EFFECT OF INDIAN MUSIC ON CARDIAC AUTONOMIC FUNCTION, PSYCHOLOGICAL STATES AND COGNITIVE FUNCTIONS IN HEALTHY VOLUNTEERS

Thesis submitted by

KARUNA NAGARAJAN

Towards the partial fulfillment of

DOCTOR OF PHILOSOPHY (YOGA)

JANUARY 2016

SWAMI VIVEKANANDA YOGA ANUSANDHANA SAMSTHANA
(Declared as Deemed-to-be University under Section 3 of the UGC Act 1956)
BANGALORE, INDIA
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Under the Guidance of

SRINIVASAN T M PhD

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DECLARATION

I hereby declare that this study was conducted by me at Swami Vivekananda Yoga Anusandana Samsthana (S-VYASA), Bangalore, under the guidance of Prof. Srinivasan T M, Dean, Divisions of Physical Sciences, Swami Vivekananda Yoga Anusandana Samsthana (S-VYASA), Deemed University, Bengaluru.

I also declare that he subject matter of my thesis entitled "EFFECT OF INDIAN MUSIC ON CARDIAC AUTONOMIC FUNCTION, PSYCHOLOGICAL STATES AND COGNITIVEFUNCTIONS IN HEALTHY VOLUNTEERS" has not previously formed the basis of the award of any degree, diploma, associate-ship, fellowship or similar titles.

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Date

Bengaluru **Karuna Nagarajan**

STANDARD INTERNATIONAL TRANSLITERATION CODE TO

TO TRANSLITERATE SANSKRIT WORDS

a	**=**	**अ**	**ṅa**	**=**	**ङ**	**pa**	**=**	**प**
ā	**=**	**आ**	**ca**	**=**	**च**	**pha**	**=**	**फ**
i	**=**	**इ**	**cha**	**=**	**छ**	**ba**	**=**	**ब**
ī	**=**	**ई**	**ja**	**=**	**ज**	**bha**	**=**	**भ**
u	**=**	**उ**	**jha**	**=**	**झ**	**ma**	**=**	**म**
ū	**=**	**ऊ**	**ñ**	**=**	**ञ**	**ya**	**=**	**य**
e	**=**	**ए**	**ṭa**	**=**	**ट**	**ra**	**=**	**र**
ai	**=**	**ऐ**	**ṭha**	**=**	**ठ**	**la**	**=**	**ल**
o	**=**	**ओ**	**ḍa**	**=**	**ड**	**va**	**=**	**व**
au	**=**	**औ**	**ḍha**	**=**	**ढ**	**sa**	**=**	**स**
m	**=**	**अं**	**ṇa**	**=**	**ण**	**śa**	=	**श**
ḥ	**=**	**अः**	**ta**	**=**	**त**	**ṣa**	**=**	**ष**
ka	**=**	**क**	**tha**	**=**	**थ**	**ha**	**=**	**ह**
kha	**=**	**ख**	**da**	**=**	**द**	**kṣa**	**=**	**क्ष**
ga	**=**	**ग**	**dha**	**=**	**ध**	**tra**	**=**	**त्र**
gha	**=**	**घ**	**na**	**=**	**न**	**jña**	**=**	**ज्ञ**
ṛ	**=**	**ऋ**	**ṝ**	**=**	**ॠ**			

ABSTRACT

BACKGROUND

Many researches have shown that music evoked significant autonomic responses as measured by HRV analysis. Studies have also demonstrated cognitive-enhancing effects of exposure to anxiety-reducing or "sedative" music. These studies have used western music such as Mozart, Vivaldi and Bach etc. Not much study has been undertaken using Indian music. The consolidation and evocation of *Rasa* or positive aesthetic mood is the function of Indian music. Indian Music therapy is the use of suitable type of music, with specific tonal quality, played at suitable time, which helps to drive out negative feelings like dependency and loneliness. We set out to examine the effect of listening to particular Indian *Rāga* or melody across cognitive, autonomic, state anxiety domain of the human stress response in healthy participants in a laboratory setting.

LITERARY REVIEW

There are many systems of healing for countering perceived stress, which helps to manage stress as well as its impact on the systems of the body. Music is one such system which works through emotional healing. Emotional healing is to ward off the negative feelings of criticism, anger, guilt and resentment and replace them with positive mental thought patterns of love, compassion, pleasantness and calmness. The willful submission to the selected Indian *Rāgās*, brings out positive aesthetic mood. In this chapter of literary research, an attempt is made to review the Indian *Rāgās, the tonal quality* and the interwoven agreeable *Rasās* (aesthetic mood) in them. The theoretical model of music therapy through emotional healing is based on the constitution or biological humor or *Prakriti* of an individual.

REVIEW OF SCIENTIFIC LITERATURE

Review of scientific literature enumerates contributions and findings from various studies done in the domains of music, autonomic variables, spatial ability, memory and psychological well-being. A growing number of studies in western music presented the need of the established effect of Indian music on autonomic functions, anxiety and cognitive process on healthy participants.

AIMS

i) We chose to evaluate the effects of HRV, State Anxiety and Subjective feeling assessment on exposure to Indian *Rāga Bhūpāli* with that of two control groups of pop music and no music or silence in a sample of healthy participants

ii) To study the impact of Indian *Rāga* on a memory task.

OBJECTIVES

- To explore the relationship between music related psychological states, subjective feeling and autonomic variables in healthy college students.
- To evaluate the effect of Indian *Rāga Bhūpāli* on autonomic variables in healthy college students.
- To examine the immediate effect of Indian *Rāga Bhūpāli* on working memory in healthy college students.

METHODS

SUBJECTS

All the studies the sources of subjects were from Residential Yoga University age range from 18 to 24.

DESIGN

The immediate effect of music through self-control case series in which the inference is within individuals. The fixed covariates such as location, diet, state of health are automatically controlled for within a proportional incidence framework.

INTERVENTION

The musical session with instrumental songs of popular classical based film music in Indian *Rāga Bhūpāli*; We chose *Rāga Bhūpāli* which instills the aesthetic mood of love within the listener. Researches imply that positive psychological well-being with a sense of hope, love, security and happiness is associated with cardiovascular health. Hence we chose the said *Rāga Bhūpāli* for measuring the Autonomic Variables. There are many studies in the west which has compared sedative and stimulative music. Hence we set out to compare the said Indian *Rāga* which is relaxing in contrast with that of Pop instrumental music with steady beats and also 'no music session'.

ASSESSMENT TOOLS

Autonomic Variables were measured through Heart Rate Variability (HRV). State Anxiety Inventory to assess the State Anxiety (how one feels at the moment); Visual Analog scale to assess the Subjective feeling; A Section of the Wechsler memory scale (WMS) - digit span forward and backward was used to assess the Working memory;

DATA EXTRACTION AND ANALYSIS

The data were collected using self-reported questionnaire and computers. All statistical analysis was performed using the Statistical Package for Social Sciences (version 16.0). Repeated measures analyses of variance (ANOVAs) procedures were used for statistical analysis.

RESULTS

i) HRV, State Anxiety and Subjective feeling

The three sessions were – the musical session intervention with Indian *Rāga* '*Bhūpāli*', Pop music with steady beats and 'no music session'. Assessments were made for all the three sessions, before (5 minutes), during (10 minutes), and after (5 minutes) each of the three states, on three separate days.

During Indian Rāga, there was a significant decrease in the low frequency (LF) power ($P<0.01$) and increase in the high frequency (HF) power ($P<0.01$) in the frequency domain analysis of HRV spectrum. There was also a significant decrease in mean HR ($P<0.01$) and a significant increase in the NN50 ($P<0.05$) and RMSSD ($P<0.05$) in time domain analysis of HRV. Both frequency and time domain analysis are indicative of parasympathetic activity. The anxiety level significantly ($P < 0.001$) decreased post Indian *Rāga* session and significantly ($P< 0.01$) increase post Pop Session. The subjective assessment of perceived feeling using Visual Analog scale comparing Indian *Rāga* with Pop and Silence sessions showed significant difference of feeling positive ($P<0.01$).

ii) Working Memory

All participants were assessed before and after (i) Indian *Rāga Bhūpāli* (R) for 10 minutes on day one; (ii) an equal duration of Pop music (P); and (iii) an equal duration of Silence or no music (S) on next two different days respectively. There was a significant improvement in digit forward ($P<0.05$, an increase of 3.17%) and backward span score after ($p<0.05$, an increase of 5.26%) immediately after the **e**xposure to Indian *Rāga Bhūpāli*.

Bhūpāli

DISCUSSIONS

i) The results were in accordance with our hypothesis. The participants who listened to Indian *Rāga 'Bhūpāli'* may have influenced by the aesthetic mood of the song that depicts *śṛngāra Rasa* or love which has brought in the relaxed state of mind. There was an increase in cardiac parasympathetic activity which is exclusively responsible for the HF peak of the heart rate power spectrum. This can be correlated with lower scores of state anxiety. The pop music which is liked by the teenagers may be exciting have an increase in cardiac sympathetic activity responsible for the LF peak of the heart rate power spectrum. The study also had another control condition of no music or silence of which has not helped silencing the mind or relax the mind.

ii) Listening to Indian *Rāga Bhūpāli* has brought in the selective attention and concentration that is required for performance of the task and has brought in significant improvement in performing the task.

CONCLUSION

The combination of notes in Indian *Rāga Bhūpāli* is said to instill *śṛngāra Rasa* or the aesthetic mood of Love. Exposure to Indian *Rāga Bhūpāli* reduced sympathetic activity and/or increased vagal modulation with reduced anxiety levels and subjective assessment of perceived feeling showed positive changes.

Memory scores improved immediately after listening to Indian *Rāga Bhūpāli*. The improvement is significant compared to the Pop music that is much preferred by the college students and Silence or No music conditions.

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CHAPTER – 1

INTRODUCTION

1.0 Introduction

Music environs everyone's lives; we hear it on music apps with smart phones, on the radio, on the television, from our car and home stereos. We come across it in the melodious tunes of a classical concert or in the devotional strains of a *Bhajan*, the wedding *Nāda Svaram*, or in the fields breaking into song to express the joy of harvest. Even chirrup in the bathroom gives us a happy beginning to the day.

The ancient Greek concept of the term Mousike is the contributions of nine muses (Greek Mythology) to the art which covers the domains of musical vibrations of the lyre, poetry, dance, seven chords of the lyre to history and even astronomy. Music is '*Saṁgīta*'– the exact equivalent of the Latin *Concentus.* The most precise translation is 'concerted song'. *Saṁgīta* is the closest equivalent to the Western concept of music which was regarded as a composite art consisting of melos (*Gīta*), syllabic accompaniment (*Vādya*) and limbic movement (*Nṛtta*) (Lewis, R. 1992).

Music is both science and an art. On one hand it awakens the aesthetic consciousness dealing with expression of one's feeling and emotions and bestows on him unbounded joy and happiness. In this state, music enables a man to enjoy the intrinsic beauty of Nature and the transcendental serenity of the Soul as well (*Prajñānanda*, Swami. 1973). On the other hand it is a science concerned with the systematic management of sound at all the levels in the Universe (Sharma, M. 2007). The appropriate type of music, with specific tonal quality, played at a suitable time, help to drive out negative feelings like dependency and loneliness. Music creates an atmosphere of harmony and well-being (Sharma, M. 2007). This forms the basis for music therapy, under the category of Mind- Body Medicine which caters to emotional healing. Emotional healing is to drive away the negative emotions and create a positive internal environment.

Negative thoughts and emotions must be allowed sufficient inner expression for their origin to be properly analyzed. It is the very analysis, which emphasizes the witnessing factor that may dissolve them. Just as the thoughts will disappear when we look at them from a distance in meditation, emotions will disappear when we fearlessly challenge their very nature and origin. This can be done through music experience (Merchand P. 2006).

Musical exercises aid in organizing one's thought processes and help in overcoming one's inhibition and restrictions. The creative process of music takes over one's mind and emotion and leads to the feeling of wholeness and completeness with the universe, physical, moral and intellectual. It helps in overcoming all forms of inadequacies or frustrations in life. (Sairam, T. V., 2004) Hence our ancient healing method like *Āyurveda* suggests music therapy.

The American Music Therapy Association (AMTA) defines music therapy as the use of music in the accomplishment of therapeutic aims: the restoration, maintenance, and improvement of mental and physical health. Music is a pervasive phenomenon in cultures and societies throughout the world and most human beings are capable of experiencing music in basic ways by listening to music, feeling its vibrations, singing, moving to music, playing simple instruments or responding emotionally to music (Peters, J. S., 2000).

Many studies have shown that Music powerfully modulates social, emotional processes, cognitive status, and mood, thus contributing to the healing (Santiago., et.al., 2014).

Music generates psychological responses within a person when it passes through the auditory cortex of the brain, which processes the music. This processing occurs in the limbic system, which is known as the center of emotions, sensations and thought patterns. Human reaction to music occurs predominantly in the right hemisphere of the brain, which is involved in intuitive and creative methods of processing information. Through effective response and cognitive recognition, music can alter mood. Thus, a person's frame of mind, reaction to the given music, type of music and musical preference play an important part in mood shift leading to various health outcomes (Murrock, & Higgins PA, 2009). Facilitatory effects of music have been reported for a range of cognitive tasks, including general intelligence tests, examination performance, arithmetic performance and reading comprehension in various studies. And also previous research pertaining to the effect of music on cognitive performance like that of spatial performance, short term memory task, short term retention, and associate learning task has shown improvement (Rickard, N. S., Toukhsati, S. R., & Field, S. E. 2005).

In 2002, a study done by Hallam showed that elementary school students who listened to mood-calming music while completing mathematical problems were able to complete more problems and solve a higher percentage of them correctly than the group who listened to no music at all (Harmon, L., Taryn Pickwick, K. T., Pelosi, G. 2008). Listening to emotionally touching music improved memory and significantly increased heart rate. (Mado Proverbio, C. A., Lozano Nasi, V., Alessandra Arcari, L., De Benedetto, F.,, Guardamagna, M., Gazzola, & M., Zani, A. 2015). As such, music can present significant additional indication which is prone to enrich the encoding of an event. On the other hand, musical stimuli was also claimed to negatively affect memory by diverting participants' attention away from the information to be remembered, creating a dual task condition with poorer memory performance than in a

silent state . In the last two decades, several studies were conducted in order to understand when and how music can have a positive effect on memory. Research on western music signify that musical exercise and also simple exposure to music leads to benefits of short- and long-term verbal memory in healthy and clinical populations (Laura F., Jean-Julien A., Makii M., Emmanuel B., & Aurelia B. 2013). With many of the studies, it is not yet clear which genre and characteristics of music are essential for any cognitive-enhancing effects, and procedural variations in experimental method can influence this relationship. Inconsistencies in findings may, for instance, be the result of differences in (i) the time at which music was presented relative to the task, (ii) the type of music stimulus, (iii) characteristics specific to the listener (iv) selection of dependent measures (Rickard, N. S., Toukhsati, S. R., & Field, S. E. 2005). There are no reports with immediate effect of the Indian Melody on working memory of healthy individual with the specific study design.

Previous studies have demonstrated that the autonomic nervous system may serve as one way by which music could be effectively used for the therapeutic application. This is explored by the assessment of Heart Rate Variability (HRV).

HRV reflects the moment-to-moment output of the CAN (Central Autonomic Network) and, by proxy, an individual's capacity to generate regulated physiological responses in the context of emotional expression (Bradley, M., Appelhans, & Luecken, L. J. 2006).

HRV represents an economical, non-invasive and sensitive procedure for investigating the autonomic neurocardiac regulation, giving a good quantitative estimation of cardiac autonomic activity (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).

The effects of music on Heart Rate Variability (HRV) have shown varied results, for

example, in one study, the HF component increased only with sedative music. In another study, rock music and noise increased Mayer Waves (i.e., the LF component) which seems to be related to sympathetic activation. Finally, mechanical sounds inhibited the parasympathetic nervous system and promoted feelings of unpleasantness and alertness. Another study in healthy women showed that acute exposure to heavy metal music reduced sympathetic activity by 50% (Santiago., et.al., 2014). Further, previous studies have taken into account the western music such as Bach, Mozart and Vivaldi as relaxing type of music, which resulted in significant reduction in heart rate. The significance of these results may be relevant for the use of music in coronary heart disease is discussed (Escher, & Evéquoz, 1999).

The biological effects of Indian music, leading to its therapeutic efficacy are not entirely known. There is no previous study on effect of particular Indian *Rāga Bhūpāli* which creates an aesthetic mood within the listener correlating with Autonomic functioning, State Anxiety and Subjective assessment of feeling.

CHAPTER – 2

LITERARY RESEARCH ON INDIAN MUSIC

2.0 Technical Compartments or Elements of Indian Music Therapy

2.1 Background and Scope

Music and other sounds have a significant effect on the body and mind. Along with the other benefits of music nowadays it is used as a therapy also. It is an emerging field in the health care system. The Greeks, Hebrews and Persians used music systematically as a therapy. In India, music originated from *Gandharva Veda*, thousands of years ago. Even today its basic principles lead to the stunning creativity by its master musicians. The approaches and the definitions of both Indian compartments or elements of Music therapy from various sources are discussed below. We have also discussed the Western concept of music therapy in contrast.

Western Concept of Music Therapy

Music therapy is the use of music and musical elements (sound, rhythm, melody, harmony and pitch) by a music therapist with a client or group, in a process designed to facilitate and promote communication, relationships, learning, mobilization, expression. It also aims at other relevant therapeutic objectives, in order to meet physical, emotional, mental, social and cognitive needs **(**Wigram, T., Pedersen, I. N., & Bonde, L. O. 2002).

Rhythm is the first element and it is the pattern of repeated sounds and silences and is music's most basic, vital, structural and organizational element. Rhythm is an auditory signal which captures an individual's attention, for the synchronization of skeletal muscle movement and is the most important consideration when making a choice of music for specific and therapeutic purposes. As the second element, *melody* is the sequencing of musical pitch and intervals between musical notes. Structured by its length and intensity, melody expresses a

mood, a thought, an idea or an emotion. Melody is a form of non-verbal communication that can elicit a broad array of emotions from one intense response (cheerful, tranquil and overjoyed) to another (gloomy, fearful and angry). The number of cycles that a particular sound vibrates per second is the third element, *pitch*. Faster vibrations cause high-pitched tones that are usually associated with cheerful or happy reactions. On the other hand, slower vibrations cause lower tones and typically connote dreariness or depression. The vibration rate per unit of time can persuade an emotional response as rapid vibrations and are viewed as stimulating and slow vibrations are considered as relaxing. The fourth element is the product of blending pitches together to form an arrangement of sounds known as *harmony*, which links rhythm to the melody. These blended combinations can be characterized as consonant or dissonant and form distinct patterns from the simultaneous musical notes resulting in a musical chord. In conjunction with timbre, the quality of sound, the composition of chords results in a specific sound that enables a person to identify a particular musical instrument or type of singing voice. The fifth and final element is *interval*, which is the distance between two notes. It is an integral component of the melody, giving it its character and emotional response. As proved by the rich selection of music among cultures, the five elements of music, along with its procedure, combine a finite range of sounds in an infinite number of ways. As one of the oldest and most accepted modes for expressing cultural diversity, music brings forth emotional responses and stimulates movement that can be used for therapeutic purposes (Murrock, C J., & Higgins, P. A. 2009).

Indian Concept of Music therapy

Music is the heart of Indian Culture. The very name *Bhārata* is explained by some scholars as consisting three elements of music Bha – *Bhāva* or feeling; Ra - *Rāga* or Melody; Ta – *Tāḻa* or rhythmic pattern. The basic elements or the technical compartments of Indian Classical

music are *Nāda, Śruti, Svara, Rāga, Tāḷa, Rasa and Thāta.* The suitable type of music, with specific tonal quality, depicting particular aesthetic mood, with the right type of melody, played at a suitable time forms the basis of Indian Music Therapy (Sharma, M. 2007). The meaning and definition of these music elements are culled out from various Indian Classical texts on music.

2.2 Aims

To understand the concept of Indian music therapy, which aims at emotional healing; elements of Indian music therapy; develop the module of music therapy based on the individual biological humor or *Dośa* of the person from the perspective of the *Āyurveda*, ancient studies and research.

2.3 Objectives

1) To enumerate the elements of Indian music from the insight of traditional scripts summarized.

2) To explain how the elements of music can be used for therapeutic applications from the outlook of classical texts re-systemized and re-organized to the present time of music.

3) To elucidate music therapy as a Mind Body medicine, a model of emotional healing – a review of ancient texts.

4) To enlist the psychological manifestation of deranged *Dośās* or biological humor, the corresponding psychosomatic ailments afflicted thereby, the interdependency of physical and psychological components from the insight of the ancient wisdom of *Āyurveda*.

5) To understand the key component of music in emotional healing which, is the concept of Rasa or aesthetic mood and the *svarās* used to produce the particular positive aesthetic mood which wards off negative thinking, from the insight of established sources.

2.4 Materials and Methods

Integrating facts from various texts, a Music therapy module based on emotional healing for treating psychosomatic ailments had to be established. In the initial stages, searches were carried out for the keyword related to music therapy in *Āyurveda*. We found references in *Āyurveda* treatise *caraka samhita*, which says that music was used to bring down *Pitta* and *Vāta* disorders by calming down the mind. The base for music therapy was treating the psychological imbalance of deranged biological humor or Dośa.

There are many ancient books on music which speaks about *Rāgās* (melodies and *Rasās* or aesthetic mood created by music such as *Nātya Śāstra by Bharata, Brihaddeśi by Mātaṅga, Saṅgīta Samaya Sāra by Pārśvadeva, Sangīta Ratnākara by Śāraṅgadeva, Saṅgīta Makaranda* by *Śri Nārada etc*. The descriptions of the *Rāgas* as given in these books do not fit with their forms as they are sung today. *Sri Vishnu Narayan Bhatkhande*, a renowned musicologist (1860-1937 AD) went on for study tours, north, south, east and west of India and collected important books on music, reading of rare books in the library, copying the rare manuscripts, meetings with renowned musicians and musicologist at that time to gather information. He engaged himself in the work of re-organization and re-systemization of music that was current in his own time on the basis of the theory from the traditional music compositions as elaborated and demonstrated by recognized musicians. We have based the theory on '*Contributions of Bhatkhande to music'*. Bhatkhande has brought scientific pattern

in line with the modern methodology in defining the *Rāga* (Indian melody), *Rasa* (aesthetic mood) which helps in emotional healing.

2.4. A – Classical Music Texts

Brihaddeśi of Mātaṅga

Sangīta Ratnākara of Śāraṅgadeva

Nātya Śāstra of Bharata

Veṅkatamakhi in Catrudandi Prakāśika

Saṅgīta Samaya Sāra of Pārśvadeva

Charaka Samhita

Saṅgīta Makaranda by *Śri Nārada*

2.4. B – Methods

The above mentioned traditional texts with English translation and purports were studied to understand the different elements of music. These classical texts on music were studied to compile the authentic information on using music for therapeutic purposes. The aphorism and verses related to the present topic were collected, compiled, and presented in a systematic way.

2.5 The Elements of Indian Music

The definition of music or *Saṅgīta and its classification:*

गीतम् वाद्यम् च नृत्यम् च त्रयम् संगीतमुच्यते ।

मार्गो देशीति तद् द्वेधा तत्र मार्गः स् उच्यते ।

यो मार्गितो विरिन्च्यध्यैः प्रयुक्तो भरतादिभिः ॥

देवस्य पुरतः शम्भोर्नियताभ्युदयप्रदः ।

देशे देशे जनानाम् यद्रुच्या हृदय रंजकम् ॥

गीतम् च वादनम् नृत्तम् तद्देशीत्यभीधीयते ।

(S. R., Vol: 1, Sec: 1 v: 21c – 24b)

mārgo deśīti tad dvedhā tatra mārgaḥ s ucyate।

yo mārgito virincyadhyaiḥ prayukto bharatādibhiḥ।।

devasya purataḥ śambhorniyatāabhyudayapradaḥ।

deśe deśe janānām yadrucyā hṛdaya rañjakam।।

gītam ca vādanam nṛttam taddeśītyabhīdhīyate।

Vocal Music, instrumental music and dancing all the three put together are known as *Saṅgīta* which is two fold *Mārga and Deśī.* It was first discovered by Brahma (the creator) and practiced by Bharata and others as the audience of Lord Shiva is known as *Mārga Saṅgīta,* which definitely bestows prosperity*;* while the music comprising of *gītam, vādyam and*

nṛttam, that entertains people according to their taste in the different regions is known as *Deśī..*

Nārada also in his treatise '*Saṅgīta Makaranda'* says that song, Instrumental melody and dance, three put together is called *Saṅgīta* or music.

नृत्तम् वाद्यानुगम् प्रोक्तम् वाद्यम् गीतानुवर्ति च ।

अतो गीतम् प्रधान्त्वादत्रादावभिधीयते ॥

nṛttam vādyānugam proktam vādyam gītānuvarti ca।

ato gītam pradhāntvādatrādāvabhidhīyate।।

(S. R., Vol: 1, Sec: 1 v: 24c – 25b)

Dancing is guided by instrumental music which in its own turn follows the vocal music. Therefore, vocal melody (*gītam),* is the main constituent of Music or *Saṅgīta.*

Origin and Object of Music

सामवेदादिदम् गीतम् संजग्राह पितामहः

गीते प्रोयते देवः सर्वज्ञः पार्वतिपतिः ॥

गोपापतिरनंतोऽपि वंशध्वनिवंशम् गतः ।

सामगीतिरतो ब्रह्मा वेनास्क्ता सरस्वती ॥

किमन्ये यक्षगंधर्वदेवदानवमानवाः ॥

अज्ञातविषयास्वादो बालः पर्यंकिकागतः ।

रुदन्गीतामृतम् पीत्वा हर्शात्कर्श प्रपद्यते ॥

वनेचरस्त्रुणाहार्स्चित्रम् मृगशिशुः पशुः ।

लुब्धो लुब्धकसंगीते गीते यच्चति जीवितम् ॥

तस्य गीतस्य माहाऽऽत्म्यम् के प्रशंसितुमोशते ।

धर्मार्थकाममोक्षाणामिदमेवैकसाधनम् ॥

sāmavedādidam gītam sañjagrāha pitāmahaḥ

gīte proyate devaḥ sarvajñaḥ pārvatipatiḥ||

gopāpatirananto'pi vaṁśadhvanivaṁśam gataḥ|

sāmagītirato brahmā veenāsktā sarasvatī||

kimanye yakṣagandharvadevadānavamānavāḥ||

ajñātaviṣayāsvādo bālaḥ paryaṅkikāgataḥ|

rudangītāmṛtam pītvā harśātkarśa prapadyate||

vanecarastruṇāhārscitram mṛgaśiśuḥ paśuḥ|

lubdho lubdhakasaṅgīte gīte yaccati jīvitam||

tasya gītasya māhā′′tmyam ke praśaṁsitumośate।

dharmārthakāmamokṣāṇāmidamevaikasādhanam।।

(S. R., Vol: 1, Sec: 1 v: 25c – 30)

Gītam (the vocal music) was extracted from the *Sāmaveda* and collected by Brahma (the creator). Lord Shiva, the husband of Parvati is appeased by *Gītam;* Krishna the Supreme Lord was enthralled by the sound of the flute. When the Brahma the creator is devoted to *Sāmagīti* (*hymns of Sāmaveda* sung in a particular style) and when Sarasvati is attached to the Veena. What to speak of other beings such as yakshas and gandharvas (semi divine beings), the demons and the human beings? An infant, crying in the cradle, which is unaware of the enjoyment of senses enjoys the nectar of a song joyfully!! Even a fawn, animal moving in the grass is attracted by the song of the hunter and ready to sacrifice its life; Who indeed can describe the grandeur of melody for in fact, it is the only means for the realization of the four primary values of human life, i.e righteousness (Dharma), wealth (Artha), Desire for enjoyment (Kama), and emancipation (Moksha).

गीतम् नादात्मकम् वाद्यम् नादो व्यक्त्य प्रशस्यते ।

तद्वयानुगतम् नृत्यम् नादादीनम् मतस्त्रयम् ॥

gītam nādātmakam vādyam nādo vyaktya praśasyate।

tadvayānugatam nṛtyam nādādīnam matastrayam।।

(S. R., Vol: 1, Sec: 2, v: 1)

Music is filled with *Nāda*; Instruments are the means through which *Nādās* is manifested.

These triads Songs, Instruments and Dance are the means to attain *Nāda.*

2.5.1 Nāda

The first element of musical structure is *Nāda*. *Nāda* is the primary cause of the phenomenal world. The five basic elements which constitute life – earth, water, fire, air and ether perceived by the corresponding senses of smell, taste, vision, touch and hearing. Out of these, Ether, is the most pervasive and the cause of the rest. Sound is considered to be manifestation of *Nāda* which is described as *Nāda Brahma* in *śāstrās*. A sound which has sustained quality with a single frequency or combination of related frequencies, melodious to the ears is *Nāda*.

