# Study of Classical Ragas Structural Influence on Brain Waves

Aashish.A.Bardekar[1], Ajay.A.Gurjar[2]
[1]*Department of Information Technology*
[2]*Department of Electronics &Telecommunication*
*Sipna College of Engineering and Technology, Amravati(M.S), India*

***Abstract:*** Indian classical musical maestros recognized, ragas influences emotions of human being by changing the resonance of human body. Ragas like darbari and khamaj are found to defuse mental tension, particularly in the case of hysterics. Raga malhar pacifies anger, excessive mental, excitement & mental instability, Raga jaijaivanti have also been pound effective in curing mental disorders and calming the mind. Although it is require to verify this raga correlation systematically. By survey, it has been seen that no schemes have demonstrated yet. The proposed research presented in this paper is aimed to discover the science behind phonetics of raga and its effects on nerve system. This research is one step to explore scientifically the ancient way of alternative medicine i.e. raga therapy, which is a need of the day since current advances in technology and rising workload on human being is accompanied by stress relating to mental disorders. This research focuses on to study the influence of Indian classical ragas structure on human body while person is listening and experiencing an emotion in it by capturing EEG signals. The brainwave signals database will be collected and analyze. This research work addresses these objectives and aims to present a strong case which will help medical practitioners like psychiatrist, to treat patient by injecting music stimulus.

**Keywords:** Emotion, raga and emotions, EEG, Brainwave Signals

## I. INTRODUCTION

In our daily life human being generally come across stress resulting in various physical and psychological ailments. [1]. In Sanskrit 'Raga', literally means "colour" or "mood" similar to rasa but involving specific musical rules or guide its scope is limited to the first 7 moods.There are rules for upward directions of the scale, "aahroh," and downward movements, "aavroh"; rules that specify phrases to use and to avoid and which notes to use sparingly and often. The character of the raga is defined by the order and sequence of these notes and, just as importantly, subtle grace-notes called gamakas[2].

Traditionally music is said to evoke seven basic emotions: sadness, romance, peace, strength/courage, anger, dispassion, devotion. Each raag elicits a unique emotional state (rasa) consisting of one or more of these emotions [3].

*A. Emotions and Ragas:*

Each raga is uniquely defined by its pitch collection and characteristic phrase. Each raga has some mood associated with it that can be related to its pitches and their relations one with another. Certain pitch classes commonly occur in ragas conveying a particular kind of emotion. The pitch set of a raga and its characteristic phrase establish the flavor or mood of the raga. It is a well-accepted notion that there are 11 basic moods (based on "Raga, the soul of classical music") in North Indian classical music that can be depicted through a combination of music, dance and poetry.Eleven sentiments are stimulated through singing.

- Karuna
- Shringar
- Shanta
- Veer
- Raudra
- Vyragya
- Bhakti
- Bhayanak
- Hasya
- Bibhatsa
- Adbhuta

The ten parent classes are:

1. Bhairav: An early morning raga usually played at daybreak.
2. Bhairavi: A morning raga often played at the finale of any musical performance.
3. Asavari:A morning raga popularly known as a romantic raga.
4. Todi: morning raga meditative in nature.
5. Kafi: This raga does not have a performance time, known for its shringar (romantic) mood.
6. Marwa: A raga played around dusk bringing about an ascetic mood.
7. Purvi: An afternoon raga conveying a mood of serenity.
8. Khamaj: An evening raga, often used in semi-classical and folk music owing to its lilting character.
9. Kalyan: An evening raga used to convey descriptions of beauty.
10. Bilawal:A morning raga that conveys joy [5].

*B.Raga and Time of day:*

One of the unique characteristics of Indian music is the assignment of definite times of the day and night for performing Raga melodies. It is believed that only in this period the Raga appears to be at the height of its melodic beauty and majestic splendor. There are some Ragas which are very attractive in the early hours of the mornings; others which appeal in the evenings, yet others which spread their fragrance only near the midnight hour. There are Ragas associated with the rainy (Raga Megha and Raga Malhar), the autumn season (Raga Basant) and the spring season (Raga Bahar). Seasonal Ragas can be sung and played any time of the day and night during the season allotted to them. The obligation of time in case of such melodies is relaxed. This connection of time of the day or night, with the Raga or Raginis is based on daily cycle of changes that occur in our own moods and emotions which are constantly undergoing subtle changes in that different moments of the day arouse and stimulate different moods and emotions. The mental and emotional responses in the autumn or winter or during the rainy season are different from the spring. Scheduling playing times of ragas has a variety of advantages. It fits the mood of the raga with our own mood, thus forming a fusion of body and soul. It also creates a definite space of time hence making it possible for various ragas to get a turn at performance. Each raga or ragini is associated with a definite mood or sentiment that nature arouses in human beings. The ancient musicologists were particularly interested in the effects of musical notes, how it affected and enhanced human behavior. Music had the power to cure, to make you feel happy, sad, disgusted and so on. Extensive research was carried out to find out these effects. This formed the basis of time theory as we know it today. Aligned with the emotional and psychological effect of music on the human mind, the semitones or Shrutis of the octave were named according to subtle shades of different sentiments, feelings and emotions. The Ragas and Raginis emerge as the suggestive sound images of these sentiments, emotions and passions[6].

