A COMPARATIVE STUDY OF VOCAL PARAMETERS OF TRAINED AND UNTRAINED SINGERS

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Voice is the product of the most finely coordinated delicately balanced and harmonious movements of which the body is capable. Although it may be conceded that voice production is of secondary importance both developmentally and functionally, compared with the protective role of the larynx, it is nevertheless true that it has acquired unique possession in man as a main motor organ of communication through speech (Greene 1964).

Singing is a highly specialized form of using the vocal organs. We know less of the singing voice than of the speaking voice (D. Boone 1971).

The purpose of this study was to determine the various vocal parameters such as optimum frequency, fundamental frequency of the speaking and singing voice, pitch range, phonation time and vital capacity in trained singers and compare them with those of untrained singers. It was also planned to check whether parameters such as vital capacity and phonation time were inter related.

A review of literature reveals scanty data about the pitch used by singers while speaking and singing.

Studies by Greene (1972) Luchsinger (1965) and Fairbanks (1949) about the pitch range in singers reveal that trained singers tend to have a greater pitch range than untrained singers. There are no controversies about this.

It has long been assumed that the superior vocal ability of trained professional singers arose from a higher than average breathing capacity and consequently above normal vital capacity. Wissilow in his study found greater vital capacity in trained singers. Nadoleczny and Luchsinger (1934) also reported larger vital capacity values in trained singers. Heller Hicks and Roots (1965) found no significant difference in vital capacity between trained professional singers and untrained singers.

The determination of phonation time is an important phoniatric test which provides information on the functional state of the entire respiratory system (Luchsinger 1965).

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The recent findings by Ishiki, Yanigihara and Koike (1965) conclude that maximum sustained phonation is achieved by total air capacity for vocal production, expiratory power and glottal resistance.

Westlake states that increased ability to sustain phonation is one way of increasing speaking and singing efficiency.

Proctor describes the trained singer's mastery of expiration when he wrote 'Most singers are capable of sustaining single tones for more than 30 seconds'. Ptacek and Sanders (1963) report longer phonation time in trained singers than in untrained singers.

However no study has so far been done in India about the Vocal parameters in singers.

Definitions used in the present study

Trained singers: Trained singers are those who have undergone formal training in Vocal Music for more than five years.

Untrained singers: Untrained singers are those who can sing but who have not undergone any formal training in Vocal music.

Optimum frequency: Optimum frequency is the fundamental frequency of the vocal cords which elicits the maximum response of the Vocal tract.

O. *F.=Natural frequency of the vocal tract J* Relationship

Fundamental frequency of the Vowel/a/in the speaking pitch (Habitual speaking frequency)

It is the fundamental frequency measured with the help of the Tacho unit of the stroboscope in combination with the SPL meter when the subject is asked to phonate/a/in his speaking pitch.

Fundamental frequency of the Vowel/a/in the singing pitch (Habitual singing freqnency)

It is the fundamental frequency measured with the help of the Tacho unit of the stroboscope in combination with the SPL meter when the subject is asked to phonate the vowel/a/in his singing pitch.

Pitch Range: It is the measure of the musical interval (in terms of octaves) between the highest possible and the lowest possible pitch the subject phonates.

Phonation Time: Sustained phonation time means the time a subject holds a note comfortably at a given pitch after taking a deep breath.

Vital capacity: It is the total volume of air which the individual expels from his lungs after they have been filled to the greatest extent possible. To measure this quantity the subject inhales as deeply as possible then expels as much air as possible into the expirograph. The volume measured on the scale is known as vital capacity.

Methodology

Thirty trained singers (trained for Karnatic Music) and thirty untrained singers constituted the two groups studied. There were 24 females and 6 males in both the groups. The age range was 19 to 57 years. The two groups were matched for age, sex, height and weight. The subjects selected were free from speech and hearing problems.

Procedure: The first step was to determine the optimum frequency of both the trained and untrained singers.

To determine the optimum frequency of the vocal tract the following principle was used. Constant acoustic output over a range of 100 c's to 5000 c/s was fed into the vocal tract. The reflected sound was measured. The maximum peak of this measurement was the natural frequency of the vocal tract which when divided by five in females and eight in males resulted in optimum frequency. Hence the two problems in this experiment were:

(i) Obtaining a constant acoustical input over the considered range of frequencies.

(ii) Simultaneous recording of the reflected output at the Voeal tract.

