MEAN AIR FLOW RATE AND OPTIMUM FREQUENCY

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Optimum frequency is considered to be the frequency at which maximum physio-acoustic economy is achieved. The purpose of this study was to find out the economy in the use of air flow at optimum frequency (as determined by an objective method of locating optimum frequency). The mean air flow rate at optimum and at frequencies higher and lower than the optimum frequency were measured using an expirograph. 15 *male and* 15 *female adults were asked to phonate vowel \a\ as long as possible keeping the frequency and intensity constant, into the expirograph. Thus the mean air flow rate at optimum,* + 100 *Hz* + 200 *Hz* + 50 *Hz and*— 50 *Hz from the optimum were determined. The results show that the mean airflow rate at optimum frequency was significantly lower than at other frequency levels. Therefore it was considered that there was maximum economy at optimum frequency, as determined by this method, in terms of use of air for phonation.*

"The D.C. flow of air is converted into A.C. sound pulses by the abduction and adduction of vocal folds. During the production of sound the vocal cords are in adducted position. In this position, they vibrate alternately, opening and closing the glottis for very short periods. Actually it is the air current from the lungs that separates the vocal folds and open the glottis. But as the air begins to stream out through the narrow glottis, a suction takes place which draws the vocal folds together again. Immediately, the subglottic pressure again forces the vocal folds apart and the air streams out through the glottis. The vibratory movements are performed at a frequency, determined among other things, the tension of the vocal folds. Their vibratory frequency in turn determines the frequency of the air puffs which are the primary source of the sound " (Fletcher, 1950). Thus the frequency of vocal fold vibration is determined by the mass, length and tension of the vocal folds. It is believed that each vibrator has its own natural frequency. Similarly the vocal folds also have their own natural frequency, which is otherwise termed as ' Optimum Frequency '.

" The idea of ' Optimum' implies a standard in terms of which a thing is judged as being best. . . . Optimal vocal functioning can be defined aesthetically,

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acoustically and hygienically" (Perkins 1971). Further Perkins (1971) states that any abuse of the vocal mechanism would indicate non-optimal use of vocal mechanism. It is considered that optimum pitch is most efficient for speech, and achievement of loudness with minimal effort. Most often a hygienically and acoustically acceptable voice also satisfies aesthetic aspect. Therefore, most of the therapies are based on the belief that each individual has a pitch range at which the individual will be able to produce the voice with less effort, and make variations in terms of frequency and intensity. The therapi at aims at making the case to use this pitch range. Thus measuring optimum pitch and providing optimum pitch becomes the major part of voice therapy with most of cases of voice disorders. There are several methods of measuring or locating optimum pitch, which vary greatly from one another. These methods have been discussed elsewhere (Nataraja, 1974). To overcome the drawbacks of these methods an objective method of locating optimum pitch was developed (Nataraja, 1972) based on the natural frequency of vocal tract.

It has been stated by Murphy (1964) that at optimum pitch there will be maximum physio-acoustic economy. In an attempt to find out whether the optimum pitch (frequency) determined by this technique meets the above criterion, a study was conducted by Shashikala (1979). Shashikala (1979) measured maximum phonation duration, intensity range and mean air flow rate at optimum frequency and other frequency levels within the frequency range that the subjects could phonate. She has concluded that there was maximum physio-acoustic economy at the optimum frequency, as determined by the objective method of locating optimum frequency, when compared to other frequency level, as she found that the subjects had longer phonation duration, greater intensity range and low mean air flow rate at optimum frequency when compared to other levels. As Shashikala (1979) had used only 10 subjects (5 males and 5 females) it was felt necessary to repeat the study to further validate the occurrence of maximum physio-acoustic economy at the. optimum frequency as determined by the objective method of locating optimum frequency (Nataraja, 1972). Therefore the present study was conducted.

. It was intended to measure the mean air flow rate at optimum and -1- 50 Hz, + 100 Hz and +200 Hz from optimum ferquency, so that a comparison of these mean air flow rates would indicate whether the phonation at optimum frequency is economical. 15 males and 15 females age ranging from 18 to 25 years (with mean age of 22.2.5 years) who had no speech and hearing problem and could phonate and control the frequency and intensity at desired levels were considered as subjects for the study.

An expirograph was used to measure the air flow rate during phonation. Phonation duration was measured using a stop-watch. A contact microphone was placed over the laryngeal prominence and tied around the neck of the subject,

to pick up voice signal and was fed to a measuring amplifier B & K, 2606 (to note the intensity of voice) and further to Tacho Unit through Stroboscope B & K, 5066 to note the frequency.

With this instrumental set-up each subject was asked to phonate vowel / a / as long as possible into the mouth-piece of the expirograph at (a) optimum frequency (determined before the experiment using an objective method of locating optimum pitch (Nataraja 1972), *(b)* + 100 Hz from optimum frequency, (c) + 200 Hz from optimum frequency, *(d)* ± 50 Hz from optimum frequency.

The total volume of air collected during phonation as shown by the graphic recorder of the expirograph and the duration of phonation, measured using a stop-watch, were determined at each frequency level for all the subjects. The subjects were helped to maintain the frequency and intensity with the aid of the Tacho Unit and the measuring amplifier. The subjects were also given trials whenever they found it difficult to phonate at a particular frequency and/or intensity levels.

The experiment was repeated with 5 males and 5 females, randomly chosen for the purpose of checking the reliability. The results were consistent (only ± 5 c.c./sec variations were found).

Table I reveals that there is a low mean air flow rate at optimum frequency both in case of males and females. Further statistical analysis using Wilcoxon matched pair signed ranks test showed that the mean air flow rate at the optimum was significantly different when compared with other frequency levels. Therefore, it was concluded that the optimum frequency is meeting the criterion stated by Fisher (1966) and Murphy (1964) as there was physiological economy, *i.e.,* low

TABLE 1. Showing the mean of mean air flow rate for both male and female subjects and the statistical significance.

Frequency	Optimum	50 Hz	+ 50 Hz	+100 Hz	+ 200 Hz
Mean of Mean air flow rale for males	49.12	70.40	89.50	114.72	141.35
Significance at 0-05 level		+	+	+	+
Moan of Mean air flow rale for females	39.10 -+	53.33 +	52.49 +	68.16 +-	89.72 +

mean air flow rate. This low mean air How rate would otherwise permit the individual to phonate for a longer duration. Similar results have been reported by Shashikala (1979) ; in other words, the findings of the present study confirms the earlier findings by Shashikala (1979). Therefore the objective method of locating optimum frequency (Nataraja, J972) will be useful in determining optimum frequency which is an important step in voice therapy. In another study by Nataraja (1984) has shown that the maximum phanation duration was greater at optimum frequency than at other frequencies, *i.e.,. an* individual can phonate for a longer duration at optimum frequency than at other frequency levels. Thus the objective method of locating optimum frequency locates a frequency at which there will be maximum physio-acoustic economy. Clinically this method has been found to be useful with various cases of voice disorders.

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