



CEPSTRAL ANALYSIS OF VOICE IN CARNATIC SINGERS

KEYWORDS

Cepstral analysis, Voice, Singers, acoustic characteristics

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ABSTRACT

Even though researchers have documented the acoustic differences characteristic of the singer's voice, very less attention have been focused on examining the cepstral characteristics across various registers in singers. Thus the present study aimed to document the cepstral parameters, namely CPP and CPPs in classical singers with the widwath level of singing training across various registers of singing. Thus the voice was recorded from both singers and non singers on singing task and the recordings were analysed to extract cepstral measures namely CPP and CPPs. The values of the CPP and CPPs were further tabulated and statistically analysed using SPSS software. The results revealed that there was a significant difference between group 1 and group 2 on both CPP and CPPs values. The results also revealed significantly lower values of CPP and CPPs at high pitch singing.

Introduction

Indian music is basically divided into South Indian Carnatic style music and North Indian Hindustani music. Both of these music styles are rich in their own structure. Carnatic music is a name for an art form that lays claim to a lineage stretching back over many centuries. Carnatic music basically consists of two main elements, namely Raaga (Raagam) and Thaala (Thaalam). Raaga refers to the mode of singing where as Thaalam refers to the rhythmic cycles. Carnatic music consists of various ragas and thaalas and with their combinations. Thus the Raga and Thaala can be assumed of as corresponding to melody and rhythm in Western music. All these Raagas are primarily based on Swaras. Swaras (or note) are the most basic unit of music that specifies the locus of a particular sound in the audible spectrum or simply the pitch of the sound. Seven basic swaras are identified in Indian Classical music called saptaswarams namely Sa, Ri, Ga, Ma, Pa, Da and Ni. Thus, various ragas are created with different combination of these seven swaras.

Carnatic music, mainly emphasizes on using the powerful voice with more prominence on using low-pitch and loud singing. Carnatic singing also emphasizes a precise shruthi or tonic pitch for singing with accurate breath pattern (Durga, 1997). Execution of long musical phrases/notes across different octaves, tempos, and clear articulation of vowels and consonants are crucial for Carnatic singing (Arunachalam, Boominathan, and Mahalingam, 2014). According to Radhakrishna and Scherer (2011), open-throated singing with forward placement of voice characterizes a good voice in Carnatic singers. Brown, Rothman & Sapienza (2000) reported that the presence of vibrato, singers formant and a lower jitter value among singers compared to that of non singers.

Watts et al (2000) investigated measures of the SPR, i.e., a quantitative measure of the resonant voice quality and Long-term average spectra (LTAS) in the voices of untrained talented and nontalented singers. The results showed that there was a significant difference in SPR between both groups, suggesting the possible resonance differences in the vocal tract and its effect on perceived quality of voice. Further, LTAS values also showed a significant difference between both the groups confirming the differences in the tuning of vocal tract harmonics. Echternach, Traser, and Richter (2012) also examined the acoustic and electroglottographic parameters in professional tenors' transitions from voix mixte to falsetto on a sustained pitch F4 (349 Hz) on the various vowels. Their results showed that there was a very smooth register transition in professional singers compared to non-singers, however an increase jitter, relative average perturbation, and shimmer during register transitions were also noticed.

Even though researchers have documented the acoustic

differences characteristic of the singer's voice, very less attention have been focused on examining the cepstral characteristics in singers. In this regard, Balasubramaniam et al (2015) investigated the cepstral measures, namely, Cepstral Peak Prominence (CPP) and Smoothed Cepstral Peak Prominence (CPPs) in 30 Indian Carnatic singers and 30 nonsingers and reported higher values of CPP and CPPs among the singers compared to nonsingers. Thus the study concluded that the degree of harmonic organization was more in the voice of Carnatic singer than that of nonsingers. However, the study investigated the Cepstral measures of voice during the sustained phonation task of vowel prolongation at a single pitch. Thus the present study proposed to analyse the cepstral parameters in voice of singers across various registers.

Aim of the Study

The aim of the present study was to document the cepstral parameters, namely CPP and CPPs in classical singers with the widwath level of singing training across various registers of singing.

Method Subjects

Two groups of subjects were recruited for the study. Group I subjects consisted of 30 female singers in the age range of 25 – 35 years. All these subjects were formally trained in Carnatic classical singing and had a widwath degree in singing. Group II included 30 non singers who had no formal training in classical singing. A questionnaire in English, designed to obtain details of their profession, phonation habits, history of voice problems, regarding medical/surgical intervention or voice therapy and regarding the regular endocrine changes was administered. The responses from the questionnaire were also obtained and it was warranted that the none of the subjects had a history of vocal abuse or vocal misuse, exposure to fumes, respiratory tract infections or endocrine imbalances. Further, all the subjects of both group 1 and group 2 were explained about the purpose of the voice recording and the informed consent were obtained.

