

PHYSIOLOGY OF PRODUCTION OF SPEECH (VAAKPRAVRUTTI): AN AYURVEDA VIEW

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ABSTRACT

Vaak Pravrutti (Production of Speech) is one of the highest functions of human being which is necessary to express our thoughts and views about any particular thing. Process of speech initiate in *Shira*. This sensory order is carried out by *Vata* upto *Vagendriyas*. *Udana Vayu* plays an important role in production of speech. *Mana* is *Ubhyendriya* which leads all *Indriya*. It plays a major role in carrying out thought process. Thoughts are expressed through the way of *Shabda* (*Vaak*). Speech depends upon the coordinated activities of central and peripheral speech apparatus. Development of speech involves integration of important areas of cerebral cortex namely Wernicke's area, Broca's area and motor area of dominant hemisphere. In the present article, various aspects of production of speech are discussed from *Ayurveda* and modern point of view.

Key words- *Vaak Pravrutti, Udana Vayu, Vagendriyas, Speech, articulation, fluency*

INTRODUCTION:

Role of *Shirah Pradesh* in *Shabda Nirmitee*:

Indriya are located at *Shirah Pradesh*¹. *Jivha* is also called as '*Vaagindriya*', which ultimately is *Karmendriya* whose function is to speak². *Vachana* is the function of *jivha*³. The deity of *vaacha* is *Agni*⁴.

Injury to *Murdha* or *Shirah Pradesh* produces signs and symptoms like *Muka*, *Gadgada* and *Swarahan*⁵. This clearly shows the involvement of *Shirah Pradesh* in the production of speech. As *Mukatva* is the loss of speech and *Gadgada* is the distorted speech, it clearly shows that *Shirah* has major role in the production of speech.

Vaak Pravrutti is the function of *Udana*. The area of *Udana* is *Urah* and it roams in the areas from *Nabhi* to *Nasa*. So, the process of *Udana* is carried out majorly through *Udana Vayu*.

There must be the connection in between *Shirah Pradesh* and *Urah Pradesh* regarding the *Shabda Nirmitee* process.

Definition Speech is an expression of thoughts by production of, bearing a definite meaning⁶.

It is one of the highest functions of brain. It has brought by coordinated activity of different parts of brain particularly motor area (Brocha's area), sensory area (Wernicke's area) and psychic areas.

- '*Vach*'- *Bhasha* '*Vachanam*'⁷
- *Pravrutti* – *Pravaha*, Fluency⁸
- '*Vach*'- Voice, Talk, Language, sound⁹
- '*Vach*'- Speech, speaking¹⁰
- Word – Sound- an expression¹¹
- *Pravrutti*- *Aarambha*, Beginning, Initiation.¹²
- *Pravrutti*- Moving onward, advance progress¹³

Development of speech

Frist stage- The first stage in the development of speech is association of certain words with visual, tactile, auditory and other sensations, aroused by objects in external world. The association of words with other sensation is stored as memory.

Second stage- New neuronal circuits are established during the development of speech. When a definite meaning has attached to certain words, pathway between the auditory area and motor area for the muscle articulation which helps in speech is established.

The development of speech involves integration of important areas of cerebral cortex namely Wernicke's area, Broca's

area and motor area (Fig-1) of dominant hemisphere¹⁴.

