja* gets decreased, it also decreases the influence over the flow and orientation. So, whenever there is *Pralapaa, Vayu (Pravartako Vachah),* Mind and *Oja* are the main components which organize, shape, regularize, control the sentence formation with the logic and meaning.

Role of *Pranavaha Srotas*[17]

Injury to *Pranavaha Srotas* produces *Akroshana*. Thus, it can be said that in normalcy, *Pranvaha Srotasa* has the role in *Shabda* expression.

Role of *Agni* in speech production[18]

Agni is said to be deity of Vachah or speech. So it can be said that Agni also plays the role in production and expression of speech along with *Samana Vayu.*

CONCLUSION:

Speech physiology is the study of the physical and biological processes involved in speech production and perception. It explores the intricate mechanisms of the human body that enable us to communicate through spoken language. Speech physiology Reveals the complexity of human anatomy and

physiology. Demonstrates the remarkable coordination of multiple systems (respiratory, laryngeal, articulatory, and auditory). Highlights the importance of neural control and plasticity in speech production and perception. Provides valuable insights for understanding speech disorders and developing effective treatments.

As *Pravartako Vacha* says *Vata* plays an important role in entire process of speech production. *Prana, Udana, Samana, Vyana Vata* plays different roles in overall process. *Dhatu* and *Oja* play a supporting role in speech. Vruddhi and Kshaya of *Dhatu* affect the sound of the voice. *Mana* is the *Ubhayendriya Adhishtana* of all *Indriya*. The thought process is created in *Mana* and expressed in words by the *Jivha. Dhamanis*, *Sira* also played a role in *Vaak Pravrutti. Prakruthi* also influences one's *Vaak Pravrutti.*

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