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Effect of vocal loading on voice parameters in trainee actors

Abstract

Introduction: Prolonged use of voice or vocal load can be a risk factor for individuals and can end up in vocal fatigue and dysphonia. Vocal loading can alter tissue structure and affect the voice quality forever. An obvious factor to be considered is the vocal use by a professional voice user. Actors are a group of professionals who can be affected by the long-term use of voice. There is a higher prevalence of inflammatory lesion in acting students and they were found to have poor vocal hygiene habits; which shows that these future elite vocal performers are at risk for developing a voice disorder.

Aim: To study the objective and subjective changes in voice characteristics post vocal loading task in trainee actors.

Method: A total 37 trainee actors (14 females and 23 males) participated in the study. The age range of the participants were 20 – 39 years and the range of the training period was 6 – 12 months. The participants were instructed to read a passage for 30 – 45 minutes at a loudness level of 70 – 80 dB SPL. Individuals with perceptually normal voice in terms of pitch and intensity and with a score less than 1 in GRBASI (Grade, Roughness, Breathiness, Asthenia, Strain, Instability) rating scale were included in the study. Acoustic, and perceptual evaluation were measured immediately before and after vocal loading task. Acoustic analysis was done using MDVP, whereas The Auditory Perceptual Rating Scale and GRABASI rating scale were used for perceptual analysis. Self-rating of the voice after vocal loading task was measured after the vocal loading task using Vocal Fatigue Index.[1]

Results and conclusion: The results revealed a significant difference in perceptual parameters post vocal loading task. The f0, jitter and HNR (Harmonic to Noise Ratio) showed a significant increase in the values after the vocal loading task. However, shimmer and RAP (Relative Amplitude Perturbation) did not show significant difference in the values post vocal loading task. The self-rating of the voice after the vocal loading task revealed that 54% of the trainee actors did not perceive vocal fatigue. The study hence shows significant effects of vocal loading in perceptual and acoustic analysis whereas the self-rating shows less perception of vocal changes in training actors. The acoustic, perceptual and self-rating of the voice quality before and after vocal loading task can aid in effective training and management of the trainee actors. However, the actors themselves are not equipped to measure the voice changes acoustically or perceptually and would take much longer time to perceive changes in their voice quality. Therefore, it is important to give a vocal hygiene programme in the preventive stage, that is, in the training period.

Keywords: vocal loading, vocal fatigue, effect on voice, trainee actors

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Introduction

The voice helps an individual define his or her identity. It helps a person to project their personalities and also influence their listeners. Professional voice users, that is singers, actors, politicians and teachers depend on the vocal quality and endurance for their livelihood. Actors are a subset of professionals who have unique vocal demands and are considered Elite Vocal Performers-Level I. They are defined as "persons for whom even a slight aberration of voice may have dire consequences."

Theatre and screen actors have similar levels of vocal load or demand. A theatre actor will have to deal with both environmental as well as performance factor such as climatic changes, make-up and costumes, posture while portraying the character and the stress of memorizing the script can affect the voice projection.[2] Whereas, for an on-screen actor the hours of dubbing and the voice modulations to accommodate expressions can lead to vocal loading or stress.

Projection of voice can be defined as the strength of speaking or singing whereby the voice is used loudly and clearly with effective use of laryngeal mechanism. Therefore, an understanding of the actor's voice, perception of the acting voice as well as its role in both performance and clinical assessment is important.[3]

Several environmental, psychological and social factors contribute towards the risk of developing a voice disorder in actors. These factors include stress caused by insecurity and instability of the job and lifestyle.[4] During stage performances as well as rehearsals, actors are found to be more susceptible to vocal injury due to their increased vocal load during voice projection compared to non-actors.[5,6] There are some studies that highlight the frequent symptoms that occur in actors. These symptoms are accounted as physiological, anatomical, and acoustic findings. Physiological symptoms that were emphasized in most studies are vocal fatigue and vocal abusive behaviour like shouting, while performing. The anatomical and acoustical findings suggest incomplete glottal closure, laryngeal hyperfunction and decreased mucosal wave.[7–10]

However, studies done on students or trainee actors have been focused on beginning symptoms and exposition to risk factors

to dysphonia in their graduation process which can compromise their professional practice.[4] This can imply that the vocal abusive behaviours can be identified during a training period and the students can be made aware of this potential difficulty they may face in the future.

