A Comparison of Voice Characteristics in Congenital Visual Impaired and Normal Sighted Primary School Teachers

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Dedicated to Mamaiah, Amma, Ammama, Thathayya and My guide

CERTIFICATE

This is to certify that the dissertation entitled ***"A Comparison of Voice Characteristics in Congenital Visual Impaired and Normal Sighted Primary School Teachers***" is a bonafide work submitted in part fulfilment for the degree of ***Master of Science (Speech-Language Pathology)*** of the student Registration No. 10SLP013. This has been carried out under the guidance of a faculty of the institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that the dissertation entitled "***A Comparison of Voice Characteristics in Congenital Visual Impaired and Normal Sighted Primary School Teachers***" has been prepared under my supervision and guidance. It is also certified that it has not been submitted earlier to any other University for the award of any Diploma or Degree.

Guide

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DECLARATION

This dissertation entitled "***A Comparison of Voice Characteristics in Congenital Visual Impaired and Normal Sighted Primary School Teachers***" is the result of my own study under the guidance of Ms. K.Yeshoda, Lecturer in Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other university for the award of any Diploma or Degree.

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CHAPTER I

INTRODUCTION

Voice, the vehicle of speech is the primary instrument through which most of us project our professionalism and influence our listeners. *It is the musical sound produced by the vibration of the vocal cords in the larynx by air from the lungs. "Voice plays the musical accompaniment to speech rendering it tuneful, pleasing, audible and coherence being essential to efficient communication by the spoken word", (Greene, 1964).*

"It is increasingly being realized that a substantial section of our population vocalizes for long periods of time to earn their livelihood", (Titze & Sundberg, 1992). Stemple (1993) defines professional voice users as those individuals who are directly dependent on vocal communication for their livelihood. This group includes teachers, actors, politicians, radio announcers, air traffic controllers etc.

Voice is the most effective tool of teacher's trade, as they use their voice regularly due to the occupational demand and hence they are vulnerable to develop voice problems. There are not many professions, expect for teaching, that demand a person to go on a regular basis and within a split second, from talking at a normal level to shouting across the classroom to overcome poor acoustic conditions (Sapir, Keider, & Schmidt 1993; Vilkman, 2000). Apart from the use of voice for normal day-to-day communication, it is also used for other professional purposes. The vocal pathology along with the high level of anxiety associated with it would have potential impact on the teachers' ability to make a living. They do affect the physical and psychological health.

Professional voice users are defined as those, who require the use of their voice to maintain income (Murry & Rosen, 2000). They include singers, actors, teachers, attorneys, etc. professional voice users are of three types (a) those who use their voice for a long period time (politicians, teachers in class rooms, telephone users, shop keepers and vendors), (b) those who use their voice under adverse circumstances (persons working in noisy environment and/ polluted environments) and (c) those who use voice for special purposes (singer, theatre artists).

According to the United States Bureau of Labour Statistics (2001), out of the 144 million employed civilians in the labour force , 4.5 million (3.13%) were elementary, secondary, and higher education teachers. Teachers represent one of the largest groups of professional voice users in United States of America and are considered among those individuals at greatest risk for developing vocal problems. Several factors contribute to this risk: the professional demands placed on the voice, unsuitable acoustic working environments, lack of voice training, individual voice characteristics and psychological factors such as stress and anxiety (Sapir, Keidar, & Mathers-Schmidt, 1993).

Vocal requirements for teaching

In general, it is required that the teachers use a voice that is appropriate to the age and gender in terms of pitch, loudness and quality. It is important that the voice of the teachers is greater in volume and audible to all pupils in the classroom. They are expected to maintain a good volume voice throughout the teaching duration. Such extended periods of voice use results in vocal load and may result in changes in pitch and quality.

According to Martin (2003), if teachers were to teach effectively, then they needed voices that were able to withstand the demands of prolonged voice use often at high volume on a daily basis. It is possible to use the voice without tiring, damaging or abusing it for prolonged periods of time, but only for a few individuals. But continuous voice use that is appropriate/good would require prior training, training in how to use and care for the voice effectively and efficiently, and how to manage and monitor the often less than ideal conditions, be these physical or emotional, in which the individual is vocalizing.

Few, if any, teachers work in ideal conditions. Ideal conditions in terms of physical space would be acoustically balanced, warm but not overheated, well-ventilated buildings. Few teachers may be able to produce and sustain vocal quality and volume in an easy and relaxed manner, with well-balanced posture, good control of breath and minimal mental stress over a long period (Martin & Darnley, 2004).

Factors important for vocal projection

Projection is characteristic of both career voice and the singing voice. At the foundations of projection is the proper use of breath. It is very important to learn the control of exhalation. In addition to very definite difference in volume, controlled exhalation frequently changes the quality of the voice. A steadiness of tone results from supporting the breath. The voice without diaphragmatic control often wavers and some time cracks. Breath control determines projection (Crandell, & Smaldino, *2000).*

Other factors: *Include factors that are important for the general physical and psychological health. Normal structure and functions of various structures involved in voice production is of primary importance. Age, gender, balanced diet, adequate rest all contribute to normal functioning of these mechanisms.*

Biofeedback especially through senses of hearing and vision is very important for efficient communication through speech using voice.

Roles of Audition and vision*:*

According to Rosenhouse (1988) one of the major problems of deaf speech was intonation, which is often described as 'monotones' or 'not in pitch'. People with hearing losses will have inadequate fundamental frequencies (F0) and higher than the average F0 of people with normal hearing. People with hearing loss have unusual voice quality, characterized by over aspiration, spectral noise and so on. Radovančić (1995) describes non-balance between optimal biofeedback and receiving and production of speech as a reason for non-standard acoustical voice features of this population. Literature shows that persons with hearing loss have been reported to show wide variety of disturbances such as increased mean speaking F0, deviant intonation contour, high or low loudness levels and quality differences and poor control velopharyngeal port may lead to nasal emission and hypernasality (Bolfo-Stosic & Simunjak, 2007).

Visual cues are vital for understanding the physical environment. Sense of distance, localization, identification and judgements regarding the physical barriers in the environment, such as, physical dimension of the room, distance between the

speaker and listener, orientation to the listener/ audience, become important in controlling the vocal parameters of speech in normal communication.