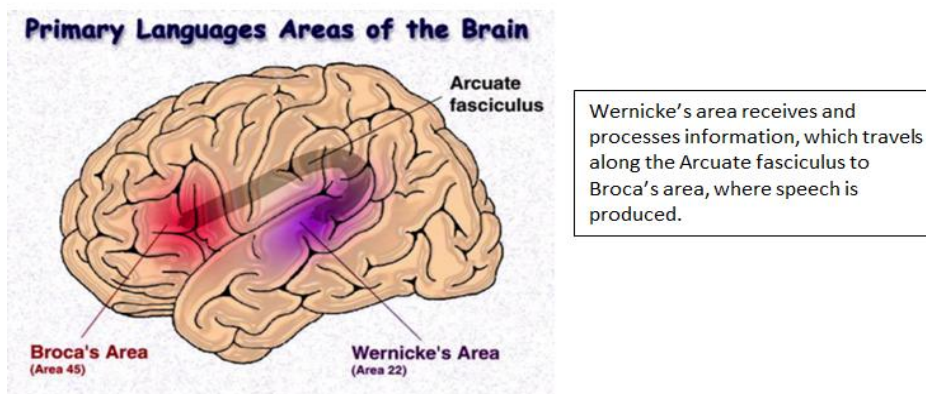


Figure 1 Primary languages area of the Brain

Nervous control of speech

The sub cortical area concerned with speech controlled by cortical areas of dominant hemisphere. In about 95% of human being the left hemisphere is functionally dominant and those are right handed. Following are the motor and sensory cortical areas concerned with speech.

- **Motor area**

A) Broca's areas-

It is also called speech center, motor speech area or lower frontal area. Speech is synthesized in the Broca's. It is situated adjacent to the motor area. By receiving the pattern of activities from Broca's area, the motor area initiate the movement of tongue, lips and larynx required for speech.

By receiving information more required for production of words from Wernicke's, the Broca's area develops the pattern of motor activities sent to the motor area. Prefrontal cortex which is the shelter of Broca's Area, controls the movement of structure concerned with vocalization.

B) Upper motor frontal area-

It is situated in the paracentral gyrus over the medial surface of the cerebral hemisphere. It controls the coordinated movement concerned with writing.

- **Sensory area**

A) Auditopsychic area- Auditopsychic area is situated in the superior temporal gyrus. It is concerned with storage of memories of spoken words.

B) Visuopsychic area- it is present in angular gyrus of the parietal cortex. It is concerned with storage of visual symbols. Speech depends upon the coordinated activities of central and peripheral speech apparatus.

Central speech apparatus consist of higher centers, means cortical and subcortical centers.

While the peripheral speech apparatus includes the larynx, pharynx, mouth, Nasal cavity, tongue and lips.

All the structure of the peripheral speech apparatus works in coordination with respiratory system, under the influence of the motor impulses from the respective motor areas of the cerebral cortex.

Role of Wernicke's area-

The understanding of speech begins in Wernicke's area which is situated in upper part of temporal lobe. It sends fibers to Broca's area through a tract called arcuate fasciculus. Wernicke's area is responsible for understanding the visual and auditory information required for production of words. After understanding the words it sends the inflammation to Broca's area.

Role of Broca's area-

Speech is synthesized in Broca's area. It is situated adjacent to the motor area responsible for the movement of tongue, lips and larynx which are necessary for speech. By receiving information required for production of words from Wernicke's area. Broca's area develops the pattern of motor activity required to verbalize the words.

Meaning of Shabda

Shabda is that, which is perceived by ears¹⁵. The property *Shabda* resides on *Aakasha Mahabhuta*. Without this *Mahabhuta* organization of *Shabda* is not impossible.

Relation of Mahabhuta & Types of Shabda¹⁶

Aakasha Mahabhuta has quality of producing sound^{17, 18} wherever there is space, it has this property¹⁹.

Shabda is categorized as following²⁰.

There three types are as per production method.

- Samyogaja Shabda*- it is produced by conjunction of two things like stick or hands with drum.
- Vibhagaja Shabda*- it is produced by separating of two things like tearing of paper or splitting of bamboo-stick.
- Shabdaja Shabda*- it is produced from first one.

In human body also, *Shabda Nirmitee* process must be producing the words in the same manner. There are two types of *Shabda* - according to form of produced word

- Dhawnya Aatmaka Shabda* (in form music),
- Varnya Aatmaka Shabda* (in the form of alphabet)

MATERIAL & METHOD:

For this article all the *Samhitas* from *Bruhatrayee* and Various physiology text book and compendia were studied.

