Carnatic Music Ragas and Their Role in Music Therapy

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Abstract—Raga, as the soul and base, is a distinctive musical entity, in the music system, with unique structure on its construction of srutis (musical sounds) and application. One of the essential components of the music system is the *'tala'* that defines the rhythm of a song. There are seven basic swaras (notes) Sa, Ri, Ga, Ma, Pa, Da and Ni in the carnatic music system that are analogous to the C, D, E, F, G, A and B of the western system. The carnatic music further builds on conscious use of microtones, gamakams (oscillation) and rendering styles. It has basic 72 ragas known as melakarta ragas, and a plethora of ragas have been developed from them with permutations and combinations of the basic swaras. Among them, some ragas derived from a same melakarta raga are distinctly different from each other and could evoke a profound difference in the raga bhava (emotion) during rendering. Although these could bear similar arohana and avarohana swaras, their quintessential differences in the gamakas usage and srutis present therein offer varied melodic feelings; variations in the intonation and stress given to certain swara phrases are the root causes. This article enlightens a group of such allied ragas (AR) from the perspectives of their schema and raga alapana (improvisation), ranjaka prayogas (signature phrases), differences in rendering tempo, gamakas and delicate srutis along with the range of sancharas (musical phrases). The intricate differences on the sruti frequencies and use of AR in composing kritis (musical compositions) toward emotive accomplishments such as mood of valor, kindness, love, humor, anger, mercy to name few, have also been explored. A brief review on the existing scientific research on the music therapy on some of the Carnatic ragas is presented. Studying and comprehending the AR, indeed, enable the music aspirants to gain a thorough knowledge on the subtle nuances among the ragas. Such knowledge helps to leave a long-lasting melodic impression on the listeners and enables further research on the music therapy.

Keywords—Carnatic music, Allied ragas, Raga analysis, Music therapy.

I. INTRODUCTION

INDIAN classical music with its rich tradition and composition structure dates back to late Bronze age and early Iron age of 1500 BC and 600 BC. It was developed from chants to musical notes arranged in rhythematic cycles called 'tala' structures. Over the years, it evolved into 2 major groups namely 'Hindustani' – prevails in the Northern part of India, and Carnatic music in the South India. In both the systems, music is closely connected to the nature and human emotions, and the raga system is codified that influences the human life. The central concept of the music is *'Raga'*, which progressed

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quite extensively over the centuries. Raga's influence on human moods has been explored and 'Ragachikitsa', the music therapy, a method of healing diseases through ragas is being practiced, has gained worldwide attention [1]. Indeed, there are several significant studies [2]-[4] by the scientific community to understand the intrinsic role and nature of specific rags in therapeutic applications toward improving human health.

The raga is a melodic structure that is constructed by the arrangement of swaras (musical sounds) in many possible rhythms that produce aesthetic effect [5]. There are 7 basic notes called sapta swaras, namely Sa, Ri, Ga, Ma, Pa, Da and Ni in one octave. Each one of them is associated with a frequency that depends on the base note 'Sa'. In the Indian music, there is no fixed frequency for the swara, but it is relative to the base note Sa. In the octave of swaras, Sa and Pa are unchanged, but the remaining Ri, Ga, Ma, Da and Ni have two frequency variations in each of them, resulting in a total of 12 notes. These are known as *'Dwadasa swara sthanas'* (Fig. 1). Their arrangement in the ascending order is called as 'arohanam' and in the descending as 'avarohanam'. The arohanam-avarohanam sequence is called as *'murchana'*. A melakarta raga contains the sequence of swaras arranged in the murchana with all the 7 notes, in the sequence of order.

A. Shodasa Swarasthanas

The melakarta raga schema was originally proposed by Sri Ramamatya during the 16th century. This system was further refined by Venkatamakhi during the 17th century, by adding another 4 swara positions (Table I) that gave rise to shodasa swarasthanas (16 swara positions) and helped in formulating the 72 ragas known as *'melakarta'* schema (Fig. 3).

