

**AN INVESTIGATION OF RELATIONSHIP BETWEEN NOTES, SCALES,
SWARAS, OCTAVES AND THEIR CORRESPONDING FREQUENCIES**

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May 2018**

CERTIFICATE

This is to certify that this dissertation entitled “**An Investigation of Relationship Between Notes, Scales, Swaras, Octaves and their Corresponding Frequencies**” is the bonafide work submitted in part fulfillment for the Degree of Master of Science (Speech Language Pathology) of the student with Registration No: **16SLP022**. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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This is to certify that this dissertation entitled “**An Investigation of Relationship Between Notes, Scales, Swaras, Octaves and their Corresponding Frequencies**” has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru, April 2018.

Dr. K.Yeshoda,

Guide,

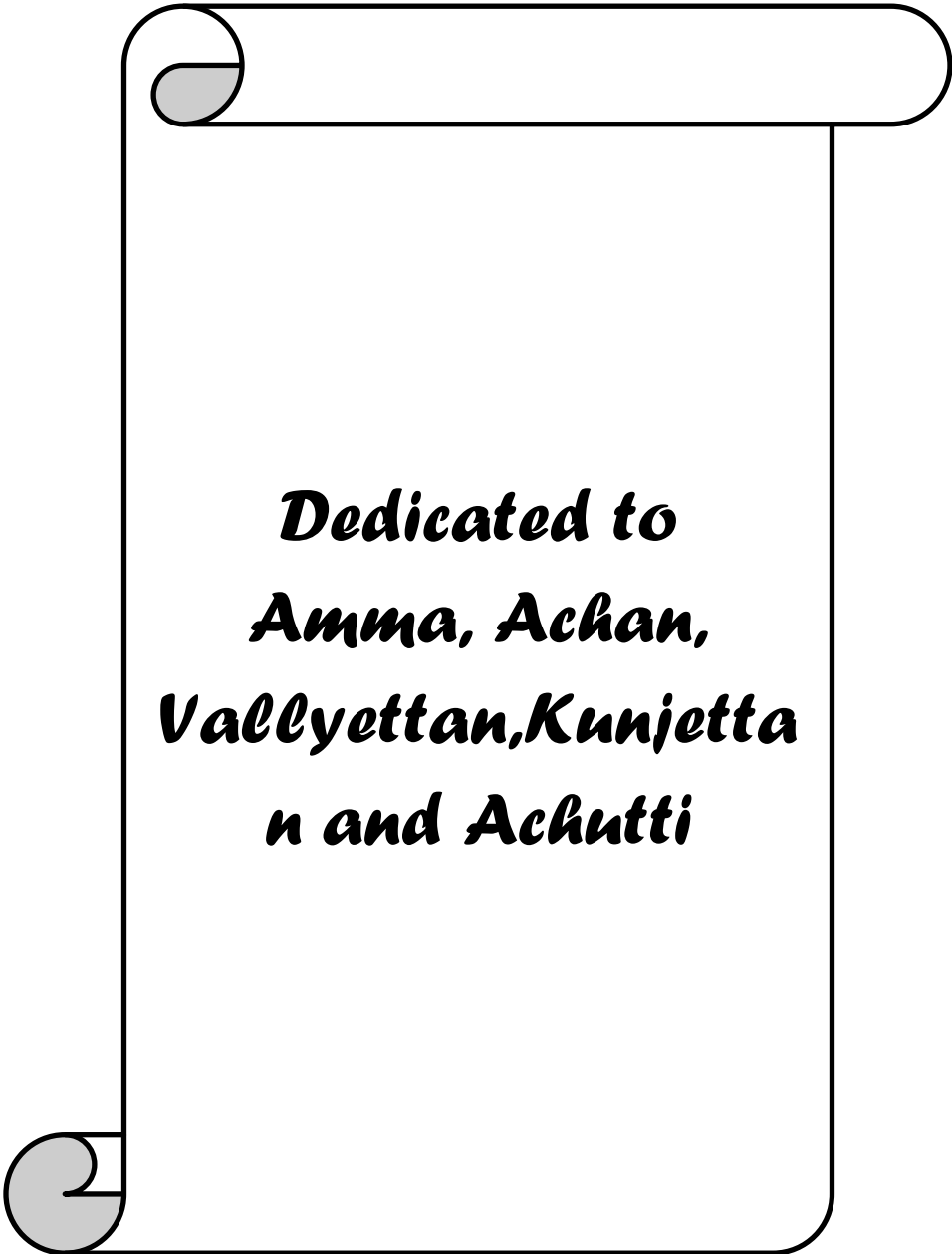
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DECLARATION

This is to certify that this Master's dissertation entitled "**An Investigation of Relationship Between Notes, Scales, Swaras, Octaves and their Corresponding Frequencies**" is the result of my own study under the guidance of Dr. K. Yeshoda, Reader in Speech Language Sciences, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in other University for the award of any Diploma or Degree.

Mysuru, April 2018.

Register No: 16SLP022



***Dedicated to
Amma, Achan,
Vallyettan, Kunjettan
and Achutti***

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“The individual is the passenger in the car of the material body, and intelligence is the driver. Mind is the driving instrument, and the senses are the horses. The self is thus enjoyer or sufferer in the association of the mind and senses” (6.34 purport, Bhagavad Gita).

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CHAPTER I
INTRODUCTION

The human voice: It's the instrument we all play.
It's the most powerful sound in the world, probably.
It's the only one that can start a war or say 'I love you.'

-Julian Treasure

Despite the information explosion in written, printed and digitized/computerized recordings, most people use their voice as their primary mode of communication and occupation. Voice is one of the most magical things humans possess. The multitudes of productions, the variability in emotions, the transition of meaning that a slight change in voice can bring about has inspired so many researchers over the decades. Singing is defined as a sensory motor phenomenon that requires particular balanced physical skills (Bunch, 1982). One of these unique groups of professional voice users are singers, who are also perhaps the most affected even by the subtle changes in their voices (Benninger and Murry, 2008). A singer learns to mold his/her skills and create a pleasant ambiance for themselves and the listeners. And gifted are those who can control this blend of physiological functions that include respiration, phonation, articulation, resonance, and audition to produce an infinite number of vocal timbres unique to an individual.

The kinesthetic control a singer achieves over years of training and experience is reflected in the singing voice as well. Sundberg (1994) stated, “The singer must gain control over all perceptually relevant voice parameters, so that they do not change by accident and signal an unintended boundary”.

Singers of today, in India, prefer to base their singing on scales, notes, and octaves of music thus reflecting the adoption of Western terms into the Indian Classical music system. Such an espousal makes it easier for the singers to perform in unison with the accompanying instruments, as most of the instruments are played on the basis of Western music genre.

India has been renowned for its musical culture. It is believed to have its root in Sama Veda and thus is an expression of the aura of Indian civilizations. The major forms of Indian Classical music are Hindustani and Carnatic styles. In general, they have the same basis being melodic and governed by the rules of raga and tala. One of the major concerns for a classical Carnatic singer is the drone note that will be constant in the background or the ‘Thambura Shruthi’ that is played according to the base pitch or ‘Adhara Shruthi’ of the Singer. In Indian classical music, the base note – ‘Sa’ or the ‘Adhara Shruthi’ is not of a constant pitch unlike the ‘C’ in Western music, which is defined as a pitch of fixed number of vibrations (cited in Arushi Chandra, 2001).

