LONG TERM AVERAGE SPEECH SPECTRUM IN KANNADA

Reg. No. M0123

An Independent Project submitted in part fulfillment of
First Year M.Sc, (Speech and Hearing),
University of Mysore, Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MANASAGANGOTHRI,
MYSORE -570 006

May - 2002

Dedicated

To

Lord Sri Krishna

&

Nanagaru, Amma, Kittu......

CERTIFICATE

This is to certify that this Independent Project entitled **"LONG TERM AVERAGE SPEECH SPECTRUM IN KANNADA** " is a bonafide work in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student (Register No. MO 123).

Director

Mysore

All India Institute of

Speech and Hearing,

May,2002

Mysore-570 006

CERTIFICATE

This is to certify that this Independent Project entitled **"LONG TERM AVERAGE SPEECH SPECTRUM IN KANNADA"** has been prepared under my supervision and guidance. It is also certified that this Independent Project has not been submitted earlier in any other University for the award of any Diploma or Degree.

Guide

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May,2002

DECLARATION

This Independent Project entitled **"LONG TERM AVERAGE SPEECH SPECTRUM IN KANNADA""** is the result of my own study under the guidance of Ms.P.Manjula, Lecturer in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore and not been submitted earlier in any other University for the award of any diploma or degree.

Mysore,

May, 2002 Reg.No.MO123

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Chapter 1

Introduction

Hearing sense is one of the gateways for learning. When a person has significant hearing loss this gateway is closed. Hearing loss ramifies into other secondary psychosocial problems. In order to alleviate these problems, amplification of sound is the method chosen by audiologists in the process of rehabilitation of the hearing impaired individuals.

Selection of an appropriate hearing aid and fitting is the first step in aural rehabilitation. Selection of these amplification systems with appropriate characteristics has been a challenge for the audiologist. There have been countless methods for selection of appropriate aid. There is a general lack of agreement among audiologists as to what is the best procedure for selecting and evaluating hearing aids for adults or children, leading to confusion on the part of many of us.

The primary goal of amplification selection and evaluation is to provide maximum auditory information in a manner consistent with the person's residual hearing. Since speech is the important input to the aid, the amplification device should present speech at a comfortable listening level considering factors such as over and under amplification (Skinner, 1988). Currently the speech spectrum based selection of electro acoustic characteristics of hearing aids appear more purposeful (Byrne, 1977; Byrne and Dillon, 1986).

One way in which the acoustic nature of speech has been studied \s in terms of long term average speech spectral characteristics (Dunn and White, 1940; Benson and Hirsh, 1956). The long term average speech spectrum (LTASS) is a direct measure of the mean sound pressure level of speech as a function of frequency and provides a global representation of the acoustic characteristics of a continuous discourse (Cox and Moore, 1988). Several hearing aid selection schemes (Cox, 1985; 1988; Seewald, Ross and Shapiro, 1985; Seewald and Ross 1988; Berger, Klich and Millin, 1982 and Skinner, 1988) have as their goal the amplification of the long term spectrum of speech to the desired target values within the residual dynamic range of the individuals. The goal of the speech spectrum based approach is to select frequency gain dimensions that place the long term average speech spectra at levels sufficiently above threshold to be useful across broadest possible frequency range.

The literature has shown that LTASS values vary from males to females (Mendozoo, Valencia, Munoz and Trujillo, 1996 and Byrne, 1977) from dialect to dialect (Byrne, 1977) and from language to language (Mc.Cullough, Tu and Lew, 1993; Byrne et al., 1994 and Jha, 1998). It also differs by levels of vocal effort (Pearson, Bennit and Fidell, 1977). One of recent studies (Byrne et aL, 1994) has considered the speech material used, reading procedure as the major variable affecting LTASS.

Need for the present study :

Long term average speech spectrum plays an important role in hearing aid selection and evaluation. It has several applications in various areas related to speech and hearing.

LTASS values have been reported by Western investigators, and the same values have been used for Indian population without taking into account, the existing differences between Indian and Western speakers' speech spectrum. Literature shows that LTASS varies across language and dialects. Hence, there is a need for deriving the LTASS values in Kannada Language.

Objectives:

The present study is an attempt to derive:

The long term average speech spectrum of Kannada language.

To compare the LTASS in Kannada language between adult males and adult females.

To compare LTASS in Kannada language between children and adults (as a group).

To compare LTASS between data obtained and Western data among adults.

To compare LTASS between the data obtained and Western data among children.

Chapter 2

Review of Literature

Speech spectrum has assumed a major role in rehabilitative audiology with its consideration in hearing aid characteristics, selection and gain prescription (Byrne, 1977). The speech spectrum, which gives a single estimate of a lengthy speech utterance, with its average properties is the long term average speech spectrum (Hawkins, 1993). The long term average speech spectrum (LTASS) is a direct measure of the mean sound pressure levels of speech as a function of frequency and provides a global representation of the acoustic characteristics of a continuous discourse (Cox and Moore, 1988).

Numerous and somewhat different representations of the long term spectra of speech are available in literature (Olsen, Hawkins and van Tassel, 1987). Various investigators have performed independent study of the Long Term Average Speech Spectrum and made different assumptions regarding the LTASS (Cox and Moore, 1988). The variations in these spectra may be due to the methodological variables.

Speech samples and procedures used in deriving LTASS :

Literature review shows that different investigators used different methods to derive LTASS. The speech samples and methodological variables viz., equipment, number of speakers, age, sex, distance of recording mic, azimuth of recording, procedure of derivation considered by various investigators are as follows:

Dunn and White (1940) in their classic study on LTASS have used a 2.5 minutes English passage from a local news paper. They recorded speech samples from 11 speakers (6 males and 5 females) with a calibrated mic positioned 30 cm away in front of the speaker's lips. Samples, 125 msec, in duration were taken at the rate of four samples per second, for a total of 600 samples for the entire 2.5 minutes passage. For analysis, the frequency range of interest was divided into bands, one octave wide below 500 Hz and ½ octave wide above that frequency. The r.m.s. pressure in each band was calculated for each 125 msec interval; these short interval r.m.s. values were integrated across all the sampled intervals for each talker. The long term estimate of speech was the result.

Niemoeller, Mc.Cormick and Miller (1974) measured the spectrum of spoken English at 1⁄3 - octave bands. They used news paper text and recorded the speech samples of 10 men, 10 women and six children in an anechoic chamber. The speech samples were electronically mixed with a 16 track tape recorder. After mixing, the resulting recordings were analysed in 1⁄3 octave bands and converted to spectrum levels.

Pearson, Bennit and Fidell (1977) reported sequential speech spectra for 42 men and 27 women at each of several levels of vocal effort. The subject had to repeat the passage "Joe took father shoe lunch eat, she was waiting at mylawn" for 10 seconds.

Byrne (1977) derived the LTASS of 30 Australian English Speakers (15 males and 15 females). He used a 2.5 minutes passage from a popular English Magazine. The speech samples were sequentially recorded with a mic positioned 16 inches in front of speakers mouth. The recordings were done onto a high quality tape recorder (Nagra IV-S-J) and analysed with a General Radio-Real - Time Analyser, Model -1921.

Berger, Klich and Milin (1982) measured the LTASS of 16 college fresh men (8 men and 8 women). The subjects had to speak the sentence "we misth is the odd joy shook chaps boot now do ev'ng few law" in two conditions. One recording was done in a sound treated room and other recording was done in a reverberant room. 1/3 octave band spectral analysis was done with FFT on a Burroughs 6800 computer.

Cox and Moore (1988) derived the average long term RMS 1/3 octave band speech spectra from 30 male and 30 female talkers. The subjects were made to read a two minute English passage from text of children's education reading source. The speech spectrum was analysed by a Signal Analyzer (Hewlett Packard, Model 3561 A) that digitally synthesized ANSI class III 1/3 octave band filters.

CorneUsse, Gagne and Seewald (1991) measured LTASS at two different recording positions: 30 cm directly in front of the talker (reference position), and at the tragus of the talker ear (ear-level position). 10 adult males (with mean age 24 years), 10 adult female (with mean age 24 years) and 10 children (with mean age 10 years 8 months) served as subjects. All had to read short segment of text taken from grade three reader. The LTASS was obtained by B & K signal analyzer.