Nāda is the very essence of music. In music, it has been perceived in various different ways. Firstly, it is taken as general sound on which the whole Universe is based. Sharangadeva in Sangeeta Ratnakara describes it as follows:

नादेन व्यज्यते वर्णः पदम् वर्णात्पदाद्वचः ।
वचसो व्यवहारोऽयं नादाधीनमतो जगत् ॥

nādena vyajyate varṇaḥ padam varṇātpadādvacaḥ।
vacaso vyavahāro'yaṁ nādādheenamato jagat।।

(S. R., Vol: 1, Sec: 2, v: 2)

Nāda manifests the letters of the alphabet. The letters of the alphabet form words, and words make a sentence which is the basis of speech. Speech controls human behavior. Hence we can say the world is bound by *Nāda.*

चैतन्यम् सर्वभूतानाम् विवृत्तम् जगदात्मना ।
नादब्रह्मम् तदानन्दमद्वितीयमुपास्महे ॥

caitanyam sarvabhūtānām vivṛttam jagadātmanā ।
nādabrahmam tadānandamadvitīyamupāsmahe ॥

नादोपासन देवा ब्रह्मविष्णुमहेश्वरः ।
भवन्त्युपासिता नूनम् यस्मादेते तदात्मकाः ॥

nādopāsana devā brahmaviṣṇumaheśvaraḥ ।
bhavantyupāsitā nūnam yasmādete tadātmakāḥ. ॥

(S. R., Vol: 1, Sec: 3, vs: 1 and 2)

Nāda is regarded as divine force – a way to realize God. In Indian Philosophy, *Nāda* has had a very important and prominent place and has been regarded as a means to free oneself from the material bondage of life. It has always been believed that worship of *Nāda,* is worshipping of the Supreme Lord.

नकारम् प्राणामानम् दकारमनलम् ।
जातः प्राणाग्नि संयोगात् तेन नादोभिधीयते ॥

nakāram prāṇāmānam dakāramanalam ।

jātaḥ prāṇāgni saṁyogāt tena nādobhidhīyate ॥

(S. R., Vol: 1, Sec: 3, vs: 6)

The word *Nāda* is formed by combining two words Na and Da. Na means Nakar which represents the vital force and Da means Dakar which represents fire. Therefore *Nāda* is produced by the interaction of the vital force and fire.

The process of the manifestation of sound in the human body

आत्मा विवक्षमाणोऽयम् मनः प्रेरयते मनः ।

देहस्थम् वह्निमाहन्ति स प्रेरयति मारुतम् ॥

ब्रह्मग्रन्थिस्ततः सोऽथ क्रमाधूर्द्धपथे चरन् ।

नाभिहृकंटमोर्धास्येष्वाविर्भावयति ध्वनिम् ॥

ātmā vivakṣamāṇo'yam manaḥ prerayate manaḥ।

dehastham vahnimāhanti sa prerayati mārutam।।

brahmagranthistitaḥ so'tha kramādhūrdvapathe caran।

nābhihṛkaṇṭamoordhāsyeṣvāvirbhāvayati dhvanim।।

(S. R., Vol: 1, Sec: 3, vs: 3 & 4)

Desirous of speech the individuated being impels the mind and the mind activates the battery of power stationed in the body which in its turn stimulates the vital force. The vital force

stationed around the root of the navel, rising upwards gradually manifests nada in the navel, the heart, the throat, the cerebrum and the cavity of the mouth as it passes through them.

आहतो अनाहतस्चैव द्वेधा नादो निगद्यते

तत्र च अनाहतम् नाद एकाग्रन्यस्त मानसाः ॥

गुरूपदिश्ट मार्गेन मुनयस्समुपासते

दशरक्ति विहीन्त्वान्मनोरंजको नृणाम् ॥

तस्माद् आहत नादस्य श्रुत्यादिद्वातो खिलम्

गेयम् वितनुते लोक रन्जनं भवभन्जनं ॥

āhato anāhatascaiva devedhā nādo nigadyate

tatra ca anāhatam nāda ekāgranyasta mānasāḥ||

gurūpadiśṭa mārgena munayassamupāsate

daśarakti vihīntvānnmanorañjako nruṇām||

tasmād āhata nādasya śrutyādidvāto khilam

geeyam vitanute loka ranjanaṁ bhavabhanjanaṁ||

There are two types of *Nāda – Āhata Nāda* is of two kinds – musical and non musical. That which is produced by regular vibrations is called musical and that in which the vibrations are irregular will produce unmusical sound or noise.

Anāhata literally means ‘unstuck’ – the sound which, already present in the Universe audible only to the Seers and introverts, worshipped by the saints to free themselves from worldly illusions.

Āhata Nāda is an object of sense perception and *Anāhata Nāda* matter of mystic experience of Yoga in which sound and light are effused together. (Sampathkumaracharya, V. S., & Ramaratnam, V. 2000)

नादोऽतिसूक्ष्मः सूक्ष्मश्च पुष्टोऽपुष्टश्च कृत्रिमः।
इति पंचबिधा धत्ते पंचस्तितः क्रमात्॥

nādo'tisūkṣmaḥ sookhśmaśca puṣto'puṣtaśca kṛtrimaḥ ।

iti pañcabidhā dhatte pañcasthānastithaḥ kramāt ॥

(S. R., Vol: 1, Sec: 3, vs: 5)

Nāda manifests itself in the human body and thus there is direct perception. Immanent sound in the human body is grouped into five types on the basis of its quality of development from the root of the navel to the cerebrum and the buckle cavity of the mouth through the heart and the throat. Stationed in these five places *Nāda* takes on five different names as associated with them respectively i.e. extremely subtle, subtle, loud, not so loud and artificial.

व्यवहारे त्वसौ त्रेधा हृदि मंद्रोऽभिधीयते।
कंठे मध्यो मूर्ध्नि तारो द्विगुणश्चोत्तरोत्तरः॥

vyavahāre tvasau tredhā hṛdi mandro'bhidhīyate।
kaṇṭhe madhyo mūrdhni tāro dviguṇaśrottarottaraḥ।।

(S. R., Vol: 1, Sec: 3, vs: 7)

However, in actual practice it is three fold called *mandra* in the heart, *madhya* in the throat and *tāra* in the head and is successively double in pitch.

In Acoustics we come across terms like frequency, amplitude, loudness, pitch, velocity, timbre, quality etc. Musical Sound has three identifying characteristics; loudness, pitch and timbre (or quality). Loudness is power, as it depends on the amplitude or the intensity of the corresponding wave, and is measured in decibels. The pitch of a musical sound is determined mainly by its frequency and is a measure of how "high" or "low" a tone is, and is measured in hertz (Hl). The frequencies of Notes used in music lie between 30 Hz and 5000 Hz. (James, K. N. 2008).

This frequency range is divided into many octaves. The third identifying feature, timbre, stems from the fact that musical sounds are made up of many different sine waves. (James, K. N. 2008).

2.5.2 Śruti

तस्य द्वाविंशतिर्भेदाः श्रवणाच्छ्रुतयो मताः।

tasya dvāviṁśatirbhedāḥ śravaṇācchrutayo matāḥ।

(S. R., Vol: 1, Sec: 3, vs: 8)

Nāda is differentiated into twenty two grades which because of their audibility are known as *Śruti.*

Mataṅga in *Brihaddeśi* says:

श्रूयन्त इति श्रुतिः

श्रु श्रवणे चास्यधातोःक्तिन् प्रत्यय समुद्भवः।

श्रुतिशब्दः प्रसाध्योयम् शब्डग्नैः कर्मसाधनः॥

śrūyanta iti śrutiḥ

śru śravaṇe cāsyadhātoḥktin pratyaya samudbhavaḥ।

śrutiśabdaḥ prasādhyoyam śabdagnaiḥi karmasādhanaḥ।।

The root *Śru* joined with क्तिन् Verb Affix will form the word *Śruti.* That which is audible is termed as *Śruti. Śruti* is that audible sound, free from resonance, devoid of tonal color. Resonance is the essential characterícstic of *Svara.* The least but audible difference between two consecutive notes or *Svara* is defined as *Śruti. Śruti* is conceived both as a "musical interval" which make up the notes of the octave and as a pitch position. The term *Śruti* is used in another sense also. The range in which a person's voice is easily negotiable in three octaves namely *mandra* (lower), *Madhya* (middle) and *Tāra* (upper octave) is called *Śruti* of the voice. The base note chosen by the singer or player (in the case of instruments) is called the *Ādhāra Śadja* or *Ādhāra Śruti.* Once the base note is fixed, all the other notes fall into allotted places automatically. This is the reference to which other instruments and tänpura are tuned. In western style, this base note is fixed and all the instruments are tuned accordingly, to create harmony and synchronization (Vasanthamadhavi. 1995).

The word *Śruti* means 'that which is heard' i.e. ' the audible'. The Sanskrit word *Śruti* is rendered into English as ' microtone'.

2.5.3 Swara

स्वतो रंजयति श्रोत्रु चित्तम् सस्वरमुच्यते ।

श्रुत्यनन्तर भावेयः स्निग्धोऽनुरण्नात्मकः ॥

svato rañjayati śrotru cittam sasvaramucyate।

śrutyanantara bhāveeyaḥ snigdhoa'nuraṇnātmakaḥ।।

(S. R., Vol: 1, Sec: 3, vs: 24)

Svara is defined as the sound which is revealed immediately after the *Śruti*. Creamy and smooth, resonating and which by itself gives pleasure to the listener.

The essential difference between *Śruti* and *svara* is implied in here. When a string of the veena is plucked the very first sound produced is considered to be *Śruti* and the very next sound following it which is resounding of the *Śruti* is called svara. In other words whereas *Śruti* is essentially free from resonance, resonance is the essential character of the *svara*.

शड्जम् ऋशब्गांधारम् मध्यमम् पंचमस्तथा ।

दैवतम् निशादश्चैव सप्तस्वर विधेयते ॥

निशादर्शभ गान्धार शड्ज मध्यम दैवताः ।

पंचम्स्चेत्यमी सप्ततंत्री कंठोत्तिता स्वराः ॥

śaḍjam ṛśabgāndhāram madhyamam pañcamastathā।

daivātam niśādaścaiva saptasvara vidheeyate।।

niśādarśabha gāndhāra śaḍja madhyama daivatāḥ।

pañcamscetyamī saptatantrī kaṇṭhottitā svarāḥ।।

(Amarakośa Nātyavarga)

Śaḍja, Riśabha, Gāndhāra, Madhyama, Pañcama, Daivata and Niṣāda are the seven svaras which is named after the first letter, namely *sa, ri, ga, ma, pa, dha, ni*. These can be produced by strings as well as voice.

Mataṅga in *Brihaddeśi* gives the reasons for the naming of the *svaras as sa, ri, ga, ma, pa, dha, ni*.

षण्णाम् स्वराणाम् जनकः षड्ःभिर्वा जन्यते स्वरैः ।

षढ्भ्योर्वा जन्यतेंगेभ्यः षड्ज इत्यभिधीयते ॥

ṣaṇṇām svarāṇām janakaḥ ṣaḍḥbhirvā janyate svaraiḥ।

ṣaḍhbhyorvā janyateṅgebhyaḥ ṣaḍja ityabhidhīyate।।

Śaḍja is the precursor of the six other notes. It is produced by six organs of the body, the nostril, the throat, the palate, the heart, the tongue and the teeth.

प्राप्नोति हृदयम् शीघ्रमन्यस्मादृषभः स्मृतः ।

स्त्रीगवीषू यथातिष्ठन्विभाति ऋषभे महान् ॥

स्वरग्रामे समुत्पन्नः स्वरोयमृषभःस्तथा ।

prāpnoti hṛdayam śīghramanysmādṛṣabhaḥ smṛtaḥ।

strīgavīṣū yathātiṣṭhanvibhāti ṛṣabhe mahān।।

svaragrāme samutpannaḥ svaroyamṛṣabhaḥstathā।

Ṛṣabha is called so because it quickly appeals to the heart or as among the herd of cows a bull appears to be distinctly strong, so also in the group of notes *Ṛṣabha* is strong and noticeable.

वाचम् गानत्मिकंदत्त इति गान्धार सञ्ञकः ॥

vācam gānatmikandatta iti gāndhāra sajñakaḥ।।

Gāndhāra is called so because it hold musical speech.

स्वराणाम् मध्यमत्वाच्च मध्यम स्वर इष्यते ॥

svarāṇām madhyamatvācca madhyama svara iṣyate||

Madhyama is so called because it is in the center of the seven notes having three on either side.

स्वरांतराणाम् विस्तारम् यो मिमीते स पंचमः ।

पाठक्रमेण गणने संख्या पंचमोतथा ॥

svarāntarāṇām vistāram yo mimīte sa pañcamaḥ।

pāṭhakrameṇa gaṇane saṅkhyā pañcamotathā||

Pañcama is that which measures the extent of other notes; or it is so called because it is fifth from the fundamental note.

धीरस्यास्तीति धीमस्तत् संबंधी धैवतः स्मृतः ।

षष्टस्थाने धृतो यस्मात्तेनासौ धैवतो मतः ॥

dhīrasyāstīti dhīmastat sambandhī *dhaivataḥ* ***smṛtaḥ***।

ṣaṣṭasthāne dhṛto yasmāttenāsau dhaivato mataḥ||

Dhaivata which comes in the sixth position and that which invokes courage and valence.

निशीदंति स्वरास्सर्वे निषादस्तेन कथ्यते ॥

niśīdanti svarāssarve niṣādastena kathyate||

Niṣāda is so called because the notes of the scale come to a close with it.

Production of the tones imitating birds and animals

शड्जम् मयूरो वदति गावो वर्दन्तिचऋशभम्।

अजाविकम् गान्धारम् क्रौंचः कृणति मध्यमम्॥

पुश्प साधारणे काले पिकः कूजन्ति पंचमम्

दैवतम् हि एश तेवाजि निषादम् बृंहते गजः॥

śaḍjam mayūro vadati gāvo vardanticaṛśabham।

ajāvikam gāndhāram kraūñcaḥ kṛṇati madhyamam।।

puśpa sādhāraṇe kāle pikaḥ kūjanti pañcamam

daivātam hi eśa tevāji niṣādam bṛṁhate gajaḥ।।

The seven notes commending with *śaḍja* are produced respectively by the peacock, Bull, goat, heron, cuckoo, horse and the elephant.

The 22 Śruti system

Bharatanātyaśāstra in Chapter, 28, verses 23 says:

चतुश्चतुश्चतुश्चैव शड्ज मध्यम पन्चम द्वैद्वै।

निशाद् गान्धारौ त्रिश्रि ऋशभ धैवतश्च॥

catuścatuścatuścaiva śaḍja madhyama pancama dvaidvai।

niśāda gāndhārau triśri ṛśabha dhaivātaśca।।

In the 22 *Śruti* system, each *svara* ri, ga, ma, **dha** and **ni** has four *Śruti*s. SA and **pa** have only one *Śruti*, to a total of 22.

We can arrive at these *Śrutis*, by taking the cycles of fourth and fifths in progression. In the cycle of fifths, the frequency of Sa is multiplied by 3/2 giving pa. Again when **pa** is multiplied by *3/2* we get **ri** (*Catur Śruti Ṛśabha*) of the next octave. In the cycle of fourths, the frequency of Sa is multiplied by *4/3* giving *ṛśabha madhyama* ma. When ma is multiplied by 4/3, we get *śuddha niśāda*. We can repeat this cyclic operation to get the other *svarās* in the 22 *Śruti*. The names of the 22 *Śruti* and their frequency ratio are given *in the table 2.4. This method of finding the 22 Śrutis was put forward by Bharata. The present day teaching is based on this theory. The name of the 22 Śrutis list Śaḍjam Sa 1, Ekaśṛuti Ṛśabham R1, Dvisṛuti Ṛśabham R2 , Trisṛuti Ṛśabham R3, Catuśṛuti Ṛśabham R4, Śuddha Gāndhāram G1, Sādhāraṇa Gāndhāram G2, Antara Gāndhāram G3, Cyuta Madhyama Gāndhāra G4, Śuddha Madhyama M1, Tīvra Suddha Madhyamam M2 , Prati Madhyamam M3, Cyuta Pañcama Madhyama M4, Pañcamam Pa, Ekasṛuti Dhaivatam D1, Dvisṛuti Dhaivatam D2 , Trisṛuti Dhaivatam D3, Catusṛuti Dhaivatam D4, Śuddha Niśādam N1, Kaiśiki Niśādam N2, Kākali Niśādam N3, Cyuta Śaḍja Niśādam N4. (James, K. N. 2008).*

Classification of Śrutis

Śrutis have been categorized into five different classes. These are *Dīpta, Āyata, Karuṇa, Mṛdu* and *Madhyā.*

Dīpta, Āyata and Madhya are found in *Śaḍja; Karuṇa* and *Mṛdu* find a place in *Ṛśabha; Dīpta* and *Āyata* are located in *Gāndhāra* and also in *Madhyama* along with *Mṛdu* and

Madhyā; Āyata and Karuṇa are placed in *Pancama*, and *Āyata, Karuṇa* and *Madhyā* in *Dhaivata;* while *Dīpta and Madhyā* in *Niśāda.*

(S. R., Vol: 1, Sec: 3, v: 27c – 31a) (Shringy, R., K. & Sharma, P. 2007)

Twenty two *Śrutis* have distinguished into five classes based on the relationship of the notes and the rasäs or the aesthetic colors attributed to them in the ancient theory of Indian music. This is implied in their classification as under:

1. *Dīpta* means illumined
2. *Āyata* Vast
3. *Mṛdu* tender or soft
4. *Madhyā.* Moderate otherwise central
5. *Karuṇa* Compassion

The subdivision of these classes is as follows positioned among different svaras:

Dīpta is said to be fourfold *Tīvra, Raudrī, Vajrika* and *Ugrā.*

Āyata is said to be fivefold *Kumudvatī, Prasāriṇi, Sandīpinī, Rohiṇī,* and *Krodha.*

Karuṇa is said to be threefold *Dayāvatī, Ālāpini,* and *Madantika.*

Mṛdu is said to be fourfold *Mandā, Ratika, Prīti,* and *Kṣiti*

Madhyā is said to be sixfold *Candovati, Rañjani, Mārjani, Rakta, Ramyā,* and *Kṣobhiṇi (*S. R., Vol: 1, Sec: 3, v: 31b – 35a) (Shringy, R., K. & Sharma, P. 2007)

Candovati, Kumudvatī, Mandā, and *Tīvra* pertain to *Śaḍja;*

Dayāvatī, Ratika and *Rañjani* pertain to *Ṛśabha;*

Raudrī and *Krodha* pertain to *Gāndhāra;*

Vajrika, Prasāriṇi,Prīti and *Mārjani* abide in *Madhyama;*

Ālāpini, Rakta, Sandīpinī and *Kṣiti* are in *Pancama;*

Madantika, Rohiṇī and *Ramyā* are in *Dhaivata;*

Ugrā and *Kṣobhiṇi* are in *Niśāda. (*S. R., Vol: 1, Sec: 3, v: 35b – 38) (Shringy, R., K. & Sharma, P. 2007)

Three sthanās or Registers of svarās

ते मंद्रमध्यतारास्थान्भेदात्त्रिविधा मताः।

te mandramadhyatārākhyasthānbhedāttrividhā matāḥ.

*(*S. R., Vol: 1, Sec: 3, v: 39ab)

These ***svarās*** are considered as threefold, according to the different registers known as mandra, Madhya, and tārā i.e. low, medium and high.

Types of svarās

चतुर्विधाः स्वरा वादि संव्ब्रदि च विवाध्यपि।

अनुवादि च व्ब्रदि तु प्रयोगे बहुलः स्वरः॥

caturvidhāḥ svarā Vādi saṁvādī ca vivādhyapi।

anuVādi ca vādī tu prayoge bahulaḥ svaraḥ।।

(S. R., Vol: 1, Sec: 3, v: 47c)

The notes are fourfold i.e. Sonant, consonant, dissonant and assonant notes. The Sanskrit name for sonant is *Vādi* which literally means speaker, i.e. the note frequently sounds. Consonant or *saṁvādī* literally means corresponding note, the note that converses in tune with the sonant with the *Vādi. Vivādi* literally means opponent, the disputant i.e. the note of discord. *Anuvādi* literally means that which sounds afterwards, which follows i.e. the note that supports the sonant.

In ancient times men used to imitate the sounds of birds and animals. As described above, *śadja* ***sa*** from Peacock, *ṛsabha* ***ri*** from Bullock, *gāndhāra* ***ga*** from Goat, *madhyama* ***ma*** from Jackal, *pancama* ***pa*** from Cuckoo, *dhaivāta* ***dha*** from and *niśada* ***ni*** from Elephant. They expressed their intimate stance to the Supreme or to Mother Nature with their own tunes & words. Initially, it was through the medium of single notes and simple rhythms. With the dawn of civilization their music was gradually evolved further with notes having grace and emotional sentiments

(Prajïänanda, Swami. 1973). *Śruti* is conceived both as a "musical interval"' which make up the notes of the octave and as a pitch position. The seven *svarās* have innumerable number of śrutis, many of which are difficult to identify except in an emotional or in a psychological sense. This accommodation of *śrutis* intensifies the *bhāva* in a *Rāga* which assumes immense significance in Indian system of music. The Indian *svarās* accommodates its semitones, harmonics etc., (called *anusvarä*s) to express themselves at appropriate places, but also glorifies their presence as *sine qua non* for determining a *Rāga* (Sairam, T. V., 2004). The seven tones or notes or *svarās* are divided into 22 microtones or *śrutis*. Each of the note or swara either lowered or raised in pitch , are known as komal or tīvra respectively. In fact

komal or tivra gives indication of the postion of a note – either higher or lower than its original position. *Śadja* and *pañcama* are two steady notes having no distortion or displacement. *Ṛśabha, Gāndhara Madhyama Dhaivata* and *Niśāda* are accepted as having two forms, one high and one low. Now we have a total of 12 notes (7 sharp + 5 flat) (Prajïänanda, Swami. 1973).

In Hindustāni Saṅgīta Paddhati (Ist part page 31), Bhatkhande has discussed the 12 *svarās* of North Indian music with the corresponding *svarās* of South Indian music. (Shobhana Nayyar. Contributions of Bhatkhande). We have also listed the corresponding notes from Solfège of the Western music system (Bhattacharjee, A., & Srinivasan, N. 2011).

Table 1 Corresponding North Indian *svarās*, South Indian *svarās*, Solfege and Western Notes.

	North Indian Svarās	***South Indian Svarās***	***Solfege***	***Western notes***
1	*Sa*	*Sa*	*Do*	*C*
2	*Komal Ri*	*Śuddha Ri*	*Re (flat)*	*Db*
3	*Śuddha Ri*	*Panchaśruti Ri or Śuddha Ga*	*re*	*D*
4	*Komal Ga*	*Shatśruti Ri or Sādhāran Ga*	*mi(flat)*	*Eb*
5	*Śuddha Ga*	*Antar Ga*	*mi*	*E*
6	*Śuddha Ma*	*Śuddha Ma*	*fa*	*F*
7	*Tīvra Ma*	*Prati Ma*	*Fa (sharp)*	*F#*
8	*Pa*	*Pa*	*sol*	*G*
9	*Komal Dha*	*Śuddha Dha*	*La (flat)*	*Ab*
10	*Śuddha Dha*	*Panchaśruti Dha or Śuddha Ni*	*la*	*A*
11	*Komal Ni*	*Shataśruti Dha or Kaiśiki Ni*	*Si (flat)*	*Bb*
12	*Śuddha Ni*	*Kākali Ni*	*si*	*B*

2.5.4 Rāga

Mataṅga in *Brihaddeśi*

योऽसौ ध्वनिविशेषस्तु स्वरवर्ण विभूशितः ।

रंजको जनचित्तानम् सराग कथितोबुधैः ॥

रंजक स्वर संदर्भो सराग इत्यभिधीयते ।

स्वरवर्ण विशिष्टेन निभेदेन वा पुनः ॥

रज्यते एन सत्चित्तम् सराग सम्मतम् सताम् ॥

yo'sau dhvaniviśeṣastu svaravarṇa vibhūśitaḥ।

rañjako janacittānam sarāga kathitobudhaiḥ।।

rañjaka svara sandarbho sarāga ityabhidhīyate।

svaravarṇa viśiṣṭena nibhedena vā punaḥ।।

rajyate ena satcittam sarāga sammatam satām।।

That particular sound which is embellished by musical tones and the movement of tonal patterns and is thereby delightful to the people's mind is called *Rāga.* It is used general sense of emotional color or aesthetic enjoyment or pleasure.

Rāga is *Svara Sanniveśa i.e.* Melodic patterns of the *Svara*. The word *Rāga* is derived from the root *Ranj* in Sanskrit means to please. Further, its general lexical meaning is also an emotion, color and so on. Analogously, a melody is a flow of sound up and down, with various rhythmic distributions. When we abstract these characteristics and make a type, it becomes *Rāga* – musical language (Sharma, M. 2007).

ग्रहांश्च मंद्रतारंस्च न्यासऽपन्यासकौ तथा ।

अभि सन्यास विन्यास बहुत्वम् चाल्पथा तथा ॥

grahāṁśca mandratāraṁsca nyāsa'panyāsakau tathā।

abhi sanyāsa vinyāsa bahutvam cālpathā tathā।।

Graha, Aṁśa, Mandra, Tāra, Nyāsa, Apanyāsa, Vinyāsa, Bahutva and *Alpatva* are the ten features *of Rāga.* Among these *Graha, Aṁśa,* and *Nyāsa* are important.

The note from which the composition begins is *Graha.* It is the trend setter*;*

Aṁśa is the *svara* which is frequently used to bring the essence of the *Rāga; Nyāsa svara* is the note with which a piece or unit comes to a close. This is also the note which helps elaboration of a *Rāga* by breaking the whole of the *Rāga* into convenient units. (Vasanthamadhavi. 1995).

Rāga cannot be formed by using less than five notes and having more than seven notes. *Rāga* should have notes in in order of ascesion and descesion – *ārohaṇ and avarohaṇ*, otherwise its variety cannot be ascertained. It is necessary to know the catch note (*Pakad*) of a *Rāga* which establishes its characteristic note denoting its identity. This enables one to intellectually grasp the minute differences between hundred *Rags.*

Rāga can be broadly classified under three categories

a. *Auḍava* – comprising of five notes (pentatonic)
b. *Śāḍava* – comprising of six notes (hexatonic)
c. *Sampūrna* – comprising of seven notes (heptatonic) (Nayar, S. 1989).

2.5.5 Tāḷa

Rhythm plays an important role in human life. Regularity is the order of the nature. The planets move around the Sun in regularity. They also move around the Sun in regularity. The entire Universe is bound by strict rules of regularity. The speed of the rhythm is measured through *Tāḷa.* The Indian *tāḷa* or time measure is more difficult to master than the melody or the *Rāga* itself. But since the *rāgā* is sung strictly in the *Tāḷa,* a person cannot know in any sense the Indian music until he masters the techniques of the *Tāḷa* (Sharma, M. 2007).

The Sanskrit word *Tāl̤a* seems to be derived from the word *Tāl̤a* or *Kara Tāl̤a* or the beating of the palm. The large family of drums, cymbals and bells are the logical development of the concept of keeping of rhythm by clapping of hands or stamping of feet, or striking of wooden or bamboo sticks (Prajïänanda, Swami.1973).

Rhythm has three aspects: *Tāl̤a, Laya* and *Mātra*. *Tāl̤a* is a complete cycle of Metrical phrase composed of a fixed number of beats. The *Laya* is the tempo, which keeps the uniformity of time span, and it has three divisions – *Vil̤ambita* (slow), *Madhya* (Medium) and *Dhṛta* (fast). The *Mātra* is the smallest unit of the *Tāl̤a* (Bigamudre, C., D. 1973).

Laya is a continuous movement in space of time. *Tāl̤a* puts a limit to time by dividing the time at a certain desired interval. The constant interval between two ticks of a second is *Laya*; the minute, which measures sixty seconds is the *Tāl̤a* (time cycle), while the second is time unit, the *Matra* (the beat) (Sharma, M. 2007).

Pārśvadeva in Saṅgīta Samaya Sāra says

ताळ शब्दस्य निश्पत्ति प्रतिषर्थेन धातुना ।

स तालः कालमनम् यत् क्रियया परिकल्पितम् ॥

tāḷa śabdasya niśpatti pratiṣarthena dhātunā।

sa Tāḷaaḥ kālamanam yat kriyayā parikalpitam।।

Bharata has described Music as स्वरताळपदात्मकः *svaratāḷapadātmakaḥ* which means a composition which is comprised of the *svara, tāḷa, padā* i.e tone, metre and verse.