The singers of today depend on an external reference to base their pitch level for singing. Majority of the singers are accustomed to shruthi box, that uses the Western notations like A, B, C, C#, D, D#, E, F, F#, G, G#, A# for referring to the particular pitch at which they are singing rather than a thambura.

While in Carnatic music, the sung 'Sa' and their corresponding frequencies depend on individual singers, their 'Adhara Shruthi', their vocal tract and other intrinsic characters. Hence, the 'Sa' sung by an Indian Carnatic Singer is at relative pitch levels rather than absolute pitch levels of the notations they are keeping the reference as. In Indian music, the music teachers allude to the 'sapta swaras' – Sa Re Ga Ma Pa Dha Ni. Singers often explicitly speak out the names of these swaras while singing, but the literature has no straight forward mapping from these onto the notes played on an instrument. The concept of scales and notes are poles apart from the Western music genre. The concept of notes is completely absent and scales are used interchangeably with notes in the Indian classical music system (Anindhya, 2013).

1.1 Need for the study

To render services to professional voice users like singers, a Speech Language Pathologist (SLP) should be aware of not only the principles of anatomy, physiology, and pathology of the voice, but also should know to relate the voice produced to the scales, notes, swaras and corresponding frequency notations. A comprehensive understanding of the differences in voice production in relation to scales and notes is important to address the singer's voice needs.

The major complaints by singers when they report to a Speech Language Pathologist (SLP) may be a shift in the scale in which they are singing, difficult to voice out certain notes while singing, strenuous shift from the comfortable (mandhyaasthaayi) to the higher (tharasthaayi) and lower (mandrasthaayi) pitch levels or registers, decreased breath support in completing the swaras etc. These complaints in singer's language can be a shift from F to G scale, difficulty in reaching the lower octave 'Sa', strenuous completion of the notes in a single breath and so on. A SLP from a non-music background would find it difficult to understand the complaints raised and in turn, the therapeutic management of the issues raised can become even more erroneous. Thus, an understanding of the basic terms and relating those to the acoustic measures used by SLP treating a singer with a voice complaint is required. Here, an attempt is made to resolve the confusions in comprehending the different terms of vocal music used by singers. And also explaining their equivalencies in frequencies is attempted.

CHAPTER II

REVIEW OF LITERATURE

The Indian music as we know today has had a long and incessant history which has been enriched with the years of civilizations and cultures that perished centuries ago. The origins of Indian classical music lie in the cultural and spiritual values of India and go back to the Vedic Age (Sama Veda). The art itself was called ‘Sangeet’ that included vocal music, instrumental music, and dance. The art of music was regarded as holy and heavenly. The receivers not only gained aesthetic pleasure but also an induced joyful religious discipline. Subsequently this art branched off into three separate streams: vocal music (geet), instrumental music (vadya), and dancing (nritya) (Chakraborty, Mazzola & Tiwari, 2014).

Vocal music involves a lot of intricate components. These components blend together and present the listeners with sounds waves that bring them sheer pleasure. There are numerous studies carried out in understanding the role of different components of music.

2.1 Components of Vocal Music

A sound that we hear to be pleasing and to be identified as music must have some characteristic features. These features differentiate the speech of an individual from a *kriti* that he sings. The material essence of music lies in its melody, harmony, and rhythm. Melody gives music the soul, while rhythm blends the expression of harmony and dynamics with the tempo of the passage. Melody, a linear sequence of

musical tones is perceived as a single entity. On the other hand harmony uses a vertical, i.e. simultaneous use of tones of different pitches. Rhythm is the temporal pattern successive melodic or harmonic patterns or weak/strong elements to create an expression (Vijayakrishnan, 2007).

Music is considered as a language of communication of the soul. And like any other language, music also has its basic elements. Chakraborty et al., (2014) suggested that these elements have its foundation on two primary sources of knowledge which include the acoustic and the semiotic. Acoustic based units are notes, scales, timbre, laya, tala etc. The semiotic units are phrases, vadi-samvadi relations (vadi refers to the most important note in a raga; samvadi refers to the second most important one), syntax, grammar, pragmatics, semantics, etc.

Studies carried out on the semiotic units of Carnatic music suggest that the general architecture of language and music are similar and the major concern is in comprehending the systematic relation between the sound and the meaning. In language, the auditory input of a lexicon is bifurcated into its constituent phonemes and then linked to its semantic correlate while, in music the represented notations are linked to its pitch correlates. Both language and Carnatic music require mechanisms to interpret sound/pitch on the one hand and evaluate the interpreted sound sequence for grammaticality and meaning properties on the other hand. Pitch is usually evaluated using musical scales and language interpretation is based on emotion, prosody, diction, meaning, audition, listeners' reactions, etc.

2.2 Musical Scales

The interval between the notes depends upon the scale which is chosen. The major types of scales include,

Pythagorean – derives all notes from the circle of perfect fifth. For example – the major third is the fourth fifth above the pre-determined tone reduced to the proper octave Mason(1960). The scale tones are derived by piling pure fifths on top of each other i.e., by repeatedly multiplying the frequency by 3:2. When the pile is seven steps high all tones in the diatonic scale are included. Then all tones are brought down to the same octave by halving the frequencies a proper number of times (Sundberg, 1982).

Just intonation – This system of tuning in effect undertakes to make use of all perfect intervals of the harmonic series. It is a system of tuning based on true ratios of intervals, as opposed to equi-tempered tuning (Mason, 1960).

Equi-tempered – A division of octave interval into twelve equal tones (Mason, 1960). In this scale the octave interval is divided into 12 equal intervals. All the intervals have exactly the same frequency ratio $2^{1/12}:1$.

2.3 A Comparison between Indian and Western Music

While the western classical music system insists on machine-like precision in determining fundamental frequencies for its notes, its Indian counterpart, shows a liberal and human approach while dealing with the rendering of swaras in raga elaboration. Melody and rhythm are the common grounds for music, be it Western or Indian. Indian music is essentially monophonic (single melody format) while Western music can be polyphonic (multiple notes played or sung in harmonized unison), monophonic or a combination of both. Western classical music is based upon the equal tempered scale, and rests upon melody, rhythm, harmony and counterparts while, *swara* and *taal* are the two basic components of Indian classical music. Swaras are the twelve notes, while a *taal* is a cycle of beats, starting with a stress point called the *sam* and with a release point called the *khali*. It is this (the *sam&khali*) that brings life to a *taal* (Datta, Solanki, Sengupta, Chakraborty, Mahto&Patranabis, 2017).