B. Melakarta Raga Schema

There are 72 ragas arranged in a systematic way as melakarta raga system. These are known as sampoorna ragas. In the construction of melakarta raga schema, as shown in the template in Fig. 2, the Sa (lower), Pa and Sa (upper) are fixed, but with permutation and combinations of Ri, Ga, Ma, Da and Ni the 72 ragas are developed. The first combination of the ragas is based on M1 and M2. There are 36 raga possibilities on the combination of M1 with variations of Ri, Ga, Da and Ni. These are called as *'suddamadhyama'* ragas. Similarly, another set with the combination of M2 and variations of Ri, Ga, Da and Ni are known as *'prati madhyama'* ragas as in Fig. 3. All these ragas are arranged in 12 sections known as chakras namely Indu, Netram, Agni, Veda, Bana, Ritu, Rishi, Vasu, Brahma, Disi, Rudra and Aditya (Fig. 3).
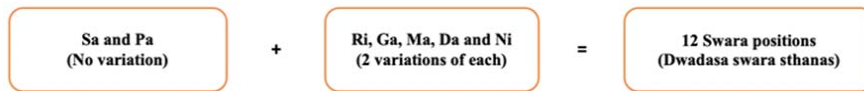
Fig. 1 Generation of Dwadasa swarastanas
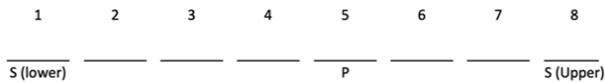
Fig. 2 Melakarta raga template

TABLE I
SHODASA SWARASTHANAS

Swara name	Swaras		Possible varieties
Shadjamam	Sa	S	Shadjamam
Rishabham	Ri	R1	Sudda rishabham
		R2	Chatusruit rishabham
		R3	Shatchutri rishabham.
Gandharam		G1	Sudda gandharam
	Ga	G2	Sadharana gandharam
		G3	Antara gandharam
Madhyamam	Ma	M1	Sudda madhyamam
		M2	Prati madhyamam
Panchamam	Pa	P	P – No variations
Dhaivatam		D1	Sudda dahaivatam
	Da	D2	Chatusruti dhaivatam
		D3	Shatchutri dhaivatam
Nishadam	Ni	N1	Sudda nishadam
		N2	Kaiseki nishadam
		N3	Kakali nishadam

C. Derived Ragas

The melakarta ragas are designed to have all 7 notes in the sequential order of Sa, Ri, Ga, Ma, Pa, Da and Ni as murchana. However, there are several ragas derived from them known as janya ragas (child ragas). The murchana needs to have a minimum of 4 swaras in the arohana or avarohana. The janya ragas are classified in multiple ways. Based on the arohana and avarohana, janya ragas are classified as varjya ragas. The janya ragas are classified based on the number of notes in the murchana, as shadava, Audava and sampoorna. Thus, the combination of swaras gives rise to different kinds of ragas as described in the Table II. There is another classification of ragas, where the murchana deviates from the regular order, and goes in zigzag pattern, known as vakra ragas, and one another classification called *'bhashanga'* ragas that takes foreign notes that does not exist in the parent raga. Inclusion of the possibilities of foreign notes and vakra patterns yields near infinite possibilities of derived ragas.

TABLE II
CLASSIFICATION OF RAGAS BY NUMBER OF NOTES

Number of notes of in arohana	Number of notes of in avarohana	Description
5	5	oudava – oudava
5	6	oudava – shadava
5	7	oudava – sampoorna
6	5	shadava – oudava
6	6	shadava – shadava
6	7	shadava – sampoorna

D. Allied Ragas

The ragas could be derived from the same melakarta raga, but use of gamakas, swara combination and the delivery tempo could be different. Consequently, the bhava (emotion) evoked by these ragas change immensely.

Herein a group of ragas have been explored to bring out their salient characteristics and differences in the rendering style. Furthermore, prominence of several ragas on emotional health has also been discussed.

II. ANALYSIS OF FEW DERIVED RAGAS

Among the plethora of ragas available, this article considered some sets of ragas which are similar in some part of the murchana, derived from same melakarta ragas, but significantly different in their rendering styles, signature phrases used, and the raga bhava evoked. In this regard, mere understanding of the arohana and avarohana will not be sufficient for the raga exposition. Instead, a detailed understanding and observations of (1) The kritis that are composed in the ragas, that is particularly meant for raga bhava in association with the lyrics that expresses the intent of the composer; (2) the treatment of the swaras in terms of their frequency of usage, length of usage, the combinational swara phrases that commonly occur; (3) the delicacy of microtones of each swara and the deflection of the swara which is very unique to the style of Carnatic music.