Moreover, some authors have studied professional actors and found that they exhibited unhygienic voice habits even though they have higher knowledge than student actors.[11] Therefore, a course that can educate acting students for the potential risk can become an effective way to prevent the future complications. A Speech and Language Pathologist is an important professional that can involve in providing vocal training along with other members.

A need for studying the effects of vocal loading in trainee or student actors can be important to educate and train future actors to effectively use their voice without causing damage to their voice or vocal functioning. Voice training and a course on vocal hygiene can make them aware of the hazardous voice habits in their training period. A speech language pathologist can aid in improving insufficient vocal knowledge and the importance of vocal warm-up to prevent occupational voice problems.[12] Prolonged voice use can cause strain in the inner and outer laryngeal structure, thus altering the effectiveness of vocal cord vibration to project voice.

There is great deal of research required to study these group of professionals in Indian scenario and make them aware of the occupational hazards they can undergo. Moreover, the acoustic and perceptual parameters after vocal loading task have not been studied in Indian population, as per the best knowledge of the investigator. Vocal loading task and its effect on voice have been studied in teachers and other professional voice users but have not been studied in trainee or student actors.

1. To compare the perceptual changes in voice quality pre and post vocal loading task.
2. To compare the acoustic changes in the voice quality pre and post vocal loading task.
3. To characterize vocal fatigue using Vocal Fatigue Index

Material and methods

Ethics, study design (selection and description of participants)

The present study is experimental research which was approved by the Bharati Vidyapeeth deemed University's (Pune) ethical committee. A participant information sheet and consent forms were given to the participants and a signed consent form was obtained from all the participants before the procedure.

Participants

A total of 37 participants (14 females and 23 males) participated in this study. The mean age of the participants was 24.6 years and the range was 20–39 years. All participants were in the stage of formal training in the acting Institutions. The mean training period of the participants was 7.7 months and the range was 6–12 months. Informed consent was taken from each participant. The participants for the present study were selected based on the inclusion and exclusion criteria as given below.

Inclusion criteria

Individuals with perceptually normal voice in terms of pitch, loudness and intensity were included in the study. Participants who have formal training of minimum four months were included in the study. Individuals who got a score of less than 1 in GRBASI scale were included.

Exclusion criteria

Participants who are under medication for hypertension, asthma, diabetes, gastro-oesophageal reflex disorders, allergies, cold and cough only were excluded from the study. Individuals who had undergone voice rehabilitation in the past or present were excluded from the study.

Tools used

Standardized reading passages in English (Appendix I) were selected for the vocal loading task. The passages were combined and the participants were asked to read it for 30 – 45 minutes.

The tools used for perceptual evaluation are The Auditory Perceptual Rating Scale which assesses 22 parameters on a 4-point rating scale, GRABASI rating scale (Japan Society of Logopedics and Phoniatrics, 1990) grades hoarseness, roughness, breathiness, asthenia (weakness), and strain in the voice quality the sub-scale Instability (I) was introduced by Dejonckere et al.[13] and Vocal Fatigue Index[1] which consist of 19 questions under 3 factors self-rated on a 5-point rating scale. The tools used for acoustical evaluation is Multi-Dimensional Voice Program (MDVP) and Speech tool, 1.65 (Hillenbrand, Western Michigan University). Five parameters out of 33 were selected for the present study; f0, jitter percent (%), shimmer (dB), Relative Amplitude Perturbation (%) and Noise-to-Harmonic Ratio) were the parameters selected for analysis.