Process of Speech

There are two stages from *Ayurveda* point of view in speech physiology-

Vaak Nirmitee - Process of *Vaak* or *Shabda Nirmitee* starts from higher center i.e. from brain.

Vaak Pravritti – process of *Vaak Pravritti* is completed at *jivha* through *Urah Pradesh* by *Udana*.

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

Functioning of Buddhi in production of speech:

Any type of *Buddhi* is produced by absolute syncing (*Sannikarsha-Sambandha*) of *Indriya* (sense organs), *Indriya Artha* (sensory inputs), *Satva* (mind) and *Aatma* (soul). Any *Indriya* perceives its unique sensory inputs and in sync with *Buddhi* creates/develops intellect (*Dnyana*) from those inputs. For any type of perception, *Aatma* gets connected with mind, mind with *Indriya*, *Indriya* with *Indriyarth*²¹

This intellect or *Buddhi* is of two types – *Kshanika* (temporary perception) and *Nishchayatmika* (definitive perception²²) 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. Then the next path follows.

All the process of functioning of senses is carried out by *Mana*, *Mana Artha*, *Buddhi* and *Aatma*. These components decide the involvement in perception of intellect and detachment /parting -/breaking up from the process.²³

These *Indriya* because of excessive exposure, wrong exposure or lesser exposure to their sensory inputs or sense objects in association with mind are the reason for *Upaghata* of their *Buddhi*. When in sync with mind, they are the reason for the proper perception of their individual sensation²⁴.

Role of Vayu in sound, language and speech production:

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 (*Vishesh 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*²⁵.

Role of Prana and Udana Vayu in process of conversion of thoughts into words and sounds:

Prana is situated in *Murdha Sthana* and regulates the functions of *Indriya* (*Dnyanendriya* and *Vagindriya*)²⁶

When it gets provoked and produces *Sarvendriyanam Shunyatvam*²⁷ and *Jada-Gadgad* and *Mukata* when encircles *Samana*.

It regulates the functions of *Buddhi*²⁸ So; *Prana* with help of *Buddhi* decides to express the thoughts into sounds. *Vayu* is the controller and initiator of mind (*Niyanta* and *Praneta*).²⁹

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:

In *Pran Avrutta Samana*, there are the signs like *Jada*, *Gad Gad* and *Mukata*³⁰. In *Samanavrut Vyan*, there is the symptom like *Pralapa*. So, when *Samana* gets *Avrutta* the production of speech gets hampered, diminished or lost. A contrary is also seen as when *Samana* encircles the other *Vayu* (*Vyana*) or remains provoked; it creates *Pralapaa*³¹. So, there is a definite role of *Samana* in producing sounds. Probably, it generates or initiates the process of sound production at *Nabhi/gut* level.

Actual conversion of the sensory inputs from *Prana* into sound and language:

Udana Vayu is said to be the reason for '*Vaak Pravrutti*'³² Even when it gets encircled by *Kapha* (*Kaphavrut Udana*), it is found to be producing *Vaakgrah*³³ So, it is the chief component in the production of sound and language production

Formation and generation of words which have to be spoken are done by *Udana*

Vayu, through the movements of abdominal muscles in umbilical region. But, the sound produced here is very low in pitch and cannot be understood. This low pitch sound is then transferred to the throat area by *Vyana Vayu* and gets presented in higher tone compared to that of umbilical region.

Mind:

Proof of existence of Mana (mind) and its attributes:

Sometimes one understands a thing and sometime one does not. This proves the existence of mind as a separate sense organ. That is why, when there is no contact of the mind with the sense organ and their objects, no understanding of things can occur. It is only when required mental contact is there, that one can understand things. Atomicity and oneness are considered to be that two characteristic feature of the mind³⁴.

Objects of mind:

Thing requiring through concentration, hypothesis, attention, determination whatever can be, known by means of the mind, are as regarded as objects. Control of sense organs, self restraint, hypothesis and consideration represent the action of mind. Beyond that, flourishes the domain of intellect³⁵.

