

Phonetics and flight safety - An orodental view point Capt K Ravishankar* , Air Cmde GP Singh VSM+

ABSTRACT

Phonetics is the study of vocal sounds. Communication between the individuals is the basis for civilized' growth of the community and speech dominates human communication. In aviation, verbal communication is the only effective means of passing information quickly. Though visual display units occupy a larger part of the modern aircraft cockpit, voice communication still plays the prime role as a means of rapid transfer of information. The factors which can affect the speech perception can be classified as (a) Aviators speaking status (b) Effectiveness of communicating system and (c) Presence of adverse conditions which interfere with the communication. Orodental structures and their health status plays a major role in the production of speech under aviators speaking status. Speech sounds are classified based on the structures involved like labials, palatals, etc. While any abnormality or disease in these structures can affect the speech sounds, understanding of this can help in the selection of aviators and maintenance of their speech status all along. Growth and development abnormalities like cleft palate, cleft lip, anterior open bite, retrognathia, skeletal CL-III and even a prominent torus pallatinus can result in difficulty in speech. Some factors like an ulcer, extraction socket, painful tooth, a missing tooth, any abnormal swelling in oral cavity, certain psychosomatic factors or neuromuscular diseases causing facial palsy, trigeminal neuralgia or glossodynia can affect speech temporarily. Surgeries causing defects in jaws, lips, tongue, larynx, nose also can cause defective speech. When rehabilitating an edentulous patient, care has to be taken to prevent any difficulty in speech. Considering the importance of phonetics in the communication of aviators and over all effect on flight safety, it is essential to take measures and screen the aviators at the selection level and also maintain the speech status while serving, by taking all preventive and corrective measures.

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Phonetics is the study of vocal sounds. Communication between the individuals is the basis for civilized growth of the community and speech dominates human communication. In aviation, verbal communication is the only effective means of passing information quickly. Though visual display units occupy a larger part of the modern aircraft cockpit, voice communication still plays the prime role as a means of rapid transfer of information. The factors which can affect speech perception can be classified under the following headings:

1. Aviator's speaking status
2. Effectiveness of communication system
3. Presence of adverse conditions, which interfere with communications.

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Aviators Speaking Status

(a) **Physiology of Speech** : Speech is a highly complex function of respiration, phonation, resonance, articulation and integration involving a number of organs. Respiration is of course concerned with exchange of air by lungs, phonation is accomplished by abduction and adduction of vocal cords, which changes the pitch of the voice, and resonance is realized in nasal, oral and pharyngeal cavities; which are prime resonant chambers. The teeth, tongue, lips and palate serve as articulator mechanisms and all of course would be nothing without the integrating facilities of human brain.

(b) **The Speaking Mechanism and Physical Nature of Speech** : The speaking mechanism involves a net outward flow of air mostly from lungs through trachea, glottis, pharynx, mouth and nose to the external ear.

(c) **Speech Learning and Development** : Speech has to be learnt. A human being left in isolation since birth will not be able to speak. Congenital blindness or deafness may lead to defective speech learning. Acquired blindness causes more changes than deafness. Like many other functions, speech also is dominant in one side of the cortex.

It has been also mentioned that appropriate speech training usually can bring about moderate improvement in intelligibility of speakers.

Effectiveness of Communication System

It is basically an engineering problem. The two interface sides between the man and the aircraft communication system are output device (mouth, throat, nose) and the input device (ear). The effectiveness of these systems in relation to man is tested by speech intelligibility test, by administering phonetically balanced words and scoring the percentage of correct words.

Presence of Adverse Conditions which Interfere with Communications

These factors have been divided into two groups :-

(a) **Intrinsic Factors** : They are language used, words used, intensity of speech, experience in communication and individual characters of speech sounds.

(b) **Environmental Factors (Aviation Causes)** : They are noise, combined stress of vibration and noise, acceleration, altitude of flight, oxygen breathing and other situations.

Role of Orodental Structure in Speech Production

The speech sounds are produced by controlled air source from lungs. Amount of air flow is variable. The controls of various articulations are valves in pharynx, oral and nasal cavities. The valves are used for modifying the flow of air to produce speech sounds which are classified as :-

1. Labial Sounds
2. Labio-dental Sound
3. Linguo-dental Sound
4. Linguo-palatal (anterior)
5. Linguo-palatal (posterior)
6. Linguo-palatal (soft palate)
7. Truly Palatal
8. Nasal

The first four involve position of the teeth. An irregularity in teeth position affects these sounds.