(i) Obtaining a constant acoustical input over the considered range of frequencies:

A hearing aid receiver was used as a probe speaker fed from a Beat frequency oscillator to get a constant output at the speaker. A portion of the output was fed to another hearing aid receiver. This was mechanically coupled to the condenser microphone. This receiver microphone coupling was kept in an anechoic enclosure (hearing aid test box) to prevent ambient noise. The condenser microphone was connected to a measuring amplifier through a pre amplifier. The output of the measuring amplifier was fed to the compressor circuit of the beat frequency oscillator. This arrangement gave an acoustical output which was treated as the baseline of the experiment.

(ii) Simultaneous recording of the reflected output in the Vocal tract:

The reflected sound from the vocal tract was picked up by the condenser microphone, which feeds a sound level measuring instrument. The output of this instrument was fed to the level recorder. The motor of the recorder which

drives a calibrated paper was used for synchronous scanning of the desired frequency range of the Beat frequency oscillator. The graphical representation was in terms of frequency versus intensity changes over the frequencies scanned.

The subject was asked to adjust his mouth around the probe speaker and condenser microphone in the vowel/a/position without any change and be relaxed. In this position the scanning was started from 100 to 5000 Hz. Comparing the response with the base line. The maximum response was taken as the natural frequency of the vocal tract which was divided by the relationship factor and the optimum frequency was determined (set up used and validated by N. P. Nataraj 1972 and George Samuel 1973).

After determining the optimum frequency the next step was to determine the fundamental frequency. The fundamental frequency of the speaking voice was determined by asking the subject to phonate/a/in his speaking pitch and the reading was directly obtained from the Tacho unit of the stroboscope. Similarly the fundamental frequency of the singing voice was also determined.

Then the pitch range of the subjects was determined by instructing the subject to phonate the lowest possible and the highest possible pitch, and the reading was obtained from the Tacho unit of the stroboscope.

After sufficient rest, the subject was asked to sustain phonation as long as possible in one breath. The time the subject maintained phonation was noted down using the stop watch.

The vital capacity of the subject was determined by using the expirograph. The subject was instructed to take a deep breath and expel as much air as possible in to the expirograph.

The graph of the expirograph represented the vital capacity.

All the above experiments were carried out with trained and untrained singers.

Results and Discussions: In order to study the comparison between the two matched groups the following hypotheses were advanced and the results were tested by using the Wilcoxon Matched Pair Sign Rank Test and the Spearman's Rank Correlation Test.

1. "Significant differences exist between the optimum frequency and the fundamental frequency of the speaking pitch". The hypothesis was rejected at 0.01 level of significance and in untrained singers it was accepted at 0.01 level.

This indicates that trained speakers studied, tend to use their optimum frequency while speaking unlike the untrained singers.

2 "Optimum frequency is neither used by trained singers nor untrained singers while singing."

This hypothesis was accepted at 0.01 level of significance both in trained and untrained singers. Both trained and untrained singers did not use their optimum frequency while singing.

TABLE 1. *Showing the data of optimum frequency, fundamental frequency of speaking and fundamental frequency of singing—in trained singers*

Optimum Frequency (c/s)	F. F. (speaking) (c/s)	F. F. (singing) (c/s)
Females		
225	220	230
245	250	240
200	195	160
180	140	310
150	180	160
255	175	200
190	210	260
290	230	260
235	210	260
245	200	230
260	220	320
240	270	520
245	215	210
260	320	310
225	210	200
220	310	400
255	240	250
240	300	180
250	200	200
235	230	200
205	210	200
250	250	230
255	200	260
255	210	240
Males		
145	155	110
120	120	110
145	135	130
160	100	120
140	125	125
155	105	112

Trained singers used optimum frequency while speaking and not while singing whereas untrained singers did not use their optimum frequency for both speaking and singing.

Usually trained singers use a pitch pipe or some other instrument for their pitch reference when they sing.

TABLE II *Indicating the Data of O.F. F.F. (speaking) F.F. (singing) in Untrained singers*

Females		
245	200	250
230	240	240
250	230	220
245	220	350
335	240	240
260	240	235
240	270	310
255	230	300
265	220	280
235	200	240
265	220	220
260	240	260
225	210	210
240	250	290
275	250	260
235	230	320
265	220	250
260	200	240
288	210	240
320	220	220
260	200	230
250	240	290
225	200	190
255	260	280
Males		
180	140	145
125	160	200
130	120	160
'130	110	160
120	110	130
120	120	130

The pitch pipe or the reference instrument may be tuned a little higher or lower when compared to optimum frequency of the subject. Hence the possibility of not using the O.F. while singing may be explained. While speaking no such reference is used and hence they tend to use their O.F. for speaking.

