Acoustic-Perceptual Correlates of Voice in Indian Hindu Purohits

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Summary: Objective. Purohit, in the Indian religious context (Hindu), means priest. Purohits are professional voice users who use their voice while performing regular worships and rituals in temples and homes. Any deviations in their voice can have an impact on their profession. Hence, there is a need to investigate the voice characteristics of purohits using perceptual and acoustic analyses.

Methods. A total of 44 men in the age range of 18−30 years were divided into two groups. Group 1 consisted of purohits who were trained since childhood (n = 22) in the traditional gurukul system. Group 2 (n = 22) consisted of normal controls. Phonation and spontaneous speech samples were obtained from all the participants at a comfortable pitch and loudness. The *Praat* software (Version 5.3.31) and the *Speech* tool were used to analyze the traditional acoustic and cepstral parameters, respectively, whereas GRBAS was used to perceptually evaluate the voice.

Results. Results of the independent *t* test revealed no significant differences across the groups for perceptual and traditional acoustic measures except for intensity, which was significantly higher in purohits' voices at $P < 0.05$. However, the cepstral values (cepstral peak prominence and smoothened cepstral peak prominence) were much higher in purohits than in controls at $P < 0.05$

Conclusions. Results revealed that purohits did not exhibit vocal deviations as analyzed through perceptual and acoustic parameters. In contrast, cepstral measures were higher in Indian Hindu purohits in comparison with normal controls, suggestive of a higher degree of harmonic organization in purohits. Further studies are required to analyze the physiological correlates of increased cepstral measures in purohits' voices.

Key Words: Indian Hindu purohits−Acoustic measures−Perceptual measures−Cepstral analysis−Harmonic organization.

INTRODUCTION

Purohit, in the Indian religious context (Hindu), means priest, which is derived from the word "puras," which means front, and "hita," which means placed. The word is also sometimes used synonymously with the word pandit. Purohits are professional voice users who use their voice while performing regular worships, such as puja (Hindu prayer), aarthi ceremony (deity songs while offering lamps), and homa (fire ritual), in temples and homes (see Appendix for more details). Purohits also conduct special ceremonies, such as wedding (prayer recitation during the fire ritual in a wedding), thread ceremonies (chanting religious hymns while boys receive the sacred thread), and housewarming ceremonies (chanting religious hymns while entering the new house) (see Appendix for more details). All these individuals are trained in the gurukul system since childhood for all these practices, including the recitation of the vedas (ancient Hindu scriptures) or shlokas (Hindu couplets) or mantras (phrases sung during prayer or meditation) (see Appendix for more details). Voice damage in these professionals can be detrimental in their profession. Thus, purohits can be possibly classified under level II or III (professional voice users) category of the professional voice users as given by Koufman and Isaacson.[1]

The importance of voice among professional voice users has been stressed in the literature.[1,2] However, the research focus on Indian Hindu purohits has been overlooked. There have been reports of voice problems among church priests, whose profession is expected to be similar to that of purohits in the Hindu tradition with regard to performing religious rituals. Hocevar-Boltezar explored the prevalence and risk factors for voice problems in church priests and reported that 85.6% of the priests they surveyed had voice problems during their career, and 15.9% of these priests experienced frequent voice problems.[3] These priests reported that respiratory tract infection is the most common cause of their voice problems. Hocevar-Boltezar reported that vocal load was reported as being the reason for voice problems in only one-third of the priests.[3] Middleton and Hinton investigated six pastors using a 31-item questionnaire addressing the health, lifestyle, and self-perception of their voice problems. Results revealed that most female clergy members engage in potentially abusive vocal behaviors while preaching, as well as outside church services. However, none believed that they are abusing or misusing their voices.[4] Devadas et al also reported that 17.8% of 270 marthoma church priests (working in different parts of Kerala, India) had voice problems.[5] Allergies and frequent throat clearing, lack of formal training, poor vocal hygiene, and a history of previous voice problems during training were stated as risk factors for voice disorders in church priests.[3−5]