Arabhi, Devagandhari, Sri Madhyamavathi, Ananda Bhairavi and Reetigowla have been chosen as the test ragas. Their murchana audio clips were procured from the 'ragasurabhi' [6], which has a rich collection of Carnatic music files. Later, the pitch and frequency measurements from the audio clips were extracted using the tool "Tony: the tool for melody transcription" [7]. This graphical interface is based on the sonic visualizer libraries and probabilistic YIN (pyIn) vamp plugins to extract the pitch and note tracking from the monophonic audio.

A. Raga Group I: Arabhi vs. Devagandhari

A comparison of murchana of Arabhi and Devagandhari along with emotion evoked is narrated in Table III. The frequencies of these ragas are portrayed in Fig. 4.

TABLE III
MURCHANA COMPARISON OF ARABHI AND DEVAGANDHARI

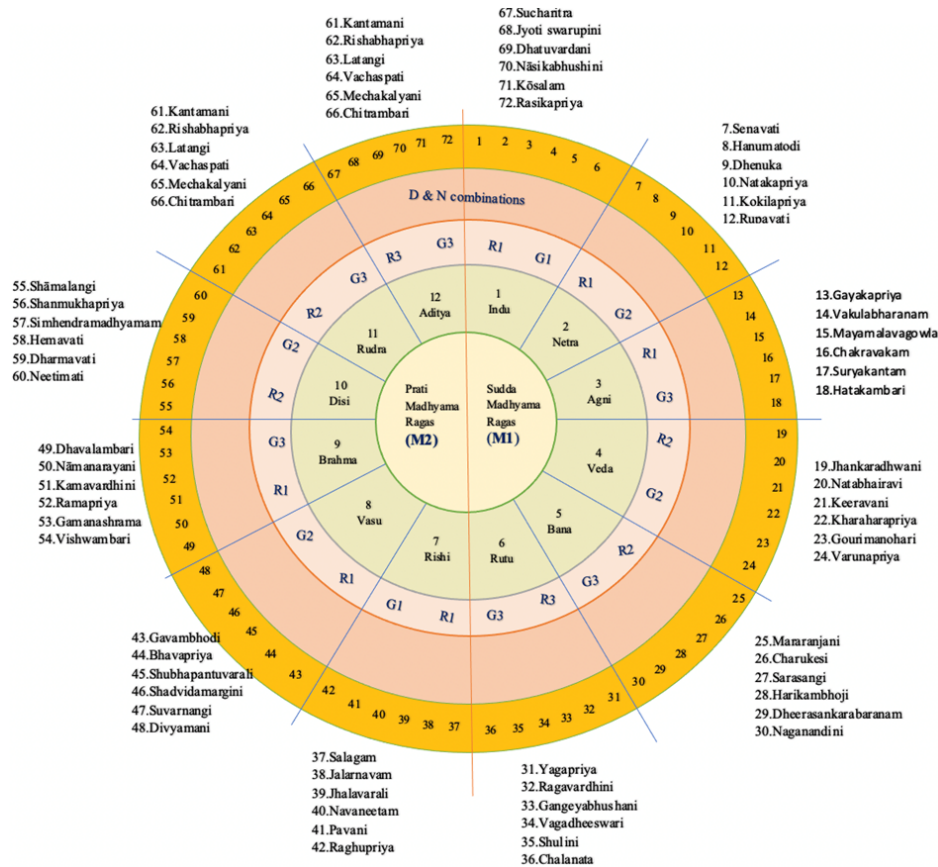| Ragam	Murchana	Emotion Evoked
Arabhi	Arohanam: S R2 M1 P D2 S Avarohanam: S N3 D2 P M1 G2 R2 S	Courage
Devagandhari	Arohanam: S R2 M1 P D2 S; Avarohanam: S N3 D2 P M1 G3 R2 S	Peace, kindness