Stelmachowicz, Mace, Kopun and Carney (1993) studied the long term and short term characteristics of speech. Speech samples of 30 mothers and 15 fathers were recorded at ear level of child in specific postural positions. The parents had to read a 2 minute abbreviated version of 'Sleeping Beauty'. The LTASS was derived by a real-time spectrum analyzer (Hewlett Packard, Model 3561 A).

Byrne, et al (1994) suggested a "Universal LTASS from 12 languages. English, Swedish, Danish, German, French, Japanese, Cantonese, Mandarin, Russian, Welsh, Singhalese and Vietnamese. Number of subjects varied from 19 to 32 in each language. All samples were analysed at N.A.L using B & K 2131 analyzer coupled to Tektronics computer to arrive at LTASS.

Jha (1998) derived LTASS in Hindi, an Indian language, from speech samples of 15 male and 15 female subjects. The subjects had to read a modified

Hindi text. The LTASS was derived by Vaglmi Software developed by Voice and Speech Systems, Bangalore.

We see from the above mentioned studies that each investigator used a different method for deriving LTASS. This could be a reason why the spectra of each investigator (which will be discussed later) are different. Though the spectra are similar in shape i.e., exhibiting more energy at low frequencies and less energy at high frequencies, there are significant differences at some frequencies in the average intensity levels. As we note some authors (Cornelisse et al., 1991; Stelmachowicz et al., 1993) have tried to account for postural positions, of talkers and listener (child). The studies varied in number of subjects considered.

Variables affecting LTASS :

The general shape of the spectrum may be altered somewhat depending upon the experimental variables used in a given study. Among the more salient variables are (1) age (Niemoeller et al., 1974) and sex (Niemoeller et al., 1974; Cox and Moore, 1988) of the talker (3) vocal effort (Pearson et al., 1977) and (4) level of recording (Cornelisse et at., 1991; Stelmachowicz et. al., 1993). Factors of lesser significance such as difference in (1) talkers - microphone distance (Dunn and White, 1940) and azimuth (Dunn and Fransworth, 1939, cited in Byrne 1977) assume importance only for extreme conditions.

The results of Stelmachowicz et aL's (1993) study showed that LTASS would be effected by postural positions. The typical spectral levels at the input to child's hearing aid microphone may be as much as 20 dB higher than those found in face to face adult conversation.

Speech spectrum by different investigators:

As stated earlier, the Long Term Average Speech Spectra obtained by various investigators showed large amount of variance, although the contour of spectra were similar. These differences were attributable to the variance in methods employed (Olsen et al., 1987).

The spectrum obtained by one of earlier investigators, Dunn and White (1940) is depicted in Figure 1. The spectrum shows maximum energy in the vicinity of 500 Hz that was largely the contribution of the first formant of voiced sounds. Above this region, the spectrum rolled off at roughly 9 dB/octave towards the high frequency region occupied mainly by the low energy noise of unvoiced consonants. This general spectral shape is characteristic of most published estimates of LTASS that followed Dunn and White study (Olsen et al., 1987).

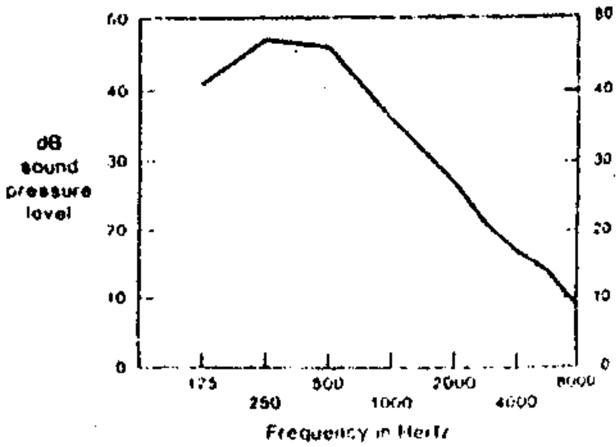

Figure 1 Speech spectrum obtained by Dunn and White (1940), adapted from OIsen et al.,(1987).

The spectrum obtained by Niemoeller et al. (1974) at 1/3 octave bands exhibited peaks and valleys appropriate to typical value of Fo, F1 and F3 for the each of three groups of males, females and children. The regions usually associated with F2 spans a dip between the F1 and F3 regions. The spectrum converted to ear drum level had 5-10 dB less intensity in band width of 1.7 to 4 kHz compared to maximum levels in the low frequency region. This region corresponds to F3 and friction components of speech.

Byrne (1977) obtained the sequential spectra of 15 males and 15 females from recordings in a sound treated room and reverberant room. He reported that ambient noise level and frequency did not affect speech analysis at 0.16 kHz and higher. The levels of female voice could not be analysed below this frequency as they were below ambient-noise level. For males, the energy concentration in spectrum was 57 dB at 0.08 Hz, 69 dB at 0.1 kHz and 5 dB at 0.125 Hz (in low frequencies). The LTASS was obtained at 0.25 Hz, 0.5 kHz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz. The data is represented in following Figure 2.

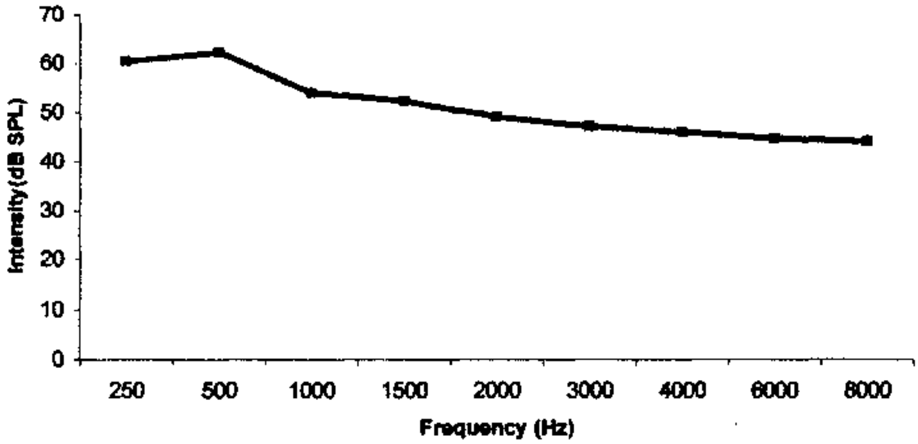

Figure 2 : LTASS obtained by Byrne (1977)

The individual spectra in Byrne's (1977) study differed considerably in their general shape. Also in contrast to the relative smoothness of the average spectra, the spectra for individuals typically showed marked peaks or valleys in certain frequency regions. The spectrum showed a marked decrease in level from 0.5 kHz to 1 kHz and a flat spectrum from 1 kHz to 8 kHz.

The LTASS obtained by Berger et al (1982) showed greatest energy around 500 Hz, which was similar to other estimates. The energy in spectrum gradually decreased towards the higher frequencies.

Byrne and Dillon (1986) have suggested a new "average speech spectrum which was expressed in critical band levels. This was incidentally necessitated some small adjustment in hearing aid selection procedure tables reported by Byrne and Tonnison (1976) and this spectrum differed slightly from that obtained by the previous, less exhaustive analysis. The new average critical band level for speech are shown in Table-1.

Table 1 : The new average critical band level for speech (Byrne and Dillon, 1986)

Frequency in kHz	0.25	0.5	1	1.5	2	3	4
Intensity in dB SPL	62	60	45	44	44	44	45

Recently, Cox and Moore (1988) have suggested a standard representation of the LTASS for use in the calculation of hearing aid gain-Figure 3 gives the LTASS derived by Cox and Moore (1988) for men and women. The average value was 70 dB SPL from a distance of 1 meter. The level of the LTASS decreased by approximately 5-6 dB per octave for the frequency bands between 500 and 4000 Hz. The male and female average spectra were essentially similar in the range from 400 to 5000 Hz. However, the small mean differences seen for the 800 and 1000 Hz, 1/3 octave bands were found statistically significant. The differences between male and female spectra were significant at 250 Hz and below.

