

Full-Length Article

Expression of Emotions in Carnatic Vocal MusicNandhu Radhakrishnan¹, Savithri S.R.², Ram Mohan Gangisetty³.¹Lamar University, Beaumont, Texas, United States.²All India Institute of Speech and Hearing, Mysuru, Karnataka, India.³San Jose, California, United States**Abstract**

Voice is the element that makes speech audible. Apart from conveying the meaning of what is spoken, it can carry a variety of information about the speaker such as gender, age, general health, mood, and emotion. Expressing emotion is a crucial aspect in speech communication and this also occurs in singing. *Bhava*, or emotions in vocal music convey the essence of a piece, rendered by the singer. This preliminary study is an attempt to understand the role of the larynx in expressing emotions such as joy and sorrow in Carnatic vocal music. 12 Carnatic singers rendered vocal emotions at 3 levels: joy, sorrow, and neutral. The output between each level was recorded, analyzed, and compared. Results showed significant differences between the laryngeal dynamics of joy and sorrow. The results of this and future studies will help in designing voice therapy techniques for disorders such as Parkinson's disease that affect both facial and vocal expression of emotions.

Keywords: *emotions, carnatic, vocal, laryngeal.*multilingual abstract | mmd.iammonline.com**Introduction**

Voice production, the non-biological function of the larynx, does not stop with mere sound generation. Voicing is an integral part of speech that may be present or ceased depending on the phonetic context. The extent of glottal opening will depend on the quality of voice desired. Apart from being a sound generator for speech production, the larynx also plays a complicated role in singing. Voice production for singing varies with the style. It not only varies between singers but also within singers depending on the emotion they want to express. Expressing emotions in singing enhances listeners' appreciation. The demands on the speech production mechanism may vary in expressing emotions during speech and singing. In speech, changes in fundamental frequency, formant trajectories, extent of vocal fold contact, amount of glottal airflow, and subglottal pressure can assist in communicating emotional expression. Similarly, in music, melody, harmonic structure, or timing may reflect the composer's intentions, depending on specific traditions of music, and may simultaneously induce strong emotional moods [1]. However, when it comes to vocal music, both the

physiology of speech production and aspects of music will influence the art of expressing emotions.

Expressing emotions in patients with voice disorders is a challenge. Change in voice quality and loudness can be detrimental in exhibiting desired emotion. However, facial expression can compensate for this loss. Patients with Parkinson's disease are challenged with facial expression due to the limitation in facial muscle movement [2]. Voice problems [3] and related treatment [4] has been well documented. Hence, expressing emotions becomes a problem.

This report is a preliminary study of *Bhava*, vocal emotions in Indian classical singing. Hindustani and Carnatic are the two basic styles of classical singing in India. While Hindustani represents North India, Carnatic music is a classical style representing the South. Yang Yang et al (2015) offer a detailed comparison of these two styles of vocal music [5]. One of the distinct differences between Carnatic and Western classical singing is that every syllable of the text has to be precisely articulated in Carnatic singing. Expressing emotions in Indian classical singing is governed by the "raga" of the song. Raga, a combination of notes aesthetically put together [6], is a scale consisting of notes specific to that raga. There are several ragas depending on combinations and permutations of musical notes. Singers select specific ragas to render emotions they wish to express [7]. For this study, the 2 basic emotions expressed in singing, joy and sorrow were compared to singing with *neutral* emotion.

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Methodology

Subjects:

12 Carnatic singers, 10 females and 2 males, ages ranging between 17 and 65 were the subjects for this study. The primary criterion for inclusion was that the subject should have cleared a Junior level exam in Carnatic vocal music. All of the subjects were vocally and physically healthy during recording and did not complain about any condition that would affect their vocal performance.

Protocol:

Ragas and songs that are capable of reflecting emotions of joy and sorrow were selected. Similarly, a song that is rendered more as a ritual without any specific emotion was selected to reflect *neutral* levels of emotion. Though ragas facilitate in rendering specific emotions, several of them are associated with more than one emotion [8]. After consultation and discussion with the participants of this study, specific ragas and songs were selected to elicit target emotions. All the participants agreed 100% about the authenticity of emotions expressed. They were given time to warm-up using an electronic Tanpura, a device that elicits notes of Tanpura, a string instrument used in Carnatic performances, at different pitch levels. Table 1 shows the list of emotions, songs, and ragas involved in this study.

	Raga	Song
Joy	Kalyani	Vasudevayani
	Kamach	Brocheva
Sorrow	Varali	Eti Jenmamidhi
	Shahana	E vasudha
Neutral	Shankarabharana	Shakti Sahita

Table 1. List of emotions, songs, and ragas.

AKG C-430 (Austria) microphone connected to a portable digital recorder, Sony MZ-R3 (44.1 KHz, 16-Bit precision, Sony, Japan), was used to record the subjects rendering emotions in different songs and ragas mentioned in Table 1. The subjects maintained loudness at conversational levels. The recordings were digitized using Vaghmi (Bangalore, India), software capable of performing voice analyses including inverse filtering. For each subject, steady state phonations of the vowel /a/ as in /father/, longer than two seconds were isolated for each emotion that was demonstrated. The samples that matched in pitch, across the 3 emotions, were targeted for analysis.

Analysis:

Each subject provided at least three segments under each emotion that fit the criteria for analysis. Inverse filtering analysis was performed for each segment. Open Quotient (OQ) and Speed Quotient (SQ) measures for five consecutive cycles were averaged for segment. Thus, each subject had fifteen cycles averaged for each emotion.

