AGE-RELATED CHANGES IN LONG-TERM SPEECH SPECTRA IN INDIAN POPULATION

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MAY-2013

CERTIFICATE

This is to certify that this dissertation entitled ***"Age Related Changes in Long-Term Average Speech Spectra In Indian Population"*** is a bonafide work submitted in part fulfillment for the degree of Masters of Science (Speech-Language Pathology) of the student (Register No.11SLP019). This has been carried out under the guidance of a faculty of the institute and not has been submitted earlier to any other university for the award of any other Diploma or Degree.

Mysore
May, 2013

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DECLARATION

I hereby declare that this dissertation entitled ***"Age Related Changes in Long-Term Average Speech Spectra in Indian Population"*** is the result of my own study under the guidance of Dr. T. Jayakumar, Lecturer in Speech-Language Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted to any other university for the award of Diploma or Degree.

Mysore
May-June 2013

Register No.11 SLP019

Dedicated to my

Parents and Lord

And Guide....

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CHAPTER I

INTRODUCTION

Population ageing involves a shift from high mortality/high fertility to low mortality/low fertility and consequently an increased proportion of older people in the total population. The Indian aged population is currently the second largest in the world. The absolute number of the over 60 population in India will increase from 76 million in 2001 to 137 million by 2021. (http://www.who.int/hpr2/ageing/ageinginindia. pdf) First of all, the prolongation of life span does not necessarily mean that 'life has been added' to these extended years. The life expectancy is increased with many dieses and disorders, communication can be one among the major disorders. Voice is the most important tool of communication. Indeed in modern society people are probably even more dependent on their voice than in the rural societies. Like any other organ in the even larynx undergoes various modifications across the life span.

A sharp high pitch voice which gets the attention of the person immediately is the characteristics of infant voice which helps the mother to monitor the children from longer distance. During the child hood the fundamental frequency (F0) of the voice reduces to the considerable extents and it is maintained till the puppetry without much of gender differences. Male produce a low tone voice and female produce high tone voice after the complete maturation. This gender difference in voice is maintained till they enter in to old age. Ageing the geriatric voice loses his voice quality and slight variation in F0 is noticed in both the gender. Similar the speech also undergoes various changes with respect to rate of speech and the duration of the consonants and

the vowels. Anatomic data suggesting that aging results in lengthening of the supraglottic vocal tract.

In general, acoustic voice analysis offers practical advantages in clinical applications since it is non-invasive, it does not require close co-operation from the patient, and can be made off-line from tape-recordings. These kinds of applications are much useful for screening over large population for early detection of voice pathology and, in particular, the follow-up of the effects of voice therapy. Few study claims that measurements derived from long term average spectra allow a classification of voice disorders, although other studies have been equivocal (Sonninen and Hurme,1982).However long term average spectra have proved to be useful in following voice changes after surgery and therapy (Hammerberg et al.,1984; Hartmann and Crammon,1984).

To study the age related changes in the speech or voice, Long term average spectrum (LTAS) is widely accepted. Advantages claimed for LTAS are that it offers an overview of the acoustic phenomena of vocal product that is largely independent of their semantic or linguistic content, provided the length of the sample is considerably longer. (Fant, 1959). It is also been claimed to be independent of the language. It is most stable characteristics of the speaker. Kitzing and Akerlund said that LTAS is most useful for securing an overall view of vocal phenomena rather than other voice or speech parameters which focuses particular aspect of vocal aspect.

Linville & Rens (2001) used LTAS to investigate resonance characteristics of dynamic speech in young adulthood and old age. Eighty subjects were divided in to two groups with equally gender. Measurement of the first three spectral peaks in LTAS from the Rainbow Passage revealed significant lowering of peak 1 from young

adulthood to old age in both men and women. Peaks 2 and 3 also lowered significantly across the adult lifespan in women and showed a tendency to lower in men. These findings suggest that vocal tract resonance changes with aging in which an interaction exists between gender, the resonance effects of laryngeal lowering, and vowel articulatory patterns.

Sergeant and Graham (2008) investigated age-related changes in LTAS. Three hundred and twenty children in age groups 4–11 were participated. Each child had sung a song which was digitally recorded. LTAS curves were calculated from the recordings of each voice and perceived age was estimated by a panel of independent judges. These took the form of increases in spectral energy in all frequencies below 5.75 kHz, which showed significant changes between the age grows. This can be attributed to Maturation and developing competence of the vocal system, both in growths of lung capacity and at a laryngeal level, are implicated in the generation of age-related spectral changes.

Johnsirani, Supraja and Savithri (2008) developed norms for LTAS in children and adults on Indian population. Hundred children in the age range of 8-12 years with equally males and females and one forty adults in the age range of 18-24 years with equally males and females participated in the study. Phonation sample of /a/ for 3 seconds was subjected to LTAS analysis using VAGHMI software (Voice and speech systems, Bangalore). Linear and dB values of alpha(α) ,beta(β) and gamma(ϒ) ratios were computed and compared across gender and groups. Results indicated all the ratios were differed significantly higher in adults compare to children.

Leino (2009) investigated voice quality estimation in on the basis of long-term average spectrum characteristics. Fifty Finnish vocally untrained male university

students was studied perceptually and using long-term average spectrum analysis of text reading samples of one minute duration. The results, the good and ordinary voices differed from the poor ones in their relatively higher sound level in the frequency range of 1-3 kHz and a prominent peak at 3-4 kHz. Good voices, however, did not differ from the ordinary voices in terms of the characteristics of the long-term average spectrum. The amplitude of the peak at 3-4 kHz and the voice-quality scores correlated weakly but it is statistically significantly. Voice quality and alpha ratio (level difference above and below 1 kHz) correlated likewise. Leq was significantly higher in the students with good and ordinary voices than in those with poor voices.