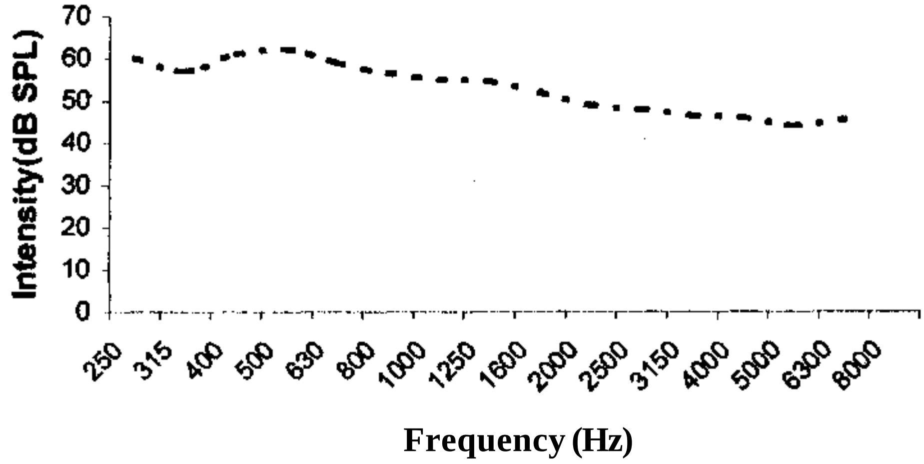

Figure 3: Standard representation of LTASS (Cox and Moore, 1988)

A "Universal LTASS" was recently proposed by Byrne et al, (1994) considering 12 languages. Figure 4 depicts the "Universal LTASS". The "Universal LTASS" had individual talker differences. The variability was more for bands above 4000 Hz. The LTASS value of individual language were not markedly different from universal LTASS. In most frequency bands, the intensity values for female's spectra were more than intensity values for male's spectra on an average of 2.9 dB. In Byrne et al.'s (1994) Universal Spectrum, the male-female differences were significant only at 800 Hz. For frequencies below 160 Hz male levels exceeded the female levels and for higher frequencies the female levels exceeded the male levels. The average difference between males and females was 2.6 dB with a range of 0.3 to 5.9 dB.

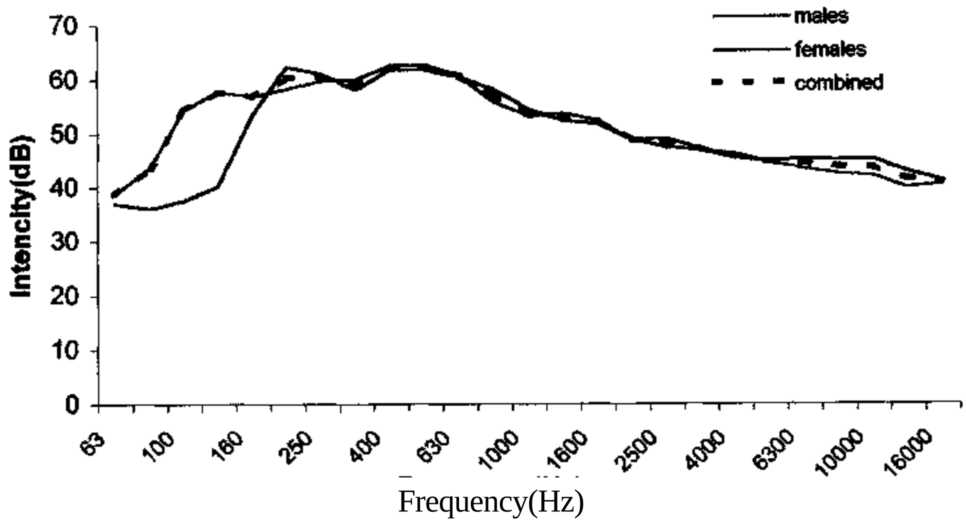

Figure 4: Universal LTASS (Byrne et al., 1994)

When individual language spectra were considered the following observations were made.

(i) New Zealand male and female speech was high by 3-6 dB from 5000 Hz and above.

(ii) Vietnamese male and female speech was low by 5-6 dB from 5000 Hz and above.

(iii) Arabic male and female speech was low by 5 dB at frequencies around 5000 Hz.

(iv) Japanese male speech was low by 3 dB around 2500 Hz.

(v) Cantonese male speech was high by 3-4 dB from 630 to 1250 Hz.

(vi) Australian female speech was high by 3-4 dB from 5000 Hz and above.

(vii) Memphis female speech was high by 3-4 dB from 1250 to 2000 Hz.

(viii) Russian female speech was high by 3-4 dB at 250 and 315 Hz.

(ix) Mandarin female speech was high by 3-4 dB from 2500 to 4000 Hz and

(x) Singhalese female speech was low by 3-5 dB from 4000Hz and above.

Byrne et al., (1994) hypothesized that vowels used in each of language and sibilant sound, frequency of occurrence may account for the variability.

Mc.Cullough, Tu and Lew (1993) compared English and Mandarin LASS. They found despite the well documented pitch contour differences between English and Mandarin, no significant difference existed in the LTASS.

The LTASS of Hindi obtained by Jha (1998) (Figure 5) showed maximum power of energy, concentrated between 156 Hz to 625 Hz., after which there was considerable decrease in intensity. The spectra of individual subjects differed considerably in their general shape. His findings showed no differences in the male and female spectra.

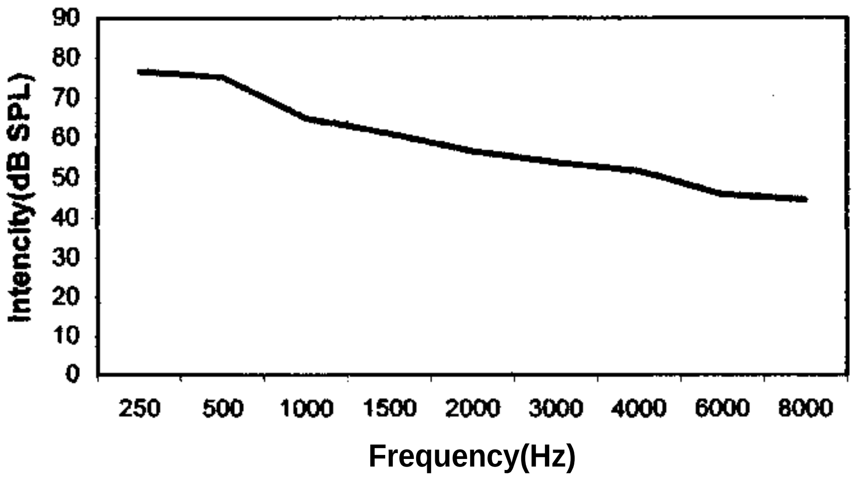

Figure 5 : LTASS in Hindi (Jha, 1998)

Review on Implications of Speech Spectrum in Amplification :

Speech spectrum has assumed increasing prominence in literature pertaining to hearing aid design, selection and evaluation. One of the primary goals of an amplification device is to present speech in comfortable listening level (Skinner, 1988). When we face difficulties in selection and evaluation of gain in pre-verbal children and behaviourally uncooperative subjects, LTASS based prescriptions are the best choice as there is a direct relationship between 1/3 octave band levels of LTASS algorithm used for gain and resulting sensation level of amplified speech (Cornelisse et aL, 1991).

As mentioned earlier substantially different spectra have been obtained for measurements made at different angles of incidence with respect to the talker and when influenced by variations in head/body diffraction effects. (Cornelisse et aL, 1991; Stelmachowicz et aL, 1993). These measurements were prompted by an interest in prescribing amplification for children and the recognition that speech is often presented from directions other than directly in front of the child.