3. "Trained singers possess significantly greater pitch range than untrained singers."

This hypothesis was accepted at 0.005 levels of significance.

Pitch range was greater in trained singers than in untrained singers.

TABLE III. *Pitch range of Trained Singers and Untrained singers*

Trained	*Untrained*
Females	
2.00	1.50
2.00	1.25
2.00	1.25
2.25	1.25
2.75	1.00
3.50	1.25
3.25	1.75
3.25	2.25
2.25	1.75
2.00	1.25
1.75	1.25
3.50	1.25
2.00	1.25
1.25	1.25
2.00	1.00
2.50	1.00
2.50	1.25
3.00	1.00
3.00	1.00
4.00	2.25
2.00	1.00
3.25	2.00
4.25	1.25
2.25	2.00
Males	
2.75	1.25
2.50	1.25
2.75	2.75
2.25	1.25
2.75	1.00
2.25	1.00

It is largely agreed by various authors (Vennard, Greene, Luchsinger and D. Boone) that trained singers possess greater pitch range than untrained singers. The explanation for this may be that trained singers are trained for expanding or improving the pitch range as a part of vocal education and this in return depends upon the number of years of vocal training and hours of practice.

4. "Trained singers possess significantly longer phonation time than untrained singers."

This hypothesis was rejected at O.005 level of significance.

No significant difference was observed in the phonation time between trained and untrained singers.

TABLE IV. *Data indicating the phonation time (in seconds) in trained and untrained singers:*

Trained Singers	*Untrained Singers*
Females	
15	19
19	15
18	14
18	20
16	20
IS	11
19	25
20	25
19	10
16	15
17	13
20	18
21	20
20	15
21	27
22	16
20	20
18	16
16	16
18	13
14	14
18	16
24	10
18	18
Males	
19	28
18	23
21	29
22	15
19	12
18	14

In this study trained singers did not van/ significantly in phonation time from the untrained singers.

The trained singers selected for the present study were trained for Karnatic music where the demands on a singer may be different when compared to Western

musicians. In the latter type sustained phonation is highly essential whereas it may not be so essential in Karnatic music.

However this should be tested with more singers.

There is a lot of controversy about the idea that phonation time and vital capacity are inter related.

Luchsinger (1965) Boone (1971) Greene, M. (1972) and others believe that in order to maintain phonation expiratory power is necessary which depends on vital capacity.

As a part of the study, it was also tested whether vital capacity and phonation time were inter-related.

5. It was hypothesized that "vital capacity and phonation time were inter-related."

To test this hypothesis the Spearmans Rank Correlation was used as the statistical method.

Hypothesis was rejected both in trained and untrained singers.

Low correlation was observed between phonation time and vital capacity.

Some of the earlier studies report that vital capacity was more in trained singers and recent studies indicate no significant differences in vital capacity between the two groups.

6. In order to study this it was hypothesized that "significant differences exist in vital capacity between trained and untrained singers."

Hypothesis was rejected at 0.01 level significance.

No significant differences was observed in vital capacity between trained and untrained singers.

The reliability was checked by conducting all the experiments again on five randomly chosen subjects and the scores were obtained. High correlation was observed between the scores obtained during the first experiment and the second.

Conclusions

1. Trained singers in the study used their optimum frequency while speaking and not while singing.

2. Untrained singers did not use their optimum frequency either for speaking or singing.

3. Trained singers were observed to have greater pitch range than untrained singers.

4. No significant difference was observed in phonation time between trained and untrained singers.

TABLE V. ***Data of vital capacity (in c.c.) in trained and untrained singers***

Trained	*Untrained*
Females	
1500	1650
2550	1800
2010	1410
1440	1560
2100	1650
1920	1710
1350	2220
1260	1560
2400	2100
1740	1560
1650	1508
1920	1350
2250	1950
2400	1530
1740	1650
2100	2100
1860	2700
1800	2100
1400	1350
2310	1650
1740	2000
2010	2100
1650	1350
1950	19S0
Males	
3300	3450
2600	3000
1800	3300
2040	2100
2490	2360
2100	1900

5. No significant difference was observed in vital capacity between trained and untrained singers.

6. Low correlation was observed between phonation time and vital capacity

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