Need of the study

The Indian aged population is currently the second largest in the world, one among the major disorder in the elderly is the communication disorder. LTAS was claimed to be most stable characteristics of the speaker and the voice quality. Also, it gives overall view of vocal phenomena. Keeping this, we can expect different from the western population to Indian population. Also the age related changes in the laryngeal structure may different between Indian to western people because of the overall food items and the environmental conditions. Noh and Lee (2012) said that LTASS of Korean speakers showed significantly lower levels in frequencies above 2 kHz in comparison with English. Hence, the current study will be focusing the age related changes in the speech using LTAS Indian population.

Objective of the study:

i) To obtain the α, β and ϒ values for adult and geriatric.

ii) To compare the α, β and ϒ values across the age groups (adult & geriatric).

iii) Correlating the perceptual rating with the α, β and ϒ values.

CHAPTER II

REVIEW OF LITERATURE

The long term average spectrum (LTAS) is widely accepted as a powerful and effective tool for assessment of voice characteristics. It is a fast Fourier transform generated power spectrum using spectral moments analysis. The measurement of the LTAS is made by passing the speech energy through a series of contigenous band pass filters and interpreting the energy at the output of each filter. These average values are then plotted to reach at the visual representation a smoothed plot by the envelope of the power spectrum of the speech sample.

Research questions to which it has been applied have ranged from studies in speakers recognition. Classification of voice qualities, pathologies and disorders of voice, aging voice, evaluation of techniques voice therapy, genders differences and acoustic analysis of speech components, such as labials, fricatives and plosives. Once dependent on use of multiple filter banks, the LTAS can now be created speedily and with ease by the recent computers. In general, auditive voice analysis offers practical advantage in clinical applications since it is non-invasive, it does not require close cooperation from the client, and can be made-off line from the tape recordings. While LTAS are potentially useful in the clinical situations and limitations are also not well understood. Representation of the long term average spectrum of speech have various acoustical and audiological applications. In rehabilitative audiology the LTAS is widely used in the prescription and evaluation of hearing aid fittings. It is used in many hearing aid prescription procedures either in the derivation of the prescriptive formula (Byrne and Dillon, 1986).

LTAS has been used to study individual age, gender and language related differences. Characteristics of vocal expression of emotions and acoustic differences between specific voice qualities have also been studied with this method. Moreover, LTAS has been used to investigate voice for example, differences between voice categories and various singing styles. Spectral moments have been also used in analyses of both normal and abnormal speakers, primarily to characterize consonant production. Spectral moments are also sensitive to specific acoustic characteristics in both normal and disordered speech. But spectral moments analysis of the LTAS used for the purpose of assessing changes in voice disorder severity has been limited. Advantages claimed for LTAS are that it offers an overview of the acoustic phenomena of vocal products that is largely independent of their semantic or linguistic content. A numbers of writers have reported differences between the spectra of children's vocalization and those of adults.

A number of changes in phonatory voice quality associated with aging have been reported in adults. In early perceptual studies, when listeners were questioned as to the vocal characteristics they considered typical of "old voices", features such as increased breathiness, lower pitch, increased hoarseness, breathiness or harshness, increased strain, higher incidence of voice breaks, and reduced loudness, vocal tremor were found from the acoustic measurements. Since that time, a number of acoustics studies have confirmed changes in measures of speaking fundamental frequency /amplitude stability, speech intensity, and spectral noise with aging. These changes are felt to reflect, at least in part, age related changes in vocal fold function resulting from anatomic alteration has been found in the larynx.

Earlier some experiments done by Hartman and Cramon (1984) found that the presence of spectral energy above 5 KHz was a strong predictor of perceived breathiness in LTAS.

Kitzing (1986) also examined spectral characteristics of the LTAS as compared with perceptual ratings of voice quality in patients with functional dysphonia. He concluded that the energy ration in LTAS is useful measure for voice quality analysis; however, a substantial influence of voice intensity is present on LTAS spectrum.

Vocal folds function also changes due to ageing effect, and this issue has received more attention towards the research. There is other concern regarding the closure pattern of the vocal folds in young and elderly adults which can be examine through visual examination of the larynx. And this is inferred from the aerodynamic measures and electroglottographic examinations. These studies have showed that the ageing process in male increases the overall incidence of glottal gaps. But in women, the overall incidence of glottal gap does not occur as increases with the aging. But incase of elderly female populations glottal gap seen in the posteriorly, while younger women demonstrates gap in the anterior places.

There are a numerous of studies which emphasizes upon the formant frequency of elderly speakers are affected by vocal tract lengthening. Benjamin (1997) conducted study on the 20 elderly speakers their (mean age 74) and demonstrated formant frequency ratios that were dispersed through the vowel quadrilateral compare to younger adults. She arrived on the conclusion that this incidence can occur due to the vowel centralization. She also noted that a substantial increase in variability of formant frequencies across the elderly speakers. Rastatter

and Jacques (1990) also reported that formant frequency is evidence of vowel centralization in elderly speakers compare to the younger speakers.

Endres et al. (1971) also reported about the lowering of formant frequencies of seven vowels and two dipthongs in running speech samples in both male and female over a time span of upto 29 years. Linville and Fisher (1985) reported about the lowering of F1 and F2 in sustained /ae/vowels in a cross sectional study of 75 women were participated, in this study they found that F2 were less prominent with advancing age.