Pārśvadeva in Saṅgīta Samaya Sāra says

ताळमूलानि गेयनि ताळे सर्वम् प्रतिष्टितम् ।

ताळहीनानि गेयम् मंत्रहीन यताहुति ॥

tāḷamūlāni geyani tāḷe sarvam pratiṣṭitam ।

tāḷahīnāni geyam mantrahīna yatāhuti ॥

Every type of music is dependent on the *tāḷa.* Rendering musical composition without *tāḷa* is like offerings made to the Supreme without a hymn.

हस्तद्वय्स्य संयोगे वीयोगे चापि वर्तते ।

hastadvaysya saṁyoge vīyoge cāpi vartate;

Tāḷa is a measure of time in music. It regulates the relative duration of musical sounds. Time measured by the beats of the hand is called *tāḷa* **(**Sampathkumaracharya, V. S., & Ramaratnam, V. 2000)**.** *Tāḷa* has two parts *saśabdha Kriya* and *Niśśabdha Kriya.* A beat

stands for a *saśabdha Kriya; Niśśabdha Kriya* is represented in the turning of the palm and counting on the fingers (Vasanthamadhavi. 1995).

2.5.6 Rasa

In the musical sense the term *Rāga*, came to use as a group of notes having specific frequencies roused a particular feeling. With the background of *Śruti, the emotional effect of a Rāga* was clearly perceived. When the mind becomes stand still or fixed in a particular aesthetic feeling or mood. This experience becomes *Rasa.* भावस्मरणम् रसः *Bhāvasmaraṇam Rasa ḥ. (*Murthy, P., S. 2006). This marks an important landmark for emotional healing through Indian music.

The basis of *Rasa* is emotional state (*bhāva*) or feeling; the seat of emotion is mind or psyche. Indian poetics have classified and anatomized the different layers of the mind. It gives a detailed account of emotional state *(bhāva*), dominant state (*sthāyi bhāva*), determinants (*vibhāva*), consequents (*anubhāva*) and transitory state (*sanchāri bhāva*). These various *bhāvas* are ultimately crystallized into one final *Rasa. Bhāvas* are the mental states caused by particular circumstances or happening. Both *Rasa* and *bhāva* are complementary to each other. In Rasa theory, *bhāva* has been used in a broad sense to include such emotional states as feeling (*anubhūti*), mood (*manaḥ sthitiḥ*), sentiment (*bhāvana*) and impulse *(vṛtti or āvega*). In other words *bhāva* in Rasa theory is a broad term and it is used in the sense of emotional tendencies (*bhāvātmaka pravṛtti*)(PRasa d, G. 2007).

According to the *Nātyaśāstra* (dramaturgy) of *Bharata* (second century BCE to the second century CE), "*Rasa* (literally, flavor or relish) is the seed and the fruit of the arts." The arts

generate and consolidate moods, sentiments, and emotions (*Rasa*), freed from the fluctuations of fleeting desires and impulses, focus and diffuse these in the minds and hearts of the people. The consolidation and evocation of Rasa, then, represent the function of all fine arts. This is the central conception in India since *Bharata Nātyaśāstra* first expounded the doctrine of *Rasa* with its eight categories, viz., love or happiness, gaiety or humor, compassion, fury, valor, awesomeness, loathsomeness, and wonder. From the third or fourth century onwards silence or tranquility was not only added as the ninth category but considered as the supreme *Rasa* . This ninth Rasa is the culmination of all other *rasās* and is one of transcendental quality. All Indian arts, including music, attempts at transcendence and is thus are of unique quality; every Rasa has a corresponding method and a path leading a person on to experience reality as defined in Indian philosophies (Mukerjee, R. 1965).

शृन्गार वीर करुणाद्भुत हास्यभयानकः ।

बीभत्सस्च तथा रोद्रो नात्येद्य्श्तो रसाः स्मृतः ॥

śṛngāra vīra karuṇādbhuta hāsyabhayānakaḥ।

bībhatsasca tathā roudro nātyedyśtou rasāḥ smṛtaḥ।।

Table -2 *Rasa* and the related emotions with their meaning (Merchand, P. 2006).

Rasa	**Meaning**	**Related Emotions**
1. Śṛṅgāra	Love	Beauty, Aesthetic, Sentiments, Devotion
2. Hāsya	Joy	Humor, Laughter, Sarcasm
3. Karuṇa	Empathy	Compassion, Pity

4. *Raudra*	Anger	Violence, Irritation, Stress
5. *Vīrya*	Courage	Heroism, Determination, Courage
6. *Bhayānaka*	Fear	Terror, Anxiety, Nervousness, Worry
7. *Bhībhatsa*	Disgust	Depression, Dissatisfaction
8. *Adbhuta*	Wonder	Curiosity, Astonishment, Mystery
9. *Śānta*	Calmness	Peace, Relaxation, Rest

Rasa is realized when an emotion is awakened in such a manner that it has none of its cognitive tendencies and it is experienced in an impersonal contemplative mood. *Rasa* is a realization of the ultimate truth, the fruition of aesthetic experience. The ultimate realization comes only "after the limitations of the egocentric attitude are transcended and all separate existence is merged in the unity of harmony realized" (Prasad, G. 2007). When a particular *Rasa* is depicted in a *Rāga* it touches our heart. Every art is an expression of happiness. Hence *Taittirīya Upaniṣad* states - रसो वै सः। रसम् ह्येवायम् लब्ध्वा आनंदीभवति*, raso vai saḥ*। *Rasam hyevāyam labdhvā ānandībhavati*। The happiness derived by the experience of a *Rasa* through music and poetry is not material. It is transcendental inner happiness which takes away the pain and miseries. When a musician and the listener is deeply immersed in such expereinces of *Rasa*, it is called as *Rasa vāda* by *Abhinavagupta*. (Sampathkumaracharya, V. S., & Ramaratnam, V. 2000).

Svara and Rasa

शड्जस्याद्भुतवीरो ऋषभस्य च रौद्रकः ।

गान्धारस्य च शान्तम् च हास्याख्यम् मध्यमस्य ॥

पंचमस्य च शृन्गारो भीभत्सो दैवतस्य च ।

करुणा च निषादस्य सप्तस्थानरसा नव ॥

śaḍjasyādbhutavīrou ṛṣabhasya ca raudrakaḥ।

gāndhārasya ca śāntam ca hāsyākhyam madhyamasya।।

pañcamasya ca śṛngāro bhībhatso *dhaivatasya* ***ca***।

karuṇā ca niṣādasya saptasthānarasā nava।

(Sangīta Makaranda (1st pāda 47 48))

- *Sa* and *Ri* creates *Vīra, Raudra, and Adbhuta Rasa*
- *Dha* creates *Bhībhatsa Rasa*
- *Ga and Ni* creates *Karuṇa Rasa*
- *Ma and Pa* creates *Hāsya and Śṛṁgāra*

Rāga and Rasa

- *Saṁdhi Prakāś Rāgās* having ***Ri dha Komal –*** *Śānta* ***and*** *Karuṇa Rasa*
- *Rāgās* having *Ri Dha tīvra - Śṛṁgāra* ***Rasa***
- *Rāgās having Ga Ni Komal – Vīra Rasa*

Tāḻa and Rasa

The piece of melody ***in*** *Vīra, Raudra Rasa must be in* dhṛta *Laya* or quick tempo; Pathetic or *Karuṇa Rasa* depiction should be in *viḻambita Laya. The* tāḻās like *ādi, rūpaka and cāpu* are helpful in producing the required Rasa (Murthy, P., S. 2006).

2.5.7 Thāta or *Meḻa*

Thāta means a scale of sequentially – arranged all seven notes in the ascending order, and all seven notes in the descending order. The scales were known as *meḻās, Thātās* or *meḻakartās* and they suggest the idea of steps or laddere (Latin- scala), which suggests the gradual arrangements of tones, so as to form a basic structure that gives birth to various melodic forms or *rāgās.* The scale is therefore the origin or fountain head of the *rāgās.* The terms *Thāta and meḻa* was well defined by Pandit Somnath from `17th century. In fact the Sanskrit name for the origin of *rāgā* is *meḻa* which helps to assimilate different tones) and the term, *Thāta* is of the Persian origin. The idea of scale really evolved in the most ancient India in the Vedic time, because it has been found that the Vedic songs or *sāmagāna* with different tones had a fixed scale, and it was in a downward movement. *Thātās* are similar to "modes" in Western music. *(Prajñānanda,* Swami. 1973). Under the *Thāta* or *Meḻa*, there are many numbers of *rāgās* called *janya rāgās*. For the purpose of identifying a particular *Thāta* it is named after an important *rāgā* which comes under its banner. The south Indian scholar Venkatamakhi took the help of mathematics and accurately calculated the maximum number of *Thātās* as 72 which could be possibly produced from one gamut. (the full range of pitches in a musical system) As for practical purposes Venkatamakhi took 19 *Thātās* in use Bhatkhande accepted 10 *Thātās* as the parent scale for the classification of the *Rāgās* (Nayar, S. 1989).

Thātās – similar to "modes" in Western music – are musical scales or frameworks for classifying *Rāgās* based on the notes used in the *Rāga*. It is a system in which ten complete scale of seven notes each, in ascending order, are formulated to categorize a maximum number of *Rāgās* within it. The ten *Thātās* are *Bilāwal*, *Kalyān*, *Khamāj*, *Bhairav*, *Pūrvi*, *Mārwa*, *Kāfi*, *Asāveri*, *Bhairavi* and *Todi*. Except one *Thāta*, nine out of ten *Thätäs* mentioned above share their name with nine prominent *rāgās* in Hindustani classical music. *Kalyān Thāta* is the only exception; *Yaman Rāga* and *Kalyān Thāta* corresponds to each other (Bhattacharjee, A., & Srinivasan, N. 2011).

A scale with only *Shuddha* (or natural) notes (*Bilāwal*) are equivalent to the major scale of Western classical music, i.e. the distance between the notes are tone, tone, semitone, tone, tone, tone, semitone, which will complete an octave. A scale which is natural minor scale (Aeolian mode) is equivalent to *Asāveri Rāga* (Bhattacharjee, A., & Srinivasan, N. 2011).

Carnātic music shares with the Hindustani tradition some basic fundamentals, such as the basic elements of *Śṛuti* (the relative musical pitch), *Swara* (the musical sound of a single note), *Rāga* (the melodic mode), and *Tāla* (the rhythmic pattern). Although creativeness plays an important role, *Carnātic* music is mainly sung through compositions, different from Hindustani music where improvisation is fundamental. *Carnātic* music is usually performed by a small group of musicians, consisting of a key performer (usually a vocalist), a melodic accompaniment (usually a violin), a rhythm accompaniment (usually a *Mṛdaṅgam*), and a *Tānpura*, which acts as a drone throughout the performance. Other distinctive instruments used in *Carnātic* concerts may include the *Ghatam*, *Kanjīra*, morsing, *Vīna* and flute (Koduri, G., K., Miron, M., Serra, J., & Serra, X. 2011).

Our music tradition in the North as well as in the South, treasures its origin in the *Sāmaveda Sāmavedadidam Gītam Sāmjagraha Pitāmahaḥ*: say the music treatises. The science of music, *Gandharva-Veda,* is an *Upaveda* of the *Sāmaveda*. The *Sāmaveda* is, therefore, of interest to music scholars as well as to Vedic scholars. The *Sāmaveda* is the musical version of the *ṛgveda*.

The seven notes as they arise in *Sāman* music are called *prathama, dvitiya, tṛtiya, caturtha, mandra, atsvarya, and kṛśta;* according to the *Nāradīya Śīkśa* these match to the following notes on the flute: *Ma-Ga-Ri-Sa Dha-Ni-Pa,* which gives not a straight sequence but a *vakra-gati*. It is also important to note that the *Sāman* singing, as contrasted with classical Indian music, shows notes in a descending series, *avarohaṇa krama*. Old Greek music was also in a descending series.

Seminar conducted a few years back showed that *Sāman* notes did not sound at precisely the same place of the note or *svara sthānās* that we are now familiar with in our classical music and that the *śṛuti*-values seem to be slightly different, when we compare *Sāman* -music with present classical music. According to the musicologists, the *Sāman* -scale comes under the Hindustani *Kāfi Thāta* and the *Carnātic Kharaharapriya-Mela*. The science of Indian music and the analytical study of *svarās* and *śṛutis* have evolved in subsequent times; but as the foundation of all this is the *Sāmaveda.* Above all, the high devotional and spiritual value we attach to our art of music derives from *Sāman* –singing and the Lord in Bhagavad-Gita says '*vedānām sāmavedosmi*'!

'Among *Vedās,* I am *Sāmaveda' (Prajñānanda*, Swami. 1963).

2.6 Emotional Healing through Music Therapy

Emotional healing is to ward off the negative feelings of criticism, anger, guilt and resentment and replace them with positive mental thought patterns of love, compassion, pleasantness and calmness. This is in line with the *Patañjali Yoga Sūtra*. [1:33].

मैत्री करुणा मुदितोपेक्षाणांसुखदुःख पुण्यापुण्यविषयाणां भावनातः चित्तप्रसादनम् ॥३३॥

The following fourfold attitudes to life's vicissitudes and in all relationships, being conducive to peace of mind, enable one to overcome the distractions of the mind:

(1) Friendliness towards pleasure or those who are pleasantly disposed to oneself (friends),

(2) Compassion for the one who is in sorrowful and painful condition, self-forgetful sympathy for those who may be in a similar painful condition,

(3) Rejoicing for the happiness of others or transpersonal happiness

(4) Neutrality or non-judgmental mindset towards the wicked (Swami, S., S. 2006).

For healing purposes, we may also consider individual's habits, tendencies, influences and desires, which create the pattern of our lives down to the subconscious and instinctual levels. We must willfully change the way we live, breathe, see and think, altering our very ego or sense of self in a positive way. This may be done through various tools provided in our ancient scriptures like Yoga, Music and *Mantras*. Music therapy is one of the complementary methods of healing as prescribed in *Āyurveda*, which works as Mind-Body Medicine. Here in this model of emotional healing, we have attempted to correlate the Indian melodies or *Rāgās* which brings out the positive emotions, warding off the negative ones, with that of the constitution or *Prakriti* of an individual.

Āyurveda the ancient healing system also says that, misuse of the powers and faculties of the 'mind-body' (*Śarīra* and *Manas*), results in ill-effects. Excessive indulgence, self-mortification, forceful repression of natural urges, excessive fear, grief, anger, jealousy, excessive craving, self-conceit, and deluded thinking will all have their harmful effects on a person in the long run and can cause illness. Thus '*Prajnāparadha* ' or erroneous judgment or lack of discernment is at the root of all illness directly or indirectly (Van Loon, G.1981).

When illness or disease is indicated, the body is communicating to us that our way of thinking (although unconscious) is out of harmony with what is beneficial to our being. Illness indicates the need to change in our belief system and tells us that we have reached our physical and psychological limits. Illness is thus a gift whose purpose is to bring back equilibrium in our being. The physical body does not create illness because the physical body can do nothing by itself. What maintains life is the interaction between *Ātma* and the body (Bourbeau, L. 2001).

The science of metaphysics has emerged since the advent of psychoanalysis. Freud discovered that the body and the psyche are irrevocably linked. Researchers in the field such as Wilhelm Reich, Fritz Perls and Louise Hay have greatly contributed to the resurgence of the body of information that constitutes metaphysical science.

The thought patterns that cause most diseases in the body are criticism, anger, resentment and guilt. The following table outlines some of the common ailments and its metaphysical cause, which is only due to negative thought pattern (Hay, L. 2007).

Table - 3 shows some Common Ailments, Probable Metaphysical Cause and replacement of New thought patterns (Hay, L. 2007).

Disease	**Probable Cause**	**New thought Pattern**
Arthritis	Feeling unloved; Criticism; Bitterness; Feeling not good enough	I choose to love and approve of myself; I see others with love.
Anxiety	Not trusting the flow and process of life	I love and approve of myself and I trust the process of life. I am safe.
Bronchitis	Inflamed family environment; Arguments and yelling; Sometimes silent	I declare peace and harmony within me and around me. All is well.
Back Pain	Back represents the support of life	I know that life always supports me - Courage
Diabetes	Longing for what might have been; Deep sorrow; No sweetness left.	This moment is filled with joy. I now choose to experience the sweetness of life - Love
Cancer	Deep hurts; Longstanding resentment; Carrying hatreds	I lovingly forgive and release all of the past. I choose to fill my world with joy. I love and approve of myself.
Hypertension	Longstanding emotional problems; Volcano within	I joyously release the past. I am at peace.
Insomnia	Fear; Not trusting the process of life. Guilt.	I lovingly release the day slip into peaceful sleep, knowing tomorrow will take care itself
Knee problem	Stubborn ego and pride; Inability to bend; Fear; Inflexibility	Forgiveness, Compassion, Understanding, I bend and flow with ease. All is well.
Atherosclerosis	Clogging the channels of joy. Fear of accepting joy.	I choose to love life. My channels of joy are wide open. It is safe to receive.

Chronic Diseases	A refusal to change. Fear of the future. Not feeling safe.	I am willing to change and grow. I now create safe, new few future.

It is so much easier to release these negative thinking patterns with love, peace, joy and self-approval when we are healthier than try to dig them out when we are in a state of panic. . When we can truly live from the loving space of the heart, approving ourselves and trusting the Divine power to provide for peace, then joy and we will fill our lives and illness and uncomfortable feelings will cease to be in our experience (Hay, L. 2007).

In *Ayurvedic* medicine, health comes when the forces of the body and mind are in balance, and restoring balance begins with the knowledge of the patient's mind-body type (Wujastyk, D., & Smith, F. 2008). A close interdependence among the physical and psychological components exists; if one component is out of balance, the others are also out of balance. Health care in *Āyurveda* is essentially aimed at balancing the *Dośās* and *guṇās,* bringing them into equilibrium (Mishra, L., C. 2003.)

The human body according to *Āyurveda* is made up of physical *Dośās (Vāta, pitta* and *Kapha*) and psychic components (*Satva, Rajas and Tamas*), body tissues (*dhatus*), and waste products (*malas*). The three physical *Dośās, vāta, pitta* and *kapha* corresponds to wind, fire and water respectively. The solid material substrate referred to as *kapha*; chemical activity (metabolic factor) referred as *pitta* and an energy pool of motion and movement referred to as *vāta*. These three *Dośās* coexist in a preset proportion and function in a balancing manner to the overall function of the total organism in spite of their opposite properties and functions. The imbalance or vitiation of *vāta, pitta,* or *kapha* is considered the major factor in the causation of a disease (Mishra, L., C. 2003).

The three psychological components are *Satva Guṇa, Rajas Guṇa*, and *Tamas guṇa* which can be correlated to balance, dynamic and lethargic personality traits respectively. *Satva* is the quality of love and light, it imparts faith, honesty, modesty, and truthfulness, which leads to purification of mind and body, including our emotions. *Rajas* gives rise to change, disturbing equilibrium with passion and agitation giving rise to emotional conflicts. *Tamas* leads to dullness, inertia, heaviness and emotional clinging (Frawley, D. 2000).

Āyurveda and Music therapy

According to *Āyurveda*, we must understand our own nature or constitution or *Dośa* and change our lifestyle, thinking and perception accordingly. The three major constitutional types – *Vāta, Pitta and Kapha*, exist according the three biological humors that are the root forces of life. These correspond to the three great elements air, fire and water respectively as they function in the mind-body complex. As long as these *Dośās* are in balance a person remains healthy, and it produces a subtle energy essence for the proper functioning of the body. When they are disturbed, they create the disagreeable *Rasās* of fear, anger, sadness and disgust for *Vāta, Pitta and Kapha* respectively which is psychological manifestation (Merchand, P. 2006). We have listed below the physical aspects of these Disturbed *Dośās* which manifests as Psycho- somatic ailments (Mishra, L., C. 2003).

Table 4 Correlation between imbalance in the *Dośa* manifesting as psychological disagreeable *Rasa* and the diseases prone to:

Dośa	Balance creates	Imbalance creates	Disease Prone to
***Vāta* (Air)**	**Calmness**	**Fear and Anxiety**	Rheumatism, nervous disorders, sciatica, insomnia, dry skin, constipation, receding gums, weak bones, infertility, impotence, colic, flatulence, stuttering, ringing in the ears, irregular menstruation with cramps, varicose veins, paralysis, blood clotting, anorexia, shivering fits, poor blood circulation
Pitta (Bile)	**Smartness And Radiance**	**Anger**	Stress-related diseases; high-blood pressure; coronary diseases; thrombosis; ulcers; cancer of the stomach, intestine, and skin; Psoriasis; inflammation of the lymph system; infectious diseases; inflammation of the spleen; hepatitis, urinary tract infection; heartburn
***Kapha* (Mucus)**	**Vigor**	**Sadness, Disgust**	Nausea, colds, bronchitis, asthma, kidney stones, swollen lymph nodes, benign tumors, dropsy, goiter, lung and breast cancer, fungal infections, digestive system problems, obesity

When *Kapha* is in balance, it produces vigor otherwise called as *Ojas*, which is its essence. If *Pitta* is in balance, it makes us smarter and radiant through its essence, which is known as *Tejas*. *Vāta* is considered as the most important of the three *Dośās*. *Pitta* and *Kapha* need the

Vāta to move them to the required places throughout the body. When *Vāta* is in perfect balance, it is converted to its essence, which is Prana and produces Calmness. Hence *Prana, Ojas, Tejas* is the subtle essences of *Vāta, Kapha and Pitta* respectively- existing beyond the physical level. There is a strong relationship between these subtle essences of the *Dośās* and the development of the higher aspects of the *rasās,* such as universal love, true compassion, absolute fearlessness, and calmness (Merchand, P. 2006). *Āyurveda* recommends hearing of vocal and instrumental music pleasing to the ears, soft, sweet and agreeable for balancing *Pitta* (Ch. Vi6#17). In case of unconsciousness one should advise to use consolation and musical sounds. (Su. I. 6#85-87) (Van Loon, G. (1981).

Music is precisely calculated to have a positive effect on *Dośa* balance. The *Dośa* can be aggravated or balanced by varying melodies and rhythm. The disagreeable Rasa of sadness and disgust in *Kapha Dośa* can be substituted with agreeable Rasa of Love and compassion created by the particular *Rāga*. Similarly, Anger of disturbed *Pitta Dośa* can be overcome by peace or *Çänta Rasa* ; Fear of disturbed *Vāta Dośa* can be overcome by *Vīra Rasa* or Self assurance.

The theory of *Sāmanya Vishesha Siddhānta* is applicable irrespective of the system of medicine that is followed by a physician. This theory says - factors that are having similar properties will lead to augmentation of that particular factor. The dissimilar factors cause reduction. (Ch.Su.1/44.45.) (Van Loon, G. (1981). The disagreeable Rasa can be overcome by substituting with agreeable Rasa created through the right type of music which depicts positive emotion.

Bhatkhande, keeping in view the ancient theory of *Rasa*, has designated only four types of

Rasa – *Śṛngāra, Śānta, Vīra and Karuṇa* as the most important of all nine varieties of *rasās*. Bhatkhande classified the existing rāgās according to the Shuddha and Komal svaras used and consequently the particular rasäs or moods they were able to create. He has suggested a general rule of *Rasās* and *Rāgās* which needs further research (Nayar, S. 1989).

Table 5 Corresponding *Thāta* and the *Svarās* used and the aesthetic mood or Rasa created (Nayar, S. 1989).

Thāta	***Svaras used***	***Rasa created***
Kalyän, Bilaval, Khamaj	*Ri, Dha tīvra*	*Śṛngāra*
Bhairav, Purvi, Marva	*Ri, Dha Komal*	*Śānta and Karuṇa*
Kafi, Asaveri, Bhairavi and Todi	*Ga, Ni Komal*	*Vīra Rasa.*

In a broader sense, *Śṛngāra* is the mood in which we will be able to bring out the beauty and harmony that is present in everything. Calmness or *Śānta* is attained, when we focus on what we truly need then the winds of unnecessary desire do not create any ripples on the surface of the mind. *Vīrya* or courage is the *Rasa* of fearlessness, self assurance, determination, heroism, valor, concentration, and perfect control of body and mind. *Karuṇa* or true compassion involves the recognition that the suffering of others (as well as their joy) is also our own. True compassion is without discrimination and can be felt for humans as well as for animals, plants, or even for enemies. It makes us a kind person, extending loving kindness to every being we meet.

Love, joy, courage, calmness, wonder are desirable *Rasās* whereas anger, fear, sadness, disgust are not desirable. When a disagreeable *Rasa* prevails for a long period, the imbalance

in the biochemical environment created in our body is difficult to get rid off and may lead to disease. Maintaining an agreeable *Rasa* over a long period will stabilize our body, keeping it healthy and facilitating in curing disease (Merchand, P. 2006). Trait anger and anger suppression are more prevalent among people with hypertension than healthy individuals (Hosseini, S., H., Mokhberi, V., Mohammadpour, R., A., Mehrabianfard, M., & Lashak, N., B., 2011). *Rasa* is considered as bio-energy that is partly physical and partly mental. It is a significant link between body and mind that affects our thoughts and emotions (Merchand, P. 2006).

We have listed the *Rāgās* which balances the *Dośa* accordingly on the basis of time theory which is discussed further.

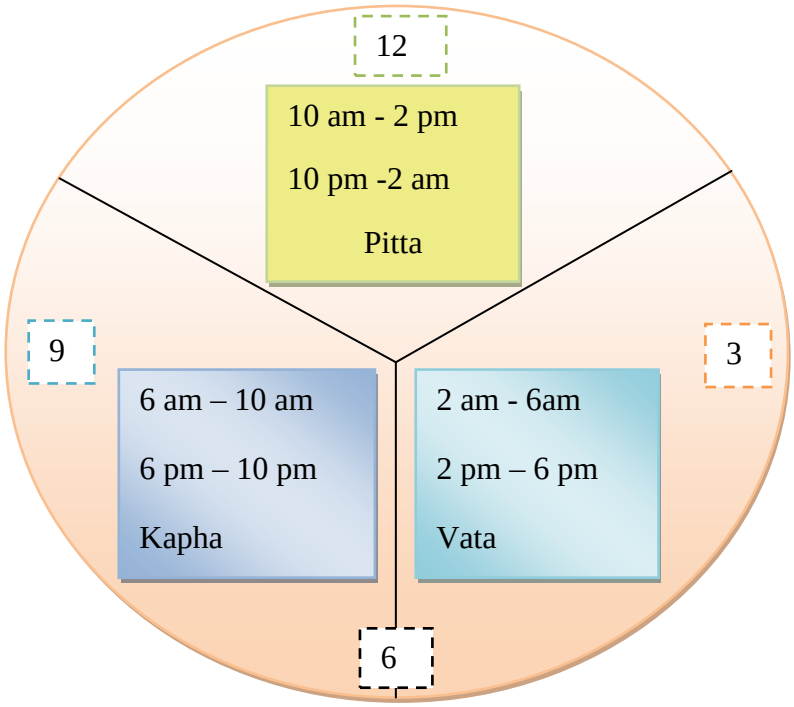
Bio- rhythm theory of Music and Ayurveda

Our ancient scholars and musician adhered strictly to the Bio- rhythm or time theory while singing a particular *Rāga*. *Sangīta Makaranda* by *Nārada*, says that the time specific *Rāga* sung at the proper time brings happiness otherwise brings disturbs the environment. The source of this concept dates back to the Vedas, especially *Yajur Veda*, deals with prescription of time and rules for the performance of *Yagnās,* or religious ceremonies (Sharma, M. 2007). *Ayurveda* also emphasis the importance of these natural cycles of the day and season. Listening to the right *Rāga* at the right time is said to smooth the natural transitions and attune the body and mind to the circadian cycle. Also, specific *Rāgās* are prescribed to balance specific *Dośās* (Clark, C., S., & Sharma, H., (2012).

It is of great importance for our study of music that *Āyurveda* also recognizes multiple cycles of time and distinguishes the specific balance between the *Dośās* existing in each section of each cycle. These factors are taken into account in diagnosis, healing as well as the guidance

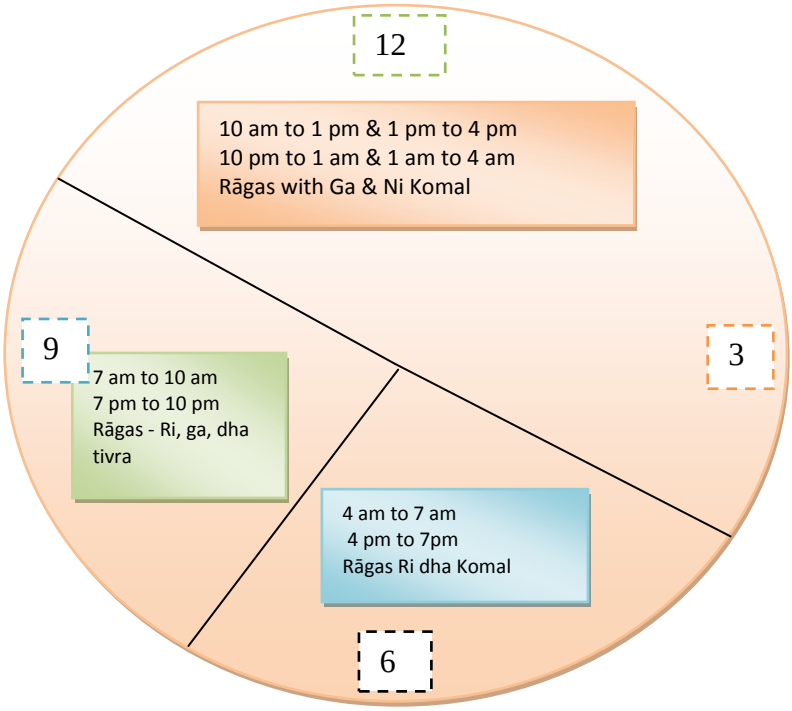
for preventing disease. During the diurnal cycle, each *Dośa* is found to predominate twice. The sequence is according to Ashtanga Sangraha (AS) #1/22.