Procedure

The participants were asked to read a passage for 30-45 minutes at a loudness of 70-80 dB SPL. A standard reading passage of 5 minutes' duration was given before and after the vocal loading task to assess the voice perceptually before and after the vocal loading task. Maximum phonation duration was assessed before and after the task. Acoustical evaluations were assessed and recorded separately before and after the vocal loading task. The participants were given the self-rating scale to categorize their vocal fatigue after the task.

The perceptual evaluations using the GRBASI rating scale and The Auditory Perceptual Rating Scale were rated by seven SLP's with more than 2 years of work experience. The recordings of the pre and post voice were rated by each rater after 1 month of their initial rating.

Statistical analysis

Normality check was carried out using the Shapiro Wilk Test. The results showed a non-homogenous distribution of the data. Hence, non-parametric test was used to compare the pre and post acoustical and perceptual evaluations. The inter-rater and intra-rater reliability analysis was also calculated and analysed.

Wilcoxon Signed Rank Test was used to compare the acoustic and perceptual parameters before and after vocal loading task. Cronbach's Alpha Test was used to calculate the inter-rater and the intra-rater reliability for pre and post task voice quality.

Result

The results of the study are summarized under four objectives, as follows:

Objective 1: To compare the perceptual changes in voice quality pre and post vocal loading task.

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The perceptual analysis was carried out and compared before and after the task respectively. Wilcoxon Signed Rank Test was done to compare the perceptual parameters before and after the task. Table 1 shows the significance value of the parameters respectively. The values show an increase in Wilcoxon Signed Rank test (p=0.001) in all the parameters post vocal loading task. Inter-rater and intra-rater reliability analysis was done using Cronbach's Alpha test and the results showed good reliability between and within the raters. Inter-rater reliability for pre and post-test was 0.70 and 0.69 respectively and Intra-rater reliability for pre and post-test was 0.68 and 0.83 respectively.

Table 1 Median and z value and the significance value of Wilcoxon Signed Rank Test

Parameters	Pre	Post	Wilcoxon signed rank test	
	Median	Median	Z value	p value
Horse	1.00	2.10	7.10	0.000
Breathy	1.00	1.30	6.53	0.000
Strained	1.00	1.70	6.53	0.000
Asthenic	1.00	1.20	6.32	0.000
Instability in pitch	1.00	1.90	6.51	0.000
Ringing Voice Quality	1.00	1.10	4.61	0.000
Weak Phonation at phrase ending	1.00	1.10	6.10	0.000
Overall	1.00	2.50	7.11	0.0000

Objective 2: To compare the acoustic changes in the voice quality pre and post vocal loading task.

The acoustic voice characteristics was analysed using MDVP of Computerized Speech Lab. The descriptive statistics were analysed and tabulated. The acoustic parameters compared in this study were f0, jitter (%), shimmer (dB), RAP and HNR. The f0, jitter (%) and HNR showed a significant change (p<0.001) post vocal loading task whereas the shimmer (dB) and RAP measures showed no difference (p>0.001) post vocal loading task. Table 2 shows the median and standard deviation of acoustic parameters before and after the vocal loading task respectively and Table 3 shows the median and the z and p value of Wilcoxon Signed Rank Test respectively of the acoustic parameters. The Figure 1–4 shows the graphs of f0, jitter (%), shimmer (dB), relative amplitude perturbation and harmonic to noise ratio respectively with pre and post values.