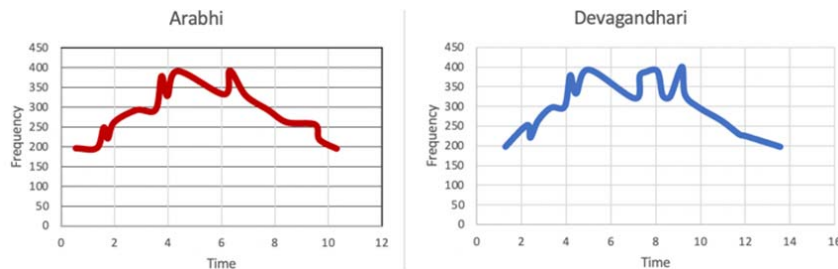Fig. 3 The Melakarta raga schema

Fig. 4 The frequency comparison of Arabhi and Devagandhari

Arabhi is a janya raga of 29th melakarta 'dheera sankarabharanam' and is an audava-sampurana raga. It is the third among the ghana panchaka ragas. It is known to exist for about 600-700 years. Its references are seen in various musical texts like Ramamatya's Swara-mela, Venkatamakhi's Chaturdandi prakasika and Govindacharya's Sangrahachoodamani, to name a few. This raga has a janta swara usage like 'RR, MM, PP, DD, DD, PP', which certainly makes it elegant and jubilant. The usages like 'SS, DD, PP, MG, R,' without 'N' are predominant with this raga. The note 'R' is the nyasa swara and 'M' and 'R' comes as graha and amsa swaras, respectively. Likewise, 'S' is a nyasa swara and 'P' and 'D' serve as graha and amsa swaras. The 'G' always comes close to 'M' as (m g r) pattern and 'N' to the 'S' as (s n

d) pattern. There is consonance between R and D notes. The notes 'N' and 'G' are used as short, and are presented as shadowy notes. The arabhi raga has the ability to expresses several emotions such as love, marveling, kindness and devotion but predominantly the 'courage' emotion. It is considered as an auspicious raga suitable for singing at the beginning of concerts and functions. Incidentally, arabhi closely resembles ragas like 'sama' and 'devagandhari'. The way these ragas are sung is very different especially the gamaka rendering is quite slow but execution of phrases is different in sama and devagandhari ragas as opposed to arabhi. The popular compositions of the raga include 'Sadhinchene' from the one of the Carnatic trinity, Tyagaraja. Sama raga expels 'peace' with the soft rendering of 'M' note.

Incidentally, there is a popular kriti in 'sama' raga by Tyaraja - 'Santamuleka soukhyamu ledu', meaning there is no happiness without mental peace.

Devagandhari is also an audava-sampoorna janya raga of 29th melakarta: 'dheera sankarabharanam'. It has similar swaras as arabhi in its murchana. However, it carries a foreign note – Kaisiki nishadam (N2) in some phrases like 'P DNDMP D P'. It renders melodic beauty while singing the chouka kala (slow speed) phrases. The notes 'D' 'G' 'N' are prominent swaras and signature phrases includes 'GR GM, MG, GR, G'. This raga is known to evoke peace emotion. Interestingly, janta swara phrases do not occur in devagandhari compared to arabhi. Devagandhari is more oriented towards the bhava; however, the Arabhi is more focused on swara and laya. Hence the Arabhi exposes the courage and even sometimes fury, however devagandhari raga eminates the impression of peace and kindness.
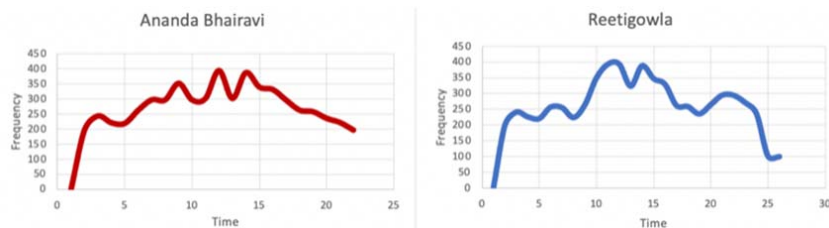
B. Ragas Group II: Ananda Bhairavi vs. Reetigowla

The murchana comparison of Ananda Bhairavi and Reetigowla along with emotion evoked is shown in Table IV. The frequencies of these ragas are highlighted in Fig. 5.