Fig:1 Cycle of predominant *Dośa* and time



Bhatkhande has classified the *Rāgās* based on the time of singing, which may be utilized during therapeutic applications. To establish the recital times of each *Rāga,* he divided the day into eight *prahārā*s or watches, each of three hours' duration, using 4 a.m. as his starting point. He then allocated each *Rāga* to a specific *prahāra* according to its basic tonal characteristics. A simple way of categorizing *rāgās* is to divide them into three categories (Nayar, S. 1989).

Fig-2 Rāgās with specific tonal characteristics based on the time of singing



There are many points of this nature that would have to be brought out in order to arrive at a complete explanation of time-related performance practices. Following points provide an outline of the time theory or bio-rhythm theory:

1. *Rāgās* with the notes *Re* and *Dha Komal* coupled with sharp *Ga* and *Ni* are meant for the twilight time.

2. The *Shuddha Re*, *Ga* and *Dha* find a place in the melodies of the first part of the day or night.

3. *Ga* and *Ni Komal* play a significant role in the midday and midnight melodies.

4. The presence of *Tīvra Ma* is a feature of an evening or night melody.

5. A Mere change of *Vādi swara* can change a *Rāga* and also the singing time. The *Rāgās* which are sung between noon and midnight have their *Vādi Swara* in lower tetrachord or

purvānga i.*e., sa ri ga ma pa*. The *Rāgās* sung from midnight to midday have their *Vādi swara* placed in the upper tetrachord or *uttarānga i.e. sa ni dha pa ma (*Nayar, S. 1989).

Saṅgīta Sampradāya Pradarśini by Sri Subbarama Dikshitar, has given the time of singing for the South Indian *Rāgās*.

Here, we have correlated the disagreeable *Rasa*, which is the cause of disturbed *Dośa*, with the Indian *Rāgās* which instills agreeable *Rasa* within the listener in **Table – 6.**

Table 6 shows Disagreeable *Rasa* treated with agreeable *Rasa* the corresponding that and important *Rāgās* of the *Thāta (*Rao, B., S. 1956)

Disturbed Dośa	**Disagreeable Rasa created**	**Substitute Agreeable *Rasa***	*Thāta*	**Some Important *Rāgās* of the** *Thāta*	**Time**	**Timings**
Vāta	Fear	*Vīra Rasa*	*Kafi,*	*Kafi*	Any time	
				Peelu	Any time	
				Bhimpalsri	Afternoon	1pm-4pm
				Brindāvani Sarang	Afternoon	1pm-4pm
				Shuddha Sārang	Afternoon	1pm-4pm
			Asaveri	*Asāveri*	Morning	7am-10am
				Adana	Mid Night	10pm-1am
				Jaunpuri	Morning	10am-1pm
			Bhairavi	*Darbāri Kānada*	Midnight	10pm-1am
				Bhairavi	Late Morning	10am-1pm
				Malkauns	Mid Night	10pm-1am
			Todi	*Bilakshani Todi*	Morning	7am-10am
				Todi	Morning	7am-10am
				Multani	Late	1pm-4pm

					Afternoon	
				Gurjari Todi	Late Morning	10am-1pm
				Madhuvanti	Dusk	4pm-7pm
Pitta	Anger	*Śānta Rasa and Karuëa*	*Bhairav*	*Bhairav*	Early Morning	4am-7am
				Ahir Bhairav	Morning	7am-10 am
			Purvi	*Ramkali*	Early Morning	4am-7am
				Jogiya	Early Morning	4am-7am
				Purvi	Dusk	4pm-7pm
			Marva	*Paraj*	Pre- Dawn	1 am-4am
				Shri	Dusk	4pm-7pm
				Mārva	Late Evening	7pm-10pm
				Puriya	Late Evening	7pm-10pm
				Bhatiyar	Early Morning	4am-7am
				Sohini	Pre-Dawn	1 am-4am
Kapha	Sadness, Disgust	*Śṛngāra*	*Kalyān,*	*Shuddha Kalyān*	Late Evening	7 pm – 10pm
				Kedar	Late Evening	7pm-10pm
				Hameer	Late Evening	7pm-10pm
				Yaman	Late Evening	7pm-10pm
				Bhūpāli	**Late Evening**	**7pm-10pm**
			Bilawal	*Alahiya Bilāwal*	Late morning	10am -1 pm
				Bihāg	Night	10 pm -1 am
				Shankara	Night	10 pm -1 am
				Durga	Late evening	7pm-10pm

			Khamaj	*Khamāj*	Late evening	7pm-10pm
				Jinjoti	Late evening	7pm-10pm
				Kalavati	Late evening	7pm-10pm
				Desh	Late evening	7pm-10pm

Indian *Rāga Bhūpāli*, belonging to *Kalyān Thāta* which instills aesthetic mood of love **is** selected for our study**.** The combination of notes ri dha *Tīvra* used in the *Rāga* instills *Śṛngāra* rasa or the aesthetic mood of love within the listener *(*Nayar, S. 1989). It is a pentatonic scale using five swaras (in the ascending and descending scale). The Carnatic equivalent to this Raga is Mohanam and the western equivalent is C Major pentatonic scale of Lydian Mode. (Jairazbhoy, N., A. (1995). *Śṛngāra* as discussed earlier is the mood in which we admire divine nature that is present in everything. It starts from observing aesthetic sense in everything and leads to being tender and loving in thought, word and deed. We chose this *Rāga* for the residential students who are away from their parents and family to feel the Love and Beauty in small and simple things such as a smile, a little neatness, attention and harmony (Merchand, P. (2006). Music therapy is eventually to cater to the emotional vitality of the person. Emotional vitality is characterized by a sense of energy, positive well-being, and effective emotion regulation. Studies have suggested that emotional vitality may influence coronary health via health enhancing behaviors. And also the effect remained significant after controlling for health behaviors and other potential confounders, including depressive symptoms or other psychological problems (Kubzansky, L., D. & Thurston, R., C. 2007).

2.7 Summary

Music therapy is mainly using the time specific *Rāga* with a particular tonal quality to restore harmony in the physical and mental faculty and eliminate the imbalances responsible for diseases. It is a Mind Body Medicine useful to treat the body through the mind.

The term *Rāga* in the musical sense came to be used when it was found that a group of notes having specific frequencies roused a particular feeling. With the background of *śruti* the emotional effect of a *Rāga* was clearly perceived and this marks an important landmark in the history of Indian music. Scientifically, the pair of notes bearing the frequency ratios 1:2 or 2:3 or 3:4 (a note and its octave; a note and its *Pañcama*; and a note and its *Śuddha Madhyama* respectively when sounded together, gives a pleasing effect. Likewise, the notes, *Komal Ṛśabha* and *Komal Gāndhara* have a tinge of pathos. According to an established concept of *Carnātic* music the emotional effect of a *Rāga* is dependent upon the frequencies of the notes that enter into its formation as also its *Jīva svarās* and *nyāsa svarās*. The *jīva svara* is the index to the Rasa of a *rāga*. The Rasa of a Rāga changes with the shift in emphasis on notes. *Jīva svara* is given that name, the word "*Jīva*" meaning "life", because that *svara* defines the "soul" of the *Rāga*. *Nyāsa svarā* is the ending note or *svara* one can settle on either by ending a composition, or a phrase.

While expounding the *Rāga,* the *Jīva svara* is played or sung more than all other *svarās*, except the *ādhāra śruti śadja* or *sa*. In Hindustani music the *Jīva svara* is addressed as *Vādi* or sonant note, which is the note of primary importance. In most cases it is also the note most frequently used. Thus it helps in evoking the Rasa to its fullest, acting like a beacon to show

the path. Different notes determined as *Vādi* notes can express different emotions at various times of the day and night. A *Vādi* note is often addressed as the king. For the proper enjoyment of the *Rasa* of a *Rāga* or a song in that *Rāga* the atmosphere of the place should be saturated with the Ś*ruti* notes of the *T*ā*npura* or other drone. The tempo or speed of a musical composition in applied music is generally in consonance with its Rasa. Pieces in *Raudra Rasa* and *Vīra Rasa* are normally sung in *Dṛta Laya* or quick tempo. Pathetic pieces generally in *Viḷambita Laya* or slow speed. Factors like pitch, intensity, timbre, massiveness, form, grace, language, rhythm are also contributory factors

in establishing the *Rasa*. Nevertheless, it is the intention of the performer to bring out a particular *bh*ā*va* or emotion through the rendition which finally determines the Rasa that is to be expressed (Murthy, P., S. 2006).

The fundamental objective of Indian classical music is to instill *Rasa* or aesthetic mood like Love, Compassion, Self-assurance and Calmness, etc. within the listener. Thus, Music is a means for educating and healing people emotionally warding off the negative side of human nature as that of fear, anger, disgust, and insecurity, etc. The classical text lists precise times of the day for playing of different *Rāgās* or melodies. Listening to the time specific *Rāga* is said to smoothen the natural transitions and regulate the body and mind to the biorhythm cycle. It also helps to balance the biological humors or *Dośās*. The *Rāgās* that instill calmness or *Shānta Rasa* in the listener may help to pacify disagreeable Rasa of anger caused by disturbed *Pitta Dośa*. The *Rāgās* that depict the *vīra* Rasa or Courage may pacify disagreeable Rasa of fear anxiety caused by *Vāta Dośa*. The *Rāgās* that infuse love and

compassion moods may appease sadness and disgust caused by *Kapha Dośa*. This is summarized in Fig – 3 Emotional healing through music therapy – A Model.

In Western music, musical tempo seems to be associated primarily with arousal (i.e. Faster tempo is more arousing than slower tempo), musical mode is a better predictor of mood (i.e. Major and minor modes stir up happiness and sadness, respectively). Effects of tempo on an emotional assessment of music also emerge earlier in development than those of mode. In addition, tempo variations are universal, whereas the major– minor distinction is particular to Western music. As such, listeners can use the tempo (but not mode) to decode the emotions expressed by music from foreign traditions (Schellenberg, G. E., Nakata, T., Hunter, P. G., & Tamoto, S. 2007).

It is of great connotation for our study of music that *Ayurveda* also identifies multiple cycles of time and distinguishes the specific balance between the *Dośās* existing in each segment of each cycle. Apart from proper diet, herbal remedies and cleansing techniques, Ayurveda also supports special method like colors, gems, mantras and music therapy to achieve higher awareness and alter the psycho-physical environment. In the following

Fig -3 we have given the summary of music therapy through emotional healing are given.

Emotional Healing through Music Therapy - A Model

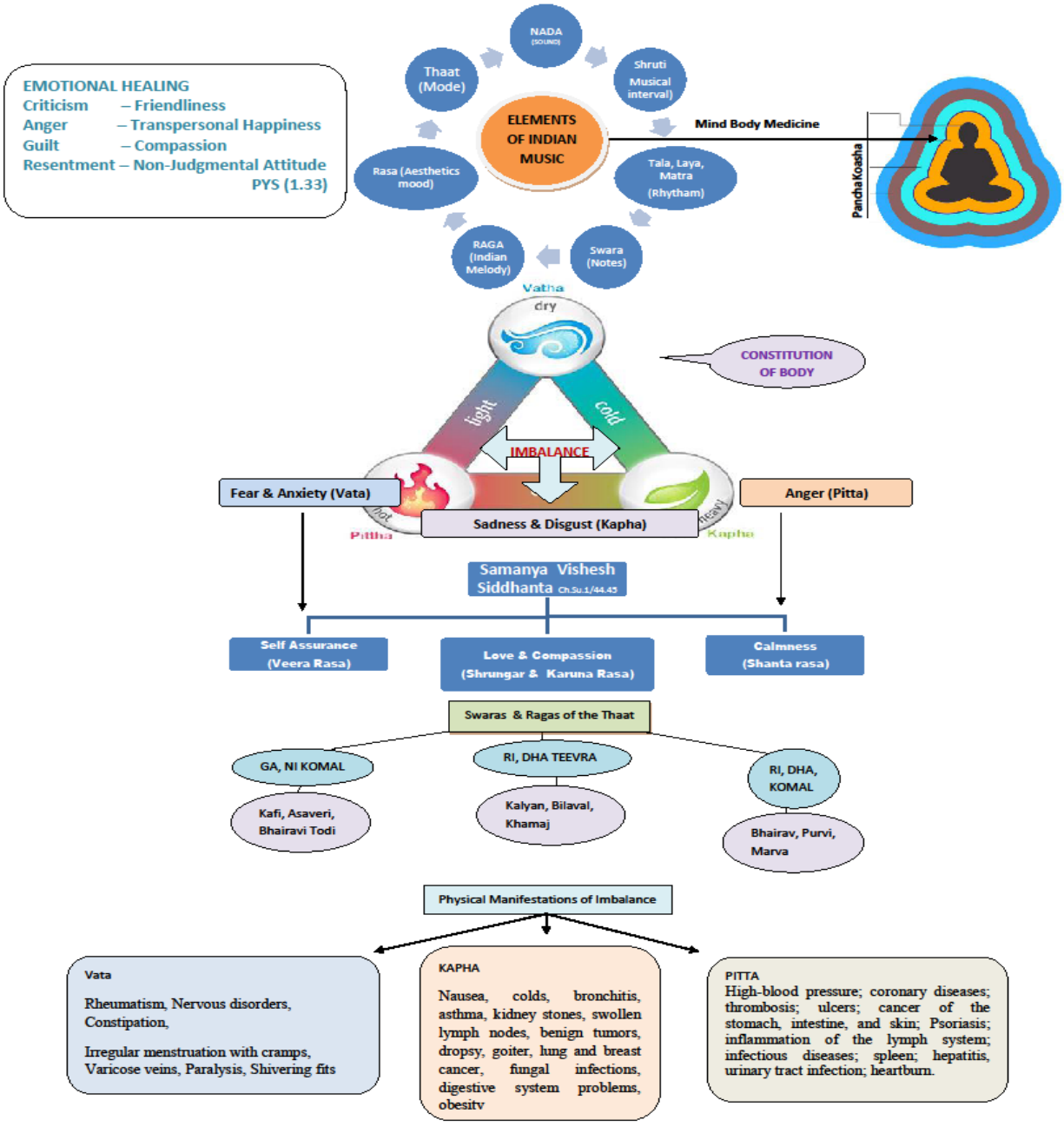


Table 7 showing Scientific studies on *Tāḻa, Rāga, Śṛuti* and *Svara*

SL NO.	Title/ Researcher / Journal/Thesis	Study	Conclusion
1.	**Meter and Tal In North Indian Music** Clayton, M. 1997).	The concept of *Tāḻa* in North Indian (Hindustani) music, and that of meter in Western music and in ethnomusicology. What is meter, What is *Tāḻa*, and to what extent do the two concepts overlap?	There are many similarities between the concept of meter as understood by Western musicologists, and that of *Tāḻa* as developed in India. The differences - the use of irregular pulse levels in India, the insistence on three or more pulse levels and the peculiarly explicit nature of *Tāḻa* are important. However, compared to the fundamental similarities between the two concepts they are relatively superficial. This is an important observation.
	A Multi pitch Approach to Tonic Identification in Indian Classical Music Salamon, J., Gulati, S., &	Tonic identification is an essential first step for most automatic scrutiny of Indian classical music, such as intonation and melodic	It presents a novel approach for tonic identification in Indian classical music. Our method is based on a multi pitch analysis of the audio signal, in which the Predominant pitches in the mixture are used to

	Serra, X. (2011).	analysis, and *Rāga* detection. In this paper, we address the task of automatic tonic identification.	construct a pitch histogram representing the most frequently played notes in the piece.
	Hindustani Rāga Representation and Identification: A Transition Probability Based Approach (Bhattacharjee, A., & Srinivasan, N. 2011).	This paper focuses on an aspect of Indian classical music called the *Rāga* system. The uniqueness of *Rāga* system is its wide scope for improvisation, which consequently poses problems for *Rāga* identification/classification.	This paper proposed a cognitively plausible representation – called Transition Probability Matrix (TPM) – for *Rāgās* and further evaluated its effectiveness in performing *Rāga* identification. We computed ten TPMs (one for each *Rāga* considered in this study) where each TPM characterizes the conditional probabilities embedded in *Svara* (i.e. musical note) sequences of a *Rāga*.
	Real Time Rāga Detection and Analysis Using a Computer (James, K. N. 2008).	The model developed in this project is capable of identifying all the 72 *Melakartha Rāgās* and also Hindustani *Rāgās* of 10 *Thātās* Performance by vocalist and instruments were tested to satisfaction.	One of the prominent achievements of this study is that it has been able to come up with a performance index for musicians, namely *Śṛuti* Consistency Coefficient (SCC) and *Rāga* Consistency Coefficient (RCC).

	Assessing the Tuning of Sung Indian Classical Music Serra, J., Koduri, G., K., Miron, M., & Serra, X. (2011).	Study of tuning in Indian classical music and its contemporary practice in singing performances of *Carnātic* and Hindustani music following an empiric and quantitative approach.	The results show that the tunings in *Carnātic* and Hindustani music differ, the former tending to a just intonation system and the latter having much equal-tempered influences. *Carnātic* music also presents signs of a more continuous distribution of pitches.

CHAPTER – 3

REVIEW OF SCIENTIFIC LITERATURE ON MUSIC THERAPY

3.0 Review of Scientific Literature on Music Therapy

3.1 Background

Mind-body medicine includes "a variety of techniques devised to facilitate the mind's capacity to influence bodily function and symptom" (Astin, J. A., Shapiro, S. L., Eisenberg, D. M., & Forys, K. L. 2003). Mind-body medicine might be defined as the conscious harnessing of positive thought and emotion and using them for the use of promoting positive health. A wide range of mind-body techniques can be used to attain a state of tranquility and affirmative focus such as biofeedback, hypnosis, guided imagery, mindfulness, music therapy, and yoga **(**McClafferty, H. 2011).

Music, which is both a science and art, is created by ordering tones or sounds in succession, in combination, and in temporal relationships to produce a composition having unity and continuity. A piece of music is a complex blend of expressively organized sound consisting of five elements: rhythm, melody, pitch, harmony and interval. These five elements are important when selecting music to invoke both psychological and physiological responses within the listener (Murrock, C J., & Higgins, P. A. 2009).

Music therapy is the use of music in clinical, educational and social situations to treat clients or patients with medical, educational, social or psychological needs. According to World Federation of Music Therapy, Music therapy is the use of music and/or musical elements (sound, rhythm, melody and harmony) by a qualified music therapist with a client or group, in a process designed to facilitate and promote communication, relationships, learning, mobilization, expression, organization and other relevant therapeutic objectives, in order to meet physical, emotional, mental, social and cognitive needs. Music therapy aims to develop potentials and/or restore functions of the individual so that he or she can achieve better intra- and interpersonal integration

and, consequently, a better quality life through prevention, rehabilitation or treatment (Wigram, T., Pedersen, I. N., & Bonde, L. O. 2002).

Music therapy employs specific musical elements such as sound, rhythm, melody, harmony, dynamic and tempo to encourage or facilitate movement, positive interactions, and/or improved emotional or cognitive states (Bernatzkya, G., Prescha, M., Anderson, M., & Pankseppb, J. 2011).

3.2 Cognitive abilities, Mental and Physical Health are associated with Emotional Response

Emotions are often viewed as short-lived, fluctuating changes in an individual's state of mind, and are associated with specific objects or situations. A range of physiological, biological, cognitive and behavioral factors are associated with emotional responses. Emotional states are distinguished from the broader concepts of "emotional episodes" and "moods." An emotional incident includes all of the events, people, and interactions that surround an individual while he or she is experiencing a particular emotion. Mood is regarded as a more pervasive, lasting, all-encompassing "emotional climate" that can control an individual's cognitions and can pervade several situations (Newell, E., M. 2005).

Positive affect and negative affect are the two primary valence dimensions of emotion, consistently analyzed right through the emotion literature. As defined in one of the studies by Watson, Clark & Tellegen, positive affect refers to the "extent to which a person feels fervent, active, and vigilant." High positive affect can be described as experiencing a state of increased energy, complete concentration, and/or enjoyable involvement. Low positive effect, on the other hand, includes feeling lethargic and dull (Newell, E., M. 2005).

There are studies that report the impact of music on physiological measures linked with emotional arousal such as electrodermal activity, heart rate and respiration rate. Brain imaging while listening to music shows the patterns of activation, which shows emotional arousal in the limbic system, including the amygdala, hippocampus, and hypothalamus, as well as parts of the paralimbic system. Some physiological measures present facts that music induces changes in emotional valence, while facial electromyography (EMG) tells that more zygomatic (smiling) activity during joyful melody compared to pathetic melody. Music listening has shown lower arousal levels to optimal levels in the presence of stressors. The participants who listen to relaxing music show faster recovery (measured with salivary cortisol levels) from a subsequent stressor compared to participants who listen to the white noise or simply rest beforehand. Studies have shown that even a 6 - month-old infants with low-baseline saliva cortisol levels show increases when they hear their mother sing, whereas infants with high-baseline levels show decreases (Swaminathan, S., Schellenberg, G., E. 2015).

Given the connection between attitudes, emotion and health, it was reported that music can facilitate stress reduction, fatigue and negative effect and enhance emotional well being and mental clarity (McCraty, R., Choplin, B., B., Atkinson, M., & Tomasino, D. 1998).

According to the "arousal and mood hypothesis", the positive effect of music on human behavior is considered to be an effect of the impact of music on mood and arousal. In particular, listening to music affects stimulation (degree of physiological activation), the frame of mind (long lasting emotions), and listener's enjoyment, which in turn influence cognitive performance (Bottiroli, S., Rosi, A., Russo, R., Vecchi, T., & Cavalini, E. 2014).

There are many studies which have shown that music wards off negative feelings and enhances performance of memory task. Recovery in the field of verbal memory and focused attention

enhanced significantly more in the music group than in the language group (listening to the audio book) and control groups. The music groups were elevated with positive mood than the control group. Music listening during the early post-stroke stage can improve cognitive recovery and prevent negative mood. (Teppo et al., 2008) Music acts as a tool for episodic memory rehabilitation on special populations with memory deficits due to frontal lobe damage such as Alzheimer's patients (Laura et al., 2014). Background music in the classroom, attending a school for children with emotional and behavioral difficulties showed significant improvement in behavior and mathematics performance for all the children (Susan, & John, 1998). Relaxing music led to better performance on arithmetic and memory tasks when compared with a no-music condition. Music that is arousing and aggressive had disrupted performance on the memory task and led to behavioral problems by the children. This suggests that the effect of music on task performance is intervened by the mood or internal environment created rather than affecting cognition directly (Susan, John, & Georgia, 2002). Mozart Sonata listening had a Positive effect on spatial abilities and mood arousal than in silence condition (Thompson, W. F., Schellenberg, G. E., & Husain, G. 2001).

Heart Rate variability (HRV) provides information regarding both Parasympathetic Nervous System (PNS) and Sympathetic Nervous System (SNS) activity, thereby permitting inferences about both inhibitory and excitatory processes in emotion regulation. As regulated emotions play a vital role in social processes and mental health (Bradley, M., Appelhans, & Luecken, L. J. (2006).

Many research have supported the link between HRV (particularly parasympathetic ally mediated HRV) and various measures and outcomes relevant to regulated emotional responding. Studies have linked greater HRV to the use of adaptive emotion regulation and coping strategies

and reduced HRV with various outcomes indicative of emotional dysregulation, such as anxiety, depression and rigid attentional processing of threat (Appelhans. B. M. & Luecken, L. J. 2006).

The activation of the sympathetic branch of the autonomic nervous system (ANS) increases heart rate while the activation of the parasympathetic branch, primarily intervened by the vagus nerve, slows it. Variation in heart rate can be caused by a variety of factors, including breathing, emotions and various physical and behavioral changes. The heart rate changes in response to internal body rhythms, many of which reveal various homeostatic control systems. In general, high HRV represents a flexible ANS that is responsive to both internal and external stimuli and is associated with fast reactions and adaptability (Leah, L., Evgeny, V., Bronya, V., Paul, L., Marsha B., & Robert P 2008).

In one of the studies, it was documented by McCraty that anger in a normal sample, elicited an increase in the low frequency and LF/HF ratio components of HRV, suggesting disruption in sympathovagal caused by the increase in the sympathetic contribution. Appreciation, on the other hand, elicited an increase in the medium frequency component and a slight increase in the LF component, suggesting more parasympathetic than sympathetic activation during the positive emotion (Newell, E., M. 2005). Emotions always have effects on the vegetative (or autonomic) nervous system, the hormonal (endocrine) system, and the immune system. Methodical knowledge of the effects that music listening and music making have on these systems is still lacking, but because of the power of music to induce and transform emotions, it is conceivable that music therapy can be used for the treatment of disorders related to dysfunctions and imbalances within these systems (Koelsch, S. 2009).

Most of the psychosomatic ailments are a result of perceived stress. Music is among those lifestyle choices that may reduce stress, protect against disease, and manage pain. Two markers

of the hypothalamic-pituitary-adrenal (HPA) axis, ß-endorphin and cortisol, were found to decrease with music interventions. Stimulating music increased plasma cortisol, ACTH, prolactin, growth hormone, and norepinephrine levels (Chanda, M., & Levitin, D. J. 2013).

3.3 Music and Cognitive Performance

In the last two decades, several studies of western music have pointed out that both musical training and music exposure experience leads to improvement in short-term and long-term verbal memory in both healthy and clinical populations (Laura F., Jean-Julien A., Makii M., Emmanuel B., & Aurelia B. 2013). Recent studies have shown that listening to music has temporarily improved performance in tests of spatial temporal abilities, attention, verbal fluency and creativity (Teppo, S., Mari, T., Sari, L., Anita, F., Seppo, S., Mikkonen, M., … Marja, H. (2008). Mozart music played in the background improved the performance in the processing speed task (Bottiroli, S., Rosi, A., Russo, R., Vecchi, T., & Cavalini, E. 2014). Children with music training have greater cognitive abilities (Corrigall, K. A. Schellenberg, E. G., & Misura, N. M. 2013). Music training improves spatial temporal reasoning, which helps to learn Science and mathematics (Rauscher, F. H., Shaw, G. L., Levine, L, J., Wright, E. L., Dennis, W. R., & Newcomb, R. L. (1997). Background music context during the encoding of verbal material modulates the activation of the PFC during encoding and, at the same time, facilitates the retrieval of the encoded material (Laura F., Jean-Julien A., Makii M., Emmanuel, B., & Aurelia, B. 2013). Listening to music prior to an attention test may produce a more efficient working rate (Shih, Y., Huangd, R., & Chiange, H. 2009). There was more improvement in spatial abilities while listening to Mozart when compared to Albinoni along with arousal and mood enhancement. Children performed drawing well while listening to familiar rhymes than to Mozart or Abinoni. (Schellenberg, G. E., Nakata, T., Hunter, P. G., & Tamoto, S. 2007) Listening to music stimulates cognitive performance, such

as language and memory. Thus, music could represent a rich and helpful source during verbal encoding and, therefore, help subsequent retrieval. Music helps older adults in memory performances by decreasing their Prefrontal cortex (PFC) activity. (Laura et al., 2014). Active Music Therapy with three months follow up brought significant improvement in changes in attention, visuomotor coordination, and verbal and spatial memory (Giovagnoli, Oliveri, Shifano, & Raglio., 2014). Speech content and fluency was better after music therapy than conversational session (Brotons, M., & Koger, S., M. 2000). Listening Music enhanced performance of an intelligence task than sitting in silence (Jenkins, J. S., 2001).