Each raga in HM, conventionally assigned to a corresponding rasa/emotion is known consistently evoke a certain emotion. The artist exploits her creativity and elaborates melodic framework to bring out the rasa or the emotion [7].

*C .Raaga Structure:*

a) Raag Desh has been used in patriotic compositions. Vande Mataram, the national song of India, is the most well-known. The popular old Doordarshan video Baje Sargam, that featured many respected Indian classical singers, is also based on Desh.

Arohana: Ni Sa Re, Ma Pa Ni,Sa.

Avarohana: Sa ni Dha, Pa Dha Ma Ga Re, Pa Ma Ga, Re Ga Ni Sa.

Pakad: Re, Ma Pa Ni, Sa Re ni Dha Pa,ma Ga Re

The vadi swara is Re

b) Raag Todi is mostly pervaded by a pensive, mournful mood.

Arohana

S r g $M^+$ d N S' or
'd 'N S r g $M^+$ d N S' or
S r g $M^+$ d P, $M^+$ d N S' or
S r g $M^+$ P, $M^+$ d N S'

Avarohana

S' N d P $M^+$ g r s or
S N d P $M^+$ d $M^+$ g r g r S

Vadi: Komal Dha

Samavadi: Komal Ga

Pakad:r/g-\r\S

Prahar(Time):late morning

A basic and one of the oldest socio-cognitive domains of the human species is music. Listening to music regularly helps keep the neurons and synapses more active. Neurological studies have identified that music is a valuable tool for evaluating the brain system. It has been observed that different parts of the brain are involved in processing music. They include the auditory cortex, frontal cortex, cerebral cortex and even the motor cortex. The first step in modeling any phenomenon is data collection, we need to design experiment methodologies that successfully induce emotions in a laboratory settings where in we can record and collect psychological data. The objective of this study is to analyze the effect of Indian classical music on brain activity during normal relaxing conditions using electroencephalography (EEG)[7].

## II. LITERATURE SURVEY

Indian music is based on the raga system. when we go through the literature related to acoustic and carnatic music, very little is available about the physics of raga. In acoustic we come across terms like frequency, amplitude, loudness, pitch, velocity, timbre, quality etc. Musical sound has three identifying characteristics, loudness, pitch and timbre(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 sound is determined mainly by its frequency and is measure of how “high” or “low” a tone is and is measured in hertz(Hz).The third identifying feature ,timbre stems from the fact that musical sound are made up of many different sound waves. Timbre (quality) essentially depends on the number intensity and distribution of the harmonics components of a tone [8].A number of studies have shown that music affects emotions and mood states as well as performance.

Brain anatomy researchers have postulated that music affects brain function in at least two ways:it acts as nonverbal medium that can move through the auditory cortex directly to the limbic system(an important part of emotional response system)and it may stimulate release of endorphins thereby allowing these polypeptides to act on specific receptors[9]. Music is an integral part of human existence. People have made and listened to

music for centuries. Different rhythms and tones evoke different responses in different people while someone may feel nostalgia upon hearing a certain song or piece of music, someone else may feel happiness, sadness, or anger. However, relatively little research has been done until recently regarding how music affects the brain what parts of the brain process it, if different kinds of music activate different parts of the brain, why music evokes an emotional response to name only a few questions. To understand music's impact on emotions and the brain, it is important to first have a basic understanding of what parts of the brain regulate emotion, and if separate parts of the brain regulate different emotions. Recent research suggests that there are numerous brain systems responsible for emotional responses, and there are specific systems for different basic emotions. The part of the brain that is most commonly associated with emotion is the amygdala. There is actually a system, consisting of three different parts of the prefrontal cortex that are connected to the amygdala that is thought to be responsible for emotions. The parts of the brain that are involved the dorsolateral, the medial, and the orbitofrontal cortex are thought to regulate decision-making and negative emotions, as well assessing the appropriate emotional response to a situation[10].Schimdt and Trainor investigated patterns of EEG actively induced by musical excerption in a group of undergraduates. They found greater left and right frontal activity during music listening to pleased and unpleasant music [11]. Various measures can be used to track related physiological responses such as electromyography(Ema) blood volume pressure (BVP) and galvanic skin response (GSR) [12].