In a similar line, Hagelberg and Simberg reported higher prevalence of voice problems in evangelical Lutheran priests.[6] Of these priests, 24.5% sought help for voice problems, and 18% were diagnosed with a voice disorder by a physician. Twenty-one percent of these priests reported having current voice problems, and 26.7% reported having frequently

occurring vocal symptoms. There was a higher prevalence of voice problems in women than in men. There were significant associations between frequently occurring vocal symptoms and several environmental and health-related risk factors.[6] However, these results cannot be generalized for purohits as the type of work they do, the rituals they perform, and the training that they receive vary widely across different religions and countries. Recently, Reed and Sims surveyed 403 clergy participants and found certain factors, such as age, length of sermon, breaking voice, wet cough, and ethnicity, as the predictors of voice problems among clergy members.[7]

Purohits can have vocal problems because of the type of work they do and the use of their voices in adverse conditions. As purohits require the use of their voice for all the rituals, such puja, aarthi ceremony, havan (fire ritual), wedding, thread ceremonies, and housewarming ceremonies in the Indian Hindu culture under adverse conditions, such as fire smoke and noise, these priests are hypothesized to exhibit voice problems. In general, these rituals last for more than 1−2 hours if performed at home. Apart from this, regular recitation of shlokas or mantras in temples from morning through evening increases the risk of voice problems. Moreover, purohits do not prefer to consume water during prayer recitation, which further puts them at risk of voice problems. Moreover, purohits neither have formal voice training during their education nor rely on public address systems or any amplification devices during their work period. Although purohits do not receive formal voice lessons during the course of their required training, some pursue singing lessons outside their studies. However, the job of purohits does not necessitate singing. Any deviations in their voice can have an impact on their profession. Therefore, it is important to study the voice characteristics among Indian Hindu purohits so that appropriate intervention can be recommended. Also, the voice is never investigated in the population of purohits so far; hence, the present study was planned with the aim of investigating the voice characteristics of purohits using perceptual and acoustic measures.

METHODS

Participants
Forty-four nonsinging men in the age range of 18−30 years participated in the study. The participants were divided into two groups: group 1 consisted of purohits who were trained since childhood (n = 22) in the traditional gurukul system for more than 10 years, and group 2 (control group) consisted of age-matched participants (n = 22) who were not purohits. The participants in the control group were students and information technology professionals living in the same locality. All these participants were nonsingers and have reported no recent history of laryngitis, surgery to the oropharyngeal and laryngeal structures, smoking, hearing loss, and neurologic problems affecting voice production. All participants gave their consent to participate in the present study. Ethical committee approval was obtained before the start of the study.

Instrumentation
Praat software (Version 5.3.31)[8] and *Speech* tool[9] were used for the purpose of acoustic analysis to obtain parameters such as fundamental frequency, average intensity, jitter, shimmer, noise-to-harmonics ratio (NHR), and cepstral measures.

The GRBAS perceptual voice rating scale was used for the purpose of perceptual voice analysis.[10] This scale evaluates voice on five aspects (grade or degree of vice abnormality, roughness, breathiness, asthenia, and strain) using a four-point rating scale from 0 to 3 (0, normal, 1, slight; 2, moderate, and 3, extreme).

Procedure
All participants from both groups were seated comfortably on a chair in a noise-free environment. Voice evaluations were done at least 4 hours after their morning ceremonies for the day. A dynamic microphone (Shure SV 100 W) (Shure Inc, Niles, Illinois, United states) was used to record the voice samples of the participants. The microphone was maintained at an approximate distance of around 10 cm from the participant's mouth. Appropriate instructions were given before the voice evaluation. All participants from both groups were asked to phonate /a/ at a comfortable pitch and loudness. A total of three trials of phonation were conducted, and the best of the three trials was considered for the present study. A spontaneous speech sample of the topic "home" was also collected for the perceptual analysis of voice.

Analysis
The middle 3-second segments of the recorded samples were subjected to acoustic analysis, and the narrated samples were used for the perceptual analysis of voice.