As cited in Vijaya (1994) the history of Carnatic music can at best be traced to the early or middle of the eighteenth century. The basic elements of Carnatic music, the swaras occupy specific points in the pitch space. The location of the particular swaras in this wide pitch space is rote for a trained Carnatic singer and is presented with precise accuracy. The earliest systematic work in the theory of Indian music was by Bharathamuni in 200 A.D. He varied the tension of a veena string and studied the perceptual variations of the tones produced. He described a 22- point

shruthi scale in his book ‘Natyashashtra’. The varieties of these swaras are as follows:-

Table 2.1: *Varieties of Swaras in Carnatic Music*

Basic swara	Name of the variety	Denoted as
Sa	Shadja	S
Ri	Shuddha Rishabha	R1
	Chathushruthi Rishabha	R2
Ga	Sadharna Gandhara	G1
	Antara Gandhara	G2
Ma	Shudhsha Madhyama	M1
	Prati Madhyama	M2
Pa	Panchama	P
Dha	Shuddha Daivata	D1
	Chathushruthi Daivata	D2
Ni	Kaisiki Nishadha	N1
	Kaakali Nishadha	N2

Bhatkande (1923) and later, Sambamoorthy (1963) gave the frequency values of each of these 12 swaras:

Table 2.2: *Values Given by Bhatkande (1923) and Sambamoorthy (1963)*

NOTES	Values given by			Freq. ratio
	<i>Bhatkande</i> (1923)	<i>Sambamoorthy</i> (1963)		
	Hz	Hz	Cents.	
S	240	240	0	1
R1	254 – 2/17	252.8	90	256/243
R2	270	270	204	9/8
G2	288	288	316	6/5
G3	301 – 14/17	300	386	5/4
M1	320	320	498	4/3
M2	328 – 14/17	337.5	590	45/52

P	360	360	702	3/2
D1	381	379	792	128/81
D2	405	405	906	27/16
N2	432	432	1018	9/5
N3	452 – 4/43	450	1088	15/8
S	480	480	1200	2

The study carried out by Sambamoorthy (1963), on the swaras produced by the string instruments revealed that in an equally tempered pitch scale (as in Carnatic Music), the relation between adjacent notes is 1:1.05946 and that each point in the scale is 81/80 higher than the previous one.

There are studies carried out on the Singers' voice that can produce such minute variations in the pitch with utmost perfection, abiding to the rules of melody. An attempt to find the fundamental frequency relation between swaras of Carnatic vocal music was done by Vijaya (1994). A sample of all swaras at the three registers: low, mid and high was recorded and the samples were analyzed for its fundamental frequency in Hz and semitones. The fundamental frequency relation between the adjacent swaras was found to be 1:1.056143 when calculated in hertz and 1:1.022583 when calculated in semitones. This ratio was found to be unaffected by the presence or absence of drone note or the vocal register in which they were singing.

Prashanth & Venugopalan(2011) studied the relative ratios of the twelve swarasthanas. The mean frequency of the regions selected by the heuristic algorithm is mapped on to the corresponding note if it lies within an experimentally determined

range around the flat frequency of the note. The same is represented in the table below.

Table 2.3: Frequency Ratios of Swaras Given by Prashanth&Venugopalan (2011)

Swara	Key	Ratio	Swara	Key	Ratio
S	C	1	M2	F#	27/20
R1	C#	16/15	P	G	3/2
R2	D	10/9	D1	G#	8/5
G2	D#	6/5	D2	A	5/3
G3	E	5/4	N2	A#	16/9
M1	F	4/3	N3	B	15/8

Unlike western music, where the note frequencies are fixed (scale), Indian music gives room for the singer to choose a suitable base frequency for the scale. This is called *Adhara Shadja*. The *Adhara Shadja* varies even for a particular singer, for different renderings of the same *raga*. All notes get fixed with respect to the base frequency. In Carnatic music, the whole *raga* structure is later built by the artist to suit the *sahitya* and *bhava*. The table below gives the names, position and notation for the *swaras* in Carnatic music (Ranjani, Arthi & Srinivas 2011)

Table 2.4: Names, Position, Notation and Frequency Ratios given by Ranjani et al., 2011

Pos	Swara name	Label	f.r.(C)	f.r.(W)
1	<i>Shadja</i>	S	1.000	1.000
2	<i>Suddha Rishabha</i>	R1	1.067 (16/15)	1.059
3	<i>Chatushruthi Rishabha</i>	R2	1.125 (9/8)	1.122
4	<i>Shatshruthi Rishabha</i>	R3	1.200 (6/5)	1.189
3	<i>Suddha Gandhara</i>	G1	1.125 (9/8)	1.122
4	<i>Sadharana Gandhara</i>	G2	1.200 (6/5)	1.189

5	<i>Andhara Gandhara</i>	G3	1.250 (5/4)	1.259
6	<i>Suddha Madhyama</i>	M1	1.333 (4/3)	1.334
7	<i>Prati Madhyama</i>	M2	1.416 (17/12)	1.414
8	<i>Panchama</i>	P	1.500 (3/2)	1.498
9	<i>Shuddha Daivatha</i>	D1	1.600 (8/5)	1.587
10	<i>Chatushruthi Daivatha</i>	D2	1.667 (5/3)	1.681
11	<i>Shatshruthi Daivatha</i>	D3	1.800 (9/5)	1.781
10	<i>Suddha Nishadha</i>	N1	1.667 (5/3)	1.681
11	<i>Kaisiki Nishadha</i>	N2	1.800 (9/5)	1.781
12	<i>Kaakali Nishadha</i>	N3	1.875 (15/8)	1.887

Chakraborty et al., (2014) pointed out that the hallmark of Indian music is the limitless field it offers for improvisation and virtuosity. It is not orchestrated, and is not written down, unlike Western music. While the framework imposes great discipline, within the area, the performer can bring his or her genius into full play. Here the performer endeavors to gain a spiritual experience, a tryst with God. Hence, the capabilities of each singer may be different and varied. This is credited as a talent which is honed to perfection with training and practice but at the same time can pose an issue when voice problems arise. Professionals dealing with the assessment and management of voice problems in singers may be non-singers with no exposure to music. A communication gap develops between the singer with a voice problem and a professional who is a non-musician. The gap has to be bridged wherein a common arena is created with exchange of information among musicians and professionals.

Indian music gives each singer the flexibility for improvisation and virtuosity and this in turn, has led to myriad of variations across singers. Hence, an attempt is

made to understand the different terms used by Carnatic singers and compile the similarities and differences so as to enable Speech-Language Pathologists to comprehend the complaints and be aware of the terminologies used by the singers. This would help an SLP to ensure quality services and meet the needs of a singer during assessment and management which may include finding the comfortable pitch to sing in, expand the range, to ease the shift between the registers, and so on.

Aim of the study

To understand the relation between the notes, scales, swaras, octaves, and their corresponding frequencies.

Objectives of the study

1. To investigate the meanings of the terms notes, scales, swaras and octaves as described by trained classical Carnatic singers.
2. To associate the sung notes, scales, swaras and octaves to their corresponding frequencies.

CHAPTER III

METHOD

The main objective of this study was to investigate the meanings of the terms- notes, scales, swaras, and octaves and to associate the sung notes, scales, swaras and octaves to their corresponding frequencies.