Professional voice users require normalcy of the senses of audition and vision to fulfil their professional demands adequately as they depend on these senses for feedback and continuous speech.

It is important to chronicle the distinctions if any in voice and speech characteristics of professional voice users who are visually impaired.

Need for the study

Limited information is available on characteristics of speech and language abilities in adults with visual impairment. A few individuals with visual impairment are in the mainstream of the society, be it education or employment. Some of these individuals are professional voice users too. The importance of audio visual cues in maintaining voice characteristics in general communication is proved in various studies. The audio visual cues are vital for use and maintenance of voice in communication. Such characteristics are very essential in professional voice users, be it singers, actors or teachers. Sense of vision is very vital for controlling pitch, loudness, and vocal projection. To continue communication these professional voice users, particularly, teachers would rely on sense of vision to modulate the vocal parameters to suit their audience. So, when the sense of vision is affected, it may lead to difficulties in speech communication, especially voice.

In this regard, it would be of interest to know characteristics of voice in primary school teachers with visual impairment and distinctions, if any, from normal sighted primary school teachers. The present study was planned to investigate the voice characteristics in primary school teachers with normal sight and those who are congenitally visually impaired.

CHAPTER II

REVIEW OF LITERATURE

Professional voice users are individuals whose livelihoods depend partially or wholly upon the ability to produce voice. Professional voice users may include, but are not limited to, teachers, ministers, salesmen, telemarketers and telephone operators, actors, singers, radio and TV announcers, and attorneys. Although the range of vocal sophistication and quality needed may vary greatly across the range of occupations, professional voice users share a dependence on vocal endurance (Benninger, Jacobsen, & Johnson, 1994; Sataloff, 2001).

Koufman and Isaacson (1991) proposed a classification based on levels of vocal usage as follows,

a) Level I: The level I elite vocal performer is a person for whom even a slight aberration of voice may have dire consequences. Most singers and actors are in this group, the opera singers being the quintessential level I performer.

b) Level II: The professional voice user, level II, is a person for whom a moderate vocal problem might prevent adequate job performance. This group includes teachers, lecturers, etc.

c) Level III: The non-vocal professional, level II is a person for whom a severe vocal problem would prevent adequate job performance. This group includes lawyers, businessmen, etc.

d) Level IV: The non-vocal non-professional, level IV is a person for whom vocal quality is not a prerequisite for adequate job performance. This group includes office workers, factory workers, venders, bus conductors, agriculturist' coolie, and so forth. Although persons in this group may suffer very significant social liability because of voice disorders, they are not prevented from doing work.

Teachers are professional voice users who depend on voice for their daily job. They use their voice for long and extended periods of time. *Jackson (1968) suggested that teachers engage in 200-300 exchanges every hour of their working day, which adds up to 1200-1800 exchanges during their working day only, and this does not take into account discussion during breaks or before or after school Martin & Darnley (2004).*

Teachers are required to use their voices for prolonged periods of time, often with few or no breaks between classes. Smith, Lemke, Taylor, Kirchner and Hoffman (1998) reported that teachers taught an average of six classes per day, requiring almost 5 hours of continuous voice use. The acoustics in classroom environments were usually less than desirable, requiring teachers to raise their voices often to compete with background noise. Teachers were also required to use their voices in situations other than the classroom that demand even greater loudness levels, such as the hallway, lunchroom, schoolyard, gymnasium, and during extracurricular activities (Roy, Weinrich, Gray & Tanner, 2002).

On average, teachers talk for 6.3 hours during a school day. The most vulnerable teachers are either the newly qualified who have had little training in voice awareness, or those who have been doing the job for 15 or 20 years and who suddenly find their voice wearing out (Siebert, 1999). Allen (1995) and Gotaas and Starr (1993) reported that 80 percent of teachers in their study claimed that they had experienced vocal fatigue. More than 20 percent of teachers had reported that voice problems prevented them from attending work ranging from one day to one week during the academic year.

Teachers who work in schools with noisy classrooms must constantly raise their vocal volume in response to varying levels of background noise. Noisy ventilation systems that cycle on and off, poor insulation between classrooms that allows sound leakage, hard surfaces that reflect student noises, and as such outside noise sources like, traffic and airplanes cause teachers to strain their voices (Herrington-Hall, Lee, Stemple, Nicmi, & McHonc, 1988; Rantala & Vilkman, 1999; Smith, Gray, Dove, Kirchner, & Heras, 1997; Titze, Lemke, & Montequin, 1997).

Studies have shown that teachers frequently report that they have to speak over background noise (Pekkarrien, Himberg & Pentti, 1992, 1992; Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998), and teachers have even reported that they commonly feel that they have to shout in order to be heard at work (Ohlsson, Järvholm, Löfqvist, 1987). The Finnish Ministry of the Environment provides specifications for background noise levels and reverberation times in classrooms. Nevertheless, classrooms in Finnish schools have been found to be too reverberant and to have excessively high levels of background noise that causes teachers to increase their vocal effort (Pekkarinen & Viljanen, 1991).

Unfortunately, vocal education and training are not a standard part of most teacher training programs. Teachers often enter the workforce and begin their careers with limited knowledge of the vocal mechanism, vocal hygiene, and effective voice use. In addition, teachers continually are exposed to upper respiratory infections, putting them at great risk for developing illnesses that adversely affect their vocal mechanism (Smith, Gray, Dove, Kirchner & Heras, 1997).

Vocal abuse and misuse due to the vocal demands of teaching and the poor acoustic environments of the classroom have been frequently hypothesized as causal factors of vocal problems among teachers (Mattiske, Oates & Greenwood 1998).

The most frequently reported vocal symptoms in several studies seem to be voice tiring, hoarseness, sensations of pain or discomfort in the throat, weak voice and lower pitch (Pekkarrien, Himberg & Pentti, 1992; Roy, Merrill, Thibeault & Gray 2004; Smith, Lemke, Taylor, Kirchner, & Hoffman, 1998). Teachers use a higher fundamental frequency (F0) during lessons than during breaks (Rantala & Vilkman, 1999) and their F0 increases toward the end of the working day, which might be an effect of vocal loading and they found that even two hours of vocal loading resulted in increased F0 (Rantala, Vilkman, & Bloigu, 2002). Teachers report that they have had more vocal symptoms since they began teaching than they had previously (Sapir et al., 1993). These symptoms have been found to appear more often in the afternoon and at the end of the week (Pekkarinen & Viljanen , 1992; Sala, Airo, Olkinuora, Simberg, Strom, Laine, Pentti, & Suonpaa, 2001), and voice quality appears to improve during the school holidays (Morton & Watson, 1998). These reports indicate that there is a strong connection between vocal symptoms and teaching.