Perceptual analysis
Perceptual analysis was performed using the GRBAS voice rating scale in both groups. Randomized samples from the experimental and the control groups were presented to the three trained speech-language pathologists who were blinded to the purpose of the study. The speech-language pathologists analyzed the spontaneous speech sample and determined the perceptual characteristics of voice. Intrajudge reliability was obtained by presenting the randomized samples after a 2-week time period.

Acoustic analysis
The *Praat* software directly measured the acoustic parameters, such as average F0, average intensity, jitter, shimmer, and NHR. Similarly, the *Speech* tool software directly measured the cepstral peak prominence (CPP) and the smoothened cepstral peak prominence (CPPS) using the Hillenbrand algorithm. CPP is a measure of the amplitude of the cepstral peak corresponding to the fundamental period, which is normalized for the overall signal amplitude. Similarly, CPPS is a measure involving smoothening the individual spectra before extracting the cepstral peak and measuring the peak prominence. Here, the smoothening is carried out by averaging the cepstral peak across time and frequency domains.

Statistical analysis

Descriptive statistics (mean and standard deviation) was calculated for all the acoustic parameters in each group. Independent *t* test was conducted to check the significant differences between the means of both groups for all the acoustic parameters at $P < 0.05$. Equality of proportions was carried out to see if any significant difference exists between the groups for perceptual analysis using GRBAS. Intrajudge and interjudge reliabilities were also calculated using kappa coefficient to determine if the repeated assessments of perceptual judgments within and across speech pathologists are similar.

RESULTS

The aim of the present study was to analyze the voices of purohits using acoustic and perceptual measures. Descriptive statistics was used to obtain the means and the standard deviations for all the acoustic measures, which are shown in Table 1.

In Table 1, we can see that all the acoustic parameters, such as average fundamental frequency, jitter, shimmer, and NHR, were similar in both groups except for intensity, which was higher in purohits than in normal controls. Moreover, the cepstral values (CPP and CPPS) were observed to be high in participants with purohits compared with normal controls.

The results of the independent *t* test revealed that there was no significant difference between both groups on traditional acoustic measures except for intensity, which was significantly higher in purohits' voices at $P < 0.05$. Also, the cepstral values (CPP and CPPS) were significantly higher in purohits than in normal controls at $P < 0.05$.

The scores for perceptual analysis of the first listener using GRBAS ratings were well within the normal limits for both groups, as shown in Table 2.

Results of the equality of proportions for the perceptual ratings of the first listener across the groups also revealed no significant differences in the ratings across the groups. Results of kappa coefficient indicated 96% and 100% agreement within and across the three judges, respectively.

DISCUSSION

The present study aimed to investigate the voice characteristics of Indian Hindu purohits using acoustic and perceptual

TABLE 2.

Perceptual Ratings of GRBAS Scale in Purohits and in Normal Controls

Perceptual Parameters	Purohits (%)				Controls (%)			
	0	1	2	3	0	1	2	3
Grade	100	0	0	0	100	0	0	0
Roughness	100	0	0	0	100	0	0	0
Breathiness	100	0	0	0	100	0	0	0
Asthenia	100	0	0	0	100	0	0	0
Strain	100	0	0	0	100	0	0	0

measures. The results revealed that both normal controls and purohits obtained similar values on all the perceptual and traditional acoustic measures. However, vocal intensity was increased in purohits' voices compared with normal controls.

In contrast, cepstral parameters such as CPP and CPPS were shown to be higher in the voices of purohits than in the voices of normal controls, which is suggestive of a high degree of harmonic organization in the voice of purohits in comparison to normal controls. This finding may be attributed to the fact that the purohits may have acquired a more delicate and precise control over their subsystems, which would have influenced their voice. The number of years of training and experience probably would have contributed to this increased harmonic organization. These findings contradict the findings of Hocevar-Boltezar and Devadas et al, where the vocal deviations were highly prevalent in church priests.[3–5] Hocevar-Boltezar and Devadas et al attributed their findings to frequent respiratory tract infection, limited training with respect to proper voice usage, and poor vocal hygiene. These findings are much different from the results of our present study, which are probably due to the nature of vocal use, which widely differs across church priests and Hindu purohits.