Table 2 Median and Standard Deviation of acoustic parameters before and after the vocal loading task

Parameters	Pre		Post	
	Median	Standard deviation	Median	Standard deviation
f0	147.18	53.5	169.28	57.9
Jitter (%)	34.25	19.9	85.05	38.14
Shimmer (%)	0.63	0.28	0.51	0.49
Relative Average Perturbation	0.65	0.55	0.52	0.39
Harmonic to noise ratio	0.12	0.009	0.15	0.12

Table 3 Median and z value and the significance value of Wilcoxon Signed Rank Test

Parameters	Median		Wilcoxon signed rank test	
	Pre	Post	z value	p value
f0	147.18	169.28	4.76	0.000
Jitter (%)	34.25	85.05	4.51	0.000
Shimmer (%)	0.63	0.51	1.76	0.077
Relative Average Perturbation	0.65	0.52	1.49	0.136
Harmonic to noise ratio	0.12	0.15	4.62	0.000

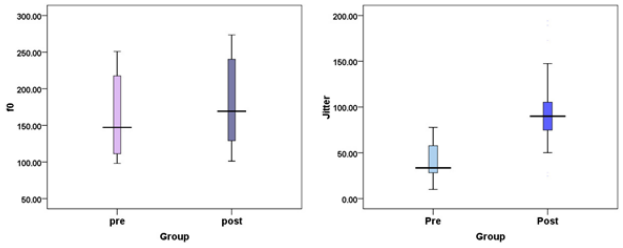

Figure 1 Pre and post f0 and jitter (%) values.

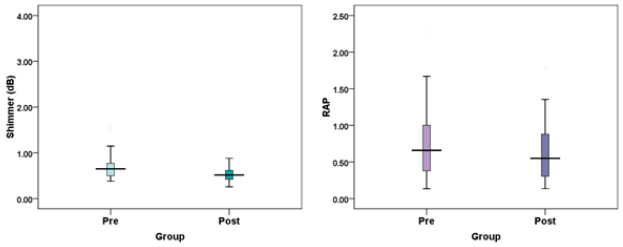

Figure 2 Pre and post shimmer (dB) and relative average perturbation (RAP) values.

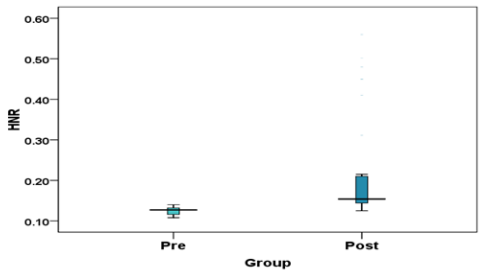

Figure 3 Pre and post harmonic to noise ratio (HNR) values.

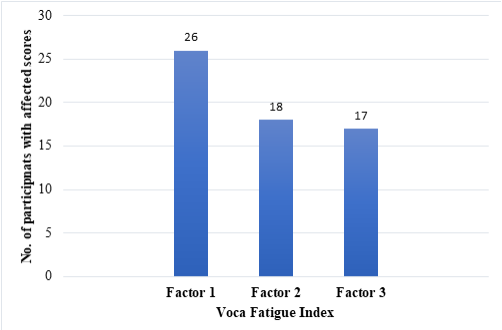

Figure 4 Number of participants who were affected in each factor post vocal loading task.

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Objective 3: To characterize vocal fatigue using Vocal Fatigue Index

The Vocal Fatigue Index (VFI) is a self-administered questionnaire which consist of a total 19 questions which are divided into 3 factors. The mean and standard deviation for each factor and the total score were calculated and analysed, the values are shown in Table 4 respectively.

Table 4 The mean and standard deviation for factor 1, factor 2, factor 3 and the total score respectively

VFI	Mean	SD
Factor 1 (Score >/= 24)	24.67	7.35
Factor 2 (Score >/= 7)	7.27	4.55
Factor 3 (Score </= 7)	8.21	2.48
Total score	40.16	8.99

The Figure 4 shows the number of participants who obtained a poor score in each factor of the VFI. Twenty-six participants scored poor in factor 1, 18 participants scored poor in factor 2 and 17 participants scored poor in factor 3. The graph shows that most of the participants obtained poor scores in factor 1 which is related to the tiredness of voice and voice avoidance.

Results showed that 17 (46%) subjects showed characterized vocal fatigue after vocal loading task whereas most of the participants (n = 20) did not have any perception of vocal fatigue post vocal loading task.