Calas, Verhulst, Lecoq, Dalleas, Seilhean (1989) reported that 67% of the teachers with voice problems were aged between 31 and 50 years. Mattiske, Oates, and Greenwood (1998) reported that younger teachers reported greater difficulties due to longer working hours and poorer vocal hygiene techniques than their older, more experienced peers.

In a study of newly qualified teachers and lecturers in their first year in post, Martin (2003) discovered that most respondents reported that they usually talked for over 60 percent of each teaching session. As it was a considerable amount of time, it

represented high vocal demand and subsequently high vocal loading. In cases of those teachers who worked primary education along with extended talking, use of voice at consistently at high volume was also noted. But in cases of those teachers with further education, a more balanced use of high and medium volume was reported Martin and Darnely (2004).

In Indian context few studies have been done. Amita Koul and Yeshoda (2004) conducted a study on vocal demands in female teachers of primary and secondary schools. The tasks were phonation, maximum phonation duration and monologue along with self appraisal using a questionnaire. They analyzed acoustic, aerodynamic and perceptual measures of teachers' voice along with measurement of back ground noise in the class rooms. The results revealed that the background noise were higher in the classrooms of secondary school teachers and also secondary school teachers showed increased values for most of the acoustic and perceptual measures of voice. Self appraisal of vocal problems also showed that the vocal demands were increased for secondary school teachers compared to primary school teachers.

Smitha Bahera and Savithri (2005) studied voice characteristics of prospective and professional teachers using phonation samples. They took two groups of subjects: Group I consisted of 10 prospective teachers (5 males and 5 females) and Group II consisted of 10 professional teachers (2 males and 8 females). Using the acoustic analysis (MDVP) extracted 33 parameters of voice. Based on the norms of MDVP, samples were classified as normal/abnormal. The results indicated that the voices of professional teachers were significantly different than those of prospective teachers in all the eight major measures of MDVP. In professional teachers, abnormal frequency and amplitude perturbation measures indicating hoarse voice were noticed.

More abnormalities were seen in professional teachers compared to prospective teachers.

Rajasudhakar and Savithri (2009) studied vocal loading in five primary school teachers. The subjects performed phonation and speech tasks which were acoustically analyzed. Eight major multi dimensional voice parameters and speech parameters were extracted. The results indicated that after 6 hours of teaching, fundamental frequency of phonation, standard deviation of fundamental frequency of phonation, jitter and speaking fundamental frequency were increased compared to the pre-teaching (baseline) condition.

Humans use the five senses of sight, hearing, taste, touch, and smell to communicate. We communicate messages through sight by using visual signals that include facial expressions, gestures and posture (or body language). We receive these signals by using our sense of sight.

The role of senses in every day communication, especially, in maintaining voice is extremely important but often neglected. The sense of vision along with audition plays a major role in the production of voice and maintaining/ modifying the characteristics of voice to suit everyday communication needs.

Our experience of the world, our 'reality', comes through our senses. People with hearing and/or visual impairments, in a sense, have a different 'reality'. They don't experience the world in the same way as sighted hearing people but with gaps; their whole knowledge and experience of the world are different. Sight and hearing are often called the distant senses because they give us information about what is happening around us. Sight and hearing provide most of the information we use to learn and function.

Russell, Oates and Green wood (1998) studied prevalence of voice problems in teachers he investigated the prevalence of self reported voice problems during the teachers' careers, during this teaching year and on the day of survey for representative sample of teachers working in state schools of South Australia. For the study, the author classified teachers by their school type, as kindergarten, primary, secondary, or area school. To investigate voice problems in teachers, a questionnaire that included questions about the prevalence of voice problems in teachers was developed. The questionnaire sought data from teachers about demographic information, singing and voice training, teaching speciality, health, information about smoking, hydration, allergies, reflux, and medications, and visits to health professionals about voice problems and voice symptoms. The main goal was to of his study was to discern the extent to which teachers report having voice problems. Thereby providing a more pragmatic estimate of resources required to address the problems. Voice problems were reported throughout the teaching careers for 21.3% of male and 11.2% of female teachers. A further 65.8% of males and 66.8% of females reported infrequent voice problems, indicating that they had occurred rarely, once every 2 to 3 years or once per year at most. The remaining 12.9% of males and 22.0% of females reported voice problems every 6 months or more frequently. A significant relationship was found that the females being more likely to report voice problems during their teaching careers than males. Prevalence of voice problems related school type (preschool, primary, secondary, area) no significant relationship was found. They found 31-40 years reporting higher prevalence of voice problems. The female teachers reported voice problems on the day of survey than male teachers, with 12% of male teachers and 18% of female teachers limited by voice problems on that day of the survey

Teaching communication should be intelligible, immediate, approachable, encouraging and non-frightening but also assertive and effective. All these attributes of class-room communication are established not only verbally but also non-verbally. The vocal non-verbal channel is essential in effective teaching communication. The ability to maintain students' attention may be impaired e.g. by the lack of pitch variation, by too fast or slow speech rate, or dysfluencies in teaching speech. Furthermore, it may be difficult for a teacher to convey assertiveness as a teacher if one's habitual voice is weak and inaudible, or to create an impression of encouraging communicator style if one's voice is habitually strained. Thus, voice use in a teacher's occupation is communicatively highly demanding, and a well functioning voice is a basic requirement in that profession (Ilomaki, leppanen, Kleemola, Tyrmi, Anne-maria, & Vilkman 2009).