3.4 HRV with Different Genre of Music

There was a differential influence of music listening on autonomic activity; music resulted in a faster autonomic recovery after stress compared to the control group (Myriam., et al., 2013). In one of the studies, results suggest that "new age" music induced a shift in HRV from higher to lower frequencies, independently on the music preference of the listener (Santiago., et.al., 2014). Further acute exposure to classical baroque music reduced the sympathetic tone of the heart, while excitatory heavy metal music decreased the variability of the heart rate (Da Silva., et al., 2014) The techno-music with steady beats was associated with a significant increase in heart rate, systolic blood pressure and significant changes in self-rated emotional states (Gerra., et al., 1998). The effect of trophotropic (relaxing) music on heart rate and heart rate variability was investigated. The results showed that relaxing music (Bach, Vivaldi and Mozart) resulted in significant reduction of heart rate. The significance of these results may be relevant for the use of music in coronary heart disease is discussed (Escher., & Evéquoz, 1999). Listening to soft music

and inhaling Citrus bergamia essential oil (aroma therapy) was found to be an effective method of relaxation, as indicated by a shift of the autonomic balance toward parasympathetic activity in young healthy individuals (Peng, Koo, & Yu, 2013).

Human beings respond to different types of music in a variety of different ways. No clear patterns have emerged relating to physiological measures, responses to specific type of music and perceived musical experience. Though, it is evident that individuals have considerable skill in self-selecting the type of music to meet their particular needs at any specific time, including helping them to relax, making a boring task less tedious, enhancing concentration for a difficult task, or reinforcing a particular mood state, the latter not always in a positive direction (Susan Hallam, 2012). The subjects most of the time preferred Rock and Popular music which is stimulative and did not bring in the state of relaxation (Iwanaga M, 1999). McNamara and Ballard have reported that men who preferred arousing music had lower resting heart rates, but women who preferred arousing music had a higher resting heart rate (Patrick, & John, 2001). In general, high arousal or stimulative music tends to cause an increase in heart rate or pulse rate, while sedative music tends to cause a decrease. However, some researchers have found that any music, whether stimulative or sedative tends to increase the heart rate. There was a study from Iwanaga et al, which reported that heart rate decreased during sedative music, but did not change to stimulative music (Patrick, & John S, 2001). The results from previous studies are different and distinct. This may be due to differences in the methods and type of music.

It has been shown that music composed by Bach, Mozart and Italian composers is the most powerful in “treating” patients. It is possible to select the “ideal” therapy for cardiovascular disturbances, recreation and refreshment of the immune system, improvement of concentration and help with depression (Trappe, H. J. 2012).

However, the biological effects of Indian music, leading to its therapeutic efficacy are not studied adequately. In this study, we aim at studying some biological correlate of listening to a particular Indian *Rāga* or melody which instills positive aesthetic mood in the listener.

Many studies with western music have shown enhancement in the cognitive performance task. The factors influencing the performance are a selection of dependent measures, the choice of the piece of music, presentation order of the conditions. Research has shown that the specific choice of musical composition may help in the improvement of the particular cognitive task. For example the reports on Mozart effect have given varied results on various categories of spatial abilities because tasks testing the various sub-skills of the construct appear to respond differently to exposure to music (Rauscher, F. H., & Shaw, G. L. (1998). There are no previous studies reporting attention, concentration and primary working memory in healthy college students after listening to Indian *Rāga.*

Each Indian *Rāga* or melody is capable of producing a particular aesthetic mood or rasa. Depicting of a particular rasa or mood from a *Rāga* depends upon the piece of the melody, the performer, tempo, rhythm, time of rendering the piece of melody etc. The willful submission to the selected Indian *Rāgās*, brings out agreeable *rasās* (aesthetic mood) such as love, compassion, courage and calmness in the listener. This aids in emotional healing and thus used in therapeutic applications (Karuṇa, Srinivasan, & Nagendra, 2013).

Table 8 - Shows Summary of Scientific Literature review on Music and Cognitive Abilities

Author and Year of Publication	N	Design	Variable Studied	Findings
Bottiroli, S., Rosi, A., Russo, R., Vecchi, T., & Cavalini, E. (2014)	65	Self as Control Design- (Mozart, Mahler, white noise & No music)	a) Vocabulary subtest b) CES-D	Performance in the processing speed task was enhanced when Mozart's music was played in the background.
Doleugui, A., S. (2013)	32	Repeated-Measure design	Five Arithmetic Tests a) Test -1 – SM –LO, b) Toast -1- LM –LO c) Test 3 – SIL d) Test 4 – SM – HI e) Test 5 – LM - H	Classical music was not shown to enhance performance. Silence seems to be the best environment to maximize performance when engaging in cognitive activity.
Corrigall, K., A. Schellenberg, E., G., & Misura, N., M. (2013)	118	a) Correlation study	b) WAIS (Wechsler Adult Intelligence scale) c) Big Five Personality Dimensions (BFI) d) Inventory of Children's Individual Differences (ICID-S)	Children with music training have greater cognitive abilities.
Laura F., Jean-Julien A., Makii M., Emmanuel B., & Aurelia B. (2013)	22	Self as Control Design (Music and Silence)	a) Item-memory and source-memory tasks b) fNIRS (O_2Hb and HHb)	Background music context during the encoding of verbal material modulates the activation of the PFC during encoding and, at the same time, facilitates the retrieval of the encoded material.

Shih, Y., Huangd, R., and Chiange, H. (2009)	32	Randomized Controlled Trial - RCT	Chu's attention test	Listening to music prior to an attention test may produce a more efficient working rate.
Teppo, S., Mari, T., Sari, L., Anita, F., Seppo, S., Mikkonen, M., … Marja, H. (2008)	60	Randomized Controlled Trial - RCT	a) MRI b) Rivermead Behavioral memoryTest (RBMT) c) Auditory list learning task, WMS –R) d) Digit Span subtest for working memory, e) Boston Diagnostic Aphasia Examination, f) Clock Task, g) Stroop test h) Frontal Assessment Battery (FAB), i) Benson Visual retention test, j) Profile of Mood State (POMS)	The main finding was the regular self-directed music listening during the early post stroke stage can enhance cognitive recovery and prevent negative mood.
Schellenberg, G., E., Nakata, T., Hunter, P., G., & Tamoto, S. (2007)	48	Self as control Design	a) Working memory Index score of Wechsler's Adults Intelligence Scale (WAIS - 1997) b) Letter–Number Sequencing c) POMS	There was more improvement in spatial abilities while listening to Mozart when compared to Albinoni along with arousal and mood enhancement. Children performed drawing well while listening to familiar rhymes than to Mozart or Abinoni.

Thompson, W., F., Schellenberg, G., E., & Husain, G., (2001)	24	Self as control Design	a) Paper folding and cutting (PF &C) b) Profile of Mood States (POMS) c) Subjective mood arousal rating	Mozart Sonata listening had a Positive effect on spatial abilities and mood arousal than in silence condition
Sims, W., (2008)	128	Self as Control Design (4 conditions) – Fast Sung, Fast Spoken, Slow spoken, Slow sung	Cued recall task - Recalling sentences from various rhymes	Participants recalled better in slow spoken condition than other conditions, including slow song condition.
Brotons, M., & Koger, S., M. (2000)	26	Pre- post design With correlation	a) Mini Mental State examination (MMSE) b) Western Aphasia Battery (WAB)	Speech content and fluency was better after music therapy than conversational session.
Rea, C., Macdonald, P., & Carnes, G. (2010)	54	Three armed, pre & post design Classical, Pop and Heavy Metal Music.	c) STAI _AD Test Form Y d) STOMP – Short test of musical preference	Classical and Pop music increased feelings of ease, whereas heavy metal music increased feeling of nervousness and tension
Rauscher, F. H., Shaw, G. L., Levine, L, J., Wright, E. L., Dennis, W. R., & Newcomb, R. L. (1997)	78	Three group pre-post design	a) Geometric Design Task b) WPPSI_R c) (Weschlers preschool and primary scale of intelligence revised	Music training improves spatial temporal reasoning which helps to learn Science and mathematics.

			d) Object Assembly (OA) Task	
Rauscher, F. H., Shaw, G. L., & Catherine, N. K. (1993)	36	Three group pre-post design (the three groups were Music, Relaxation and Silence)	a) Stanford Binet Intelligence Scale b) Pulse Rate	The Music condition helped to improve the spatial performance than the other two conditions. The enhancing effect of music on spatial performance is temporal and does not exist beyond 10-15 minutes.
Jenkins, J. S., (2001)	84 Exp 1 - 56 Exp 2 -28	Two group pre – post (Mozart and Schubert Music) Two groups (Mozart and Story)	a) Stanford Binet Intelligence Scale; b) PF&C Task	Listening Music enhanced performance of an intelligence task than sitting in silence. Both Mozart and story listening have shown improvement in the task performance.

Table – 9 Shows Summary of Scientific Literature Review on Music and Psycho physiological variables				
Gupta, U., & Gupta, B. S., (2005)	80	RCT – Two group	a) STAI b) Four Factor Anxiety Inventory (FFAI) c) The Beck Depression Inventory (BDI) d) Alpha EEG Frequency, BP and Heart rate.	The findings of a significant increase in the post-treatment scores of the experimental group for alpha EEG frequency and significant decreases in the anxiety and depression scores indicate the relaxing and soothing effects of the instrumental music in *Rāga Desi Todi*.
Kumar, T. S., Muthuraman, M., & Krishnakumar, R. (2014)	60	RCT (30 in each group)	Overt pain reaction rating scale (OPRRS)	On completion of the study and on analysis, the *Rāgam Ānandabhairavi* had a significant effect in post operative pain management which was evidenced by the reduction in analgesic requirement by 50 % in those who listened to the *Rāgam*.

Kunikullaya, K. U., Goturu, J., Muradi, V., Hukkeri, P. A., Kunnavil, R., Doreswamy, V., ..& Murthy, N. S. (2015)	100	RCT (50 in each group)	HRV, BP and STAI	Passive listening to Indian *Rāga Bhīmphalāsri* along with conventional lifestyle modifications has a role in normalizing BP through autonomic function modification and thus can be used as a complementary therapy along with other lifestyle modifications.
Agrawal, A., Makhijani, N., & Valentini, P. (2013)	30	RCT (15 in each group)	Hear Rate Pulse Rate	The results showed that 93% of subjects experienced a decrease in heart rate following the slow song and 100% of subjects experienced an increase in heart rate following the fast song. It was concluded that there is, indeed, a relationship between tempo of the music and heart rate.
Santiago, P. L., Joaquín, D., María, N. D., Andrea, A. D., Nestor, B., Daniel, P. C., & Daniel, E. V.	25	Subjects were exposed sequentially to New Age, Romantic,	HRV	New age" music induced a shift in HRV from higher to lower frequencies, indicating sympathetic activation though it was preferred by the subjects.

(2014).		Classical & No music conditions in random fashion		
Chiu, H.W., Lin, L.S., Kuo, M.C., Chiang, H.S. & Hsu, C.Y. (2003)	68	RCT (34 in each group)	HRV, BP and STAI	There was a decrease in Ln LF, LF/HF and increase in HF nu indicating vagal tone increase in the music group.
Iwanaga, M., Kobayashi, A., & Kawasaki, C., (2005)	13	Self as Control Design in three conditions – Excitative music, Sedative music and No music.	HRV	Excitative music decreased the activation of the parasympathetic nervous system.
Da Silva, S. F., Heraldo, L. G., Antonio, A. M.S., Carlos de Abreu, L., Monteiro, C. B. M., Ferreira, C., … Vitor, E. V. (2014)	12	Self as Control Design. The subjects were exposed to classical baroque and heavy metal music.	HRV	Acute exposure to classical baroque music reduced the sympathetic modulation of the heart, while excitatory heavy metal music decreased the global variability of the heart rate suggesting sympathetic activation.

Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M., (2013)	60	RCT (20 in each group) Relaxing music (RM) Sound of rippling water (SW) Rest without acoustic stimulation (R)	a) Salivary cortisol and salivary alpha-amylase (sAA) b) Heart rate (HR) Respiratory Sinus Arrhythmia (RSA) c) Emotion Regulation Questionnaire (ERQ), Beck Depression Inventory (BDI)	Cortisol response to the stressor, was high in the RM and lowest in the SW condition. After the stressor, sAA baseline values were reached considerably faster in the RM group than in the R group. HR and psychological measures did not significantly differ between groups.

CHAPTER – 4

AIMS AND OBJECTIVES

4.0 Aims and Objectives

4.1 Aims of the Study

This study aims at investigating the effect of Indian *Rāga* (Melody) on Cardiac Autonomic Function, Psychological States and Cognitive Functions in Healthy Volunteers with that of two control groups of pop music and no music or silence.

4.2 Objectives of the Study

To investigate the effect of Indian *Rāga Bhūpāli*, Pop Music and Silence on

i) Cardiac Autonomic Function using HRV

ii) Psychological State with State Anxiety Inventory (STAI)

iii) Performance in the digit span forward and backward task of the Wechsler memory scale (WMS) that requires attention and concentration.

iv) Subjective assessment of feeling on Visual Analog Scale.

4.3 Justification of the Study

Many studies have suggested that the most common purpose of musical experiences is to persuade emotions: People use music to modify emotions, to go emotions, to match their current emotion, to rejoice or pacify themselves, and to relieve stress and rejuvenate (Patrik, & Daniel, 2008). It was reported that positive emotions are related to speeded-up recovery from cardiovascular reactivity generated by negative emotions for resilient individuals. Research has also shown that positive emotions may have beneficial physical and psychological health outcomes by serving as defensive role and thus providing a useful remedy to the problems associated with negative emotions and illness (Michele, Tugade, Barbara, Fredrickson, & Lisa, 2004). With emotional healing as the underlying mechanism,

there is no published study to the best of our knowledge that have investigated the effect of the particular Indian *Rāga* on autonomic changes, State anxiety and cognitive functions. We have used Indian *Rāga Bhūpāli* which belongs to *Kalyān Thāta*, equivalent to Lydian mode of western music (John H. Bec, 2007). Indian *Raga Bhūpāli*, which instills aesthetic mood of love, a positive feeling, may be effectively used in cardiac regulation and may also facilitate recovery from post-stress anxiety suggestive of applications as an effective music therapy. From the emotive point of view, when we can truly live from the loving space of the heart, and approving ourselves then peace and joy will fill our lives and illness and uncomfortable feelings will cease to be in our experience (Louise L Hay, 2007).

Apart from comparing silence with music sessions, a contrasting music form is used for obtaining a greater difference between one music form and the Indian form. There are also many studies in the west which has compared sedative and stimulative music. The studies of have used Mozart, Vivaldi and Bach as sedative music. We have chosen this particular composition which is a popular film based music in *Raga Bhūpāli* as a relaxing music. We have chosen POP music with steady beats as it is popular and in general much preferred by the younger generation.

Many studies with western music have shown enhancement in the cognitive performance task. Research has shown that the specific choice of musical composition may help in the improvement of the particular cognitive task. With a variety of music genres available to music listeners, it is also essential to appreciate how different types of music impact performance. There are no previous studies reporting immediate effect of listening to Indian raga on Attention and Concentration in Healthy College Students. Hence this study was planned on this rationale of looking at these outcome parameters.

4.4 Research Questions and Hypotheses

Research Question 1: *What is the immediate effect of listening to Indian Rāga 'Bhūpāli' on Cardiac autonomic Function as measured by Heart Rate Variability spectral analysis on Healthy College Students?*

Hypothesis 1 Listening to Indian *Rāga 'Bhūpāli'* subject may be influenced by the aesthetic mood of the song that depicts *shringara rasa* or love. This state of mind may in turn bring in relaxation.

Hypothesis 2: Listening to Indian *Rāga* '*Bhūpāli'* may increase cardiac parasympathetic activity which is exclusively responsible for the HF peak of the heart rate power spectrum.

Research Question 2: *What is the immediate effect of listening to Pop Music which is much preferred on Cardiac autonomic Function as measured by Heart Rate Variability spectral analysis on healthy College Students?*

Hypothesis 3: Listening to Pop music generally liked by the teenagers may be exciting have an increase in cardiac sympathetic activity responsible for the LF peak of the heart rate power spectrum.

Research Question 3: *What is the immediate effect of Silence or No music condition on Cardiac autonomic Function as measured by Heart Rate Variability spectral analysis on healthy College Students?*

Hypothesis 4: Sitting with no music or silence may not help to silence the mind or relax the mind which is responsible for the LF peak of the heart rate power spectrum.

Research Question 4: *What is the correlation between State Anxiety, Subjective assessment of feeling with Visual Analog Scale and Heart Rate Variability spectral analysis?*

Hypothesis 5: Immediate effect of listening to Indian Rāga Bhūpāli may reduce state anxiety and increase subjective feeling good in healthy college students correlating with the increased HF peak of *Heart Rate Variability spectral analysis*.

Research Question 5: *What is the immediate effect of listening to Indian Rāga Bhūpāli on working memory of healthy college students?*

Hypothesis 6: Listening to Indian *Rāga Bhūpāli* may bring relaxation which enhances the working memory of the students.

Research Question 6: *What is the immediate effect of listening to Pop Music generally preferred by youngsters on Working Memory of healthy college students?*

Hypothesis 7: Listening to Pop music generally liked by the teenagers may be exciting and distracting, may not have a positive effect on working memory.

Research Question 7: W*hat is the immediate effect of Silence or No music condition on Working memory of healthy college students?*

Hypothesis 8: Sitting with no music or silence may not help to silence the mind or relax the mind, may not have a positive effect on working memory.

CHAPTER – 5

METHODS

5. 0 METHODS

In this thesis, the changes in autonomic variables based on HRV, correlating with State anxiety (STAI) and Subjective feeling assessment (VAS) were studied in normal, healthy volunteers, both male and female following Indian *Rāga* and two control groups, Pop music and No music conditions. Additionally, we have assessed (i) attention and concentration (digit span forward and backward) before and immediately after the intervention using a section of the Wechsler memory scale (WMS).

The methodology of the research has been described using the following subheadings:

5.1 PARTICIPANTS

5.2 DESIGN OF THE STUDY

5.3 VARIABLES STUDIED

5.4 INTERVENTIONS

5.5 DATA EXTRACTION

5.6 DATA ANALYSIS

5.1 PARTICIPANTS

5.1.1 Sample Size

Thirty participants, both male and female between the age group 18 to 24 years (group mean age ± SD, 19.68 ±2. 57) were recruited by announcements in the university notice boards. A power analysis using the G-power computer program (Faul & Erdfelder, 1998) indicated that a total sample of 26 people would be needed to detect large effects (d=0.5) with 90% power

using a t test between means with alpha at .05. We recruited 30 people anticipating drop outs. The data from 28 participants in HRV (ranging from 18 to 24 years, the group mean age ± SD, 19.68 ±2. 57) and in working memory 26 participants (ranging from 18 to 24 years, the group means age ±SD, 18.84±3.53) were included for final analysis.

The details are as follows:

Sl. No.	Variable Studied	No. of Subjects	No. of recording Sessions
1.	Autonomic Variables	28	28x3= 84
2.	STAI	28	28x3=84
3.	VAS	28	28x3=84
4.	Working memory	26	26x3=78

5.1.2 Selection and Source of the Participants

Participants were undergraduate college students both male and female, age ranged 18 to 24. They were all students of Residential Yoga University. The routine of the University had prescribed time for food and sleep. The students were not provided tea or coffee as one of the rules and regulations of the University.

5.1.3 Inclusion Criteria:

(i) Have normal health based on routine clinical examination

(ii) Both female and male.

(iii) Normal to corrected vision

(iv) Age range between 18 to 24

5.1.4 Exclusion criteria:

(i) Persons with major disability and history of neurological disorder,

(ii) Persons with a history of psychiatric disturbance,

(iii) Undergoing any medication, especially which alters the function of the nervous system (including autonomic functions,

(iv) Females during menstruation,

(v) Participants with Auditory deficits assessed by checking the auditory thresholds of each ear separately,

(vi) Participants having extra systoles or Cardiac problems,

(vii) Habits of smoking or alcoholism, which may have influenced the autonomic and respiratory variables.

5.1.5 Ethical consideration

The project was approved by the Institutional ethical committee of S-VYASA University. The study protocol, the nature of the experiments and the operating mode of the instrument was explained to the subjects before providing written, signed consent (a sample copy in Appendix -1). None of them were aware of the hypothesis of the study. They were not compensated for the time and participation in the study.

5.2 DESIGN OF THE STUDY

5.2.1 Structure of Sessions

(i) Heart Rate Variability (HRV), Anxiety scores and Subjective assessment of feeling

Each subject was assessed in three sessions, to which they are randomly assigned using a standard random number table. Two of them are musical sessions and one session without music. One musical session was an intervention session with Indian Rāga '*Bhūpāli*' based on popular composition. The second - control session was with pop music with steady beats. The third – control session was silence or 'no music session'. All the three sessions consisted of three states, i.e., 'Pre' (5 minutes), 'during' (10 minutes), and 'post' (5 minutes) for HRV. The State-anxiety questionnaire (STAI) was administered before and after the sessions following HRV. The Subjective assessment of feeling (VAS) was taken after all the sessions following HRV. The assessments were made on three different days for each recording, not necessarily on consecutive days, but at the same time of the day, at the late evening time suitable for the listening the Indian *Rāga Bhūpāli*. The design is presented schematically in **Table- 10.**

Table - 10 Schematic representation of Study design for Music and Heart Rate Variability (HRV) – D1 indicates During1; D2 indicates During 2.

<table>
<tr><td rowspan="2">Pre
5 Mins
(HRV)</td><td rowspan="2">STAI</td><td colspan="2">During - Indian Rāga 10 Mins</td><td rowspan="2">Post
5 Mins
(HRV)</td><td rowspan="2">STAI,
VAS</td></tr>
<tr><td>D1 (5 Mins)</td><td>D2 (5 Mins)</td></tr>
<tr><td rowspan="2">Pre
5 Mins
(HRV)</td><td rowspan="2">STAI</td><td colspan="2">During – Pop Music 10 Mins</td><td rowspan="2">Post
5 Mins
(HRV)</td><td rowspan="2">STAI,
VAS</td></tr>
<tr><td>D1 (5 Mins)</td><td>D2 (5 Mins)</td></tr>
<tr><td rowspan="2">Pre
5 Mins
(HRV)</td><td rowspan="2">STAI</td><td colspan="2">During – No music or Silence 10 Mins</td><td rowspan="2">Post
5 Mins
(HRV)</td><td rowspan="2">STAI,
VAS</td></tr>
<tr><td>D1 (5 Mins)</td><td>D2 (5 Mins)</td></tr>
</table>

(ii) Working Memory

Assessments were made on three different days, which were not necessarily on consecutive days, but at the late evening time suitable for the listening the Indian *Rāga Bhūpāli*. The allocation of participants to the three sessions was random using a standard random number table. The sessions were Indian *Rāga* (R), Pop (P) and No Music or Silence (S). The duration of the sessions was ten minutes. The piece of music in MP3 format set for 10 minutes was administered to the subject through headphones via laptop in a sound proof room. Throughout all the sessions' participants sat comfortably on a reclining chair and kept their eyes closed. Participants were tested on the memory task before and immediately after the session. The design is presented schematically in **Table - 11**.

Table - 11 Schematic representation of Study design for Working Memory and Music

Pre Assessments	Listening to Indian Rāga *Bhüpäli* for 10 Minutes	Post Assessments
Pre Assessments	Listening to Pop Music for 10 Minutes	Post Assessments
Pre Assessments	Sitting with No music or in Silence – 10 Minutes	Post Assessments

5.2.2 Order of Sessions

The order of the three sessions was randomized for each subject using a random number table. This was done to prevent the influence of being exposed to the laboratory for the first time. The recordings were made on different days, not necessarily on consecutive days, but at the same time of the day.

5.3 VARIABLE STUDIED

The word parameter is described as 'characteristic of distribution or a relationship in the population which are estimated by statistical analysis of a sample of observation' whereas the word variable denotes measurement or attribute on which observations are made (Altman, Gore, Gardner, & Peacock, 1983). Hence, in this thesis the term variable has been used to describe the assessments studied.

5.3.1 Autonomic Variables using Heart Rate Variability (HRV)

5.3.1 A Rationale for studying Heart Rate Variability (HRV)

The HRV spectrum is believed to be a useful indicator of sympathetic activity (reflected by low frequency [LF] band power values) and parasympathetic activity (reflected by high frequency [HF] band power values) (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). In the present study, we have used autonomic balance with assessing heart rate variability to verify parasympathetic activation while listening to particular Indian *Rāga*.

Heart Rate Variability (HRV) describes the variations consecutive heartbeats. The regulatory mechanisms of HRV originate from the sympathetic and parasympathetic nervous systems in addition to other controls and hence HRV is used as quantitative markers of the autonomic control over the heart (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).

HRV was recorded by using Biopac MP 100, USA and analyzed by Kubios HRV 2.00 software. Noise free data were included for analysis. The HRV power spectrum was obtained using Fast Fourier Transform (FFT) analysis. There are several methods for the calculation of

the HRV. According to the mathematical processing they can be divided into two classes, time domain and frequency domain methods. The Time domain parameters, its physiological correlate and its frequency domain correlates are summarized in **Table 12**. In the Time domain method, the heart rate is determined at any point in time or the intervals between successive normal complexes or the instantaneous heart rate is determined. The frequency domain parameters, its frequency range and the physiological correlates are summarized in **Table – 13.** These frequency domain analyses contribute to the understanding of the autonomic background of RR interval fluctuations in the heart rate record (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology 1996).

Table – 12 Time domain parameters (Gujjar et al., 2004; Udupa et al., 2006)

Parameters	**Units**	**Description**	**Physiological Correlates**	**Frequency domain correlates**
RMSSD	ms	The square root of the mean of the sum of squares of differences between adjacent NN intervals	Both the RMSSD and pNN 50 indices are most sensitive to components. They select the changes that occur from one QRS cycle to the very next. Some evidence suggests these time domain measures are the best predictors of parasympathetic activity.	HF
NN50	Count	Count of the number of pairs of NN (Normal to normal RR) intervals differing by 50 ms		HF
Mean HR	Beats per minute	The number of contractions of the ventricles (the lower chambers of the heart).	Sympathetic and parasympathetic tone	Total power

Table – 13 Frequency domain parameters (Gujjar et al., 2004; Udupa et al., 2006)

Power	**Units**	**Frequency range**	**Physiological Correlates**
LF nu	Normalized units	LF/(LF+HF) *100	Sympathetic and parasympathetic tone
HF nu	Normalized units	HF/(LF+HF) *100	Parasympathetic tone, Respiration
LF/HF	Ratio	-	Sympathovagal balance

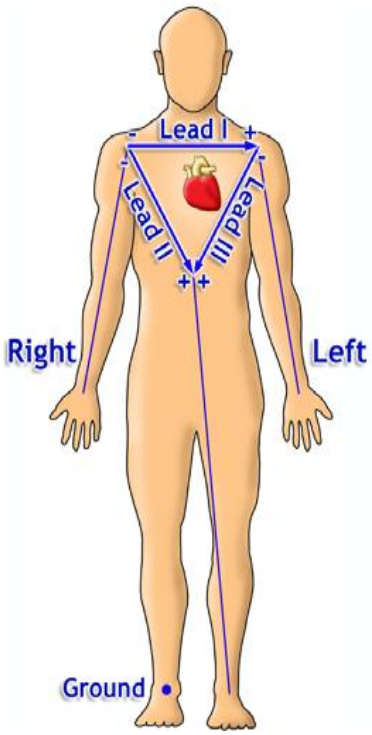
5.3.2. B Recording Conditions

The Heart Rate Variability was assessed throughout the session, which lasted for 20 minutes ('Before', 'During' and 'After') using a 16 channel polygraph system (MP100 BIOPAC, Kubios software, BIOPAC System Inc., U.S.A.). Kubios software was used to provide a complete Lead II ECG analysis. The software automatically exported to excel or pasted in the Journal file. Kubios also includes a fully automated HRV analysis feature. The HRV analysis provides values for VLF, LF, HF, VHF, sympathetic, and vagal, as well as sympathetic vagal balance. The EKG was recorded using Ag/AgCI pre-gelled electrodes (3 M Health Care, India) and recording were made with the standard limb lead I configuration. Data were acquired at the sampling rate of 1024 Hz and were analyzed offline. Noise free data were included for analysis.

5.3.3 C Electrode Position

Common placement of the electrodes is based on Einthoven's triangle, which is theoretical triangle drawn around the area of the heart. Each apex of the triangle represents where the fluids around the heart connect electrically with the limbs. Typically, separate amplifiers

would be placed at each of the three points of the triangle and data from Lead I, II and III would be acquired. However the Einthoven's law states that if the values of two points of the triangle are known the third can be computed.



5.3.3 D Variables Measured

The energy in the HRV series in the following specific frequency bands studied viz., low frequency (LF) band (0.05-0.15 Hz) and high frequency (HF) band (0.15-1.50 Hz) and the LF/HF ratio. The low frequency and high frequency band values were expressed as normalized units. The following components of time domain HRV were analyzed: (i) Mean HR (average number of times your heart beats in one minute), (ii) RMSSD (root mean square of successive differences) and (iii) NN50 (the number of interval differences of successive NN intervals greater than 50 ms).

