

Effect of Hindustani Vocal Training on Voice Measures

Sangeetha Mohan

Abstract— This paper explores the effect of training on voice measures of Hindustani singers. Stabilization of the frequency of base note, improvement of the Maximum Phonation Duration, extension of the frequency range has been reported to improve with training. Though Indian music is termed as homophonic, in Hindustani singing the singer tries to project his voice over the accompanying instruments (heterophonic). To achieve this, a higher frequency of base note and an extensive frequency range is needed. Hence, present study was undertaken to compare the effects of music training on the frequency of base note and frequency range of Hindustani singers having less than thirty six months of music training with Hindustani singers having greater than thirty six months of music training. Training was found to help the singers to gain an appropriate frequency of the base note and extend their frequency range aiding them to project their voice well.

Keywords— Heterophonic, Hindusthani Music, Homophonic, Maximum Phonation Duration

I. INTRODUCTION

AS any other musical instrument there must be a source of the vibrations required to make sound, and for the voice this is the vocal folds (or cords), situated within the larynx. An effective and controlled modulation of the air stream leading to the perception of well arranged intonation patterns would result in the production of music. The vocal folds, in combination with the articulators, are capable of producing highly intricate arrays of sound. The tone of voice may be modulated to suggest emotions such as anger, surprise or happiness.

Same speech apparatus is used for singing and speaking, but difference exists in the mode of usage of the apparatus. Singing against speaking is a matter of sophisticated use and precision in use of speech apparatus.

A highly intricate and precisioned manipulation of human voice resulting in a pleasurable listening experience is singing. Singing involves effective spanning across a wide range of pitches from low to high pitch. Using a high or low pitch involves effective manipulation of the laryngeal cartilages and muscles.

Music is an art form that involves organized audible sounds and silence. India is a land of music. Indian music has been classified with respect to the regions of its origins as

Hindusthani music originating from northern region of India and Carnatic music originating from the southern region of India.

The Hindustani and Carnatic style of music differ significantly in terms of repertoire, vocal techniques & instruments. Several changes have been reported by authors in the acoustic parameters of voice following singing. The changes that have occurred can be evidenced in the following parameters:

II. THEORETICAL BACKGROUND

A. Maximum Phonation Duration

Maximum phonation duration is defined as the maximum duration for which an individual can sustain phonation and is measured for three basic vowels /a/, /i/ and /u/.MPD provides information on vocal efficiency (Yaragihara, Koike, Van Lende 1966), respiratory system efficiency (Boone 1977), laryngeal functioning and tension (Gould and Tanable 1975) and thereby serves as a quick measure for determining the voice quality.

An MPD of 34.6 secs and 25.7 secs have been reported in normal adult males and in normal adult females Hirano (1981).In Kannada speaking population the MPD for normal adult male and female range from 15 – 30 secs Nataraja and Savithri (1990). Developmental changes have been reported in MPD at the age of 5 to 13 years the mean MPD for / a/ among girls between 5 – 5.11 years was 5.33 seconds which increased to 14.8 seconds in the girls between 12 – 12.11 years . Statistically significant increase in MPD was noticed till 8 yrs, after which there was no rise in MPD till 12 years. Venugopal, Rajsudhakar and Savithri (2005). Reduced MPD implies inefficient glottal control, faulty learned pattern of speaking or singing or neurologic involvement. Frequency of base note

In India it is the „sargam“ and in Western music/system it is known as „sol-fa „ system.It is the 1st „Sa“ that constitutes the basic of a person. Pitch or adhara Shadja/Adharaswara. „Sa“ then becomes the fixed or tonic note (adharashadja/sruti/swara) and all other notes are sung in relation to and relative to „Sa“.

Studies have revealed that female singers are found to use „sa“ at a lower frequency than males.Females are found to have lower base pitch Chandra (2001) ,than males.