It is straightforward that a noisy environment and large class-rooms or rooms with too long or short a reverberation time require louder voice and thus increase vocal loading. Air quality factors like dryness or dustiness may irritate the mucosa and negatively affect the voice. Poor acoustic conditions may be found in all types of class-rooms, and loud background noise in classrooms may come from many sources, e.g. ventilation and heating or traffic noise from outside the building. Long duration use of voice may affect voice endurance, especially in female teachers, who may have as much as 1 million vocal fold vibrations during a normal working day, while identical phonation times caused a 50% lowering in total number of vibrations in males.

Inadequacies of the teacher's vocal communicative competence and the ineffective/ inadequate use of a vocal non-verbal channel in the instructional

communication are not disorders in the clinical sense; however, they are important themes for future research in the teachers' occupational voice use.

Unfortunately, vocal education and training are not a standard part of most teacher training programs. Teachers often enter the workforce and begin their careers with limited knowledge of the vocal mechanism, vocal hygiene, and effective voice use. In addition, teachers continually are exposed to upper respiratory infections, putting them at great risk for developing illnesses that adversely affect their vocal mechanism (Smith, Gray, Dove, Kirchner & Heras, 1997).

Study, conducted in Iowa by Smith, Lemke, Taylor, Kirchner, and Hoffman (1998) looked at 554 teachers (274 males and 280 females) and found that of the 554 respondents, >38% reported that teaching negatively affected their voice and 39% reported having difficulty with teaching lessons because of voice problems. Female teachers reported more frequently than male teachers (38 versus 26%, respectively, $P < 0.05$), both acute ($P < 0.05$) and chronic ($P < 0.05$) voice problems. There were no gender differences in the perception that a voice problem adversely affected their current or future teaching career. Females had a higher probability of reporting voice problems compared with men (odds ratio = 1.7–2.1).

Prolonged voice use is not the only risk factor for voice disorders in vocally demanding occupations, for environmental factors, such as background noise, acoustic conditions and air quality, also contribute to voice disorders (e.g. Morton & Watson, 1998; Pekkarinen & Viljanen, 1991; Vilkman, 1996). In some studies, classrooms have been found to provide poor acoustic conditions (Knecht, Nelson, Whitelaw, & Feth, 2002; Pekkarinen & Viljanen, 1991). The acoustics of the rooms in day care centres and preschools have also been found to be unsatisfactory (Sala et al.,

2002; Truchon-Cagnon & Hétu, 1988). There are several sources of background noise in the classroom. Noise from the activity of the pupils and from ventilation and air conditioning can be disturbing. In addition, external background noise, such as noise from traffic or from the schoolyard, can be disturbing (Crandell & Smaldino, 2000; Knecht et al., 2002). Background noise affects the pupils' ability to perceive speech (Crandell & Smaldino, 2000). Accordingly, teachers have to raise their voice to ensure that their voices are heard in noisy and reverberant classrooms (Nelson & Soli, 2000; Pekkarinen & Viljanen, 1991).

Majority of the studies in the area of teachers' voice focus on voice problem or disorders in teachers during professional related voice load. Most teachers seek expert guidance only when their voice is affected. Most studies on voice characteristics focus on female teachers as majority of primary school teachers are women. And majority of all phoniatric voice patients are also women. Limited literature are available on voice characteristics in males teachers.

Sensory impairments involving one and / more sense organs will result in varying degrees of disturbances in the human behaviours. The impairment of auditory sense results in varying degrees of communication impairment and this area is widely researched. But the role of the sense of vision is not extensively researched except for a few studies that report of delayed acquisition of speech and language abilities in children with visual impairment with no major difficulties in parameters of speech and language.

The impact of low or no vision on the development of language is profound Jan, Sykanda, & Groenveld, 1990; Kekilis & Prinz, 1996; Preisler, 1995; Reynell, 1978; Sonksen, Levitt, Kitsinger, 1984; Troster & Bramberg, 1993. Preisler (1995) reported that language development in children with severe visual impairments is

more delayed than in children with hearing impairment. Infants with visual impairment miss interpersonal cues that typically take place between infant and care giver, in part because the baby who is visually impaired cannot observe and learn the traditional non verbal cues from the caregiver (Preisler, 1995; Sonksen, et al, 1984). In turn, care givers miss the communication efforts of the young infants because of the non traditional nature of the cues from the baby. For example , blind infants may become very still when interested in a external stimuli compared to sighted infants who will look to the stimuli, turn their heads , and have increased arm and leg motions (Preisler ,1995; Sonksen et al, 1984).

The review indicates that voice characteristics in visually impaired are not extensively studied. Hence, the present study planned to investigate the voice characteristics in visually impaired and compare the same with normal sighted teachers. This would help in understanding the voice characteristics in VI and check for differences if any among them when compared with normal sighted teachers.

Aims of the study

1. To investigate the voice characteristics of primary school teachers with congenital visual impairment and normal sighted primary school teachers using acoustic and perceptual measures.
2. To correlate the acoustic characteristics of voice with perceptual correlates across the two groups.
3. To compare the voice characteristics across the two groups.

CHAPTER III

METHODOLOGY

The main objective was to study the voice characteristics in normal sighted and visual impaired primary school teachers.

Subjects

Control group: 20 normal sighted primary school teachers in age range of 34 to 51 years formed the controls. The mean age was 40.6 years and SD was 6.26.

Experimental group: 20 visual impaired (as diagnosed by authorized medical expert) primary school teachers formed the experimental group. They ranged in age from 33 to 50 years. The mean age was 41.4 years and SD 5.38.

All the subjects in the control and experimental groups were males and spoke Telugu as their native language. They were chosen from the government schools for normal sighted children from the districts of West and East Godavari, Vishakhapatnam and Krishna in Andhra Pradesh and had minimum teaching experience of five years. The subjects volunteered and consented to be part of the study. They did not report of speech, language and hearing problems at the time of recording.

Procedure

All the subjects carried out the following tasks individually in a quiet environment in their respective schools. Subjects were tested individually.

Task

1. Phonation: The subjects were instructed to phonate vowel /a/ at comfortable pitch and loudness after a deep inhalation for at least 5 seconds.
2. Monologue**:** All the subjects were asked to speak about themselves for about 2 minutes.

Recording:

The tasks were audio recorded using the digital voice recorder, Olympus (WS-100). The samples were recorded directly on to the digital voice recorder. The microphone was positioned at a distance of about 4 inches from the subject's mouth during recording. First phonation sample was recorded followed by monologue. All the recordings were done in a quiet environment. Suitable instructions were given to subjects before the performance of the task.