Seewald, Ross and Stelmachowicz (1987) developed a hearing aid fitting strategy based on the relationship between the LTASS and the listeners thresholds. The major assumptions of their fitting strategy was that "... an electro-acoustic system capable of delivering an amplified speech signal that is sufficiently audible across the widest possible frequency range will allow for optimal use of residual hearing in speech perception". (Seewald and Ross, 1988). The goal was to select frequency gain characteristics that place the long term average speech spectrum at levels sufficiently above threshold to be useful across the broadest possible range. To accomplish this goal, Seewald and Ross (1988) have developed frequency specific estimates of the sensation levels at which amplified speech should be delivered. With these estimates, the attempt is to deliver as much of the speech spectrum as possible at levels sufficiently above threshold to be useful in speech perception, yet at the same time, to recognize the limitations of the reduced dynamic range. While this approach was developed primarily for the application to young, hearing impaired children, the rationale, assumptions and objectives of this strategy appear reasonable in terms of an adults' amplification needs (Loven, 1991). Similar real ear speech spectrum based selection and fitting was advocated by Loven (1991) where amplified LTASS was packed within the dynamic range of hearing impaired person.

Amplifying LTASS to desired target values :

As mentioned earlier several hearing aid selection schemes (Cox, 1985, 1988; Seewald 1988; Seewald and Ross 1988; Seewald, Ross and Stelmaehowicz, 1987; Skinner, 1988) have as their goal the amplification of the LTASS to desired target values within the residual dynamic range of the individual. For instance, Skinner (1988) suggested that the Long Term Speech Spectrum be amplified close to the most comfortable loudness levels. Cox (1985, 1988) proposed that the amplified speech spectrum bisect the long term listening range, which is defined as the area between auditory threshold and the upper limit of comfortable listening (ULCL).

Each of these selection strategies can be implemented with a probe tube microphone approach in which all of the measurements are defined as SPL in the ear canal. Cox and Alexander (1990) recently described such a procedure to verify the MSU - V3 (Cox, 1988) hearing aid selection procedure.

To explain briefly, the above procedure, the SPLs in the ear canal at the auditory thresholds are obtained with probe tube in the ear canal. Target values for the amplified speech spectrum in the ear canal are determined by adding the Desired Sensation Levels (DSL) to auditory thresholds, which have been expressed in SPLs in the ear canal. A hearing aid is then evaluated and adjusted so that a spectrum input is amplified and matches as clearly as possible to desired target levels as specified and measured in the ear canal.

Prescription of real ear gain have considered speech spectra a few among these are Prescription of gain/output of hearing aids (POGO) derived by Mc.Candless and Lyregaard (1983), Half- gain rule by Berger, Hagburg and Rane (1984) and NAL procedure by Byrne and Dillon (1986). All the above prescriptive techniques used the Pascoe speech spectrum except the Byrne and Dillon's (1986) procedure.

The review of literature state different standard speech spectra and suggests that more gain is needed for the higher frequencies in comparison to lower frequencies. Also the higher frequency contains intelligibility of speech. There might be differences in Indian and Western speakers LTASS values and that will lead to differences in required gain for any individual. So there is a need to derive LTASS in Kannada to see the differences for consideration of use of some Western spectra or a different one for hearing aid gain and selection and evaluation.

Speech spectrum for counseling :

A plot of a speech spectrum on an audiogram along with sound field thresholds obtained with the patient wearing a given bearing aid arrangement can demonstrate the portion of the speech spectrum made audible by the hearing aid. Adjustment then can be made to shape the amplified spectrum so it is maintained within a comfortable listening region for the patient (Olsen et al., 1987).

Speech spectrum can also be used for counseling patients. A transparency with *a.* speech spectrum plotted on it and sized to the audiogram obtained for a given patient can be used. With such overlays, the patient can 'see' and understand better some of the communication difficulties associated with hearing losses of various degrees and configurations. Without knowledge of the shape and intensity of the long-term speech spectrum, pure tone thresholds actually mean very little to the patient. Placing the transparency over an audiogram showing thresholds obtained without and with hearing aid clearly demonstrates that portion of the speech spectrum not heard without the amplification but made audible by a given hearing aid. Thus, it can help in counseling when plotted on audiogram format.

Chapter 3

Method

The following methodology was adapted to derive the long term average speech spectrum in Kannada language. Kannada is a Dravidian language used in the state of Karnataka.

1. Selection of subjects :

Two groups of subjects were taken for the study. Group I consisted of adults, in age range of 15-45 years, which was further sub-divided into Group I-A consisting of 15 males and Group I-B consisting of 15 females. Group II consisted of 15 children in age range of 8-10 years. The two groups of 45 subjects satisfied the following criteria:

(i) All were native speakers of Kannada language,

(ii) Each subject had normal speech and hearing,

(iii) All subjects could read the Kannada script.

2. Speech material:

A Kannada passage, running for 60-90 seconds, which represented all phonemes in the language, was developed [Appendix l-b (in phonemic transcription); Appendix l-a(in Kannada)]. The passage consisted of a story derived from I standard text book (state syllabus) with simple and compound sentences without any emotional context. The linguistic complexity of the passage was made in such a way that, both children and adults could read it.

3. Equipment:

The speech samples were recorded using a Mini Digital Disc recorder (Sony Portable Mini Disc recorder, MZ- R70) with an external microphone Sony Dynamic Mic - F- 500.

To derive LTASS, a computer software programme — "Audio Lab" was used which is a custom made software, developed by Voice and speech systems, Bangalore in collaboration with All India Institute of Speech and Hearing, Mysore.

4. Test environment:

The speech sample recording was done in a sound treated room.

5. Procedure (Recording and Analysis):

- The subjects were made aware of the nature of experiment.
- The subjects were instructed to read the passage silently first and aloud towards the end of passage, for familiarity, before recording.
- They were instructed to read the passage with normal vocal effort and minimal pausing.
- They were instructed to read continuously even if they realized that they have made an error.
- The distance of the microphone from the speaker was 8-10 inches and monitored, such that the V.U meter reading in the recorder was at 3 units.
- The recorded samples were represented as tracks in the mini-disc. These were digitized and stored on a computer hard disc.
- The recording in the computer was done with 16 Bit -mono setting.

- The inter-phrasal, inter-word and inter-syllabic pauses were edited out (deleted) using the wave editor provision of the "Audio lab" software programme.
- The resultant wave was manually analysed using the LTASS programme of "Audio lab" software to record the intensity levels at octave/mid octave frequencies such as 246 Hz, 496 Hz, 746 Hz, 996 Hz, 1496 Hz, 2996 Hz, 3995 Hz, 5995 Hz, 7994 Hz and rounded off to the audio - metric frequencies.
- The LTASS was displayed in intensity (dB SPL) Vs frequency (Hz) scale. A cursor was provided to read the dB value at any desired frequency. Figure 6 depicts the LTASS of a subject.

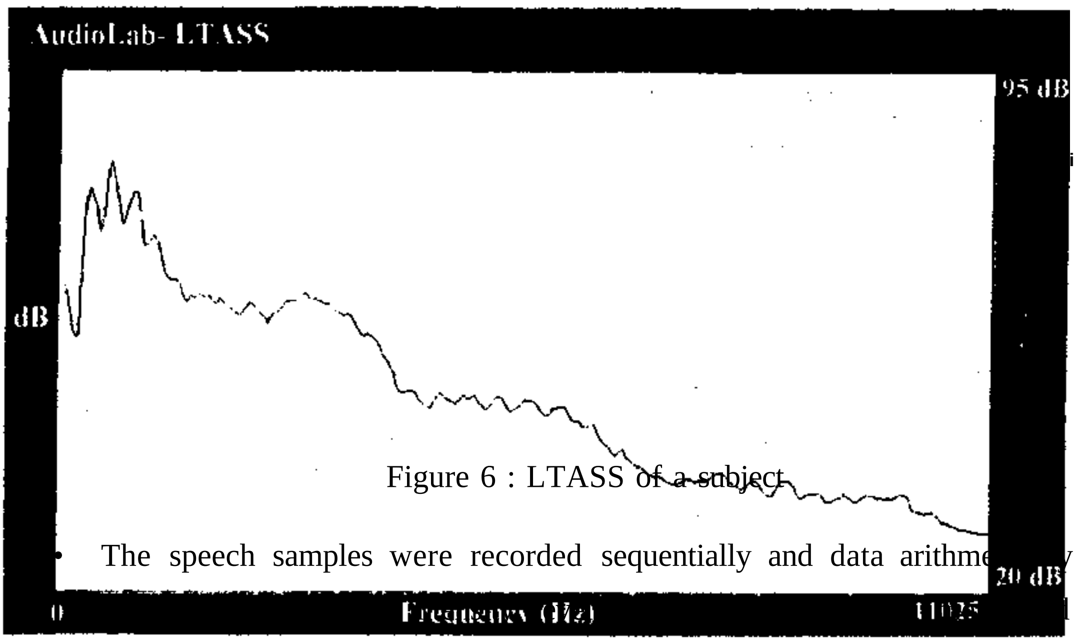

Figure 6 : LTASS of a subject

- The speech samples were recorded sequentially and data arithme
frequency was calculated.