TABLE IV
MURCHANA COMPARISON OF ANANDA BHAIRAVI AND REETIGOWLA

Ragam	Murchana	Emotion Evoked
Ananda Bhairavi	Arohana: S G2 R2 G2 M1 P D2 P S Avarohana: S N2 D2 P M1 G2 R2 S	Kind, Love
Reetigowla	Arohana: S G2 R2 G2 M1 N2 N2 S Avarohana: S N2 D2 M1 G2 M1 P M1, G2 R2 S	Devotion, Compassion

Fig. 5 The frequency comparison of Ananda Bhairavi and Reetigowla

The raga Ananda Bhairavi was derived from the 20th melakarta raga called Nata Bhairavi, while Reetigowla from the 22nd melakarta kharahara priya. The Reetigowla is an ubhaya vakra type of raga, meaning the swara order is not chronological in both the arohana and avarohana. On the other hand, Ananda Bhairavi is vakra-shadava sampoorna raga. It takes D2 as the foreign note while reetigowla takes the D1. The key difference relies on the 'PDPS' usage in ananda bhairavi that cannot occur in reetigowla. However, 'GMNNS' and 'NSGGM' and 'GM N, N, S' and 'NDMGM' , 'NPN, N, S' and 'NSG, GM' (in lower octave) and 'GMN,N, S' (in the middle octave) phrases occur commonly in the Reetigowla. The phrases in Ananda Bhairavi are with 'P' but without 'P' in the Reetigowla.

The 'Ananda Bhairavi' raga evokes kindness, Romance and humor. This raga does not dwell much on 'N' and it could otherwise appear like 'Reetigowla'. This raga has been used in the design of 'Navavarna' kritis – set of 9 kritis in the praise of Kamakshri, by the composer, Diskshitar. Reetigowla is known for its charming expression for evoking the ultimate devotion. There is a popular kriti 'Janani ninnu vina' – from composer subbaraya sastri with expression of the ultimate surrender to the supreme mother goddess in seeking the refuge, was composed in the 'Reetigowla' ragam.

C. Ragas Group III: Sri vs. Madhyamavathi

These two ragas are derived from the 22nd melakartha raga kharaharapriya, with same arohana sequence but differ in their avarohana only. The murchana comparison of Sri and Madhyamavathi is narrated in Table V and the frequencies comparison would be as highlighted in Fig. 6.

TABLE V
MURCHANA COMPARISON OF SRI AND MADHYAMAVATHI

Ragam	Murchana	Emotion Evoked
Sri	Arohanam; S R2 M1 P N2 S Avarohanam: S N2 P D2 N2 P M1 R2 G2 R2 S	Kind, Love
Madhyamavathi	Arohanam; S R2 M1 P N2 S Avarohanam: S N2 P M1 R2 S	Devotion, Compassion

Sri ragam is one of the major ragas called 'ghana' ragas. Only avarahona allows the 'vakra' patterns of phrases. Elongation of 'G' is a beautiful occurrence in this raga. Its signature phrases include 'PMRG, R S', and 'NSRMPN' and 'P DNPMRGRS'. On the other hand, Madyamavati raga is an audava raga. The prominent notes of this raga are 'R' and 'N' and often rendered as elongated swaras. The popular phrases include 'R, PMR, S', and 'RMRMP' and 'MPNPNN, S'. These two are highly preferred by the musicians while ending the concerts. Composer Tyagaraja has chosen Madhyamavati raga in expressing the ultimate devotion and calmness in the kriti – 'alakalalla ladaga' – describing Lord Rama's characteristics as soft breeze caress his hairline while he is busy protecting the world. These two sibling ragas evoke ultimate devotion. The heavy deflection of 'R' is not allowed in 'Sri' ragam, as the immediate 'G' is prominent as opposed

to Madhyamavathi ragam. Another closer ragam for 'Sri' Ragam is *'Manirang'*, which has same arohana, but Avarohana of manirang raga is 'S N2 P M1 G2 R2 S'. Manirang has phrases, like 'P, MGRS', In sri, it is

'PMRGRS'. The mention of 'sri' ragam is not complete without the great composition 'endaro mahanubhavulu' – meaning, 'my humble salutes to all great people' from Tyagaraja.
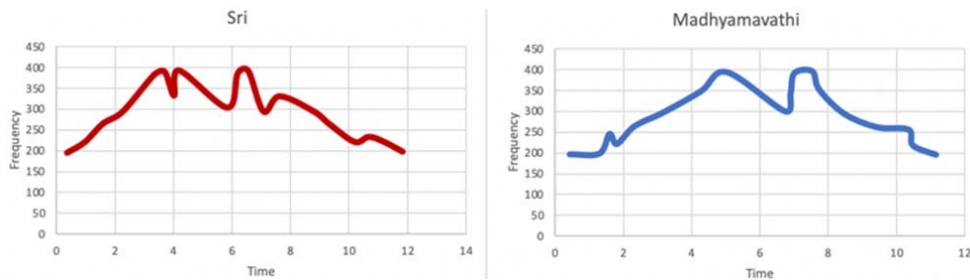