The soft palate performs any of the following basic functions in speech. It closes off nasal cavity as in producing 'k' and hard 'G'. It closes off oral cavity for production of sounds 'M', 'N' and 'NG' (as in ring) or it may close neither cavity completely but allow varying portions of air stream to enter the appropriate resonant chamber.

Although soft palate is but one part of the velopharyngeal mechanism (the other part being pharyngeal muscles), it is of such importance that when cleft, the individual cannot effect velopharyngeal closure and speech is defective.

A voice sound is one that is initiated in the vocal cords such as vowels a, e, i, o, u, and the voiced consonants b, d, g, j, v, m, n, 1 and r. The voice sounds may or may not be a part of the sounds produced by the action of valves. This makes possible the production of at least two speech sounds at each of the valves. Some voice sounds too may be made without involving the use of the air valves. These are modified when one changes the resonance of the oral and nasal cavities. Sinusitis, swelling or ulcer etc in oral cavity can affect these speech and sounds. Changes in resonance can change the sounds produced by some of the air valves.

1. Labial Sounds : The labial sounds b, p, m are made at lips with the air pressure built up behind the lips releases with or without a voice sound. Insufficient support by the teeth and denture can cause these sounds to be defective. So labiolingual position of the anterior teeth and thickness of the labial flanges of dentures can affect the sounds a and p. Cleft lip or incompetent upper lip can affect these sounds.

2. Labio-dental Sounds : f, v & ph are the labiodental sounds between the upper incisors and the labiolingual centre to the posterior one third of the lower lip. If the upper teeth are too long, the T sound will be like V and if they are too short V sounds like 'f'. Teeth position in both upper and lower anterior teeth affects these sound functions.

3. Linguo-dental Sounds : 'th' produced with the tip of the tongue extending between the upper and lower

anterior teeth. The tongue is actually closer to alveolus than to teeth. If 1/8" of the tip of the tongue is not visible, the anterior teeth are too far forward except with class II occlusion. If more than 1/4" of the tip is visible then teeth are placed too far lingually. Excessive vertical over lap (over bite) also does not provide sufficient space for the tip of the tongue.

4. Linguo-palatal (Anterior) : c (soft) d, t, n, s, z & r are in this group. They are formed by the contact of the tip of the tongue with anterior most part of the palate called the alveolus or the lingual side of anterior teeth. If the teeth are too far lingually placed, the 't' in 'tend' sounds like 'd', if the teeth are placed too far anteriorly the 'd' sounds like 't'. If denture base in the rugal area is too thick can produce a similar effect. V sound produced by the position of tongue so that air stream released through a small gap between tongue and rugae, 's' can sound like 'sh' by incorrect lower anterior teeth anteroposterior position.

5. Linguo-palatal (Posterior) : j, ch, sh, 1 and r are produced by the formation of valve by tongue and palate. When these sounds are made, the upper and lower teeth come very close but do not touch. This can be used as a guide in positioning the anterior teeth.

6. Linguo-palatal (Soft Palate) : c (hard), k, g, ng, also described by some authors as velar sounds not affected by artificial dentures unless there is cleft in soft palate or some other disease.

Speech Difficulties related to Malocclusion

Speech Sound	Problem	Related Malocclusion
1. /S/, IZI (sibilants)	Lisp	Anterior Open bite, larger gaps between incisors
2. IM, Idl (linguo alveolar stops)	Difficulty in pronunciation	Irregular incisors, especially lingual position of maxillary incisors
3. HI, hi (labio dental fricatives)	Distortion	Skeleton class II
4. th, sh, ch (linguo dental fricatives) (Voice or voiceless)	Distortion	Anterior open bite

7. Truly Palatal Sounds : Year, she, vision etc are truly palatal.

8. Nasal Sounds : m, n, ng are the nasal sounds. The vowel sounds a, e, i, o, u are formed by continuous air flow, the alteration in size of the mouth and the changes in shape and size of the lip opening gives the various sounds their characteristics form.

The Factors in Denture Construction Affecting Phonation :

One of the most important aims of artificial dentures is to restore normal speech. Brecher has listed seven different factors, which produce defective speech with artificial dentures, crown and bridges. Carl O Boucher suggested use of speech sounds for positioning of artificial teeth. But Judson C Hickey [1] felt that the speech sound is not a safe guide to position of teeth. The safe guide is the careful observation of relationships of the lips and tongue to the teeth and the denture bases.

Correct lower anterior teeth anteroposterior position, thickness and proper merger of the posterior border of the upper denture base can cause defective production of vowel sounds. Defective denture base and teeth placement can produce defective consonant sounds and certain labial, linguo-dental, linguo-palatals, truly palatals and even nasal sounds.