Therefore, the present study results show that the participants had complained more of vocal tiredness and avoidance than physical discomfort.

Discussion

The results from the study conclude that there was a significant increase in the perceptual parameters in both the perceptual tests, after the vocal loading task. Similarly, D'haeseleer et al.,[14] has also obtained an increase in the parameters post vocal loading task in theatre actors. Aragão et al.,[15] has also concluded that the perceptual evaluation results have shown an increment in the parameter post vocal loading task in teachers. The increase in these parameters indicates irregular vocal fold vibration resulting from vocal fatigue. A study by Whitling[16] has shown the participants have rated hyper-functional voice on VAS post vocal loading task. Boominathan et al.,[17] and Remacle et al.,[18] found a significant increment in the perceptual parameters post vocal loading task.

Krishna and Nataraja[19] and Daelman & Leyns studied vocal loading effects on teachers and trainee actors respectively. The results show significant changes in the acoustic parameters like f0 and shimmer (dB). Whereas, Boominathan et al. (2010) found significant differences found in all the acoustic parameters which included f0, jitter (%), shimmer (dB), relative average perturbation and HNR values post vocal loading task.

The hypothesized reason for post-test elevated f0 values was due to the strain in the intrinsic muscles of the larynx. Fundamental frequency (f0) represents the balance between the thyro-arytenoid and the cricothyroid muscles, hence, due to the strain in these muscles there is an increase in the f0 values induced by prolonged loud reading. Another hypothesis is that, due to prolonged hours of loud reading, there could be a motor learning effect which can increase the f0 post task.[20] Also, the possible reason for increase in the jitter percent values can be due to the irregular vocal fold vibration. The irregular vocal fold vibrations can be attributed as the effect of vocal loading. Therefore, due to this altered vibration of the vocal folds there was an increase in the jitter percent values in the present study.

Higher NHR values indicates that there is considerable increase in noise component in voice after vocal loading task and this may be due to increase in glottal gap during phonation. An increase in NHR is hypothesized because of extended voice use and evidence of vocal fatigue.[17] It is also considered one of the most sensitive measures of vocal fatigue. Similar to the present study results Lerner et al.,[8] studied vocal loading effect on acoustic parameters on 30 trainee actors. The results showed that there was no significant difference in the Shimmer (dB) and relative average perturbation values post 2 hours of vocal loading task.

The overall perception of vocal fatigue was only perceived by 17 participants (out of 37) in the present study, however, the acoustic as well as perceptual analysis shows significant vocal fatigue in voice after vocal loading. Laukkanena, showed that the participants reported of more voice symptoms than throat symptoms of vocal fatigue after a 45–90 minutes of vocal loading task on a self –rating scale.

The current study findings were supported by Lerner, Paskhover, Acton and Young[8] and Boominathan et al.,[17] found significant changes in the acoustic parameters, however, the self-rating of the participants did not show any effect on their voice.

Therefore, the present study results show a significant difference in the acoustic, as well as perceptual measurement after vocal loading task. However, most of the trainee actors did not perceive vocal fatigue after the task. This can be due to the lack of experience they have in perceiving minute changes in their own voice quality.

Conclusion

The objective measurements along with subjective ratings will help in analysing the voice characteristics post vocal loading task. The study also highlights the role of a speech language pathologist in improving the insufficient vocal knowledge and vocal function in trainee actors. An SLP can improve the vocal knowledge and its care by working as a part of a team of voice trainers and/or coaches and acting instructors. The study also states the importance of training the students to perceive minor changes in the voice quality as they are students and are not experienced to hear the finer differences in the voice. The objective voice examinations of vocal fatigue can effectively contribute towards the effective management for the professional. The subjective ratings along with the objective measurements will help in counselling as well as training the student actors for the future. Hence, it is strongly recommended to implement the vocal education and create awareness on vocal hygiene among professional voice users during their training period.

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Conflicts of interest

The author declare that there are no conflict of interest.

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