6. Statistical analysis :

- The obtained data from LTASS were tabulated separately for males (Group I-A), females (Group-B) and children (Group II).
- The data for each group showed the dB, intensity level at octave/mid-octave frequencies from 250 Hz to 8 kHz.
- The data of each group was subjected to statistical measure of mean and standard deviation.
- The inter group mean difference and significance of mean difference was measured by independent Sample T-test.

Chapter 4

Results and Discussion

The study was carried out with an aim of deriving Long Term Average Speech Spectrum in Kannada language and note the differences, if any, existing between the spectra of males, females and children as a group and comparing the results with western data.

Long term average speech spectrum was derived from 45 subjects who were categorised into 2 groups (Group IA-adult males, Group IB adult females, Group II-children). The intensities, in dB SPL, were noted at octave/ mid octave frequencies and averaged. The results of the present study are as follows:

Table 2 shows the Mean and Standard Deviation values of intensity levels in dB SPL at audiometric frequencies (octave/mid octave) for Group IA, IB and Group II. Table 3 shows the Mean and Standard Deviation of dB intensity levels of Group I and the combined spectrum for 45 subjects in Kannada. The spectra of each group and combined spectrum are shown in Figure 7. Figure 8 depicts the LTASS of Kannada.

Table 2: Mean and Standard Deviation values of intensity levels in dB SPL across frequency (octave/ mid octave) for each of the groups.

Frequency (Hz)	GROUP IA (N=15)		GROUP IB (N=15)		GROUP II (N=15)	
	Mean	SD	Mean	SD	Mean	SD
250	70.50	3.26	73.29	5.35	53.79	5.11
500	80.9513	1.90	79.27	4.61	67.83	6.06
750	70.88	3.14	72.86	2.41	73.22	4.94
1000	59.84	3.24	62.45	4.38	68.79	4.90
1500	60.60	2.48	62.02	3.66	59.45	9.05
2000	57.42	1.92	58.22	2.96	57.49	3.93
3000	52.95	2.85	57.34	2.95	59.50	5.15
4000	50.53	4.87	46.76	5.58	45.11	5.23
6000	43.31	3.38	41.96	5.18	41.33	3.90
8000	39.30	4.29	39.44	4.86	34.69	2.47

Table 3 : Mean and Standard Deviation values of intensity levels in dB SPL across frequencies (octave/mid octave) for Group I (adults) and combined LTASS.

Frequency (Hz)	Group I (N=30)		Combined (N=45)	
	Mean	SD	Mean	SD
250	71.90	4.58	63.88	9.83
500	80.11	3.57	74.08	7.37
750	71.87	2.93	70.75	3.72
1000	61.15	4.01	62.36	5.61
1500	61.37	3.16	59.42	5.78
2000	57.82	2.48	56.62	3.00
3000	55.13	3.63	55.45	4.63
4000	48.65	5.48	46.70	5.60
6000	42.63	4.35	41.40	4.20
8000	39.37	4.50	36.97	4.50

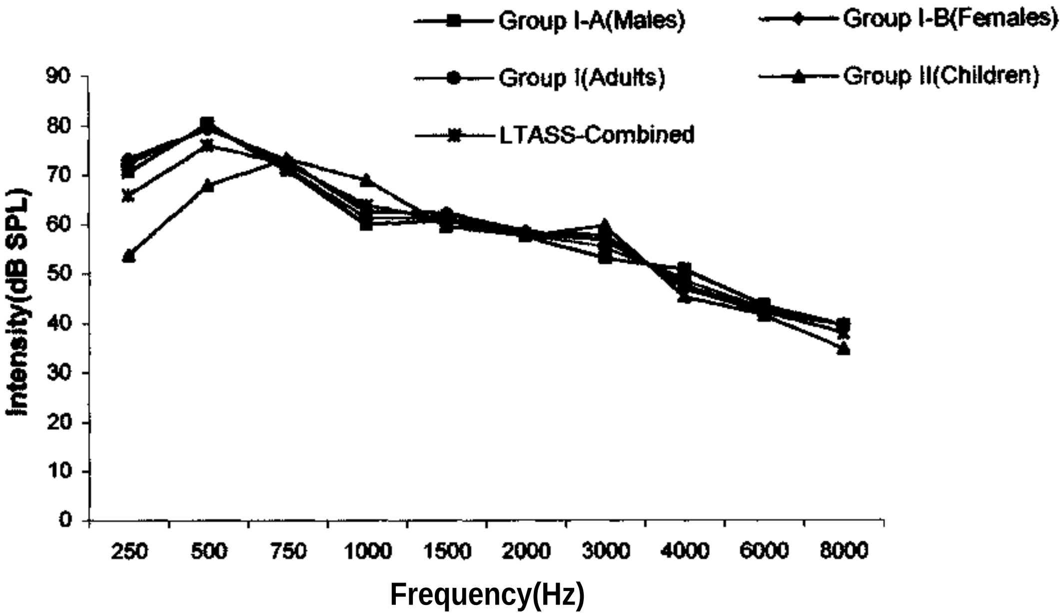

Figure 7 : LTASS of Group I, I A, IB and Group II and Combined

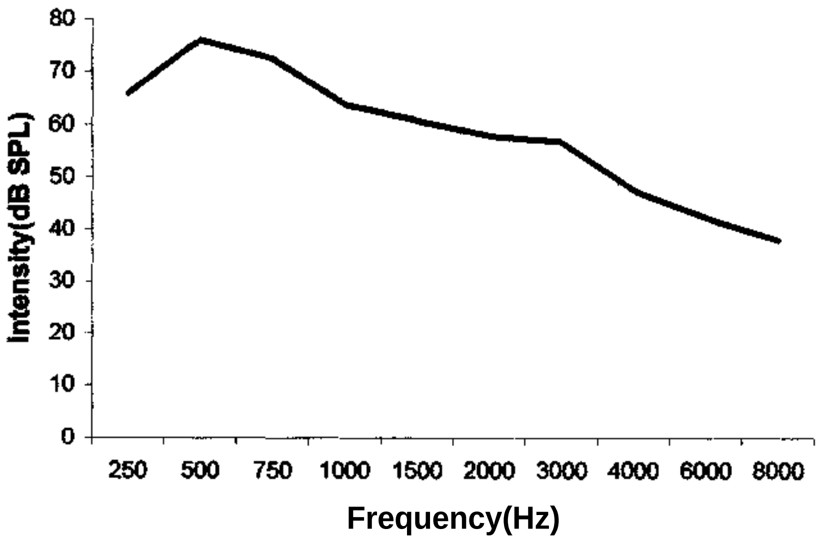

Figure 8 : LTASS in Kannada

The over all contour of the spectrum showed peaks and valleys corresponding to intensity values at different frequencies. The combined spectrum was relatively more smooth than individual spectra. The maximum power energy occurred at 500 Hz, after which there was considerable decrease in mean intensity level. The mean intensity drop was such that at 8000 Hz, the level was approximately 30 dB below the maximum, measured at low frequencies. The intensity increased from 250 Hz to 500 Hz. The drop in mean intensity was as follows.

500 Hz to 1 kHz	-	12.32 dB SPL
1 kHz to 2 kHz	-	5.98 dB SPL
2kHzto4kHz	-	1.13 dB SPL
4kHzto8kHz	-	9.66 dB SPL

This shows that intensity drop was more between 500 Hz and 1 kHz and at higher frequencies. The spectrum was relatively flat in mid frequencies.