Suckanec et al. (1991) experimented their study on three elderly women and six young women and tried to measure four vowels (/i/,/ae/,/u/,and /a/) formant frequency. The authors concluded that lowering of F2 was seen in elderly female cases. Even F2 lowered was also significant only for/a/and /u/. This study indicates that ageing affects in the lowering of formant frequencies. Therefore, aging would be interest for the researchers to explore about the voice quality parameters which characterized by the aging effects and too involved in the speaker recognition research.

Spectral tilt is, one of the methods for LTAS measurement that may have particular relevance to voice changes associated with aging. Spectral tilt is the ratio of energy in the frequency region of the fundamental frequency region of the fundamental and lower harmonics compared with energy present in the upper harmonics. Generally the frequency range considered is 0-5 KHz with the cut-off either at 1 kHz or 1.6 kHz. If the resulting value is low the upper harmonics have appropriately more energy in comparisons with the lower harmonics.

Klatt and Klatt (1990) investigated that the female larynx, in comparison with the male, generates greater levels of aspiration noise in the spectral region corresponding to the third formant, resulting in a breathier voice quality.

Klatt et al. (1990) also found that the male generates more levels of aspiration noise in the spectral region of the third formant compared to females. Similarly, Mendoza et al. (1996) attributed findings of lower spectral tilt in female (compared with male) and both studies findings were same. In elderly voice findings of lower spectral tilt in comparison with younger voice with would be consistent with declining glottal competence. These authors tried to find out about the LTAS could be useful for recognition and synthesis of aged voice.

Acoustical data from several reports have suggested that elderly speakers tend to centralize their tongue position during vowel production. Benjamin (1997) said that the tendency to centralize vowels may become more pervasive with advanced old age, at least in males.

Vocal tract lengthening in the elderly was reported as early as 1959 by Ferreri. Several acoustic studies have suggested that the formant frequencies of elderly speakers also are affected by vocal tract lengthening. Long term average spectral analysis (LTAS) provides an averaged spectrum of all voiced sounds across a relatively long speech sample. The advantage of including only voiced sounds in the analysis is that the contaminating influence on the averaged spectrum of phonemes with a source other than the vocal folds for example above 1 KHz and below 1 KHz and conclusions drawn as to patterns characteristics of given phonatory vocal qualities such as breathiness.

Kahane (1981) brought attention to this early report, noting that Ferreri used the term “laryngeal ptosis” to describe an aging process in which the larynx assumes position one to three vertebrae lower in the neck than the position observed in young adults. He also suggested that weakening of structural support elements in the vertebral column in the elderly results in a series of changes in the lower respiratory tract including lowering of both the larynx and the trachea-bronchial tree and lungs. Interestingly, Biever and Bless (1989*)* noted indirect evidence of vocal-tract lengthening through observations of darker images during stroboscopic examinations on elderly women, in comparison with younger women.

Rothenberg (2007) opened the discussion by asking whether all LTAS analyses were done on speech material from which the voiceless segments had been removed. The general opinion seemed to be the relevant information is hidden by the noise components from voiceless sounds, so that the elimination is essential. On the other hand wendler (1980) had found that, in comparing his groups of patient’s voices, it did not matter whether or not voiceless parts were eliminated.

Hirano (1989*)* reported difficulties in finding typical LTAS correlates of breathiness and wondered if a method for extracting a signal to noise ration could be developed. Gauffin (1980) mentioned comb filtering controlled by fundamental frequency as a possibility. Sundberg (2005) pointed out that breathy voice in contrast to normal voices, Produce LTAS with high sound level at the low frequency end and steep falling curves.

Hammerberg (1970) reported from a study on 16 patients before and after injection of Teflon in a paralyzed vocal fold. The LTAS analysis of these patients

having a breathy voice before Teflon injection and voice therapy, largely confirmed the findings reported on by Hume and speaking against

Some authors like Klatt and Klatt (1990) have suggested that the voice differentiation between the genders comes from the generation of a noisier aspiration in women's larynxes compared with men. These greater levels of aspiration noise, centred in the high-frequency spectral regions corresponding to the third formant. It makes the female voices more breathier than the male voice.

Rashmi (1985) has made an attempt to study the ratio of intensities below and above 1 KHz,in the spectra of vowel/i/.she has also concluded that:-

(i) The energy level above 1 KHz is less than the energy level below 1 KHz.

(ii) The alpha parameter shows no significant difference till the age of 9 years in both males and females.

(iii) They found no significant difference between males and females. The female groups above 9 years at age showed a change in the voice quality both in the case of males and females as reflected by the changes in the ratio.

Gopal (1986) also reported there is no significant difference between males and females upto the age of 55 years. A significant difference was observed between males and females in the age range of 56 to 65 years age group.

Mendoza et al. (1996) studied on 40 males and 40 females consisted in two age groups (young and eldery). Young speakers age ranged in age from 19 to 24 years, eldery speakers age ranged from 62 to 79 years of age. Subjects read the Rainbow passage aloud. Results revealed that the elderly women demonstrated

significantly higher spectral amplitude levels compare than younger women at the different frequencies as 320, 6080, 6240, 6400, 6560, and 6720Hz. Elderly women also tended towards higher spectral amplitude than young women. Elderly men also showed significantly higher amplitude levels than younger men at 160 Hz. This study also suggests that both young and elderly women demonstrate spectral features accompanied with breathy voice quality. Young women results showed higher spectral amplitude level than elderly women at the frequency region of 3000Hz.

Nawaka et al. (1997) compared the normal and moderately rough voices. He experimented on German actors, he found that the an energy increases between 3.150 and 3.700 Hz, and correlate with the "loud and shiny "quality of voice and a more gentle fall of the actors's voice.