Shown here in concert C, the ten common thaats are:

1. KALYAN: C D E F# G A B.
2. BILAVAL: C D E F G A B.
3. KHAMAJ: C D E F G A Bb
4. BHAIRAV: C Db E F G Ab B
5. PURVI: C Db E F# G Ab B
6. MARVA: C Db E F# G A B
7. KAFI: C D Eb F G A Bb
8. ASAVARI: C D Eb F G Ab Bb
9. BHAIRAVI: C Db Eb F G Ab Bb
10. TODI: C Db Eb F# G Ab B.[2]

*A. Linking Emotion, EEG & Music:*

Recent efforts is using more adequate measures of larger parts of the recorded Electro-Encephalographic (EEG) dynamic information have proved more successful [12]. Emotions are not just what are displayed. In psychology an explicit separation is made between the physiological arousal, the behavioral expression (affect) & the conscious experience of an emotion (feeling) [15].Music at different pitches elicits exceptionally emotions and is capable of reliably affecting the mood of individuals which is turn changes the brain activity [16].The frequencies of notes used in music lie between 30hz to5000hz.This frequency range is divided into many octaves. In western music we have the notes C,C#,D,D#,E,F,F#,G,G#,A,A# and B. The frequency of these notes is fixed, middle octave C4 is 261.63, C#4 is 277.18 etc. In music shruti ordinally refers to frequency. It can be said as a group of frequencies with varying amplitudes, but one with maximum amplitude will represents a shruti. Gamaka (Arohana and Avarohana) shakes the notes (swara) resulting in a musical effect. The individual shade and color of raga becomes clear only with proper usage of the gamakas.Gamaka plays a vital part in Indian music, and they determine the melodic part of a raga [8].

Depending on the way sound waves are listened to or pronounced, they have an impact in the way the neurological (brain nerve) system works in human body. Neurological studies have indentified that music is a valuable tool for evaluating the brain system. The frontal EEG coherence increased during verbal learning with musical template. Under the influences of alpha music, great reduction in feelings of stress and or increased sense of physical relaxation was observed. Music evoked emotions can modulate activity in all limbic and para-limbic brain structures. These brain structures are involved in the initiation, generation, detection, maintenances regulation and termination of emotions that have survival value for the individual & species [16].

The acoustic cues that differentiable emotions cover virtually all aspects of musical structure and include both structural what is given by the composer and performance characteristics e.g. sadness is conveyed by quiet low, legato articulation timing, where as happiness or joy is conveyed by high pitched, fast staccato features & small variations from metrical timing music bears some relation to emotion in the rise and fall of tension in music [17].

In India, saint musician Thyagaraja is said to have brought a dead person back to life with Bilahari raaga, and in our own times Pt Omkarnath Thakur is said to have cured Mussolini of his insomnia with a song[ 20].Thakur began with hindolam raag , which depicts valor. "When I was soaring in the high notes of the rāga," he later recalled, "Mussolini suddenly said 'Stop!' I opened my eyes and found that he was sweating heavily. His face was pink and his eyes looked like burning coals. A few minutes later his visage gained normalcy and he said 'A good experiment."After Thakur brought him to tears with rāga chayanat, which is meant to depict pathos, Mussolini said, after taking some time to recover, "Very valuable and enlightening demonstration about the power of Indian music."[21]

*B. Electro-encephalogram(eeg):*

The language of communication with the nervous system is electric. Electroencephalography (EEG) is a tool for measuring electrical activity generated in the brain, which opens a window for exploring neural activity and brain functioning. The EEG signal is measured using electrodes placed on the scalp, which

.record the electrical field generated by the nerve cells Changes in the brain's electrical activity occur very quickly, and extremely high time resolution is required to determine the precise moments at which these electrical events take place. Today's EEG technology can accurately detect brain activity at a resolution of a single millisecond even less unlike other electrical recording devices that require inserting electrodes into the brain, EEG electrodes are simply stuck onto the scalp. In addition, EEG equipment is relatively inexpensive compared with other devices and simple to operate. Another way that researchers use EEG signals for studying the brain is to examine responses to stimuli and other events. This method is based on the assumption that when a particular event occurs we see a familiar face, for instance, something changes in the brain's regular activity. A series of particular responses to a stimulus can indicate the time course of various neural processes invoked in order to process the stimulus, understand it, and decide on the appropriate reaction. In this way, researchers can compare the brain's responses to various types of stimuli, or its activities as we perform certain tasks, and then draw conclusions about the .different brain processes involved in each of these situation [19].