The increased harmonic organization and the higher intensity in purohits' voices could account for the good harmonic organization in their voice. This finding might be due to the type of training that purohits received during their childhood, the amount of experience, and the expertise developed during recitation of shlokas (more open throated) in the past, which might have resulted in a loud and clear voice. The nature of

TABLE 1.

Means and SDs of Acoustic Measures in Purohits and in Normal Controls

Acoustic Parameters	Purohits		Controls		*t* Value	*P* Value
	Mean	SD	Mean	SD		
Average frequency (Hz)	137	32.68	142	34.10	−1.005	0.322
Average intensity (dB)	82.69	3.10	69.91	7.05	4.612	0.000*
Jitter (%)	0.33	0.14	0.31	0.09	1.421	0.164
Shimmer (%)	6.16	3.04	5.78	1.97	1.585	0.122
NHR	0.03	0.02	0.05	0.06	−0.321	0.750
CPP (dB)	17.84	1.40	13.65	0.9	3.457	0.001*
CPPS (dB)	6.71	0.37	6.30	0.35	0.728	0.472

* Statistically significant.
Abbreviation: SD, standard deviation.

their job also involves /o:m/ chantings. This om chanting with a forward focus also would have contributed to the increased harmonic organization in purohits' voices. However, the om chanting also depends on the characteristics of the variable vocal tract resonator. Durga described that the "projection of voice" and "open-throated feature" (resonance) are other identities of a good voice in singers.[11] This type of voice is most often associated with an appropriate posture; adequate breath support, along with a well-balanced respiratory phonatory system; and increased resonances, which are known to result in increased voice projection.

The present study provides valuable insight on the voice characteristics of Indian Hindu purohits. Further research directions should be toward the analysis of voice using a multi-dimensional protocol involving different perceptual, acoustic, aerodynamic, and videostroboscopic measures in Indian Hindu purohits using a larger sample size, which can provide a clearer picture of their voice. Future research should also be directed toward understanding the physiology behind the remarkable voice projection in Indian Hindu purohits. By making use of this knowledge about the process involved in increased voice projection, speech-language pathologists could device good intervention techniques to help individuals with voice disorders. One of the limitations of the present study is that the authors did not consider self-reported vocal complaints. These reports, when correlated with the acoustic and perceptual measures, would have been valuable in interpreting the findings in this population.

CONCLUSIONS

The present study investigated the voice characteristics of purohits using acoustic and perceptual measures. The results did not reveal any vocal deviations in purohits using perceptual and traditional acoustic measures. In contrast, the Indian Hindu purohits had higher intensities and increased cepstral values compared with normal controls. Further research can be directed toward the physiological correlates of purohits' voices.

APPENDIX

Puja: A puja is a prayer ritual performed by Hindus to host, honor, and worship one or more deities or to spiritually celebrate an event.

Aarthi ceremony: Aarthi refers to songs sung in praise of a deity while lamps are being offered.

Homa: Homa is a sanskrit word that refers to a ritual wherein an oblation or any religious offering is made into fire.

The priests sing hymns and recite mantras while the offerings are made.

Wedding ceremony: This is a ceremony during a wedding characterized by the recitation of vedic mantras around the "homa."

Thread ceremony: This is a ceremony marked by the entry of a student into formal education, where the boy receives the sacred thread, which he continues to wear around his chest. This ceremony is characterized by the chanting of shlokas and religious hymns.

Housewarming ceremony: This is a ceremony performed on the occasion of the first entry into a house where a homa, puja, or aarthi ceremony would be performed.

Vedas: Vedas are the most ancient Hindu scriptures, written in early Sanskrit and containing hymns, philosophy, and guidance on rituals for priests.

Shloka: A shloka is treated as a couplet. It is a four-quarter verse, each with eight syllables.

Mantra: A mantra is a word, phrase, or sound that is repeated again and again, especially during prayer or meditation.

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