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Linville (2002) investigated 80 speakers with different age and gender. All read the Rainbow Passage. Spectral energy measurements were of LTAS was done. In comparison with young women, elderly women demonstrated: (a) significantly higher spectral amplitude levels at the frequencies of 320, 6080, 6240, 6400, 6560, and 6720

Hz; (b) significantly lower levels at the frequencies of 3040 and 3200 Hz; and (c) a tendency toward higher levels at 160 Hz. Result suggest that both young and elderly women demonstrate spectral features associated with breathy voice quality, while differing in the specific spectral regions in which breathiness is indicated. Elderly men demonstrated significantly higher spectral amplitude levels than young men at 160 Hz, as well as significantly lower levels at 1600 Hz

Sergeant and Graham (2008) investigated age-related changes in LTAS. Three hundred and twenty children in age groups 4–11 were participated. Each child had sung a song which was digitally recorded. LTAS curves were calculated from the recordings of each voice and perceived age was estimated by a panel of independent judges. These took the form of increases in spectral energy in all frequencies below 5.75 kHz, which showed significant changes between the age grows. This can be attributed to Maturation and developing competence of the vocal system, both in growths of lung capacity and at a laryngeal level, are implicated in the generation of age-related spectral changes.

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Paula, Suely, Solange, Paulo and Luiz (2011) studied acoustic and long-term average spectrum measures to detect vocal aging in women. They included 60 participants. Group 1consists of 30 participants in the age range of 20 to 35 years and group 2 consists of eldery speakers in age ranges were 60 to 82 years. Subjects were asked to read-aloud task of a 250 –word text, in habitual and loud levels. Duration of the each recordings consisted about 200 seconds. The measurement were considered in the LTAS windows at the F1 and F0 regions. The level difference between the F1 and F0 regions is 300-400 Hz, and the difference between the phonation mode is 50-300 Hz. and the level difference of the alpha ratio was 1-5KHz. The results revealed (Leq) mean values for habitual levels were 70 dB and 72 dB and at loud levels, were 76.20 and 80.13 dB respectively. The SFF values at habitual levels were found as 188 and 202Hz. Result shows there is a significant difference between elderly and younger women. The authors attributed that due to vocal aging process and anatomical and physiological alterations of the vocal mechanism.

Need of the study

The Indian aged population is currently the second largest in the world, one among the major disorder in the elderly is the communication disorder. LTAS was claimed to be most stable characteristics of the speaker and the voice quality. Also, it gives overall view of vocal phenomena. Keeping this, we can expect different from the western population to Indian population. Also the age related changes in the laryngeal structure may different between Indian to western people because of the overall food items and the environmental conditions. Noh and Lee (2012) said that LTASS of Korean speakers showed significantly lower levels in frequencies above 2 kHz in comparison with English Hence, the current study will be focusing the age related changes in the speech using LTAS Indian population.

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CHAPTER III

METHOD

Participants

A total of 60 individuals were participant in the study. Thirty adult in the age range of 21-30 years was considered as group I, Thirty geriatric in the age range of 60-70 years was considered as group II. Both the group had equal number of males and females. The participants height variation will be restricted as for as possible in both males and females. All participants will be native speaker of Kannada language.

Exclusion criteria

- Participants with the history of neurological, speech, hearing and language disorders.
- Participants with history of heavy alcohol or smoking will be excluded.
- Participants who has formal singing training.
- Participants who under sever medication.
- Participants without corrected visual acuity.

Instruments

VAGHMI software (Voice and Speech systems, Bangalore) was used for the LTAS analysis.