EEG rhythms are classified into four basic types:

i. Delta (1/2 - 4 cycles per second),
ii. Theta (4-7 cycles per second),
iii. Alpha (8-13 cycles per second), and
iv. Beta (13-40 cycles per second.

Selecting the right type of music is thus important because the EEG spectral power depends on the intensity and style of music[7].

The Five Categories of Brainwaves

1. Beta brainwaves(14 to 32 Hz alert, focused)

Features and Benefits of a Beta State: This is the brainwave for,

- Increased concentration and alertness
- Improved logic, reasoning and critical thinking
- Feelings of anxiety, stress, scary unfocused thought.

2. Alpha brainwaves (7 to 14 Hz relaxed, meditative)

Features and Benefits of an Alpha State: Our brain hemispheres become naturally synchronized, or in-phase with each other.

- Enables us to remember our dreams and meditative states.
- Increased vividness benefits creative visualization and triggers imagination
- Increased memory retention , concentration & focus for super learning Health benefits include:
- Reduced anxiety
- Alleviates stress and depression

3. Theta brainwaves (3.5 to 7 Hz deep relaxation)

Features and benefits of Theta brainwaves

- Increased sense of inner peace and emotional stability
- Deep relaxation
- Health benefits of Theta brainwaves
- Reduce mental fatigue
- Reduction of anxiety and stress

4. Delta brainwaves (0.1 to 3.5 Hz deep sleep)

Delta is the place of deepest relaxation, deepest healing, deepest spiritual connection and deepest connection with the subconscious mind.

Each of us can use brainwave entrainment to achieve a variety of results. You may want to target a specific brainwave frequency range to help you relax. On the other hand you may want to increase you creative energy, improve your memory, deepen your sleep or get better results when playing a sport[18].

## III. OBJECTIVES

The Goal of this research work is to explore:

a) To collect the database of different Indian classical ragas sung by experts of different age group.
b) To convert time series of raga to frequency domain using time-frequency analysis.
c) To study EEG pattern of human subject listening the raga within a focus on Alpha, Beta Theta and Delta frequency bands.
d) To correlate sequence of notes in raga within frequency deviation of EEG, to understand which raga structure elicit specific emotion such as Peace, Happiness, Cheerful, Sadness and Depressed.

## IV .EXPERIMENTAL PROTOCOL

*A. Feasible Study*

The research focuses on to study the influence of Indian classical ragas structure on human body by capturing EEG signals. For this purpose we will require to collect brainwave signals database of persons listening to music .By selecting Indian classical ragas, we will ask person to listen and experience an emotion in it.

*B. Input Output Specifications*

1) A data of EEG signal samples of different subjects with and without knowledge of music, while listening to different ragas.
2) Extracting brain waves and evaluation.
3) Drawing Experimental Result and Conclusion.

## V. DESIGN

*A. Proposed design:*

Our brain is made up of billions of brain cells called neurons, which use electricity to communicate with each other. The combination of millions of neurons sending signals at once produces an significant amount of electrical activity in the brain, which can be detected using sensitive medical equipment such as an electroencephalogram (EEG).This electrical activity of the brain is commonly known as a Brainwave pattern, because of its cyclic, 'wave-like' nature. You can train your brain to change your brainwaves by learning meditation and relaxation

techniques. However, it can take weeks, and for some people even years to experience the proven and powerful benefits of brainwave entrainment through meditation alone. There is also a short cut to getting the best from your brainwaves by using an audio tone known as binaural beats. Binaural beats effectively entrain and synchronize your brainwaves to enhance any specific brainwave pattern. This allows you to rapidly enter states of relaxation, focus, high-energy, or meditation whenever you want.

*B. Detailed design:*

Due to the high temporal resolution of EEG, it is possible to study neuronal processes at different time scales, that is, frequency bands that are related to different mental functions and most presumably also to emotional states. The present study aimed to elucidate whether and in which frequency bands EEG would raise reliable correlates of emotion processing [14].With this approach we are performing an experimental study to find out while listening to classical ragas whether emotions are generated and how they get induced in human brain. For this purpose to analyze emotions we are using an EEG signals approach.

*C. Methodology:*

The Proposed methodology for EEG Signals analysis is based on empirical study to find out the EEG spectra indifferent areas of the brain cortex in the state of quiet wakefulness & listening to classical ragas, subject's emotional responses will be recorded and analyses will be done to find out which emotion is generated by the particular classical ragas structure. Some subjects will be chosen and will be asked to listen to classical ragas for some minutes through earphones & EEG signals will be recorded & the frequency bands (delta, theta ,alpha & beta) with be calculated and result will be drawn depending on the variation in the frequency bands for a particular emotional response.

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