

Modal Vocal Fundamental Frequency of Young Adults

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Recordings of 100 male and 100 female young adults who were judged to have normal speech, voice, and hearing were analyzed for vocal fundamental frequency. A technique of determining modal fundamental frequency by systematic screening of the recorded samples through variable filters was employed. The mean of the vocal fundamental frequencies of males was found to be 116.65 hertz and the mean of the vocal fundamental frequencies of females was 217.00 Hz.

RECENT research on vocal fundamental frequency by Mysak,¹ McGlone and Hollien,² Michel,³ and Hollien and Paul⁴ has been directed to the study of change with increasing age. These, along with earlier studies by McIntosh,⁵ Curry,⁶ Hanley,⁷ Snidecor,⁸ and Linke,⁹ have provided information concerning normal vocal fundamental frequency levels of young adults.

In only two of the above studies, Michel,³ and Hollien and Paul,⁴ was the population

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sampled at one age level large enough to provide representative data. Subject selection in these studies, however, may have reflected a sampling bias, ie, a large percentage of the subjects were cheerleaders.

The method of analysis used in the above studies was a highly accurate wave-by-wave analysis, with later studies having more sophisticated electronic data processing to greatly decrease analysis time. Generally, the measure of central tendency used to describe the vocal fundamental frequency has been the median of the pitches used, with the mean used to a lesser degree. The measure of central tendency would appear to make a difference, as Hollien and Malcik¹⁰ reported a variation of as much as 12 hertz between mean vocal fundamental frequency and median vocal fundamental frequency.

Modal vocal fundamental frequency was reported by Roll¹¹ and Holbrook and Meador.¹² These studies were directed to the modification of vocal behavior and yielded no information that could be applied to describing normal vocal fundamental frequency.

Purpose

The purpose of this study was to provide normative data on the modal vocal fundamental frequency characteristics of a representative population of young adults. To accomplish this, vocal fundamental frequency data for 100 male and 100 female university students were obtained. Only subjects judged to have speech, voice, and hearing within normal limits were selected for the study. In addition, no subjects with formal

training or experience in public speaking or singing were used in the study.

Methods

Subjects.—Two hundred students of Florida State University, 100 males and 100 females, participated in the study. The age range was 17.5 years through 25.5 years. This age range was selected on similar criteria to that employed by Hollien.¹³ That is, the subjects had completed voice change and were young enough so that tissue change associated with increasing age was not evident. Subjects were selected by a random procedure designed to exclude special subgroups within the experimental population. A hearing screening test was administered to each subject. Individuals who failed at any one frequency were eliminated from the study.

Three judges, each with the American Speech and Hearing Association Certificate of Clinical Competence, listened to the recordings. They were instructed to make a judgment on the voice and speech of each subject. Only subjects judged to have speech and voice characteristics within normal limits were included in the study.

Experimental Procedure.—The speech sample obtained was the middle 55 words of the "Rainbow Passage" by Fairbanks,¹⁴ a phonetically balanced prose passage. Recordings of speech samples were made on a tape recorder operated at 15 inches per second tape speed. Subjects were seated in a soundproof booth, and a microphone was used.

Measurement.—A device called FLORIDA (frequency lowering or raising intensity determining apparatus) was used to locate modal vocal fundamental frequency. A detailed description of this apparatus has been presented by Fitch¹⁵ and by Holbrook and Meador.¹² In general, it is an electronic device consisting of a set of variable filters connected in series to a system of relays. When the relays are triggered, an electric stop clock is activated. The sample passage is systematically analyzed at increasing frequency settings on the variable filters (5-Hz steps) until the highest reading on the time clock is found. The frequency at which the highest reading is obtained is defined as the modal vocal fundamental frequency. The use of filters in fundamental frequency analysis has been employed previously by Dempsey¹⁶ and others.

Measurements of the vocal fundamental frequency of three male and three female subjects were determined with this technique and compared to measurements obtained from the

sound spectrograph, used by Fitch,¹⁵ and from the fundamental frequency indicator (FFI), described by Hollien and Tamburrino (unpublished data). Table 1 indicates the results. It is felt that the differences are due to the method of measurement which yielded a different measure of central tendency, but one that is, nonetheless, descriptive of vocal fundamental frequency.