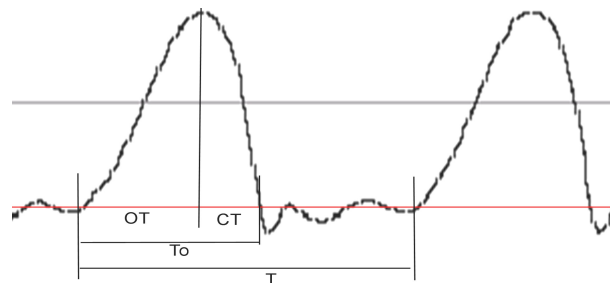


Figure 1. Open quotient and speed quotient. OT refers to the duration of the glottis being open. CT is the duration of vocal folds approximating to close the glottis. To is the time spent during opening and closing of the glottis and T is the period of one complete glottal cycle.

Open Quotient and Speed Quotient:

Figure 1 shows two cycles of vocal fold vibration. The glottal wave rises up as the vocal folds open and drops down as the vocal folds begin to close. Each cycle has an open time (T_o) and closed time (T_c) indicating the status of the glottis. The open time is the duration between the opening and closing phase of each vocal fold vibration and T_c is the duration when the vocal folds are closed. Open Quotient is the ratio of the open phase (T_o) to the entire duration of the glottal cycle and Speed Quotient is the ratio of the duration of the opening phase (OT) to the duration of the closing phase (CT) [9].

Results and Discussion

The average values of OQs and SQs for each emotion portrayed by the subjects are shown in Table 2. The OQ appears to be maximum for Sorrow and minimum for Joy. On the other hand, the SQ is maximum for Neutral and minimum for Sorrow.

	Open Quotient			Speed Quotient		
	Joy	Sorrow	Neutral	Joy	Sorrow	Neutral
Avg.	0.71217	0.8335	0.77617	2.209	1.93683	2.345
SD	0.09954	0.1191	0.07275	0.73036	0.52363	0.71627

Table 2. Average values of open quotient and speed quotient for the 3 levels of emotions.

Figures 2 and 3 show the average open quotient, speed quotient, and their standard deviation. Repeated measures ANOVA with Bonferroni Post Hoc was applied to the data and the statistical analyses suggest that the OQ for Joy is significantly lower than the OQs of Sorrow and Neutral. However, OQs for Sorrow and Neutral were not statistically different from each other ($p < 0.05$). On the other hand, there were no statistical difference between the SQs of Joy, Sorrow, and Neutral.

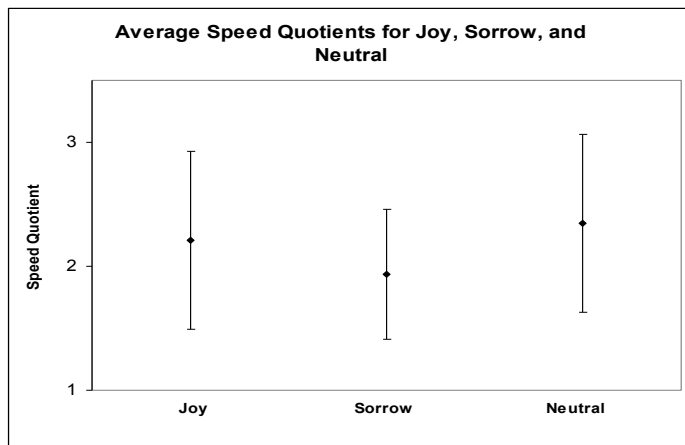


Figure 2. Speed quotient across the 3 levels of emotions

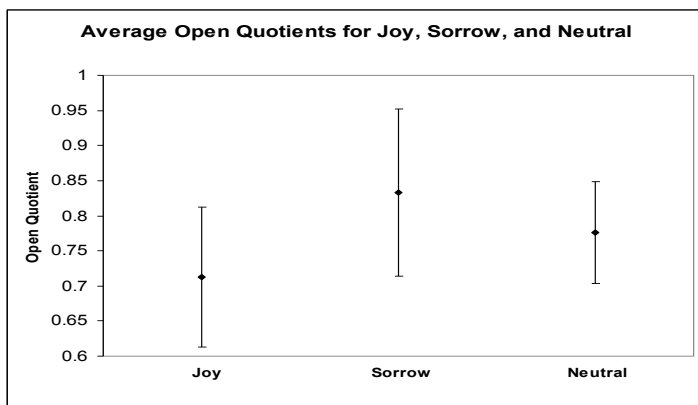


Figure 3. Open quotient across the 3 levels of emotions.

Implications:

The above findings suggest that laryngeal adjustments with respect to glottal closure that governs the measure OQ can be made to assist in eliciting emotions of joy and sorrow. Therapy techniques currently used in the field of voice therapy include airflow coordination. Techniques such as stretch-and-flow [11] facilitate control over glottal closure and airflow. Patients having difficulty in expressing vocal emotion can be trained to increase or decrease OQ accordingly to match desired emotions. Further study related to other emotions

such as anger, fear, love may be explored to map the relationship of voice measures and emotions.

Summary and Conclusions

12 trained singers were asked to sing songs expressing emotions such as joy, sorrow, and neutral. Samples of these emotions were taken to analyze the open quotient and speed quotient of glottal waves. Statistical analysis revealed that the OQ was greater for expression of sorrow and less for expressing joy. There were no significant differences between OQs of sorrow and neutral. Similarly there were no statistical differences for SQ between any of the 3 emotions. This suggests that the singers use greater adduction levels for joy compared to sorrow. The results of this study can be incorporated in voice therapy training for patients exhibiting difficulty in expressing vocal emotions.

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