

# The Relation Between Fundamental Frequencies and the Resonant Frequencies of the Vocal Tract\*

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The study was concerned with the frequency response of the vocal tract. This was undertaken on assumption that the vocal tract is an acoustical system having a series of coupled resonance elements with resonance peaks in the response frequencies. These resonance peaks are given by formants, and these formants were compared in turn with the natural frequency of the vocal tract (Maximum increase in the intensity when the vocal tract was stimulated with an external source) as found by Nataraja (1972).

The study was also concerned with finding out the effect of change in fundamental frequencies on formant frequencies.

It was also attempted to see whether fundamental frequency found by stroboscopic technique and spectrographic analysis tallied.

In order to study these aspects the following hypotheses were advanced :

- (1) Natural frequency of the vocal tract is a formant ; and
- (2) The formant frequencies are independent of the fundamental frequencies.

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In order to study these hypotheses the following experiments were undertaken. The natural frequency of the vocal tract was found out by using Nataraja's technique.

The subjects of the above experiment were asked to phonate [ a ] for 5 seconds. This was recorded and fed to the Sonograph. Formant analysis was done.

The fundamental frequency was measured directly from the Tachometer which was used in combination with a Stroboscope, SPL meter and Octave filter.

Hypothesis (1) was rejected.

To test the hypothesis (2), 5 subjects (males) were taken. They were asked to phonate vowels [ a ] and [ i ], each for 5 seconds. A tone of 110 Hz, 160 Hz and 200 Hz was given for matching through the earphones of the Bekesy audiometer. Vowels [ a ] and [ i ] were recorded in the Ampex Tape Recorder at the three levels mentioned above.

The spectrograph analysis of formant frequencies and fundamental frequencies were done.

Hypothesis (2) was accepted.

## Conclusions

- (1) The natural frequency of the vocal tract does not coincide with any of the formants.

- (2) On statistical examination 30 subjects taken for the study showed that there is no correlation between the average of  $F_1$   $F_2$  and the natural frequency found by Nataraja (1972).
- (3) Means of fundamental frequencies found from the Stroboscopic technique and the Spectrographic analyses were closer. Mean of the two methods showed 6 Hz difference. The correlation between Fundamental Frequencies obtained by Stroboscopic technique and Spectrographic analysis was 0.5711.
- (4) Formant frequencies are independent of the fundamental frequencies. That is, if the same person phonates vowel [ a ] in different fundamental frequencies still, you perceive it as vowel [ a ].

## Recommendations

- (1) Objective confirmation of the frequency located as optimum pitch by studying the physio-acoustic economy at this level by using C.M.G.
- (2) To study the effects of the changes in resonators on normal and abnormal changes in pitch.
- (3) Validating the natural frequency and the dimensions of the vocal tract by means of analogues technique.
- (4) In subjects with good voices, to correlate fundamental frequencies found from Purdae pitch meter, Sonogram, Stroboscope and the natural frequency of the vocal tract.