The audio recorded samples were converted to .wav format using the Adobe Audition (version 3) for further acoustic analysis.

Analyses: was carried out in 2 stages.

(A). Acoustic analysis

The recorded data were analysed for acoustic parameters using the MDVP and Real Time Pitch softwares of CSL 4500 (Kay Pentax, New Jersey). The phonation samples were subjected to MDVP analysis and the monologues were subjected to Real Time Pitch analysis tool for analyzing monologue. The middle 3 seconds duration of the phonation samples, eliminating the initial and final portions of the recordings were used for analysis. This was done to avoid the influence of voice onset and offset on the acoustic measures.

The following acoustic measures were extracted for phonation after MDVP analysis:

I. Fundamental Frequency Information Measures.

1. Mean Fundamental Frequency (Mfo): Average value of all extracted period to period fundamental frequency values.
2. Highest Fundamental Frequency (Fhi): Highest fundamental frequency value in phonation.

3. Lowest Fundamental Frequency (Flo): Lowest fundamental frequency values in phonation.
4. Standard Deviation of Frequency (STD): Variation of F0 within the analyzed voice sample.

II. Short and Long Term Frequency Perturbation Measures

1. Absolute Jitter (Jita): An evaluation of period-to-period variability of pitch period with in the analyzed voice sample.
2. Jitter Percent (jitt): Relative evaluation of period-to-period (very short-term) variability of the pitch within analyzed voice sample.
3. Relative Average Perturbation (RAP): Relative evaluation of period-to-period variability of the pitch within analyzed voice sample with a smoothing factor of 3 periods.
4. Pitch Perturbation Quotient (PPQ): Relative evaluation of period-to-period variability of the pitch within analyzed voice sample with a smoothing factor of 5 periods.
5. Smoothed Pitch Perturbation Quotient (sPPQ): Relative evaluation of the short or long term variability of the pitch period within the analyzed voice sample.
6. Fundamental Frequency Variation (vF0): Variation of the fundamental frequency.

III. Short and Long Term Amplitude Perturbation Measures

1. Shimmer in dB (ShdB): It is the period to period variability of the peak to peak amplitude within the analyzed voice sample.
2. Shimmer Percent (Shim): It is the relative evaluation of the period-period variation of the peak to peak amplitude within the analyzed voice sample.

3. Amplitude Perturbation Quotient (APQ): Relative evaluation of the period-period variation of the peak to peak amplitude within the analyzed voice sample at smoothing of 11 periods.
4. Smoothed Amplitude Perturbation Quotient (sAPQ): It is a relative evaluation of the short or long term variability of the peak to peak amplitude within the analyzed voice sample.
5. Peak Amplitude Variation (vAm): It is the relative standard deviation of the peak to peak amplitude.

IV. Voice Break Related Measures

1. Degree of Voice Breaks (DVB): The ratio of total length of voice breaks to voicing.
2. Number of Voice Breaks (NVB): Number of times the fundamental period interrupted during the voice sample.

V. Sub-Harmonic Related Measures

1. Degree of Sub Harmonic Segments (DSH): Estimated relative evaluation of sub-harmonics to F0 components in the voice sample.
2. Number of Sub Harmonic Segments (NSH): Number of auto correlation segments where the pitch was found to be a sub-harmonic F0.

VI. Voice Irregularity Related Measures

1. Degree of Voice less (DUV): Estimated relative evaluation of non-harmonic areas (where F0 can't be detected) in the voice samples.
2. Number of Unvoiced Segments (NUV): Number of unvoiced segments detected during the auto-correlation analysis.

VII. Noise Related Measures

1. Noise to Harmonic Ratio (NHR): Average ratio of harmonic energy in range of 1500-4500 HZ to harmonic energy in the range of 70-4500 Hz.
2. Voice Turbulence Index (VTI): A ratio of the spectral in-harmonic high frequency energy in range 1800-5800 Hz to the spectral harmonic energy in the range 70-4200 Hz.
3. Soft Phonation Index (SPI): Average ratio of the lower frequency harmonic energy in the range of 70-1550 Hz to the higher frequency harmonic energy in the range of 1600-4200 Hz

VII. Tremor Related Measures

1. F0 Tremor Intensity Index (FTRI): Average ratio of frequency magnitude of the lowest frequency modulation to the total frequency magnitude.
2. Amplitude Tremor Intensity Index (ATRI): Average ratio of the amplitude of the most intense low- amplitude modulating component for the total amplitude of the analyzed voice sample.
3. F0 Tremor Frequency (Fftr): It is the frequency of the lowest frequency modulation component.
4. Amplitude Tremor Frequency (Fatr): Frequency Tremor Amplitude Index Average ratio of the frequency.

Monologue Analysis:

The middle 30 seconds duration segments from the monologue samples were considered for acoustic analysis using Real Time Pitch. The following acoustic measures of speech measures were extracted.

1. **Mean F0 (SMF0): Mean F0 reports the harmonic mean. It is calculated using the formula M=n /(1/f1+1/f2+….+1/fn), where n is the total number**

of voice periods and f1…..fn are the frequency values for each period .For pitch synchronous F0 extraction , the Mean F0 is not weighted toward the higher frequency values as is the arithmetic mean. Mean F0 is the inverse of Mean Period.