3.1 Participants

A total of 60 participants from 3 regions – Kerala (Ernakulam& Palakkad), Karnataka (Mysore) and Tamil Nadu (Coimbatore) were selected comprising of 10males and 10 females in each group who were classical Carnatic singers. The participants were within the age ranges of 25-50 years (mean age: male= 29.7years; female = 31.96years). The demographic details regarding age, education, occupation and singing training, that is, details of years of training, hours of practice per day were obtained using a semi structured interview.

The subjects fulfilled the following inclusion criteria:-

1. Minimum of 10years of music training.
2. Involved in regular practice and singing in classical Carnatic style.

Precautions were taken to exclude participants with noticeable voice changes using informal perceptual screening. None of them had any recent history of ear, nose or throat problems at the time of recording.

3.2 Procedure

All the subjects participated in the following two tasks in a quiet environment. The tasks were:

1. Questionnaire: A questionnaire was formulated which encompassed a total of 15 open-ended questions directed at a singer's perception of terms such as, scales, notes, swaras and octaves. Validation of the questionnaire was done by 3 qualified SLPs, who were also trained classical Carnatic singers. The questionnaire was administered individually, through a direct interview method. The interview sessions were audio recorded.
2. Singing: The subjects were asked to sing the madhyasthaayi 'shadja' (base 'Sa') at the different pitch levels ranging from –A#, B, C, C#, D, D#, E, F, F#, G, G#, A. The drone note was given using the Tanpura Droid v 1.3 – android application. The audio recording of the singing sample was done using the digital recorder Olympus LS-100. The microphone was positioned at a distance of 10cms from the subject's mouth. The subjects were instructed to listen to the drone note at the mentioned pitches and then sing the madhyasthayi shadja at the same pitch level. All the recordings were made in a quiet environment.

3.3 Analysis

Questionnaire: Audio recordings of the direct interviews transcribed verbatim and analyzed individually and then compiled for commonalities and/ differences. The terms – notes, scales, swaras, and octaves as described by the subjects were summarized.

Singing analysis: The audio samples were transferred on to a Sony-vaio laptop with a 64-bit operating system –x64 bit processor. The audio samples were stored separately for each subject onto the laptop memory at mono-channel, 16-bit resolution and 44 kHz sampling rate using PRAAT 5.2.01 software (Boersma & Weenick, 2009).

After eliminating the initial and final portions of the recordings, mid three seconds duration of the recording was used for the analysis. This was done to avoid the influence of voice onset and offset on the acoustic analysis. The fundamental frequency of the phonation at all the 12 pitch levels sung by the 60 subjects was extracted separately using the PRAAT software.

Statistical Analysis: Descriptive statistical procedures (arithmetic mean and percent) were used to analyze the derived mean of the frequencies obtained of the Madhyasthayi Shadja sung at all 12 scales and an equivalency table was derived. Also, a frequency ratio of the initial lowest pitch level (A# according Tanpura Droid v 1.3) and each successive pitch levels were calculated.

CHAPTER IV

RESULTS AND DISCUSSION

The study aimed to investigate the relation between the terms notes, scales, swaras, octaves and their corresponding frequencies. The study was carried out to understand these terminologies and check for consensus among the different classical Carnatic music regions which included Kerala, Karnataka and Tamil Nadu. The results are presented and discussed according to the objectives.

1) The first objective of the study was to investigate the meanings of the terms notes, scales, swaras and octaves as described by trained classical Carnatic singers. The 14 open ended questionnaire gave the participants the freedom of expression and they were able to impart the information to the fullest of their capability. There were more individualistic variations than the regional variations that were received from the participants. The responses of all the participants were transcribed verbatim and analyzed individually and then compiled for commonalities and/ differences. The common terms, phrases and sentences used in the responses were compiled, tabulated and percentage calculated. Elaborate descriptions are summarized and presented. The details of the compilation are elaborated below.

1) **Notes**: 95% of the participants opined that notes are the western equivalent of the term 'swaras' that are used in Indian classical music system. They explained the term as particular points in the pitch space which was very much similar to the concept of swaras in the Indian music system. However, 5% of the participants proposed that the concept of notes and swaras are very much intertwined, but they are not the

same. Participant no.5 of the Kerala region suggested that note can be defined as a 'sound' as the very basic definition of itself. A sound which has its own characteristic frequency and intensity can be a note. But when a note is assigned to a particular point in the pitch space such that it adorns a characteristic pleasantness it becomes different from just a note and becomes a swara. According to the participant's own perception, if ten notes are aligned together, one will be able to sing it or play it, but it need not be necessarily musical. Participant no.8's view from Kerala belt was similar to participant 5 and seemed to support this view. He proposed that every sound can be taken up as a note. The frequency attributes of that particular sound can categorize it into a note or a swara. The participant also opined that difference between a note and a swara can be understood from the phrase – 'Hitting the notes, but missing the music', notes when enhanced with its musical pleasantness becomes swaras.

Participant no.1 of the Karnataka belt proposed that any sound that has a particular location in wide pitch space is termed as a note. When these particular locations are defined more with respect to minute changes it can undergo, then a note becomes a swara. Participant 2 of Karnataka state suggested that similarities between a note and a swara can be clearer when a singer has knowledge about the way an instrument has to be played.

As mentioned by Chakraborty et al., (2014) notes form one of the basic components of the music. But, in Indian music, the music teachers allude to the

‘sapta swaras’ – Sa Re Ga Ma Pa Dha Ni. Singers often explicitly speak out the names of these swaras while singing, but the literature has no straight forward mapping from these onto the notes played on an instrument (Anindhya, 2013). This indicates that there are subtle differences between a note and swara and a singer learns to comprehend the differences only after considerable mastery in singing. Not all singers may be able to delineate the subtleties.

2) **Swara**–All the participants despite the regional variations had similar view points on the term ‘swara’. 31.6% of the participants proposed that there are 22 *shruthis* and 7 *swaras* mentioned in ‘*Natyashastra*’. And when there are further variations, there will be 12 *Swarasthanas* which are identified just based on the difference in pitch or frequency levels.

All the participants commented about the ‘*Saptaswaras*’ of the Carnatic music system- Sa Re Ga Ma Pa Dha Ni and the varieties of these swaras. The responses of the participants are tabulated below in table 4.1.

Table 4.1: *Compilation of the basic swaras, nomenclature and denotation.*

Basic swara	Name of the variety	Denoted as
Sa	Shadja	S
Ri	Shuddha Rishabha	R1
	Chathushruthi Rishabha	R2
Ga	Sadharna Gandhara	G1
	Antara Gandhara	G2
Ma	Shudhsha Madhyama	M1
	Prati Madhyama	M2
Pa	Panchama	P
Da	Shuddha Daivata	D1
	Chathushruthi Daivata	D2
Ni	Kaisiki Nishadha	N1
	Kaakali Nishadha	N2

This was in consensus to the results of Vijaya (1994) and Ranjani et al., (2011). These swaras increase in the pitch levels or frequency levels as they progress from the Shadja to the Kaakali Nishadha in the pre-determined frequency ratios. Among the different varieties of swaras that exist, Participant no.2 from Karnataka proposed that the swara ‘*Shadja- Sa*’ is considered as the ‘*samasta swara*’ – the ‘*swara janani*’. The participant further proposed that the Sama veda talks about the different kinds of swaras that exist in the nature. Some of them being - *eekaswara*, *dviswara*, *triswara* and so on, which are referred to as *archika*, *samika*, *gahatika* in the vedas. The sapta swaras that forms the base of the Carnatic classical music originated from these swaras mentioned in Sama veda. These sapta swaras combined in different permutations formed the multitudes of ragas and the ragas formed the basis of *varnas* and *kritis*.