Process of perception:

The objects are perceived with the help of sense organs together with mind. This perception is purely mental in the beginning. The practical advantages and disadvantages are ascertained thereafter. The intellect which determines the specific properties of object impels an individual to speak or act intelligently³⁶.

Role and properties of Mana:

Rajasa Prakruti is said to be '*Bahubhashi*'³⁷. It clearly means that *Raja Guna* has role in *Vaak Pravrutti*. Mind is the leader which directs, leads all the other *Indriya* in carrying out their functions (*Cheshta Pratyaya Bhutanam*). Whenever *Indriya* get focused into mind, they start perceiving their own sensory inputs (*Swa Vishaya dnyana*)³⁸. *Indriyas* are able to

perceive their *Artha* or *Vishaya* (Sensory inputs) under the shelter of mind³⁹.

Role of Dhamani in speech production:

There are 24 *Dhamani* which start from *Nabhi*. Out of that, 10 move into upward direction. Those *Dhamnis* produce *Shabda-Sparsha-Rupa-Rasa-Gandha-Prasahwasa-Uchchhwasa* etc functions. These *Dhamnis* after reaching heart divide into three separate directions.

Out of them two *Dhamnis* carry *Shabda*. These *Dhamanis* move in upward direction. They carry *Shabda* through them. Then, separate two *Dhamanis* are used for speech (*bhasha*) and another two are used for *Avyakta DhVaani* i.e *Ghosha*⁴⁰. These two *Dhamanis* are *Neela* and *Manya*.

Role of Neela and Manya Dhamani Marma:

These two *Marmas* are situated at *kantha* region. Injury to these *Marmas* creates *Mookata*, *Swara Vaikrutam* and *Rasa Grahita*⁴¹. So, these *Dhamnis* have definite role in the expression of speech. They help in expressing the sound. They maintain the normalcy of sounds as their pathology creates the *Swara Vikruti*.

Role of Siraa (Vein):

There are two *Siras* present at *Jivha Pradesh*; they carry the function of *Vachah Pravartinyoh*⁴². These *Siras* must be helping in expression of speech.

There are two *Sira* located in *Karna* which have the function of *Shabda Bodhana*⁴³. They help us to understand the meaning of *Shabda*.

Role of Shabdavahi Siraa in understanding Shabda:

These *Shiraas* help in understanding the external sound carry their meanings to *Shabda Indriya*, storing the meaning for recalling the same whenever needed. *Indriya* work in synchronize with each other through the medium of mind. So, whenever needed, the words or sounds stored by *Dhruiti* are recalled and reproduced. Thus, these *Shiraas* work with *Shabdendriya*, mind and *VagIndriya* in production of speech⁴⁴

Speech in context with other factors: -

This complete procedure of pronunciation carried out in four phases.

Paraa Vaani- This phase of pronunciation carried out in umbilical region and the words are suspected and these are sensory words which know to subject him.

Pshyanti Vaani- The words which are pronounced in thoracic region and mildly expressed.

Madhyma Vaani- voice pronounced in throat are above the thoracic region and expressed more clear than the *Pashyanti* is known as *Madhyma Vaani*

Vaikhari Vaani- The voice produced clearly in oral cavity by the help of tongue lips, tooth soft palate more clearly and can be understandable to others is called as *Vaikhari*⁴⁵

Effect of Dhatus on Shabda-

Rasa Dhatu is related with *Shabda Asahishnuta*. So perception of *Shabda* is related to *Rasa Dhatu*⁴⁶.

Saarata and Swara⁴⁷

In the *Lakshana* of, *MedaSara Puruhsa*, *ShukraSara Puruhsa* and *Sarvasara Purusha* are said voice of these *Purusha* is-

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

Humans have vocal cords that can loosen, tighten or change their thickness and over which breath can be transferred at varying pressures. The shape of chest and neck, the position of tongue and the tightness of tongue and the tightness of otherwise unrelated muscles can be altered. Any one of these actions result in change in pitch, volume, timbre or tone of the sound produced.