5.3.4 State Anxiety Inventory (STAI)

The anxiety levels were assessed using a questionnaire 'State – Trait Anxiety Inventory' (STAI). This is a self-reported assessment anxiety scale, which includes separate measures of state and trait anxiety. State anxiety (S-Anxiety) is defined as a transitory emotional state characterized by consciously perceived feeling of tension and apprehension. Trait anxiety (T-

Anxiety) refers to relatively stable individual differences in anxiety proneness. Depending on the characteristics of the stressful stimulus conditions, individual's experience, differential levels of state anxiety as a function of their level of trait anxiety.

The STAI consists of two separate subscales that contain 20 items each. The items are in the form of statements people used to describe themselves. The essential qualities evaluated are feelings of apprehension, tension, nervousness, and worry. Both subscales (S-Anxiety and T-Anxiety) use a 4-point Likert scale to allow the subject to show how often or how much each question applies to them in both situations. It has high internal consistency with Cronbach's alpha of 0.73. Also, the test is designed to take only 20 minutes at the maximum to reduce the amount of fluctuations in S-Anxiety that could become apparent if the test was to go for a long period of time. However, for our study, we have used the state- anxiety inventory (STAI) questionnaire consists of 20 items (Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). The questionnaire measures state anxiety (how one feels at the moment);

5.3.4 A Testing Procedure

Each participant was assessed in three sessions, to which they are randomly assigned using a standard random number table. Two of them are musical sessions and one session without music. All the three sessions consisted of three states, i.e., 'pre' (5 minutes), 'during' (10 minutes), and 'post' (5 minutes) for HRV. The State-anxiety questionnaire (STAI) was administered before and after the sessions following HRV.

5.3.4 B. Reliability and validity of the test

State Trait Anxiety Inventory (STAI) has been used widely in earlier studies on Indian populations and has a concurrent validity ranging from 0.75 to 0.80 with other tests

(Spielberger, Gorsuch et al., 1970). The scale has shown excellent reliability and validity across populations (Spielberger, Gorsuch, Lushene, R., Vagg, & Jacobs, 1983).

5.3.5 Visual Analogue Scale (VAS)

Participants were assessed in three sessions, i.e., while listening to Indian *Rāga Bhūpāli,* listening to Pop Music and sitting in silence or no music condition with – Visual Analogue Scale (VAS).

5.3.5 A. *Testing procedure*

A VAS is an instrument to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured (Wewers and Lowe, 1990). A visual analogue scale is a horizontal line, 10 cm in length, anchored by word descriptors at each end. The right anchor of the scale was identified as 'feeling very good' and the left anchor was labeled as 'feeling not good'. Participants indicated their state of feeling by marking a point after the experimentation. The Subjective assessment of feeling (VAS) was taken after all the sessions following HRV.

5.3.5 B. Reliability and validity of the test

VAS was used to assess the ability to follow the guided instructions for the first time. The visual analogue scale is a common method for rapidly gathering quantifiable subjective rating in both research and clinical settings. This method of rating is thought to provide greater sensitivity for reliable measurement of subjective phenomena, such as various qualities of pain or mood (Pfennings, Cohen, & van der Ploeg, 1995). Reliability of visual analog scale is measuring acute pain was observed to be adequately high (Bijur, Silver & Gallagher, 2001). Another study reports that the reliability of visual analog scale in patient

with chronic musculoskeletal pain is at moderate to good level, however, with questionable validity (Boonstra et al., 2008).

5.3.6 Working memory with Wechsler Memory Scale

Working memory refers to the cognitive system that stores information in an accessible state for utilization in complex mental tasks. This system also allows for updating and manipulation of relevant information. It is composed of both passive storage and dynamic control processes in order to hold information in an active form. Working Memory Index is derived from the performance on the Digit Span, Arithmetic, and Letter-Number Sequencing subtests. (Hill, B., Elliott, E., Shelton, J., Pella, R., O'Jile, J., & Gouvier, W. 2010).

5.3.6A Testing Procedures

Assessments with Digit span section of Wechsler's memory scale were made on three different days, which were not necessarily on consecutive days, but at the late evening time suitable for the listening the Indian *Rāga Bhūpāli*. The allocation of participants to the three sessions was random using a standard random number table. The sessions were Indian *Rāga Bhūpāli,* listening to Pop Music and sitting in silence or no music condition. The duration of the sessions was ten minutes. The piece of music in MP3 format set for 10 minutes was administered to the subject through headphones via laptop in a sound proof room. Throughout all the sessions' participants sat comfortably on a reclining chair and kept their eyes closed. Participants were tested on the memory task immediately before and after the three sessions, Indian *Rāga,* Pop Music and silence or no music.

Each correct answer was scored as '1' (for digit span forward or backward). This was based on the conventional scoring for Wechsler memory scale (Winocur, & Weiskrantz, 1976).

Parallel worksheets were prepared, changing the digits to eliminate serial testing artifacts when retesting. (Morris, Kumka, & Rossini).

5.3.6 B Validity

Memory tasks were selected from the Wechsler Memory Scale, which has been standardized for use in an Indian population. The digit span forward and digit span backward with ten items each were selected. The digit span tests assess attention, concentration and primary working memory (Lichtenberger, Kaufman, & Lai Z, 2001).

5.4 INTERVENTION

The music played the instrumental melody in both the cases, without the interference of lyrics.

5.4.1 Indian Rāga

We used two pieces of melody in *Rāga Bhūpāli* from *Kalyān Thāta* (Lydian Mode) which uses ri, dha *Tīvra* (sharp) notes or *svarās*. The combination of *svarās* instills the aesthetic mood of love within the listener. The songs are popular classical based film music which are relaxing and melodious – a.'*Jyoti Kalash jhalake'* played in confluence of three instruments sitar (Sunil Das), flute (Rakesh Chaurasia) & santoor (Ulhas Bapat); and b.'*pankh hoto uda aatire'* flute rendition by Praveen Gorkhindi.

5.4.2 Pop Music

The term "pop" is originally derived from an abbreviation of "popular. It borrows elements from other pre-existing musical styles which include urban, dance, Latin, rock and country (Rojek, C. 2011). In general college students prefer them since it invokes the feeling of excitement.

We used Electro Pop - Beat – a. "Can't Keep Me Away" by Chinchilla Music Production and b. K-391 - Sky City 2013 by K-391. Both the pieces of music use synthesizers and various electronic musical instruments.

5.5 DATA EXTRACTION

5.5.1 Heart Rate Variability (HRV)

Recordings of heart rate variability were taken for 20 minutes for each participant. The 'Before' intervention (5 minutes), 'During' intervention (10 minutes), and 'After' intervention (5 minutes) data were analyzed separately. 'Before' and 'After' sessions had one epoch of 5 min, whereas during had 2 similar epochs viz. D1, D2 The recorded data were visually inspected off-line and only noise free data included for analysis. The HRV power spectrum was obtained using Fast Fourier Transform (FFT.) analysis.

The energy in the HRV series in the following specific frequency bands studied viz., low frequency (LF) band (0.05-0.15 Hz) and high frequency (HF) band (0.15-1.50 Hz) and the LF/HF ratio. The low frequency and high frequency band values were expressed as normalized units. The following components of time domain HRV were analyzed: (i) Mean HR (average number of times your heart beats in one minute); (ii) RMSSD (root mean square of successive differences); (iii) NN50 (the number of interval differences of successive NN intervals greater than 50 ms).

5.5.2 State Anxiety Inventory (STAI)

Each participant was assessed with State and Trait Anxiety Inventory in three consecutive days at the same time, followed by Heart rate Variability before and after the session. Participants were requested to use any necessary visual aids (i.e. glasses, contact lenses). On

the day 1, participants in each group carried out the HRV first, followed by the State Anxiety Inventory on the day 2 at the same time. To ensure each item was carefully considered and participants were advised they had an unlimited amount of time to complete the questionnaire. Participants received a recording blank with the front page on top and a pencil without an eraser. Participants were instructed as per the instructions stipulated in the manual of the questionnaires. Testing began once participants had confirmed they understood the given instructions. Participants were advised to provide an answer as honestly and spontaneously as possible for every statement. The scoring was done by a person who was unaware when the assessment was made as whether the assessment was a musical session or a control session.

5.5.3 Visual Analog Scale (VAS)

A VAS is an instrument to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured (Wewers and Lowe, 1990). A visual analogue scale is a horizontal line, 10 cm in length, anchored by word descriptors at each end. The right anchor of the scale was identified as ‘feeling very good’ and the left anchor was labeled ‘feeling not good’ as shown in Participants indicated their state of feeling by marking a point after the experimentation. Immediately after the session, following HRV, participants were asked to put a mark on the line which represents how they felt about the session. The Subjective assessment of feeling (VAS) was taken after all the sessions following HRV.

Fig 4 Visual Analog Scale for assessing subjective Feeling

Name: **Age:** **Gender:** **Date:**

Feeling not Good Feeling Good

Score:

5.5.4 Working Memory

Each participant was assessed with digit span forward and backward to investigate verbal memory before and after two musical sessions – Indian *Rāga,* Pop Music and silence or no music session. Each correct answer was scored as '1' (for digit span forward or backward). This was based on the conventional scoring for Wechsler memory scale (Winocur, G., & Weiskrantz, L. 1976).

5.6 DATA ANALYSIS

The raw data obtained for each subject in each recording session were tabulated separately. The group mean values ± standard deviation were calculated for all the variables. All statistical analysis was performed using the Statistical Package for Social Sciences (version 16.0).

5.6.1 Heart Rate Variability (HRV)

(i)The data were tested for variance and normal distribution by F-test and Kolmogorov-Smirnov test respectively.

(ii) Since the same individuals were assessed in repeat sessions on separate days (i.e., Indian *Rāga,* Pop Music and silence or no music session, repeated measures analysis of variance (ANOVAs) were performed with two 'Within subjects' factors, that is, Factor 1: Sessions

such as Indian *Rāga,* Pop Music and silence or no music session, and Factor 2: States that is 'Before', 'During' (1 to 2), and 'After'. There were separate repeated measures ANOVAs for heart rate variability (HRV) components (frequency domain and time domain).

5.6.2 State Anxiety Inventory (STAI)

(i) The data were tested for normal distribution by Kolmogorov-Smirnov test.

(iii) Repeated measures ANOVA was followed by a *post-hoc* analyses with Bonferroni

adjustment for multiple comparisons between the mean values of two states ('Before' and 'After') these sessions of Indian *Rāga,* Pop Music and silence or no music sessions and all comparisons were made with the respective 'Before' state.

5.6.3 Visual analog scale

(i) Data were tested for normality by Kolmogorov-Smirnov test.

(ii) Repeated measures analysis of variance (ANOVA) was performed with one 'within'-subjects' factor i.e: Indian *Rāga*, Pop Music and silence or no music sessions.

(iii) This was followed by post-hoc analyses with Bonferroni adjustment for multiple comparisons between the mean values of different sessions.

5.6.4 Working Memory

(i) The data were tested for normal distribution by Kolmogorov-Smirnov test.

(ii) Since the same individuals were assessed in repeat sessions on separate days

(i.e Indian *Rāga,* Pop Music and silence or no music sessions) repeated measures analysis of variance was used (ANOVA). Repeated measures analysis of variance

(ANOVA) was performed with two within subject factors' i.e Factor 1 : Sessions Indian *Rāga,* Pop Music and silence or no music sessions and Factor 2 States, 'Pre' and 'Post'.

(iii) This was followed by post-hoc analyses with Bonferroni adjustment comparing 'pre' with 'post' values.

CHAPTER – 6

RESULTS

6.0 Results

The results of the variables studies during three independent sessions i.e Indian *Rāga*, Pop Music and silence or no music sessions are described below.

These are

(i) Heart Rate Variability (HRV) recorded before, during and after the interventions.

(ii) Spielberger's State Anxiety Inventory is taken before and after the interventions

(iii) Subjective assessment (visual analog scale) was done immediately after the practice of three sessions.

(iv) Digit forward and digit backward test from Wechsler's Memory scale administered before and after the interventions

6.1 Heart Rate Variability (HRV)

6.1.1. Recapulation

The HRV power spectrum was obtained using Fast Fourier Transform (FFT) analysis. Heart Rate Variability (HRV) were recorded on 28 subjects in three sessions i.e Indian *Rāga*, Pop Music and silence or no music sessions. Repeated measures analyses of variance (ANOVA) were performed with two 'Within subjects' factors, i.e., Factor 1: Sessions; Indian *Rāga*, Pop Music and silence or no music sessions, and Factor 2: States; Pre, During (D1 and D2), and Post. These Repeated measures analysis of variance (ANOVA) was carried out for each variable separately. This was followed by a Post-hoc analysis with Bonferroni adjustment for multiple comparisons between the mean values of different states (Pre, During 1 to During 2

and Post). The mean (SD with statistical significance of autonomic for all the sessions are given below in the result sections as **Summary Tables.**

The actual data of individual subjects in Sessions (Indian *Rāga*, Pop Music and silence or no music sessions) for the individual variables of frequency domain analysis of heart rate variability i.e., low frequency [LF], high frequency [HF] and low frequency and high frequency ratio [LF/HF]. The individual variables of time domain analysis of heart rate variability i.e., Mean HR, NN50, and RMSSD are presented with group mean values ± SD in different tables**.**

The Graphs for the actual data of individual subjects in Sessions (Indian *Rāga*, Pop Music and silence or no music sessions) for the individual variables of frequency domain analysis of heart rate variability i.e., low frequency [LF], high frequency [HF] and low frequency and high frequency ratio [LF/HF]. The individual variables of time domain analysis of heart rate variability i.e., Mean HR, NN50, and RMSSD are also graphically presented with group mean values ± SD.

LF Low frequency (in normalized units)

Repeated measures analyses of variance (ANOVA) were performed with two within subject factors i.e (i) Sessions (Indian Rāga, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

Indian *Rāga* verses Pop showed a significant difference, $p<0.05$ during the 1 session. ($p=0.047$); Indian *Rāga* verses silence showed a significant difference $p<0.05$ poster session ($p=0.046$). In the Indian Raga session there was a significant decrease in low frequency (Indian *Rāga*: Pre Versus Post; $p<0.01$ ($p=0.003$).

Table -14 Mean and Standard Deviation values for LF (Low Frequency) recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

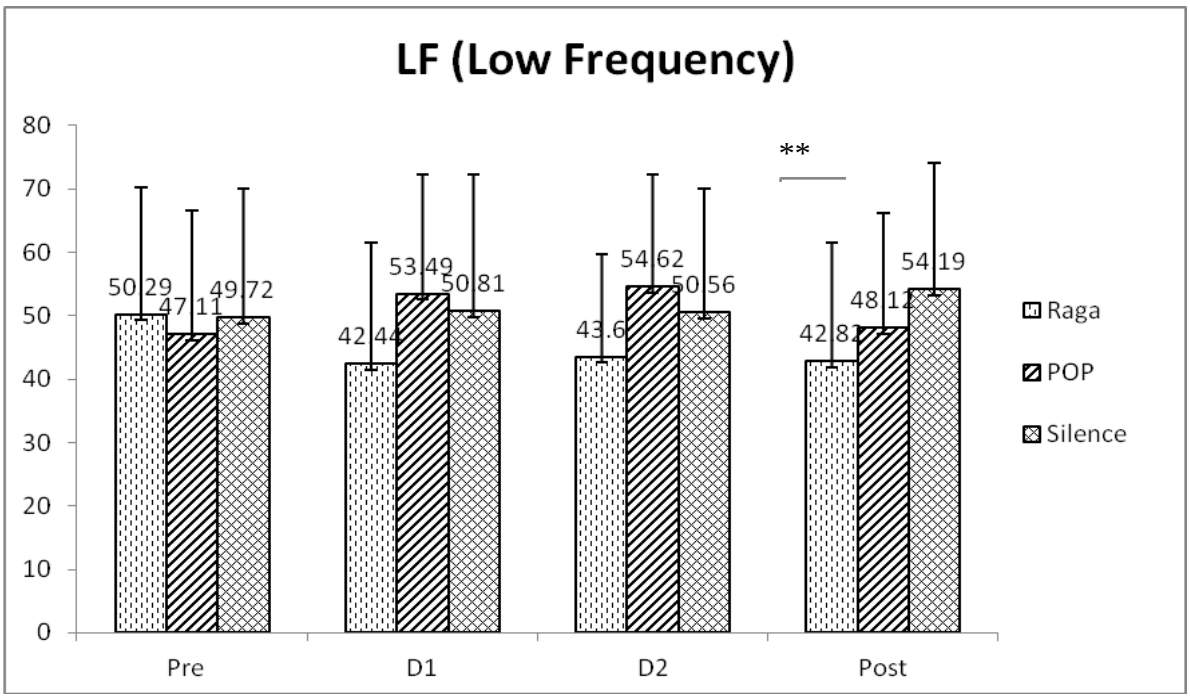
Phases	**Pre**	**D1**	**D2**	**Post**
Indian Rāga	50.29 ±19.95	42.44 ±19.09	43.60 ±16.0	42.82 ±18.79
% Change		**↓18.49**	**↓13.29**	**↓14.85 ****
POP	47.11 ±19.50	53.49 ±18.79	54.62 ±17.65	48.12 ±18.06
% Change		**↑13.54**	**↑15.95**	**↑2.13**
Silence	49.72 ±20.31	50.81 ±21.46	50.56 ±19.54	54.20 ±19.81
% Change		**↑2.17**	**↑1.68**	**↑8.98**

*p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post). Percentage % change observed in D1, D2 and Post values are calculated with respect to the baseline values.

While there was a percentage % decrease of LF from 18. 49% to 14.85%.; p<0.01 from ‘pre’ to ‘post’ in Indian *Rāga* session. The summary is given in **Table – 14.** The graphical representations of Low Frequency in all the three sessions and in the four states ‘Pre’, ‘D1’, ‘D2 ‘and ‘Post’ are given **Fig. 5.**

Fig 5 LF (Low Frequency) scores recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



HF High Frequency (normalized units)

Repeated measures analyses of variance (ANOVA) were performed with two 'within' subject factors i.e (i) Sessions (Indian *Rāga*, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post). Indian *Rāga* verses Pop showed a significant difference, $p<0.01$ ($p=0.006$); Indian *Rāga* verses silence showed a significant difference $p<0.05$ ($p= 0.039$). In the Indian Raga session, there was a significant increase in high frequency between states [Pre Versus Post; $p<0.01$ ($p=0.003$)]. In Pop Session, there was a significant decrease in high frequency between states [Pre Versus during2; $p<0.05$ ($p= 0.039$)].

Post-hoc tests with Bonferroni adjustment for multiple comparisons was used to detect significant differences between mean values.

Table-15 Mean and Standard Deviation values for HF (High Frequency) recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

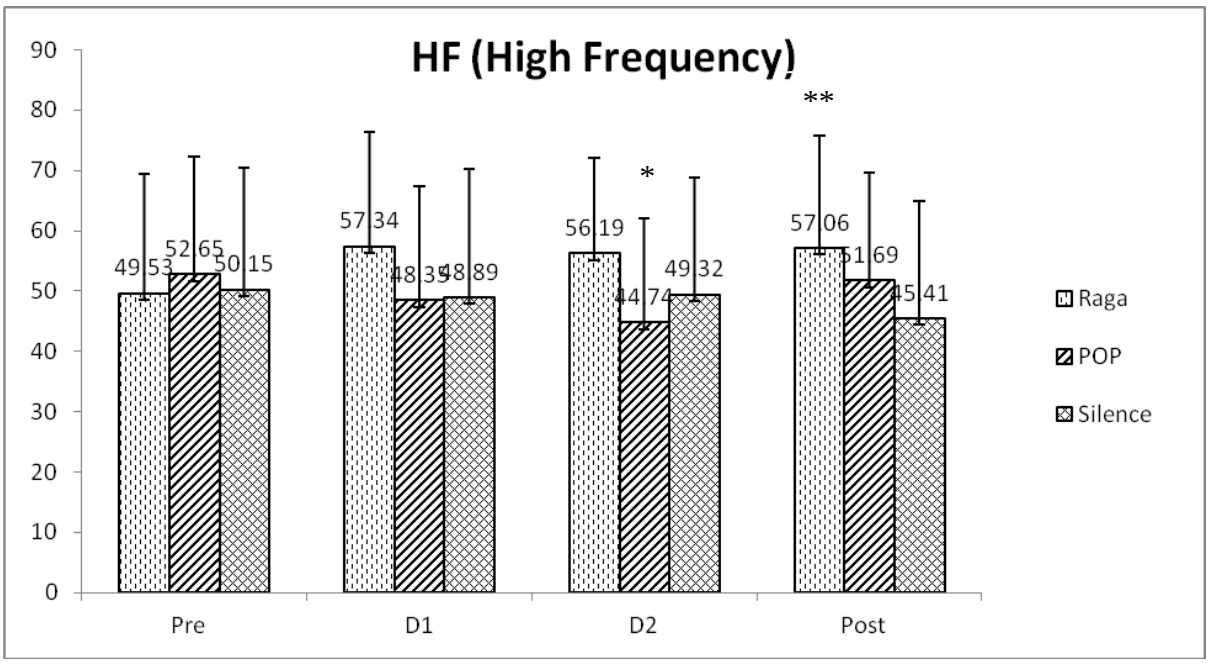
Phases	**Pre**	**D1**	**D2**	**Post**
Indian Rāga	49.52 ±19.97	57.34 ±19.13	56.20 ±15.93	57.06 ±18.81
% Change		**↑15.77**	**↑13.47**	**↑15.21****
POP	52.65 ±19.58	48.35 ±19.04	44.74 ±17.34	51.69 ±17.99
% Change		**↓8.17**	**↓15.02***	**↓1.82**
Silence	50.15 ±20.29	48.89 ±21.39	49.32 ±19.49	45.41 ±19.53
% Change		**↓2.51**	**↓1.64**	**↓9.45**

*p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post).

% Change observed in D1, D2 and Post values are calculated with respect to the baseline values. In the Indian Raga session there was % increase of HF from Pre Vs During1;15.77, During2;13.47, Post; 15.2. In Pop session there was a % decrease of HF from Pre Vs During1; 8.17, During2; 15.02. The Summary is presented in **Table – 15**. The graphical representations of High Frequency (HF) in all the three sessions and in the four states Pre, D1, D2 and Post are given **Fig. 6**.

Fig 6 HF (High Frequency) scores recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



LF and HF ratio

Repeated measures analysis of variance (ANOVA) was performed with two Within subject factors i.e (i) Sessions (Indian *Rāga*, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

Indian *Rāga* verses Pop showed a significant difference, $p<0.01$ ($p=0.003$) During 1;

Indian *Rāga* verses Pop showed a significant difference, $p<0.05$ ($p=0.018$) During 2

There are no significant changes between the states.

Table -16 Mean and Standard Deviation values for LF and HF Ratio recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

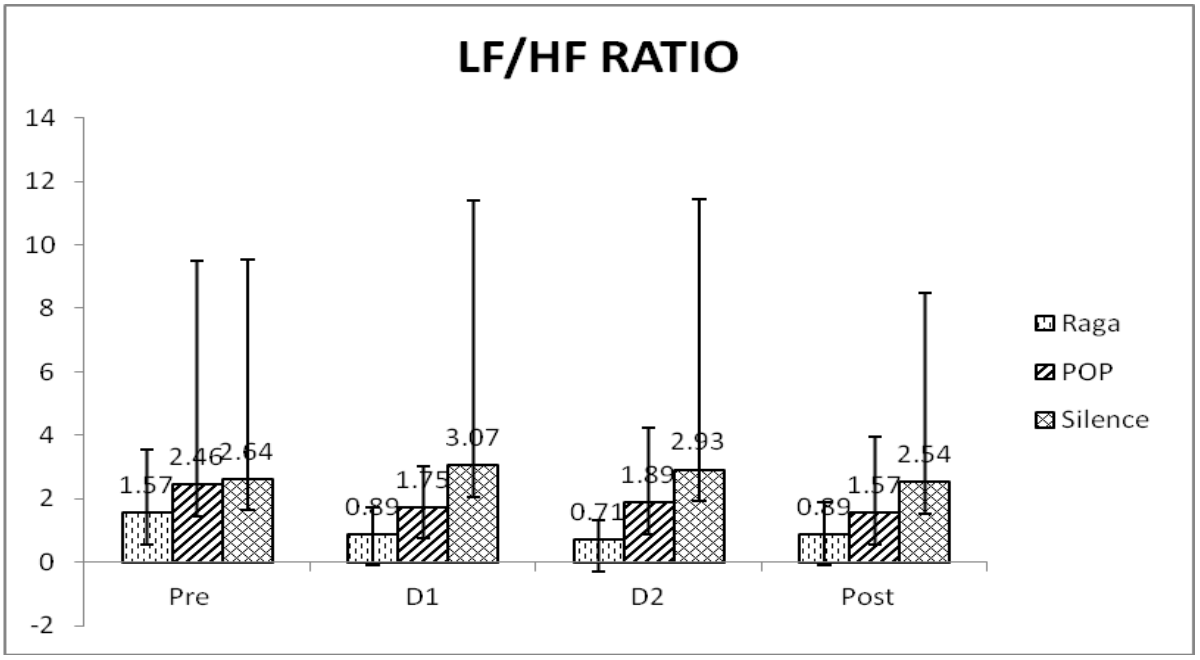
Phases	**Pre**	**D1**	**D2**	**Post**
Indian Rāga	1.57 ±1.99	.89 ±.83	.71 ±.60	.89 ±.99
% Change		**43.31**	**54.78**	**43.31**
POP	2.46 ±7.03	1.75 ±1.29	1.89 ±2.35	1.57 ±2.38
% Change		**28.86**	**23.17**	**36.18**
Silence	2.64 ±6.91	3.1 ±8.32	2.93 ±8.51	2.54 ±5.94
% Change		**-16.2**	**-10.93**	**10.72**

*p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post).

% Change observed in D1, D2 and Post values are calculated with respect to the baseline values. The Summary is given in **Table – 16**. The graphical representations of LF and HF Ratio in all the three sessions and in the four states Pre, D1, D2 and Post are given **Fig. 7**.

Fig 7 LF and HF Ratio recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



Mean HR

Repeated measures analysis of variance (ANOVA) was performed with two Within subject factors i.e (i) Sessions (Indian *Rāga*, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

RMANOVA consisted of two within subject factors i.e (i) Sessions (Indian *Rāga*, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

There was no significant difference between the sessions.

There was a significant difference between the states Pre Indian *Rāga* to Post Indian *Rāga* states $p<0.01$ ($p= 0.002$).

Table -17 Mean and Standard Deviation values for Mean HR recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

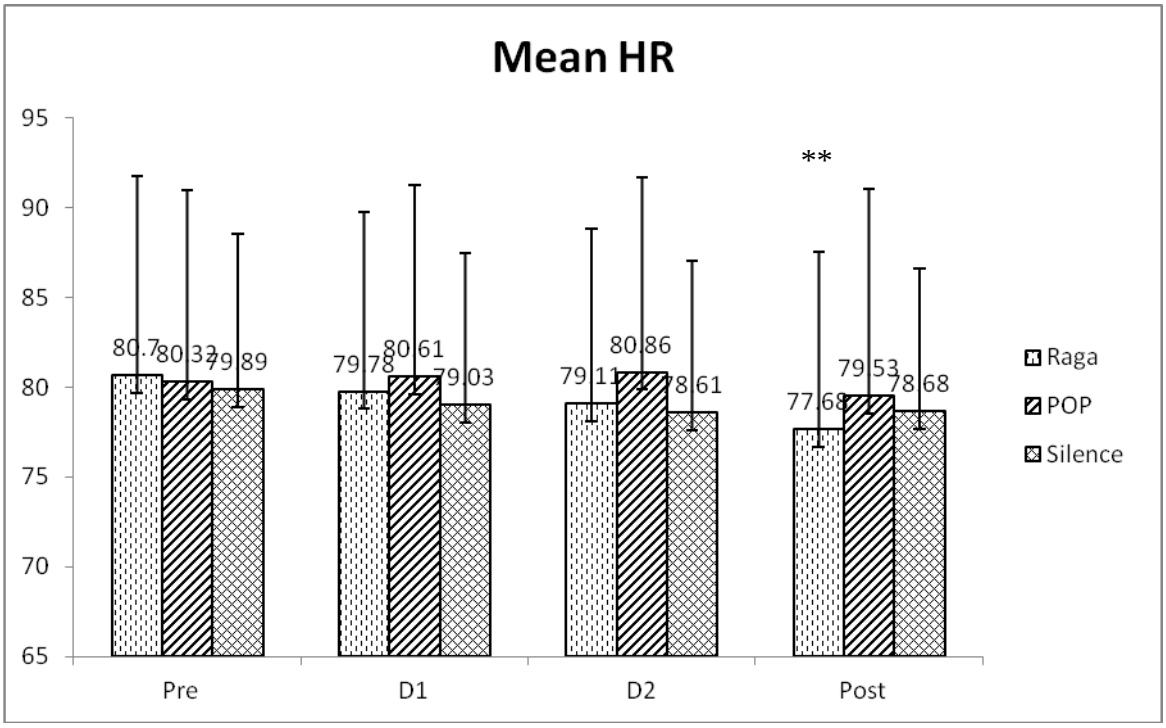
Phases	**Pre**	**D1**	**D2**	**Post**
Indian *Rāga*	80.71 ±11.04	79.78 9.99	79.10 ±9.74	77.68 ±9.86
% Change		**↓1.15**	**↓1.99**	**↓3.76****
POP	80.32 ±10.64	80.61 ±10.65	80.86 ±10.81	79.54 ±11.50
% Change		**↑0.36**	**↑0.67**	**↓0.98**
Silence	79.89 ±8.65	79.03 ±8.42	78.61 ±8.46	78.68 ±7.96
% Change		**↓1.07**	**↓1.61**	**↓1.52**

*p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post).