Participant no.1 of Karnataka apprised that when notes are sung at a particular level in the pitch space they bring a charm to the sounds heard by the listener. These sounds that impart pleasantness to the listener can be categorized as ‘swaras’. To quote the participant’s own words –

“ *Thaanethaanagi beereyavarige keeluvaaga ranjane koduvantha dhwani.* ”

Participant no.5 of Kerala suggested that a note becomes a swara when the frequency or pitch level settles at an assigned scale and is within a framework of pitch and rhythm i.e, when a note becomes enjoyable to a listener it becomes a

swara. The participant also reports of swaras which are in reality not so musical like ‘*Vivaadi swaras*’, which occur in particular ragas and are said to be *vivaadi* or negative in relation to the other swaras of the raga. Singers take up different strategies like shortening the duration of the ‘*sahitya*’ to diminish this negative effect.

15% of the participants put forth the terms ‘*Prakruti swara*’ and ‘*Vikruti swara*’ to explain the swaras. Participant no.5 of Tamil Nadu described *Shadja- Sa* and *Panchama –Pa* as the ‘*Prakruti swaras*’ and the other swaras as ‘*Vikruti swaras*’. *Prakruti swara* has only one form of itself and *Vikruti swara* has different variations which may differ by minute pitch changes. The variety of swaras and their frequency differences can be identified from the table provided by Ranjani et al., (2011).

Frequency of the swaras

Majority (98.3%) of the participants reported to be unaware and to be less concerned about the frequency values of the swaras that they sang. The singers even at the under graduation level were not found to be aware about the physical characteristics of sound. This could be because, in most of the arts colleges, the practical performance is given more weightage than the theoretical knowledge of the singer.

Participant no.5 expressed his views about the frequency of the swaras sung as he was also an instrument (violin) player and thus had a better exposure to the

frequency values and variations of the played notes. The participant proposed that the violin strings are of the frequency; G around 195 Hz, D around 295Hz, A around 440Hz, E around 660 Hz if tuned. He opined that G, D and to an extent A matches the human singing frequency, while to match which E will be too difficult for the human voice. He also reported that when the sung notes are being matched with the played notes, he observed a decreasing distance between the finger placements of the adjacent swaras at the higher limit, which could be related to the increase in pitch production at higher frequencies.

Styles of Carnatic singing

Only 18.33 % of the participants related the different styles of classical Carnatic singing as the stylistic variations that can be followed and propagated by the disciples of a legend or individualistic styles that people put forth as '*manodharma*' in their singing. These stylistic variations majorly differ in the way the singers sing the swaras, not in terms of the '*swarasthanas*' or the assigned pitch spaces but in terms of the way they adorn their singing with intricate or smooth or simple to difficult flow of the *swaras* abiding to the rules of *raga* and *taala*. These different styles were termed as '*Bani*' by 8.33% of the participants. These different schools of music were based on the different south Indian Carnatic music legends like Muthuswami Dikshitar, ChembaiSwamy, Semmangudi, Swathi Thirunal, G. N. Balasubramaniam (GNB), Muthiah Bhagavata, etc. Participant no.6 from Tamil Nadu described the bani of Dikshitar as tough to learn and understand but brought sheer pleasure in the listeners. Participant no.7 of Karnataka described GNB's bani

to possess a lot of intricacies and to be rich in ‘*gamakas*’ (ornamental notes) and ‘*brigas*’ (vibrato).

But the majority, i. e., 81.66 % of the participants was unaware of the different styles of Carnatic singing. It was noticed that a large portion of this group were of younger age and hence with comparatively less number of years of singing experience. These participants also were of the view that Carnatic music abides by a number of rules and the experimentations that one could do should be adhering to these set of rules. Participant no. 9 of Tamil Nadu opined that Carnatic music doesn’t permit a singer to explore beyond the limit and the improvisations one introduces to a ‘*kriti*’ should be according to the rules of *raga* and *taala*.

3) **Scale** – The participants had three diverse views (responses) on the meaning of this term. One view was explained by 8.33% of the participants who opined that scale refers only to a set of swaras that are put together and are labeled as a ‘*raga*’ in Indian musical system. These participants proposed that a scale represents the ‘*aarohana*’ – the ascending order and ‘*avarohana*’- the descending order of a *raga*. The *aarohana* and *avarohana* of each *raga* will have a set of swaras that are unique to that particular *raga*. Specifically, Participant no.1 of Karnataka belt explained that there are 72 ‘*melakarta ragas*’ (fundamental melodic structures) that are ‘*sampoorna ragas*’ i.e., with all the seven *swaras*, one variation of a swara, constituting the *aarohana* and *avarohana*. For instance- ‘*Mayamalavagowla*’ has a scale constituting the swaras-

Aarohana- S R1 G3 M1 P D1 N3 S

Avarohana – S N3 D1 P M1 G3 R1 S

The participant further elaborated that there are other infinite number of ‘janya ragas’ which originated from the sampurna ragas, which doesn’t have all the swaras. The janya ragas are further classified into ‘shadava raga’ (6 swaras), ‘audava raga’ (5 swaras) and ‘swarantara raga’ (4 swaras). For instance, in ‘Mohana raga’, which is an audavajanya raga, the scale of the raga constitutes the swaras-

Aarohana - S R2 G3 P D1 S

Avarohana – S D1 P G3 R2 S

Participant no.15 of Tamil Nadu belt explained that the presence/absence of a particular variation of a swara determines the difference between two ragas. Presence/ absence of swara combinations accessorize the scale or raga with different colours and emotions. Participant no.6 of Tamil Nadu belt proposed that scale in Western music system is raga in the Indian music system. He explained giving examples like C major scale of Western music system is the ‘Shankarabharanaraga’ in Carnatic music system. He further proposed that almost all the ragas are represented as different scales in Western music.

The other view was expressed by 56.66% of participants who suggested that scales are the different pitch levels at which the singer bases his/her singing. Unlike the Western music system, the Indian classical music system uses the concept of

relative pitches rather than absolute pitch levels. The singers sing at different pitch levels/scales with reference to their singing as the '*Adhara shruthi*'. Among the 56.66% of participants there were some particular trends found in the usage of different pitch levels referred to as scales. The pitch levels ranged from A# B C C# D D# E F F# G G# A. The frequency levels increased from A# and reached the highest at A. So when a participant chose C, C#, D as his comfortable pitch levels/scales, he was expected to sing the pitch of C as his '*madhyasthayi shadja*', and build upon that and similarly with C# and D.