1. Denture Thickness Oral Peripheral

Outline : One of the reasons for loss of tone and incorrect phonation is the decrease of air volume and loss of tongue space in oral cavity resulting from unduly thick denture base and medially or lingually placed teeth. Peripheries should not be extended to movable tissues. Poorly retained dentures should not hinder function of lips. Linguo-palatals are worst affected by thick and bulky denture base.

2. Vertical Dimensions: - Use of phonetic assessment and speech is most valuable for basic evaluation of vertical dimensions. Disregard to correct

vertical dimension affect the labials b, p & m. The sound 'm' produced by passive lip movement, C (soft), s, z, ch sounds also need correct vertical dimensions. Increased vertical dimensions will result in clicking the teeth, while attempt is made to pronounce c (soft), s, z, ch sounds.

3. Occlusal Plane : Phonetic assessment guides

positioning of teeth in the correct occlusal plane. We have already discussed the effect of change of anterior teeth positioning on pronouncing f, v and ph.

4. Anteroposterior Position of Incisors : The effect of wrong anteroposterior positioning will affect the labio-palatals f, v, ph, s, c, soft p and z, the tongue will accommodate more readily in anteroposterior errors in setting than the errors in vertical dimensions.

5. Post Dam Area : The contact of the dorsum of the tongue in this area to divide the oral cavity into two chambers. Also linguo-palatal consonants such as k, ng, g and c (hard) are affected by incorrect post dam extensions. Thick base in post dam area instead of tapering will irritate the dorsum of the tongue. Post dam seal indirectly influences the phonation, if inadequate by unseating denture. In patients with loose upper denture, the tongue pressed against the denture for retention affects speech. Pronunciation of m,n & ng called nasal group are also affected, which will need sealing of soft palate and pharyngeal wall.

6. Width of Denture Arches : Too narrow is the arch, tongue gets cramped, affecting the size and shape of air channel, resulting in faulty pronunciation of f, d, s, m, n, k, 1, a and h, where lateral margins of the tongue contact with palatal surface of teeth. Every endeavor is made to set teeth in their natural position or as per the standard laid down.

7. Relationship of Upper Anterior to Lower Anterior Teeth : While producing 's' sound, the upper and lower anterior teeth almost come in contact

with a narrow air channel provided between teeth. Also similar air channel is required for ch, j & z.

8. Retention of Dentures : Loose dentures will not allow the tongue to function normally and there by affect speech.

Speech is definitely a principle objective in maxillofacial prosthodontic treatment. Elimination or reduction of escape of excessive air into nasal cavities improves voice quality and basis for normal speech is established. The terms 'obturator', 'speech bulb', 'speech aid' are used interchangeably for the mechanical appliances used for restoration of speech. Hayes [2] defined obturator as a mechanical device which improves voice quality by reducing nasality and excessive nasal friction. Obturators actually establish oronasal integrity. Ivy [3] states that patients with cleft palates with anatomical limitations have not developed normal speech and so require speech therapy, but in case of patients with acquired defects, normal speech can be restored with obturators. While functional continuing of dentures will improve speech production, but in the greatest adaptability of the tongue it would have been very difficult to master speaking with artificial dentures.

While it is not within the scope of this paper to discuss in detail various anomalies or diseases which cause defective speech, it is worth mentioning about the changes in speech in individuals under stress. It has been observed that in individuals in depression, the volume and tone of speech is lowered, in maniacs both the pressure and tone are increased, under severe stress stammering, stuttering and in Hysterical aphonia, total loss of speech is possible.

Some factors like an ulcer, extraction socket, painful tooth, a missing tooth, any abnormal swelling in oral cavity,

certain psychosomatic factors or neuromuscular diseases causing facial palsy, trigeminal neuralgia or glossodynia can affect speech temporarily. Surgeries causing defect in jaws, lips, tongue, larynx & nose can also cause defective speech.

9. Speech standards laid down in IAP 4303, 2nd Edition 1987 for selection in IAF : Speech must be clear, of adequate loudness to be intelligible," stammering, lisping, slurring of words and hesitation in speech must be noted. The candidates are asked to read a paragraph in English to determine speech abnormalities.

Conclusion

Importance of speech communication in Aviators needs no further emphasis, as the alternative ways of expression like gesticulation, facial expression etc will not be possible.

With a view to improve the speech status of aviators, in addition to adhering to strict standards, a system of evaluation of articulation could be developed under different stressful states and provide the aviator with well fitting artificial dentures, crowns, bridges etc. As far as possible fixed bridges be provided to aviators.

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