All these factors need elasticity and it is provided by *Snigdhatu*. The *Dhatus* which will provide this *Snigdhatu* are *Meda*, *Majja* and *Shukra* as explained clearly in *Dhatusarata*. The best part of these *Dhatus* i.e. *Saarata* is the reason for providing the

strength to the specific component of the body like *Swara*. The above said *Saarata* of *Dhatus* show the nature of *Swara* as *Snigdha*.

A register in the human voice is a particular series of tones, produced in the same vibratory pattern of the vocal folds, and possessing the same quality. Registers originate in laryngeal functioning. They occur because the vocal folds are capable of producing several different vibratory patterns. Each of these vibratory patterns appears within a particular Vocal range of pitches and produces certain characteristic sounds. The occurrence of registers has also been attributed to effects of the acoustic interaction between the vocal fold oscillation and the vocal tract⁴⁸.

The strength of *Udana* & *Vyana Vayu*, *Shabdavahi Sira*, *Neela* & *Manya Dhamanis* and *Swaravaha Srotasas* has the influence over a register of human voice.

Prakruti and Swara-

Vatapradhana Prakruti Purusha Swara Lakshana are- *Ruksha*, *Kshama*, *Sannaa*, *Sakta*, *Jarjara Swara* due to *Ruksha Guna* of *Vata*⁴⁹

Pittapradhana prakruti Purusha Swara lakshana is- *Bhuryucchara* (clear speech)⁵⁰

Kaphapradhana Prakruti Purusha Lakshana of *Swara* is *Prasanna Snigdha Swara* due to *Accha Guna* of *Kapha*⁵¹.

Role of Oja in speech production⁵²

Pralapa is the sign in *Ojo Kshaya*. *Pralapa* is *anarthaka Vaakyam*. It is “*Prayojana Shunya Unmattadi Vachanam*. “Unmeaning, incoherent speech lamentation, An Unjustified statement, non sensical statement ” 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

also gets decreased. So, it can be said that *Oja* might be helping in controlling the thoughts, regulating them and reproducing them in controlled manner during normal speech production with other biochemical and biophysical factors.

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 meaning⁵³.

Role of Pranavaha Srotas:

Injury to *Pranavaha Srotas* produces *Akroshana*⁵⁴ Thus, it can be said that in normalcy, *Pranavaha Srotasa* has the role in *Shabda* expression.

Role of Agni in speech production-

Samano Agni Sameepasthah

Vacho Agnihi. means *Agni* is the deity of *Vacha*⁵⁵

Shabdopatti according to Panineeyam⁵⁶

Aatma works in coordination of *Buddhi*. So the decision of speaking with appropriate thoughts are taken by *Aatma* inspired *Buddhi*. The decision over appropriate speech is ordered by *Aatma* inspired mind. *Mind* inspires *kayagni* which further stimulates *Vayu* for further processing of producing sound. *Vayu* stimulated by mind, then produces *Manda Swara* in *Urah* . This *Vayu* with *Manda Swara* moves out of *Urah Pradesh* and travels towards the *Mukha Pradesh* where it produces the vowels and consonants.

The role of 8 *Sthanas* explained in *Panineeyam* in *Shabdopatti*:

Urah , *Kantha*, *Shirah*, *Jivha*, *Danta*, *Nasika*, *Oushtha*, *Talu* are the 8 places of *Shabda Utpatti*. Out of that *Urah* and *Shirah* are not taking participation in actual sound production. Any syllable is produced through only these 6 anatomical positions only. The syllables are produced when the tongue touches one of these places.