2. **Minimum F0 (SMinF0): One of the extremes of data distribution reflecting the lower limit, or lowest value, among the captured data. The minimum F0 refers to the lowest pitch value recorded.**
3. **Maximum F0 (SMaxF0): One of the extremes of data distribution reflecting the upper limit, or highest value, among the captured data. The maximum F0 refers to the highest pitch value recorded.**
4. **Standard Deviation F0 (SDF0): This is the measure of variability in the data. It reflects the spread of the data, or the average amount of which the data deviates from the harmonic mean. Standard deviation of F0 is computed in Hz on all F0 values in the selection area. It indicates how much variation in pitch occurred around the average value and is a useful indicator of monotonocity.**
5. **Fundamental Frequency Variation (vF0): It is defined as the standard deviation F0 divided by the arithmetic mean .It is useful in facilitating comparisons regardless of F0 obtained.**
6. **Relative Average Perturbation (SRAP%): It gives an evaluation of the variability of the peak to peak amplitude within the analyzed voice sample. It represents relative period to period (very short term) variability of the peak to peak amplitude.**

(B). Perceptual analysis

The middle 30 seconds duration segments used for acoustic analysis of speech were used for rating during the perceptual analysis. These tokens were presented individually through the headphones (Bettel 500) in a quiet environment. Five qualified Speech Language Pathologist with a minimum clinical experience of 5 years were the judges. The samples were randomized prior to presentation to minimize familiarity effect and order effect. The judges were kept blind to the purpose of the study and no identification of subjects was revealed to the judges except for age and sex of the subjects. The judges rated the tokens (the four perceptual correlates of voice: pitch, loudness, quality and effort) using a 3 point rating scale. A rating of 0 indicated normal, 1 denoted slight deviancy, and 2 denoted obvious deviancy. The perceptual evaluation was carried out individually in a quiet environment.

The responses of the judges were compiled and subjected to statistical analysis.

Statistical analysis

SPSS version 17 was used for statistical analysis of the acoustic and perceptual data. Descriptive statistics was employed to find mean and standard deviation of the extracted acoustic measures. One way MANOVA, Mann-Whitney and independent 't' tests were used for finding the significance depending on the parameters.

CHAPTER IV

RESULTS AND DISCUSSION

The voice characteristics in phonation and monologue tasks for experimental and control groups were analyzed for the 28 Parameters on MDVP. Further perceptual evaluation of voice was also done. The results are discussed under the eight major categories and the details are shown tables 1-10 in subsequent pages.

The results of the study are presented under two sections as follows:

A. Acoustic analysis for phonation and monologue

B. Perceptual analysis

A. Acoustical analysis

Acoustic analysis was done for phonation

Table 1: Mean, Standard deviation,"F" and "p" values for frequency related measures in control and experimental group.

Parameters	Groups	Mean	SD	F	P
MF0	Control	120.97	14.14	.03	.85
	Experimental	122.01	21.03		
Fhi	Control	128.60	14.97	.01	.91
	Experimental	129.37	29.20		
Flo	Control	115.16	16.07	.20	.65
	Experimental	112.61	19.08		
STD	Control	1.75	0.85	1.28	.26
	Experimental	1.45	0.82		

Table 1 shows the mean and standard deviation (SD) for frequency related measures for the 2 groups of subjects. From table 1 it can be seen that the mean values for frequency related measures for MF0 and Fhi were high in experimental compared to control group. In Flo and STD the mean values were high for control group when compared to experimental group. MANOVA was administered to find significance difference for frequency related measures between control and

experimental groups. There was no statistical significance difference observed for F0 related parameters between control and experimental groups.

The MF0 was slightly higher in experimental group and also the F0 range (difference between MinF0 and MaxF0) was more in them. This indicates that the experimental group subjects showed signs of vocal strain than control group. Vocal strain affects F0 and its related measures. These results find support from the studies of Rantala & Vilkman (1999) and Rantala, et.al, (2002) wherein they reported that teachers used a higher fundamental frequency (F0) during lessons than during breaks and their F0 increases toward the end of the working day, which might be an effect of vocal loading. It was also reported that even two hours of vocal loading resulted in increased F0.

Amita Koul & Yeshoda (2004) and Rajasudhakar & Savithri (2009) also found increased F0 and related measures in the voice of teachers.

Table 2: Mean and standard deviation, Z and p values for short and long term frequency perturbation measures across the 2 groups.

Parameters	**Groups**	**Mean**	**SD**	**/Z/**	**p value**
Jita	Control	59.0	35.5	.243	0.808
	Experimental	61.8	50.3		
Jitt	Control	0.7	0.4	.298	0.766
	Experimental	0.7	0.6		
RAP	Control	0.4	0.2	.014	0.989
	Experimental	0.4	0.4		
PPQ	Control	0.4	0.2	.243	0.808
	Experimental	0.4	0.5		
sPPQ	Control	0.7	0.2	-	-
	Experimental	0.6	0.2		
vF0	Control	1.4	0.7	-	-
	Experimental	1.2	0.6		

In Table 2 the Mean, SD, Z and p values are tabulated for short term and long term frequency perturbation measures. It can be observed that the mean values for Jita, Jitt, RAP and PPQ are less in control group compared to experimental group. In sPPQ and vF0 the mean values were high in control group compared to experimental group. Mann-Whitney U test was done to check the significant difference. There was no statistical significance difference observed for the same.

The perturbation measures of frequency were similar in both groups except for Jita. Even though the F0 related measures were slight high in experimental group they did not reveal increased frequency perturbations indicating better control of voice in experimental group.

Amita Koul & Yeshoda (2004), Smitha Bahera & Savithri (2005) found that the frequency and amplitude perturbations were increased in teachers.

Rajasudhakar and Savithri (2009) also reported increased jitter, fundamental frequency and standard deviation of fundamental frequency after 6 hours of teaching compared to pre teaching condition.

Table 3: Mean, standard deviation F and p values for short and long term amplitude perturbation measures across the two groups.

Parameters	Groups	Mean	SD	F value	p value
ShdB	Control	0.5	0.1	0.1	0.7
	Experimental	0.5	0.1		
Shim	Control	6.5	1.1	0.1	0.7
	Experimental	6.3	1.6		
APQ	Control	5.5	0.8	1.4	0.2
	Experimental	5.1	1.3		
sAPQ	Control	7.2	1.0	0.2	0.6
	Experimental	6.9	1.9		
vAm	Control	10.4	1.6	1.3	0.2
	Experimental	12.2	6.6		

As seen from the table 3, the Short and long term amplitude perturbation measures shows that for vAm the mean value is higher in experimental group compared to control group. For the remaining measures ShdB, Shim, APQ and sAPQ high mean values are noticed in control group compared to experimental. MANOVA was administered to find significance difference in short and long term perturbation measures across the two groups. There was no statistical significance observed for all these parameters.