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B. Singing Frequency Range

Singing frequency range is the span from the lowest to the highest note a person can create with their voice. In singing, pitch reaches one to one and a half octaves (1-1.5) in untrained voices and two to two and a half (2-2.5) octaves in trained voices; i.e., on the 8th or 10th note above or below the middle note Greene (1972). The frequency range of trained singers between 19 and 57 years of age are higher than untrained singers. The frequency range in trained singers was found to be 2 to 2.75 octaves whereas untrained was 1 to 1.5 octaves as reported by Sheela (1974).

Arnold (1962) states that “the untrained singing voice will have a range of one and half to two octaves or less, while the trained singers may exceed their limits by as much as an octave or more in some cases.

Significant effect of training were evidenced as changes in mean frequency range and minimum vocal intensity across frequency levels among trained singers observed as changes in Phonetograms Wendy Deleo Le Borgan PhD, Barbara D, Weinrich (2001). The mean maximum vocal intensity and nasalance remained unaffected following training. Fowler LP, Morris RJ (2007).

C. Singers' Formant

Bartholomew (1934) was the first to report on the singers' formant or the singing formant. Later Winkel commented on singer's formant Winkel (1952, 1953, 1954, 1956). The singers' formant is a spectrum peak. It is higher than normal amount of energy near the third highest vocal resonance (“formant”), or at roughly 3000 Hz Bartholomew (1934). The presence of singers formant was deeply investigated in North Indian Classical singing Senguptha (1990).

D. Vibrato

One of the specialties of singing voice is its natural vibrato. Vibrato is a musical effect used to add expression.

Saitou.T, and Gotu.M, (2009) studied the acoustic and perceptual effects of vocal training on amateur male singers revealed that the characteristics of 2 kinds of fundamental frequency fluctuations [vibrato and overshoot] and singing formant were changed by vocal training.

Practice leads to perfection works for every aspect of life. The measure of perfection differs for every act that is measured. The effect of practice/ training on singing has been extensively reviewed across the world using acoustic analysis. In India, a greater number of studies have been conducted on Carnatic singers than the Hindustani singers. Since both types of Indian classical singing differ significantly, in terms of rendering, repertoire, vocal technique & instruments used, both the styles need to be viewed discretely. Parameters studied extensively are MPD, vibrato, singers formant than “frequency of base note” and the “singing frequency range”.

To overcome the dearth of studies relating to Hindustani style of singing and effect of training on “frequency of base note” and the “fundamental frequency range”, the present study was undertaken. The objective of the study is to evaluate effect of training on trained Hindustani singers on

the acoustic parameters like “frequency of base note” and “fundamental frequency range”.

III. METHOD

A. Subjects

Trained Hindustani singers in the age range of twenty to forty years were chosen as subjects for the study. Twenty singers (males=10, females=10) with a training of six months to thirty six months formed Group A and twenty singers (males=10, females=10) with a training of thirty seven months to forty years formed group B.

B. Procedure

Subjects were asked to carry out two tasks for deducing the frequency of base note and fundamental frequency range using the sapthaswaras / seven notes. To deduce the frequency of the base note, the subjects were instructed to sing 'sa' 'pa' 'sa' by sustaining each swara / note as long as possible by imitating the researcher. For obtaining the fundamental frequency range, they were instructed to sing the sapthaswaras two octaves to the highest and to the lowest note the singer could produce by imitating the researcher. Two practice trials were provided for singers and the third trial sample was audio recorded using Audacity recording software with Plantronics Blackwire 220 microphone. The recorded data was transferred to PRAAT to extract the mean frequency of base note and minimum and maximum values of fundamental frequency range. Independent sample 't' test and Pearson's rank correlation were administered to find out significant difference between the two groups of subjects.

IV. RESULTS AND DISCUSSION:

A. Relation Between frequency of base note of Male Singers And Music Training More Than Thirty Six Months

Higher frequency of base note was found among male singers with more than thirty six months of music training as a significant difference was found ($P=0.032$) ($t=2.332$) between the means of frequency of base note in male singers in group A ($M=128.529$ Hz) and Group B ($M=142.203$ Hz).