Procedure

The recording took place in a room with relatively low ambient noise. Each subject was seated comfortably in a chair in front of the laptop computer screen during the recording. Subjects of group I were instructed to sing saptaswarams in arohana style and the voice samples were recorded using a unidirectional microphone. Group II subjects were asked to sing a commonly known song "raghupathi raghava" at their comfortable loudness levels. The voice recordings of participants were collected with a high quality microphone onto the Praat software (version 5.3.23). The distance between the microphone and the participant's mouth was 15 cm. Voice recordings were digitized at a sampling frequency of 44.1 Hz and 16 bits/sample

quantization. The sample of each participant was retrieved separately for the purpose of acoustic analysis. The acoustic analysis was carried using Hillenbrand's script and the Cepstral parameters, namely CPP and CPPs were extracted.

Results and Discussion

The values of the CPP and CPPs were further tabulated and statistically analysed using SPSS software. As a part of descriptive statistics, mean and standard deviation were calculated for all the parameters analysed across both the groups.

Table 1: Mean and Standard Deviation (SD) values of CPP and CPPs for both the groups.

		Group 1	Group 2
CPP	Mean	15.5	12.9
	SD	3.0	2.3
CPPs	Mean	6.6	4.3
	SD	2.6	1.8

As it can be noted from the table 1, the mean CPP and CPPs values for group 1 was higher than that of group 2. Further, MANOVA was also carried out as a part of inferential statistics to compare the scores obtained across both the groups. The results of MANOVA revealed that there was a significant difference between group 1 and group 2 on both CPP ($F=5.3, p<0.05$) and CPPs values ($F=5.6, p<0.05$). Thus the subjects of group 1 showed significantly higher values of CPP and CPPs compared to the subjects of group 2.

Table 2: Mean and Standard Deviation (SD) values across various singing registers.

		CPP		CPPs	
		Mean	Standard Deviation	Mean	Standard Deviation
Sa	CPP	15.5	3.0	6.6	2.6
Re	CPP	14.4	2.6	6.5	1.7
Ga	CPP	16.7	3.6	8.2	2.2
Ma	CPP	16.9	1.8	9.5	1.0
Pa	CPP	18.5	4.2	7.0	3.0
Da	CPP	15.2	2.9	5.9	1.5
Ni	CPP	14.4	1.8	4.9	1.0

Further with respect to CPP, descriptive statistics showed that the lowest mean value of CPP was noted for the swaras Re and Ni, however highest CPP value was found for the swara Pa. The pairwise comparison showed that there was a significant difference in between Ma and Ni. With respect to CPPs values, the highest mean CPPs was seen for swara Ni. It was also observed that there was a significant difference in CPPs between the swaras Re and Ma, Ga and Ni, Ma and Da and Ma & Ni. Thus, from both descriptive and inferential statistics it was evidenced that the lowest CPP and CPPs values were found at the high registers of singing rather than the registers at low and mid pitch.

The results of the current study revealed lower values of CPP and CPPs at high pitch singing. This can be attributed to the possible alterations of harmonic structure due to the glottal configuration at higher pitch levels. Due to the increased noise level, CPP and CPPs values tend to be lower. Literature review also suggests that both the Cepstral measures, namely CPP and CPPs are good predictors of dysphonia. Heman-Ackah et al (2003) studied CPPs in continuous speech and sustained vowels and attempted to correlate perceptual parameters to roughness and breathiness as also to the overall dysphonia and reported that CPPs was the best predictor of dysphonia and breathiness but did not correlate to roughness. Thus, it can be concluded that at high pitch singing, more breathy component of voice can be evidenced and thus a decrease in the CPP and CPPs values were noted.

Summary and Conclusion

Carnatic music is a name for an art form that lays claim to a lineage stretching back over many centuries. Carnatic music consists of various ragas and thaaals and with their combinations. Carnatic singing emphasizes a precise shruthi or tonic pitch for singing with accurate breath pattern. Execution of long musical phrases/notes across different octaves, tempos, and clear articulation of vowels and consonants are crucial for Carnatic singing. Even though researchers have documented the acoustic differences characteristic of the Carnatic classical singer's voice, very less attention have been focused on examining the cepstral characteristics in singers across various singing registers. Thus the present study aimed at investigating the cepstral parameters among classical singers across various registers of singing. Hence, voice recording was done from both singers and non singers on singing task and the recordings were analysed to extract cepstral measures namely CPP and CPPs. The results revealed that there was a significant difference between group 1 and group 2 on both CPP and CPPs values. The results also revealed significantly lower values of CPP and CPPs at high pitch singing. These results were attributed to the alterations of harmonic structure due to the glottal configuration at higher pitch levels among singers.

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