Results

Table 2 shows the mean, standard deviation, and range of height, weight, age, and fundamental vocal frequency of all subjects by sex. The mean age was 19 years, 6 months for males and 19 years, 5 months for females, with a standard deviation of 15 months for males and 19 months for females. The age range for males was from 18 years to 25 years, 2 months. For females the age range was from 17 years, 9 months to 23 years, 6 months.

The mean height was 180.3 cm (5 ft 11 inches) for males and 166.4 cm (5 ft 5½ inches) for females, with a standard deviation of 7.0 cm (2.90 inches) for males and 6.4 cm (2.42 inches) for females. The height of males ranged from 162.6 cm (5 ft 4 inches) to 200.7 cm (6 ft 7 inches) and for females, from 152.4 cm (5 ft) to 182.9 cm (6 ft).

The mean weight was 74 kg (163 lb) for males and 56 kg (123½ lb) for females with a standard deviation of 11.3 kg (25 lb) for males and 6.4 kg (14 lb) for females. The weight of males ranged from 54.4 kg (120 lb) to 122.5 kg (270 lb) and for females 43.1 kg (95 lb) to 78 kg (172 lb).

The mean of the modal vocal fundamental frequencies was 116.65 Hz for males and 217.00 Hz for females, with a standard deviation of 1.05 tones for males and 0.85 tones for females. The modal range was from 85 Hz to 155 Hz for males and 165 Hz to 255 Hz for females.

Table 3 indicates results of major studies of fundamental vocal frequency to date. It is evident that the modal vocal fundamental frequency of males obtained in this study is lower than the central tendency reported in previous studies.

Results of vocal fundamental frequency studies of females to date are also contained in Table 3. The findings of 217.00 Hz in this

Table 1.—Comparison of Fundamental Frequency Analyzers*

Technique of Measurement	Male Subjects			Female Subjects		
	1	2	3	4	5	6
Modal fundamental frequency-FLORIDA	110	125	110	245	240	225
Median fundamental frequency-sound spectrograph	107	131	105	242	235	210
Mean fundamental frequency-FFI	110.2	127.7	105	239.2	230.7	209.8

* All measurements are in Hz.

Table 2.—Statistical Data of Subjects

Type of Data	Mean	SD	Range
Modal fundamental vocal frequency			
Males	116.65 Hz	2.11 s-t*	85 Hz-155 Hz
Females	217.00 Hz	1.70 s-t	165 Hz-255 Hz
Age, mo			
Males	233.87	19.05	216-302
Females	232.95	14.75	213-282
Height, in			
Males	70.89	2.90	64-79
Females	65.46	2.42	60-72
Weight, lb			
Males	163.29	24.75	120-270
Females	123.47	14.06	95-172

* S-t indicates semitones.

Table 3.—Research on Fundamental Vocal Frequency

Investigator	Males		
	Age, yr	Fundamental Frequency, Hz	SD, s-t*
Curry (1940) ⁶	18	137.00	1.79
McIntosh (1939) ⁵	Young adult	132.00	1.89
Hanley (1949) ⁷	Young adult	118.80	1.30
Present study	Young adult	116.65	1.06
	Females		
	Age, yr	Fundamental Frequency, Hz	SD, s-t*
Hollien and Paul (1969) ⁴	17.5	211.50	1.67
Present study	Young adult	217.00	.85
Linke (1953) ⁹	Adult	199.80	1.52
Snidecor (1951) ⁸	Superior adult speakers	213.50	1.56

* See Table 2 footnote.

study are slightly higher than those reported in the previous studies.

Comment

The results of this study are in general agreement with those from previous studies of female vocal fundamental frequency. The values are slightly higher, but indicate, as have other studies employing objective frequency measures, that the suggested vocal fundamental frequency levels of Fairbanks¹⁴ (middle C—256 Hz) and Judson and Weaver¹⁷ (288 to 320 Hz) are not accurate.

The standard deviation of vocal fundamental frequency levels in the present study was less than that of previous studies. Whether this is a function of the measuring

instrument or the selected population is not known. Further studies are needed to investigate this.

The discrepancy between results of older studies of male vocal fundamental frequency and those of more recent studies suggests the possibility that vocal fundamental frequency decreases as the size of the individual in our culture increases. Hollien¹³ indicated that laryngeal size was negatively correlated with vocal fundamental frequency. A Pearson product-moment correlation was calculated between height and modal vocal fundamental frequency and weight and modal vocal fundamental frequency in the present study. While the results were not statistically significant, they were consistently negative.

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