The average spectra of Group IA (male talkers) Figure 7, showed similar contour with maximum power of energy at 500 Hz. In individual spectra the maximum energy was variable between 500 Hz and 750 Hz. There was a drop in intensity levels after the maximum. The average spectrum of Group IA was relatively smoother compared to individual spectra. The drop in intensity was such that at 8 kHz the intensity was 30-35 dB below peak intensity. The drop in mean intensities above 500 Hz was as follows :

500 Hz-1 kHz	-	21.11 dB SPL
1 kHz-2 kHz	-	2.42 dB SPL
2kHz-4kHz	-	6.89 dB SPL
4 kHz-8 kHz	-	11.23 dB SPL

This shows that intensity drop was more between 500 Hz and 1 kHz and between 4 kHz and 8 kHz with relatively less drop in mid frequencies. The spectrum of Group IA mimics the combined average spectrum.

The average speech spectrum of Group IB (females) is shown in Figure 7. It showed similar findings with maximum power of energy at 500 Hz. The average spectrum was smoother than individual spectra. The intensity level rose between 250 Hz to 500 Hz. This was about 14.04 dB SPL. From 500 Hz onwards there was a drop as follows.

500 Hz - 1 kHz	-	16.82 dB SPL
1kHz-2kHz	-	4.23dBSPL
2kHz-4kHz	-	11.46dBSPL
4 kHz-8 kHz	-	7.32 dB SPL

The average speech spectrum of Group I (adults), depicted in Figure 7, showed maximum energy at 500 Hz. The drop in intensity across frequencies from peak was prominent in between 500 Hz and 1 kHz. The intensity at 8 kHz was approximately 40 dB lower than the maximum at 500 Hz. Inter subject variability was more in frequencies 250 Hz, 4000 Hz, 8000 Hz. The inter-subject variability was less at 500 Hz. The roll off in intensities was as follows:

500 Hz-1 kHz	-	18.96 dB SPL
1 kHz-2 kHz	-	6.02 dB SPL
2 kHz-4 kHz	-	9.17 dB SPL
4 kHz-8 kHz	-	9.28 dB SPL

The average speech spectrum of Group II (children) depicted in Figure 7 is slightly different from the spectrum of Group I. For Group II the maximum power of energy was concentrated at 750 Hz and only a slight drop in intensity till 1 kHz and gradual decrease from there till 8 kHz was noted. The intensity at 8 kHz was 38.53 dB below the peak intensity at 750 Hz. The drop in intensity was as follows:

750 Hz - 1 kHz	-	4.43dBSPL
1 kHz - 2 kHz	-	11.3 dB SPL
2kHz-4kHz	-	12.38 dB SPL
4 kHz - 8 kHz	-	10.42 dB SPL

It was noted that the intensity drop in Group II spectrum was pronounced and much more than that of Group I. The intensity drop started from 750 Hz.

Inter-group differences:

The inter-group differences were tested by subjecting data of the groups to Independent, Sample T-test. Table 4, 5, 6 show the comparison between Group IA- Group IB, Group IA- Group II, Group IB- Group II, and Group I - Group II respectively.

Comparison between Group IA and Group IB (Table 4) shows that the average of the male spectrum and average of the female spectrum were not significantly different. There were no significant differences at octave and mid octave frequencies, except at 3000 Hz ($p<0.05$). Where as, Group IB (females) spectrum showed higher intensity level than Group IA (male) spectrum. Hence, the Group IA and IB can be considered as a single group (i.e., Group I).

Table 4 : Showing T test values and significance of mean difference for Group IA and Group IB

Frequency (Hz)	Group IA (N=15)		Group IB (N=15)		T value	Significance
	Mean	**SD**	**Mean**	**SD**		
250	70.50	3.26	73.29	5.35	-1.722	0.96
500	80.95	1.90	79.27	4.61	1.298	0.205
750	70.88	3.14	72.86	2.41	-1.934	0.63
1000	59.84	3.24	62.45	4.38	-1.849	0.075
1500	60.60	2.48	62.02	3.66	-1.241	0.225
2000	57.42	1.92	58.22	2.96	-0.885	0.383
3000	52.91	2.85	57.34	2.95	-4.181	0.000 *
4000	50.53	4.87	46.76	5.55	1.974	0.058
6000	43.31	3.38	41.96	5.18	0.847	0.404
8000	39.30	4.29	39.44	4.86	-0.821	0.936

indicates significance level at $p < 0.05$

When spectra of Group 1A and Group II (children) were compared, there were significant differences in intensity levels at 250 Hz, 500 Hz, 1 kHz, 3 kHz, 4 kHz and 8 kHz with intensity levels being more for Group IA at 250 Hz, 500 Hz, 1 kHz, 3 kHz, 4 kHz and 8 kHz. The intensity levels of Group II were more at lHz and 3 KHz (Table 5)

Table 5 : Showing T test values and significance of mean difference for Group IA and Group II

Frequency (Hz)	Group IA (N=15)		Group II (N=15)		T value	Significance
	Mean	SD	Mean	SD		
250	70.50	3.26	53.79	5.11	-10.662	0.000 *
500	80.95	1.90	67.83	6.06	-7.995	0.000*
750	70.88	3.14	73.22	4.94	1.544	0.134
1000	59.84	3.24	68.79	4.90	5.897	0,000 *
.1500	60.60	2.48	59.45	9.05	-0.476	0.638
2000	57.42	1.92	57.49	3.93	0.065	0.948
3000	52.95	2.85	59.50	5.15	4.332	0.000 *
4000	50.53	4.87	45.11	5.23	-2.933	0.007 *
6000	43.31	3.38	41.33	3.90	-1.488	0.148
8000	39.30	4.29	34.69	2.47	-3.600	0.001 *

* indicates significance level at $p < 0.05$

When spectra of Group IB (females) and Group II (children) were compared (Table 6), there were significant differences in intensity levels at 250 Hz, 500 Hz, 1 kHz, and 8 kHz with intensity level of Group IB being more at 250 Hz, 500 Hz, and 8 kHz. Group II, intensity level was high, comparitively at 1 kHz.

Table 6 : Showing T test values and significance of mean difference for Group IB and Group II

Frequency (Hz)	**Group IB (N-15)**		**Group II (N=15)**		**T value**	**Significance**
	Mean	**SD**	**Mean**	**SD**		
250	73.29	5.35	53.79	5.11	-10.198	0.000 *
500	79.27	4.61	67.83	6.06	-5.815	0.000 *
750	72.86	2.41	73.22	4.94	0.249	0.805
1000	62.45	4.38	68.79	4.90	3.737	0.001 *
1500	62.02	3.66	59.45	9.05	-1.020	0.316
2000	58.22	2.96	57.49	3.93	-0.576	0.569
3000	57.34	2.95	59.50	5.15	1.405	0.171
4000	46.76	5.58	45.11	5.23	-0.836	0.410
6000	41.96	5.18	41.33	3.90	-0.376	0.710
8000	39.44	4.86	34.69	2.47	-3.370	0.002 *

* indicates significance level at $p < 0.05$

Comparison of spectra of Group I and II (Table 7) showed significant differences in the mean intensity levels at 250 Hz, 500 Hz, 1 kHz, 3 kHz, and 8 kHz. The mean intensity levels of Group I were comparitively more at 250 Hz, 500 Hz, and 8 kHz and comparitively less at 1 kHz and 3 kHz.

Table 7 : Showing T test values and significance of mean difference for Group I and Group II

Frequency (Hz)	Group I (N=30)		Group II (N=15)		T value	Significance
	Mean	SD	Mean	SD		
250	71.90	4.58	53.79	5.11	-12.02	0.000 *
500	80.11	3.57	67.83	6.06	-8.56	0.000 *
750	71.87	2.93	73.22	4.94	1.146	0.258
1000	61.15	4.01	68.79	4.90	5.595	0.314
1500	61.31	3.16	59.45	9.05	-1.019	0.733
2000	57.82	2.48	57.49	3.93	-0.343	0.002*
3000	55.13	3.63	59.50	5.15	3.298	0.045 *
4000	48.65	5.48	45.11	5.23	-2.067	0.054
6000	42.63	4.35	41.33	3.90	-0.981	0.332
8000	39.37	4.50	34.69	2.47	-3.733	0.001 *

* indicates significance level at $p < 0.05$

The results of comparison thus showed that the spectra of males and females were similar and the spectrum of children was very different from both male and female spectra and spectrum of adults (combined male and female spectrum). The comparison revealed that Group II spectrum had a greater intensity drop across frequency and had maximum energy at 750 Hz compared to Group I, which has maximum energy at 500 Hz.