However, 43.33% of the participants agreed that scale was the raga of the Indian music system and also of scale referring to the pitch level or the *Adhara shruthi* of a singer. To quote participant no.6 from Kerala – “While in practical singing scale refers to the *adhara shruthi* of the singer, the pitch levels where the singer is the most comfortable to sing. In music theory, scales refer to the set of *aarohana* and *avarohana* of particular ragas.”

It was noted from the responses that the majority of the participants had at least three *adharashruthi* levels that were comfortable for them to sing. The female *adharashruthi* levels were reported to be F, F#, G, G#, A and the male *Adhara shruthis* were reported to be B, C, C#, D, D#. There were 3 participants who reported that they are able to sing at any pitch level according to the need of the song they sang. These participants were more influenced by the commercial film music and were of different opinion about the tradition of basing their singing on a constant two or three comfortable *Adhara shruthis* that suited their voice instead they believed in changing the *Adhara shruthis* to suit the songs they sang.

The scales as in the pitch levels that singers used ranging from A to A#, is different from the notes that Western music uses, though they are represented similarly. Participant no.8 pointed out that the term scales that Indian singers use to represent the Adhara shruthis are different from the actual scales of the Western system. In Western music system, scales will be represented as C scale, C major scale etc. and there will be a set of notes that make up the C major scale. But in Indian music system, when scale is referred to as the pitch level or adharashruthi, we refer to the different notes like - C, C#, G, G# - that are used to sing and not the real scales as such. These observations are in agreement with that of Anindhya, (2013).

4) **Octaves** –All (100%) the participants proposed that octave is the ‘sthaayi’ of the Indian music system. Each octave or sthaayi comprises of 7 swaras and 12 swara sthanas. The participants also proposed that there are 5 octaves audible to human beings and listed them as,

-Anumandrasthaayi

-Mandrasthaayi

- Madhyasthaayi

-Tharasthaayi

- Athitharasthaayi

Among these only middle three octaves – Mandra, Madhya and Tharasthaayis - are achievable by the human voice. The other two extremities are produced only on instruments. Participant no.1 of Karnataka explained ‘*Sangeetha*’ as a ‘*Samyakgeetha*’ in which different kinds of sounds are collate together. All the

different productions in different octaves or sthaayis are brought together and presented to the listeners in a space made of pitch and loudness.

Further, Participant no.5 pointed out that the octave differentiated singing is more common in Western music system. The participant gave the example of a Western Symphony, where the singers and instruments occupy spaces according to the octave they sing or play. She compared this concept with the Carnatic classical music, in which each singer is expected to sing at all the three octaves with equal competence.

Registers in singing

The participants' opinions were sought about the usage of the falsetto and fry registers during singing. 25% of participants answered that the use of falsetto and fry is not allowed in the Carnatic music system. The rules of the Carnatic music compel the singer to sing in their modal register and to make use of the open throat singing through the swaras of all the three octaves. Majority of these participants were older in age and were also comparatively with more number of years of experience in traditional Carnatic classical singing.

Remaining 75% of the participants opined that singing full throated especially at high pitch levels could create vocal trauma and hence, they sought to shift to the falsetto register at pitch levels that are near the physiological limits of the voice apparatus. 3 of these participants specifically, admitted that they always shift to the falsetto register when there are swaras in the tharasthaayi to be sung. The rest of participants who used falsetto reported that the swaras adjacent to panchama in tharasthaayi were usually sung by shifting to falsetto register. The tharasthaayi swara

where the shift happens also depends upon the adhara shruthi chosen by the singer as reported. None of the participants reported using fry register in singing

Octaves in singing

3.33% of the participants reported that they have a range of full three octaves and demonstrated by singing them. Auditory analysis of the sung utterances by the experimenter revealed that the participants used falsetto at the higher tharasthaayi swaras. These participants also proposed that with regular practice one can reach the ideal condition of having a range of full 3 octaves with all swaras sung at the modal register. 96.66% of the participants reported that they had a range of around 2 octaves, ranging from tharasthaayi panchama, full madhyasthaayi and till, and mandrasthaayi panchama. 3 participants reported no use of falsetto or fry while singing within the 2 octaves range. But others confessed that the 2 octave range involved use of falsetto.

Participant no 12 of Kerala belt opined that the use of falsetto should not be discouraged if the flow of the shift from modal to falsetto is smooth. Participant no.5 of Karnataka belt proposed that the use of falsetto actually imparts a touch of sheer melody to notes sung at high pitches.

In summary, the terms notes, swaras, scales and octaves are inter-dependent and hence have many shared characteristics. It is the experience, exposure to instrumental music, practice and versatility in combining skills of vocal apparatus, audition, music and personal preference of the idol and following of the idol's style

and adapting these intricacies into one own singing that is responsible for the views of the singers.

II) The second objective of the study was to associate the sung notes, scales, swaras and octaves to their corresponding frequencies. The sung utterances were subjected to PRAAT analysis and frequency information was noted. The same was compiled using descriptive statistics to extract the mean and standard deviation using MS Office Excel.

The arithmetic mean of all the fundamental frequency values of the madhyasthayi shadjas are represented in the form of an equivalency table and shown in Table: 2. This is derived from the scales sung by 30 male singers (10 from Kerala, 10 from Karnataka and 10 from Tamil Nadu regions) at all scales ranging from A# to A.

Table 4.2: *Summary of equivalence of note, scale, swara and octave in frequency for male singers.*

Pitch levels	2 nd Octave			3 rd Octave			3 rd Octave
	N	%	Value (Hz)	N	%	Value(Hz)	Freq. Ratio
A#				30	100	116.18	1
B				30	100	122.7	1.05
C				30	100	129.89	1.11
C#				30	100	137.79	1.18
D				30	100	146.11	1.25
D#				30	100	153.89	1.32
E	1	3.33	81.4	29	96.6	163.87	1.41
F	1	3.33	86.57	29	96.6	172.9	1.48
F#	1	3.33	89.5	29	96.6	183.42	1.57
G	3	10	94.72	27	90	194.19	1.67
G#	3	10	99.9	27	90	206.15	1.77
A	3	10	105.1	27	90	219.72	1.89

Mean of the fundamental frequency (Hz), N- number of participants, and percentage of participants (%)

From the table 4.2, it was observed that all the 30 male singers (100%) sang in the third octave from A# to D# pitch levels. As the pitch levels increased, variations were found. One participant (3.33%) preferred singing E, F, and F# in the second octave, while the remaining 29 participants (96.6%) preferred singing in the third octave. Three participants (10%) preferred singing G, G#, A in second octave, while the rest 27 participants (90%) preferred singing in third octave.

Table 4.3: Summary of equivalence of note, scale, swara and octave in frequency for singers

Scales	3 rd Octave			4 th Octave			4 th Octave
	N	%	Value (Hz)	N	%	Value (Hz)	Freq. Ratio
A#				30	10	232.44	1
B				30	100	246	1.05
C				30	100	261.76	1.12
C#				30	100	276.55	1.18
D				30	100	293.66	1.26
D#				30	100	311.03	1.33
E	9	30	165.76	21	70	328.88	1.41
F	21	70	173.91	9	30	348.22	1.49
F#	23	76.66	184.92	7	23.33	366.13	1.57
G	24	80	195.52	6	20	391.41	1.68
G#	26	86.66	207.23	4	13.33	414.57	1.78
A	26	86.66	219.45	4	13.33	440.57	1.89

Mean of the fundamental frequencies (Hz), N – Number of participants, Percentage of the total no. of participants.