TABLE I
MEAN, STANDARD DEVIATION, 'T' AND 'P' VALUES OF FREQUENCY OF BASE NOTE OF MALE HINDUSTHANI SINGERS BASED ON MONTHS OF MUSIC TRAINING.

Months of music training	Parameter	N	Min	Max	Mean	SD	t	p
Group A	Frequency of base note	10	104.20	148.31	128.52	15.60	2.332	0.032
Group B	Frequency of base note	10	122.96	153.47	142.20	10.01		

Music training over months was found to contribute in increasing the frequency of base note ($r= 0.423$) ($p=0.063$).

TABLE II
'R' AND 'P' VALUES OF FREQUENCY OF BASE NOTE OF MALE HINDUSTHANI SINGERS WITH MONTHS OF MUSIC TRAINING

Frequency of base note	r	p
	0.0423	0.063

From the tables I and II it is found that frequency of base note of Male Hindusthani singers, was found to be increased as the period of training in music exceeds thirty six months.

1) *The reason for frequency of base note increase in males.*
 "Perceptually the pitch related factors like base pitch, vibrato and pitch range contribute maximum to the good loud projection of voice" (Devvuru & Savithri 2006). Thus, an increase in pitch would help them to project their voices better. "As mentioned earlier the voice projection is seen in Hindustani singers since the Hindusthani music like the Western music is a heterophonic or harmonic system and hence needs to require his or her voice to be heard over the orchestra" (Bhoominathan 2004) leading them to use higher pitch during their singing. Hence it could be the influence of training which lead to the use of a higher frequency of base note in male Hindusthani singers with greater than thirty six months of music training.

B. Relation Between frequency of base note of Female Singers And Music Training More Than Thirty Six Months.

In case of female Hindusthani singers the results reveal that there exists no significant difference ($P=0.803$) ($t= 0.253$) between the means of frequency of base note in female singers with music training less than thirty six months ($M=210.515$ Hz) and in female singers with music training greater than thirty six months ($M=212.394$ Hz.) as the p value is greater than 0.05.

TABLE III
MEAN, STANDARD DEVIATION, 'T' AND 'P' VALUES OF FREQUENCY OF BASE NOTE OF FEMALE HINDUSTHANI SINGERS BASED ON MONTHS OF MUSIC TRAINING

Months of music training	Parameter	N	Min	Max	Mean	SD	t	p
Group A	Frequency of base note	10	174.46	240.53	210.51	20.98		
Group B	Frequency of base note	10	194.64	232.0	212.39	10.52	0.253	0.803

The results of the correlation between months of music training and frequency of base note of female Hindusthani singers revealed that there exist a poor correlation between

the frequency of base note ($r= -0.064$) ($p=0.790$) and months of music training .

TABLE IV
'R' AND 'P' VALUES OF FREQUENCY OF BASE NOTE OF FEMALE HINDUSTHANI SINGERS WITH MONTHS OF MUSIC TRAINING

Frequency of base note	r	p
	-0.064	0.790

Table number III and IV analyses that the study conducted among female Hindusthani singers regarding the relation between the months of training and frequency of the base note. and there is no significant increase in frequency of base note even after more than thirty six months of training in Music.

1) *The reason for frequency of base note remains unchanged in females.*

The reason could be that already the frequencies of base note of females are in a higher pitch level and further increase in frequency of base note due to training may lessen the singing range of females since while singing they need to reach a higher pitch level or a higher note than male singers .Hence the female singers especially the trained group of singers might pay a conscious effort in not to increase the frequency of base note.

This result is supported by the study done by Ranjini M (2010) who obtained no significant difference in frequency of base note for trained vs beginning female Carnatic singers .Usually music teachers do not select an appropriate base pitch as relevant to the physique of the student. Therefore it cannot be expected that the frequency of base note will be different in two groups of subjects

C. Relation Between Fundamental frequency range of Male Singers And Music Training More Than Thirty Six Months.

Table V analyses that there exists a significant difference ($P=0.002$), ($t=3.597$) between the means of fundamental frequency range of male singers with less than thirty six months of music training ($M=284.606$ Hz) and in male singers with training greater than thirty six months ($M=344.225$ Hz) as the p value is less than 0.05.