% Change observed in D1, D2 and Post values are calculated with respect to the baseline values. The Summary is given in **Table – 17**. The graphical representations of Mean HR in all the three sessions and in the four states Pre, D1, D2 and Post are given **Fig. 8**.

Fig 8 Mean HR recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



NN50

Repeated measures analysis of variance (ANOVA) was performed with two Within subject factors i.e (i) Sessions (Indian *Rāga*, Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

There was no significant difference between the sessions.

There was a significant difference between the states Pre Indian *Rāga* to Post Indian *Rāga* states $p<0.05$ ($p= 0.015$)

There was a significant difference between Pre pop to During 2 states $p<0.05$ ($p<0.024$)

Table -18 Mean and Standard Deviation values for NN50 recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

Phases	**Pre**	**D1**	**D2**	**Post**
Indian Rāga	84.32 ±67.46	98.25 ±73.26	102.61 ±73.01	108.28 ±69.29
% Change		**↑16.52**	**↑21.68**	**↑28.41***
POP	93.86 ±62.81	78.86 ±62.45	84.11 ±64.76	85.43 59.92
% Change		**↓15.98**	**↓10.39***	**↓8.98**
Silence	92.61 ±68.70	81.71 ±69.04	91.96 ±63.16	86.86 ±66.76
% Change		**↓11.76**	**↓0.69**	**↓6.2**

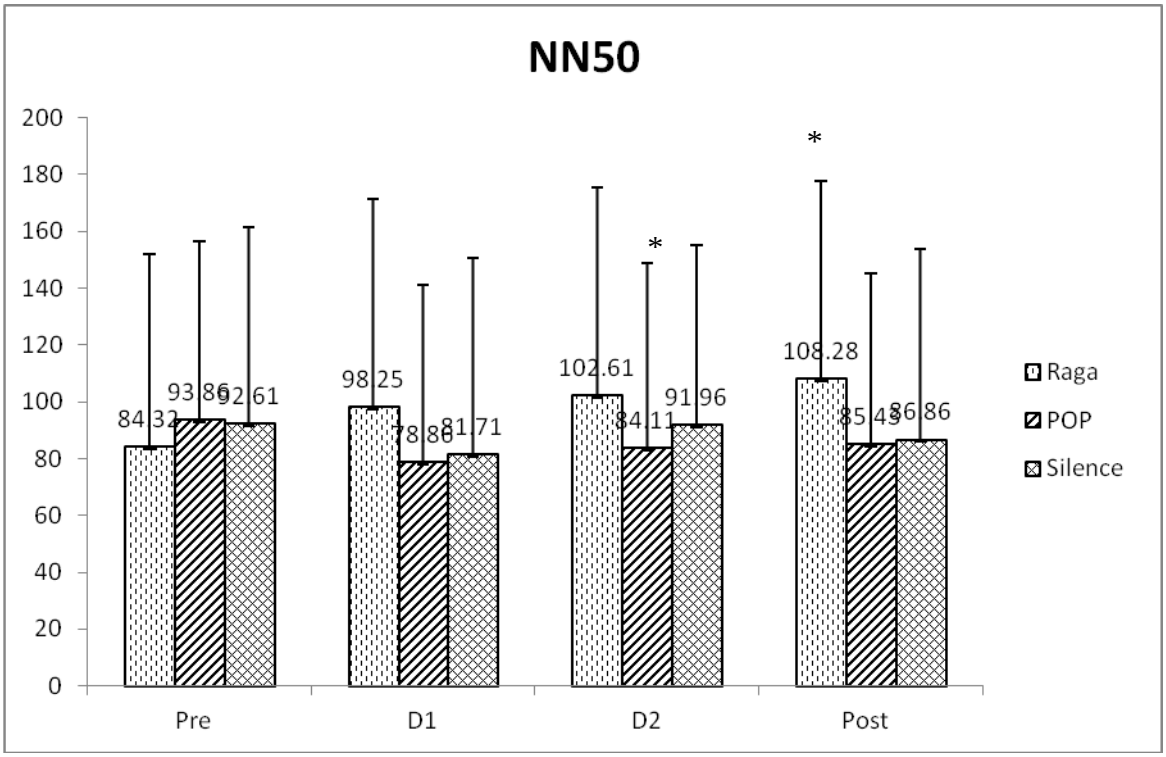
p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post).

% Change observed in D1, D2 and Post values are calculated with respect to the baseline values. During Indian *Rāg*a session there was a significant increase of % value from 16.52% to 21.68% to 28.41%. During Pop session there was a significant decrease of % value from 15.98 to 10.39 to 8.98.

The Summary is given in **Table – 18**. The graphical representations of NN50 in all the three sessions and in the four states Pre, D1, D2 and Post are given **Fig. 9**.

Fig 9 NN50 recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



RMSSD

Repeated measures analyses of variance (ANOVA) were performed with two 'within' subject factors i.e (i) Sessions (Indian *Rāga,* Pop and Silence) and (ii) States (Pre, During 1, During 2 and Post).

Indian *Rāga* verses Pop showed a significant difference, $p<0.05$ ($p=0.043$);

Indian *Rāga* verses silence showed a significant difference $p<0.05$ ($p= 0.032$);

In the Indian Raga session, there was a significant increase in RMSSD between states [Pre Versus Post; $p<0.05$ ($p=0.016$].

Table 19 Mean and Standard Deviation values for RMSSD recorded before, during and after Indian *Rāga,* Pop Music and silence or no music (n=28).

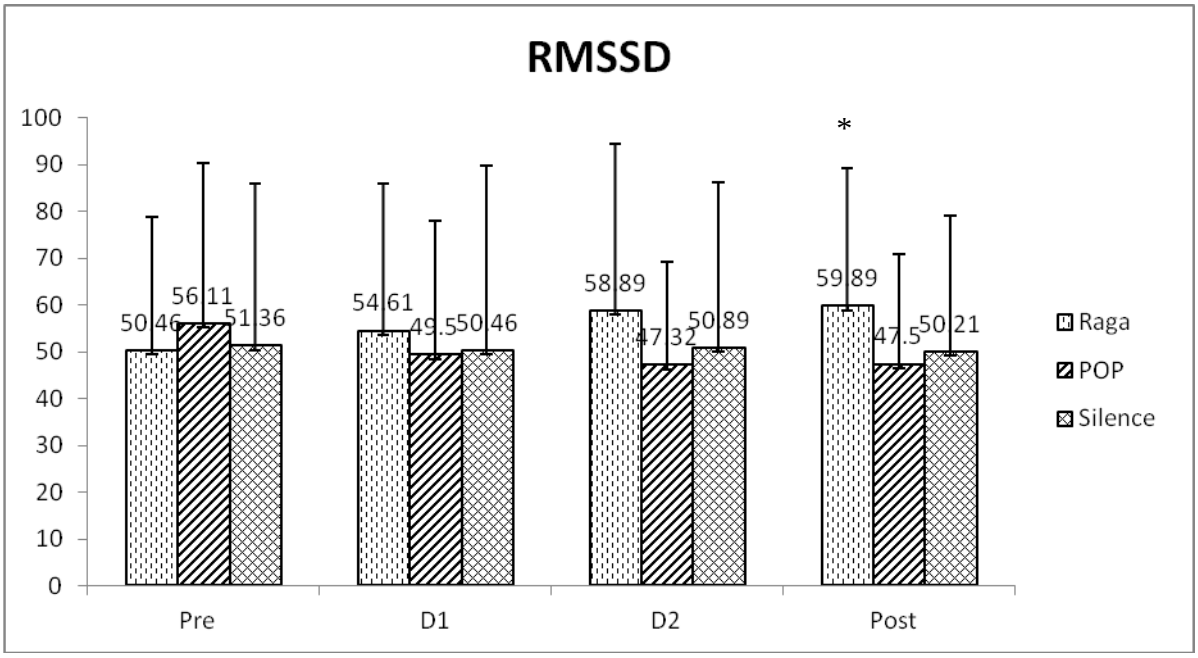
Phases	**Pre**	**D1**	**D2**	**Post**
Indian *Rāga*	50.46 ±28.28	54.61±31.30	58.89±35.46	59.89 ±29.36
% Change		**↑8.21**	**↑16.70**	**↑18.68***
POP	56.11 ±34.23	49.50 ±28.41	47.32±21.99	47.5 23.39
% Change		**↓11.77**	**↓15.66**	**↓15.28**
Silence	51.36 ±34.51	50.46 ±39.24	50.89±35.35	50.21±28.97
% Change		**↓1.74**	**↓0.90**	**↓2.22**

*p<0.05; ** p< 0.01;*** p<0.001:

Comparing individual states (D1, D2 and Post).

% Change observed in D1, D2 and Post values are calculated with respect to the baseline values. During Indian *Rāga* session there was a significant increase of % value from 8.21% to 16.70% to 18.68%. The Summary is given in **Table – 19**. The graphical representations of RMSSD in all the three sessions and in the four states Pre, D1, D2 and Post are given **Fig. 10**.

Fig. 10 RMSSD scores recorded before, during and after Indian *Rāga,* Pop Music and silence or no music. (Values are group mean and ± SD.)



6.2 State Anxiety Inventory (STAI)

6.2.1 Recapulation

State Anxiety Levels was measured using STAI in 28 participants following Indian Rāga, Pop and Silence following HRV. The State Anxiety Inventory (STAI) was used to assess anxiety. The STAI consists of 20-items questionnaires that assess the state anxiety level in clinical and non-clinical populations. Scores for both scales range between 20 (low anxiety) and 80 (high anxiety).

Repeated measures ANOVA was followed by a *post-hoc* analyses with Bonferroni adjustment for multiple comparisons between the mean values of two states (‘Before’ and ‘After’) these sessions of Indian *Rāga,* Pop Music and silence or no music sessions and all comparisons were made with the respective ‘Before’ state.

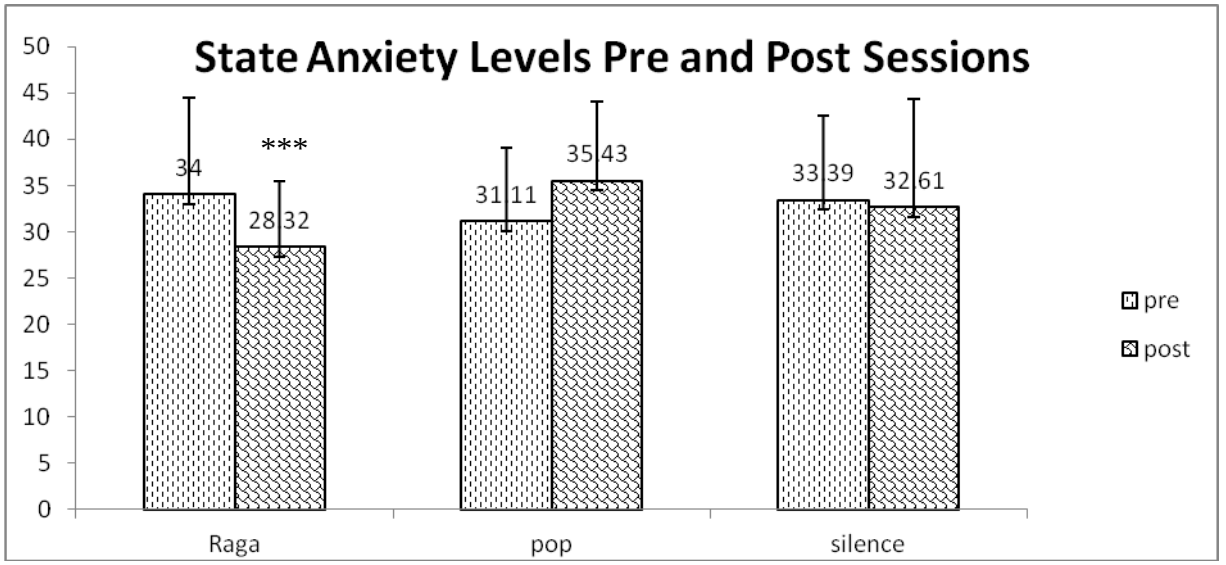
The anxiety level significantly ($P < 0.001$) decreased post Rāga session. There was a significant increase in state anxiety level ($P < 0.01$) after Pop Session. This is summarized in **Table 20**. The graphical representation of STAI scores for the three sessions **Indian *Rāga,*** Pop Music and silence is given in **Fig. 11.**

Table – 20 Scores obtained with Spielberger's State Anxiety Inventory before and after the sessions of Indian *Rāga,* Pop Music and silence (Values are Group mean and ±SD. n= 28)

	Indian Rāga				Pop Music				Silence			
Variable	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**
STAI 28	34.00 ± 10.50	28.32 ± 7.12	↓16.71	0.000***	31.11 ± 7.98	35.43 ± 8.66	13.89↑	0.003	33.39 ± 9.16	32.61 ± 11.68	2.34↓	0.637

*p<0.05; ** p< 0.01; ***p<0.001:

Fig.11 Scores obtained with State Anxiety Inventory (STAI) before and after the sessions of Indian *Rāga,* Pop Music and silence or no music. (Values are Group mean and ±SD. n= 28)



6.3 Visual Analog Scale

6.3.1. Recapulation

Perceived feeling was measured using Visual analog scale (VAS) in 28 participants following Indian Rāga, Pop and Silence following HRV. The VAS consists of a horizontal 10 cm line with one end representing the maximum and the other end representing the minimum of the variable to be measured [18]. The right anchor of the scale was identified as 'feeling very good' and the left anchor was labeled 'feeling not good'. Participants indicated their state of feeling by marking a point on the scale after the three sessions, namely Indian *Rāga,* Pop Music and silence or no music.

Repeated measures analysis of variance (ANOVA) was performed with one 'within'-subjects' factor i.e: Indian *Rāga*, Pop Music and silence or no music sessions.

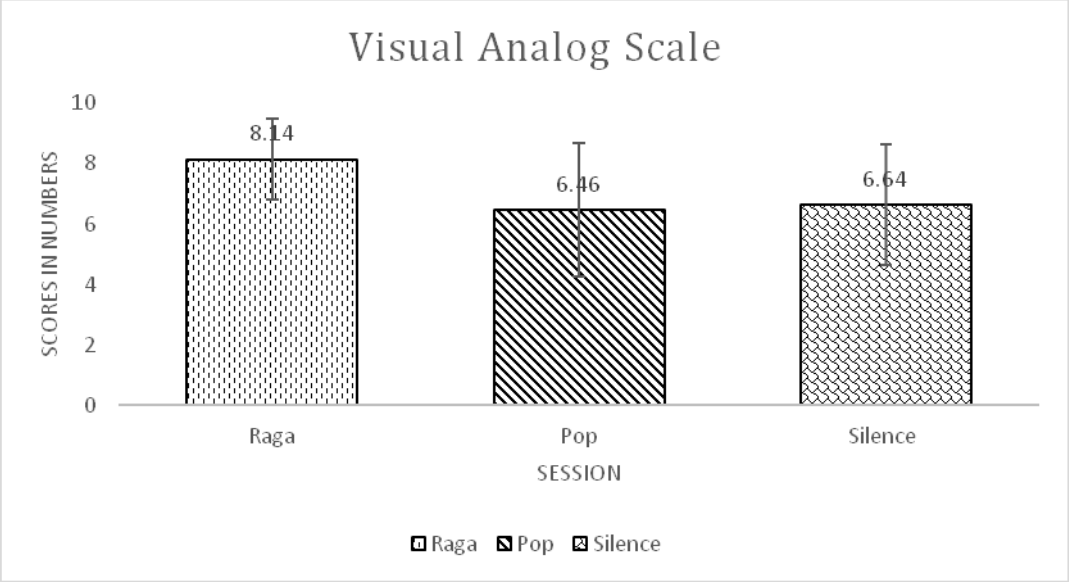
The subjective assessment of perceived feeling using Visual Analog scale comparing Rāga with Pop and Silence sessions showed a significant positive difference ($P < 0.01$) as summarized in **Table 21.** The graphical representation of the scores obtained with Visual Analog Scale after the three sessions of Indian Rāga, Pop and Silence is given in **Fig. 12.**

Table 21 Scores on visual analog scale after the sessions of Indian Rāga, Pop and Silence. (Values are group mean ±SD. n=28).

Sessions	Indian Rāga	Pop	Silence
Mean ± SD	8.14 ± 1.32	6.46 ± 2.20 **	6.64 ± 1.98 **

** Comparing Indian Rāga with Pop and Silence sessions shows significant difference with all the three ($p<0.01$).

Fig.12. Scores obtained with Visual Analog Scale after the three sessions of Indian Rāga, Pop and Silence. (Values are group mean ±SD. n=28.)



6.4 Working Memory

6.4.1 Recapulation

Twenty six participants were tested on the memory task ‘before’ and immediately ‘after’ the three sessions Indian *Rāga*, Pop and Silence or no music. Digit span forward and digit span backward, a section of Wechsler’s Memory task is used for testing. Assessments were made

on three different days, which were not necessarily on consecutive days, but at the late evening time suitable for the listening the Indian *Rāga Bhüpäli*. The allocation of participants to the three sessions was random using a standard random number table. The duration of the sessions was ten minutes. The piece of music in MP3 format set for 10 minutes was administered to the subject through headphones via laptop in a sound proof room. Throughout all the sessions' participants sat comfortably on a reclining chair and kept their eyes closed.

Since the same individuals were assessed in repeat sessions on separate days (i.e Indian *Rāga,* Pop Music and silence or no music sessions) repeated measures analysis of variance was used (ANOVA). Repeated measures analysis of variance (ANOVA) was performed with two within subject factors' i.e Factor 1: Sessions Indian *Rāga,* Pop Music and silence or no music sessions and Factor 2 States, 'Pre' and 'Post'.

The memory scores significantly increased immediately after listening to the Indian Rāga

Digit span forward scores differed significantly between Sessions ($F = 1.98$, $p < 0.05$). Digit span backward scores also differed between Sessions ($F = 2.51$, $p < 0.05$).

The increase in scores for the digit span tasks following listening to Rāga was greater [digit span forward (3.17 percent)], backward (5.26 percent), than the increase following Pop Music [digit span forward (1.02 percent), backward (1.49 percent)] and Silence or No music condition [digit span forward (0.17 percent), backward (1.87 percent)]. **Table 22** gives the summary of Digit span forward scores and the graphical representation in **Fig. 13.**

Table 23 gives the summary of Digit span backward scores and the graphical representation in **Fig. 14.**

Table 22 Mean and Standard Deviation (SD) scores obtained in Digit Forward test before and after listening to Indian *Rāga*, Pop and Silence or no music conditions (n=26)

	Indian Rāga				Pop Music				Silence			
Variable	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**
DF 26	23.04 ± 1.886	23.77 ± 1.704	↑3.17	0.025*	22.46 ± 2.005	22.69 ± 2.112	1.02	0.574	23.00 ± 1.876	23.04 ± 2.049	0.17	0.906

Fig 13 Digit Forward test scores before and after listening to Indian Rāga, Pop Music and in Silence conditions

Values are Group mean and ±SD. (n= 26).

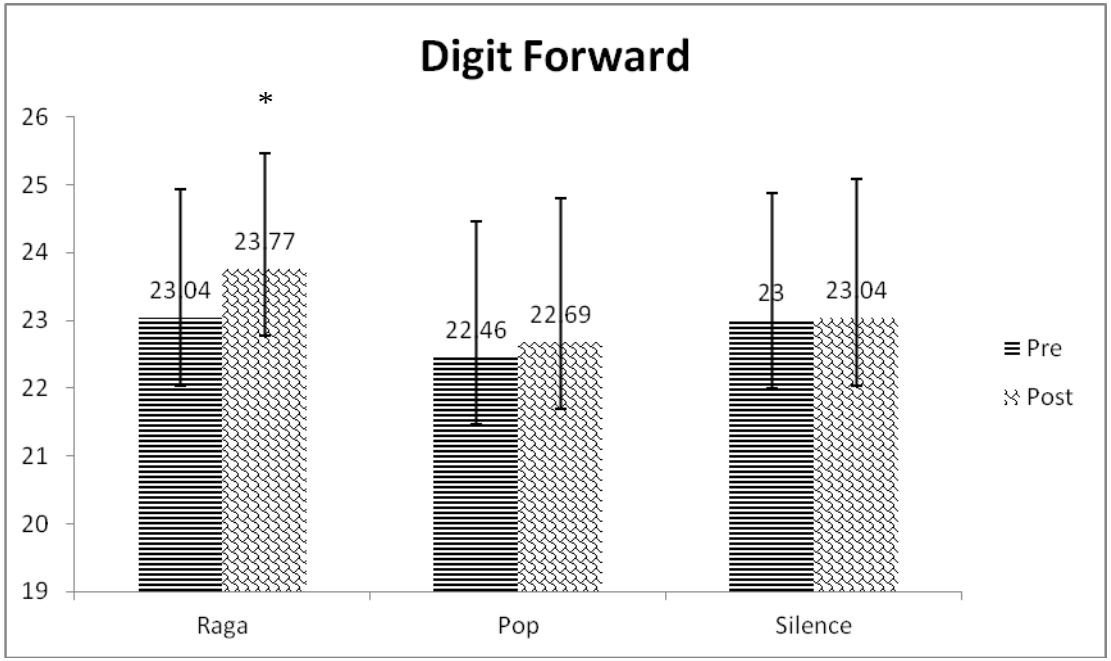
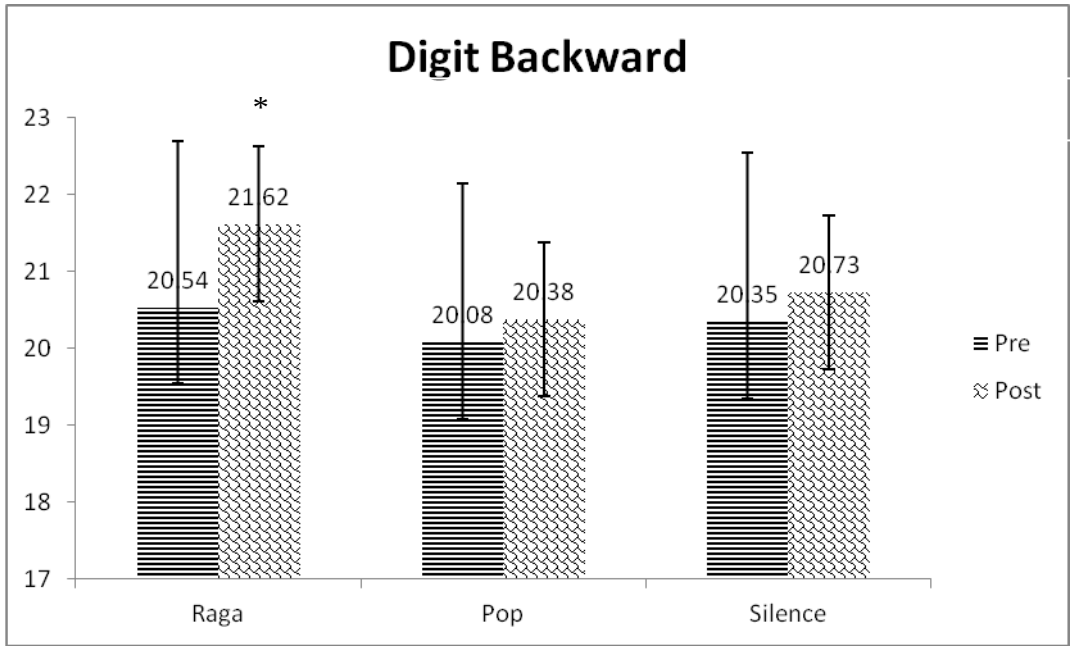


Table 23 Mean and Standard Deviation (SD) Scores obtained in Digit Backward test before and after listening to Indian *Rāga*, Pop and Silence or no music conditions (n=26)

	Indian Rāga				Pop Music				Silence			
Variable	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**	**Pre**	**Post**	**% change**	**p value**
DB 26	20.54 ± 2.158	21.62 ± 1.856	↑5.26	0.031*	20.08 ± 2.058	20.38 ± 2.155	1.49	0.456	20.35 ± 2.190	20.73 ± 2.273	1.87	0.332

Fig 14 Digit Backward test scores before and after listening to Indian Rāga, Pop Music and in Silence conditions Values are Group mean and ±SD. n= 26.



Chapter 7

DISCUSSIONS

7.0 DISCUSSIONS

The significant results detailed in the previous section are discussed under two main categories of variables,

7.1 Heart Rate Variability, State Anxiety Inventory and Visual Analog Scale

Previous studies have demonstrated particular profiles of autonomic responses on different styles of music. This has prompted the need to explore the effects of Indian *Rāga* which has the effect of instilling positive emotions within the listener before they can be proposed as an effective music therapy. The present study examined the changes in subjective and psycho-physiological responses to Indian *Rāga Bhūpāli,* Pop music and No music conditions. The perceived relaxation induced by Indian *Rāga* was shown in both frequency domain and time domain measures of HRV.

The LF (normalized units) component was significantly decreased and correspondingly HF component was significantly increased immediately after listening to Indian Rāga *Bhüpäli*. This was indicative of reduced arousal and a shift in the autonomic balance towards parasympathetic dominance. There was a decrease in the LF/HF ratio, which was not statistically significant. The LF/HF ratio is correlated with sympatho-vagal balance (Malliani, Pagani, Lombardi, & Cerutti, 1991). The LF component of the HRV is mainly related to sympathetic activation when expressed in normalized units, (Task Force, 1996) whereas afferent vagal activity is a major contributor to the HF component. Apart from this there was a significant decrease in HF component during Pop music indicative of an increase in Cardiac sympathetic activity (Billman, 2013). **Table 24** shows the percentage trend of ‘pre’ versus ‘post’, of all the sessions. There is a significant percentage reduction (14.85%) in Low

frequency (LF) and significant percentage increase (15.21%) in High Frequency (HF) Post Indian *Rāga* session.

Table 24 Summary of trend of percentage changes in frequency domain measures of heart rate variability spectrum (Pre Versus Post) Indian *Rāga,* Pop Music and silence or no music.

Variable	Indian ***Rāga***	Pop Music	Silence
LF	↓ 14.85**	NS	NS
HF	↑ 15.21**	NS	NS
LF/HF	NS	NS	NS

Note: n= 28; Significant *p<0.05; ** p< 0.01;*** p<0.001; NS = Not Significant; ↓ **decrease,** ↑ **increase.**

In the time domain measures, there was a significant increase in RMSSD and NN50. These indices reflect short-term variation and are correlated with the HF power or the parasympathetic activity (Kim, et al., 2006). There was a significant decrease in mean HR. As described above, most of the changes immediately after listening to Indian *Rāga* were indicative of reduced activity in the different subdivisions of sympathetic nervous system, though some variables are regulated by several factors. The heart rate, for example, is regulated by twofold innervations (sympathetic and parasympathetic), as well as humoral factors (Andreassi, 2007). This makes the decrease in heart rate complex to interpret (i.e., it could be due to increased vagal tone or due to sympathetic withdrawal). This also applies to HRV components. On the contrary, there was a significant decrease in NN50 of frequency domain measure during Pop session, which reflects sympathetic activation.

Table 25 Summary of trend of percentage changes in Time domain measures of heart rate variability spectrum (Pre versus Post) Indian *Rāga,* Pop Music and silence or no music.

Variables	**Rāga**	**Pop**	**Silence**
Mean HR	**↓3.76****	**NS**	**NS**
RMSSD	**↑18.78***	**NS**	**NS**
NN50	**↑28.41***	**NS**	**NS**

.

Note: n= 28; Significant *p<0.05; ** p< 0.01;*** p<0.001; NS = Not Significant; ↓ **decrease,** ↑ **increase.**

Table 25 shows the percentage trend of 'pre' versus 'post', of all the sessions in time domain measures. There is a significant reduction in percentage (3.76%) in Heart rate; significant increase in percentage (18.78%) in RMSSD; significant increase in percentage (28.41%); Collectively, the results suggest that the immediate effect of listening to Indian Rāga '*Bhūpāli'* is associated with changes in the autonomic nervous system suggesting vagal control. This was also correlated with the significant reduction in anxiety level assessed using the State and Trait Anxiety Inventory (STAI) and subjective feeling (VAS) of the session. Cardiac Vagal Tone has been proposed as a stable biological marker for the ability to sustain attention and regulate emotion (Porges, Doussard, & Maita, 1994).