Fig. 6 The frequency comparison of Sri and Madhyamavathi

III. THERAPEUTIC APPLICATIONS RESEARCH OF THE CARNATIC RAGAS

Ragachikitsa (music therapy) is an ancient tradition for curing diseases by using ragas. Despite scanty reports on this interesting research topic, available findings stress the importance of music therapy for the therapeutic benefits, especially the Carnatic music. Fang et al. [8] provided a deeper review on the possibilities of music therapy as possible intervention for the most dreadful health challenge of the modern times Alzheimer's disease, especially in protecting the autobiographical and episodic memories and global cognition. However, more clinical trials and rigorous investigations need to be carried out. On a similar note, Yang et al. [9] measured the psychiatric symptoms and neuropsychological measurements, and reports the improved emotion and sensorimotor functions within brain circuitry of schizophrenia subjects. A comparative study on the auditory processing of brain highlights the correlations among cognitive functions such as episodic memory, attention and focus [10]. Similarly, clinical neuroscience researches presented the analysis of activation regions from fMRI brain structures by studying the influence of two classical ragas 'Sankarabharanam' and 'Madhyamavati', and concluded that 'madhyamavathi' raga has more influence, even on non-musical subjects [11]. The frontal theta activity of brain through Electroencephalogram (EEG) clearly suggests greater relative theta power in the left hemisphere via positive valence emotions evoked through music [12]. The practice of notu swaras (composed by Dikshitar, in translating some of the western compositions into Carnatic music tunes) in the raga 'sankarabharanam' yielded positive results on the cognitive development, communication skills and social-emotional development of preschool children further accentuates the importance of music on brain functionality [13]. The ragas bimpalas, hindolam, and todi have the ability to normalize the blood pressure [14]. The Bhegesri raga is found to be effective for chemotherapy patients that significantly waned the raised body temperature [3]. Furthermore, listening to Ananda Bhairavi raga has profound effect on postoperative pain management with reduced analgesic requirement by about 50% [4]. All these

results point out a window of opportunities of for ragas in general for furthering behavioral studies with an emphasis on emotions and health improvement.

IV. CONCLUSION

Music is the fundamental part of human evolution and musical experience certainly has an influence on human emotions [14]-[16]. Music penetrates the brain and sets an intricate balance between mind and organ system [17]. In this regard, song pitch and rhythm play a significant role [18]. During singing, highly pleasing words come to alive in an orchestrated manner that bring an unparallel harmony and indeed best human expressions could be made through songs. The Carnatic music has the ability to evoke emotions based on raga [19]. Herein, the Carnatic music system in conjunction with the prime concept of raga and few related ragas like Anandabhairavi-Reetigowla, Arabhi-devagandhari and Sri-Madhyamavathi had been explored on similarities and contrasts and their signature phrases. In addition, a few of the on-going research methods on raga-based music therapy research have been narrated. Though these results are highly encouraging, a detailed analysis on how musical emotions could be evoked especially the intricate mechanisms and associated interactions along with role of music, a particular song and listener, need to be explored at length toward reaping benefits for modern science and human health.

GLOSSARY

- *Graha swara:* Beginning note for raga exploration
- *Nyasa swaras:* End note for usually the raga is ended
- *Raga bhava:* Emotion evoked by the raga
- *Amsha swara*: Key note that usually brings out the raga bhava
- *Oudava ragam*: Raga that contains 5 notes in the murchana (in the arohana/avarohana)
- *Shadava ragam*: Raga that contains 6 notes in the murchana (in the arohana/avarohana)
- Rasika: fan of music
- Bhava: Emotion
- Arohana: Sequence of swaras in ascending order

- Avarohana: Sequence of swaras in descending order

REFERENCES

[1] Y. P. Pingle, and A. Bhagwat, "Music Therapy and Data Mining Using Indian Ragas as a Supplementary Medicine," in *Int. Conf. Computing for Sustainable Global Development (indiacom)*, pp. 11-13, Mar. 2015.