TABLE V
MEAN, STANDARD DEVIATION, 'T' AND 'P' VALUES OF FUNDAMENTAL FREQUENCY RANGE BASED ON MONTHS OF MUSIC TRAINING

Months of music training	Parameter	N	Min	Max	Mean	SD	t	P
Group A	F0 range	10	241.58	321.38	284.60	26.06		
Group B	F0 range	10	275.16	425.41	344.22	45.47	3.597	0.002

TABLE VI
'R' AND 'P' VALUES OF FUNDAMENTAL FREQUENCY RANGE OF MALE HINDUSTHANI SINGERS WITH MONTHS OF MUSIC TRAINING

Fundamental frequency range	r	P
	0.522	0.018

The analysis of Table VI reveals that in male singers who had music training for more than thirty six months the fundamental frequency range was higher than in male singers who had music training less than thirty six months.

D. Relation Between Fundamental frequency range of Female Singers And Music Training More Than Thirty Six Months

TABLE VII
MEAN, STANDARD DEVIATION, 'T' AND 'P' VALUES OF FUNDAMENTAL FREQUENCY RANGE BASED ON MONTHS OF MUSIC TRAINING

Months of music training	Parameter	N	Min	Max	Mean	SD	t	P
Group A	Fundamental frequency range	10	244.71	407.46	343.49	54.55		
Group B	Fundamental frequency range	10	338.7	454.48	418.81	39.41	3.539	0.002

Table VII analyses that there exists a significant difference ($P=0.002$), ($t=3.539$) between the means of fundamental frequency range of female singers with less than thirty six months of music training ($M=343.49$) and in female singers with training greater than thirty six months ($M=418.81\text{Hz}$) as the p value is less than 0.05.

The above results thereby imply that in female singers who had music training for more than thirty six months, the fundamental frequency range was higher than in female singers who had music training less than thirty six months.

TABLE VIII
'R' AND 'P' VALUES OF FUNDAMENTAL FREQUENCY RANGE OF FEMALE HINDUSTHANISINGERS WITH MONTHS OF MUSIC TRAINING

Fundamental frequency range	r	P
	0.565	0.009

It can be inferred from the above table that, as the months of music training increased a corresponding increase was observed in the fundamental frequency range of female Hindusthani singers.

1) Common Reason For Fundamental Frequency Range increase in males and females.

The reason for the increase in the fundamental frequency range of female singers could be attributed to the fact that a well trained singer will be having a good coordination between the muscles of the larynx and the respiratory system and hence will be having a well controlled movement of the pitch raising and lowering mechanism. To a little extent physiologic changes might contribute to this increase in frequency of base note. In the middle ages the ossification of laryngeal cartilages occurs and these changes can improve the singing voice in some since a more bony support framework in the larynx better supports the tension in vocal folds quiet similar to the case of a piano in which the strings are attached to a solidly anchored metal posts at each end allowing the piano strings to stay in tune & make a predictable sound. At younger ages when flexible cartilage supports the vocal folds, there is a greater chance of unpredictability, but in stiffer bony supports, it is logical that the voice could perform more reliably (Proctor 1980).

V. CONCLUSION

Training is found to have significant positive effects on the singing voice by aiding them to achieve an appropriate frequency of the base note enabling them to project their voice effectively. The frequency range was found to get extended helping them to span over a wide range of octaves and sing at the extremes of their ranges with greater ease. For the effects of music training to be evidenced on the acoustic parameters, more singers with greater years of music training should be evaluated. Evaluations of the ornamentations used in Hindusthani style of singing could also be carried out. The changes in the laryngeal biomechanical during singing and through the course of training can also be evaluated.

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