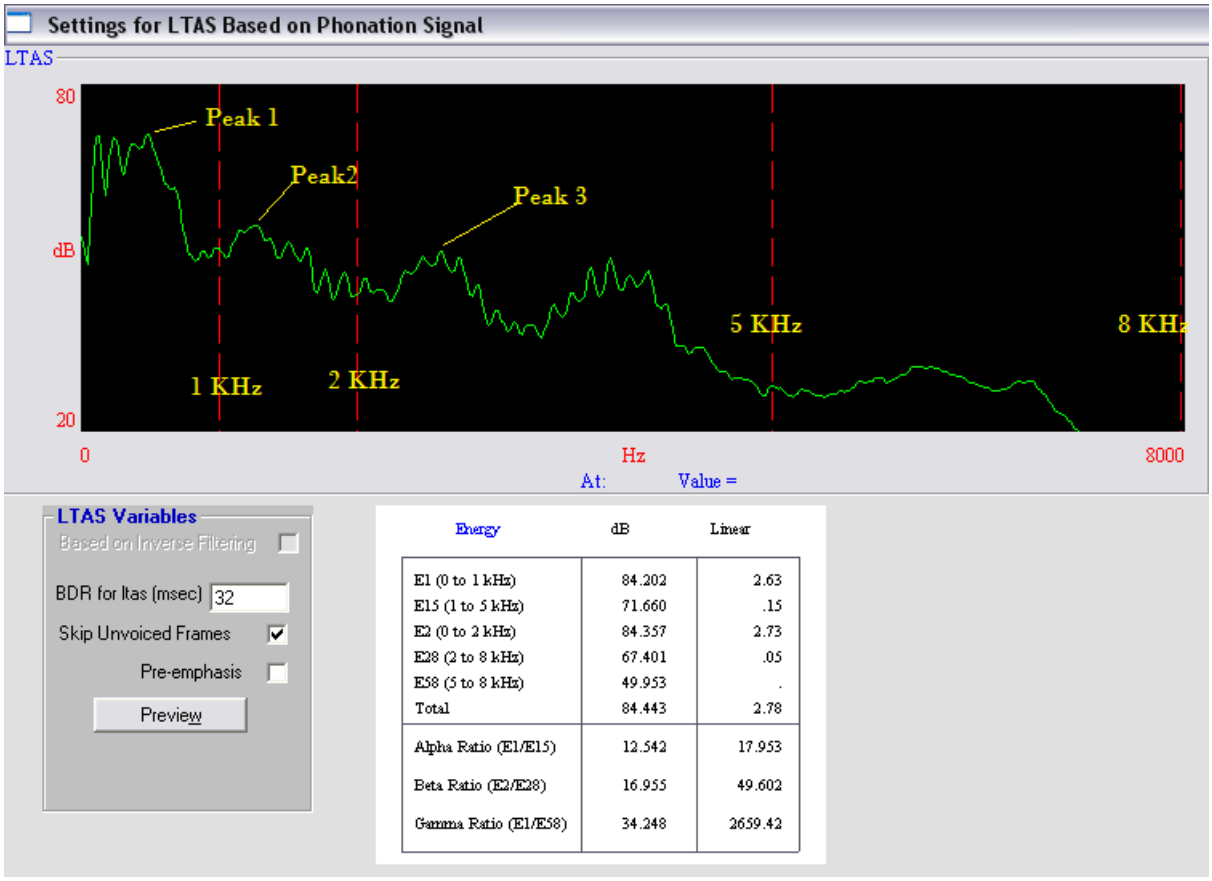
Procedure

All the participants will read the standard Kannada passage at the comfortable pitch and the loudness with optimal mouth open. The sound level meter (Radio shock) was used to monitor the intensity level (app =70 dBSPL). The recording was made in

the quite room with the digital voice recorder with the sampling frequency of 44 KHz and the 16 bit rate.

Analysis

The recorded sample was converted to 16 KHz sampling rate to make it compatible with the vaghmi software using the "VAGHMI DIAGNOSTIC" module the alpha(α) ,beta(β) and gamma(ϒ) value was measured for each participant. Alpha is ratio of average energy between 0-1KHz to 1-5 KHz, Beta is ratio of average energy between 0-2KHz to 2-8 KHz and gamma is ratio of average energy between 0-1KHz to 5-8 KHz. The band duration range was kept as 32 msec. Also the prominent peak energy between 0-1KHz was considered as Peak1, the peak energy between 1-2 KHz was considered as Peak 2 and the peak energy between 2-5 KHz was considered as Peak 3. The For the subjective assessment ten point rating scales (0-9) was used to assessing the quality of voice (Appendix). The voice quality was rated separately for harshness, hoarseness and breathiness. Five experienced speech language pathologist were rated the voice sample. However, one among them was considered as export as he was having ten years experience in the field of speech sciences. Picture 1 shows the screen shot of the vaghmi LTAS.



Picture 1: Screen shot of the vaghmi LTAS.

Statistical analysis

To find the difference between adult and geriatric, two-way MANVOVA was done for LTAS parameters and for perceptual assessment Mann Whitney U test was done. Since, there was interaction effect in the MANVOVA; separate t test was done to find the difference individually. To find the correlation between the perceptual assessment and LTAS parameters, Pearson correlation test was used.

CHAPTER IV

RESULT AND DISCUSSION

In the present study, there were two groups of participants, group I with adult having 30 participants and group II with the geriatric having 30 participants. The study was aimed to find out the effect of aging on LTAS parameters (alpha(α) ,beta(β), gamma(ϒ), peak1, peak2 and peak3) and also to find correlation between perceptual and objective measurements of voice quality. Descriptive statistical analysis was done to observe the mean and standard deviation for both the groups in each parameter. The results of the study sub grouped under three main headings.

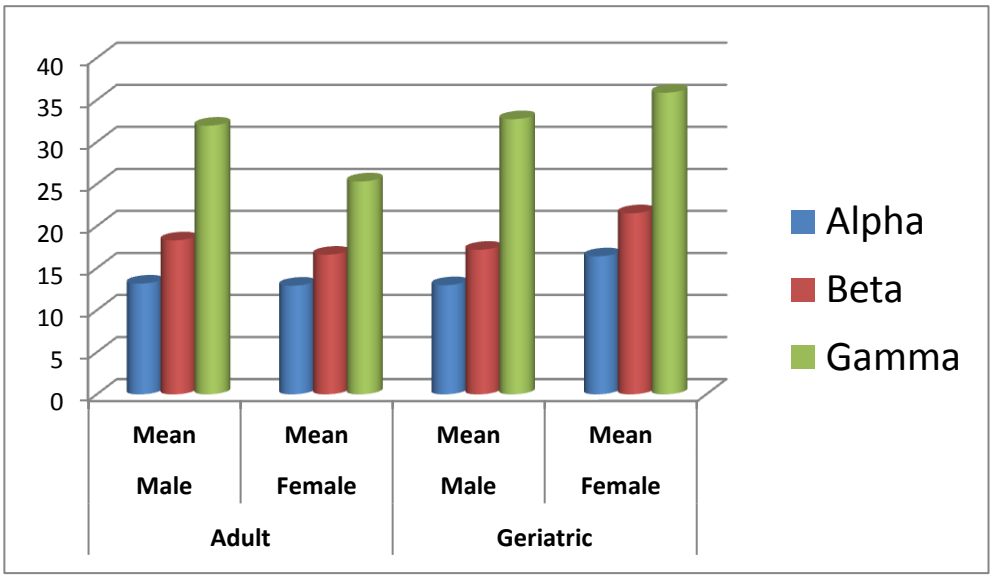
- LTAS Parameters for adult and geriatric
- Comparison of LTAS Parameters for adult and geriatric
- Perceptual assessment for adult and geriatric
- Comparison of Perceptual assessment for adult and geriatric
- Correlating the perceptual rating with the LTAS Parameters