The arithmetic mean of all the fundamental frequency values of the madhyasthayi 'shadja', sung by the 30 female singers, (10 from Kerala, 10 from Karnataka and 10 from Tamil Nadu) is represented in the form of an equivalency table - Table(4.3).

From table 3, it was observed that all the 30 female singers (100%) sang in the fourth octave from A# to D# pitch levels. Variations were found as the pitch levels increased. 9 participants (30%) preferred singing in E, F, and F# in the third octave, while remaining 21 participants (70%) preferred singing in the fourth octave.

21 participants (76.66%) preferred singing F in the third octave, while the rest 9 participants (9%) preferred singing in fourth octave. 23 participants(76.66%) preferred singing F# in the third octave while 7 participants (23.33%) sang in the fourth octave. 24 participants (80%) sang the madhyasthayi shadja of G pitch level in the third octave while 6 of the participants (20%) sang in the fourth octave. G# pitch level was preferred to be sung in the third octave by 26 participants (86.66%), while 4 of them (13.33%) sang in the fourth octave. The madhyasthayi shadja in the highest pitch level A was sung in the third octave by 26 participants (86.66%), while 4 participants (13.33%) sang in the fourth octave.

Here, when comparing the frequency values of the madhyasthayi shadja sung by the male and female Carnatic classical singers, it was observed that the male Carnatic Singers sang the madhyasthayi shadja from A# pitch till D in the third octave, covering a frequency range of 116.16 Hz to 163.87 Hz. We observe that 29 participants (96.6%) continued singing in the third octave from E to A, ranging a frequency value of 163.87 Hz to 183.42 Hz. One participant shifted to the

lower, second octave, when the pitch is further increased to E to sing at 81.4Hz, towards the lower limit of the normal physiology of human larynx. The same participant continued singing in the second octave as the pitch level was increased to F and F#, with frequencies 86.57 Hz and 89.5Hz, respectively. Further, 3 participants were observed to sing the madhyasthayi shadja at the pitches G, G# and A, in the second octave, ranging a frequency of 94.72 Hz to 105.1 Hz.

On further investigation it was found that the two of the participants who shifted to the second octave had reduced duration of formal music training when compared to the rest of the participants. It is hypothesized that the duration of music training can affect the judgment of the participant of whether to sing in the second octave or the third octave.

Majority of the singers were found to sing at different pitch levels ranging from A# to A within the third octave (116.18 Hz to 219.72 Hz). The singers who shifted to the second octave had an extended lower range when compared to the other singers as they could produce madhyasthayi shadja at 81.4 Hz to 104.1Hz, which will be at the lower limit of the modal register of human voice and may have restricted upper range such that the singers are unable to reach the pitch levels above E in the third octave, i.e., above 153.89Hz.

In the course of analysis it was found that, shifting of the scales was found to be more prominent in female singers. The majority (70%) of the female singers shifted the octave in which they sang from the fourth octave to the third octave, at F scale. There were 9 participants who shifted the octave lower to the third octave 165.76Hz, while 21 of the remaining participants continued singing in the fourth

octave. A shift in the octave was observed in the F pitch level, in which 21 participants shifted to the lower third octave to a frequency value of 173.91 Hz, while 9 of them continued singing in the fourth octave at a mean value of 348.22 Hz.

This suggests that as the female singers reach the higher limit of their modal register, which was found to be around 348.22 Hz for the madhyasthayi shadja at E pitch level in majority (70%) of the participants, they try shifting their pitch to the lower octave and sing at the same pitch level, which has a lower frequency value. The singers who continued singing in the fourth octave might have had an extended higher limit for their modal register (348.22Hz to 440.57 Hz) [At F -30%; F#- 23.33%; G- 20%; G# - 13.33%; A -13.33%].

The frequency ratios for both male and female singers in the present study correlated with the results, i.e., frequency ratios given by Sambamoorthy (1923) and Bhatkande (1963) and also correlated with the relative ratios of the twelve swara sthanas given by Prashanth & Venugopal (2011).

To conclude, it was observed that the majority of the male singers sang in one octave, the third octave, from the lowest to the highest pitch levels of a chosen shruthi box. At the same time, the female singers started at the fourth octave, as in the lower pitch levels and later, as they reached the higher pitch levels, majority of them shifted to the lower octave, the third octave. Anindya (2013) reported similar observations in Hindustani singers where the female (fourth to third octave) and male (third to second octave) singers were found to shift to the lower octave as they reached the higher pitch levels during singing. Thus in an inversion of the Western

choir, the “high parts” in Indian vocal music are sung by men, when in fact the male singers must actually be singing low frequencies.

Tuning the singing to a higher octave initially and shifting to lower octaves when they are expected to sing at much higher pitch range is a common practice with most singers, especially female singers. This could be a compensatory strategy learnt over a period of time to avoid pitch breaks or register shifts. Such practices may be overcome with incorporation of basic lessons on vocal physiology, honing of the uniqueness of one’s voice and maintaining the individualistic style of voice in singing practice.

It was interesting to note that the participants from different regions who were older in age revealed superior singing skills, flexible in their views and also exhibited similarities in views in spite of differences in their training regimens. The participants in the younger age group lacked these qualities.

CHAPTER V

SUMMARY AND CONCLUSION

The present study aimed to understand the relation between the notes, scales, swaras, octaves, and their corresponding frequencies. A total of 60 classical Carnatic singers from 3 regions – Kerala (Ernakulam & Palakkad), Karnataka (Mysore) and Tamil Nadu (Coimbatore) of comprising of 10males and 10 females in each group were the participants. The demographic details regarding age, education, occupation and singing training details regarding years of training, hours of practice per day were obtained using a semi structured interview. All the subjects carried out the following two tasks in a quiet environment.

1. *Questionnaire*: answering the questionnaire encompassing a total of 15 open-ended questions directed at the singer's perception on terms such as, scales, notes, swaras and octaves which were audio-recorded. The responses of all the participants were transcribed verbatim and analyzed individually and then compiled for commonalities and/or differences.

2. *Singing*: The subjects were asked to sing the madhyasthaayi 'shadja' (base 'Sa') at the different pitch levels ranging from –A#, B, C, C#, D, D#, E, F, F#, G, G#, A. The audio recording of the singing sample was done using the digital recorder Olympus LS-100. The sung utterances were subjected to PRAAT analysis, frequency information were extracted and compiled. The arithmetic mean of all the fundamental frequency values of the madhyasthayi shadja and the frequency ratios

between the lowest pitch level and the other pitch levels was represented in the form of an equivalency table.

The results were discussed under the objectives of the study.

Objective I: To investigate the meanings of the terms notes, scales, swaras and octaves.