Table no- 1 Words and their uttering sites

Sr.no	Uttering sites	words
1	Throat (<i>Kanthyā</i>)	अ, क, ख, ग, घ, ङ, ह.
2	soft palate (<i>Talvyā</i>)	ई, च, छ, ज, झ, ञ, श, य.
3	Hard Palate (<i>Murdhā</i>)	ऋ, ट, ठ, ढ, ण, र, ष.
4	Tooth (<i>Dantya</i>)	लृ, त, थ, द, ध, न, ल, स.
5	Lips (<i>Oshthya</i>)	प, फ, ब, भ, म, ड.
6	Nasal (<i>Anunasika</i>)	ङ्, ञ, ग, न, ण, म.

Articulation: Articulation is process of pronunciation of words. Different parts of oral cavity which helps in process of speech production are known as articulators, and the study of them is called articulatory phonetics.

Role of articulators in production of speech⁵⁷

All the sounds we make when we speak are the result of muscles contracting. The muscles in the chest that we use for breathing produce the flow of air that is needed for almost all speech sounds; muscles in the larynx produce many different modifications in the flow of air from the chest to the mouth. After passing through the larynx, the air goes through what we call the vocal tract, which ends at the mouth and nostrils. Here the air from the lungs escapes into the atmosphere. We have a large and complex set of muscles that can produce changes in the shape of the vocal tract, and in order to learn how the sounds of speech are produced it is necessary to become familiar with the different parts of the vocal tract.

DISCUSSION

- *Vata Dosha* especially *Udana Vayu* Plays an important role in production & expression of speech⁵⁸.
- *Prana Vayu* is said to be controlling the articulation of speech organs as it is said to be the “*Indiyadhruk*”⁵⁹
- When *Samana* gets encircled by any other *Vata*, speech gets hampered. So,

Samana Vayu has role in the physiology of speech production⁶⁰.

- *Vyana Vata* is present all over the body. It has supportive role at every stage. It helps in contraction and relaxation of various muscles used for the speech production. It also has the role in opening and closures of laryngeal sphincters⁶¹.
- *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*⁶².
- *Dhatu* helps to maintain the pitch of sound, *Medo-Majja-Shukra Sara Purusha* have *Snigdha Prasanna Swara*. *Swara of Sarva Dhatu Sara Purusha* is *Saanunada, Snigdha Gambhira* and *MahaSwara*. It means that *Dhatu Saarata* is also important factor of sound process⁶³.
- The nature and fluency of produced speech is different according to *Prakruti* of *Purusha* as explained in *Samhitas*. The nature and fluency of *Vata-Prakruti Purusha* is *Ruksha, Kshama, Sannaa, Sakta, Jarjara Swara*, because of *Ruksha Guna* of *Vata*. *Swara of Pitta Prakruti Purusha*⁶⁴ is of *Bhuryucchara*⁶⁵. *Swara of Kaphapradhana Prakruti Purusha* is *Prasanna Snigdha* due to *Accha Guna* of *Kapha*⁶⁶.
- Role of *Oja* in production of speech- *Pralapaa* is the sign in *Ojo Kshaya*. *Pralapaa* is a condition in which *Oja* gets decreased and person losses his command over speech which result into irrelevant talking. *Oja* is the *Sara* of all *Dhatu*s as we discussed above *Lakshana*

of *Sarva Sara Purusha* are opposite of *Oja Kshaya*. So if all *Dhatu* are well nourished the *Oja* become strong and results into *Uttama Swara*⁶⁷.

CONCLUSION: In whole process of speech production *Vata* plays chief role as said '*Pravartako Vacha*'. *Prana*, *Udana*, *Samana* and *Vyan* types of *Vata* have distinct roles to play in the whole process. *Dhatu* and *Oja* play supportive role in speech production. *Vrudhi* and *Kshaya* of *dhatu* affect the pitch of sound. *Mana* is an *Ubhyendriya Adhishtana* of all *Indriyas*. Thought process gets generated in *Mana* and gets expressed as speech through *jivha*. *Dhamnis*, *Sira* also plays role in *Vaak-Pravrutti*. *Prakruti* also influences the *Vaak Pravrutti* of an individual.

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