I. LTAS Parameters for adult and geriatric

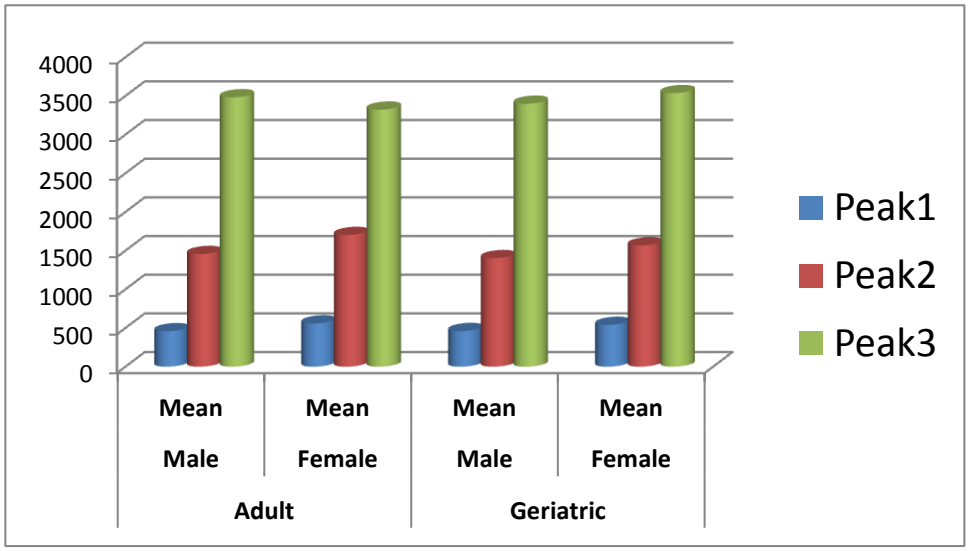
	Adult		**Geriatric**	
	Male	Female	Male	Female
	M(SD)	M(SD)	M(SD)	M(SD)
Alpha	13.17(3.59)	12.92(3.08)	12.98(3.23)	16.41(3.70)
Beta	18.31(3.74)	16.6(2.55)	17.19(3.44)	21.53(3.98)
Gamma	31.95(4.68)	25.32(3.25)	32.72(9.28)	35.87(4.72)
Peak1	458(48.2)	559(131.8)	460(45.9)	540(100.7)
Peak2	1456(171.2)	1702(154.2)	1403(147.9)	1568(196.5)
Peak3	3482(536)	3323(594)	3399(561)	3536(604)

Table 1: Mean and standard deviation (SD) of LTAS parameters for adult and Geriatric across the gender.

The descriptive data of LTAS parameters for adult and geriatric was shown in table 1. The result shows that geriatric shows higher value in majority of the parameters than adult. Alpha, beta, gamma and peak 3 shows high value for male compare to female in adult. Peak 2 and peak 3 shows low value for male compare to female in adult. However in geriatric the all the parameters shows higher value for female compare to male. Picture 2 shows the mean and standard deviation (SD) of LTAS parameters for adult and Geriatric across the gender. Picture 3 shows the mean and standard deviation (SD) of peak1, peak2, and peak3 for adult and Geriatric across the gender.



Picture 2: Mean and standard deviation (SD) of α, β, ϒ for adult and Geriatric across the gender.



Picture 3: Mean and standard deviation (SD) of peak1, peak2, peak3 for adult and Geriatric across the gender

The result of the present study showed that geriatric had higher values that adult which is supported by many early studies. There difference can be attributed to age related changes in the anatomical and functional aspect of laryngeal system. Mendoza *et al. (*1996) showed that elderly voice findings of lower spectral tilt in comparison with younger voice with would be consistent with declining glottal competence. Linville (2002) elderly men demonstrated significantly higher spectral amplitude levels than young men at 160 Hz, as well as significantly lower levels at 1600 Hz. Johnsirani, Supraja and Savithri (2008) developed norms for LTAS in children and adults on Indian population.. Results indicated all the ratios were differed significantly higher in adults compare to children the average value of alpha beta and gamma is more than the current study result. This may be because of the task difference, where Johnsirani, Supraja and Savithri used the phonation task.

II. Comparison of LTAS Parameters for adult and geriatric

To find the difference between adult and geriatric, two-way MANVOVA was done. The LTAS parameters which showed the significant difference has been listed in the table 2. Beta, gamma and peak 2 showed significant difference between the groups. Geriatric showed higher value than adult. Peak 1 and peak 2 showed significant difference between the genders. Female showed higher than male. There was a significant interaction between group and gender for alpha, beta and gamma.

	Parameter	**df**	**F-Value**	**P-Value**
Group	Beta	1,56	5.471	0.023*
	Gamma	1,56	14.997	0.000**
	Peak2	1,56	4.312	0.042*
Gender	Peak1	1,56	14.419	0.000**
	Peak2	1,56	20.766	0.000**
Group*Gender	Alpha	1,56	4.116	0.047*
	Beta	1,56	12.623	0.001**
	Gamma	1,56	11.176	0.001**

Table 2: Results of two-way MANVOVA for LTAS parameters.

The two-way MANVOVA showed that there was significant difference between and adult and geriatric for beta, gamma and peak 2. It suggested that there was not much change in the LTAS up to the 5KHz frequency region. Linville (2002) investigated 80 speakers with different age and gender. All read the Rainbow Passage. Spectral energy measurements were of LTAS was done. Result suggest that both young and elderly women demonstrate spectral features associated with breathy voice quality, while differing in the specific spectral regions in which breathiness is indicated. Elderly men demonstrated significantly higher spectral amplitude levels than young men at 160 Hz, as well as significantly lower levels at 1600 Hz. Secondly

the present study also shows that there is a gender difference in peak1 and peak2, this result is well expected. However this difference was expected even for peak3, may be the difference was less compared to peak1 and peak2.