[2] M. A. Rajalakshmi, "Dikshitar's music and neurodevelopment", *Int. J. Public Mental Health Neurosci.*, vol. 4, Dec. 2017.

[3] P. Bharathi, K. Jaiganesh, R. Sobana, and S. Parthasarathy, "Effect of Indian Raga Bageshri on the body temperature of cancer patients on chemotherapy", *Int. J. Cur. Sci. Res.,* vol. 2, pp. 243-245, 2012.

[4] T. S .Kumar, M. Muthuraman, and R. Krishnakumar, "Effect of the raga Ananda Bhairavi in post-operative pain relief management", *Indian J Surg.*, vol. 76, pp. 363-370, Oct. 2012.

[5] S. Prajnananda, "A History of Indian Music", Ramakrishna Venanta Math, India, 1963.

[6] https://www.ragasurabhi.com/

[7] https://code.soundsoftware.ac.uk/projects/tony/wiki

[8] R. Fang, S. Ye, J. Huangfu, and D. P. Calimag, "Music therapy is a potential intervention for cognition of Alzheimer's disease: A mini-review," *Transl. Neurodegener.*, vol. 6, pp. 1 - 8, Jan. 2017.

[9] M. Yang, H. He., M. Duan, X. Chen, X. Chang, Y. Lao, J. Li, T. Liu, C. Luo, and D. Yao. "The effects of music intervention on functional connectivity strength of the brain in Schizophrenia", *Neural Plasticity*, vol. 2018, article ID 2821832, 10 pages, May 2018.

[10] A. K. Santhosh, M. Sangilirajan, N. Nizar, R. Radhamani, D. Kumar, S. Bodda, S. Diwakar, "Computational exploration of neural dynamics underlying music cures among trained and amateur subjects", *Procedia Comp. Sci.*, vol. 171, pp. 1839-1847, 2018.

[11] J. Satheeshkumar, S. Arumugaperumal, R. Rajesh, and C. Kesavadas, "Does brain react on Indian music? - A functional magnetic resonance imaging study", *2008 IEEE International Joint Conference on Neural Networks (IEEE World Congress on Computational Intelligence),* pp. 2696-2702, 2008.

[12] A. Tandle, N. Jog, A. Dharmadhikari, and S. Jaiswal, "Estimation of valence of emotion from musically stimulated EEG using frontal theta asymmetry", in 2016 12th Int. Conf. on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD)*,* Changsha*,* pp. 63-68, 2016.

[13] K. U. Kunikullaya, J. Goturu, V. Muradi, P. A. Hukkeri, R. Kunnavil, V. Doreswamy, V. S. Prakash, and N. S. Murthy, "Music versus lifestyle on the autonomic nervous system of prehypertensives and hypertensives--a randomized control trial", *Complement. Ther. Med.*, vol. 23, pp. 733-740, Oct. 2015.

[14] P. N. Juslin, and D. Vastfjall, "Emotional responses to music: The need to consider underlying mechanisms," *Behav. Brain Sci.*, vol. 31, pp. 559-621, Oct. 2008.

[15] J. Schulkin, and G. Raglan, "The evolution of music and human social capability", *Front. Neurosci.*, vol. 8, article 292, Sep. 2014.

[16] P. N. Juslin, and P. Laukka, "Expression, perception and induction of musical emotions: A review and a questionnaire study of everyday listening", *J. New Music Res.*, vol. 33, pp. 217-238, 2004.

[17] N. Steinbeis, and S. Koelsch, "Shared neural resources between music and language indicate semantic processing of musical tension resolution patterns", *Cereb. Cortex.*, vol. 18, pp. 1169-1178, 2007.

[18] P. N. Juslin, "What does music express? Basic emotions and beyond", *Front. Psychol.*, vol. 4, article 596, Sep. 2013.

[19] G. K. Koduri, and B. Indurkhya, "A behavioral study of emotions in South Indian Classical music and its implications in music recommendation systems", in *Proc. 2010 ACM workshop on Social, Adaptive and Personalized Multimedia Interaction and Access.* pp. 55-60, Oct. 2010.