Amplitude perturbation measures were relatively lesser in experimental group except vAm which was high. This indicates better control of loudness of voice in experimental group. Increased amplitude and amplitude perturbations in voice of control group draws support from findings of Martin (2003), Smith, et.al, (1998), Martin (2003), Amita Koul & Yeshoda (2004) and Smitha Bahera & Savithri (2005). Martin (2003) reported that teachers working in primary education along with extended talking often used increase in voice intensity levels. Teachers were required to use their voice at greater loudness levels to compete with back ground noise (Smith, et al., 1998; Amita Koul & Yeshoda, 2004). Smitha Bahera & Savithri (2005) found that the frequency and amplitude perturbations were increased in teachers resulting in an abnormal vocal quality.

Table 4: Mean, Standard deviation, F and p values for noise related parameters across two groups.

Parameters	Groups	Mean	SD	F value	p value
NHR	Control	0.15	0.02	1.1	0.2
	Experimental	0.14	0.02		
VTI	Control	0.03	0.01	0.0	0.8
	Experimental	0.03	0.01		
SPI	Control	18.3	7.7	0.8	0.3
	Experimental	16.4	5.0		

Table 4 reveals the mean, SD, F and p values for noise related measures. In NHR and SPI the mean values were noticed to be higher in control group compared to experimental group. For VTI the mean value is same in the both the groups. MANOVA was administered to find significance difference. There was no significance difference observed for all above mentioned parameters between control and experimental groups.

Most noise related parameters showed lesser values for experimental group indicating better glottal valving/ closure in subjects of experimental group when compared to control group.

Table 5: *Mean, SD, t, p values standard of tremor related measures across the two groups.*

Parameters	**Groups**	**Mean**	**SD**	**t value**	**p value**
FTRI	Control	0.32	0.20	-0.187	0.852
	Experimental	0.47	0.60		
ATRI	Control	3.16	1.07	-1.060	0.296
	Experimental	4.24	2.30		
Fftr	Control	4.01	2.58	-1.031	0.309
	Experimental	4.14	1.82		
Fatr	Control	4.31	2.54	-1.780	0.084
	Experimental	5.28	2.89		

Table 5 depicts that the mean values for tremor related measures FTRI, ATRI, Fftr and Fatr. The mean values of all the four parameters were higher in experimental group compared to control group. Independent “t” test administered to find significant difference. There was no statistical significance difference observed for all above mentioned parameters between control and experimental groups

Table 6: Z and p value for FTRI parameter

Mann Whitney U test	FTRI
/Z/	.423
P	.672

From the table 6 it can be observed that the FTRI parameter was separately analyzed using Man-Whitney U test because of high standard deviation and a few missing values in some subjects. There was no statistical significance difference observed for FTRI between control and experimental groups.

Tremor related parameters were lesser for control group when compared to experimental group. Modulations in frequency and amplitude were more voices of the experimental group.

The mean values for Degree of voice less (DUV), Number of Unvoiced segments (NUV), Degree of voice breaks (DVB), Degree of sub-harmonic component (DSH), Degree of voice less (DVV), Number of voice breaks (NVB), Number of sub-harmonic components (NSH), Number of unvoiced segments (NUV) were zero indicating that in normal voices these parameters will be zero. Hence these measures were not subjected to statistical analysis.

Control group and experimental groups were compared in phonation task, it was found that experimental group revealed significant increase in mean values of some of the F0 related measures, short and long term perturbation measures, In short and long term amplitude perturbation measures ShdB, Shim, APQ and SAPQ measures showed more mean values in normal teachers compared to experimental group. In tremor related measures, FTRI, ATRI, Fftr and Fatr showed higher values in experimental group than normal teachers. The present study results were in consonance with the results of Amita and Yeshoda (2004) who reported that

frequency related measures had increased values compared to other measures. But in general, the mean values were high for all acoustic parameters in secondary school teachers compared to primary school teachers. The reason was that secondary school teachers would have more years of experience and also taught larger number of children in classrooms.

Acoustic analysis for monologue

Table 7 reveals the mean values for speech measures, i.e., mean F0, minimum and maximum F0, variation in fundamental frequency and relative amplitude perturbation.

Table 7: *Mean and Standard deviation for different parameters for monologue in experimental group and control group.*

Parameter	Group	Mean	SD
MSF0	Control	133.7	19.7
	Experimental	136.5	17.6
MinSF0	Control	87.5	9.4
	Experimental	92.1	13.5
MaxSF0	Control	297.2	73.9
	Experimental	284.4	67.1
SDSF0	Control	25.7	11.6
	Experimental	25.5	14.5
vF0 in speech	Control	0.2	0.08
	Experimental	0.2	0.1
RAP in speech	Control	1.4	0.3
	Experimental	1.3	0.1

The mean values were high in experimental group compared to control group for MSF0, MinSF0. MaxSF0, SDSF0 and SRAP mean values were had high mean values in control group compared to experimental group. vF0 were same in both groups.

Subjects in experimental group, increased strain in voice. When strain increases, muscle tension increases and glottal efficiency decreases leading to increased F0 values and perturbations.

B. Perceptual assessment

Table 8: *Response Scores for Experimental group for Perceptual measures of voice by judges.*

Judges	Pitch			Loudness			Quality			Effort		
	0 (%)	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**
J1	95	5	0	100	0	0	65	30	5	75	25	0
J2	40	50	10	35	55	10	25	40	35	15	65	20
J3	85	15	0	80	20	0	80	5	15	85	15	0
J4	85	15	0	85	15	0	50	40	10	70	20	10
J5	90	10	0	100	0	0	85	15	0	95	5	0

Table 8 depicts the percent response score for the experimental group on perceptual measures of voice as judged by the listeners. Perceptual measures of voice were pitch, loudness, quality and effort rated by the 5 judges. In pitch parameter, Judge 1 rated 95% of the participants in the experimental group to be normal and remaining 5% as slight deviant. Judge 2 rated 40% of the participants as normal and 50% as with slight deviance and other 10% were rated as obviously deviant. Whereas Judges 3 and 4 rated 85% of the participants as normal and 15% as with slight deviancy. Judge 5 rated 90% of the participants to be normal and other 10% as slight deviancy.

For loudness parameter, Judges 1 and 5 rated 100% of the participants to be normal. Whereas judge 2, 3 and 4 rated 35%, 80%, and 85% of the participants to be normal respectively and 55%, 20%, and 15% of them as with slight deviancy

respectively whereas 10% of the participants were rated as with obvious deviancy by judge 2.