Notes: 95% of the participants opined that notes are the western equivalent of the term ‘swaras’ that are used in Indian classical music system. They explained the term as particular points in the pitch space which was very much similar to the concept of swaras in the Indian music system.

Swaras: All the participants referred to the sapta swaras – Shadja, Rishabha, Gandhara, Madhyama, Panchama, Daivatha, Nishadha - as the swaras in Carnatic music. 31.6% of the participants proposed that there are 22 *shruthis* and 7 *swaras* mentioned in ‘*Natyashastra*’. And when there are further variations, there will be 12 *Swarasthanas* which are identified just based on the difference in pitch or frequency levels. Other than shadja and panchama, all the other swaras have different variations of its own which sums upto 12 swara sthanas.

Scales: 8.33% of the participants opined that scale referred only to a set of swaras that are put together and are labeled as a ‘*raga*’ in Indian musical system. These participants proposed that a scale represents the ‘*aarohana*’ – the ascending order and ‘*avarohana*’- the descending order of a *raga*. 56.66% of participants who suggested that scales are the different pitch levels at which the singer bases his/her singing. The singers sing at different pitch levels/scales with reference to their

singing as the '*Adhara shruthi*'. 43.33% of the participants agreed that scale was the raga of the Indian music system and also of scale referring to the pitch level or the Adhara shruthi of a singer.

Octaves: All (100%) the participants proposed that octave is the 'sthaayi' of the Indian music system. Each octave or sthaayi comprises of 7 swaras and 12 swara sthanas. The participants also proposed that there are 5 octaves audible to human beings and listed them as: Anumandrasthaayi, Mandrasthaayi, Madhyasthaayi, Tharasthaayi, and Athitharasthaayi. Among these only middle three octaves – Mandra, Madhya and Tharasthaayi are achievable by the human voice. The other two extremities are produced only in instruments.

Objective II: To associate the sung notes, scales, swaras and octaves to their corresponding frequencies. The results indicated that the majority of the male singers sang in one octave, i.e., the third octave, from the lowest to the highest pitch levels of a shruthi box. At the same time, the female singers started at the fourth octave, in the lower pitch levels and later, as they reached the higher pitch levels, majority of them shifted to the lower octave, i.e., the third octave. The frequency values of these pitch levels were also identified and was related to the notations in a shruthi box and tabulated.

Even though participants from different regions revealed similarities in views in spite of differences in their training regimens it was found that older participants possessed extraordinary singing knowledge, liberal views on different music forms and also exhibited superior singing skills. It seemed that the participants in the

younger age group were lacking in these qualities compared to their older counterparts.

Conclusion

Western vocal music concepts have been borrowed into Indian classical vocal music leading to varied thoughts, practice schedules and formulation of individualistic conceptions that are challenging to the singers as well as the professionals involved in the management of voice problems in singers. In the current scenario, the singers depend majorly on an external reference like a shruthi box, which is based on the Western note concept. This helps the singer to realize the selected pitch level clearly during singing. Also the singer will be able to gauge the extent of range he/she can produce in a register. Here the singers use the term notes, swaras, scales, octaves etc. while describing their singing which for instance, may be a shift in pitch levels or scale that a singer sings from G to F# based with shruthi box as reference.

Hence, it important to note that the reference for singing could be a thambura, shruthi box, piano, key board or the electronic applications now available on the mobile phone networks. Speech Language Pathologists could confer with these references and help a singer achieve the singing of the seven notes comfortably in the modal register with some notes at the lower and higher extremes of this range itself. The notes sung by a singer are not absolute and is always relative and individualistic and may not necessarily equate a single frequency value always. Also

realization of singing in two octaves at the modal register requires sound knowledge of the vocal music, speech and vocal apparatus, appreciation of the individuality of one's voice and practice.

Therefore, it is important for the SLPs to orient themselves with basic knowledge of music for the efficient assessment and management of the singers, the elite professional voice users.

Limitations

The sample size was small and also the participants belonged to wider age range and hence, the influence of age related factors on voice, especially for devising the frequency conversion table could not be considered.

Implications

Similar study could be attempted using a larger sample size incorporating different age groups.

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APPENDIX 1

अखिलभारतीयवाक्श्रवणसंस्थान, मैसूरु - 570 006
ALL INDIA INSTITUTE OF SPEECH AND HEARING, MYSURU - 570 006

**AN INVESTIGATION OF RELATIONSHIP BETWEEN NOTES, SCALES,
SWARAS, OCTAVES AND THEIR CORRESPONDING FREQUENCIES**

Participant details

Name:

Age/Gender:

Occupation:

Years of music training:

Hours of practice per day:

Date:

Participant Consent Form

I have been given the information about the research associated to which the data collection is carried out. I have been given opportunity to ask question/s about the research and my participation. I voluntarily agree to participate in this research.

Signature:

Date:

QUESTIONNAIRE

1. What is a note?
2. What is a swara?
3. What is an octave?
4. Which scale do you sing in?
5. How did you decide upon that scale?

6. Are you aware of the frequency notation/octave in which you are singing?
7. What is the difference between a scale and a note?
8. Is there a difference between a note and a swara?
9. What determines the notes/swaras that you sing in one scale?
10. What will be the notes that you sing for Sa Re Ga Ma Pa Dha Ni, if the base pitch is kept at A[#] or B^b?
11. How do you differentiate between two ragas?
12. How much is your range?
13. Does your range involve falsetto and fry? If yes, how many notes/swaras?
14. What scales are you comfortable singing in?
15. Are there any singing styles in Carnatic? (For example: Hindustani has dhrupad, khyal, tarana etc.) If Yes, what style have you been trained in?

APPENDIX 2

अखिलभारतीयवाक्श्रवणसंस्थान, मैसूरु - 570 006
ALL INDIA INSTITUTE OF SPEECH & HEARING: MYSORE – 6
वाक्भाषाविज्ञानविभाग/ DEPARTMENT OF SPEECH-LANGUAGE SCIENCES

Informed Consent Form for Dissertation Data Collection

Title: An Investigation of Relationship between Notes, Scales, Swaras, Octaves and their corresponding Frequencies

Guide: डॉ. के. येशोदा/ Dr. K. Yeshoda
रीडर & विभागाध्यक्ष, वाक्भाषाविज्ञानविभाग/ Reader & Head-Speech-Language Sciences

Candidate: Ms. Revathi, R. (Reg. No: 16SLP022) II MSc (SLP), AIISH

I do hereby give consent to participate in the study titled “Effect of cognitive load on voice characteristics”. I have been briefed about the purpose of the study and express my whole hearted consent to participate. I have also been informed about the approximate time of testing and understand that the procedure is purely unharmed with research benefits only. I agree to cooperate with the investigators in this study and for the project/official communication in journals/magazines/newsletter and research purposes.

Furthermore, I have been assured that there will not be any financial commitment on my part during the course of this study. It has been further stated that my identity as a participant in this study will be strictly confidential and will not be divulged without my express consent.

Having read the above, I express my voluntary consent for my participation in this study.

Sl. No.	Name	Signature with date