The results are in coherence with that of the Western studies (Dunn and White, 1940; Cox and Moore, 1988 and Byrne et al 1994). The maximum power of energy is located around 500 Hz, which is largely contributed by the first formant of voiced sounds. The rapid roll off of intensity between 500 Hz and 1 kHz was also noted in the spectra of Byrne (1977), Dunn and White (1940), Cox and Moore (1988) and Byrne et al (1994). It was observed by Cox and Moore, (1988) that the 1/3 octave band levels of the LTASS decreased by approximately 5 to 6 dB per octave for the frequency bands between 500 Hz and 4000 Hz. The maximum power of energy in Group II spectra was located at around 750 Hz. This could be due to shift in formant frequencies with shortening of the vocal tract. This reasoning is supported by Niemoeller et al (1974). The observed rapid roll off in intensity in the spectrum of Group II, can be attributed to hypothetically less use of sibilant and high frequency sounds by children.

The spectra for individual talkers showed substantial variations. The standard deviation of individual variations from the mean value at each frequency for males and females show less variation at around 500 Hz. This is because most of them have their first format around this region. The high variability in other regions can be attributed to individual differences in the vocal tract shape and locations of constrictions for articulatioa It is stated that acoustic variability is brought about by both fundamental frequency and variation in vocal tract transfer function (Ladefogged, and Maddison, 1996).

The results of inter-group comparison show that male and female spectra differed significantly around 3000 Hz. This finding is similar to the findings in Japanese and Mandarin spectra obtained by Byrne et al (1994). Some previous investigations have found higher overall level, typically 2-3 dB, for male than for female voices (Benson and Hirsh, 1956; Byrne, 1977, Pearson et aL, 1977, Cornilesse, 1991). The results of current data did not show **a** significant difference although small mean differences existed. Some of the studies, which showed similar findings are that of Pavolic, (1989), Byrne et al (1994) and Jha (1998).

In the current study the spectra of Group II (children) showed lower energy levels at low frequency when compared to Group I (adults), but relatively high power of energy was noted at 1 kHz for children, which was statistically significant. The reasons for such findings are unclear. The difference could be due to results based on limited data (N=15) for Group II. However, since significant differences occurred between the spectra of children and adults, a thorough investigation into LTASS of children with a larger data can be attempted. In view of the important role, the process of auditory self-monitoring plays for children who are learning to produce oral language (Fry, 1978), we must be equally concerned with the spectrum characteristics associated with the child's speech. In light of this view, the current study took children as subjects.

Comparison with results of previous investigations :

The combined Mean LTASS of Kannada and LTASS of Group I obtained at octave and mid octave frequencies is plotted in Figure 9. For comparison the LTASS reported by Cox and Moore (1988), Byrne et al (1994), Comilesse (1991) and Jha (1998) are also plotted.

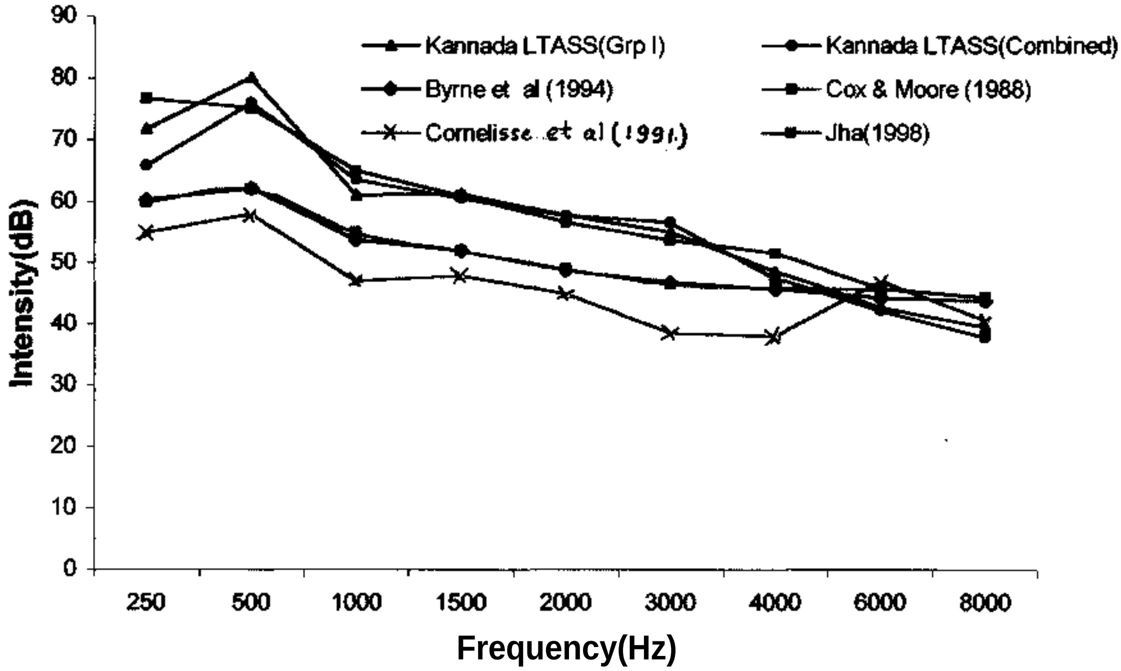

Figure 9 : Comparative chart of Long Term Average Speech Spectra

On broad inspection of the spectra, it is evident that the Kannada spectrum has more power of energy at almost all frequencies than the western spectra. The spectrum of Hindi (Jha, 1998) is also having high intensity levels, compared to Western spectra. The Kannada spectrum in comparison with other spectra shows more differences in the low frequency region. The difference between Hindi and Kannada spectrum, as compared to differences between Kannada and Western spectrum, are less pronounced. The intensity drop is more in Kannada spectrum compared to other spectra. The spectra reported by Byrne et. al, (1994), Cox and Moore (1988) and Cornelisse et al (1991) show relatively flat contour at mid frequencies. The spectrum obtained by Cornelisse et al (1991) is relatively lower in intensity levels as compared to spectrum of Byrne et al (1994) and Cox and Moore (1988). This may be because of inclusion of

On the whole, the Kannada spectrum is higher in intensity level than spectra of previous investigations. This may be because of three reasons. One being that Kannada like any other Indian language has more long vowel usage as compared to the English which have more of short vowel usage. The relative occurrence of long vowels in Kannada is more, which contribute to more intensity. Secondly, the frequency of phoneme occurrence may determine the differences. Finally, the difference may be attributed to procedural variations, such as, distance of recording. The current study was carried out at a distance of 8-10 inches with the V.U. meter being monitored. The difference in vocal effort may also contribute to this finding (Byrne et aL, 1994). But the overall spectral shape is well within prediction i.e., more energy at low frequencies and less energy at high frequency. The differences in levels between different spectra can be compensated by adjusting the volume of the hearing aid.

Implications of current study :

The results of current study i.e., LTASS of Kannada language, has major implications in hearing aid selection and evaluation. The current study showed minor difference between spectrum of Kannada and English, the difference is more in terms of levels and less in spectral shape. The difference in levels could be compensated by volume alterations in the hearing aid. The hearing aid prescriptive formulae are generally based on assumptions about the particular level and shape of the Long Term Average Speech Spectrum used to derive the formula. Since the spectral configuration is similar, we do not require any change or alterations in the prescriptive procedures for hearing aid selection. Differences in the speech spectrum input at the microphone of a hearing aid may cause different processing to occur, depending on the algorithm incorporated in the circuitry (Agnew, 1999). The minor differences in level of the spectrum may not cause large variations. Since the Kannada speech spectrum is similar in shape, with the western spectra not much variability can be expected in hearing aid processing.

The present study's speech spectrum supports the earlier investigation that energy concentration was more at lower frequencies than at high frequencies. At frequencies below 1 kHz, less gain should be provided than at higher frequencies because of the above fact.