Table 26 summarizes the values of mean and standard deviation in all the three sessions in four states with a percentage change of the frequency domain measures. The graphical representation of the same is given in **Fig. 15**. **Table 27** summarizes the values of mean and standard deviation in all the three sessions in four states with a percentage change of the Time domain measures. The graphical representation of the same is given in **Fig. 16**.

Table -26 Frequency domain measures for 3 sessions in 4 states for LF, HF and LF/HF with a percentage change for (pre versus Post) [a]

Measures	Sessions	Pre	During 1	During 2	Post	% change
Low frequency (LF) Power (n.u.)	**Rāga**	50.29± 19.95	42.44±19.09	43.60±16.0	42.82±18.79**	14.85 ↓
	Pop	47.11±19.50	53.49±18.79	54.62±17.65	48.12±18.06	2.13 ↑
	Silence	49.72±20.31	50.81±21.46	50.56±19.54	54.20±19.81	8.98 ↑
High frequency (HF) Power (n.u.)	**Rāga**	49.52±19.97	57.34±19.13	56.20±15.93	57.06±18.81**	15.21 ↑
	Pop	52.65±19.58	48.35±19.04	44.74±17.34*	51.69±17.99	1.82 ↓
	Silence	50.15±20.29	48.89±21.39	49.32±19.49	45.41±19.53	9.45 ↓
LF/HF Ratio	**Rāga**	1.57 ±1.99	.89 ±.83	.71 ±.60	.89 ±.99	43.31 ↓
	Pop	2.46 ±7.03	1.75 ±1.29	1.89 ±2.35	1.57 ±2.38	36.18 ↓
	Silence	2.64 ±6.91	3.1 ±8.32	2.93 ±8.51	2.54 ±5.94	10.72 ↓

Abbreviations: SD, Standard Deviation

[a] Values are group mean ±SD

***p < 0.05; ** p < 0.01; *** p < 0.001. ↑, increase; ↓, decrease.**

Fig-15 Trend of percentage change shown in frequency domain measures of heart rate variability spectrum recorded Post - Indian Rāga Session and two control sessions of Pop Music and Silence

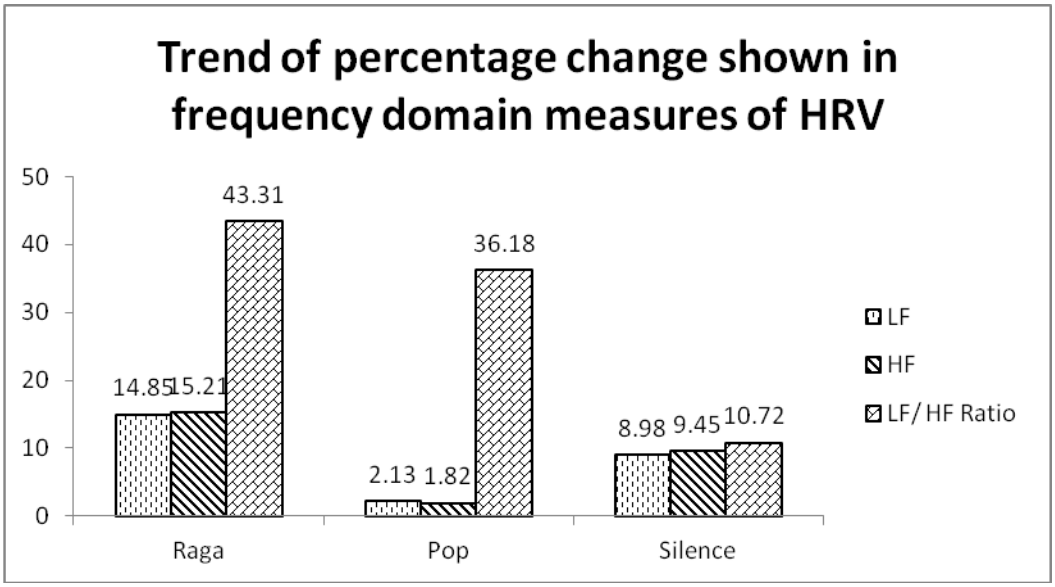


Table – 27 Time Domain measures for 3 sessions in 4 states for Mean HR, RMSSD and NN50 and the percentage change (pre versus Post) [a]

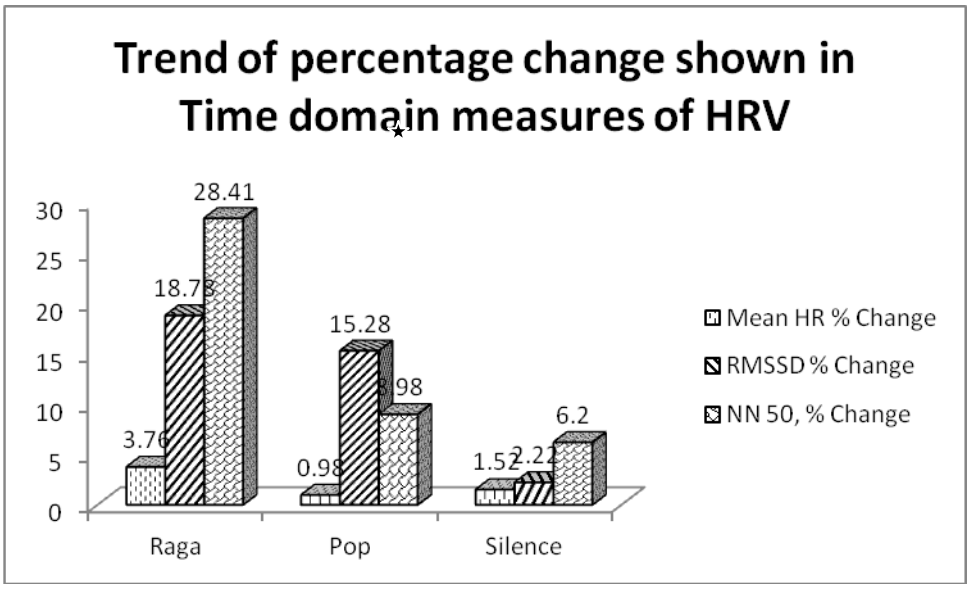
Measures	Sessions	Pre	During 1	During 2	Post	% change
Mean HR	**Rāga**	80.71±11.04	79.789.99	79.10±9.74	77.68±9.86**	3.76 ↓
	Pop	80.32±10.64	80.61±10.65	80.86±10.81	79.54±11.50	0.98 ↓
	Silence	79.89±8.65	79.03±8.42	78.61±8.46	78.68±7.96	1.52 ↓
RMSSD	**Rāga**	50.46 ±28.28	54.61±31.30	58.89±35.46	59.89 ±29.36*	18.68 ↑
	Pop	56.11 ±34.23	49.50 ±28.41	47.32±21.99	47.5 23.39	15.28 ↓
	Silence	51.36 ±34.51	50.46 ±39.24	50.89±35.35	50.21±28.97	2.22 ↓
NN50	**Rāga**	84.32±67.46	98.25±73.26	102.61±73.01	108.28±69.29 *	28.41 ↑
	Pop	93.86±62.81	78.86±62.45	84.11±64.76*	85.4359.92	8.98 ↓
	Silence	92.61±68.70	81.71±69.04	91.96±63.16	86.86±66.76	6.2 ↓

Abbreviations: SD, Standard Deviation

[a] Values are group mean ±SD

***p < 0.05; **p < 0.01; *** p < 0.001. ↑, increase; ↓, decrease.**

Fig-16 The trend of percentage change shown in time domain measures of heart rate variability spectrum recorded post session of Indian Rāga Session and two control sessions of Pop Music and Silence



The factors which reflect emotional and effective response to music are soothing and relaxing music, urban factor like rhythm and percussion, sophisticated factor which includes classical music, an intense factor like loudness, forceful and energetic music, Campestral factor comprising of country and folk songs (Rentfrow, Goldberg, & Levitin, 2011). We were certain that this stimulus with Indian *Rāga Bhūpāli* had a stress-reducing capacity independent of individual preferences because of the combination of the notes, aesthetic mood, it instills while listening, the slow tempo and the popularity of the piece of music we used. The point to be noted here is that using researcher-selected music stimuli have been shown to have greater

effects on stress reduction than music stimuli selected by the subjects themselves **(**Pelletier, C. L., 2014). The *Rāga Bhūpāli* may have helped to create the positive mood of love or *Śṛngāra* rasa, within the listener who are away from their family. Such emotional regulation is the goal of any music therapy. This may have helped in parasympathetic activation and a relaxing internal environment.

In general, Rock music, is preferred by contemporary college students and heavy metal is mostly preferred by adolescent boys. Concerns have been raised regarding psychological, emotional, behavioral, and physical effects associated with this music preference. **(**Milton, et al., 2008). Study taking Self report reasons for pop music preference revealed that characteristics such as the melody, mood, rhythm and lyrics of a selection were the important reasons for preference. (David, Glenn, & Ramsey, 1981). But, the results in one of the studies indicated that the dominant factor affecting emotional response was music type (either relaxing or stimulating) but not preference (Gerra., et al., 1998).

In one of the studies, the stimulating music aroused feelings of vigor and tension more than did the calming one while sedative music eased tension. Favorite music, regardless of music type, lowered subjective tension. Physiological responses (heart rate, respiration, and blood pressure) were greater during stimulating music than during calming music. Music preference did not, however, affect the physiological responses (Iwanaga, Kobayashi, & Kawasaki, 2005). Passive listening to music accelerates breathing rate and increases blood pressure, heart rate, and the LF: HF ratio (thus suggesting sympathetic activation) proportional to the tempo and perhaps to the complexity of the rhythm. (Bernardi, Porta, & Sleight, 2006)

Slow tempo with soothing notes may have had helped in parasympathetic activation, which is shown in our study. Pop music generally preferred by the young college students with steady beats has increased sympathetic activation. The three universals of music are (a) Low

frequencies can relax; (b) Rhythmical music can invigorate; (c) Loud music can create aggression (Wigram, T., Saperston, B., West, R. 2000).

In summary, there was a significant decrease LF ($p < 0.01$) and Mean HR ($p < 0.01$) after *Rāga* session compared to the pre-period. There was a significant increase in HF ($p < 0.01$), NN50 ($p < 0.05$) and RMSSD ($p < 0.05$) after *Rāga* session compared to the pre-period. There was a significant decrease in HF ($p < 0.05$) and NN 50 ($p < 0.05$) during Pop session compared to the pre-states. The anxiety level significantly ($p < 0.001$) decreased post *Rāga* session. There was a significant increase in state anxiety level ($p < 0.01$) after Pop Session. The subjective assessment of perceived feeling using Visual Analog scale comparing *Rāga* with Pop and Silence sessions showed a significant positive difference ($p < 0.01$).

The significant changes in both frequency and time domain measures in three sessions are given in **Table -28.** Post Hoc Analyses with Bonferroni Adjustment were performed and all comparisons were made with respective 'pre' states summarized in **Table -29**.

Table – 28 Summary of ANOVA showing statistically significant results

Variables	Factor	F value	DF	Huynh-Feldt epsilon	Level of significance
HF	Session	3.493	(2,54)	1.000	p<0.05
HF	Sessions*states	3.420	(4.99, 134.721)	0.832	p<0.01
LF	Sessions	3.579	(2,54)	1.000	p<0.05
LF	Session*states	3.792	(5.21,140.70)	0.869	p<0.01
Mean HR	States	7.922	(2.249, 60.719)	0.750	p<0.01
Mean HR	Session*states	2.461	(69.054, 131.368)	0.811	p<0.01
NN50	Session*states	3.795	(6,162)	1.000	p<0.01

Abbreviation: ANOVA Analysis of Variance

Table –29 Significant results of Post hoc analysis where the arrows show the direction of changes

Variable	Session	During 1	During 2	Post
LF	Rāga	NS	NS	$p>0.01$ ↓
HF	Rāga	NS	NS	$p<0.01$ ↑
HF	Pop	NS	$p<0.05$ ↓	NS
Mean HR	Rāga	NS	NS	$p< 0.01$ ↓
NN 50	Rāga	NS	NS	$p<0.05$ ↑
NN 50	Pop	NS	$p >0.05$ ↓	NS
RMSSD	Rāga	NS	NS	$p <0.05$ ↑

Abbreviations: NS, not significant;↑, increase; ↓, decrease**.**

7.2 WORKING MEMORY

This study of music and memory showed that the performance of a cognitive task, such as digit span can be affected by the type of music played prior to the test. In this study, Indian *Rāga Bhūpāli* had a significant effect on the performance of the attention and concentration tasks when compared to the scores of the attention and concentration task with pop music.

Studies have shown that the choice of the musical genre may influence cognitive performance. Rauscher has provided the neurophysiological basis for the improvement in performance considering theoretical and experimental factors. The factors influencing the performance are the choice of dependent measures, the selection of musical composition, presentation order of the conditions, and the inclusion of distracter task. Digit span scores of subjects who listened to the Pachelbel Canon versus a Bartok piece did not improve (Rauscher, & Shaw, 1998). Listening to a piece of melody, of Vivaldi's "Four Seasons" had a positive effect on older adults' cognitive performance in two working memory tasks compared with the no-music condition. In addition, this effect did not occur with white noise (Nicola, Beth, & Cesare, 2007). It was shown, that exposure to Mozart piano sonata enhanced performance on an abstract/spatial reasoning task from the Stanford-Binet intelligence scale when compared with silence, a relaxation tape (Rauscher, Shaw, & Ky, 1993). In 1995, they found that Mozart piano sonata had a positive influence on the performance when compared to a short story, minimalist music, or dance music (Rauscher, Shaw, & Ky, 1995). Rideout *et al.*, have reported that a present-day composition by the Greek-American musician Yanni is also effective and is similar to the Mozart sonata in its physical characteristics. Two Bachs also have shown a similar effect with that of Mozart (Jenkins, 2001). Studies utilizing paper –folding tasks, maze tasks showed enhancement following exposure to Mozart music. Whereas as studies utilizing paper form board task,

Digit span test, Raven Progress Matrices test did not show any enhancement following exposure to Mozart music. Research put forward that these tests measure general analytic intelligence rather than spatial ability. (Rauscher, & Shaw, 1998).

The selected Indian Classical *Rāga* in our study is said to create a pleasing effect on the internal environment due to the combination of notes. The improvement in memory scores could be due to the rasa or aesthetic mood induced by the *Rāga*.

Listening to music helps to calm down the nervous system. One of the studies showed, music prior to a standardized stressor predominantly affected the autonomic nervous system in terms of a faster recovery (Thoma, et al., 2013). Music influences how a listener feels, and feelings influence a wide range of stimulus, including cognitive performance like that of thinking, logical analysis, problem-solving, originality, and mental flexibility (Schellenberg, 2012). Listening to classical relaxing music after exposure to a stressor resulted in considerable reductions in anxiety, anger, and sympathetic nervous system arousal, and increased relaxation compared to those who sit in silence or listen to heavy metal music (Elise, et. al., 2007).

Digit span forward scores differed significantly between Sessions ($F = 1.98$, $p < 0.05$).

Digit span backward scores also differed between Sessions ($F = 2.51$, $p < 0.05$).

The increase in scores for the digit span backward tasks following listening to Indian *Rāga* was significantly greater (5.26 %), than Pop Music (1.4 %) and Silence or No music condition (1.87 %). There were separate repeated measures analyses of variance (ANOVAs) for each of the assessments, with two Within Subjects factors [i.e., Time (before, after) and Sessions (*Rāga*, Pop, Silence)]. *Post-hoc* analysis was with Bonferroni adjustment, comparing after with before values.

The following **Table 30** denotes the Pre and Post results of group mean and Standard deviation (SD) for the three sessions of India *Rāga*, Pop Music and Silence or No music conditions.

Table – 30 Values of Group Mean ±SD score of time assessments for sessions (Digit Forward Task) N=26.

Time of assessment	Indian Rāga	Pop Music	Silence
Pre	23.04±1.886	22.46±2.005	23.0±1.876
Post	23.77±1.704	22.69 ±2.112	23.04±2.049
% change	3.17↑	1.02↑	0.17↑
Significance	0.025*	0.574	0.906

* $p \leq 0.05$

SD - Standard Deviation

Table –31 Values of Mean ±SD score of time assessments for sessions (Digit Backward Task) N = 26.

Time of assessment	Indian *Rāga*	Pop Music	Silence
Pre	20.54±2.158	20.08±2.058	20.35±2.190
Post	21.62 ±1.856	20.38 ±2.155	20.73± 2.273
% Change	5.26↑	1.49↑	1.87↑
Significance	0.031*	0.456	0.332

Analysis of Variance (ANOVA) + Bonferroni Adjustments * $p \leq 0.05$

The above **Table 31** denotes the Pre and Post results of group mean and Standard deviation (SD) for the three sessions of India *Rāga*, Pop Music and Silence or No music conditions.

Table - 32 Values of mean difference before the Sessions for Digit Forward Task – Pair wise comparison

(I) Session	(J) Session	Mean Difference (I-J)	Significance.
Indian Rāga	Pop Music	.577	.587
	Silence	.038	1.000
Pop Music	Indian Rāga	-.577	.587
	Silence	-.538	.722
Silence	Indian Rāga	-.038	1.000
	Pop Music	.538	.722

Analysis of Variance (ANOVA) + Bonferroni Adjustments

The above **Table – 32** denotes mean difference before the sessions of Indian *Rāga*, Pop Music and Silence, a pair wise comparison, for Digit Forward Task. There were no significant changes between the sessions.

Table -33 Values of mean difference after the Sessions for Digit Forward Task - Pair wise comparison.

(I) Session	(J) Session	Mean Difference (I-J)	Significance.
Indian	Pop	1.077	.112
	Silence	.731	.521
Pop	Indian	-1.077	.112
	Silence	-.346	1.000
Silence	Indian	-.731	.521
	Pop	.346	1.000

Analysis of Variance (ANOVA) + Bonferroni Adjustments

The above **Table - 33** denotes mean difference between the baseline and post results of digit Forward Task across the three sessions. There were no significant changes between the sessions.

Table – 34 Values of mean difference before the Sessions for Digit Backward **Task - Pair wise comparison**

(I) Session	(J) Session	Mean Difference (I-J)	Significance.
Indian Rāga	Pop Music	.462	1.000
	Silence	.192	1.000
Pop Music	Indian Rāga	-.462	1.000
	Silence	-.269	1.000
Silence	Indian Rāga	-.192	1.000
	Pop Music	.269	1.000

Analysis of Variance (ANOVA) + Bonferroni Adjustments

The above **Table – 34** denotes mean difference before the sessions of Indian *Rāga*, Pop Music and Silence, a pair wise comparison, for Digit Backward Task. There were no significant changes between the sessions.

Table - 35 Values of mean difference after the Sessions for Digit Backward Task - Pair wise comparison

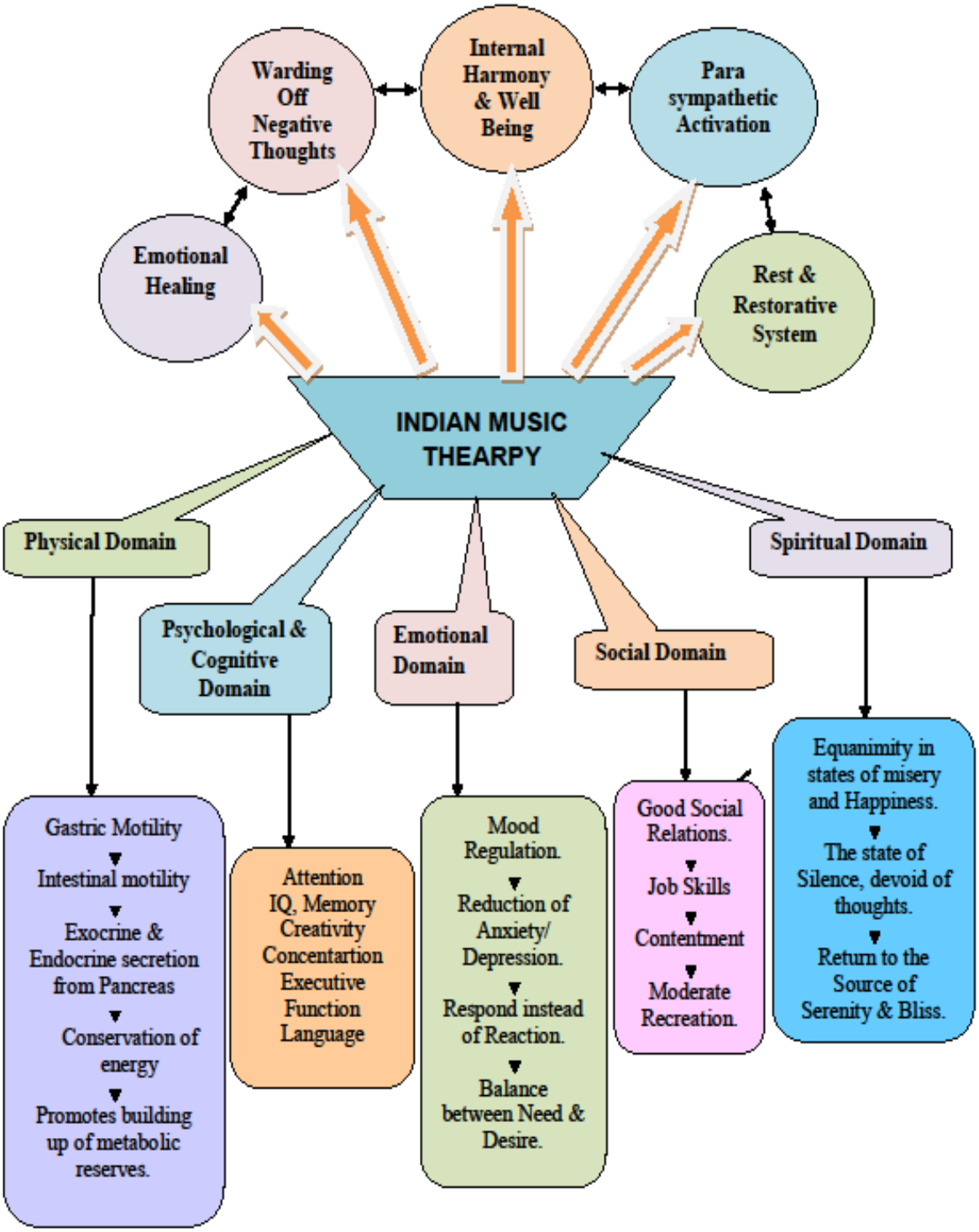
(I) Session	(J) Session	Mean Difference (I-J)	Significance*
Indian	Pop	1.231*	.015*
	Silence	.885	.179
Pop	Indian	-1.231*	.015*
	Silence	-.346	1.000
Silence	Indian	-.885	.179
	Pop	.346	1.000

Analysis of Variance (ANOVA) + Bonferroni Adjustments

The above **Table - 35** denotes mean differences between the baseline and post results of Digit Backward task across three sessions. There were significant changes between the sessions – Indian *Rāga* and Pop Music; Pop Music and Indian *Rāga.*

From the summary of the various research works in Music it may be concluded that Music therapy brings improvement in Physical, Psychological, Emotional, Social and Spiritual Domains. The main purpose of Indian music **t**he consolidation and evocation of *rasa* or positive aesthetic mood represent the function of all fine arts. By experiencing the dominant state of the rasa or aesthetic mood again and again, it is easy to adapt the same in one's day to day life. This will help one to live harmoniously in the society by equating inner and outer expressions. Further, this aids in the total personality development of physical, mental, emotional social and spiritual (*Karuṇa*, Srinivasan, & Nagendra, 2013). Fig 17 below gives the summary of improvement Physical, Psychological, Emotional, Social and Spiritual Domains through Music Therapy.

Improvement in Physical, Psychological, Emotional, Social and Spiritual Domains through Music Therapy



Chapter – 8

Appraisal

8.0 Appraisal

To understand the limitations of the present study as well as to get insight into new ideas for future research, a critical review of the work done has been done. The appraisal of the research work in this thesis is presented under the following headings:

1. Summary of the findings
2. Conclusion
3. Implications and applications of the study
4. Strength of the study
5. Limitations of the study
6. Suggestions for future studies

8.1 Summary of the findings

The study of Heart Rate Variability was conducted on twenty eight participants, both male and female with ages ranging from 18 to 24 (group average age± SD 19.68 ±2. 57). They were studied in three sessions viz., Indian *Rāga,* Pop Music and silence or no music. Each session consisted of 'Before' (5 minutes), 'During' (10 minutes) and 'After' (5 minutes) states.), Autonomic changes were recorded before, during and after sessions, attempting to correlate with State anxiety with STAI and Subjective Feeling with VAS before and after the three sessions following the HRV.

Memory Task was studied in twenty six participants, both male and female (group average age ± S.D., 18.84±3.53 years). The immediate effect of two musical conditions, Indian *Rāga Bhūpāli,* Pop Music and No music condition was studied on memory.

For each of the variables the data were analyzed separately using SPSS (Version 16.0). There were separate repeated measures analyses of variance (ANOVAs) for each of the assessments, with two Within Subjects factors [i.e., Time (before, after) and Sessions (Rāga,

Pop, Silence)]. *Post-hoc* analysis was with Bonferroni adjustment, comparing after with before values.

During Indian *Rāga*, there was a significant decrease in the low frequency (LF) power and increase in the high frequency (HF) power in the frequency domain analysis of HRV spectrum. There was also a significant decrease in mean HR; a significant increase in the NN50 and RMSSD in time domain analysis of HRV. Both frequency and time domain analysis are indicative of parasympathetic activity. The anxiety level significantly decreased post Indian *Rāga* session and significantly increase post Pop Session. The subjective assessment of perceived feeling using Visual Analog scale comparing Indian *Rāga* with Pop and Silence sessions showed significant difference of feeling positive.

A Section of the Wechsler memory scale (WMS) was used to assess; (i) attention and concentration (digit span forward and backward) before and immediately after the intervention. There was a significant improvement in digit forward and backward span score after immediately after the **e**xposure to Indian *Rāga Bhūpāli*.

8.2 Conclusion

The present study results suggested that the importance of the aesthetic mood of music in altering autonomic responses and reducing the anxiety levels. We chose *Rāga Bhūpāli* which instills the aesthetic mood of love within the listener. Calm spirit with a sense of hope and love, security and happiness leads to sound heart and health (Asadzandi, 2015).

This also has helped in recognizing the mechanism through which Indian music may affect the physiological change by instilling a particular aesthetic mood within the listener.

Research has shown that the specific choice of musical composition may help in the improvement of the particular cognitive task. The selected Indian Classical *Rāga* in our study is said to create a pleasing effect in the internal environment due to the combination of notes.

The improvement in memory scores could be due to the rasa or aesthetic mood induced by the *Rāga*.

8.3 Implications and applications of the study

Many studies have shown that music experience is a key to develop future therapies in order to prevent the development of cardiovascular disorders.

Indian *Rāga* '*Bhūpāli'* may be effectively used in cardiac regulation and may also facilitate recovery from post-stress anxiety suggestive of applications in clinical settings. Musical exercise stabilizes the mind, decrease mental modifications which are helpful to cultivate the attitudes of friendliness, compassion, cheerfulness, loving kindness and forgiveness.

Working memory

Many college students listen to music to ease the emotional effects of stress and anxiety when engaged in cognitive performance, such as studying for exams, writing the assignments, etc. Listening to Indian *Rāga Bhūpāli* has a positive effect on attention and concentration of the student leading to better performance in their studies.

8.4 Limitations of the study

- In our study, the participants were the students of Residential Yoga University. As a part of their curriculum they were all exposed to evening Bhajans set to different *Rāgās*. This may have caused an improvement in the memory scores. This is the downside of our study.
- All participants were assessed in three sessions; there may have been an element of adaptation and boredom.

- The respiratory rate is also influenced by the autonomic nervous system, but we did not measure the respiratory rate during the sessions, this account to limitation of our study.

8.5 Strength of the Study

The *Rāga* chosen from the theoretical model of emotional healing is based on the *Rasās* or aesthetic mood theory from ancient Indian music texts. This has shown improvement in the autonomic variables, reduction in anxiety and also has improved memory scores.

In our study, the participants were from different ethnic groups and not all of them had musical training or the knowledge of the elements of Indian music. In spite of this factor, the musical stimulus has brought positive changes.

8.6 Suggestion for the Future

The study may be extended to various other Indian *Rāgās* in the above applied areas by identifying sensitive physiological variables.

The study of Indian music therapy may be extended to various Indian *Rāgās* and other dependent measures or cognitive tasks.

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