Since there is interaction between the group and gender separate Independent‘t’ test has been done only alpha, beta and gamma. Independent‘t’ test was done for find the group difference in male separately and female separately. Result showed that alpha beta and gamma had significant group difference in female, geriatric had higher value than adult.

Group Difference	df	**Male**		**Female**	
		F-Value	P-Value	F-Value	P-Value
Alpha	28	0.145	0.886	-2.843	0.008**
Beta	28	0.802	0.430	-4.465	0.000**
gamma	28	-0.293	0.772	-7.134	0.000**

Table 3: F-value and P-value for gender difference across group.

The present study showed significant difference between adult and geriatric in female only. This suggested that the age related change in laryngeal system is more for female compared to male and the alpha, beta and gamma ratio are very sensitive in decting this changes with respect to aging voice compared to peak values. Paula, Suely, Solange, Paulo and Luiz (2011) studied acoustic and long-term average spectrum measures to detect vocal aging in women. They included 60 participants. Group 1consists of 30 participants in the age range of 20 to 35 years and group 2 consists of eldery speakers in age ranges were 60 to 82 years. Subjects were asked to read-aloud task of a 250 –word text, in habitual and loud levels. Result shows there is a significant difference between elderly and younger women. Among the LTAS

parameters, L1-L0 and alpha ration are the most reliable measures to indicate age related changes in the voice. The authors attributed that due to vocal aging process and anatomical and physiological alterations of the vocal mechanism.

Independent‘t’ test was also done to find the gender difference in adult separately and geriatric separately. Result showed that gamma had significant gender difference in adult, male had higher than female where as alpha and beta had a significant gender difference in geriatric, here female had higher value than male.

Gender Difference	df	**Adult**		**Geriatric**	
		F-Value	P-Value	F-Value	P-Value
Alpha	28	0.210	0.836	- 2.534	0.013**
Beta	28	1.912	0.066	-2.992	0.006**
gamma	28	4.467	0.000**	-1.214	0.235

Table 4: F-value and P-value for gender difference across group.

Present study result showed that geriatric shows the significant gender difference than adult. The different profiles of energy distribution in the spectrum are seen mostly due to the present of greater aspiratory noise in female. Mendoza et al. (1996) studied on 40 males and 40 females consisted in two age groups (young and eldery). Young speakers age ranged in age from 19 to 24 years, eldery speakers age ranged from 62 to 79 years of age. Subjects read the Rainbow passage aloud. Results revealed that significant difference were present between genders. However the difference was more for female compared to male. Also the elderly women demonstrated significantly higher spectral amplitude levels compare than younger women at the different frequencies as 320, 6080, 6240, 6400, 6560, and 6720Hz.

Elderly women also tended towards higher spectral amplitude than young women. Elderly men also showed significantly higher amplitude levels than younger men at 160 Hz. This study also suggests that both young and elderly women demonstrate spectral features accompanied with breathy voice quality. Young women results showed higher spectral amplitude level than elderly women at the frequency region of 3000Hz.

III. Perceptual assessment for adult and geriatric

The For the perceptual assessment ten point rating scales (0-9) was used to assessing the quality of voice from the reading sample. Five experienced speech language pathologist were rated the voice sample. However, one among them was considered as export rating. Inter – rater reliability was calculated between the raters table 5 shows the reliability coefficient for each perceptual measures.

	Inter rater-reliability
Harshness	0.663
Hoarseness	0.774
Breathiness	0.703

Table 5: Reliability coefficient value for perceptual measures

Although five experienced speech language pathologist were rated the reading sample, only the one export rating was taken for the comparison between the adult and geriatric. Descriptive data for perceptual measures for adult and geriatric was shown in table 6. Result shows that geriatric had higher value in all the parameters also the variation among the parameters also higher compare to adult. Table 7 shows that result of Mann-Whitney U test which shows the comparison between adult and geriatric.

	Adult		Geriatric	
	Male	Female	Male	Female
	M (Median)	M (Median)	M (Median)	M (Median)
Harshness	0.60(0)	0.3(0)	0.73(1.0)	0.73(1.0)
Hoarseness	0.20(0)	0(0)	2.0(1.0)	2.4(2.0)
Breathiness	0.53(0)	0.40(0)	0.93(1.0)	0.93(1.0)

Table 6: Mean and standard deviation (SD) of perceptual assessment for adult and Geriatric across the gender.

Parameter	Adult Vs Geriatric	
	Z-Value	P-Value
Harshness	-3.203	0.001**
Hoarseness	-5.226	0.000**
Breathiness	-2.487	0.013**

Table 7: Result of Mann-Whitney U test for group difference for Perceptual assessment.

The present study result showed that geriatric had rating in all the parameters compare to adult. The result is in support of the LTAS parameters of the present study. Linville (2002) and Paula, Suely, Solange, Paulo and Luiz (2011) also showed that elder people shows poor voice quality compared to adult.

Parameter	Adult Vs Geriatric			
	male		Female	
	Z-Value	P-Value	Z-Value	P-Value
Harshness	-1.302	0.193	-3.780	0.000**
Hoarseness	-2.679	0.007**	-4.479	0.000**
Breathiness	-1.334	0.182	-2.292	0.022*

Table 8: Result of Mann-Whitney U test for group difference across gender for Perceptual assessment.

Mann-Whitney U test was also done to find group difference across male and female. The results were shown in the table 8. Results revealed that female showed greater group difference compared to male. The result is in support of the LTAS parameters of the present study. Mendoza et al. (1996), Linville (2002) and Paula, Suely, Solange, Paulo and Luiz (2011) also showed that female shows greater difference compared to male.

IV. Correlating the perceptual rating with the LTAS Parameters

The present study result showed that similar results from the LATS parameters and the perceptual assessment. This shows that there is good relation between perceptual and LTAS parameters. To quantify the relation, the Pearson correlation test was used. The export perceptual rating was correlated with the LTAS parameters (only alpha, bets and gamma) table 9 shows the Pearson correlation coefficient for perceptual rating and LTAS parameters.

	Correlation coeffecient		
	Alpha	Beta	Gamma
Harshness	0.514	0.642*	0.354
Hoarseness	0.684*	0.584*	0.521
Breathiness	0.752*	0.564	0.541

Table 9: Correlation coefficient between perceptual rating and LTAS parameters.

Limitation of the study

- Present study considered of only thirty subjects.
- Only reading task was taken in this study.
- Limited LTAS parameters were used.

CHAPTER V

SUMMARY AND CONCLUSION

The Indian aged population is currently the second largest in the world. Ageing the geriatric voice loses his voice quality and slight variation in F0 is noticed in both the gender. Similar the speech also undergoes various changes with respect to rate of speech and the duration of the consonants and the vowels. Anatomic data suggesting that aging results in lengthening of the supraglottic vocal tract. To study the age related changes in the speech or voice, Long term average spectrum (LTAS) is widely accepted. Advantages claimed for LTAS are that it offers an overview of the acoustic phenomena of vocal product that is largely independent of their semantic or linguistic content, provided the length of the sample is considerably longer. (Fant, 1959). It is also been claimed to be independent of the language. It is most stable characteristics of the speaker. The age related changes in the laryngeal structure may different between Indian to western people because of the overall food items and the environmental conditions. Noh and Lee (2012) said that LTASS of Korean speakers showed significantly lower levels in frequencies above 2 kHz in comparison with English Hence, the current study will be focusing the age related changes in the speech using LTAS Indian population.

In the present study a total of 60 individuals were participant in the study. Thirty adult in the age range of 21-30 years was considered as group I, Thirty geriatric in the age range of 60-70 years was considered as group II. Both the group had equal number of males and females. The participants height variation will be restricted as

for as possible in both males and females. All participants will be native speaker of Kannada language.VAGHMI software (Voice and Speech systems, Bangalore) was used for the LTAS analysis. All the participants will read the standard Kannada passage at the comfortable pitch and the loudness with optimal mouth open. The sound level meter (Radio shock) was used to monitor the intensity level (app =70 dBSPL). The recording was made in the quite room with the digital voice recorder with the sampling frequency of 44 KHz and the 16 bit rate.

The recorded sample was converted to 16 KHz sampling rate to make it compatible with the vaghmi software using the "VAGHMI DIAGNOSTIC" module the alpha(α) ,beta(β) and gamma(ϒ) value was measured for each participant. Also the prominent peak energy between 0-1KHz was considered as Peak1, the peak energy between 1-2 KHz was considered as Peak 2 and the peak energy between 2-5 KHz was considered as Peak 3. The For the subjective assessment ten point rating scales (0-9) was used to assessing the quality of voice. The voice quality was rated separately for harshness, hoarseness and breathiness. Five experienced speech language pathologist were rated the voice sample.

The descriptive data of LTAS parameters for adult and geriatric The result of the present study showed that geriatric had higher values that adult which is supported by many early studies. There difference can be attributed to age related changes in the anatomical and functional aspect of laryngeal system. Mendoza et al. (1996) and Linville (2002) support the same result. Johnsirani, Supraja and Savithri (2008) developed norms for LTAS in children and adults on Indian population.. Results

shows that the average value of alpha beta and gamma is more than the current study result. This may be because of the task difference, where Johnsirani, Supraja and Savithri used the phonation task. The two-way MANVOVA showed that there was significant difference between and adult and geriatric for beta, gamma and peak 2. It suggested that there was not much change in the LTAS up to the 5KHz frequency region.

Independent 't' showed that significant difference between adult and geriatric in female only. This suggested that the age related change in laryngeal system is more for female compared to male and the alpha, beta and gamma ratio are very sensitive in decting this changes with respect to aging voice compared to peak values. Paula, Suely, Solange, Paulo and Luiz (2011) supported the same notion. He also told that among the LTAS parameters, L1-L0 and alpha ration are the most reliable measures to indicate age related changes in the voice. Independent 't' also showed that geriatric shows the significant gender difference than adult. The different profiles of energy distribution in the spectrum are seen mostly due to the present of greater aspiratory noise in female. Perceptual assessment result shows that that geriatric had rating in all the parameters compare to adult. The result is in support of the LTAS parameters of the present study. Linville (2002) and Paula, Suely, Solange, Paulo and Luiz (2011) also showed that elder people shows poor voice quality compared to adult. Mann-Whitney U test was also done to find group difference across male and female. The results were shown in the table 8. Results revealed that female showed greater group difference compared to male. The result is in support of the LTAS parameters of the present study. Mendoza et al. (1996), Linville (2002) and Paula, Suely, Solange, Paulo and Luiz (2011) also showed that female shows greater difference compared to

male. Correlation of perceptual rating with the LTAS Parameters shows that good correlation coefficient. Among all the LTAS parameters, alpha correlates well with the breathiness and hoarseness of the perceived voice quality.

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APPENDIX

Perceptual Rating Scale (Kannada Reading Passage) - (Adult / Geriatric)

Name:-

Sample No: 01

Hoarseness: 0_____5_____9 ____/ 10

Harshness: 0_____ 5_____9 ____/10

Breathiness: 0_____ 5_____9 _____/10