The current study also supports the notion that excessive low frequency amplification would result in low frequency regions, speech signal being delivered a level where it would tend to mask the lower energy higher frequency parts of the speech signal. It is known that high frequency region of speech though not redundant with respect to acoustic information, does provide the cues necessary for speech perception. This has to be viewed with respect to low energy concentration at high frequency region of Kannada speech spectrum. It warrants more gain prescription at high frequency regions than low frequency region.

Thus speech spectrum in Kannada can be used, keeping in mind its similarities with the Western spectra. Along with this the spectrum can be used in counseling patient regarding their hearing loss and which part of speech energy is not reaching them. Speech spectrum based hearing aid selection evaluation makes the process of amplification provision easy for child cases.

Since overall shape of spectra is similar to that in Western studies, and the spectra (in Kannada and in other reviewed studies) differed only in levels, this can be compensated by adjustment of volume of the hearing aid output.

Chapter 5

Summary and Conclusion

The present study was concerned with the derivation of long term average speech spectrum in Kannada language. The review revealed slight variations in the spectrum, though overall shape of spectrum were similar. Long term average speech spectra were derived for various languages and used for hearing aid selection prescription procedures. Hypothesizing a variation in Kannada spectrum from Western spectra and bearing in mind its significance in amplification, the current study was attempted.

To obtain a reliable measure of the Long Term Average Speech Spectrum, 45 subjects including males, females and children were taken. The spectra were derived with a custom-built software programme "Audio Lab". The results showed no significant variation of the male and female talker's spectra, but children spectra was slightly lower. The combined spectra proposed was in coherence with that reported in earlier studies in Western and Indian literature with more energy at low frequency and less energy towards high frequencies. The spectrum obtained had slightly higher level than Western spectrum especially at low frequencies.

The present study throws light on the similarities of speech spectrum of Kannada and Western spectra and implies its consideration in Hearing Aid selection, amplification and counseling.

Since there are slight differences between Western and Indian speakers, there is a further need of developing language specific spectra or a Universal Indian Spectra of all the languages for use in Hearing Aid technology.

Suggestions for future research :

- Universal Indian language speech spectrum could be developed from all official languages for use in developing Articulation Index and use in Hearing Aid selection and evaluation.
- Long Term Average Speech Spectra could be derived and compared for Dravidian and Indo-Aryan languages.
- LTASS could be derived taking more number of subjects in each group
- LTASS could be derived for the hearing impaired as there is **a** critical role that auditory self-monitoring plays for children who are in the language learning process.

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Appendix I-a

ಸುಳ್ಳಿನ ಫಲ

ಒಂದು ಹಳ್ಳಿಯಲ್ಲಿ ಒಬ್ಬ ಕುರುಬ ಹುಡುಗ ವಾಸವಾಗಿದ್ದನು. ಅವನು ಮುಂಜಾನೆಯೇ ಕಾಡಿಗೆ ಹೋಗಿ ಅಲ್ಲಿಯೇ ಝುರಿಯಲ್ಲಿ ಸ್ನಾನಮಾಡಿ ಸಂಜೆಯವರೆಗೆ ಕುರಿಯನ್ನು ಮೇಯಿಸಿ, ಸಂಜೆ ಹಳ್ಳಿಗೆ ವಾಪಸಾಗುತ್ತಿದ್ದ. ಒಮ್ಮೆ ಅವನು ಕುರಿ ಮೇಯಿಸುವಾಗ ಇದ್ದಕ್ಕಿದ್ದಂತೆಯೇ ಹತ್ತಿರದ ಹೊಲದಲ್ಲಿ ಕೆಲಸ ಮಾಡುತ್ತಿದ್ದ ರೈತರನ್ನು ತಮಾಷೆ ಮಾಡಬೇಕು ಎಂದುಕೊಂಡ. ಅಂತೆಯೇ ಅವನು ಎಅಯ್ಯೋ ! ಹುಲಿ ! ಹುಲಿ! ಕಾಪಾಡಿ ಎಂದು ಕೂಗತೊಡಗಿದ. ಇದನ್ನು ಕೇಳಿದ ರೈತರು ಖಡ್ಗಗಳನ್ನು ತೆಗೆದುಕೊಂಡು ಹುಲಿಯನ್ನು ಕೊಲ್ಲಲು ಸಿದ್ದರಾಗಿ ಓಡಿಬಂದರು. ಇದನ್ನು ನೋಡಿದ ಹುಡುಗ ನಕ್ಕುಬಿಟ್ಟ. ರೈತರು ಕೋಪಗೊಂಡು ವಾಪಸಾದರು. ಹುಡುಗ ಇದೇ ರೀತಿ ಐದಾರು ಬಾರಿ ಮಾಡಿದ. ರೈತರು ಆ ಹುಡುಗನ ಮೇಲಿನ ನಂಬಿಕೆ ಕಳೆದುಕೊಂದರು.

ಒಮ್ಮೆ ಸುಮಾರು ಹನ್ನೆರಡು ಘಂಟೆ, ಬಿಸಿಲು ತಾಳಲಾರದೆ ಹುಡುಗ ಛತ್ರಿಯನ್ನು ಹಿಡಿದು ಕುಳಿತ್ತಿದ್ದ. ಇದ್ದಕ್ಕಿದ್ದಂತೆ ನಿಜವಾಗಿಯು ಠಕ್ಕಹುಲಿ ಬಂದೇ ಬಿಟ್ಟಿತು. ಹುಡುಗ ಮತ್ತೆ ಕಾಪಾಡಿ ! ಕಾಪಾಡಿ ! ಎಂದು ಚೀರಿದ. ಆದರೆ ಯಾರೂ ಸಹ ಅವನ ಸಹಾಯಕ್ಕೆ ಬರಲ್ಲಿಲ್ಲ. ಹುಲಿಯು ಅವನ ಸಣ್ಣ ಸಣ್ಣ ಕುರಿಗಳನ್ನು ಕೊಲ್ಲಲಾರಂಭಿಸಿತು. ಅದನ್ನು ಕಾಪಾಡಲು ಹೋದ ಆ ಹುಡುಗನ ಮೇಲೆ ಆ ಹುಲಿ ಹಾರಿ, ಅವನನ್ನು ಕೊಂದಿತು. ಈ ಕಥೆಯ ನೀತಿ ಏನೆಂದರೆ, "ಸುಳ್ಳುಗಾರನಿಗೆ ಶಿಕ್ಷೆ ತಪ್ಪದು".

Appendix I-b

Suḷḷina Pʰala

Ondu haḷḷijalli obba kuruba huḍuga vasava:giddanu avanu prati nitjavu: kurigaḷannu me:isalu ka:ḍige ho:guttiddanu. avanu mundza:neje: ka:ḍige hogi allije dʒʰarijalli sna:nama:ḍi sandzevarage kurijannu me:isi, sandze haḷḷige va:pa:sa:guttidda. Omme avanu kuri meisuva:ga iddakkiddahteje hattirada holadalli kelasa maḍuttidda raitarannu tamaʃe ma:ḍabeku endukonḍa. anteje: avanu ajjo:! huli! huli! ka:pa:ḍi endu ku:gatoḍagida idannu keḷida raitaru kʰadgagaḷannu tegedukonḍu hulijannu kollalu siddava:gi O:ḍibandaru. idannu noḍida huḍuga nakkibiṭṭa. raitaru kopagonḍu va:pa:sa:daru. huḍuga ide ri:ti aidar:ru ba:ri ma:ḍida. raitaru a:huḍugana melina nambike kaḷedukonḍaru. Omme Suma:ru hanneraḍu gʰanṭe, bisilu ta:ḷala:rade huḍuga tʃʰatrijannu hiḍidu kuḷittidda. iddakkiddante nidʒava:giju ṭʰakkahulli bande: biṭṭitu huḍuga matte kapa:ḍi! ka:pa:ḍi! endu tʃi:rida. a:dare ja:ru saha avanu saha:jakke baralilla. hulju avanu saṇṇa saṇṇa kurigaḷannu kollalaranbʰisitu. adannu ka:pa:ḍalu ho:da a: huḍugana mele a: huli hari, avanannu konḍitu. i: katʰeja ni:ti janandare "Suḷḷuga:ranige ʃikʃe tappadu"