On quality parameter, Judge 1 rated 65% of the participants to be normal and other 30% and 5% were slight deviancy and obvious deviancy respectively. Judge 2 rated 25% of the participants as normal and 40% with slight deviancy and other 35% as obviously deviant. Whereas judge 3 and 4 rated 80% and 50% as normal and 5% and 40% as with slight deviancy and 15% and 10% as obvious deviancy respectively. Judge 5 rated 85% of the participants to be normal and other 15% as with slight deviancy.

For effort parameter, Judges 1 and 4 rated 75% and 70% of the participants as normal and 25% and 20% as with slight deviancy respectively and other 10% as obvious deviancy by judge 4. Whereas Judges 2, 3 and 5 rated 15%, 85%, and 95% of the participants as normal respectively and 65%, 15%, and 5% were rated as with slight deviancy respectively whereas 20% of the participants were rated obvious deviancy by Judge 2.

Table 9: Percent scores for control group for perceptual measures of voice by the judges.

Judges	**Pitch**			**Loudness**			**Quality**			**Effort**		
	0 (%)	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**	**0 (%)**	**1 (%)**	**2 (%)**
J1	100	0	0	100	0	0	70	30	0	95	5	0
J2	45	40	15	60	40	0	45	50	5	10	75	15
J3	75	25	0	85	15	0	55	45	0	65	35	0
J4	95	5	0	100	0	0	85	15	0	75	15	10
J5	100	0	0	100	0	0	95	5	0	95	5	0

Table 9 depicted the percent response score for the control group on perceptual measures of voice. On pitch parameter, Judges 1 and 5 rated 100% of the participants to be normal. Judge 2 rated 45% as normal and 40% as slight deviancy and remaining 15% as with obvious deviancy. Judges 3 and 4 rated 75% and 95% of participants as normal but 25% and 5% of the remaining participants were rated as slight deviancy respectively.

On loudness parameter, Judges 1, 4 and 5 rated 100% of the participants to be normal whereas Judges 2 and 3 rated 60% and 85% as normal. Other 40% and 15% were rated as slight deviancy by Judges 2 and 3 respectively.

For quality parameter, Judge 1 rated 70% of the participants to be normal, 30% as slight deviancy. Judges 2 and 3 rated 45% and 55% of participants as normal whereas 50% and 45% were rated as slight deviancy respectively and remaining 5% as with obvious deviancy by Judge 2. Judges 4 and 5 rated 85% and 95% of the participants as normal and 15% and 5% respectively rated as slight deviancy.

On effort parameter, Judge 1 and 5 rated 95% of the participants as normal and 5% as slight deviancy. Judges 3 and 4 rated 65% and 75% of the participants as normal and 35% and 15% as slight deviancy respectively and remaining 10% were rated as obvious deviancy. Judge 2 rated 10% of the participants as normal and 75% of the participants as slight deviancy and 15% as obvious deviancy.

For the parameters pitch and loudness there was no much difference observed between experimental and control groups in perceptual task. In quality parameter both the groups were more deviant compared to pitch and loudness parameters which was in consonance with Amita and Yeshoda (2004) wherein, it was reported that 12 out of 14 secondary and 9 out of 13 primary school teachers had deviant voice quality.

Vocal effort was rated as being high in experimental group compared to control group. Pekkarinen and Viljanen (1991) stated that excessive high levels of back ground noise causes teachers to increase their vocal effort. Teachers report that they had more vocal symptoms since they began teaching then they had previously (Sapir et al., 1993). These reports indicate that there is a strong connection between teaching and vocal symptoms

CHAPTER V

SUMMARY AND CONCLUSION

The present study aimed to investigate voice characteristics in experimental group and control group. A total of 40 male primary school teachers: 20 visual impaired primary school teachers and 20 normal sighted primary school teachers were considered as subjects for the study.

Acoustic and perceptual analyses were carried out for the tasks phonation and monologue. All the subjects phonated vowel /a/ for 5 seconds and spoke about themselves for 2 minutes as monologue which were audio recorded on to the digital voice recorder.

The sustained phonation samples were subjected to MDVP and acoustic parameters under eight major categories were extracted. Acoustic analysis of monologues was done using Real Time Pitch and 6 acoustic measures for speech were extracted.. Perceptual analysis rating of the monologue on 4 perceptual correlates of voice: pitch, loudness, quality and effort using three point rating scale. Statistical analysis was conducted using SPSS version 17.

In general, the results indicated that a few acoustic parameters in F0 and related, short and long frequency and amplitude perturbation, noise related and turbulence measures were increased in control group when compared to experimental group. But these results were not statistically significant. Perceptual analysis revealed that both control and experimental were rated similarly on the perceptual correlates pitch, loudness and quality except effort. Effort was rated to be increased in experimental group. However, this difference was not significant statistically.

The results of the present study cannot be generalized as the sample size was small. Here, an attempt was made to study the normal voice characteristics in the voice of primary school teachers who were males and comparing normal sighted teachers with teachers with visual impairment.

Most studies in literature are on voices of female teachers and hence support could be drawn only regarding the trends of acoustic parameters variations and direct correlation would be difficult. Also most studies in literature aimed to study characteristics of voice in teachers with voice disorders.

Suggestions for the future studies

- The study could be repeated on a large sample.
- This study can be extended by including non professional voice users as control and study the characteristics and variations across the subject subgroups. This would help chronicle the characteristics of voice in non professional voice users and professional voice users. Variations among teachers with normal sight and visual impairment could also be documented.

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APPENDIX

DEPARTMENT OF SPEECH – LANGUAGE SCIENCES

Perceptual analysis of voice: Normal vs. visually impaired

Name:

Qualification: Designation: Years of experience:

Samples	Pitch	Loudness	Quality	Effort	samples	pitch	loudness	quality	Effort
1					21				
2					22				
3					23				
4					24				
5					25				
6					26				
7					27				
8					28				
9					29				
10					30				
11					31				
12					32				
13					33				
14					34				
15					35				
16					36				
17					37				
18					38				
19					39				
20					40				

0: Normal 1: Slight deviancy 2: Obvious deviancy

Signature: