Normative Data for Multi-Dimensional Voice Program (MDVP) for Adults - A Computerized Voice Analysis System

[1]Hema N., [2]Sangeetha Mahesh & [3]Pushpavathi M.

Abstract

Multi-Dimensional Voice Program (MDVP) is one of the instruments which provide the detailed acoustic analysis on all parameters. Among Western population many studies have been conducted to develop normative data across gender, dialect and language. The present study is aimed to develop norms for voice variable of MDVP in Indian population and compare same across western norms. Subjects considered were thirty male and thirty female normal subjects without any voice/communication disorders with age range of 18 to 25 years. MDVP- Computerized voice analysis (model 3950) system was used, voice parameters were displayed using Visi-Pitch IV hardware system. Voice sample was collected by asking subjects to phonate /a/ in their comfortable pitch and constant amplitude. The mean, standard deviation and the range (Indian norms) of MDVP is obtained using Independent t-test and is compared with the Western norms to see the significant difference in the voice variables using one sample t-test. Difference is seen only in perturbation measurements. Comparison between genders has shown significant difference for few voice variables. The reason for increase in all the perturbation measurements of Indian norms would be due to difference in the vocal tract length, mass and tension. Factors like F0 level, phonatory initiation and termination also affects jitter magnitude in sustained phonation. More variation in amplitude perturbation may be due to room acoustics and microphone placement. Increment for soft phonation index may be due to the difference in manner of vowel phonation among the Indian and the Western population. Difference across the genders may be attributed to specific method of muscle excitation, laryngeal mucosal mechanism, sample size and higher Fo. These results can be attributed as norms which can be clinically used for the Indian population. It is apparent that measurement of acoustic variable has important application in diagnosis and treatment of voice disorders.

Keywords: Perturbation, Soft phonation index, MDVP

Voice plays a major role in speech and communication. Therefore voice needs to be constantly monitored and in the event of abnormal functioning of voice, an immediate assessment should be undertaken which would lead to the diagnosis which not only identifies the voice disorder but also acts as an indicator for the treatment and management to be followed.

Computer-assisted voice analysis represents an important diagnostic advancement because it provides objective acoustic measurements. There are many computer based techniques which are designed to extract different parameters of voice. Voice is a multi dimensional series of measurable events. It is necessary that various dimensions of voice are measured to obtain accurate knowledge about vocal function. The Multi-Dimensional Voice

Program (MDVP) is one of the software tools for quantitative acoustic assessment of voice quality, calculating more than 30 parameters on a single vocalization. The Multi- Dimensional Voice Program (MDVP) in conjunction with the Computerized Speech Lab (Kay Elemetrics Corp, Lincoln Park, NJ) is a highly versatile voice processing and spectrographic analysis software package ideally suited for use in the pediatric and adult population. It provides an objective, reproducible and noninvasive measure of vocal fold function. The MDVP compares the acoustic variables graphically or numerically with a built-in normative database. MDVP is unique in its ability to work accurately over a wide range of pathological voices. Its normative references are based on an extensive database of Western norms and disordered voices and results are graphically

[1]*Speech Language Pathologist, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:hema_chari2@yahoo.com,.* [2]*Clinical Lecturer, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:sangmahesh9@yahoo.co.in,.* [3]*Reader and Head, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570 006, email:pushpa19@yahoo.co.in,*

and numerically compared to these normative threshold values. MDVP quickly and easily provides a revealing snapshot of voice quality.

As revealed in the professional literature on voice analysis, one or two voicing parameters alone (e.g., only jitter and shimmer) are not sufficient to accurately describe an aberration in a patient's voice. Jitter values may be within normal limits in a patient who demonstrates a breathy voice quality, and periodic modulation over many glottal periods (tremor) should be differentiated from cycle-to-cycle modulation. Similarly, turbulence caused by incomplete glottal closure can contribute a different type of "noise" compared to noise from aperiodic vibration and long-term periodic modulation of amplitude (amplitude tremor) may have physiological causes that differ from those of long-term periodic modulation of frequency. With the multi-dimensional analysis approach of the MDVP, the clinician can assess more comprehensively the patient's pathology and can track changes over time. Additionally, because the MDVP presents cycle-to-cycle frequency modulation (i.e., jitter or pitch perturbation) in many different variations, for example absolute jitter, relative average perturbation (RAP), pitch period perturbation quotient (PPQ), the results can be readily compared with results described in the professional literature highlighting periodic measurement of these parameters during the course of therapy may well provide an useful index so as to the success of the treatment.

Xue and Deliyski (2001) conducted a study to obtain normative acoustic data of voice for elderly male and female speakers and explored the educational implications of the effects of aging on selected acoustic parameters. Voice samples from 21 male and 23 female elderly speakers aged 70 to 80 years were obtained on measures of 15 selected Multi-Dimensional Voice Program acoustic parameters. The data was compared with the published norms which are reported by Putzer (2001) considering six MDVP parameters for young and middle-aged adult male and female subjects. The results showed that, compared with young and middle-aged adults, elderly speakers had significantly different (usually poorer) vocal output on all of the selected acoustic parameters of voice. These findings illustrate the importance of establishing acoustic norms and thresholds for elderly men and women and also on adult subjects. The study stress the necessity of using discretion in making diagnostic measurements of elderly speakers' acoustic parameters of voice.

Campisi, Tewfik, Manoukian, Schloss, Pelland-Blais and Sadeghi (2002) established the first pediatric normative database for the Multi-Dimensional Voice Program. One hundred control subjects (50 boys and 50 girls) aged 4 to 18 years contributed to the normative database. The voices of 26 patients (19 boys and 7 girls) with bilateral vocal fold nodules were also analyzed and compared with the normative data. Mean values of each of the acoustic variables were compared. The voices of patients with vocal fold nodules had significantly elevated frequency perturbation measurements compared with control subjects ($P<.001$). They also concluded that the vocal profile of children is uniform across all girls and prepubescent boys. Subjects with vocal fold nodules demonstrated a consistent acoustic profile characterized by an elevation in frequency perturbation measurements. Normal acoustic reference ranges may be used to detect various vocal fold pathologic abnormalities and to monitor the effects of voice.

Need for the study

The voice analysis using MDVP on normal population shows the interpretation with reference to western norms. Almost all normal Indian individuals' voice variables are shown as affected on the graphical display of MDVP. Hence, it becomes difficult to compare the data in pathological cases. The reason for this could be due to the difference in the vocal and the resonatory structures between the Indian and the Western population. Previous studies indicate changes in acoustic values using MDVP across different groups. Hence there is a need to develop separate norms for the Indian population in adult subjects.

Objectives of the study

1. To establish the normative database for the Multi-Dimensional Voice Program in adults and to compare across gender.

2. To compare the normative data with the western norms.

Method

Apparatus

Wipro-personal computer was used to operate MDVP module which acquires, analyzes and displays voice parameters using Visi-Pitch IV hardware system (Model 3950). The MDVP uses the signal conditioning and analog/digital hardware to sample speech at 50 KHz for sustained voicing. The MDVP extracted up to 33 acoustic voice variables from each voice analysis. These variables were displayed numerically and graphically and were classified into 6 groups: (1) fundamental frequency information; (2) frequency perturbation; (3) amplitude perturbation; (4) noise

and tremor evaluation; (5) voice break, subharmonic and voice irregularity; or (6) miscellaneous. The parameters are depicted in Table1.

Acoustic Variables	Symbol
Fundamental Frequency Information Measurements	
Average fundamental frequency, Hz	Fo
Average pitch period, ms	To
Highest fundamental frequency, Hz	Fhi
Lowest fundamental frequency, Hz	Flo
Standard deviation of the fundamental frequency, Hz	STD
Phonatory fundamental frequency range, semitones	PFR
Fo tremor frequency, Hz	Fftr
Amplitude tremor frequency, Hz	Fatr
Frequency Perturbation Measurements	
Absolute jitter, µs	Jita
Jitter, %	Jitt
Relative average perturbation, %	RAP
Pitch period perturbation quotient, %	PPQ
Smoothed pitch period perturbation quotient, %	sPPQ
Fundamental frequency variation, %	vF0
Amplitude Perturbation Measurements	
Shimmer, dB	ShdB
Shimmer, %	Shim
Amplitude perturbation quotient, %	APQ
Smoothened amplitude perturbation quotient, %	sAPQ
Coefficient of Amplitude Variation, %	vAM
Noise and Tremor Evaluation Measurement	
Noise-harmonic ratio	NHR
Voice turbulence index score	VTI
Soft phonation index score	SPI
Fo tremor intensity index score, %	FTRI
Amplitude tremor intensity index score, %	ATRI
Voice Break, Subharmonic and Voice Irregularity Measurements	
Degree of subharmonics, %	DSH
No. of voice breaks	NVB
No. of subharmonic segments	NSH

Table1: Parameters of MDVP

Subjects

Sixty control subjects (30 males and 30 females) aged 18 to 25 years participated as subjects. All subjects were healthy and had no history of laryngeal or voice pathologic abnormalities. All subjects had normal hearing and orofacial structure.

Procedure

The subjects were seated comfortably in a quiet room. The subjects were instructed to phonate to a microphone which is fixed and placed at distance (2 inches). The subject was then instructed to sustain the vowel /a/ at their comfortable level three times in a comfortable pitch and constant amplitude. To standardize the input amplitude, the input signal was adjusted to a predetermined level. This adjustment prevented signal loss and system overloading.

Four seconds voice sample was selected by trimming few milliseconds in the initial and the final position of the recorded samples. The MDVP analysis was then performed, and the acoustic voice variables were displayed.

Statistical Analysis

The normative data were analyzed using a statistical software program (SPSS). Mean, standard deviation and the range for each acoustic voice variable was calculated. Independent t-test was used to find the significant difference in acoustic voice variables between Indian adult male and female subjects. One sample t-test was used to analyze the significant difference between the western norms and the norms obtained in the present study (Indian norms).

Results and Discussion

1) To establish and compare the normative data in adults across gender.

The mean, standard deviation and the minimum to maximum range of each acoustic voice variable were obtained for male and female subjects. The details regarding the variables are provided in Table 2.

The parameters related to fundamental frequency for female ranged from 187.87 Hz to 268.42 Hz and for male fundamental frequency ranged from 106.71 Hz to 166.56 Hz. The other parameters like average pitch period (T0), lowest fundamental frequency (FL0) and other ranged from 2.21 ms to 4.39 ms for females and for males it ranged from 1.29 to 7.65 ms.

The parameters related to frequency perturbation measurement ranged from 0.56 to 0.99 and absolute jitter (JITA) was 42.77 ms for females and for males the range was from 0.43 to 0.98 and 53.98 ms respectively.

The parameters related to amplitude perturbation measurements ranged from 2.19 to 8.82 in terms of percentage and shimmer (SHDB) was 0.28 in terms of dB for females and for males it was from 2.46 to 10.13 and 0.29 respectively.

Parameters	GENDER							
	Female				Male			
	Mean	SD	Min	Max	Mean	S. D	Min	Max
Fundamental Frequency Information Measurements								
F0	228.26	15.52	192.21	261.87	131.62	12.72	111.96	176.73
MF0	228.52	15.65	192.20	261.86	130.17	14.15	101.92	176.71
T0	4.39	0.30	3.81	5.20	7.65	0.69	5.66	8.97
FHI	237.62	17.28	198.10	268.42	136.51	12.43	114.32	166.56
FL0	219.77	14.45	187.87	255.64	125.49	10.83	106.71	155.96
STD	2.21	0.87	1.24	5.16	1.29	0.35	0.70	1.86
PFR	2.34	.57	1.67	3.67	2.42	.80	1.33	4.67
FFTR	4.10	1.64	1.81	8.17	3.56	1.48	2.19	7.68
FATR	2.64	1.82	.00	4.10	4.19	1.53	2.43	7.05
Frequency Perturbation Measurements								
JITA	42.77	24.15	19.10	139.21	53.98	22.90	19.89	111.37
JITT	.99	.55	.41	2.95	.73	.35	.27	1.64
RAP	.58	.32	.25	1.78	.44	.21	.15	.99
PPQ	.56	.30	.25	1.68	.43	.20	.16	.95
SPPQ	.60	.28	.34	1.67	.63	.20	.27	1.35
VF0	.95	.38	.53	2.42	.98	.26	.47	1.50
Amplitude Perturbation Measurements								
SHDB	.28	.04	.20	.44	.29	.06	.18	.54
SHIM	3.14	.65	.60	3.99	3.33	.72	2.09	5.00
APQ	2.19	.28	1.66	2.70	2.46	.49	1.45	3.66
SAPQ	2.91	.43	2.09	3.81	3.98	.90	1.69	6.19
VAM	8.82	2.10	5.28	13.73	10.13	2.95	5.40	15.77
Noise and Tremor Evaluation Measurement								
NHR	.12	.06	.09	.46	.14	.07	.10	.55
VTI	.04	.03	.02	.21	.03	.00	.02	.05
SPI	14.47	4.60	6.38	23.09	17.59	10.82	6.47	61.99
FTRI	.14	.07	.03	.34	.22	.10	.10	.47
ATRI	1.88	1.89	.00	4.19	2.86	1.55	.53	6.10
Voice Break, Subharmonic and Voice Irregularity Measurements								
DSH	.10	.16	.00	.65	.00	.04	.00	.27
NVB	.00	.00	.00	.00	.00	.00	.00	.00
NSH	.21	.53	.00	2.67	.02	.12	.00	.67

Table 2: Acoustic variables across gender

The parameters related to noise and tremor evaluation measurement scores ranged from 0.04 to 14.47 and for noise to harmonic ratio (NHR) the ratio was 0.12 for females and for males scores were from 0.03 to 17.59 and ratio 0.14 respectively.

The other parameters related to voice break, subharmonic and voice irregularity measurements ranged from 0.00 to 0.21 in terms of number and degree of subharmonics (DSH) was 0.10 in terms of percentage for females and for males it ranged from 0.00 to 0.02 and DSH was 0 respectively.

Independent samples test was used to find the difference across the gender. The results showed significant difference between the male and female subjects which were evident only for few acoustic variables as shown in Table 3. Under fundamental frequency measurements, the acoustic variables included fundamental frequency, mean fundamental frequency, average pitch period, highest fundamental frequency, lowest fundamental frequency, standard deviation of the fundamental frequency. These differences are normal across the gender which may be attributed to the size, length, tension and mass of the vocal folds which determine these factors. Under frequency perturbation measurements, jitter percentage and relative average perturbation showed difference and under amplitude perturbation measurements, amplitude perturbation quotient, smoothed amplitude perturbation quotient had significant difference between the genders, female subjects showing little increase in value compared to male subjects. The significant difference across the gender was evident on few parameters like F0, tremor, intensity index and degree of subharmonics.

Parameters	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Fundamental Frequency Information Measurements			
F0	26.36	58	.000
MF0	25.53	58	.000
T0	23.50	58	.000
FHI	26.00	58	.000
FL0	28.59	58	.000
STD	5.33	57	.000
PFR	.43	58	.668 *
FFTR	.84	22	.406 *
FATR	1.70	15	.110 *
Frequency Perturbation Measurements			
JITA	1.84	58	.070 *
JITT	2.19	58	.032
RAP	2.02	58	.047
PPQ	1.93	58	.058 *
SPPQ	.48	58	.627 *
VF0	.42	57	.675 *
Amplitude Perturbation Measurements			
SHDB	.77	57	.440 *
SHIM	1.02	57	.309 *
APQ	2.67	58	.010
SAPQ	5.86	58	.000
VAM	1.97	58	.054 *
Noise and Tremor Evaluation Measurement			
NHR	.91	58	.362 *
VTI	.82	57	.415 *
SPI	1.42	56	.159 *
FTRI	2.68	37	.011
ATRI	1.12	16	.276 *
Voice Break, Subharmonic and Voice Irregularity Measurements			
DSH	1.11	54	.272 *
NSH	1.93	56	.059 *

Table 3: t value of the acoustic variables across gender. (Note: '*' indicates no significant difference)

The gender difference is apparent in adolescents where there is a substantial drop for male voice compared to female voice. This result is in support with the finding of Sorenson and Horii (1983), who reported higher jitter value in normal female speakers compared to normal male speakers. Vocal jitter has specific method of muscle excitation based on neuro muscular model of Fo and has a specific physiology, where the laryngeal mucosal mechanism contributes for Fo perturbation. Contrary to the present study, Robert and Baken (1984) found higher jitter values in males compared to females. They attribute this difference to Fo. As the Fo increases, the percentage of jitter value decreases. In the present study significant difference was not seen for shimmer parameters. They have found difference with Shridhara (1986) who studied laryngeal waveform of young normal males and females and found that the shimmer value is more for females compared to males. Sussman and Sapienza

(1994) examined the developmental and sex trends in fundamental frequency in 17 boys and 14 girls aged 6.1 to 9.2 years. They found that the fundamental frequency for vowel production of boys and girls (aged <12 years) was not significantly different but were markedly different from men. This is due to the subject selection as they had selected only children.

2) Comparison of acoustic variables between the Indian and Western norms

Parameters	Female groups			
	Indian norms		Western norms	
	Mean	SD	Mean	SD
Fundamental Frequency Information Measurements				
F0	228.26	15.52	243.97	27.45
MF0	228.52	15.65	241.08	25.10
T0	4.39	0.30	4.41	0.43
FHI	237.62	17.28	252.72	26.57
FL0	219.77	14.45	234.86	28.96
STD	2.21	0.87	2.72	2.11
PFR	2.34	0.57	2.25	1.06
FFTR	4.10	1.64	3.07	1.96
FATR	2.64	1.82	2.37	1.74
Frequency Perturbation Measurements				
JITA	42.77	24.15	26.92	16.65
JITT	0.99	0.55	0.63	0.35
RAP	0.58	0.32	0.37	0.21
PPQ	0.56	0.30	0.36	0.20
SPPQ	0.60	0.28	0.53	0.22
VF0	0.95	0.38	1.14	1.00
Amplitude Perturbation Measurements				
SHDB	0.28	0.04	0.17	0.07
SHIM	3.14	0.65	1.99	0.79
APQ	2.19	0.28	1.39	0.52
SAPQ	2.91	0.43	2.37	0.91
VAM	8.82	2.10	10.74	5.69
Noise and Tremor Evaluation Measurement				
NHR	0.12	0.06	0.11	0.00
VTI	0.04	0.03	0.04	0.01
SPI	14.47	4.60	7.53	4.13
FTRI	0.14	0.07	0.30	0.15
ATRI	1.88	1.89	2.65	1.93
Voice Break, Subharmonic and Voice Irregularity Measurements				
DSH	0.10	0.16	0.20	0.10
NVB	0.00	0.00	0.20	0.10
NSH	0.21	0.53	0.20	0.10

Table 4: Indian and Western norms in terms of mean and standard deviation in female group.

Table 4 provides data of acoustic variables between the Indian and Western norms of female and male group of subjects. The statistical analysis, one sample t-test was used to find the differences between the groups of Indian and Western male and female adult subjects. Significant difference was noted between the Western norms and the Indian norms for all the parameters. There was slight variation/increment in frequency and amplitude perturbation measurements in Indian population.

Parameters	Male groups			
	Indian norms		Western norms	
	Mean	SD	Mean	SD
Fundamental Frequency Information Measurements				
F0	131.62	12.72	145.22	27.45
MF0	130.17	14.15	141.74	25.10
T0	7.65	.69	7.05	0.43
FHI	136.51	12.43	150.08	26.57
FL0	125.49	10.83	140.41	28.96
STD	1.29	.35	1.34	2.11
PFR	2.42	.80	2.09	1.06
FFTR	3.56	1.48	3.65	3.73
FATR	4.19	1.53	2.72	1.75
Frequency Perturbation Measurements				
JITA	53.98	22.90	41.66	16.65
JITT	.73	.35	0.58	0.35
RAP	.44	.21	0.34	0.21
PPQ	.43	.20	0.33	0.20
SPPQ	.63	.20	0.56	0.22
VF0	.98	.26	0.93	1.00
Amplitude Perturbation Measurements				
SHDB	.29	.06	0.21	0.07
SHIM	3.33	.72	2.52	0.79
APQ	2.46	.49	1.98	0.52
SAPQ	3.98	.90	3.05	0.91
VAM	10.13	2.95	7.71	5.69
Noise and Tremor Evaluation Measurement				
NHR	.14	.07	0.12	0.00
VTI	.03	.00	0.05	0.01
SPI	17.59	10.82	6.77	4.13
FTRI	.22	.10	0.31	0.15
ATRI	2.86	1.55	2.13	1.93
Voice Break, Subharmonic and Voice Irregularity Measurements				
DSH	.00	.04	0.20	0.10
NVB	.00	.00	0.20	0.10
NSH	.02	.12	0.20	0.10

Table 5: Indian and Western norms in terms of mean and standard deviation in male group.

Significant difference was present between the Indian and the Western norms. During speech using a normal phonatory mechanism a certain degree of variability in frequency is expected and indeed necessary. As Moore (1958) reports presence of small amount of perturbation is required in normal voice. Secondly, more variation in amplitude perturbation is also seen across the genders. This difference could be due to the room acoustics, the microphone placement and the difference in the vocal tract length, mass and tension. Other factors such as intensity, Fo level, and type of phonatory initiation and termination affect the jitter magnitude in sustained phonation (Moore & Von Leden, 1958; Jacob, 1968; Koike, 1973; Hollien, Michel & Doherty, 1973). The other acoustic voice variable, the soft phonation index shows increment when compared with Western norms. The reason for this is the manner of vowel phonation used by subjects. The Western population phonates using more of open mouth with increased loudness whereas the Indian population uses approximately closed mouth with reduced loudness. First the smaller sample size considered for Indian norms could have contributed for the discrepancy between the Western and the Indian norms. Increment in sample size among Indian subjects may be required to validate the results.

The overall difference between the Western and the Indian population is more in female group compared to male group suggesting increased variability in females.

Conclusions

The functional assessment of pathologic voices is commonly achieved using perceptual and equipment-based clinical tools. The lack of consistency and standardization in the basic methods of perceptual assessment continues to be a major clinical problem. Instrumental diagnostic modalities such as video stroboscopy, electroglottography, and phonetography are indispensable components of a modern voice laboratory. This equipment based tools, however, require costly and specialized instrumentation, an experienced clinician, cooperative patients, and interpretation of complicated graphs and mathematical formulae. The main objective of this study was to establish normative Indian database for the MDVP.

This is a first attempt to develop Multi-Dimensional Voice Program (MDVP) norms among Indian population. The results can be attributed as norms which can be clinically used for the Indian population. However, as sample size is comparatively small, there is a need to validate the same results. It is apparent that the measurements of acoustic variable has important application in both diagnosis and treatment of voice disorders. As a final conclusion our skilled ear should be the primary evaluation tool for any voice evaluation. The acoustic analysis should play a supporting role.

References

Andrews, M.L. & Schmidt, C.P. (1997). Gender presentation: Perceptual and acoustical analysis of voice. *Journal of Voice, 11*, 307-313.

Campisi. P, Tewfik. T.L., Pelland-Blais. E, Husein. M. & Sadeghi. N. (2000). Multi-Dimensional Voice Program analysis in children with vocal cord nodules. *Journal Otolaryngology, 29*, 302-308.

Campisi P, Tewfik T.L., Manoukian J.J., Schloss, M.D., Pelland-Blais E. & Sadeghi N. (2002). Computer-Assisted Voice Analysis -Establishing a Pediatric Database. Archives of Otolaryngology Head Neck Surgery. 128, 156-160.

Dwire, A. & McCauley, R. (1995). Repeated measures of vocal fundamental frequency perturbation obtained using the visi-pitch. *Journal of Voice*, *9*, 156-162.

Hollien, H., Michel, J. & Doherty, E.T. (1973). A method for analyzing vocal jitter in sustained phonation. *Journal Phonetics*, *1,* 85-91.

Jacob, L. (1968). A normative study of laryngeal jitter. Unpublished Master's Thesis, University of Kansas.

Kent, R.D. & Ball, M.J. (2000). *Voice Quality Measurement*. San Diego: Singular Publishing Group. Inc.

Koike, Y. (1973). Application of some acoustic measures for the evaluation of laryngeal dysfunction. *Studia Phonologica*, *7*, 17-23.

Moore, P. & Von Leden, H. (1958). Dynamic variations of the vibratory pattern in the normal larynx. *Folia Phoniatricia*, *10*, 205-238.

Moore, P. & Von Leden, H. (1958) cited in Sorensen, D. & Horii, Y. Directional perturbation factors jitter and shimmer. *Journal of Communication Disorders*, *17*, 1983, 143-151.

Multi-Dimensional Voice Program, Model 3950 [operation manual]. Pine Brook, NJ: Kay Elemetrics Corp; 2006.

Putzer, M. (2001). Sighted in Xue S.A. & Deliyski D. (2001). Effects of aging on selected acoustic voice parameters: Preliminary normative data and educational implication. Educational Gerontology, 27, 2, 159-168 (10).

Robert, R. & Baken, R.J. (1984). Cited In Anita. (1994). Multi-Dimensional Analysis of Voice Disorders. Unpublished Master's Dissertation. University of Mysore.

Shridhara, R. (1986). Glottal wave forms in normals'. Unpublished Master's Dissertation, University of Mysore.

Sorenson, D. & Horii, Y. (1983). Directional perturbation factors for Jitter and Shimmer. *Journal of Communication Disorder*, *17*, 143-151.

Sussman. J.E. & Sapienza C. (1994). Articulatory developmental and gender effects on measures of fundamental frequency and jitter. *Journal of Voice. 8*, 145-156.

Xue S.A. & Deliyski D. (2001). Effects of aging on selected acoustic voice parameters: Preliminary normative data and educational implication. Educational Gerontology, *27*, 2, 159-168(10).

Assessment of Voice Quality in Monozygotic Twins: Qualitative and Quantitative Measures

[1]Jayakumar T. & [2]Savithri S. R.

Voice quality is the multidimensional vocal attribute, covering both laryngeal and supra laryngeal aspect. It is generally accepted that the physical characteristics of the laryngeal mechanism and vocal mechanism are genetically determined. It may be hypothesized that monozygotic (MZ) twins voice quality sound similar to certain degree. To measure the voice quality qualitative and the quantitative assessments can be used. The present study investigated MZ twins voice quality using Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) as qualitative and Dysphonia Severity Index (DSI) as a quantitative measure and compared both the voice quality measurements. Twenty pairs (6 M pair, 14 F pair) of MZ twins in the age range of 18 to 25 years were participated. Phonation of a, i, and u were recorded 3 times at comfortable pitch and loudness using Sony mini digital recorder. Five speech-language pathologists carried out qualitative assessment. CSL 4500 was used to measure the frequency and intensity parameters and jitter values. Correlation coefficient was significant (p< 0.01) for all the parameters except strain, loudness, low-Intensity and jitter, and paired't' test showed no significant difference between twins for any of the parameters. Gender difference was significant for maximum phonation time and high fundamental frequency. This difference was attributed to anatomy and physiological variation among gender. High negative Correlation coefficient (r = - 0.78) was found between qualitative and quantitative measurements. DSI also showed good coefficient value with roughness and breathiness of CAPE-V. In conclusion, voice quality of monozygotic twins was similar in many of the parameters of qualitative and quantitative measures. Further investigation with a large scale of sample and confirmed genetic analysis is warranted.

***Keywords**: CAPE-V, DSI, Correlation*

Voice quality is the term that subsumes a wide range of possible meanings, covering both laryngeal and supra laryngeal aspect. Vocal quality serves as a primary means by which speakers project their physical, psychological and social characteristics to the world. It is a multidimensional vocal attribute that is related to the distribution of acoustic energy in the vocal spectrum. Monozygotic twins resemble each other in many aspects like aptitude, habit, taste and style that constitute what we think of as human individuality (Gedda, Fiori & Bruno, 1960). It is generally accepted that the physical characteristics of the laryngeal mechanism, such as vocal fold length and structure, size and shape of the supraglottic vocal tract, and phenotypic similarities elsewhere in the vocal mechanism are genetically determined (Sataloff, 1997). It may be hypothesized that their voice also may sound similar at least to a certain degree. Several research groups have studied genetic similarities in monozygotic twins. Though voice is unique to individuals, studies involving listeners perception have showed the perceptive similarity in monozygotic twins (Decoster, Van Gysel, Vercammen & Debruyne, 2001). Also, several quantitative measures like fundamental frequency in phonation (Przbyla, Hori, & Crawford 1992; Decoster, Van Gysel, Vercammen, & Debruyne 2001; Kalaiselvi, Santhosh & Savithri 2005), speaking fundamental frequency (Debruyne, Decoster, Van Gysel, & Vercammen 2002), formants (Forrai, & Gordos 1983), Dysphonia Severity Index (Van Lierde, Vinck, De Ley, Clement, & Van Cauwenberge 2005) and glottal parameters (Jayakumar & savithri 2008) show similarity in monozygotic twins.

According to the European Laryngeal Society, an assessment of voice disorders should consist of laryngo-stroboscopy, perceptual voice assessment, acoustic analysis, aerodynamic measurement and subjective self-evaluation of voice. Two of the advice assessment tools, the perceptual assessment and the acoustic analysis address the voice quality. The perceptual assessment in its most simple form is a description of the sound of the voice. But it lacks precision and is hardly useful to compare results of individual or

group participants. Besides, communication between clinician will be difficult, which is due to lack of agreement on definition and terminology. On top of that, each clinician has his own internal standard to compare the perceived voice quality (De Bodt, Wuyts, Van de Heyning, & Croux, 1997). To reduce these drawbacks different type of scale have been introduced to score specific aspect of voice quality. The GRBAS scale introduced by Hirano (1981), is widely used. The parameters of this scale are overall Grade, Roughness, Breathiness, Asthenia, and Strain. For each parameter, a four-point scale is used to indicate severity. The inter-rater reliability is moderate (Kreiman, Gerratt, 1998, De Bodt, Wuyts, Van de Heyning, Croux, 1997). Kreiman, Gerratt, Kempster, Erman and Berke (1993) further suggested that scaling system that replies primarily on ordinal or equal-appearing internal scales may have limited reliability potential. They suggested visual analog scaling procedure which could address several limitations of the other approaches. This perspective was incorporated into a new scaling tool produced by a group of clinical speech-language pathologists and voice scientists at Consensus conference for perceptual measure of voice quality by American speech-language hearing Association (ASHA, 2002). The tool was called CAPE-V (Consensus Auditory - Perceptual Evaluation of voice) and used a type of visual analog scaling supplemented by various other descriptors. In CAPE-V apart from Roughness, breathiness, strain, pitch and loudness the judges can introduce the parameters which they feel important for the particular voice ample. Secondly the judges can vary their rating from 0 to 100%. The Standard CAPE-V protocol includes sustained vowel /a/, and /i/, sentence repetition, and a brief sample of conversation.

On the other hand, instrument measurements frequently involve instrumentation to quantify voice quality. They are regarded as less subjective and hence are a more reliable method to document vocal dysfunction. It is therefore not surprising to find the extensive literature identifying which instrument measure can best predict perceptual assessment, with the intention of replacing perceptual evaluation to document voice quality. The results of these studies are inconclusive. (Heman-Ackah, Michael, Goding, 2002 / Heman-Ackah, Heuer, Michael, et al. 2003) Many researchers considered the multi dimensional nature of voice and advocated measure to predict perceptual voice quality (Piccirillo, Painter, Fuller, Haiduk, Fredrickson, 1998a / Piccirillo, Painter, Fuller, Fredrickson, 1998, Wuyts, De Bodt, Molenberghs, et al. 2000, Yu, Ouaknine, Revis, Giovanni, 2001). A disadvantage of some of these

multi parametric methods is the need of specific equipment for some of the Lyapunov coefficient. The Dysphonia Severity Index (DSI) as proposed by Wuyts et. al. (2000) is also an objective multiparametric measurement. The DSI was derived from multivariate analysis of 387 subjects with the goal to describe the perceived voice quality, based on objective measurement it constructed so that perceptually normal voice corresponds with a DSI +5 and severely dysphonic voice corresponds with a DSI of -5, but scores beyond this range are also possible. An Advantage of this DSI is that the parameters can be obtained relatively quick and easily by speech pathologist in daily clinical practice.

Van Lierde et. al. (2005) assessed vocal quality in 45 monozygotic twins (19 males and 26 females). The authors hypothesized that the vocal characteristics and overall vocal quality will be identical in monozygotic twins. They used DSI to measure voice quality, in addition the effect of age and gender on voice quality was also determined. For quality assessment perceptual and objective measurement were made. In subjective assessment GRBAS scale was used. Maximum phonation duration (MPD), voice range, fundamental frequency, jitter, shimmer and DSI were measured for objective assessment. The results showed that the perceptual voice characteristics, the laryngeal, aerodynamic measurement, the vocal performance and the vocal quality by means of DSI were similar in monozygotic twins. But frequency and amplitude perturbation were dissimilar though in the normal range. Additionally results showed no effect of age and gender. But the perceptual voice characteristics were not compared with objective voice parameters. Santhosh & Savithri (2005) investigated acoustic and perceptual characteristics of the speech of five monozygotic twins. The results indicated no significant difference between twins for VOT and closure duration. However, significant differences between twins were noticed for vowel duration. Perceptual evaluation indicated significant difference between four twin pairs for all parameters, except articulation. Jayakumar & savithri (2008) investigated similarity of voice source in monozygotic twins using inverse filtering and the consistency of inverse filtered parameters. 6 monozygotic twins and matched unrelated pairs voice were investigated. Vag_physio module of VAGHMI software was used for inverse filtering. Results showed no significant difference between groups on voice source characteristics, specially the open quotient (OQ) and speed quotient (SQ) was more similar than unrelated pairs group. However further investigation on twin pairs

selection based on perceptual similarity and confirmed genetic analysis was recommended by the researches.

Hakkesteegt, Brocaar, Wieringa, Feenstra, (2008) compared the GRBAS scale with DSI. The result showed that the range of DSI with in each G score was quite large, possibly due to differences in severity of dysphonia that was not reflected in the G score. They also reported DSI cut off 3.0 to differentiate between groups of individual with and without voice complaints. Hence, the limited insight necessitates further investigation on the voice characteristics of monozygotic twins. Also, comparison between Quantitative and Qualitative measure using limited range of equal-appearing interval scale (GRBAS) did not comprehensively reflect the consistency of the measurement, due to it is larger interval. To address these issues the present study aimed at investigating monozygotic twins' voice quality using CAPE-V as qualitative and DSI as a quantitative measure and comparing both the measurements.

Method

Participants: Twenty pairs (6 male pair, 14 female pairs) of monozygotic twins in the age range of 18 to 25 years (mean = 22.5 yrs) were participated in the study. Criteria for selecting monozygotic twins include (a) they should be same in gender, (b) Should have approximately similar height and weight. (c) Should have same blood group. None of the participant had any unstable voice, voice disorders, speech disorders, neuro-motor disorders, endocrinal disorders and/or hearing disorders.

Procedure and Measurements

Qualitative: The recording was made in quiet room. Participants phonated vowels |a|, |i|, & |u| three times for a minimum of five seconds at comfortable pitch and loudness. Sony mini digital recorder (MZ-R3, Sony Corporation, Japan) was used to record all the voice samples. CAPE-V scale was used as a qualitative scale for the voice assessment. In current study only vowel voice sample was used unlike standard vowel, sentences and brief conversation samples for CAPE-V scale. Five speech language pathologists (Master holders) were judged the MZ Twin voice samples.

Quantitative: A DSI measurement is a multi parameter approach to objectively measure the voice quality. DSI is based on the weighted combination of the following selected set of voice measurements: highest frequency (in hertz), lowest intensity (in decibels), maximum phonation duration (in sec), and jitter (in percent). It ranges

from +5 to -5 respectively in healthy and severe dysphonic voice. It will be calculated as follows:

$$DSI = 0.13(MPT) + 0.0053 \text{ (high F0)} - 0.02(\text{low intensity}) - 1.18(\text{jitter \%}) + 12.4$$

Frequency and Intensity: The subjects were instructed to phonate vowel |a| as softly as possible at a comfortable pitch. After that they were asked to phonate vowel |a|, starting at a comfortable pitch going up to the highest and down to the lowest pitch. The clinician prompted and modelled the subject to achieve the highest possible pitch.

Maximum phonation time: The subjects were instructed to inhale deeply and sustain vowel |a| for as long as possible at a comfortable pitch and loudness. This was recorded three times the longest phonation time was used for further analysis.

Jitter: Subjects phonated vowel |a| 3 times at a comfortable pitch and loudness 5 seconds. The percentage jitter was calculated on a sample of 4 seconds, starting a half second after voice onset. To rule out technically invalid measurement due to correct marking of the voiced periods, the lowest of the three calculations was used.

Analyses: Monozygotic twins voice sample were judged by 5 speech-language pathologists who had one years of experience after the completion of master degree. Two samples were repeated once to check the test re-test reliability of the subjects, which showed 73% correlation. CSL 4500 was used to measure the frequency and intensity parameters and jitter values. MPT was calculated using stopwatch. To check the test re-test reliability 10% of the sample was re-analyzed using the same instrument, which showed 98% reliability.

Statistical analysis: SPSS 15 was used to make the statistical calculation. Paired t- test was used to find the difference between twins's pairs for qualitative and quantitative measures. Mann-Whitney 'U' test was performed to find the gender difference. Pearson product correlation was used to find the relation between the qualitative and quantitative measurements.

Results

Vocal characteristics in MZ Twins

Results of paired t test indicated no significant difference between twin pairs on any of the qualitative and quantitative parameters. The correlation between twin pairs was significantly high on breathiness, Roughness, Pitch, Overall severity (qualitative), and MPT, High-F0, and DSI

(qualitative). Table 1 shows the mean, SD, r-value   and p-value for all measures.

	Qualitative parameter (CAPE-V)					
	Roughness	Breathiness	Strain	pitch	Loudness	**Overall**
Mean (SD)	4.1(4.9)	6.5(6.7)	5.2(6.5)	5.8(5.6)	1.5(2.8)	**13.8(10.1)**
r-value(Pearsons)	0.56**	0.66**	0.39	0.59**	0.34	**0.83****
p-value (paired t)	0.48	0.13	0.37	0.05	0.06	**0.20**
	Quantitative parameter (DSI)					
	MPT	High-F0	Low Int		Jitter (%)	**DSI**
Mean (SD)	14.6(2.9)	919(123)	55.3(2.8)		0.80(.43)	**3.82(1.1)**
r-value(Pearsons)	0.74**	0.92**	0.29		0.40	**0.74****
p-value (paired t)	0.23	0.12	0.74		0.36	**0.06**

Table 1: Mean, SD, r-value, and p-value of all parameters.**(p<0.01)

Gender difference: Mann-Whitney 'U' test showed gender difference for MPT* (z = 0.042) and F0-high** (z=0.002) Value.

Comparison of Qualitative and Quantitative Evaluation

Over all DSI and CAPE-V values were negatively correlated (r = - 0.78, p<0.01). CAPE-V values increased with decrease on overall DSI values. Figure 1 shows the scatter plot of CAPE-V on X-axis and DSI on Y-axis.

DSI was correlated with two of the CAPE-V parameters. DSI was negatively correlated with roughness (r= -0.43, P<0.01), breathiness (r= -0.36, p<0.05). Figures 2 and 3 show the scatter plot of DSI with roughness and breathiness, respectively. Figure 2 & 3 shows scatter plot of DSI Vs Roughness and Breathiness.
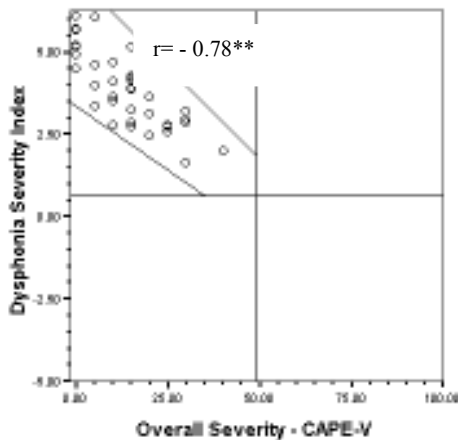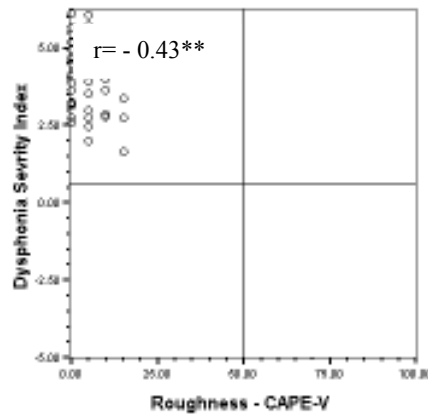

Figure 2: Scatter plate of DSI Vs Roughness

Figure 1: Scatter plate of DSI Vs CAPE-V scale.
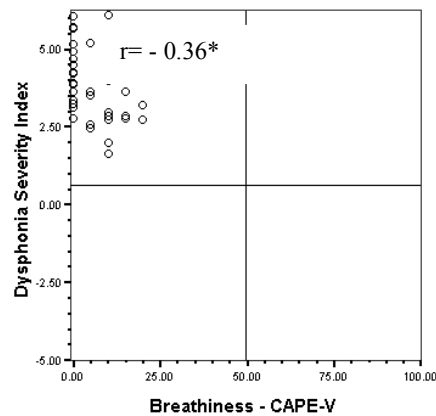

Figure 3: Scatter plate of DSI Vs Breathiness.

Also, jitter had positive correlation with overall severity, roughness, breathiness and strain on CAPE-V. Table 2 shows the r-value of jitter with each of the CAPE- V parameters.

r	Jitter
Overall severity	0.36*
Roughness	0.32*
Breathiness	0.60**

Table 2: r – value of jitter, across CAPE-V.

Discussion

Few studies have investigated the vocal characteristics in monozygotic twins. The picture that emerges from the existing studies show similarities in fundamental frequency, voice onset time, voice quality, glottal parameters, and formant frequency. However, the results were inconsistent across the studies. Also there is inconsistent correlation between qualitative and quantitative measurements of voice monozygotic twins. The Current study investigated the voice quality in monozygotic twins using CAPE-V and DSI.

The objective of the study was to compare the qualitative and quantitative measurements of voice quality of monozygotic twins using CAPE-V and DSI. The results revealed several interesting points. First, there was no significant difference between twin pairs on any of the qualitative and quantitative measurements was observed. The results are in consonance with Van Lierde et al. (2005). They showed perceptual voice characteristics; the laryngeal, aerodynamic measurement, the vocal performance and the vocal quality by means of DSI were similar in monozygotic twins. But frequency and amplitude perturbation were dissimilar. Mann-Whitney 'U' test showed gender different for MPT and Fo-high among all the qualitative and quantitative assessment. These differences can be attributed to the anatomy and physiological difference in respiratory and phonatory difference among gender.

Secondly, DSI had high negative correlation between overall severity, and negative correlation between roughness and breathiness of CAPE-V. As the severity of voice increased DSI value decreased, which is an expected result. Hakkesteegt et al (2008) investigated 294 clients with voice compliant and 118 volunteers without voice complaint. The result showed that DSI significantly lower when the score on GRBAS grade was high. Also, DSI cut off 3.0 to differentiate between groups of individual with and without voice complaints. With a cut off 3.0, Maximum sensitivity (0.72) and specificity (0.75) were found. The current study also shows sensitivity value of 0.70 as DSI cut off being 3.0. High negative Correlation coefficient value($r = -0.78$) clearly reflects the relationship qualitative and quantitative assessment.

Third, jitter positively correlated with breathiness, roughness and overall severity. Breathiness, roughness and overall severity increased as the jitter percentage increases. Dejonckere, Remacle , Fresnel-Elba, Woisard, Crevier-Buchman, Millet (1996) investigated 943

voice patients and showed a good correlation between jitter and roughness on GRBAS scale.

In conclusion, voice quality of monozygotic twins was similar in many of the parameters of CAPE-V (qualitative) and DSI (quantitative). The correlation coefficient was significant between qualitative and quantitative parameters. Also DSI had good correlation with perceived roughness and breathiness of CAPE-V scale. DSI can be used as voice quality measurement to differentiate minimal changes like, comparing monozygotic twins voices and even to monitor the progress of voice therapy. Further investigation with a large scale of sample and confirmed genetic analysis is warranted.

References

ASHA. (2002). http://www.asha.org/about/ mem bership-certification/divs/div_3.htm

De Bodt, M. S., Wuyts, F. L., Van de Heyning, P. H., Croux , C. (1997). Test-retest study of the GRBAS scale: influence of experience and professional background on perceptual rating of voice quality. *Journal of Voice*, 11, 74–80.

Debruyne, F., Decoster, W., Van Gysel, A., & Vercammen, J. (2002). Speaking fundamental frequency in monozygotic and dizygotic twins. *Journal of Voice*, 16, 466-471.

Decoster, W. A., Van Gysel, A., Vercammen, J., & Debruyne, F. (2001). Voice similarity in identical twins. *Acta Oto Rhino laryngological belg*, 55, 49-55.

Dejonckere, P. H., Remacle, M., Fresnel-Elbaz, E., Woisard, V., Crevier-Buchman, L., Millet, B. (1996). Differentiated perceptual evaluation of pathological voice quality: reliability and correlations with acoustic measurements. Rev Laryngol Otol Rhinol (Bord), 117(3), 219-24.

Forrai, G., & Gordos, G. (1983). A new acoustic method for the discrimination of monozygotic and dizygotic twins. *Acta paediatrica Hungarica*, 24, 315-321.

Gedda, L., Fiori, R., & Bruno, G. (1960). Viox chez les jumeaux monozygotiques. *Folia phoniatrica,* 12, 81-94

Hakkesteegt, M. M., Brocaar, M. P.,Wieringa, M. H., Feenstra, L. (2008). The relationship between perceptual evaluation and objective multiparametric evaluation of dysphonia severity. *Journal of Voice*, 22, 138–145.

Heman-Ackah,Y. D., Michael, D. D., Goding, G. S., (2002). The relationship between cepstral peak prominence and selected parameters of dysphonia. *Journal of Voice*, 16, 20–27.

Heman-Ackah, Y. D., Heuer, R. J., Michael, D. D., et al. (2003). Cepstral peak prominence: a more reliable measure of dysphonia. *Ann Otology Rhinology & Laryngology,* 112, 324–333.

Hirano, M. (1981). *Clinical Examination of Voice*. Wien; New York: Springer.

Jayakumar, T & Savithri, S. R. (2008). Investigation into voice source of monozygotic twins using formant based inverse filtering. *Journal of the All India Institute of Speech &Hearing,* 27, 8-14.

Kalaiselvi, P. S., Santhosh, M., & Savithri, S. R. (2005). Multi dimensional analysis of voice in monozygotic twins. *Journal of the Acoustical Society of India*, C, 25-28.

Kreiman, J., Gerratt, B. R. (1998). Validity of rating scale measures of voice quality. Journal of Acoustic Society of America, 104(3 Pt 1):1598–1608.

Kreiman, J., Gerratt, B. R., Kempster, G. B., Erman, A., Berke, G. S. (1993). Perceptual evaluation of voice quality: review, tutorial, and a framework for future research. *Journal of Speech and Hearing Research,* 36, 21–40.

Piccirillo, J. F., Painter, C., Fuller, D., Haiduk, A., Fredrickson, J. M. (1998a). Assessment of two objective voice function indices. *Ann Otology Rhinology & Laryngology,*107, 396-400.

Piccirillo, J. F., Painter, C., Fuller, D., Fredrickson, J. M. (1998). Multivariate analysis of objective vocal function. *Ann Otology Rhinology & Laryngology,* 107, 107-112.

Przbyla, B., Horii, T., & Crawford, M. (1992). Vocal fundamental frequency in a twin sample: looking for a genetic effect. *Journal of Voice*, 6, 261-266.

Sataloff, R. (1997). *Professinal Voice, the Science and Art of Cliniccal Care.* Singular Publishing Group, San Diego: CA.

Santosh, M., & Savithri, S. R. (2005). Voice prints in monozygotic twins. *Journal of the Acoustical Society of India*, C, 1-7.

Van Lierde, K. M., Vinck, B., De Ley, S., Clement, G., & Van Cauwenberge, P. (2005). Genetics of vocal quality characteristics in monozygotic twins: a multiparameter approach. *Journal of Voice*, 19, 511-518.

Wuyts, F. L., De Bodt, M. S., Molenberghs, G., et al. (2000). The Dysphonia Severity Index: an objective measure of vocal quality based on a multiparameter approach. *Journal of Speech and Hearing Research*, 43, 796-809.

Yu, P., Ouaknine, M., Revis, J., Giovanni, A. (2001). Objective voice analysis for dysphonic patients: a multiparametric protocol including acoustic and aerodynamic measurements. *Journal of Voice*, 15, 529-542.

Acknowledgements

Influence of Native Language on Nasalance Measurement

[1]Leah Philip, [2]Pushpavathi M. & [3]Sangeetha Mahesh

Abstract

'Nasalance' is influenced by many parameters such as age, dialect, native language and gender. Measurement of nasalance is usually done for standard passages such as Zoo passage, Rainbow passage and standard oral and nasal speech stimuli. However, the normative data of native English speakers for the same cannot be considered, as native language influence may play a significant role. Hence, the present study aimed at investigating the influence of three native languages (Kannada, Malayalam and Hindi) on nasalance values for standard Zoo passage, and compared the same with established data. The mean nasalance values were obtained from thirty normal adult females (17-35 years) each, having native language as Kannada, Malayalam and Hindi, while they read the Zoo passage, using Nasometer II 6400. Results indicated higher nasalance scores in Hindi and Malayalam speakers. The mean nasalance score for native Kannada speakers was found to be significantly lower than that in other two languages. Comparison of the results with the standard norms provided for English speaking individuals revealed similar mean nasalance values for native Kannada speakers. However, nasalance scores of native Malayalam and Hindi speakers were found to be significantly higher. These differences can be explained based on the phonemic characteristics of these languages. These inherent features of the language are also reflected in reading English. The results indicate that mean nasometric values obtained for a specific linguistic group may not be valid with other language speakers, even though they speak the same language. Thus, the results highlight native language as a factor influencing nasalance of normal reading. It is essential that for establishing normative data for Nasometer, issues pertaining to native language and dialect need to be considered.

Key Words: Nasalance, Zoo passage, Nasometer, linguistic influence

Nasality is a common problem in subjects with repaired / un-repaired cleft palate, which in turn affects speech intelligibility. Increased nasal resonance is not only seen in disordered speech, even normal speech may have some amount of nasality (for example, perceptually, it appears that Malayalam has more nasal consonants compared to other languages (Syamala Kumari (1972). The term nasality refers to an auditory impression about speech and is not a precise physical variable. The primary underlying physical variable is the opening and closing of the velopharyngeal port. Hyper nasal speech is when there is the presence of an abnormally increased nasal airflow during oral speech sounds.

Nasality is an aspect of voice "quality" traditionally assessed by the perceptions of professionals involved in the evaluation and treatment of resonance disorders. However, despite the importance of perceptual evaluation, there is also a need for objective measurement.

Many devices have been developed for objective measurement of nasality. Nasometer, a microcomputer-based instrument developed by Kay Elemetrics in 1986 is one such device. The Nasometer is an easy, non-invasive method, which provides the user with a numeric output indicating the relative amount of nasal acoustic energy in subject's speech. The Nasometer has been used both clinically and in research studies to measure the acoustic correlate of nasality. Several speech samples and reading material are included in the nasometry package for use in assessment of nasal resonance. Some of the more commonly used standard material for evaluation of nasality include Rainbow passage (Fairbanks, 1960) and Zoo passage (Fletcher, 1972).

Since the Nasometer was introduced in 1986, several articles have appeared in the literature on developing normative data in various languages. These studies have indicated that nasalance scores vary across languages (Anderson, 1996;

[1]*Speech Language Pathologist, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:lee_philip21@yahoo.com, [2]Reader and Head Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570 006, email:pushpa19@yahoo.co.in, [3]Clinical Lecturer, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:sangmahesh9@yahoo.co.in,.*

Van Doorn & Purcell, 1998; Van Lierde, 2001; Whitehill, 2001; Van Lierde, Wuyts, Bodt & Cauwenberge, 2003; Sweeney, Sell, & Regan, 2004. However, there is limited data on nasometric values in Indian languages. Normative data is available for English, as most of the studies have been conducted on native English speakers. However, these studies indicated that not all native English speakers obtained the same nasalance scores.

Litzaw and Dalston (1992) studied the nasalance scores, nasal cross-sectional area and fundamental frequency of fifteen adult males (mean age of 24 years) and females (mean age of 28 years) who spoke the Mid Atlantic dialect of English. The stimuli used for nasalance measurement included standard Zoo and Rainbow passages, and, a series of nasal sentences. The mean nasalance scores, compared with mean nasalance scores for other dialects of English such as American English (Fletcher et al, 1989), Midwestern, Ontario and Southern American (Seaver et al, 1991), was higher. In the Indian context, Mahesh and Pushpavathi (2008) also reported significant differences in nasalance scores comparing native and non-native English speakers. Their subjects constituted of Indian speakers with English as second language. Several factors such as the dialect spoken and gender have been attributed to these differences in mean nasalance scores (Seaver, Dalston, & Leeper, 1991).

Anderson (1996) also reported native language as a factor that influences nasalance of normal speech. Leeper, Rochet, & MacKay (1992) obtained nasalance scores for French from bilingual Canadian subjects. The stimulus items in French were correlated with the standard English passages used to obtain the English normative data (Zoo passage and Rainbow passage). Bilingual English-French speakers obtained different mean nasalance scores across the languages. As suggested by Leeper et al. (1992) differences in phonetic contexts and differential use of nasal consonants and vowels results in differences in nasalance values across languages in these bilingual speakers. Several hypotheses were also provided to explain the differences such as: (1) different qualities of nasal phoneme (consonants and vowels) production in each language, (2) the balance of nasals between equivalent passages in the two languages, and (3) coarticulation of nasal phonemes and segments. Nasal phonemes in English are consonants and coarticulated nasalized vowels and in French a large proportion of the nasal phonemes are nasalized vowels. Hence they concluded that the VP mechanism functions in part by an articulatory

set typical of a particular dialect and/or language. Results of the above studies suggest effect of cross-linguistic differences in nasalance values.

These studies would substantiate the necessity of developing normative data in different Indian languages, which becomes important as speech pathology clinics in India are using the Nasometer to confirm the perceptual judgment of abnormal levels of speech nasality.

The primary purpose in providing normative data for a given language is clinical; such information is necessary to assist in evaluation and management of persons with resonance disorders. In addition to the clinical implications, investigations and comparisons of nasalance from different languages would be of theoretical benefit because they facilitate our understanding of the influence of linguistic and socio-cultural factors on resonance judgment and measurement. Hence, it would be of significance to explore the influence of three Indian languages (Hindi, Kannada, and Malayalam) on nasalance values using standard Zoo passage. English, being a global language is widely used in India and as such, nasalance measurement is also done in English, using standard passages (Zoo and rainbow passage). However, using English normative data for comparison may not be reliable as native language may influence nasalance measurement. In this context, the present study investigated the native language influence on nasalance measurement using standard English passages.

The objective of this study was to investigate the influence of three Indian languages (Kannada, Malayalam, and Hindi) on nasalance values using standard Zoo passage and to compare these nasalance values of Zoo passage with the established data.

Method

Participants: Thirty females in the age range of 18 to 30 years, for each of the three language groups (Kannada, Malayalam, and Hindi) participated in the present study. The subjects in each group had the respective language as their first language. All the subjects had learnt English as a second language. All the subjects had normal structure and function of the orofacial structures.

Test stimuli: Zoo passage (Fletcher, 1962), a Standard English passage commonly used for nasalance measurement was used. The "Zoo passage" contains no nasal consonants and is loaded with only high-pressure oral consonants.

Instrumentation: The Nasometer II Model 6400, a microcomputer based system (Kay Elemetrics,

New Jersey) was used in the present study. The oral and nasal components of the subject's speech are sensed by microphones on either side of a sound separator that rests on the patient's upper lip. Nasometer computes a ratio of the nasal acoustic energy to the nasal – plus - oral acoustic energy from the digitized signals. Nasalance is expressed as a percentage value computed from that ratio (nasalance = nasal / {oral + nasal} * 100).

Procedure: Prior to data collection, the instrument was calibrated as per the guidelines provided in the manual. Subjects were then seated in a quiet setting with the Nasometer headpiece adjusted so the separation plate rested comfortably but firmly on the subject's upper lip and perpendicular to the plane of the face. Each subject read the standard Zoo passage. The mean nasalance score as well as minimum and maximum nasalance scores were computed for each of the subjects, using the Nasometer software package.

Results

Results indicated high nasalance percent in Hindi compared to Malayalam and Kannada. The mean, minimum and maximum score and standard deviation for the Zoo passage for the three languages are in table 1. Figure 1 depicts mean nasalance scores for all the three languages.

Language	Parameter	Mean	SD
Kannada	Min	2.40	1.25
	Max	91.57	10.30
	Mean	**19.53**	7.56
Malayalam	Min	2.87	2.09
	Max	92.57	7.06
	Mean	**24.73**	7.99
Hindi	Min	3.77	3.38
	Max	94.03	3.58
	Mean	**25.37**	7.19

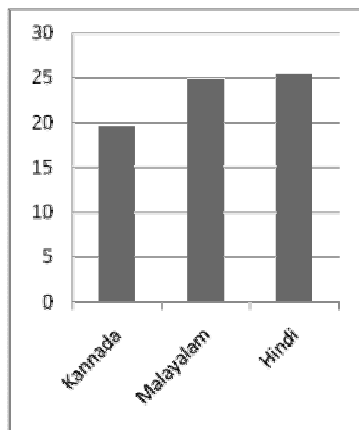**Table 1:** Mean and SD scores across different languages

Figure 1: Mean scores for different languages

Results of One-way ANOVA showed significant differences (F [2, 87] = 5.335, p<0.05) across the languages. Duncan's post hoc analysis revealed that Kannada had significantly lower nasal scores compared to Malayalam and Hindi. Interestingly, no significant difference was observed between Malayalam and Hindi.

Independent t test was done to compare the mean nasalance score for each of the three groups (Kannada, Malayalam and Hindi) considered in the present study with a Western [Litzaw and Dalston (1992)] and an Indian study [Mahesh and Pushpavathi (2008)]. Results revealed that mean nasalance scores of native Kannada speakers was in consensus with that of the established data, whereas mean nasalance values of native Hindi and Malayalam speakers were significantly higher compared to the established data. The results are given in table 2.

		Studies	
		Litzaw and Dalston (1992)	Mahesh and Pushpavathi (2008)
Kannada	Subjects	Females	Females
	"t" value	T(18) = 1.10	T(18.46) = 0.77
	"p"value	> 0.05	> 0.05
Malayalam	Subjects	Females	Females
	"t" value	T(18) = 4.618	T(18.46) = 4.302
	"p"value	< 0.001	< 0.001
Hindi	Subjects	Females	Females
	"t" value	T(18) = 5.605	T(18.46) = 5.255
	"p"value	< 0.001	< 0.001

Table 2: Nasalance values across languages with established data

Discussion

The current study analyzed the influence of native language on the nasalance scores using the standard English Zoo passage. Results showed mean nasalance scores for Zoo passage obtained for native Kannada speakers to be significantly lower compared to native Malayalam and Hindi speakers. Interestingly, though mean nasalance score for native Hindi speakers was found to be higher compared to that of native Malayalam speakers, no significant difference was obtained. Also, it was seen that mean nasalance scores of native Kannada speakers was in consensus with that of the established data, whereas mean nasalance values of native Hindi and Malayalam speakers were significantly higher compared to established data. This study provides support for the intrinsic characteristics of the velopharyngeal closure which vary based on the age, gender, stimulus length and phonetic characteristics.

These differences in mean nasalance scores across native language groups may be attributed to the phonemic characteristics of these languages. Consequently, the number of nasal sounds in the respective language as well as frequency of occurrence of nasal sounds may be an important factor. This also depends on the influence of nasalized consonants on the adjacent speech sounds due to the coartculation. The difference in nasalance scores, various dialects and languages represents difference in amount of "*Inherent nasal quality*" among speakers of different regions and languages. Since Malayalam speakers have *"Inherent nasal quality"* they also use the same while speaking other languages. Dialects, accents or languages that use more high vowels or higher tongue positions might be expected to have higher nasalance scores as compared to those with a greater incidence of low vowels or lower tongue position. There may be a difference in dialect between the timing of velopharyngeal closure when transition is made between nasal consonants and vowels. Difference in mean nasalance scores across language may be explained by different use of vowels and oral and nasal consonants across language (Anderson, 1996).

Hindi has five nasal sounds mainly, velar, palatal, dental, alveolar and bilabial of which three are more prevalently used. In addition to these nasal sounds, nasalization is also highly prevalent, which may account for increased nasal resonance. Malayalam has six nasal consonants, all of which are prevalently used, whereas, Kannada has five nasal consonants of which only four are commonly used (bilabial, alveolar, dental and retroflex).

The frequency of usage of different sounds has been studied (Ramakrishna et al, 1962). Looking at the frequencies of nasal sounds in Kannada, Hindi and Malayalam, it can be seen that nasals are more prevalently used in Hindi and Malayalam as compared to Kannada. The frequency of occurrence of nasal sounds in Kannada, Malayalam and Hindi are given in Table 3.

	m (bilabial)	n (alveolar)	n (palatal)	ng (velar)	n (retroflex)	Total
Kannada	2.00	4.90	0	0.03	0.65	7.58
Malayalam	2.65	7.55	0.43	0.82	1.36	12.81
Hindi	2.98	4.02	0.15	0.17	0.74	8.06

Table 3: Frequency of occurrence of nasal sounds (in %)

These inherent characteristics of the native languages may influence articulatory characteristics in spoken English. Again, these factors can explain the significant difference seen between the mean nasalance scores of Mid Atlantic English (Litzaw and Dalston, 1992)

speakers and native Hindi and Malayalam speakers, for standard Zoo passage.

Again, the nasal characteristics of Kannada and Mid Atlantic English (Litzaw and Dalston, 1992) may hold certain similarities which may account for similar mean nasalance scores. However, further research is warranted to validate the same. Also, similarity in mean nasalance scores of native Kannada speakers obtained in this study and the Indian study (Mahesh and Pushpavathi, 2008) may possibly be explained by the subject population chosen in the Indian study, which may have included more number of subjects with Kannada as their native language.

To conclude, the results of the present study are in consensus with that of Anderson (1996), who reported native language as a factor that influences nasalance of normal speech. Thus, it is essential that for establishing normative data for Nasometer, issues pertaining to native language and dialect need to be considered. Mean nasometric values obtained for a specific linguistic group may not be valid for use with other groups, even though they may speak the same language. This study is an initial step to ascertain the influence of native languages on nasalance measurement. This signifies the essentiality to develop normative data for different linguistic and dialectal populations. Clinically, the normative data reported in the present study may help identify the clients with resonance disorders.

Conclusions

An exploration of mean nasalance scores across native Hindi, Malayalam and Kannada speakers, for Zoo passage revealed native language as one of the factors influencing nasalance of normal speech. Thus, it puts emphasis on the necessity of considering issues pertaining to native language and dialect while establishing normative data for Nasometer especially in the Indian context as linguistic and cultural diversity are gaining more relevance.

References

Anderson, R.T. (1996). Nasometric values for normal Spanish speaking females: A preliminary report. *Cleft Palate Craniofacial Journal, 33*, 333-336.

Fletcher, S.G. (1972). Contingencies for bio-electronic measurement of nasality. *Journal of Speech and Hearing Disorders, 37*, 329-346.

Fletcher, S.G., Adams, L.E. & Mc Cutcheon, M.J. (1989). Cleft palate speech assessment through oral-nasal acoustic measures. In:, K.R. Bzoch, ed. Communicative Disorders Related to Cleft Lip and Palate. Boston: Little, Brown, 246-257.

Leeper, H. A., Rochet, A. P., & MacKay, I. R. A. (1992). Characteritics of nasalance in Canadian speakers of English and French. Presented at the International Conference on Spoken language Processing (Abstract), Banff, Alberta, 49-52.

Litzaw, L.L., & Dalston, R.M. (1992). The effect of gender upon nasalance scores among normal adult speakers. *Journal of Communication Disorders, 25 (2),* 55-64.

Mahesh, S. M.,& Pushpavathi, M. (2008). Nasalence value for zoo passage: a preliminary report. Proceedings of the International Symposium"Frontiers of Research on Speech and Music, 115 – 119.

Ramakrishna, B. S., Nair, K. K., Chiplunkar, V. N., Atal, B. S., Ramachandra, V., & Subramanian, R. (1962). Some Statistics of Indian Languages. In Some Aspects of the Relative Efficiencies of Indian Languages. Catholic Press, Ranchi, India, 12-17.

Seaver, E.J., Dalston, R.M., & Leeper, H.A. (1991). A study of nasometric values for normal nasal resonance. *Journal of Speech and Hearing Research*, *34,* 715-721.

Syamala Kumari. B (1972). Malayalam Phonetic Reader .CIIL Publications . Mysore .

Sweeney, T., Sell, D., & O'Regan, M. (2004). Nasalance scores for normal speaking Irish children. *Cleft Palate Craniofacial Journal*, *41(2),* 168-174.

Van Doorn, J., & Purcell, A. (1998). Nasalance level in speech of normal Australian children. *Cleft Palate Craniofacial Journal*, *35,* 287-292.

Van Lierde, K. M., Wuyts, F. L., De Bodt, M., & Van Cauwenberge, P. (2001). Normative value for normal nasal resonance in the speech of young Flemish adults. *Cleft Palate Craniofacial Journal*, *38,* 112-118.

Van Lierde, K. M., Wuyts, F. L., Bodt, M., & Cauwenberge, P. (2003). Age related pattern of nasal resonance in normal Flemish children and Young adults. *Scandinavian Journal of Plastic Reconstructive Surgery*, *37,*344-350.

Whitehill, T. L. (2001). Nasalance score in Cantonese speaking women. *Cleft Palate Craniofacial Journal*, *38,* 119-125.

Gene- Environment Interaction in Speech and Language Development- A Case Study of Monozygotic Twins

[1]Maya Sanghi, [2]Sidheshwar Pandey & [3]Hetal Shah

Abstract

Heritability of speech and language disorders is not a simple, straightforward process. There is good evidence that genetic factors play a role in the etiology of speech and language impairment; twin data may help us arrive at a clearer conception of the phenotype as well as quantifying the extent of the genetic contribution. By investigating identical and non-identical twins, researchers have been able to deduce that genetic variability plays a big role in determining whether or not a child will have developmental language problems. The current scientific view is that neither genetics nor environment is solely responsible for producing individual variation, and that virtually all traits show gene-environment interaction. In identical twins, DNA is same and they are brought up in the same surroundings hence case studies of the identical twins help us to study the effect of genetics, environment or both. Case studies also help in better understanding about the nature of the disorder. Aims of the study were 1)To improve our understanding of the nature of the speech and language disorder in identical twins and thereby facilitate further research in this area.2)To share the experience of working with a pair of identical twins with concomitant speech and language disorders. For assessment, 3D Language Acquisition test, Linguistic Profile Test, Stuttering Severity Index, Stuttering Chronicity Prediction Checklist and Pure Tone Audiometry were done. Possible causes of stuttering in the twins under study may be the interaction of genetic predisposition and precipitating factors such as home environment, competitive pressure etc. This paper also highlights the need for the clinicians to be alert about the speech language problems twins are prone to and the need to work in close co-operation with the pediatricians to prevent the developmental communication disorders in this population.

Key Words: Genetics, Environment, SSI, LPT, 3DLAT

Heritability of speech and language disorders is not a simple, straightforward process. In complex behavioral traits, such as stuttering, it can be difficult to identify the contribution of gene or genes and their interaction with environmental factor. One or more genes may be responsible for the underlying susceptibility of stuttering and they may have wider effects and cause susceptibility to other disorders as well. They may also interact with other genes to cause variety of effects (Yairi, Ambrose & Cox, 1996). Conditions that sometimes coexist with stuttering, such as phonologic disorders, learning deficits, and lower intellectual function, may be explained in this fashion. There is good evidence that genetic factors play a role in the etiology of speech and language impairment; twin data may help us arrive at a clearer conception of the phenotype as well as quantifying the extent of the genetic contribution. By investigating identical and non-identical twins, researchers have been able to deduce that genetic variability plays a big role in determining whether or not a child will have developmental language problems.

Fraternal twins (commonly known as "non-identical twins") usually occur when two fertilized eggs are implanted in the uterine wall at the same time. The two eggs form two zygotes, and these twins are therefore also known as dizygotic as well as "biovular" twins. Dizygotic twins, like any other siblings, have an extremely small chance of having the exact same chromosome profile.

Identical twins occur when a single egg is fertilized to form one zygote (monozygotic) which then divides into two separate embryos. Although their traits and physical appearances are not exactly the same due to environmental conditions both in and outside the womb, they do have identical DNA. The two embryos develop into fetuses sharing the same womb. When one egg is fertilized by one sperm cell, and then divides and separates, two identical cells will result. If the zygote splits very early (in the first 2 days after

fertilization) they may develop separate placentas (chorion) and separate sacs (amnion). These are called dichorionic, diamniotic (or "di/di") twins, which occurs 20-30% of the time (which is present in our case study). Most of the times in identical twins the zygote will split after 2 days, resulting in a shared placenta, but two separate sacs. These are called monochorionic, diamniotic ("mono/di") twins. In about 1% of identical twins the splitting occurs late enough to result in both a shared placenta and a shared sac called; monochorionic, monoamniotic ("mono/mono") twins (Nieuwint, Van Zalen-Sprock, Hummel, Pals, Van Vugt, Van Der Harten, Heins, & Madan, 1999).

Concordance as used in genetics usually means the presence of the same trait in both members of a pair of twins. However, the strict definition is the probability that a pair of individuals will both have a certain characteristic; given that one of the pair has the characteristic. For example, twins are concordant when both have or both lack a given trait. A twin study examines the concordance rates of identical twins having the same trait, especially a disease. This can help determine whether the disease has a genetic cause. Thus, the concordance rate of a given characteristic helps establish whether or to what extent it is caused by genetic mutation (Lewontin, 1982).

Twin language is unique in several ways. One of the aspects of the 'twin situation' is that each twin receives relatively less individually directed parental speech (Conway, Lytton, & Pysh 1980; Lytton, Conway, & Suave 1977; Stafford 1987; Tomasello, Mannle, & Kruger 1986).

Gene Environment interaction- Some researchers think that interaction between genes and environment, rather genes and environment separately, may influence many traits. The current scientific view is that neither genetics nor environment is solely responsible for producing individual variation, and that virtually all traits show gene-environment interaction (Yairi, Ambrose & Cox, 1996).

Need for the Case Report: In literature, researchers have used twin studies to try to disentangle the environmental and genetic backgrounds of a cornucopia of trait. Modern twin studies also try to quantify the effect of a person's shared environment (family) and unique environment (the individual events that shape a life) on a trait. Twin researchers acknowledge that limitations do exist, but they further add that the limitations don't negate the usefulness of twin studies. In identical twins, DNA is same (i.e. all genes are the same) and they are brought up in the same surroundings hence case studies of

identical twins help us to study the effect of genetics , environment or both. Case studies also help in better understanding about the nature of the disorder. Further, single case study designs help us answer questions about the treatment effects. In India, to the best of our knowledge, there are very few studies (published in literature) on problems in speech and language development in identical twins. Hence the clinicians intended to report this study.

Aim: 1) To improve our understanding of the nature of the speech and language disorder in identical twins and thereby facilitate further research in this area.

2) To share the experience of working with (an interesting case reported to our department) a pair of identical twins with concomitant speech and language disorders.

There is a pervasive assumption in the twin language development literature that twins are somewhat delayed in language development and more prone to language disabilities.

Day (1932) studied 80 pairs of twins and 140 singletons. On several gross measures of language complexity (such as sentence length, number of different grammatical categories in a sentence) twins were found to be as much as two years behind singletons by the age of five.

Lytton (1980) and Conway, Lytton & Pysh (1980) report a study comparing twins and singletons on language measures. Their study suggests that both biological and environmental variables contribute to language delays in twins, and the authors conclude that the environmental variables are more important.

Lewis & Thompson (1992) studied fifty-seven same-sex twin sets (32 monozygotic and 25 dizygotic) for concordance of speech and language disorders. Results showed monozygotic twins to have higher concordance than dizygotic twins.

A half-dozen studies of twins have found that concordance for stuttering (both twins either stutter or don't stutter, rather than one twin stuttering and the other not stuttering) is much more likely in identical twins than in fraternal twins. Yairi, Ambrose & Cox (1996) also endorses the same findings.

A review of the literature regarding recovery from stuttering indicates that clinicians might expect that two out of every three stutterers observed in a school –age population will recover spontaneously. Recognizing a need to identify those who will not recover without intervention, and in view of the lack of research on which to

base such identifications, a stuttering chronicity prediction checklist for use in such research was devised. This inventory consists of 27 questions which the speech clinician may answer with yes or no responses after consultation with the stutterer's parent and after observations of and interaction with stutterer. "Yes" response may be interpreted as predictors of stuttering chronicity, but no individual question weighting for predictive value should be attempted. However, the validation of the checklist is not yet done (Cooper, 1973).

Dworzynski, Remington, Rijsdijk, Howell, & Plomin (2007) conducted a study to assess contribution of genetic factors in the persistence and early recovery from stuttering. The study also tried to address the question whether there are different genetic and environmental influences for children who recover from stuttering and those who persist. To answer this question data from the Twins Early Development Study were employed. Parental reports regarding stuttering were collected at ages 2, 3, 4, and 7 years, and were used to classify speakers into recovered and persistent groups. Thus, they concluded stuttering appears to be a disorder that has high heritability and little shared environment effect in early childhood and for recovered and persistent groups of children, by age 7.

Concomitant Speech and Language Problems in Children Who Stutter

Research has found that other speech and language difficulties more common among children who stutter than those who do not.

Another perspective of some authorities is that a common deficit may be responsible for the articulation errors, language deficits and stuttering and this deficit may be passed on genetically. Delayed development of circumscribed areas of the brain responsible for speech and language related functions might result in language, articulation and fluency difficulties combination. Some differences on i) How the brain processes such functions and ii) the kind of stimulation the child was exposed to, may tip the balance towards any one of these disorders or in any combination (Silverman,1992). Clinicians with this view would work intensively on all areas involved, simultaneously. Recent literature in this area supports the concept for integrating work on fluency with other speech and language problems in a child with beginning stuttering.

Case Study

Twins (same sex- male) named K.S and J.S. aged 5yrs 8 months were brought to our Audiology and Speech Therapy department with a complaint of stuttering.

Case History of Both Twins: No significant pre-natal history

Peri-natal History: Pre term (30 weeks) normal delivery. CIAB, BW- 1.56 Kg, Length-41 cm, HC-30.5 cm (Twin I), BW- 1.33 Kg, Length-38 cm, HC-29.5 cm (Twin II)

Post natal History: Both twins were kept in NICU for 28 days. ? Viral G. E. at the age of 2 yrs. (Twin I)

Medical History

- Diamniotic Dichorionic twins and each had 2 episodes of Apnea.

- APGAR Score: 1 – 7/10, 5- 8/10. (Twin I) , 1 – 6/10, 5- 7/10.(Twin II)

- Preterm male neonates with AGA with sepsis.

On Examination

- Eyes- Right eye-Squint present, Left eye - Vision affected(Twin I),

- Eyes – Normal(Twin II)

Motor Milestones were typical.

Speech Milestones: There is a history of delayed speech milestones in the family (Father and Grandfather). The children's history is also suggestive of delayed speech milestones.Vocalizations-1yr of age, Babbling-1.6 yrs of age,

1st word- 2.2 yrs of age, 3 word sentences-4 yrs of age.

Fluency Problem: Mother reported that the Twin I had history of dysfluency for a short period at the age of 3 yrs and there was spontaneous recovery. However, dysfluencies increased in the child at the age of 5.8 yrs and parents reported with the child for therapy. Twin II became markedly dysfluent around 3.4 yrs of age and took therapy for 3 months. Due to mother's health problems, they didn't attend therapy for about a year. Again dysfluencies increased at the age of 5 .8 yrs. Hence this child registered for therapy once again along with Twin I.

Family History: Father of the children had a history of mild stuttering in childhood and he recovered without any treatment. As reported by the parents, children's father's first cousin sister (maternal uncle's daughter) is a PWS. They stay in a joint family.

Handedness: Right handedness was noticed at the age of 2.5 yrs in both the twins. Twin I still erases with left hand. Twin II is predominantly right handed. Father is left handed only for writing.

Education: Both the twins are attending Sr. Kg. in school which has English as the medium of instruction.

Mother Tongue: Hindi, Marwari

Assessment

Language Assessment was carried out using 3D Language Acquisition Test (Vaidyanathan, 1989) for both the twins. Results revealed: Comprehension: 30-32 months, Cognition: 30-32 months, Expression: 27-29 months suggestive of delay of about 34 months (2 yr 10months) in comprehension and 37months (3 years 1 month) in expression.

Hearing Assessment: Pure Tone Audiometry revealed Bilateral Hearing Sensitivity within Normal Limits for both the twins.

Muscle tone was assessed by physiotherapist and it was seen that their muscle tone is normal. (This was ensured in view of children who are preterm are susceptible for muscle tone abnormalities).

Intelligence Quotient Assessment: Results revealed Average Intelligence (on Seguin Form Board) in both the twins.

The Cooper Chronicity Prediction Checklist (Cooper,1973) for School Age Stutterers- Twin I-11/27 , Twin II-10/27 which predicts that children may have a good chance of outgrowing stuttering.

Stuttering Severity Index (Riley, 1980): The scores were calculated on spontaneous speech and picture description task. To check the reliability of scores obtained two clinicians separately calculated the scores of the same sample. To check the consistency of the disorder and its degree the test was administered twice first in session1 and then after two weeks in session 3.

TWIN I- The scores revealed Severe Stuttering.

Twin II- The scores revealed Moderate Stuttering.

Mother- child interaction was assessed and it was observerd that the mother is very authoritative, perfectionist and uses complex sentences while conversing. To check the anxiety and depression levels in the parents Hospital Anxiety And Depression Scale (Snaith and Zigmond, 1994) was administered on both parents. It revealed that Mild Anxiety is present in the father.

Management

Long Term Goal: To achieve age appropriate language skills and to achieve fluent speech in all situations within the limit of children's potential.

Short Term Goals

1) Parent counseling.

2) Language Therapy: Variety of activities was implemented to enhance comprehension and expression.

3) Activities for Fluency Enhancement were carried out.

4) Since there was competition for speaking between the twins which in turn increased the dysfluencies hence turn taking was encouraged.

5) Most often, activities for fluency and language were incorporated in the games. Children enjoyed receiving reinforcement and hence were motivated to use slow rate of speech and simple complete sentence.

6) Parents were an active part of the therapy sessions and were therefore advised to follow similar activities at home.

7) Parents tried their best in spite of time constraints, as they were very motivated.

Assessments After 18 Sessions: On Linguistic Profile Test scores (for language assessment) revealed:

Twin I: Receptive Language Age- 4-4½ yrs, Expressive Language Age-3 ½-4 yrs that is language delay of about 1 ½ yrs in comprehension and 2 yrs in expression as compared to earlier delay of 2 yrs 10 months in comprehension and 3 yrs 1 month in expression.

Twin II: Receptive Language Age- 4 ½ -5 yrs, Expressive Language Age-4-4 ½ yrs that is language delay of about 1 yrs in comprehension and 1 ½ yrs in expression as compared to earlier delay of 2 yrs 10 months in comprehension and 3 yrs 1 month in expression.

SSI scores for stuttering revealed Twin I – Mild Stuttering (Total Task Score=12), earlier result revealed Severe Stuttering score being 25.

Twin II- Mild Stuttering (Total Task Score=10), earlier result revealed Moderate Stuttering score being 21.

Perceptually both the children are showing significant reduction in hard attacks and physical concomitants. Parents also feel that stuttering has decreased in both the children.

Discussion and Conclusions

Language Delay: There is a family history of delayed speech and language development (grandfather and father). In the twins in the present study, the Language delay was 2 yrs 10 months in

comprehension and 3 yrs 1 month in expression on the initial assessment.

This endorses the study done by Day (1932) that twins were found to be as much as two years behind singletons by the age of five.

Language delay in the present study could be due to:

i) Twining and genetic predisposition. ii) Inadequate language stimulation at home.

iii) Bilingualism: Since children are exposed to Hindi language at home but in their school, medium of instruction is English.

The possible explanations for stuttering present in the children are

Genetic Predisposition – There is family history of fluency disorder. Father of the children had a history of mild stuttering in childhood and from which he has recovered without any treatment. Father's first cousin sister (maternal uncle's daughter) is a stutterer as reported by the parents of the children.

Environmental Factors: The precipitating factors present in the environment are- i) Both parents are extremely busy, therefore there was lot of time pressure imposed on the children during speaking activities. It was also observed parents had fast rate of speech.

ii) Mother is very authoritative, perfectionist and uses complex sentences.

iii)Bilingualism.
iv)There are demands on the children in terms of display of speech.   v) Competition for the floor to speak amongst the twins.

Thus our study supports the view that it is not the genetic or the environmental factor alone that plays a role in speech and language disorders but an interaction of both. Similar view was given by Felsenfeld, Kirk, Zhu, Statham, Neale, & Martin (2000).

Good chance of recovery? The following facts are suggestive of these children having very high probability of recovery from stuttering.

Firstly, these children reported at early age for therapy, particularly Twin II. Bentley (1988) studied the speech and language development of twins and one of the conclusions drawn by him is that the earlier the speech and language delays are identified, the better are the chances of successful treatment. Our experience also endorses this finding as children are responding well to the treatment program so far.

Secondly, the Chronicity Prediction Checklist scores -11/27(Twin I) and 10/27 (Twin II) that is less than 50% of the total scores, are suggestive of both the children having good chances of outgrowing stuttering (Lesser the scores better is the outcome).

The third fact is that the father of the children had outgrown his mild stuttering and therefore chances that these children may outgrow stuttering are high. This can be said on the basis of recent data indicating a strong genetic factor in recovery from stuttering. Both persistent and recovered stuttering tends to run in families (Yairi et al., 1996). A study done by

Dworzynski et. al (2007) revealed that a positive family history, and the fact that both early recovery and persistence are heritable, may play a role in risk assessment. Therefore genetic information can be employed at diagnostic, prognostic, treatment, and counseling levels.

Thus, there are high chances that children may outgrow fluency disorder. Clinicians are optimistic about their outgrowing the fluency disorder since children have responded well to the therapy so far. However to confirm our belief children should be kept on long term follow up.

This paper also intends to emphasize that many a times a clinician is likely to miss the concomitant speech and language disorders that occur along with stuttering. Parents themselves may not be aware of coexisting disorders and may come with the sole complaint of fluency problem. However one must not over look the importance of detailed assessment in all the domains of speech as well as language, however busy the clinician may be.

The studies reported by Day (1932), Lewis and Thompson (1992) , Yairi et al. (1996) suggest that it would be beneficial to keep all the twins on a regular follow up for assessment and management (if required) of their speech and language problem from an early age and thus, facilitate secondary prevention of speech and language challenges they are prone to. It would be important that pediatrician and speech language pathologist work hand in hand to prevent the speech and language problems in twins.

References

Bentley, P. (1988). Speech and Language Delays in Identical Twins. Retrieved September 8, 2007 from Web site: http://www.eric.ed.gov

Conway, D., Lytton, H., & Pysh, F. (1980). Twin-singleton language difference. *Journal of Behavioral Sciences, Vol.12*, 264-271.

Cooper, E. (1973).The Development of a Stuttering Chronicity Prediction Checklist: A Preliminary Report, *Journal of Speech and Hearing Disorders*, *Vol. 2,* 215-221.

Day, E. J. (1932). The development of language in twins 1. A comparison of twins and single children 2. The development of twins: their resemblances and differences. *Child Development, 3*: 179-199, 298-316.

Dworzynski. K., Remington .A., Rijsdijk. F., Howell. P. & Plomin. R. (2007). Genetic Etiology in Cases of Recovered and Persistent Stuttering in an Unselected, Longitudinal Sample of Young Twins. *American Journal of Speech-Language Pathology*, *Vol.16*:169-178.

Felsenfeld, S., Kirk, KM., Zhu, G., Statham, DJ, Neale, MC & Martin NG. (2000). A study of the genetic and environmental etiology of stuttering in a selected twin sample. *Behavioral Genetics, 30:*359–366.

Guitar, B. (1991). *Introduction to stuttering*; *Nature of stuttering*, Stuttering: An integrated approach to its nature and treatment; Baltimore, London, 2 ed; Lippicot Williams and Wilkins.

Lewis, & Thompson, J. (1992). A study of developmental speech & language disorders in twins. *Speech and hearing res., Vol. 35*: 1086-1094.

Lewontin, R. (1982). Human Diversity. Retrieved September 19, 2007 from Web site: http://en.wikipedia.org/wiki/Concordance_%28genetics%29

Lytton, H. (1980). *The socialization process observed in twin and singleton families*. Parent- child interaction, Plenum, New York.

Lytton, H., Conway, D., & Sauve, R. (1977). The impact of twinship on parent-child interaction. *Journal of Personality and Social Psychology, Vol. 25*: 97-107.

Nieuwint, A., Van Zalen-Sprock , R., Hummel, P., Pals, G., Van Vugt, J., Van Der Harten, H., Heins, Y., & Madan, K. (1999). "'Identical' twins with discordant karyotypes". *Prenatal Diagnosis*. *Vol. 19 (1):* 72-76

Riley(1980), Stuttering Severity Index.

Snaith, R. D. & Zigmond, A. S. (1994). Hospital Anxiety And Depression Scale. *Acta Psychiatra, Scand*, *Vol. 67*: 361 – 370.

Stafford, L. (1987). Maternal input to twin and singleton children: Implications for language acquisition. *Human Communication Research, Vol. 13*: 429-462.

Silverman, F. (1992). *Etiology of Stuttering*, Stuttering And Other Fluency Disorders, New Jersey, Prentice and Hall, pp.117-123, 226.

Souter, V., Parisi, M., Nyholt, D., Kapur, R., Henders, Opheim, K., Gunther, D., Mitchell, M., Glass, I., & Montgomery, G. (2007). A case of true hermaphroditism reveals an unusual mechanism of twinning, *Human Genetics journal, Vol. 121: No 2:* 179-185.

Tomasello, M., Mannle, S. & Kruger, A. (1986). Linguistic environment of 1- to 2-year-old twins. *Developmental Psychology*, *Vol. 22*: 169-176.

Vaidyanathan, R. (1989). Language Developmental Scale for Pre-school Children: A pragmatic approach. *Interdisciplinary seminar on language process and language disorder.* Osmania University. Hyderabad.

Van Riper, C. (1982). *Organicity of Stuttering,* The Nature Of Stuttering, Toronoto, Prentice and Hall 2 ed.

Yairi, E., Ambrose, N., & Cox. N. (1996) Genetics of Stuttering; A Critical Review. *Journal of Speech and Hearing Research, Vol39:* 771-784.

Voice Handicap Index – A Comparison of Clinician's Ratings and Self Ratings by Individuals with Dysphonia

[1]Medha Hegde, [2]Achala C. & [3]Sapna Bhat

Abstract

Voice Handicap Index (VHI) is one of the measures of self perception of voice problem. It is a short self report questionnaire which is useful in routine clinical situations for assessing the progress of the disorder and the influence of interventions. Although various studies are done on self ratings by individuals with dysphonia (IWD) on VHI, there is a scarcity of studies on comparison of ratings by clinicians and self ratings by IWD. To compare the ratings between the VHI report of the IWD and that obtained by the clinician for the same patient. 13 IWD ranging in age from 18 to 57 years and 13 normal individuals matched on age and gender were chosen as the subjects. VHI was administered for both the groups and results were analyzed by the researcher. The SLP assessed the voice aspect in a separate assessment. VHI was also administered on the control group. Data was analyzed using Mann-Whitney 'U' test, Pearson's correlation procedure and Wilecoxon Signed Ranks Test. The mean scores were higher in experimental group than those obtained by the control group in all the three sections of the VHI questionnaire. Mann Whitney U test showed high correlation between the scores obtained by the IWD and the clinician. There was no significant difference between the two groups on Wilecoxon Signed Ranks Test. Pearson's correlation procedure showed that there is a high correlation between the VHI scores of the IWD and the scores of the clinician. These results suggest that clinicians are also reliable respondents in assessing the voice handicap in IWD. It may be concluded that the client's perception of severity of voice disorder will enable the examiner to give treatment to IWD and to know the treatment efficacy by obtaining the clinician's opinion on the VHI for individuals with voice disorders.

Key Words: Voice Handicap Index, Dysphonia

Voice Handicap Index (VHI) is one of the measures of self perception of voice problem. It is a short self-report questionnaire which is useful in routine clinical situations for assessing the progress of the disorder and the effectiveness of intervention. There are other instruments such as Voice Symptom Scale (VOISS) [Deary, Wilson, Carding & Makenzile, 2003], the Voice Related Quality of Life measure (VRQOL) [Murry, Medrado, Hogilegan & Aviv, 2004]. Among quality of life measures, VHI is widely accepted and used for research as well as for clinical application. Agency of Health care research and quality in 2002 acknowledged VHI as reliable and valid diagnostic tool (Cited in Amir et.al, 2006).

Voice Handicap Index was developed and validated by Jacobson, Johnson, Grgnalski, Silbergleit and Benninger in 1997. The purpose for developing VHI was to device a method for quantifying voice treatment outcomes with particular emphasis on the patient's physical, emotional and functional changes that occur with treatment. Initial version of VHI had 85 items and from this it was reduced to 30 items and this was known as VHI -30. Although there are various versions of VHI, the one popularly used is VHI-30.

VHI-30 is a question and answer tool, containing 2 appendices. (Appendix A and Appendix B). Appendix A comprises of three domains that are emotional (E), physical (P) and functional (F). It is composed of 30 questions or statements. Appendix B is a Life Stressor scale which consists of 43 items regarding changes in life situations within the last year. Each item on the Life Stressor scale is given a weighted score as per the test protocol. Scores below 150 indicate one in three chances of serious health changes and the score of 300 or more indicates that a person is at high risk for serious health changes. During the administration of VHI (VHI-30, see

Appendix-A for details of VHI), the individual has to read each question or comment and indicate how frequently that statement applies to individual situations. Responses are scored from 0 to 4 for each question. On completion of the voice handicap index, the scores can be tabulated for total score. A VHI score 0 to 30 represents low scores indicating that there is a minimal amount of handicap associated with the voice disorder. A score of 31 to 60 denotes a moderate amount of handicap due to voice problem. A VHI score from 60 to 120 represents significant and serious amount of handicap due to voice problem and are often seen in patient with new onset vocal fold paralysis or severe vocal fold scarring. (Jacobson, Johnson, Grgnalski, Silbergleit & Benninger, 1997).

Voice handicap index has been used in different populations as a subjective measure to find the emotional, physical and functional handicap present in each individual and various groups. The results of the study done by Rosen and Murry, (2000) indicated that singers scored significantly lower on VHI compared to the non-singers. A study on VHI of laryngectomees with tracheoesophageal speech showed that, in comparison to normals, control group and the functional voice disorders, the VHI demonstrates significantly higher voice handicap for laryngectomees in each scale. A significant difference between laryngectomees and patient with organic voice disorder was detected on the functional scale (Schuster, Lohscheller, Hoppe, Kummer, Eysholdt & Rosanowski, 2004).

A study by Olival and Matias, (2005) on vocal impact on quality of life of elderly women concluded that the vocal condition may significantly interfere with quality of life in women aged over 60. Results of the study on quality of life issues, functional outcomes and VHI in partial laryngectomee patients for early glottic cancer were done to gather information about the quality of life issues. Functional outcomes and voice problems facing early glottic cancer patients treated with the surgical techniques showed that there was no significant difference between the three groups. All the participants expressed the view that their new voices have similar functional, physical and emotional impact on their life (Kandogan & Sanal, 2005). Results on Voice handicap in patients with organic and functional dysphonia using German version of VHI showed significant difference between pathological group and the control group (Weigelt, Krischke, Klotz, Hoppe, Kollner, Egsholdt & Rosanowski, 2004). The prevalence of voice complaints, risk factors and the impact of voice problems in female student teachers could be successfully evaluated with this

tool (Thomas, Dejong, Cremers & Kooijman, 2006).

Rosen, Murry, Zinn, Zullo, Sonbolian (2000) reported, Voice handicap index as a useful instrument to monitor the treatment efficacy for voice disorder. VHI is also qualified as a diagnostic tool for German speaking countries (Nawaka, Wiseman & Gonnerman, 2003). VHI is reported to be a valuable tool for assessment of speakers with as well as without laryngeal pathologies. (Amir et.al, 2006). However, very few Indian studies have looked into this aspect of voice disorder. Sovani, Keer and Sanghi (2007), conducted a study on correlation of VHI scores with client's perception of severity in males and females with voice disorder and results showed moderate correlation in males and females showed poor correlation. A study by Kuniyil (2007) aimed at developing the VHI in Malayalam language and also to assess the reliability and validity of the same version. The results of this study indicated that the adapted Malayalam version is as reliable and valid as the original version and it is also a useful tool to evaluate the differences among the voice disordered groups and between the voice disordered and the control group.

VHI is a valuable tool to identify emotional, physical and functional problems present in voice disordered population. As the voice disordered populations are vulnerable to get emotional, physical and functional problems, it is important to administer VHI on this population. However, very few studies have been done on these aspects in India and as there could be cultural variation in perception of quality of life, such studies are necessary. Studies comparing VHI ratings by clinician and self rating by the patients are conspicuous by their absence. If there is a good correlation between the two, then clinicians could also be used as valid respondents to provide information on effect of voice problem on an individual. This study also aimed to recheck the validity of the voice handicap index between the control and dysphonic group.

Method

In this study, 13 subjects with dysphonia and 13 normal individuals matched on age and gender served as the subjects. Based on self reports and subjective perception, voice problem in controls was ruled out. Among clients with dysphonia, 7 were males and 6 females ranging age from 18 to 57 years. VHI was administered on 13 clients with dysphonia cases who had undergone voice therapy for around three months (3 subjects had puberphonia, 7 subjects had hoarseness in the voice, one subject had highly strained voice with

high pitch and breathiness, one subject had harshness in the voice and one had mild breathiness). The clinician's opinion on VHI for the same clients with dysphonia cases was taken. VHI was also administered on the control group. Later comparison of the VHI scores between the control group and the clients with dysphonia was done. Also, comparison between the VHI scores of clients with dysphonia and the scores of the clinician for the particular patients were made.

To analyze the obtained data, non-parametric statistical procedure was used. In order to compare the scores between the control group and the dysphonic group, Mann Whitney 'U' test was used. To compare the scores between the dysphonic group and the clinicians, Wilecoxon Signed Ranks Test was carried out. Pearson's correlation procedure was used to find out the correlation between the dysphonic and the control group scores.

Results and Discussion

Individual mean of all the three sections in each group were compared. The mean corresponds to moderate problem as reported by Amir et al. (2006). The mean scores were higher in dysphonic group than those obtained by the control group in all the three sections of the VHI questionnaire suggesting that it helps in differentiating normals from the voice disordered group. As our subjects comprised mainly of hyperfunctional voice disorders, the amount of voice handicap correlated with the cause of voice condition. Another reason could be that these reports are post therapy which could have led to the lower scores in various domains. Similar results were obtained in the study done by Guimaraces & Abberton (2003); Kuniyil (2007).

Groups	Mean		
	Physical (Part- A)	Functional (Part-B)	Emotional (Part-C)
Control group	2.07	1.38	0.92
Dysphonic group	16.07	21.3	17.15
Clinician's view	15.46	18.46	14.23

Table 1: Individual mean of all the three groups on three different sections of VHI.

Dysphonic group showed more problems in emotional domain rather than the physical and functional domains. It could be because the questions in part-c of the VHI deals only regarding the effects of voice on the emotions of the

individuals with dysphonia, whereas part-a and part-b of the VHI deal regarding the physical and functional aspects of the voice problem. The mean scores obtained by the clinician group were similar to the scores obtained by the dysphonic group. This suggests that the clinician scoring the clients with dysphonia is as accurate as the clients with dysphonia rating their voice problem themselves.

	Range	Mean	S.D.	Z
Control group	0-13	4.3846	4.292	4.342*
Dysphonic Group	15-98	54.3846	29.04	

* = Significant at 0.05 level

Table 2: Results of Mann Whitney "U" test for control and dysphonic group.

Groups	Range	Mean	S.D.	Z
Dysphonic View	15-98	54.3846	29.04	0.769 NS
Clinician's View	27-86	48.00	16.69331	

NS= Not significant

Table 3: Results of Mann Whitney "U" for Dysphonic and Clinician Views.

Mann Whitney 'U' test was carried out to compare the scores between the control group and the dysphonic group which showed that there is a very highly significant difference between them. Studies done by Amir et.al, 2006; Guimaraces and Abberton, 2003; Kuniyil, 2007; showed similar results. To compare the scores between the dysphonic group and the clinician group, Wilecoxon Signed Ranks Test was carried out. The results of the test showed that there is no significant difference between the two groups. Correlation of the scores between the two groups was checked using Pearson's correlation procedure which showed that there is a high correlation between the VHI scores of clients with dysphonia and the scores of the clinician for this particular group of subjects. These results suggest that clinicians are also reliable respondents for voice problems in subjects. Thus, it would be of clinical interest to see if other people related to voice disordered individuals could also provide such information. The comparison was carried out according to the questions of each section of the VHI between the clinician's opinion and the client's opinion. There were deviances between the clinician's and client's opinion for few questions such as "My voice difficulties restrict personal and social life" "I am ashamed of my voice problem", "My voice problem upsets me". This could be because of the deviation in the perception of the problem by clinician and the client. This would suggest that counseling should be carried out on those aspects.
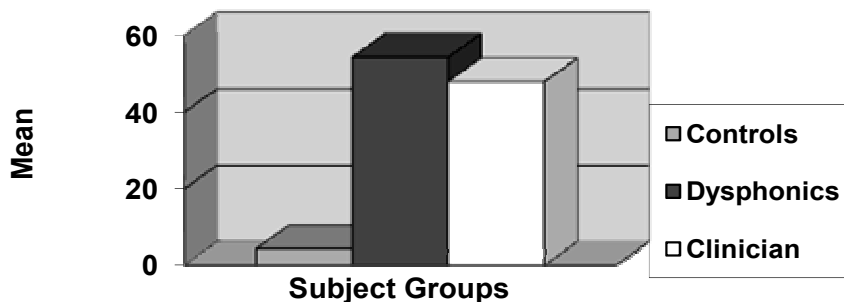
Figure 1: Results of Mann-Whitney "U" test for all the 3 groups.

Present study showed that the mean of the scores on VHI for the control group is less compared to the mean score of the dysphonic group and the high correlation of the scores between dysphonic group and the clinician group suggests that the voice handicap index is sensitive to the voice related changes. Higher scores in group with voice disorders suggest that VHI is a valid tool. Correlation between client and the clinician shows, even clinician rated VHI could give valuable information and could be used clinically.

Conclusions

From the results of the present study conclude that the voice handicap index can also be used to differentiate clients with dysphonia and the control group. It should be differentiated to understand how individuals with dysphonia perform differently from normal and on VHI. Client's perception of severity of voice disorder will help the examiner to give treatment to the client and improve him/her as a person rather than a person with a voice disorder. This VHI questionnaire helps to know the treatment efficacy by obtaining the clinician's opinion on the VHI for the voice disordered population. Future studies can be carried out on larger population in order to generalize the results. Other individuals close to the individuals with voice disorders, such as family members and friends could also be evaluated for their responses. Results from these studies would suggest the probable areas of counseling for that set of respondents.

References

Amir, O., Ashkenazi, O., Leiboritzh, T., Michael,O., Avov, Y. & Wolff (2006). Applying the Voice Handicap Index to dysphonia and non dysphonic Hebrew speakers. *Journal of Voice, 20(2),* 318-324.

Clark, R., Annies, Z., Jamie, O., Thomas, Z. & Thomas, M. (2004). Development and Validation of Voice Handicap Index -10. *Laryngoscope, 114(9),* 1549-1556.

Deary, I. J., Wilson, J. A., Carding, P. N. & Mackenzis, K. (2003). VOISS: a patient derive voice symptom sale. *Journal of Psychosom Res, 54,* 483-489.

Guimaraces. I. & Abberton, E. (2003). An investigation with speakers of Portuguese: Preliminary data. *Journal of Voice, 18(1),* 71-82

Jacobson B. H., Johnson, A., Grgnalski, C., Silbergleit, A.B. & Benninger,M.S. (1997). Development and Validation of Voice Handicap Index. *American Journal of Speech- Language Pathology 6(3),* 66-70.

Kuniyil, J. G. (2007). Development and validation of Voice handicap index in Malayalam. *An unpublished master's dissertation submitted to the University of Mangalore.* 24 - 37.

Kandogan, T. & Sanal, A. (2005). Quality of life, functional outcome and Voice Handicap Index in partial laryngectomy patients for early glottic cancer. (Electronic version) *Ear, Nose and Throat disorder, 5(3).*

Murry, T., Medarado, R., Hogikyon N.D. & Aviv, J. E. (2004). The relationship between ratings of voice quality and quality of life measures. *Journal of Voice, 18,* 183-192.

Nawka, T., Wiesmann, U. & Gonnermann, U. (2003). Validation of The German version of the Voice Handicap Index (Electronic Version). *Abteilung Phoniaric and Padaudiologic, 51(11), 921* - 931.

Olival, H. & Matias, C. (2005). Vocal impact on quality of life of elderly female subjects(electronic version). *Revista Brasileria de Otorrinolaringologi, 71(2),* 172 - 178.

Rosen, C., & Murry, T. (2000). Voice Handicap Index in Singers. *Journal of Voice, 14(3),* 370 - 377.

Rosen, C., Murry, T., Zinn, A., Zullo, T. & Sonbolian, M. (2000). Voice Handicap Index following treatment of voice disorders, *Journal of Voice*, *14 (4),* 619-623.

Schuster, M., Lohscheller, J., Hoppe, U., Kummer,P., Eysholdt, U. & Rosanowski, F. (2004). Voice Handicap Index of laryngectomees with tracheoesophageal speech. *Fol Phoniatrica Ettlogopaedica*, *56,* 62-67.

Sovani, P., Keer, V. & Sanghi, M. (2007). Correlation of Voice Handicap Index scores with client perceptions of severity in males v/s females with voice disorder. *Paper presented in 39th ISHA Conference* at Calicut, India, January.

Thomas, G., Dejong, Cova, R. J. C. & Kooijman, G.C. (2006). Prevalence of voice complaint, risk factor and impact of voice problem in female student teachers. *Folia Phoniatrica Logopaedica*, *58,* 65-84.

Weigelt, S., Krischke, S., Klotz, M., Hoppe, U., Kollner, V., Eysholdt,U. & Rosanowski, F.(2004). Voice Handicap in patients with organic and functional dysphonia (electronic version). *Abteiung Phoniatric and Padaaudiologic*, *52(8),* 751-756.

Appendix

VOICE HANDICAP INDEX

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

0=Never   1=Almost Never   2=Sometimes
3=Almost always   4=Always

Part 1-F

1. My voice makes it difficult for people to hear me.

    0   1   2   3   4

2. People have difficulty in understanding me in a noisy room.

    0   1   2   3   4

3. My family has difficulty in hearing me when I call them through out the house.

    0   1   2   3   4

4. I use the phone less often than I would like to.

    0   1   2   3   4

5. I tend to avoid groups of people because of my voice.

    0   1   2   3   4

6. I speak with friends, neighbors and relatives less often because of my voice.

    0   1   2   3   4

7. People ask me to repeat myself when speaking face to face.

    0   1   2   3   4

8. My voice difficulties restrict personal and social life.

    0   1   2   3   4

9. I feel left out of conversations because of my voice.

    0   1   2   3   4

10. My voice problem causes me to loose income.

    0   1   2   3   4

Part-2-P

1. I run out of air when I talk.

    0   1   2   3   4

2. The sound of my voice varies throughout the day.

    0   1   2   3   4

3. People ask, "What is wrong with your voice?"

    0   1   2   3

4. My voice sounds creaky and dry.

    0   1   2   3   4

5. I feel I have to strain to produce voice.

    0   1   2   3   4

6. The clarity of my voice is unpredictable.

    0   1   2   3   4

7. I try to change my voice to sound different.

    0   1   2   3   4

8. I use great deal of effort to speak.

    0   1   2   3   4

9. My voice sounds worse in the evening.

    0   1   2   3   4

10. My voice gives out on me in the middle of speaking.

    0   1   2   3   4

Part 3- E

1. I am tense when talking to others because of my voice.

    0   1   2   3   4

2. People seem irritated with my voice.

    0   1   2   3   4

3. I feel that other people do not understand my voice problem.

    0   1   2   3   4

4. My voice problem upsets me.

    0   1   2   3   4

5. I am less outgoing because of my voice problem.

    0   1   2   3   4

6. My voice makes me feel handicapped.

    0   1   2   3   4

7. I feel annoyed when people ask me to repeat.

    0   1   2   3   4

8. I feel embarrassed when people ask me to repeat.

    0   1   2   3   4

9. My voice makes me feel incompetent.

    0   1   2   3   4

10. I am ashamed of my voice problem.

    0   1   2   3   4

Acknowledgements

Effect of Temporal Variation on Phoneme Identification Skills in 2-3 Year old Typically Developing Children

[1]Powlin Arockia Catherine S. & [2]Savithri S. R.

Abstract

The present study investigated the ability of 2 to 3 year old Kannada speaking children to identify synthetic phonemes varying in voice onset time (VOT). Four picturable (two minimal pair) words with stop consonants contrasting in voicing (labial: /b/ and /p/, velar: /g/ and /k/) in word-initial position in Kannada were selected. These words as uttered by 21-year-old female native Kannada speaker were recorded and stored onto the computer memory. A VOT continuum from /b - p/, and /g - k/ were synthesized using Praat software which was audio recorded on to a CD. The edited tokens were audio presented to thirty (15 boys and 15 girls) 2 to 3 year old children individually. Subjects pointed to one of the pictures placed before them as they heard the tokens. The investigator noted their responses on a binary forced-choice scoring sheet. The results indicated that the 50% crossover from voiced to unvoiced cognate occurred in the lead VOT region and boundary width was wider for /g - k /continuum compared to /b - p/ continuum. The results of the current study can be used to compare phoneme identification skills in clinical population of same age.

Keywords: Voice onset time, synthesis, stop consonants, phoneme boundary

Speech perception refers to the processes by which humans are able to interpret and understand the sounds used in a language. Research on speech perception seeks to understand how human listeners recognize speech sounds and use this information to understand spoken language. Studies on infant speech perception postulates that the ability to perceive universal phoneme contrast is present at birth and with exposure, infants loose this ability and could perceive only the native contrasts (Werker & Tees, 1984). Also, cross language studies on adults demonstrated language specific perception patterns (Abramson & Lisker, 1970). A great deal of modification of perceptual abilities takes place between infancy and adulthood. It is important to investigate and document the modification process in phoneme perception during language development period, which would also strengthen our understanding of perception-production relationship. Phoneme perception ability is studied by altering the acoustic correlates that distinguishes speech sounds from one another.

In the past, perception of stop consonants along voice onset time (VOT) continuum has been studied in infants, children and adults. The early studies in children didn't show a developmental trend in perception. Winterkorn, MacNeilage & Preston (1967) using VOT continuum of /t - d/ reported that children aged 2.9 to 3.6 years could identify stop consonants similar to adults. Also, Yeni-Komishian, Preston & Cullen (1967) experimented 5 to 6 year old American English speaking children's ability to identify synthetic syllables (apical consonants /t/ and /d/) through imitation. The authors reported adult like perception in their subjects. However, results by Zlatin & Koenigsknecht (1975), Simon & Fourcin (1978) and Williams (1977a, 1977b) indicate a development trend in VOT in English and French speaking children. In the Indian context, Savithri (1996) (Kannada), Sathya (1996) (Telugu) and Catherine & Savithri (2007) (Kannada) reported developmental trend in VOT in children.

Studies in the past have focused on different age groups with small sample size and in different languages. The results found in one language cannot be generalized to other languages since auditory processing skills may differ with languages as the phonemic structure of languages are different and also normative research is required for clinical purposes in individual languages. In this context, the present study investigated phoneme identification skills in typically developing Kannada speaking children between the age range of 2 and 3 years. More specifically, the investigation would help in finding the cause for late talking and Specific language

[1]*Junior Research Fellow, Department of Speech-Language Sciences, AIISH, Mysore, email:arockia_cath@yahoo.com,*
[2]*Professor of Speech Sciences, Department of Speech-Language Sciences, AIISH, Mysore. email:savithri_2k@yahoo.com*

impairment.

Method

Subjects: Thirty typically developing, Kannada speaking children from four play schools in Mysore participated in the study. The subjects included 15 boys and 15 girls in the age range of 2 to 3 years. All the children were from middle socio-economic status. The children were formally screened for speech, language and hearing abilities by the experimenter and those who passed the screening were included in the study.

Stimuli: Two meaningful, picturable, bisyllable word pairs with stop consonants in the initial position in Kannada were selected. The two words in a pair contrasted in voicing (p - b; pennu – bennu, k - g; kere - gere). The words as uttered thrice by a 21-year-old female, native Kannada speaker were recorded onto a computer using SSL Pro3V3 software (Voice and Speech Systems, Bangalore) and stored onto the computer memory. Mean voice onset time, phoneme duration and total word duration were obtained using waveform display. Voice onset time (VOT) continuum was synthesized using lengthen (PSOLA) module of Praat software. Waveforms of /b/ and /g/ (from onset of voicing to start of burst) were truncated from the waveform display of the words /bennu/ and /gere/ in steps of 0.9 (factor) till the burst using PSOLA module and then concatenated to the original word. Silence in steps of 10 ms was inserted between the burst and voicing of the vowel, till +40 ms. A total of 15 tokens were generated for /b - p/ VOT continuum (-77 to +40 ms) which was termed test 1. Fifteen tokens were generated for /g - k/ VOT continuum (-78 to +40 ms) and constituted test 2. The tokens were iterated thrice, randomized and recorded onto a CD. Thus a total of 90 tokens (15*2*3) formed the stimulus.

Procedure: Children were tested individually. Each child was familiarized with the pictures of the words used in test 1 and 2 before data collection. Training was provided using live voice and was for a maximum of 3 half-an hour session. Four pictures were presented to the children at a time, two were the pictures of the target stimuli (bennu and pennu/ gere and kere) and other two were distracters. Of the two distracters, one was semantically related to a target stimulus and the other was unrelated to the target stimuli. This is to reduce the chance of false positive responses. The pictures were placed in front of the child. The investigator named the pictures and the child was instructed to listen to it and point to the respective picture. Childs responses were noted by the investigator. After the child correctly responded

100% of the time to the target words, synthetic tokens were introduced. As in training session, experiment was carried out in a quiet room. The stimuli were audio-presented through two speakers placed at 45° azimuth at a comfortable loudness. The child was instructed to carefully listen to the synthetic tokens and point to the respective picture out of four picture cards placed before him/her. The investigator noted the child's responses on a binary forced-choice scoring sheet. Percent identification scores were calculated and identification curves were plotted. From identification curve, 50% crossover, lower limit of phoneme boundary (LLPB), upper limit of phoneme boundary (ULPB) and phoneme boundary width (PBW) were obtained (Doughty, 1949). Fifty percent crossover is the point at which 50% of the subject's response corresponds to the voiced (voiceless) category. Lower limit of phoneme boundary width is the point along the acoustic cue continuum where an individual identified voiced (voiceless) stop 75% of the time and upper limit of phoneme boundary width defined as the corresponding point of the identification of the unvoiced (voiced) cognate 75% of the time. Phoneme boundary width was determined by subtracting the lower limit from upper limit of boundary width. Mean 50% crossover, mean LLPB, mean ULPB and mean phoneme boundary width was calculated. Independent sample t- test and paired sample t-test were carried out to find the gender difference and across continuum difference.

Results

/b - p/ continuum: Results indicated that mean values of 50% crossover occurred at lead VOT region (-7.9 ms). Also, mean LLPB and mean ULPB were found in the lead VOT region. The mean phoneme boundary width for children was 12 ms. Independent sample t- test showed no significant difference between gender for 50% crossover [t (28) = -0.96; p>0.05], LLPB [t (28) = -1.72; p>0.05], ULPB [t (28) = -0.13; p>0.05] and phoneme boundary width [t (28) = 1.11; p>0.05]. Table 1 shows the mean values of all the parameters for /b-p/ continuum. Figures 1 and 2 show identification functions in a boy and girl for /b - p/ continuum.

Parameters	Boys	Girls	Average
50% rossover	-6.47	-10.27	-7.9
LLPB	-10.13	-17.67	-14.47
ULPB	-2.47	-3.13	-2.23
PBW	10.47	13.87	12.03

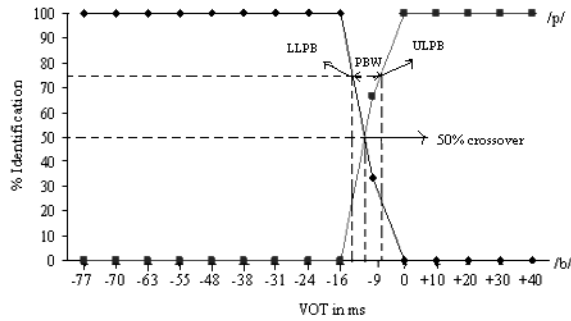**Table1:** Mean values of measures for /b-p/ continuum (in ms).

Figure 1: Percent identification scores of a boy (B3) on /b/-/p/ continuum.
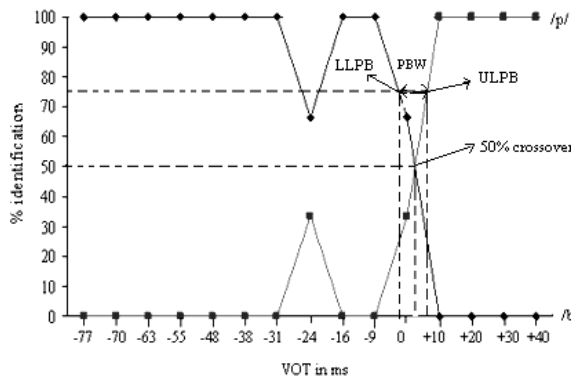

Figure 2: Percent identification scores of a girl (G7) on /b/-/p/ continuum.

/g - k/ continuum: Children changed their percept from /g/ to /k/ in lead VOT region (-9.8 ms). Lower limit of phoneme boundary and ULPB occurred in lead (-15.8 ms) and lag (5.8 ms) VOT region, respectively. Also mean phoneme boundary width was 19.6 ms. Independent sample t-test showed no significant difference across gender for 50% crossover [t (28) = -1.602; p>0.05], LLPB [t (28) = 1.44; p>0.05], ULPB [t (28) = -0.039; p>0.05] and phoneme boundary width [t (28) = 0.545; p>0.05]. Table 2 shows the mean values of all parameters for /g - k/ continuum. Figures 3 and 4 show percent identification in a boy and a girl for /g - k/ continuum.

Parameters	Boys	Girls	Average
50% crossover	-6	-14.33	-9.8
LLPB	-12.33	-19.33	-15.8
ULPB	4.07	3.87	5.83
PBW	18.27	21	19.63

Table2: Mean values of measures for /g-k/ continuum (in ms).

Results of paired t-test indicated significant difference between continuums for ULPB [t (29) = 2.73; p< 0.05] and phoneme boundary width [t (29) = 2.94; p< 0.05]. Upper limit of phoneme boundary and phoneme boundary width were significantly

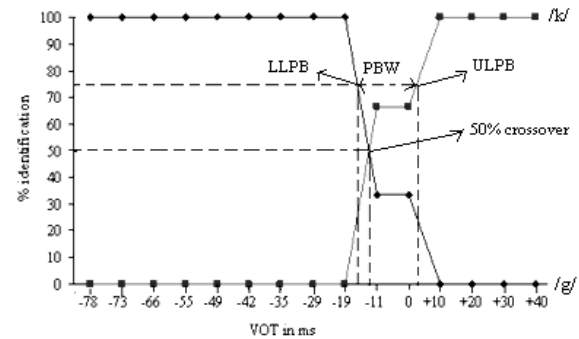higher in /g - k/ continuum compared to /b - p/ continuum.

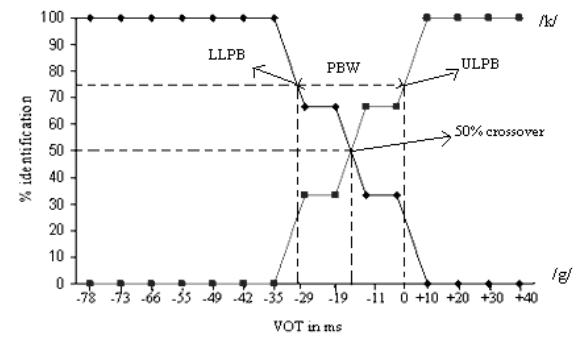**Figure 3:** Percent identification scores of a boy (B15) on /g/-/k/ continuum.

Figure 4: Percent identification scores of a girl (G7) on /g/-/k/ continuum.

Discussion

The results revealed several interesting findings. Firstly, 50% cross over occurred in lead VOT region for /b - p/ (-7.9 ms) and /g - k/ (-9.8 ms) continuum. That is, the children shifted their percept from voiced to unvoiced stop consonants in the lead region of VOT. This result is in consonance with those of Abramson & Lisker (1965) in Thai language (-20 ms), Savithri (1996) in Kannada speaking children (-16.8ms) and Sathya (1996) in Telugu speaking children (-10 ms), and Catherine & Savithri (2007) in Kannada speaking children (-22 ms) who have reported 50% crossover in lead VOT region. The result is in contrast with those of Winterkorn, MacNeilage & Preston (1967), Yeni-Komishian, Preston & Cullen (1967), Zlatin & Koenigsknecht (1975), Simon & Fourcin (1978) Williams (1977a, 1977b) and Flege & Eefting (1986) who reported 50% crossover in lag VOT region. The difference in result may be due to the phonemic structure of the two languages. In English, stops have two way (i.e. p, b) classification where as Kannada has a four way

(e.g. p, ph, b, bh) classification. The distinction between unvoiced aspirated and unvoiced unaspirated stop is phonetic in English but phonemic in Kannada (Savithri, 1996). As in Spanish (Williams, 1977b), listener in the present study gave greater weight to prevoicing as a cue to voiced stop consonants than English listeners. This indicates that phonetic processing of speech sounds are governed by acoustic properties of stops found in a language (Aslin & Pisoni, 1980). Cross language studies by Simon & Fourcin, (1978), Flege & Eefting (1986) also suggest that speakers of different languages may learn to perceive stop consonants differently as they are exposed to different kinds of stops.

Secondly, phoneme boundary was within ± 20 ms. This finding is in consonance with the reports of Abramson & Lisker (1965), Savithri (1996), Sathya (1996) and Catherine & Savithri (2007) who also reported phoneme boundary within ± 20 ms region. Aslin & Pisoni (1980) asserts commenting on the experiment by Pisoni (1977) on perception of non speech stimuli that a psychophysical process is probably responsible for the categorical-like discrimination within this region. Also, such narrow region of high discriminability had resulted due to general sensory constraints on mammalian auditory system to resolve small differences in temporal order and not because of phonetic categorization.

Third, phoneme boundary width for /b - p/ continuum (12 ms) and /g - k/ continuum (19.63 ms) were narrower in the present study compared to those reported by Savithri (1996) for both /b - p/ (25 ms) and /g - k/ continuum (34 ms) and Catherine & Savithri (2007) for /b - p/ continuum (36 ms). This difference in boundary width may be attributed to smaller subject size that is, 6 subjects per age group (4 - 6 year old children) in Savithri's (1996) study and 10 subjects (2 - 3 year old children) in Catherine & Savithri's (2007) study. Also adult's phoneme boundary width was wider, 13 ms for /b/-/p/ and 25 ms for /g/-/k/ continuum (Savithri, 1996) compared to 2 - 3 year old children in the present study.

Fourth, there was no significant difference in the identification scores of boys and girls implying that phonetic processing abilities are similar for both the gender. Zlatin & Koenigsknecht (1975) also reported no significant difference between genders.

Fifth, ULPB occurred in the lead VOT region for /b-p/ continuum and in lag VOT region for /g - k/ continuum. Also, boundary width for /g - k/ continuum was wider compared to /b - p/ continuum. This trend was also reported by Zlatin & Koenigsknecht (1975) and Savithri (1996). This

trend probably reflects the pattern of phoneme acquisition in which labial stop consonants are acquired prior to velar stop consonants.

To conclude, typically developing Kannada speaking children in the age range of 2-3 years had adult-like identification skills on /g-k/ and /b-p/ continuum. Future research on older age groups to study the developmental pattern of speech perception in Kannada and other languages are warranted.

Conclusions

The present study provides a basic knowledge on phoneme identification skills in 2-3 year old Kannada speaking typically developing children. The phoneme identification skills of normal children can be compared with clinical population including late-talking children, children with hearing impairment, mental retardation, seizure disorder and high-risk children. More specifically, late talking children between 2 to 3 years who exhibit language disorder in the absence of specific causes may be impaired in phoneme identification. Also, using the findings of this study as baseline, perception training program for this age group can be devised.

References

Abramson, A., & Lisker, L. (1965). Voice onset time in stop consonants: Acoustic analysis and synthesis. *Proceedings of the 5th International Congress of Acoustics.* Liege: Imp. G. Thone.

Abramson, A., & Lisker, L. (1970). Discriminability along the voicing continuum: Cross-language tests. *Proceedings of the sixth International congress of phonetic sciences*, Academia, Prague, pp 569-573.

Aslin, R.N., & Pisoni, D. B. (1980). Some developmental process in speech perception. In G. H. Yeni-Komshian, J. F. Kavanagh & C. A. Ferguson (Eds.), Child Phonology, vol.2: Perception, Academic press: NewYork, 1980.

Catherine, S. P. A., & Savithri, S. R. (2007). Effect of temporal variation on phoneme identification skills in typically developing children. *Proceedings of the National Symposium on Acoustics*, pp 193-198.

Doughty, J. (1949). In Zlatin, M., & Koenigsknecht, R. (1975). Development of the voicing contrast: Perception of stop consonants. *Journal of Speech and Hearing Research, 18*, 541-553.

Flege, J. E., & Eefting, W. (1986). Linguistic and developmental effects on the production and perception of stop consonants. *Phonetica*, 43, 155-171.

Pisoni, D. B. (1977). Identification and discrimination of the relative onset of two component tones: Implication for the perception of voicing in stops. *The Journal of the Acoustical Society of America*, 61, 1352-1361.

Sathya, K. (1996). *Development of auditory perceptual processing in children.* Unpublished doctoral thesis submitted to University of Mysore, Mysore.

Savithri, S. R. (1996). Speech perception in children: Temporal aspects. Research project funded by the Department of Science and Technology, Ministry of Science and Technology, New Delhi, India.

Simon, C., & Fourcin, A. (1978). Cross language study of speech pattern learning. *The Journal of the Acoustical Society of America*, 63, (3), 925-935.

Werker, J. H., & Tees, R.C. (1984). Cross-language speech perception. Evidence for perceptual reorganization during the first year of life. *Infant behavior and development*, 7, 49-63.

Winterkorn, J., MacNeilage, P., & Preston, M. (1967). Perception of voiced and voiceless stop consonants in three-year-old children. *Haskins Laboratries: Status Report on Speech Research*, SR-11, 41-45.

Williams, L. (1977a). The voicing contrast in Spanish. *Journal of Phonetics,* 5, 169-184.

Williams, L. (1977b). The perception of stop consonant voicing by Spanish-English bilinguals. *Perception and Psychophysics,* 21, 289-297.

Yeni-Komshian, G., Preston, M., & Cullen, J. (1967). A brief report on the study of imitation of synthetic speech stimuli by children. *Haskins Laboratries: Status Report on Speech Research*, SR-11, 48-49.

Zlatin, M.., & Koenigsknecht, R. (1975). Development of the voicing contrast: Perception of stop consonants. *Journal of Speech and Hearing Research, 18, 541-553.*

Acknowledgements

Voicing Periods in a Primary School Teacher

[1]Rajasudhakar R. & [2]Savithri, S. R.

Abstract

Teachers form a large group of professional voice users and are thought to be at risk for voice problems than the general population. Primary school teachers report the common need to shout or raise the voice to make children heard. In a complete working day, the excessive vibration of vocal fold tissues due to loud or prolonged vocalization has been assumed to contribute to voice problems. There are relatively few studies focused on measuring the amount of voicing performed by speakers over time. Hence, the present study quantified the amount of voice use on a single workday and measured the changes, if any, in the acoustic parameters of voice [mean fundamental frequency (F0), standard deviation of fundamental frequency (SD F0), and mean jitter]. A primary school teacher of 32 years of age having twelve years of teaching experience participated in the study. The voice samples were recorded in a class room setting, the natural working environment of the teacher, with a portable, lightweight digital audio tape (DAT) recorder. The entire workday speech/voice sample (throughout the working hours) was recorded. Also, prolongation of vowel /a/ was recorded at four times of interval in the day - before the first class, after the first class, after lunch and after the last class. The external noise was removed by using CoolEdit software. The voicing (pitch) periods were measured using PRAAT software. Dr. Speech software was used to analyze F0, SD F0, and jitter at four different intervals of time. The voicing percentage was found to be around 31.46 % (i.e., 1 hour 49 minutes 48 seconds). F0, SD F0 and jitter increased from the first to the last recording. The results of the study throw light on vocal usage and its effect on voice by a primary school teacher who work with children on a entire workday.

Key words: Phonation, Jitter, Accumulation, Vocal fatigue

Voice is defined as the laryngeal modulation of the pulmonary air stream which is then modified by the configuration of the vocal tract (Brackett, 1971). The term 'professional voice user' is applied to individuals whose professional role and employment are dependent on effective and efficient use of voice. Kaufman (1998) classified lecturerers, teachers as level II professional voice users. Teaching is one of the most vocally demanding occupations. In classrooms teachers need to speak frequently and often loudly in the presence of background noise, risking occupational damages to their voices. Loud speaking, increase of pitch and straining of voice may lead to vocal fatigue that eventually causes damage to vocal fold tissue. As many as 50% to 80% of teachers experience and have experienced voice problems according to several questionnaire studies (Pekkarinen, Himberg & Pentti, 1992; Gotaas & Starr, 1993).

The vocal loading in teachers has been quantified thoroughly and systematically in the recent past. Voice accumulation and voice dosimetry devices have been developed for monitoring voice use at work (Buekers, Bierens, Kingma & Marres, 1995; Airo, Olkinuora & Sala, 2000; Cheyne, Hanson, Genereux, Stevens & Hillman, 2003). Measures called 'Vocal Dose' have been proposed for quantifying voice usage (Svec, Titze & Popolo, (2003). The three vocal doses identified so far are the time dose, the cycle dose and the distance dose. The time dose is equal to the voicing time and measures the total time the vocal folds are vibrating. The cycle dose measures the total number of cycles accomplished by the vocal folds (in the unit of thousands). The distance dose measures the total distance traveled by the vocal folds on their oscillatory trajectory. The simplest vocal dose is time dose, often called the voicing time, which accumulates the total time the vocal folds vibrate during speech. Rantala & Vilkman (1998) reported that the F0 time is a bigger risk factor for vocal fatigue.

Voice accumulation times and the voicing percentages relative to total time at work have been found to be higher in teachers than in other

[1]*Junior Research Fellow, Department of Speech Language Sciences, All India Institute of Speech & Hearing, Manasagangothi, Mysore-6, email:rajasudhakar82@yahoo.co.in,* [2]*Professor of Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech & Hearing, Manasagangothi, Mysore-6, email:savithri_2k@yahoo.com.*

professions. Masuda, Ikeda, Manako and Komiyama (1993) measured a voicing percentage of 21% for teachers in an 8 hours workday, compared to 7% for office workers. Sala, Airo, Olkinuora, Simberg, Strom, Laine, Pentti & Suonpaa (2001) reported that the average speaking time of day care teachers was 40% of the time at work, compared to 28% for nurses. In these studies, the primary focus was on the accumulated phonation time, also referred to as 'vocal load'.

Analyses of teachers' voices, recorded over the course of a working day have been carried out in order to detect changes in voice quality and parameters such as the fundamental frequency and sound pressure level (Rantala, Paavola, Korkko & Vilkman, 1998). There are relatively few studies on voice changes induced by vocal loading. In addition, most studies have used short loading times, the shortest being 15-20 minutes (Stone & Sharf, 1973; Linville, 1995) and the longest from 45 minutes to 2 hours (Neils & Yairi, 1987; Gelfer, Andrews & Schmidt, 1996). These studies have reported contradictory results. The most common result was an increase in fundamental frequency after loading (Gelfer, Andrews & Schmidt, 1991; Stemple, Stanley & Lee, 1995). Studies have also explored the relationship of voice loading versus jitter and standard deviation of fundamental frequency (SD of F0). The jitter values have reportedly increased (Gelfer, Andrews & Schmidt, 1991), decreased (Stemple, Stanley & Lee, 1995) or shown no essential change (Verstraete, Forrez, Mertens & Debruyne, 1993) after loading. Rantala, Vilkman & Bloigu (2002) reported increased SD F0 after vocal loading.

Voice loading investigations have been usually conducted in laboratory settings (Gelfer, Andrews & Schmidt, 1991; Stemple, Stanley & Lee, 1995). Only a very few trails have been arranged in a work environments (Ohlsson, 1988; Novak, Dlouha, Capkova & Vohradnik, 1991). Subsequently, questions about the generalisability of the results to real-life situations remain unresolved. Field studies involve many practical and technical problems, which probably explain the small number of these investigations. No studies are reported on Indian primary school teachers. The primary schools in India have more background noise and sometimes there are no partitions between classes. Also, it can be assumed that primary school teachers in India have more voice loading factors. They handle more number of subjects/classes than their western counter part and spend extra time in teaching academically poor students, participating in extra-curricular aspects like training the students

for sports, drama, dance and conducting parents meetings. In this context, the present study quantified the amount of cumulative vocal fold vibration on a single workday of a primary school teacher and documented the effect of prolonged teaching on voice parameters (F0, SD of F0 and jitter).

Method

Subject: A normal 32 year old adult female who has been working as a primary school teacher for 12 years participated voluntarily in the study. She teaches Kannada, Environmental science and Mathematics to second and third grade children. The average number of students in each class was about 30. She did not have any speech, language, hearing or voice problems at the time of the study. The subject was explained about the study and instructed to teach in a normal workday manner. Written consent was taken for her participation.

Phoniatric examination: A stroboscopic evaluation was done before the voice recording which indicated that the regularity of vocal fold (VF) vibration, amplitude of VF vibration, quality of mucosal wave and glottic closure were normal.

Instruments used: A portable, light-weight digital audio tape (DAT) recorder was used. The recorder has in-built electret condenser microphone and weight of the devise is about 54 grams. PRAAT and Dr. Speech software were used to extract voicing periods and other voice measures such as F0, SD F0 and jitter.

Recording procedures and samples

(a) Classroom speech: The recording of voice samples was done on a normal workday (Monday) after a relaxed week end. The DAT recorder was worn around the neck of the subject. The distance between microphone and mouth was 10-12 cm. As the recorder was tiny, it allowed the teacher to move, walk freely in the classroom. An entire workday speech/voice was audio recorded from first to last class. The subject was asked to maintain a logsheet where the she made a note about the vocal activities through-out the day. It also included the time at which the voice activities took place; for e.g. 9.45-10.30 am taught Kannada to II standard. Figure 1 shows the subject wearing the DAT recorder.

(b) Sustained phonation: The subject was instructed to phonate vowel /a/ for 7-8 seconds at four different time intervals – (1) before first class, (b) after first class, (3) after lunch and (d) after last class. Both oral and written instructions for using the tape recorder and

performing the tasks were given to the subject in advance.

Figure1: Subject wearing the digital audio tape recorder.

Analyses: The recorded six hours voice/speech sample was transferred onto the computer memory. The external noise was removed by using CoolEdit software. The entire day speech/voice sample was truncated into ten minute tokens and a total of 36 ten minutes tokens were made. Each of the ten minute samples was viewed as waveform on PRAAT software and the voicing periods were extracted. In addition, the voicing periods or F0 time was calculated for classroom teaching/at work, and not at classroom teaching/not at work. Inclusion of voicing duration not at classroom teaching definitely resulted in the entire vocal load in the school circumstances. Voice activities at leisure time, lunch time with colleagues and advicing students/guiding parents-personally are some of voice usage that comes under not at classroom teaching. Dr. Speech software (Tiger Electronics) was used to analyze jitter, F0 and SD of F0 of the sustained vowel /a/ at four time intervals. Figure 2 illustrates extraction of voicing periods.
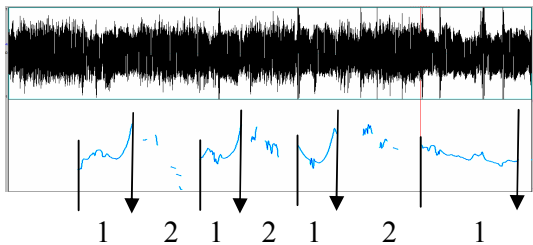

Figure 2: Voicing periods of teacher's utterances (1) and students' repetitions (2).

Results and Discussion

Voicing periods: The total time of the recorded sample was 5 hours 48 minutes i.e., about 20,880 secs. It was found that the voicing time (active vocal fold vibration time) was 6568.94 secs. Teacher's vocal folds were vibrating a cumulative average of 31.46% (voicing percentage) of her time at work (about 1 hour 49 minutes, 48 seconds).

	Voicing periods (seconds)	Percentage of voicing (%)
At classroom teaching	5479.99	83.42
Not at classroom teaching	1088.95	16.57
Total	6568.94	99.99

Table 1: F0 time and percentage of voicing at classroom and not at classroom teaching.

Table 1 shows the cumulative vocal fold vibration time (F0 time) and percentage of voicing at classroom teaching and not at classroom teaching. Further, the results indicated that the teacher's vocal folds were vibrating a cumulative average of 83.42% at classroom teaching (about 1 hour 31 minutes, 33 seconds), and a cumulative average of 16.57% not at classroom teaching (about 18 minutes 14 seconds). Figure 3 shows the total voicing durations on a single working day of 5 hours 48 minutes.
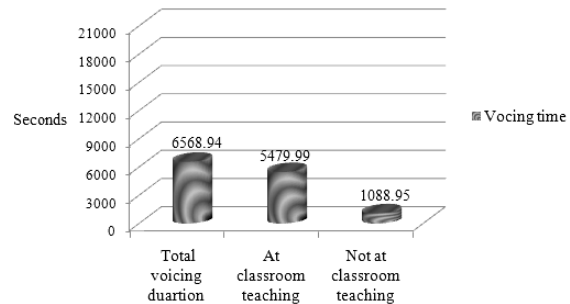

Figure 3: Total voicing time (out of 20880 seconds).

The results of this study are in agreement with Masuda et al. (1993) who reported that the voicing percentage was 21 % in an eight hours workday, considering a somewhat different teacher population. The obtained voicing duration of 1 hour 49 minutes is in consonance with the result of Titze, Hunter & Svec (2007) who found in their teachers the voicing duration was about 1 hour 50 minutes for 8 hours of working day. The comparison indicates that the teacher in this study used her voice more excessively, vigorously within shorter period of nearly 6 hours. The teacher used her vocal folds about 83 % of her time at classroom teaching and only about 16 % of her time for non-teaching purpose. It indicates that the voice usage was at maximum in classroom situation where the teacher prolonged, raised her voice loudly for a long period in presence of background noise to make every student heard. This excessive continuous voicing may be a fatiguing factor for the vocal folds because of repetitive motion and collision of tissue. As these

results were obtained from a single primary school teacher, one should be cautious enough in generalizing the results.

Effects of prolonged teaching on F0, SD of F0 and jitter: The results showed that some voice features changed during the course of a workday. The most obvious change was in fundamental frequency (F0), which increased towards the end of the day. Figure 4 depicts the changes of F0 at four different intervals of time across the working day. The F0 increased around 7.24 Hz between the first and last recording. The obtained result is in agreement with the results of Rantala, Vilkman and Bloigu (2002) who reported that the F0 increased about 9.7 Hz between the first and last lesson.
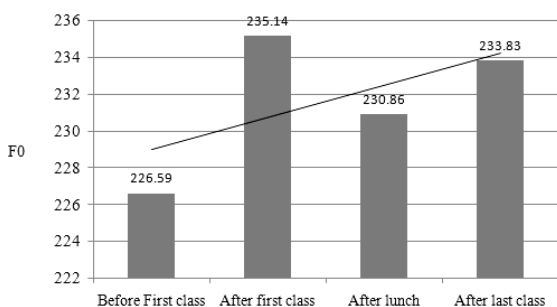

Figure 4: Fundamental frequency (F0) at different interval of time.

Two explanations for the F0 rise have been offered in the literature. According to Stemple, Stanley & Lee (1995), increased F0 is a consequence of weakness of the thyroarytenoid muscle. When the muscular layer of thyroarytenoid muscle slackens, the cover and transition layers of the vocal folds stiffens. This leads to an increase of the rate of vibrations in the vocal folds and hence a rise of the F0. Vilkman, Lauri, Alku, Sala, & Sihvo (1999) have suggested another explanation. The increased F0 was caused by the speaker's compensatory reactions to alterations in their voice. When compensating for the physiological changes, which could be alterations in the mucosa, the speaker increases the frequency of vocal fold vibration and the glottal adductory forces. This increased constriction influenced the F0 indirectly. It increases the subglottal pressure, which adds tension to the vocal folds and, consequently raised the F0.

The standard deviation of fundamental frequency (SD F0) increased from the first recording to the end of the day recording by 1.02. Hammarberg (1986) examined the relationship between voice disorders and SD F0, who found that larger than normal SD F0 accompanied a hyperfunctional, rough or unstable voice. Thus, increased SD F0 may indicate instability of

laryngeal function and one possible reason for this could be impaired coordination of VF movements, which is a symptom of fatigue. Also, results are in consonance with the findings of Rantala, Vilkman & Bloigu (2002) who reported increased SD F0 after loading. Figure 5 shows the SD F0 across the working day at four different intervals of time.

The jitter value also increased from starting of the day to end of the day. It was 0.42 % at the first recording (before the first class) and increased to 0.84 % after the last class (figure 6). The same findings was reported by Gelfer, Andrews & Schmidt (1991) and Rantala, Vilkman & Bloigu (2002) who found increased jitter value after vocal loading.

The variables like F0, SD F0 and jitter had peaks and valleys during the course of a teaching day. It was less at the starting of the day and rose after the first class. The reason could be because of vocal warm-up. The duration of the first class was about 45 minutes. Rantala, Vilkman & Bloigu (2002) also observed the same phenomenon where parameters like F0, shimmer and jitter increased after first 4 minutes of teaching sample. Elliot, Sundberg & Gramming (1995) and Vilkman, Lauri, Alku, Sala, Sihvo (1999) reported that vocal warm up is a normal phenomenon that takes place about 10-30 minutes after talking has begun. In vocal warm up, some adaptation of the voice apparatus obviously takes place, and vocal and physical changes follow. However, the physiological backgrounds of the phenomenon as well as its effects are largely unknown. In this study, increase in F0, SD F0 and jitter after the first class may probably caused due to vocal warm-up.
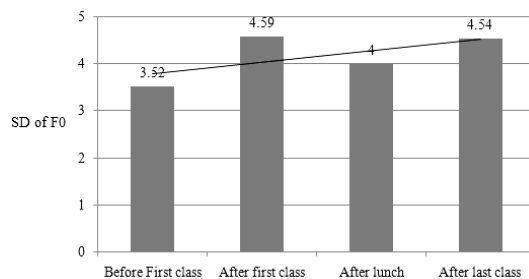

Figure 5: Standard Deviation (SD) of F0 at different interval of time.

The 'trend' followed at four intervals of time for F0, SD F0 and jitter was same and uniform. This can be observed in figures 4, 5 and 6 where it is depicted as 'trend line' in the graphs. There was an increase in F0, SD F0 and jitter after first class, followed by a reduction in these values after lunch. It can be inferred that vocal warm up has taken place after beginning of teaching. Then, the system learned to adjust with the demands of the classroom requirements. This laryngeal

adjustment depends on the classroom situations. Hence there was a reduction in the afternoon. At the end of the day, the phonation sample had higher F0, SD F0 and jitter values compared to the starting of the day. These observations were made on a single workday of a primary school teacher. Larger number of sample is warranted to generalize the results.
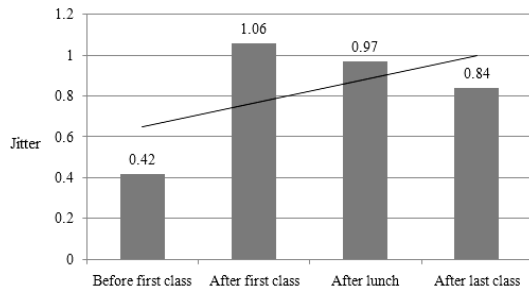

Figure 6: Jitter at different intervals of time.

Conclusions

The present study quantified the cumulative vocal fold vibration of a primary school teacher and measured the effects of prolonged teaching on acoustic parameters F0, SD F0, and jitter. The results indicated 31.46% voicing periods including 83.42% at classroom teaching and 16. 57% not at classroom teaching. Also, the F0, SD F0 and jitter increased from the first to the last recording. The F0 increased was 7.24 Hz between the two recordings i.e., before first class and after last class; SD F0 increased by 1.04 and jitter increased by 0.42%. The F0 rise may be a consequence of the normal physiological adaptation of the vocal apparatus to loading and hence, a sign of healthy voice. These findings indicate that the vocal fold movement may be impaired in coordination which in-turn put in the picture of laryngeal instability due to loading. Hence, these parameters are sensitive enough to document the one working-day related changes on voice. Further investigation on vocal health of teachers and other professional voice users is warranted. Also, the rest periods, its distribution and its effect on vocal fatigue recovery can be determined.

References

Airo, E., Olkinuora, P. & Sala, E. (2000). A method to measure speaking time and speech sound pressure level. *Folia Phoniatrica Logopaedica*, 52, 275-288.

Buekers, R., Bierens, E., Kingma, H. & Morris, E. H. M. A. (1995). Vocal load as measured by the voice accumulator*. Folia Phoniatrica Logopaedica*, 47, 252-261.

Brackett, I. P. (1971). Parameters of voice quality. In L. E. Travis (Ed). *Handbook of Speech pathology and Audiology*. New Jersy: Prentice-Hall, Inc. 441-464.

Cheyne, H. A., Hanson, H. M., Genereux, R. P., Stevens, K. N. & Hillman, R. E. (2003). Development and testing of a portable vocal accumulator. *Journal of Speech, Language & Hearing Research*, 46, 1457-1467.

Elliot, N., Sundberg, J. & Gramming, P. (1995). What happens during vocal warm-up? *Journal of Voice*, 9, 37-44.

Gelfer, M. P., Andrews, M. L. & Schmidt, C. P. (1991). Effects of prolonged loud reading on selected measures of vocal function in trained and untrained. *Journal of Voice*, 5, 158-167.

Gelfer, M. P., Andrews, M. L. & Schmidt, C. P. (1996). Documenting laryngeal change following prolonged loud reading: a videostroboscopic study. *Journal of Voice,* 10, 368-377.

Gotaas, C. & Starr, C. D. (1993). Vocal fatigue among teachers. *Folia Phoniatrica Logopaedica,* 45, 120-129.

Hammarberg, B. (1986). Perceptual and acoustic analysis of dysphonia. [doctoral dissertation]. Stockholm, Sweden: Huddinge University Hospital.

Kaufman, J. A. (1998). What are voice disorders and who gets them? Website: www.bgsm.edu/voice/voice_disorders.html

Linville, S. E. (1995). Changes in glottal configuration in women after loud talking. *Journal of Voice,* 9, 57-65.

Masuda, T., Ikeda, Y., Manako, H. & Komiyama, S. (1993). Analyses of vocal abuse: fluctuations in phonation time and intensity in four groups of speakers. *Acta-Oto-Laryngology*, 113 (4), 547-552.

Neils, R. L. & Yairi, E. (1987). Effects of speaking in noise on vocal fatigue and vocal recovery. *Folia Phoniatrica Logopaedica*, 39, 104-112.

Novak, A., Dlouha, O., Capkova, B. & Vohradnik, M. (1991). Voice fatigue after theater performance in actors. *Folia Phoniatrica Logopaedica,* 43, 74-78.

Ohlsson, A, C. (1988). Voice and work environment: towards an ecology of vocal behavior [dissertation]. Gothenburg: University of Gothenburg.

Pekkarinen, E., Himberg, L. & Pentti, J. (1992). Prevalence of Vocal symptoms among teachers compared with nurses: a questionnaire study. *Scandinavian Journal of Logopedics & Phoniatrics,* 17, 113-117.

Rantala, L. & Vilkman, E. (1998). Relationship between subjective voice complaints and acoustic parameters in female teachers' voices. *Journal of Voice*, Vol 13 (4), 484-495.

Rantala, L., Paavola, P., Korkko, P. & Vilkman, E. (1998). Working day effects on the spectral characteristics of teaching voice. *Folia Phoniatrica Logopaedica,* 50, 205-211.

Rantala, L., Vilkman, E. & Bloigu, R. (2002). Voice changes during work: Subjective voice complaints and objective measurements for female primary and secondary school teachers. *Journal of Voice*, 16 (3), 344-355.

Sala, E., Airo, E., Olkinuora, P., Simberg, S., Strom, U., Laine, A., Pentti, J. & Suonpaa, J. (2001). Vocal loading among day care center teachers. *Logopedics Phoniatrics Vocology,* 27 (1), 21-28.

Stemple, J. C., Stanley, J. & Lee, L. (1995). Objective measures of voice production in normal subjects following prolonged voice use. *Journal of Voice*, 9, 127-133.

Stone, R. E. & Sharf, D. J. (1973). Vocal changes associated with the use of atypical pitch and intensity levels. *Folia Phoniatrica Logopaedica,* 25, 91-103.

Svec, J. G., Popolo, P. S. & Titze, I. R. (2003). Measurements of vocal doses in speech: Experimental and signal processing. *Logopedics Phoniatrics Vocology*, 28 (4), 181-192.

Titze, I. R., Hunter, E. J. & Svec, J. G. (2007). Voicing and silence periods in daily and weekly vocalizations of teachers. *Journal of Acoustic Society of America*, 121 (1), 469-478.

Verstraete, J., Forrez, G., Mertens, P. & Debruyne, F. (1993). The effect of sustained phonation at high and low pitch on vocal jitter and shimmer. *Folia Phoniatrica Logopaedica*, 45, 223-228.

Vilkman, E., Lauri, E-R., Alku, P., Sala, E. & Sihvo, M. (1999). Effects of prolonged reading on F0, SPL, subglottal pressure and amplitude characteristics of glottal flow waveforms. *Journal of Voice*, 13, 303-315.

Acknowledgements

Etiological Correlates of Hoarse Voice

[1]Ranjeet Ranjan & [2]Pushpavathi M.

Abstract

Hoarse voice is a common voice disorder seen in majority of the clients. Hoarse voice is a symptom in structural and neurological voice disorder. Apart from this it is also seen in developmental voice disorder (puberphonia) and reported more in professional voice users. The present study is an attempt to find the prevalence, etiology spectrum of and pathology related to hoarse voice, based on retrospective design. Sixty eight cases file with voice disorder were reviewed to explore the etiology and pathology. The hoarse voice was prevalent more common in adult males compared to females. The pathology correlated with hoarseness were laryngitis and vocal nodules. Acoustically the fundamental frequency was reduced in 60 patients and normal intensity was seen in all the clients.

Key words: Hoarse voice, etiology, pathology

Hoarseness is a hybrid descriptor that denotes a voice with both breathy and harsh/rough qualities (Anders, 1988). Hoarseness is also described as a voice quality characterized by a rapsing, grating and husky sound. Hoarseness originates from a combination of irregularity of vocal fold vibration and turbulent airflow through the glottis. (Anders, 1988, Omri, 1997). There are many varieties of hoarse quality and degrees of severity that are complicated additionally by changes of pitch and loudness.

Hoarseness is a common symptom in older individuals and may reflect a wide variety of pathologic, medical, physiologic, and/or functional causes. Hoarseness may be associated with voice breaks and diplophonia. Viral and bacterial infections can directly affect the throat and vocal cords, resulting in hoarseness. Allergies are common non-infectious processes that can result in hoarseness. Hoarseness perceived when noise takes place of harmonic structure. The more severe hoarseness the greater the increase in aperiodic sound. This occurs due to adduction of the vocal folds during the closed phase of the vibratory cycle is incomplete and the

mass of the folds is increased in a way that results in an irregular vibratory pattern.

Hoarseness is a voice quality characterized by a rasping, grating, sometimes husky sound, frequently accompanied by voice breaks and/or diplophonia.This description is typical of the perceptual usage of this term. Several authors have described acoustic characteristics involved in hoarseness, including vowel roughness (Emanuel & Whitehead, 1979), quasi-periodicity or aperiodicity of vocal fold vibratory pattern (Liberman, 1963) and abnormal frequency perturbation (jitter) patterns (Murry & Doherty, 1980). In addition, the hoarse voice may also be characterized as dry versus wet in which wet hoarseness is related to the presence of secretions at the vocal fold level (Moore, 1971, Boone & McFarlane, 1988, Andrews, 1995). A number of authors have concluded that hoarseness is probably the most common voice
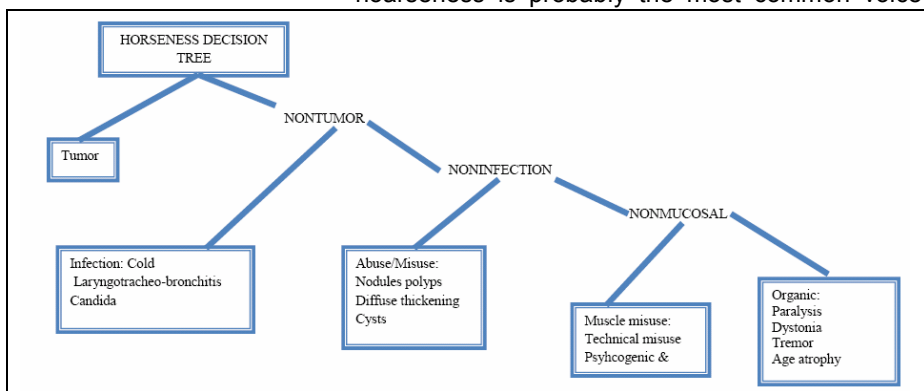

Figure 1: Etiology of hoarse voice from Murray and Rammage (1994)

[1]*Itinerant Speech Therapist, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, ranjeetaslp@rediffmail.com,* [2]*Reader and Head, Department of Clinical Services, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570 006, pushpa19@yahoo.co.in,*

quality characteristics (Boone & McFarlane, 1988, Andrews, 1995).

Hoarseness may be permanent or transitory depending up on the laryngeal changes. Hoarseness can seen in children age from 5 to 10 years (Ellis, 1952).It is clear from the description of hoarseness that many different characteristics are involved that have been described perceptually and acoustically. Many different organic conditions affecting the vocal folds can produce perceptual quality described as hoarseness (Boone & McFarlane, 1988).

Curry (1949) reported that the incidence of hoarse voice was high below the age of 10 years and diminished considerably as children grow older. A state of mild chronic laryngitis generally accompanies the dysphonia and the folds may be swollen and show incomplete adduction in the arytenoids region. Brondnitz (1962) pointed out the hyperfunction usually involves the entire vocal mechanisms although certain areas of the vocal mechanism may show more hyperfunction sites than others. Baynes (1966) found 7.1% of children in chronic hoarseness with the highest incidence in children in first grade at the school. Seth and Guthrie (1969) conducted a study to find the prevalence of hoarse voice in West Germany. They found that prevalence was more in boys compared to girls.

Zhang and Zhao (2008) evaluated characteristics of distribution of causes of hoarseness in the Han and Uighur.The data of 933 cases of hoarseness in different ages, which included 654 cases of the Han and 279 cases of the Uighur, were analyzed with largyofiberoscope. They were divided into different age groups and were compared.The common causes of hoarseness of the Han, which occupied 90.1% of its all cases, were polyp of vocal cord (31.8%), chronic laryngitis (24.9%), vocal nodules (12.2%), carcinoma of larynx (11.2%), paralysis of vocal cord (9.9%), while that of the Uighur, which occupy 96.4% of its all cases, were chronic laryngitis (27.2%), paralysis of vocal cord (21.1%), polyp of vocal cord (19.4%), carcinoma of larynx (12.9%), laryngeal papillomatosis (7.9%), vocal nodule (7.9%), There was significant differences between them (chi=73.19, p < 0.01) and significant difference between them in distribution of polyp of vocal cord, paralysis of vocal cord and laryngeal papillomatosis (p< 0.01). There was also significant difference among 2 to 20 years old group, 21 to 40 years old group and 41 to 60 years old age group. However, 61 to 85 years old age group was excempted. There was difference in distribution of causes of hoarseness between the Han and the Uighur, which was also different in

different ages. The main causes of hoarseness in the Han were chronic laryngitis and vocal nodule in children and teenagers, polyp of vocal cord and chronic laryngitis in youth and adult, while in the Uighur, they were chronic laryngitis and laryngeal papillomatosis in children and teenagers, chronic laryngitis, polyp of vocal cord and paralysis of vocal cord in youth and adult, In the aged, there was no statistical difference between the two nations, and the major cause was carcinoma of larynx and paralysis of vocal cord.

As discussed earlier there are only few studies on the etiology of different organic voice disorder. But not many studies have been done to find the spectrum of laryngeal pathology associated with hoarse voice. Hence the present study was aimed to (a)Find the prevalence of hoarse voice across age and gender ,(b) Explore the laryngeal pathology associated with the hoarse voice and to Investigate the acoustical and perceptual aspects of hoarse voice

Method

The retrospective design was used in the present study. A total number of 68 cases files who were diagnosed as having hoarse voice were reviewed in the present study. All these clients had reported to the institute with the complaint of change in voice or difficulty in swallowing. They were evaluated by qualified professionals which consisted of Speech Language Pathologist, ENT Surgeon and Phonosurgeon. The case files with the complete voice evaluations were considered for the present study. The following table depicts the details of the case files considered for the present study

	Male	Female	Total
Children (0 – 15years)	8	2	10
Adult (15 - 50 years)	32	11	43
Geriatric (50 years above)	10	5	15
Total	50	18	68

Table 1: Details of the case files selected for the study

Statistical Analysis

Descriptive statistics was used to compile the information.

Results

The prevalence of the hoarse voice was seen more in males compared to females. Also the problem was reported to be more in adults compared to children and geriatric population. Table 1 shows the prevalence of hoarse voice across age and gender (in percentage).

	Male	Female	Total
Children (0 – 15years)	12 %	3%	13%
Adult (15 - 50 years)	47%	16%	63%
Geriatric (50 years above)	14%	7%	21 %

Table 2: Prevalence of hoarse voice across age and gender

The results indicated that the hoarse voice is seen more in adult males. This is due to the history of vocal abuse and misuse which is reported to be more in adult males. The history of vocal abuse was seen in 60 cases. The present study supports the findings of Seth and Guthrie (1969), who reported an increased incidence of hoarse voice among males. In the present study the hoarse voice was observed more in adult males . This may be due to the limited sample size selected for the present study.

      a. To explore the laryngeal pathology associated with the hoarse voice

Hoarse voice is a common term used to describe the combination of breathiness and harsh voice. To find the laryngeal pathology associated with hoarse voice, the diagnosis made by the ENT Surgeon/Phonosurgeon was compiled. The figure 2 shows the different causative factors associated with hoarse voice. Results indicated different laryngeal pathologies associated with hoarse voice. vocal nodule (20%) , laryngitis (20 %) and glottis chink (14.55 %) were the main causes associated with the hoarse voice.   The other causes were vocal cord paralysis (12.73%), GERD (7.27 %) , polyp (5.45%) , tonsillitis (1.82%).   Apart from this the other causes like bowing of the vocal folds etc (18.18 %) were also observed. The results clearly indicate that the vocal nodule and laryngitis were the predominant causes for the hoarse voice. This pathology may be due to the history of vocal abuse and misuse. The vocal abuse was present in 60 clients and was absent in eight cases.

This study supports the finding of Curry (1949), who reported the increase incidence of laryngitis among subjects with hoarse voice. But the present study does not support the finding of Zhang and Zhao (2008), who reported increase vocal polyp in their study. Muscle tension of the muscle of the larynx which cause irritation of the delicate tissue also lead to the formation of polyps. Incorrect breathing, excessive tension in the larynx imbalance between glottal resistance and air pressure in individuals who use their voices considerably can cause a chronic laryngitis and weakness or tiredness of the muscles and laryngeal joints.   This condition gives rise to varying degrees of hoarseness and discomfort.
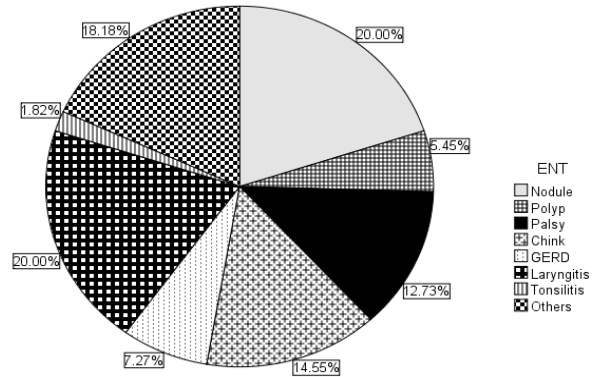

Figure 2: Laryngeal pathologies of the hoarse voice

The acoustical parameters related to fundamental frequency and intensity were also extracted from these case files. To find the perceptual correlates for the hoarse voice, the degree of hoarseness was evaluated. Degrees of hoarse voice -mild hoarse voice (10.29 %), moderate hoarse voice (4.41 %), severe hoarse voice (7.35%) and with other problems (13.24%) were noted. The fundamental frequency was reduced in 61 cases, leading to the low pitch associated with hoarseness. The intensity was normal in all the clients. This study supports the findings of Emanuel & Whitehead (1979), who reported vowel roughness quasi periodicity or aperiodicity of vocal fold vibratory pattern (Liberman, 1963) and abnormal frequency perturbaration patterns (Murray & Doherty, 1980)
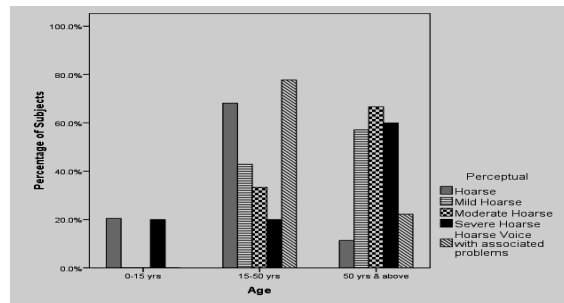

Figure 3: Details of perceptual evaluation

Conclusions

The present study is an initial attempt to explore the spectrum of causes and laryngeal pathology associated with hoarse voice. The study also highlighted the associated and perceptual feature of hoarse voice.

References

Anders, L. C. (1988). Perception of hoarseness by several classes of listeners,Folia Phonetrica,40(21), 91-100

Andrews, M. (1995) Manual of voice treatment, Pediatrics through geriatrics San. Diego, CA: Singular Publishing Group, INC

Baynes, R. A. (1966). An incidence study of chronic hoarseness in children. *Journal of Speech Disorde*r, 31,172.

Boone & M.C. Farlane (1988). *The voice and voice therapy* (5th ED). Englewood cliffs, NJ: Prentice-Hall.

Brondnitz, F. S. (1962). *The voice of the speaker and singer in voice and speech disorder:*. Medical aspects, Chap 12 Ed. N. M. Levin (Ed) Illinois, Curry, E.T. (1949). Hoarseness and voice change in male adolescents, *Journal of Speech Disorder*, 14, 356.

Curry, E.T. (1949b). Voice breaks and pathological larynx condition, *Journal of Speech Disorder*, 14,356.

Emanuel, F.W. & Whitehead, R.L. (1979). Harmonic levels and vowel roughness, *Journal of Speech & Hearing Research,* 22, 829-840.

Ellis, M. (1952). *Acute diseases of larynx in disease of ear nose & throat*, Chap 29.Ed. W.G. (Scott-Brown Butterworth, London:

Ellis, M (1952b). Chronic specific laryngitis in disease of ear nose and throat Chap 31 .Ed. W. G., Scott-Brown, Butterworth, London.

Liberman, P. (1963). Some Measures of the fundamental periodicity of normal and pathological Larynges, *Journal of the Acoustical Society of America*, 35, 344-353.

Moore, G.P. (1971), Voice and Voice Disorders Organically Based, In L.E. Travis (Ed) Handbook of Speech Pathology & Audiology (pp. 535-569).NJ: Prentice Hall.

Murry T. & Dohetry E.T. (1980). Selected acoustic characteristics of pathological and normal speech, *Journal of Speech and Hearing Research* 23, 361-369.

Murray & Rammage (1994) in Boone & M.C. Farlane (1988). *The voice and voice therapy* (5th ED). Englewood cliffs, NJ: Prentice-Hall.

Omori .K (1997). Acoustic characteristics of rough voice, sub harmonics, *Journal of Voice*, 11 (1), 40-47.

Seth G.& Guthrie D. (1935). *Speech in childhood*, Oxford University press

Zhang H, He M, Zhao Q (2008). Analysis of different distribution of causes of hoarseness between the Han and the Uighur, *Journal of Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*, 22 (24): 1138-1140.

Voicing Contrast in Tracheoesophageal Speakers

[1]Santosh M., [2]Priyanka Parakh & [3]Rajashekhar B.

Abstract

For optimal rehabilitation, it is essential to evaluate different factors which affect the intelligibility of alaryngeal speakers. Previous studies on Tracheo Esophageal (TE) speech production have mainly focused on aspects of neo-glottal phonation, speaking rate and pausing, and have ignored the changes in other speech characteristics. One such aspect which has not been studied extensively is the voiced/unvoiced distinction. Hence, the present study investigated the voicing contrasts in TE speakers. Two groups of subjects participated in the present study. Group I consisted of six TE speakers in the age range of 45 to 70 years. Group II consisted of six age and gender matched normal laryngeal speakers. Eight meaningful bisyllabic words containing all the voiced and unvoiced plosives (velar, palatal, dental and bilabial) in Kannada, uttered by the subjects were recorded and analyzed perceptually and acoustically. The results of the perceptual analysis revealed that, voicing contrast in TE speakers were near normal except for /p/. Acoustic analyses showed significant differences between acoustic parameters of voiced and unvoiced plosives, endorsing the view that TE speakers make use of multiple acoustic parameters for voicing contrast. The results of the present study have clinical relevance as reduced voicing contrast in case of alaryngeal speakers may indirectly reflect on intelligibility of speech.

Key words: Voice onset time, TE speakers, acoustic analysis

Total laryngectomy is the treatment of choice for individuals with carcinoma of larynx. This procedure alters speech production as there is removal of the larynx and rerouting of respiration through a stoma at the base of the neck. There are three ways of voice restoration after total laryngectomy: the esophageal speech, speech with the assistance of speech aids and the speech produced by the voice prosthesis i.e., tracheoesophageal (TE) speech production. In TE speech production, pulmonary air is shunted from the trachea to the esophagus to set pharyngo-esophageal (PE) segment into vibration.

Previous research with respect to TE speech production has mainly focused on aspects of neoglottal phonation, speaking rate and pausing (Singer & Blom, 1980; Debruyne, Delaere, Wouters & Uwents, 1994). However, changes in other speech characteristics have been largely ignored or have received very little attention. One such aspect is the voiced/unvoiced distinction. The knowledge about the ability of the TE speakers to produce voicing distinction is relevant as there is a change in the anatomy and physiology of voice production in these individuals. In TE speakers the

source of voice production is PE segment, located between the third and sixth cervical vertebrae. After total laryngectomy, constriction of the cricopharyngeal muscle narrows the PE segment and results in the formation of a vibrator for pseudo-voice production. PE Segment is, at best, a quasielastic sphincter mechanism, not supported by an abductor –adductor system of muscles like that of the vocal folds within larynx. Rather, it functions as an unpaired, comparatively thick and inelastic fibromuscular mechanism (Dworkin & Meleca, 1997). It is obvious that, this would preclude the precise control of voicing.

The primary acoustic cue for voicing distinction in word-initial position is voice onset time (VOT). Voice onset time is defined as the time interval between the release of the burst and the onset of glottal pulse. Physiologically, VOT reflects the timing coordination between the articulatory and the phonatory systems. The release of stop closure is related to the supralaryngeal articulators such as lips, tongue tip, and tongue dorsum, while the onset of the phonation is a laryngeal event. In Indian context for normal speakers, voiced plosives are characterized by lead VOT and

[1]Assistant Professor, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka-576104, email:santosh.m@manipal.edu, [2]Intern, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka-576104, email:priyanka_aslp@yahoo.co.in, [3]Professor and Head, Department of Speech and Hearing Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka-576104. email:b.raja@manipal.edu,

unvoiced plosives are characterized by lag VOT (Lisker & Abramson, 1964; Savithri, Sridevi & Santosh, 2003).

In general, studies on VOT values in TE speakers are few, with contradictory reports. Saito, Kinishi and Amatsu (2000); Searl and Carpenter (2002) reported that unvoiced stops produced by TE speakers were longer than produced by normal speakers. Further, longer VOT values were noticed for unvoiced stops as compared to voiced stops which is comparable to normal speakers. However, Robbins, Christensen, and Kempster (1986) reported that overall VOT values produced by TE speakers were shorter than those by normal speakers, while, Most, Tobin and Mimran (2000) investigating VOT values in Hebrew speakers, reported of no significant difference in VOT values between normal and TE speakers.

Acoustic and physiologic parameters other than VOT also play an important role in signaling a phoneme's voicing feature (Lisker & Abramson, 1967). In word - initial position, lead voice onset time (VOT) and shorter transition duration correlated with voicing. In the word-medial position, shorter closure duration and shorter transition duration correlate with voicing. In word-final position, larger preceding vowel duration and shorter transition duration correlate with voicing (Savithri, Sridevi & Santosh, 2003). There is a paucity of studies in literature on the other parameters and far less is known about these. The evidence of multiple parameters to the voicing feature may prove advantageous for TE speakers who are at risk for difficulty in making the voicing distinction via primary feature; VOT. The TE speakers conceivably could be trained to use secondary cues to enhance the voiced/unvoiced contrast. However, a primary need exists to describe what parameters are being employed by TE speakers to produce unvoiced and voiced phonemes. Also, most of the studies related to voicing distinction in alaryngeal speakers are in English, Mandarian and Hebrew languages. There are no reports in the Indian context. As Gandour, Weinberg, Petty, and Dardarananda (1987) point out, studies of alaryngeal speech in different languages are necessary, as they are expected to distinguish those features that are common across languages from those specific to particular languages. In addition, they contribute essential information to developing model of alaryngeal speech production applicable to all languages. In this regard, the present study was initiated. The present study investigated the voicing contrast in TE speakers.

Method

Subjects: Two groups of subjects participated in the present study. Group I consisted of six individuals who underwent total laryngectomy. All the subjects had undergone secondary tracheo-esophageal puncture (TEP) and used tracheo-esophageal voice as their primary mode of communication for minimum duration of two years. All the TE speakers were native speakers of Kannada and literates in Kannada and English. All of them were males in the age range of 45 to 70 years (mean – 59 years). The post-operative time ranged from three months to seven years (mean – 3.4 years). All the TE speakers used Blom Singer Low pressure (1.8cm) voice prosthesis (choice of the prosthesis was made by the Speech-Language Pathologists) and digital occlusion of the tracheostoma to produce voice. In the present study, proficiency criteria on the use of alaryngeal speaking method were not taken to facilitate generalization. Group II consisted of five age, gender and language matched laryngeal speakers.

Speech material: Eight meaningful Bisyllabic words in Kannada served as the material for the study. These eight words contained all the voiced and unvoiced plosives (velar, palatal, dental and bilabial) in Kannada. All the plosives in word-initial position were followed by vowel /a:/. The words were in a carrier phrase /Idhu ------ a:gidhe/. Table 1 shows the word list.

Place of articulation	Unvoiced	Voiced
Velar	/ka:ru/	/ga:re/
Dental	/tha:ru/	/dha:ri/
Retroflex	/ta:ru/	/dabbi/
Bilabial	/pa:ru/	/ba:ri/

Table 1: Bisyllabic word list in Kannada

Recording: Sentences were written on a flash card and visually presented to subjects in a sound treated room. They were instructed to read the sentences six times at their comfortable pitch and loudness into the microphone kept at a distance of 5 cm away from their mouth. Readings were directly recorded on to the computer memory using external module of Computerized Speech Lab. The recorded words were subjected to two experiments, Perceptual and acoustical analyses.

Experiment I: Perceptual analyses

Procedure: The first syllable of all the bisyllabic words (example /ka:/ of /ka:ru/) was selected and copied using COOLEDIT software and was made as a separate token for perceptual evaluation. Each token was presented thrice in random order. Further, 10% of the samples were re-recorded to check for the reliability. These recorded samples were presented to three trained listeners (SLP with minimum experience of 10 years). The listeners

transcribed the consonants using open response paradigm. Listener's pooled responses were converted to confusion matrices and analyzed for voicing, manner and place of articulation.

Experiment II: Acoustic analyses

   Procedure: Waveform display and spectrogram of Computerized Speech Lab (CSL 4500, Kay Elemetrics), which permitted digitization and storage was used for analysis. Each word was displayed as a broadband spectrogram with a pre emphasis factor of 0.80. The analysis size and bandwidth were set to 50 points and 'Hamming' window was used. Spectrograms were displayed as monochrome (black on white) with a grid size of 8x8 pixels (x grid -8 pixels and y grid -8 pixels) with a linear vertical axis. Words were displayed on

broadband spectrogram and the target syllables (stop consonant vowel) were 'zoomed in'. The segment was visually and auditorily verified to make sure of the target syllable. Acoustic measures were made using the cursors as follows.

Acoustic measures

(1) Voice onset time (VOT): It is the time difference between the onset of the burst and the onset of the voicing depicted as voice bars on the baseline. During VOT measurement for voiced stops in TE speakers, it was noted that for two speakers pre-voicing was present. In them VOT was measured as showed in figure 1 (lead VOT). However, in rest of subjects there was no pre-voicing. In them VOT was measured as shown in figure 2 (Lag VOT).
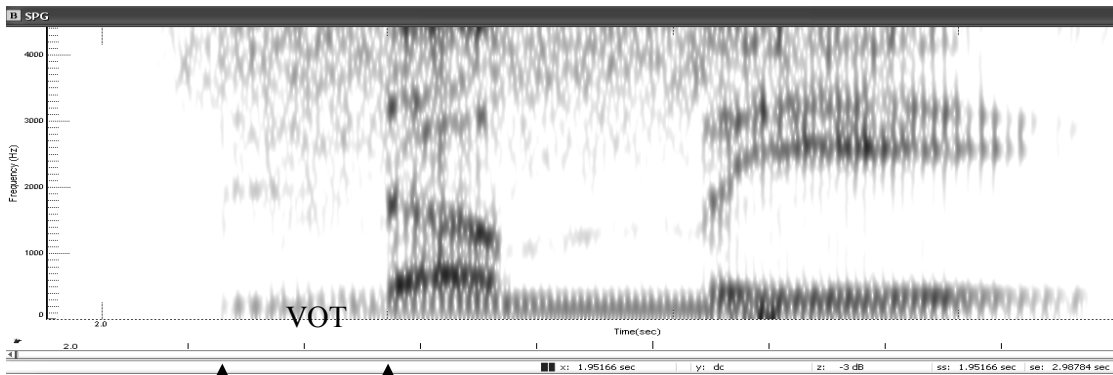

Figure 1: Measurement of VOT for voiced stop /da/ in the word /dabbi/.

(2) Vowel duration (VD): It is the time difference between the onset and offset of voicing of the vowel.

(3) Burst duration (BD): It is the time difference between the onset and offset of the articulatory release.

(4) F_2 transition duration (F_2 TD): It is the time difference between the onset and steady state of the second formant of the following vowel.

(5) Errors on the spectrograms: For TE speakers, different types of errors were identified and classified as visible on wide-band spectrograms like absent voicing, absent burst and weak burst.
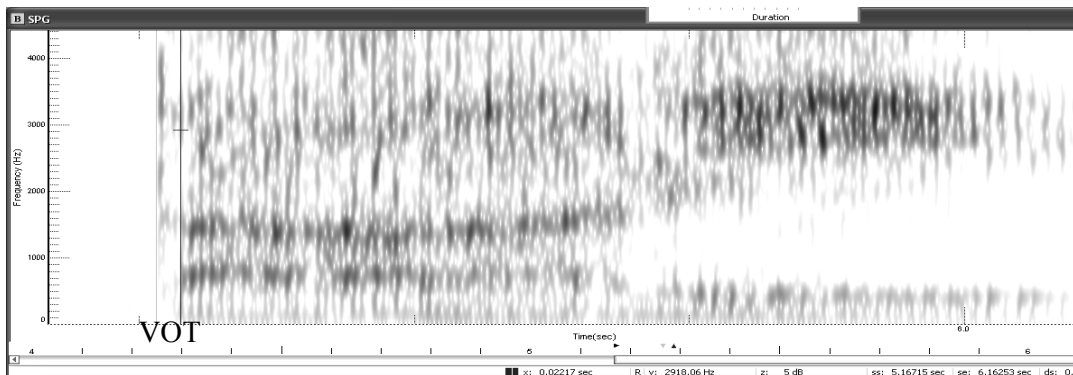

Figure 2: Measurement of VOT for voiced stop /dh/ in word /dha:ri/.

Intra and Inter Judge reliability: For perceptual analysis, both intra- and inter-judge agreement was greater than 80%. For acoustical analysis, the samples were re-analyzed after a time gap of 1 week to check for intra judge reliability. The differences between the two values were less than 5 ms.. Another experienced speech language pathologist who was unaware of the purpose of the study analyzed 10% of the samples. The differences between the two examiners were less than 5 ms.

Statistical analysis: The analyzed data was tabulated for each subject and subjected to statistical analysis. SPSS (Version 11) was used for the statistical analysis. Means and standard deviations were calculated. Paired sampled t-test was done to find the significant difference between VOT of the voiced and unvoiced plosives. Independent sampled t-test was used to find the significant difference between the groups.

Results

Experiment I: Perceptual analyses

The results of the perceptual analysis indicated that in normals all the consonants were identified with 100% accuracy. Whereas in alaryngeal speakers, all the phonemes were identified with high level of accuracy ($\geq$ 70%) except for /p/. Phoneme /p/ was confused with its voiced counterpart /b/, 20% of the time, and also with other phonemes like /m/, /v/, /a/, and /n/. Table 2 shows percent correct identification of plosives in word initial position.

		Stimulus								
		/k/	**/g/**	**/t/**	**/d/**	**/th/**	**/dh/**	**/p/**	**/b/**	**Others**
Response	**/k/**	**74.6**	15.49	0.0	0.0	0.0	1.4	0.0	4.2	/n/= 1.4 /n/= 1.4 /ch/ = 1.4
	/g/	5.4	**80.43**	0.0	0.0	1.08	3.26	0.0	1.08	/r/ = 7.6, /n/ = 1.08, /h/ = 2.15, /a/ = 2.15
	/t/	3.22	0.0	**80.06**	3.22	2.15	6.45	1.07	1.07	/m/ = 1.07
	/d/		0.0	0.0	**100**	0.0	0.0	0.0	0.0	-
	/th/	7.2	0.0	13.54	0.0	**73.95**	4.16	1.04	0.0	-
	/dh/	1.04	0.0	2.08	0.0	9.37	**82.2**	0.0	2.08	/m/ = 1.04, /v/ = 1.04, /a/ = 1.04
	/p/	4.2	0.0	1.05	0.0	0.0	0.0	**66.33**	20	/n/ = 2.1, /v/ = 2.1, /a/ = 1.05, /m/ = 3.10
	/b/		1.04	0.0	0.0	2.08	6.25	0.0	**86.45**	/m/ = 1.04, /n/ = 1.04, /v/ = 2.08

Table 2: Percent correct identification of plosives in word initial position in TE speakers.

Experiment II: Acoustical analyses

1. **Voice onset time:** The mean VOT values were significantly longer for voiced plosives (lead) compared to unvoiced plosives in both the groups. However, in those individuals in group I who had short lag VOT values for voiced plosives, VOT values were longer in unvoiced plosives compared to voiced counterparts. Between groups comparisons showed that the mean VOT values were longer in group I compared to group II. Table 3 shows the mean and SD values for VOT in group I and group II.

Groups	Unvoiced		Voiced (short Lag)		Voiced (Lead)	
	Mean	SD	Mean	SD	Mean	SD
Group I	28.00	17.40	22.35	12.35	108.97	70.31
Group II	25.93	14.24	-	-	90.60	33.17

Table 3: Mean and SD of VOT for unvoiced and voiced plosives in two groups.

2. **Vowel duration:** The results indicated significant difference (group I- (t=3.77, df= 102, p<0.05), group II- (t= 6.46, df=90, p<0.05)) between unvoiced and voiced plosives in both the groups. The mean vowel duration was significantly longer following unvoicedbv plosives compared to voiced plosives in both the groups. The mean vowel duration was significantly longer in group I compared to group II. The results of independent samples 't' test showed significant difference (unvoiced- (t= 5.3, df= 192, p<0.05), voiced- (t 4.25, df= 199, p<0.05)) between groups for both voiced and unvoiced plosives. Table 4 shows the mean and SD values of vowel duration in group I and group II.

3. **Burst duration:** The results showed no significant difference [group I- (t= 1.27, df= 79, p<0.05), group II-(t= 0.654, df= 90, p<0.05)] between voiced and unvoiced

Groups	Unvoiced		Voiced	
	Mean	SD	Mean	SD
Group I	309.19	82.21	264.77	15.76
Group II	260.88	30.03	206.07	76.77

Table 4: Mean and SD values of vowel duration (ms) for preceding unvoiced and voiced plosives in two groups.

plosives. The mean burst duration was significantly longer in unvoiced plosives compared to voiced plosives in both the groups.The between groups comparison showed that the mean burst duration values were significantly longer in group I compared to group II. The results of the paired sampled t test showed no significant difference (unvoiced- (t= 4.28, df= 182, p>0.05), voiced- (t= 3.4, df= 173, p<0.05)) between unvoiced and voiced plosives in both group I and II. Table 5 shows the mean and SD values for burst duration in both the groups.

Groups	Unvoiced		Voiced	
	Mean	SD	Mean	SD
Group I	18.35	8.75	16.31	10.99
GroupII	12.05	7.25	11.46	8.42

Table 5: Mean and SD values of burst duration (ms) for unvoiced and voiced plosives in both groups.

4. **Transition duration:** The results indicated no significant difference [group I- (t= 0.835, df= 102, p>0.05), group II- (t=

0.031, df= 89, p>0.05)] between unvoiced and voiced plosives in both groups. The mean transition duration was longer in unvoiced plosives compared to voiced plosives. Also, the mean transition duration was significantly longer in group I compared to group II. The results of independent samples t test showed significant difference [unvoiced- (t= 2.9, df= 191, p<0.05), voiced- (t= 1.66, df= 196, p> 0.05)] between groups only for unvoiced plosives. Table 6 shows the mean and SD values for transition duration in group I and group II.

Groups	Unvoiced		Voiced	
	Mean	SD	Mean	SD
Group I	48.09	17.89	45.96	20.83
Group II	40.40	20.73	40.50	21.89

Table 6: Mean and SD values of transition duration (ms) for unvoiced and voiced plosives in two groups.

5. **Errors on spectrograms:** Observation of the spectrogram revealed the following aberrant errors.

A. **Absent voicing**: Normal voiced phoneme is characterized by voice bars preceding the burst on the baseline of the spectrograms. The absence of voice bars was noted for voiced phonemes in three of the five subjects. Figure 3 and 4 show the spectrograms of the word /ga:re/ and /dabbi/ in word- initial position indicating absent voicing.
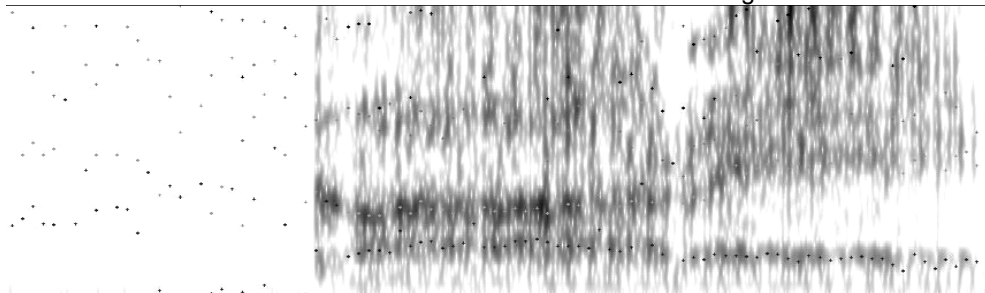

Figure 3: Spectrogram of the word /ga:re/ indicating absence of voice bars before the burst.
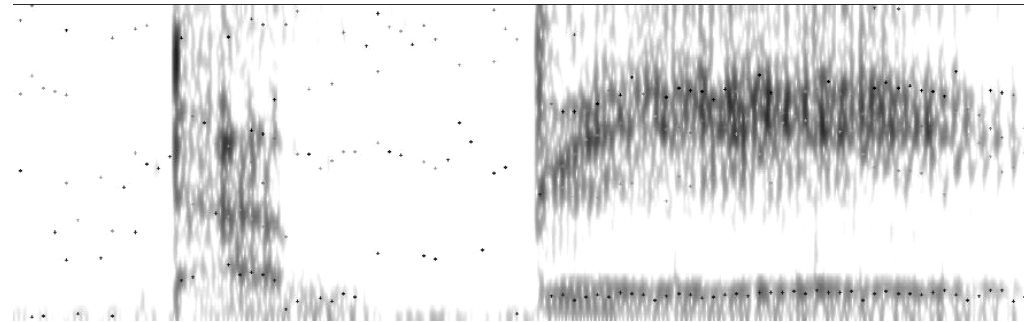

Figure 4: Spectrogram of the word /dabbi/ indicating absence of voice bars before the burst.

B. **Absent burst:** Burst is indicated by noise energy spread as irregular vertical striations across the frequency spectrum on the broadband spectrogram. Figure 5 shows the spectrogram of the word /pa:ru/ indicating absent burst.
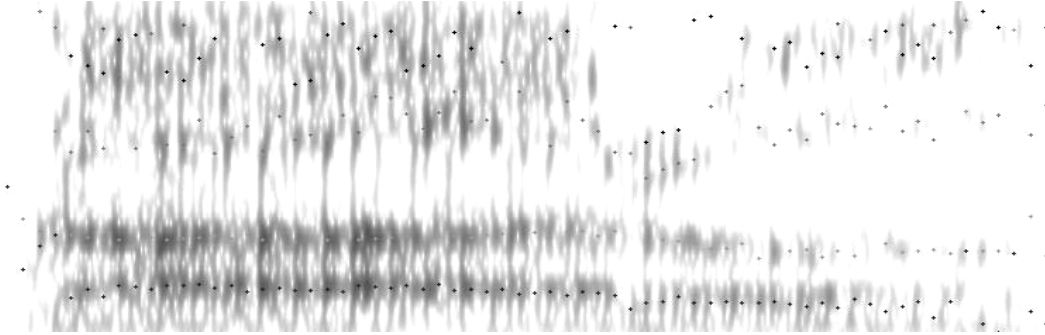
Figure 5: Spectrogram of the word /pa:ru/ indicating absence of burst before voicing bars of the vowel /a/ in the word-initial position.

C. **Weak burst:** Weak burst is characterized by less energy (light vertical striations) on the spectrogram. Weak burst is typically seen in normal speakers for voiced plosives. Weak burst was noted in four of the five TE speakers for both unvoiced and voiced phonemes. Figure 6 shows the spectrogram of the word /ta/ indicating weak burst.
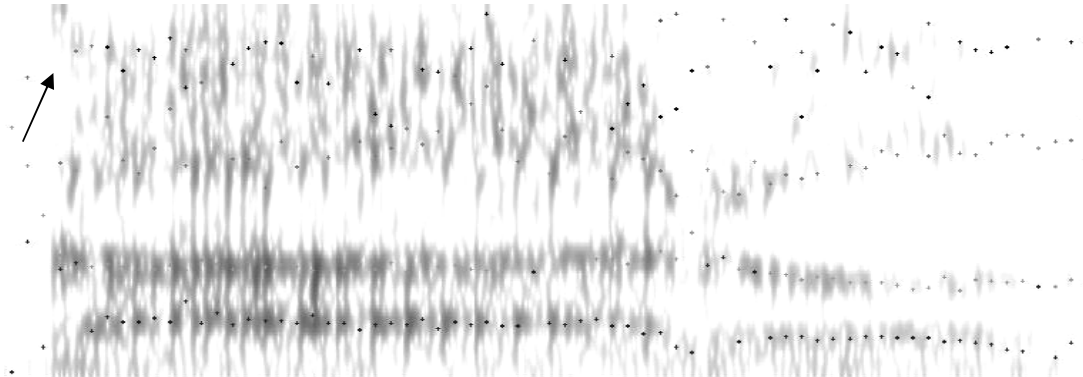
Figure 6: Spectrogram of the word /taru/ indicating weak burst in the word-initial position.

Discussion

The present study investigated the voicing contrasts in TE speakers through perceptual and acoustical analyses. Several points of interest evolved from the study. First, results of the perceptual analysis indicated that voicing contrast in TE speakers were perceived correctly except /p/, which was confused with its voiced counterpart. The results of the present study highlight that TE speakers with good intelligibility and adequate loudness, have the ability to contrast voicing, unlike their esophageal counterparts (Hyman, 1955; Shames, Font, Matthew, 1963; Sacco, Mann, Schultz, 1968; Nicholas, 1976; Hirose, 1996). This difference between TE and esophageal speakers may be due to the difference in air reservoir in TE speakers. In esophageal speakers, due to the limitation of air volume in the oral-pharyngeal air reservoir, it is difficult for them to produce high intraoral pressure, which results in voicing

confusion. Whereas in TE speakers, as they make use of lung air, they are able to build sufficient intraoral air pressure which results in voicing distinction. However, it will be interesting to investigate TE speakers' production for aspirated and unaspirated plosives.

Second, significant differences between unvoiced and voiced plosives were observed in both the groups for voice onset time, vowel duration and burst duration in the word-initial position. The mean VOT values were significantly longer in voiced plosives (lead VOT) compared to unvoiced plosives, and mean vowel duration and burst duration values were significantly longer in unvoiced stops compared to voiced stops. This supports the findings of Lisker & Abramson, (1967); Savithri, Sridevi & Santosh, (2003), that there are multiple acoustic cues for distinguishing voicing contrast in the word-initial position. Another important point is about functioning of PE segment. The results of the present study highlight that TE speakers also make use of multiple

acoustic parameters to contrast voicing in word-initial position.

Third, the results also showed significantly longer vowel duration and burst duration (both voiced and unvoiced plosives) and longer transition duration (unvoiced plosives) in TE speakers compared to normal speakers. The reason for longer duration of parameters may be attributed to attempts of alaryngeal speakers to increase articulatory precision (Searl & Carpenter, 2001). The longer VOT in TE speakers when compared to normals can be due to functioning of PE segment. Unlike vocal folds which have to be adducted to begin vibration, the PE segment will be relaxed to assume vibration. In the production of unvoiced plosives in which the intraoral pressure is lower, the time for the release of intraoral pressure is short. Therefore, the onset of vibration depends largely on the timing of PE segment relaxation. Since motor control of neoglottis is limited, it is speculated that the time needed to relax the neoglottis in TE speakers is longer when compared to adduction of vocal folds in normal speakers, yielding a longer VOT in TE speech (Ng & Wong, 2009).

The presence of weak burst and absence of burst reflects on the insufficient oral release of the plosives, which is attributable to insufficient respiratory support. Also, the aberrant spectrograms indicate that three out of the six TE speakers had absent voicing bars for voiced plosives in word-initial positions. This further reveals that PE segment does not appear to have motor control like the vocal folds, for quick abduction and adduction and appropriate coordination with other speech structures.

Conclusions

In the present study, TE speakers could contrast voicing similar to normals with high level of accuracy. Both TE and normal speakers used multiple acoustic parameters for voicing contrast. However, in TE speakers, the values of acoustic parameters were longer when compared to normals. This may be due to absence of the precise control of voicing, which may not be present due to limited motor control of PE segment. The results of the present study have clinical relevance as reduced voicing contrast in alaryngeal speakers may indirectly affect the intelligibility of speech. This study, in addition, gives an overview of the nature of voicing contrast in case of alaryngeal speakers, where the vibrating segment is the PE segment and not the vocal cords as in normals. However, results cannot be generalized owing to the limited number of subjects. Also, trained SLP's were used for the

consonant identification which could have led to the higher percent consonant accuracy. Further research incorporating large group of subjects is warranted to substantiate the present study. Further, comparison of acoustical differences between accurately identified and inaccurately identified consonants, between proficient and non-proficient speakers, and comparison of values across place of articulation needs to be done.

References

Debruyne, F., Delaere, P., Wouters, J., & Uwents, P. (1994) Acoustic analysis of tracheoesophageal versus esophageal speech. *Journal of Laryngology and Otology*, *108*, 325-328.

Dworkin, J.P, & Meleca R.J. (1997). *Vocal Pathologies: Diagnoses, treatment and case studies*. San Deigo, CA: Singular.

Gandour, J., Weinberg, B., Petty, S.H., & Dardarananda R. (1987) Voice onset time in Thai alaryngeal speech. *Journal of Speech and Hearing Disorders, 52,* 288-294.

Hirose, H. (1996). Voicing distinction in esophageal speech. *Acta Otolaryngol Suppl*, *524*, 56-63.

Hyman, M. (1955). An experimental study on artificial larynx and esophageal speech. *Journal of Speech and Hearing Disorders, 20,* 291-299.

Lisker, L., & Abramson, A.S. (1964). A Cross language study of voicing in initial stops: Acoustical measurements. *Word, 20*: 384-422.

Lisker, L., & Abramson, A.S.(1967). Some effect of context on voice onset time in English stops. *Language and Speech, 10*, 1-28.

Most, T., Tobin, Y., & Mimran, R.C. (2000). Acoustic and perceptual characteristics of esophageal and tracheoesophageal speech production. *Journal of Communication Disorders, 33,* 165-181.

Ng, M. L. & Wong, J. (2009). Voice onset time characteristics of Esophageal, Tracheoesophageal, and Laryngeal speech of Cantonese. *Journal of Speech and Hearing Research*, *52,* 780-789.

Nicholas, A. (1976) Confusions in recognizing phonemes spoken by esophageal speakers: initial consonants and clusters. *Journal of Communication Disorders, 9*, 27-41.

Robbins, J., Christensen, J., & Kempster, G. (1986). Characteristics of speech production after tracheoesophageal puncture: voice onset time and vowel duration. *Journal of Speech and Hearing Research 29*,499-504.

Sacco, P., Mann, M., & Schultz, M. (1968) Perceptual confusions in selected phonemes in esophageal speech. *Journal of Indiana Speech and Hearing Association*, *6,* 196-203.

Saito, M., Kinishi, M., & Amatsu, M. (2000) Acoustic analyses clarify voiced-voiceless distinction in tracheoesophageal speech. *Acta Otolaryngologica, 120,* 771-777.

Savithri, S.R., Sridevi, M., & Santosh, M. (2003). Voicing Contrasts in Indian Languages: Acoustic measurements. A paper presented at the National Symposium of Acoustics, Pune.

Searl, J, & Carpenter, M.A. (2002).Acoustic cues to the voicing feature in tracheoesophageal speech. *Journal of Speech Language and Hearing Research, 45, 2*82-294

Shames, G.H., Font, J.M., & Matthews, J. (1963) Factors related to speech proficiency in the laryngectomized. *Journal of Speech and Hearing Disorders*, *28*, 273-278.

Singer, M.I., & Blom, E.D. (1980) An endoscopic technique for restoration of voice after laryngectomy. *Annals of Otology, Rhinology and Laryngology*, *89*, 529-532.

Perceptual Gender Identity of Voices in Pre-pubertal children

[1]Sirisha Duvvuru & [2]Sreedevi N.

Abstract

The present study investigated sexual dimorphism in voices of children. Ten children each in the age group of 4-5 years and 5-6 years participated in the study. Listener's identification of gender in phonation and speech tasks were obtained. Results revealed that gender identification was better in the older age group, and in speech compared to phonation. The results are discussed with reference to perceptual cues taken by the listeners to identify the gender of the preadolescents.

Key words: Voice, Prepubertal, Perceptual, gender identity

It is widely assumed that listeners are able to identify the gender of a person through the recordings of speech. Lass,Schwartz, Coleman (1976) stated that listeners can accurately differentiate the recorded voices of men and women and these perceptions are related to acoustic variable reflecting their gender differences in overall head and neck size. Listeners have no difficulty in differentiating the voice of adult men and women on the basis of voice alone suggesting that the acoustic parameters which underlie gender identity in adult voice are prominent. Indeed both phonation and vocal tract resonances appear to provide highly relevant information about the sex of an adult speaker (Lass et.al, 1976). Negus (1949) pointed out that larynx develops most rapidly between three and five years and during puberty.

Until recently, the extent of our knowledge regarding gender differences of children's voices consisted of speculative comments and opinions. Several investigators have revealed that gender characteristics in voice are indeed perceptually prominent in many pre pubertal speakers. Curry (1940) suggested that the voices of boys and girls are highly similarly prior to pubescence. Moses (1954) on the other hand believes that gender differences in children's voices emerge early in life. Bennett and Weinberg (1971) were the first to report on the gender identification by voice in preadolescents. They recorded 66 spontaneous speech samples of 5-6 year old children and 61 listeners heard the recorded samples of each child. The listener's task was to identify the gender of the child and the results indicated that 78% of listeners identified male voices correctly and for 71% of listeners identified female voice correctly.

Bennett and Weinberg (1978) studied the acoustic cues that influenced the listener's judgments of gender identity in children. They tool recordings of 73 children (6 to 7 years) of four utterance types – whispered and normally phonated vowels , spoken sentences in normally and monotonous fashion. Perceptual judgments of gender identity is obtained in response to these recordings and they reported many of their 6to 7 years old children showed sexual dimorphism in their voices. Peta-white (2000) studied a total of 44 children in the age of 1 to 11 years in three tasks – singing a song, repeating syllable /pa/ at three loudness levels and speaking vowels. The results indicated significant differences in LTAS spectrum (variability in high frequency region), formant frequencies and glottal waveform which gives substantial evidence that significant gender specific articulatory behaviors occur in childhood which enhance gender distinction in voice.

Rashmi (1983) also studied various acoustic parameters in 220 children of age range of 4 to 15 years and found that F0 in phonation decreased gradually in females and in males there was a sharp decrease after 14 years. More recently in 2001, Perry, Ohde and Ashmead took vocal recordings on seven diphthongal vowels of American English and gross physical measurements of 4,8,12,16 year old children (10 boys and 10 girls per age group). 20 adults rated the voices of children based on seven point gender rating scale and results indicate that vowel formant frequencies differentiate children's gender as young as four years of age. It has also been reported earlier that intonation patterns also provide listeners with perceptually relevant information. Regarding this, Richards (1975) has reported the differences in the intonation patterns /contours of adult men and women.

[1]*Student, All India institute of Speech and Hearing, Manasagangothri, Mysore – 570006, email:duvvuru.siri@gmail.com.*
[2]*Lecturer in Speech Sciences, Dept. of Speech Language Sciences, All India institute of Speech and Hearing, Mysore – 570006, email:srij_01@yahoo.co.in.*

Literature supports the gender related perceptual differences present in the voices of preadolescents in western population. But this kind of information is limited in Indian scenario. The present work was undertaken to broaden the understanding of perceptual sexual identity in the voices of pre pubertal children in Indian population. Therefore this study proposed to find the earliest age at which preadolescents can be identified correctly as male or female by their voices.

Method

Subjects

The subjects considered here were 5 boys and five girls each, ranging in the age from 4 to 5 years and five to six years. All the subjects were from mono lingual home and spoke the dialect common to respective region. Subjects were free from vocal abnormalities and demonstrated error free production of experimental utterances.

Material

The material consisted of two tasks. 1) Phonation of vowel /a/, and 2) three spoken sentences in Kannada language. These sentences were / ha:lu kudi:ta ida:ne/, /hallu udzutha ida:ne/, and /batte ha:ko:ltha ida:ne/. These sentences were chosen so as to avoid any kind of possible cues for speaker gender recognition. Elicitation of sentences is done by using picture cards.

Procedure

Tape recordings were obtained from each child producing sustained phonation of vowel /a/ in a normally phonated mode. Then children were presented picture cards and they were asked to describe them. Recordings were made in the quiet room using a high fidelity tape recorder. (Sony TCM 150)

Perceptual judgments

Tape recorded samples obtained from these children were given for perceptual judgments to 20 judges who were adult native Kannada speakers proficient in language. Judges were young adult males and females (10 each) in the age range of 19 to 30 years with normal hearing acuity. The judges were not related directly or indirectly to any speech and hearing services. None of the judges were familiar with the subjects selected. The judges were asked to listen to each utterance carefully and indicate whether the sample (phonation and speech) was of a boy or girl.

Intrajudge reliability

Each judge was asked to listen to the samples for a second time after a span of one week to verify the intrajudge reliability. If the intra judge reliability was less that 50 % in either phonation or speech sample, that judge was excluded from the study and the sample was given to another judge for perceptual evaluation. There fore it was ensures that intrajudge reliability of all the judges in the study were 50% or above. During the perceptual evaluation, six judges were eliminated in each age group because of poor reliability scores (50%). Reliability analysis of SSPS package (version10.0) was used to calculate the intra and inter judge reliability.

Results

Percentage of correct gender identification

Results indicated better than chance identification of gender in 5-6 years of age, and in speech task compared to phonation. Table 1 shows the percentage of correct identification of gender in both age groups with respect to both phonation and speech tasks.

	Phonation		Speech	
	4-5 years	5-6 years	4-5 years	5-6 years
Boys	38%	73%	52%	66%
Girls	45%	61%	58%	58%

Table1: Percentage corrects identification in phonation and speech.

In phonation task, 38% of males, 45% of girls were identified correctly in 4-5 years age group whereas in 5-6 years, 73% of males and 61% of girls were identified correctly. This indicated that in phonation task, there is large variation in the identification of gender between both the age groups. In addition, data reveals that girls are better identified than boys in both the age groups in the phonation task.

For speech task, 52% of boys and 58% of girls were indentified correctly in 4-5 years group where as 66% of boys and 58 % of girls were identified correctly in 5-6 years group by the listeners. Figure 1 depicts the percentage of correct identification of both boys and girls with respect to phonation and speech tasks.

Association of perceptual identification and age

Chi-square revealed no significant association between age and perceptual judgments in speech task, (p>0.005) and a high significant association between age group and judgments (p<0.001) in phonation task. Table 2 shows the association between perceptual

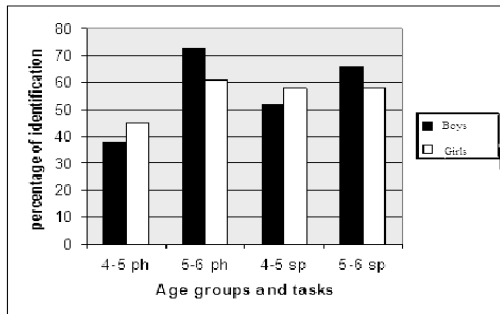judgments and age in both phonation and speech tasks.

Figure 1: Percentage of correct identification of both genders in phonation and speech tasks.

	Phonation		Speech	
	Correct	Incorrect	Correct	Incorrect
4-5 years	83	117	110	90
5-6 years	134	66	124	76

Table 2: Number of correct and incorrect responses in both the groups in two tasks.

Association of perceptual identification and gender

Chi-square test revealed no significant association between gender and perceptual judgments in both tasks indicating that judges identified boys and girls equally. Table 3 shows association between the perceptual identification and gender of children.

Interjudge reliability analysis

The results revealed that high inter-judge reliability in phonation - 73.32% and 91.50 % in 4-5 and 5-6 years respectively. The interjudge reliability for younger group of children was lower compared to older group. This is indicative of more confusion in judging the gender from phonation samples of 4-5 years. In speech task, interjudge reliability was 87% and 88% respectively in the two groups. This suggests less variability in judgments of gender based on speech sample. Several additional cues like formant frequencies, place and manner of articulation, suprasegmental features abundant in speech can contribute to reason this.

	Phonation		Speech	
	Correct	Incorrect	Correct	Incorrect
Boys	111	89	118	82
Girls	106	94	116	84

Table 3: Association between judgments and gender.

Discussion

Till date there are research reports supporting that gender identification by the voices of prepubertal children in the western population. The results of present study indicate that more than 50% of listeners identified the gender of children correctly in both phonation and speech in 5-6 years. In 4-5 year old children, gender identification was better in speech samples (more than 50 % of times) compared to phonation. This finding can be explained on the basis of additional cues in speech such as suprasegmentals which include intonation, stress patterns and rate of speech.

The results indicated that the perceptual identification of gender was better at 5-6 years compared to 4-5 years. This can be explained on the basis that gender related changes in voice appear, as children grow older. Negus (1949) pointed out that larynx develops most rapidly between three to five years and during puberty. Also Crelin (1973) stated that the sex related changes in larynx begin to appear as early as third or fourth year. These structural modifications may result in age related fundamental frequency lowering. However, it is important to note that such sexual dimorphism in voice varied across race, geographical conditions and physical characteristics of the subjects. Hence it is very likely that in Indian children, sexual dimorphism in voice emerges in 5 years or so as the percentage of identification is more than 50%.

There was significant difference in the identification scores of gender in phonation task across the two age groups. The perceptual cues that are present in phonation are formant frequencies, fundamental frequencies etc. Eguchi & Hirish (1969) reported that variability of formant frequencies for vowels between subjects is independent of age and sex. Kirchner (1970) stated that the larynx of a preadolescent boy and girl is likely to be the same size given the same height and weight. It has been suggested that gender specific articulatory behavior, such as difference in jaw opening and lip rounding, could be of significance to the variance in formant frequencies between boys and girls.In the speech task, both the age groups were identified relatively with more ease. This could be due to dynamic cues like formant transitions, voice onset time, place and manner and co-articulatory patterns that are supplementary to speech unlike phonation. Perry, Ohde and Ashmead (2001) indicated that vowel formant frequencies differentiate children's gender as young as four years of age. Also suprasegmentals act as a cue for gender identification. In this context, Richards (1975) reported differences in intonation contours of men and women and if such differences exist in the voices of preadolescents it would give important gender relate information.

In both Phonation and speech, girls were better identified at the age of 4-5 years and boys were better identified at the age of 5-6 years. There is lot of evidence to support the fact that puberty takes place earlier in girls than boys. Fant (1966) argued that there are differences other than size between vocal tract anatomies in men and women and those children appear more like women in configuration of vocal tract. Kent (1967) reported that in the case of females, decrement of F0 in infancy to childhood is somewhat in excess of an octave where as males exhibit an overall decrease approaching two octaves. Zemlin, (1981) states that the prepubertal female is developmentally more mature. Also female larynx requires less growth per unit time to reach maturity. Another possibility that may be speculated is rate differences. Feminine speech sounds smooth and fast due to decrease in inter-word pause time, coupled with increase in phoneme duration (Avery and Liss, 1996) which would have some effect on the durational characteristics of speech. This could speculate a number of possibilities for perception of gender differences.

Conclusions

To conclude, it can be stated that sex related changes in voice begin early in life and continue through out life. It is said that age of onset of puberty varies greatly, and is determined by factors such as race, heredity and perhaps general nutrition among others. The present study revealed that sexual dimorphism exists for speech at a younger age whereas it emerges only by 5 to 6 years for phonation in Indian population. The information obtained in the study is of application in speaker verification tasks and preparation of synthetic speech stimuli. If we know that children's gender is identified as early as 4-5 years of age, this helps in forensic voice science in speaker verification tasks. However, this needs further research probing into acoustic parameters confirming the gender identification in the children as young as 5 years.

References

Avery, J.D., &Liss, J.M. (1996). Acoustic characteristics of less-masculine sounding male speech. *Journal of the Acoustic Society of America*, 99, 3738-3748.

Bennett, S. (1980). Vowel formant frequency characteristics of preadolescent males and females. *Journal of the Acoustical Society of America*, 60, 231 – 238.

Bennett, S. & Weinberg, B. (1979). Acoustic correlates of perceived sexual identity in preadolescent children's voices. *Journal of the Acoustical Society of America*, 66, 989-1000.

Bennett, S., & Weinberg, B. (1979). Sexual characteristics of preadolescents in children's voices. *Journal of the Acoustic Society of America*, 65, 179-188.

Crelin, E.S. (1987): The human vocal tract anatomy, function, development and evolution. New York:Vantage.

Curry, R. (1940). The mechanisms of human voice. NewYork: Longmans.

Eguchi, D.,& Hirsh, I.J. (1969). Development of speech sounds in children. *Acta Otolaryngologica Suppl,* 257, 5-48.

Fant, G. (1973): Speech sound and features. Cambridge: The MIT press.

Kent, R.D. (1976). Anatomical and neuromuscular maturation of speech mechanism: Evidence from acoustic studies. *Journal of the Acoustical Society of America*, 59, 675-678.

Kirchner, J.A. (1970). Physiology of the larynx. In:Ingrisano D, Weismer G, Schuckers GH (eds.). Sex identification of preschool children's voices. *Folia Phoniat,* 1980, 32, 61–9.

Lass, N., Schwartz, M.F., & Coleman, V. (1976). Speaker sex identification from voiced, whispered and filtered isolated vowels. *Journal of the Acoustic Society of America*, 59, 675-78.

Moses, P. (1954). The voice of neurosis. New York: Grune and Stratton.

Negus, V.E. (1949). The comparative anatomy and physiology of larynx. Newyork: Heinman Medical Books Ltd.

Perry, T.L., Ohde, R.N., Ashmead, D.H. (2001). The acoustic bases for gender identification from children's voices. *Journal of the Acoustical Society of America*, 86, 2988-2998.

Peta White. (2000). Child voice. Stockholm: Sweden: Voice Research Center, KTH.

Rashmi, M. (1985). Acoustic aspects of speech of children. *Unpublished masters dissertation*, University of Mysore.

Richards, M (1974) cited in S.Bennett, & Weinberg, B. (1979). Acoustic correlates of perceived sexual identity in preadolescents childrens voices. *Journal of the Acoustic Society of America,* 66, 989-1000.

Weinberg, B., & Bennett, S. (1971). Speaker sex recognition of 5 and 6 year old childrens voices. *Journal of the Acoustical Society of America*, 50, 1210-1213.

Zemlin,W.R. (1981). Speech and Hearing Sciences (III Ed). Englewood cliffs: NewJersey: Prentice hall Inc.

Acknowledgements

Analysis of Voice in Yakshagana Singers

[1]Usha Devadas, [2]Rajashekhar B. & [3]Venkataraja Aithal U.

Abstract

Yakshagana (street play) is a performing art of Karnataka in which different channels of communication like dance, music, costume are utilized. Yakshagana songs are sung by a member of the troupe known as Bhagavata. Using a standard comparison study design, the parameters viz. fundamental frequency[F0], speaking fundamental frequency[SFF], jitter percent[JITT], shimmer dB[SH dB], noise to harmonic ratio[NHR]), maximum phonation duration(MPD) and S/Z ratio of Bhagavata's voice were compared with age matched nonsingers. Results of the study revealed, significantly higher fundamental frequency, speaking fundamental frequency and reduced MPD in Bhagavatas as compared to their non-singing counterparts. Laryngeal evaluation (rigid telescopy) in Bhagavatas revealed signs of vocal abuse.

Key words: Yakshagana, Bhagavatas, Rigid telescopy, Acoustic evaluation

Vocal music is a large artistic field where Hindustani, Carnatic and Light music occupy an important portion of music in India. Other than these types of music, Yakshagana (street play) a folk art and a traditional vernacular drama is the largest and possibly most popular style of music in South Karnataka. The term "Gana" signifies music and Yakshagana means a particular style of music with characteristics of its own, distinct from the other two systems of Indian music, "Hindustani" and "Carnatic". It is a combination of music and dance. A character called Bhagavata (Yakshagana Singer) sings songs, conducts the play and edits the prasanga (theme of the play). Bhagavata who is present on the stage through out the performance exercises total artistic control over the proceedings on the stage (Gururao Bapat, 1998).

In Yakshagana, the kind of formal training imparted to the learners of the classical music is never done. The novitiate normally learns the skill by copying the songs sung by senior Bhagavatas. The emphasis here is on learning the tunes of songs rather than learning the parameters of 'raagas' (special combination of notes in ascending or descending order in a scale of notes or swaras) in which they were set. One of the unique features of Yakshagana music is the dominance of high pitch as compared to other schools of music. The 'sruti' (the base note of the singer) is always on a higher note. Starting from there, the singer moves in the middle and higher octaves and almost never in the lower octave.

Such a high-pitched singing is attributed to the singer's need to be audible to a large audience in open air. The voice of Bhagavatas needs to compete with the musical instruments like Maddale and Chande (percussion instruments) to be heard. Bhagavatas, though indulge predominantly in singing, also participate occasionally in dialogue delivery. Most of the time, they will be doing so, above the level of background music which could lead to vocal abuse (Karanth, 1997; Gururao Bapat, 1998).

Many studies have explored the incidence of vocal fold pathology in singers using self-reported questionnaires. Singing teachers were more likely to have self-reported voice problems than controls and were 1.7 times more likely to have had a history of vocal disability compared to non-singers (Miller & Verdolini, 1995; Phyland, Oates, Greenwood, 1999). Perkner, Fennelly and Balkisson, (1999) compared three types of singers – opera, musical theatre and contemporary singers with 'friendship' controls. They found a significant increase in voice disorders (44% versus 21% in controls) and voice disability (69% versus 41% in controls) in the singers, with no difference between the different types of singers.

Research in the past few decades has grown up predominantly with the singers' voice reflecting instances of getting partially or totally incapacitated due to vocal abuse (Sundberg, 1987; Fritzell, 1996). Vocal abuse has been reported to be a vital factor of vocal disorders amongst professional singers and occupations, who are often considered

[1]Assistant Professor, Department of Speech and Hearing, MCOAHS, Manipal University, Manipal – 576104, email:usha.d@manipal.edu. [2]Professor & Head, Department of Speech and Hearing, MCOAHS, Manipal University, Manipal – 576104. [3]Associate Professor, Department of Speech and Hearing, MCOAHS, Manipal University, Manipal – 576104.

to be at risk for development of voice problems (Aaltonen, 1989; Fritzell, 1996)**.** In singing, it is common for an untrained but professional singer to attempt to use tones at the extreme limits of their range, either too high or too low causing damage to the vocal structure in the long run (Proctor, 1980)**.** Upper respiratory tract infection, reflux laryngitis, voice abuse in singing, voice abuse from speaking, poor general health, aging, anxiety have been reported to be the common causes of voice problems in singers (Proctor, 1980; Sataloff, 2000).

High risk performers are often exposed to unique vocal abuse characteristics which include high environmental and performance demands. Each type of professional uses the voice in a different manner. The country/pop singer may use a breathy or "rough" type of voice while an opera or classically trained singer will strive for a very specific balance of tonality and rehearse or perform on a limited time schedule. Musical theater performers typically sing during a highly exhausting choreographed production and actors may strictly use their voice in projected dialogue. It can be these attributes that make these professionals to perceive different types of voice difficulties (Rapheal, 1998). The typical abuse related changes of the vocal folds are hyperemia and edema of the vocal folds, where viscous sputum clings to the free edges of the vocal folds (Chernobelsky,1996)**.** Music teachers are also prone to develop vocal symptoms due to extended voice use, higher pitch and higher intensity (Fritzell, 1996). Depending on the environmental and performance demands, distinguishing laryngostroboscopic and acoustic characteristics are reported by Ruddy, Lehman, Crandell, Ingram & Sapienza (2001) in musical theater, choral ensemble and street theater performers.

Yakshagana singer (Bhagavata) usually sings in a high pitch. Yakshagana performance spreads from sunset to sun rise. After singing for several hours, the Bhagavata's voice undergoes subtle changes. Hence, in the early morning, he shifts to high pitch. Other than this, the singer has to sing one or two words and stop abruptly most of the times. The singer has no liberty to elaborate on the parameters of the 'raaga' and at all times, has to keep in mind the actor, dancer with no liberty to indulge in pyrotechniques to which the actor dancer cannot respond through his media of expression. Further, the shift from higher pitch to the lower or the reverse is done so suddenly that it creates a jerking effect (Gururao Bapat, 1998). All these factors make Yakshagana singers more vocally abusive and prone to develop laryngeal disturbances.

Even though Yakshagana is the largest and possibly most popular style of music in South Karnataka, till date, only one study is reported in the literature related to the Bhagavatas' voice characteristics (Jayaram & Kalaiselvi, 2006). They studied the short term consequences of vocally violent behaviours in Yakshagana artists (actors and singers) on acoustic parameters by comparing their vocal parameters prior to, and following performance of one episode of Yakshagana and the effect of 12 hours of complete voice rest following an Yakshagana performance. The results indicated increase in frequency and intensity related measures (mean, maximum, speed of fluctuation, extent of fluctuation), increased speaking fundamental frequency, reduced intensity and frequency range, poor perturbation and HNR scores following Yakshagana performance in both the groups.   However, improvement in these parameters was reported with 12 hours of complete voice rest in both groups. This study shows that Yakshgana artists, both, the actors and singers are at risk for vocal deterioration and fatigue following performance though these measures showed slight improvement following voice rest. Till date, no study has been done comparing the voice of Bhagavatas with that of age matched non singers. The present study hence aims at comparing the various acoustic and temporal parameters between Bhagavatas and non singers to explore the possible effect of Yakshagana singing.

Method

Subjects

Two groups consisting of 20 male Bhagavatas (group I) and 20 age and gender matched non-singers (group II) participated in the study. Yakshagana singers were in the age range of 24 to 44 years with a mean age of 30 years. Their professional experience varied from 5 to 21 years. All the singers were in good health with no evidence of speech and hearing problems. The comparison group of age-matched non-singers consisted of 20 males, ranging in age from 24 to 45 years with a mean age of 31 years with good health, normal hearing, speech and voice. Non-singers were selected randomly and subjected to rigid telescopic examination and Multidimensional Voice Program (MDVP). The non-singers included in this study had normal vocal fold structure and function with acoustic parameters falling within normative range on MDVP. Their professions did not involve excessive use, misuse or abuse of their vocal mechanism.

Recording & Analysis

Acoustic Parameters

Each subject's phonation of vowel /a/ was recorded in a sound treated room for acoustic analysis. The Shure Dynamic SM 48 microphone was positioned at a constant distance of six inches and connected to a PC. The subjects were instructed to phonate the vowel /a/ at their comfortable pitch and loudness level for a duration of five to six seconds. The initial and final parts of the vowel were eliminated, selecting a signal duration of 3 seconds (the central part of the vowel) for the analysis. The voice samples were analyzed by Multidimensional Voice Program (Multi Dimensional Voice Profile, Kay Elemetrics Corp, model 4305) using Computerized Speech Lab (CSL) at a sampling rate of 44kHz. For the purpose of analyzing the SFF (speaking fundamental frequency), the subjects were asked to read three standardized meaningful Kannada sentences; /idu pa:pu/, /idu ko:ti/, /idu kempu banna/. These sentences were recorded using the same instrumental setup used for recording the vowel phonation. The acoustic parameters viz F0, SFF, jitter percent, shimmer dB and Noise to Harmonic Ratio (NHR) were determined from the recorded samples.

Maximum phonation Duration (MPD)

MPD refers to the maximum amount of time an individual can sustain phonation after taking a deep inhalation. It is the simplest test that demonstrates the status of the respiratory system and the relative efficiency of the interaction of the respiratory and laryngeal system.

For the measure of MPD, the subjects were instructed to take a deep breath and phonate the vowel /a/,/i/ and /u/ at their comfortable pitch and loudness levels and the duration of phonation was measured using stopwatch. The task was recorded for three times with a short gap between the trials. The longest duration of the three trials was considered as the MPD.

S/Z Ratio

For the measure of S/Z ratio, the subjects were instructed to sustain /s/ and /z/ as long as possible and the time is determined using a stop watch. It is the ratio between the durations of sustained /s/ and /z/. This measure provides information about the laryngeal system.

Laryngeal Examination

In order to define the participants' (Bhagavatas and non-singers) vocal fold structure, standard procedure for oral rigid telescopy (Hopkins 8706 CS 70) was used by a qualified and experienced ENT specialist. Vocal structure was assessed during quiet breathing and during phonation of /i/ for any functional inadequacy.

Statistical Analysis

Statistical analysis was carried out using the SPSS Statistical package Version 11.0. Comparison of acoustic parameters between Bhagavatas and non-singers were done using t-Test. The parameters average fundamental frequency (F0), S/Z ratio and MPD of /u/ were compared using Mann-Whitney U test as they violated the assumption of normal distribution.

Results

Results indicated significant differences between the groups on F0, SFF, MPD(/a/, /i/ and /u/). F0 and SFF were significantly higher and MPD was significantly lower in group I as compared to group II. No significant difference between the groups on jitter%, shimmer dB, NHR, and S/Z ratio were observed. Table 1. depicts the mean, SD, t/u values and p values for all parameters.

Laryngeal findings

Rigid telescopic findings in Bhagawathas revealed normal structure and function of the vocal folds in 25% of the subjects. 70% of the subjects had bilateral vocal fold edema with phonatory gap and bilateral arytenoids mucosal edema in 25% of the subjects. All the non-singers had normal rigid telescopic findings.

Parameter	Group I Mean (SD)	Group II Mean (SD)	t / u values	p values
Fo (Hz)	145 (27)	123 (10)	U = 103	0.002
SFF (Hz)	159 (20)	138 (14)	3.928	0.000
Jitter %	0.803 (0.73)	0.604 (0.31)	0.188	0.242
Shimmer dB	0.26 (0.15)	0.25(0.14)	0.203	0.840
NHR	0.132 (0.26)	0.131(0.46)	0.105	0.917
MPD /a/	14 (4)	24 (5)	-7.509	0.000
/i/	13(4)	23(6)	-7.607	0.000
/u/	13 (4)	22 (6)	U=43	0.000
S/Z ratio	1.05 (0.33)	0.94 (0.21)	U = 180	0.227

Table 1: Mean, SD, t/u values, and p values of various measures in two groups.

Discussion

Bhagavatas had significantly high Fo and SFF in comparison to non-singers. This is in consonance with the findings of Jayaram et al,(2006), where they reported an increased

speaking fundamental frequency following Yakshagana performance. Many studies in the literature have reported increase in fundamental frequency following vocal performance (Gelfer, Andrews & Schmidt,1991; Rantala & Vilkman, 1999; Vilkman, Lauri, Alku, Sala & Sihvo, 1999). Higher speaking fundamental frequency in Sopranos, Tenors, Altos and Baritone singers as compared to age matched non-singers has been reported (Brown, Morris, Hollien and Howell, 1991). The possible explanation given in the literature for these changes are the compensation for the symptoms of vocal fatigue (Vilkman et al,1999) and the influence of formal training received by them (Brown et al, 1991). Probably, as a part of the effort to increase the vocal loudness in the presence of background himmela (background music), Bhagavatas tend to tense their vocal apparatus which inturn results in higher F0. Further, it could be hypothesized that the higher F0 in phonation and SFF in Bhagavatas may be the influence of unique features of Yakshagana music, where high pitch dominates during vocal performance. It is felt that this practice of singing for several hours in a high pitch over a period of time could have resulted in a persisting higher F0 in phonation as well as in speech.

The perturbation measures obtained in this group of singers are contradicting those reports in the literature among the professional voice users (Kitch, Oates, & Greenwood 1996, Brown, Rothman, & Sapienza, 2000, Lundy, Roy, Casizno, Xue, Evans, 2000). Slightly increased mean values of perturbation measures observed in Bhagavatas (jitter % 0.803; shimmer dB 0.26) as compared to nonsingers (jitter % 0.604; shimmer dB 0.25), were however not significant between groups. Poor perturbation scores following Yakshagana performance was reported by Jayaram et al,(2006), which improved within 12 hours of complete voice rest. The increase in the perturbation measures though not significant in Bhagavatas in the present study may be attributed to the medical observation of vocal fold mucosal edema and phonatory gap, in nearly 70% of the subjects.

There was no significant difference in noise to harmonic ratio between the Bhagavatas and nonsingers in the present study. Noise to Harmonic Ratio has been reported to be a useful, quantitative index to confirm a perceptual diagnosis of dysphonia and to evaluate quantitative changes in a dysphonic voice user over time (Kitch et al, 1996; Ferrand, 2002). High degrees of variability in H/N ratio among subjects between pre and post performance have been reported (Lundy et al, 2000)**.** **T**here are also studies in the literature reporting of no significant

difference in noise to harmonic ratio between the dysphonic and non-dysphonic group, thus questioning the sensitivity of this acoustic parameter in detecting dysphonic voice from that of a normal voice (Yiu, Worrall, Longland, & Mitchell, 2000; Ma & Yiu, 2005). Poor H/N ratio was reported in Bhagavatas following Yakshagana performance (Jayaram et al, 2006), however some improvement in the scores with 12 hours of complete voice rest have been reported.

MPD provides information on the general state of the subjects' respiratory coordination and overall status of vocal apparatus. Decreased MPDs has been observed in cases of vocal dysfunction. The results of the present study are in consonance with observations in literature in singers (Boone, 1971; Timmerman, De Bodt, Boundewijns, Clement, Peters, & Van de Heying, 2002)**.** Reduced mean MPD in Bhagavatas (13 secs) as compared to nonsingers (23 secs) could be related to the presence of vocal fold edema and phonatory gap observed during rigid telescopic examination in Bhagavatas as a contributing factor in addition to their high pitch phonation.

S/Z ratio, an indicator of vocal fold marginal pathology has been reported to be higher and significant in the presence of laryngeal lesion (Eckel & Boone, 1981). Investigating this measure in laryngeal pathology (nodules or polyps), dysphonic subjects without laryngeal pathology and normal speaking subjects they reported that S/Z ratios were significantly higher for laryngeal pathology with no significant difference in S/Z ratios between dysphonics without laryngeal pathology and normal subjects. These findings suggested that an additive mass present on the glottal margin significantly affects the S/Z ratio. The presence of normal S/Z ratio in Bhagavatas endorses the absence of significant vocal fold marginal lesions usually associated with higher scores. Though vocal fold edema was observed in majority of Bhagavatas, it had no effect on their S/Z ratio. This warrants further research to explore the effect of Yakshagana form of singing on respiratory and laryngeal mechanisms.

In singing, it is common for professional singers to attempt to use tones at the extreme limits of their range, either too high or too low causing damage to the vocal structures in long run (Proctor,1980). Elias, Sataloff, Rosen, & Heuer (1997) reported a higher incidence (58%) of abnormal laryngeal findings in singers without vocal complaints. In professional singers, in addition to the performance demands, environmental factors play a large and unique role in creating dysphonia, such as out door setting with competing noise, excessive amount of

performance time, dusty environment and onstage smoke (Ruddy et.al. 2001). Voice use in such conditions can lead to vocal fold edema, increased vascularity, disruption of the vocal fold edge resulting in vocal fold nodules, polyps, or polypoid changes. Rigid telescopic findings in the present study revealed the presence of bilateral vocal fold mucosal edema (70%). This could be attributed to the performance demands (high pitch singing, no liberty to elaborate on parameters of 'raaga', singing one or two words and stopping abruptly, sudden variation in pitch from higher to lower or the reverse creating jerking effect, raising voice above the background noise) and the environmental factors (high back ground noise of percussion instruments, outdoor setting with competing noise, excessive amount of performance time) of Yakshagana singing.

Conclusions

To conclude, this study is one of the preliminary attempts at providing data on Yakshagana singing, targeting acoustic and temporal parameters along with laryngoscopic findings of Bhagavatas in comparison with age matched non-singers. Significant differences in few acoustic and temporal parameters (F0, SFF and MPD) were observed in Bhagavatas compared with age matched non-singers. Most of the subjects showed changes in bilateral vocal fold mucosa indicating that Yakshagana singers are at risk for vocal fold lesions. Hence, it is warranted that more extensive studies need to be conducted to know the different risk factors leading to voice problems in these singers and their knowledge regarding voice care techniques and the voice care strategies followed by them. This information could help the Speech Language pathologist to device appropriate voice conservation strategies for these singers.

References

Aaltonen, T. A. (1989). Comparison of subjective voice complaints of teachers in northern and southern Finland (in Finnish), a Licentiate thesis. . University of Ouler.

Boone, D. (1971). *The voice and voice Therapy*. New Jersy, Englewood Cliffs:

Brown, W. S. Jr., Morris, R. J., Hollien, H., & Howell, E. (1991). Speaking fundamental frequency characteristics as a function of age and professional singing. *Journal of Voice, 5*(4), 310-315.

Brown, W. S., Rothman, H. B., & Sapienza, C. M. (2000). Perceptual and acoustic study of professionally trained Vs untrained voices. *Journal of Voice, 14*(3), 301-309.

Chernobelsky, S. I. (1996). Dtermination of laryngeal muscle tension in professional singers. *Folia Phoniatr Logop, 48*, 171-174.

Eckel, F., Boone, D. (1981). The S/Z ratio an indicator of laryngeal pathology. *J Speech Hear Res, 46*, 147-149.

Elias, M. E., Sataloff, R. T., Rosen, D. C., Heuer, R. J. (1997). Normal Strobovideolaryngoscopy: Variability in healthy singers. *Journal of Voice, 11*, 104-107.

Ferrand, C. T. (2002). Harmonics-to-Noise ratio: An Index of Vocal Aging. *Journal of Voice, 16*(4), 480-487.

Fritzell, B. (1996). Voice disorders and occupations. *Logop Phoniatr Vocol, 21*, 7-12.

Gelfer, M. P., Andrews, M. L., & Schmidt, C. P. (1991). Effects of prolonged loud reading on selected measures of vocal function in trained and untrained singers. *Journal of Voice, 5*, 158-167.

Gururao Bapat. (1998). *Semantics of Yakshagana: Yakshagana performance and meaning a semantic study*. Kunjibettu, Udupi, Regional Resources for Folk Performing Arts.

Jayaram, M., Kalaiselvi, P.S., . (2006). Effect of performance and voice rest on voice characteristics of Yakshagana folk artists. *journal of indian Speech and hearing Association, 20*, 21-25.

Karanth, K. S. (1997). *Yakshagana*. New Delhi: Indira Ghandhi National Center for Arts.

Kitch, J. A., Oates, J., Greenwood, K. (1996). Performance effects on the voices of 10 choral tenors: Acoustic and perceptual findings *Journal of Voice, 10*(3), 217-227.

Lundy, D. S., Roy, S., Casiano, R. R., Xue, J. W., Evans, J. (2000). Acoustic analysis of singing and speaking voice in singing students. *Journal of Voice, 14*(4), 490-493.

Ma, E. P. M., & Yiu, E. M-L. (2005). Suitability of acoustic perturbation measures in analysing periodic and nearly periodic voice signals. *Folia Phoniatr Logop, 57*, 38-47.

Miller, M. K., Verdolini, K. (1995). Frequency and risk factors for voice problems in teachers of singing and control subjects. *Journal of Voice, 9*, 348-362.

Perkner, J. J., Fennelly, K. P., Balkisson, R. (1999). Self reported voice problems among three groups of professinal singers. *Journal of Voice, 13*, 602-611.

Phyland, D. J., Oates, J., Greenwood, K. M. . (1999). Self reported voice problems among three groups of professional singers. *Journal of Voice, 13*, 602-611.

Proctor, D. F. (1980). *Breathing, speech and song*. New York: Springer-Verlag.

Rantal, L., & Vilkman, K. (1999). Relationship between subjective voice complaints and acoustic parameters in female teachers' voice. *Journal of Voice, 13*, 484-495.

Raphael, B. N. (1998). Special patient history consideration relating to members of the acting profession. In: Sataloff, R. T. ed. *Vocal health and Pedagogy*. San Diego, Calif: Singular Publishing Group Inc.

Rudyy, B. H., Lehman, J., Crandell, C., Ingram, D., and Sapienza, C. (2001). Laryngoscopic, acoustic and environmental characteristics of high risk vocal performers. *Journal of Voice, 15*(4), 543-552.

Sataloff, R. T. (2000). Evaluation of professional singers. *Otolaryngol Clin North Am, 33*, 923-956.

Sundberg, J. (1987). *The Science of the singing voice* Illinois: Northern.

Timmermans, M. S., De Bodt, F. L., Boudewijns, W. A., Clement, G., Peters, A. and Van de Heying, P. H. (2002). Poor voice quality in future elite vocal performers and professional voice users. *Journal of Voice, 16*(1), 372-383.

Vilkman, E., Lauri, E. R., Alku, P., Sihvo, M. . (1999). Effects of prolonged loud reading on F0, SPL, subglottal pressure and amplitude characteristics of glottal flow waveforms. *journal of voice, 13*(303-315).

Yiu, E. M.-L., Worrall, L., Longland, J., Mitchell, C. (2000). Analyzing vocal quality of connected speech using Kay's Computerized Speech lab: A priliminary finding. *Clin Linguist Phon 14*, 295-305.

Acknowledgements

Phonological Awareness in Specific Learning Disability: A Journey into Search for Genetic Inheritance

[1]Deepa M. S. & [2]Prema K. S.

Abstract

Specific learning disability (SLD) is a condition debated for long particularly for the causation. The genetic nature of specific learning disability in particular, has been widely discussed. The recent literature increasingly highlights the associated phonological skill deficits as the underlying core cause for the genetic inheritance with SLD. The present study aimed at comparing the phonological skills of families of children with SLD with that of children and adults without SLD. Three families of children with first cousins, the siblings and only one child in family who were diagnosed as having SLD were selected for the study along with the normal sibling and both the parents. All were tested on phonological tasks. Results were compared with normal children and normal adults. The results indicate that both the qualitative and quantitative performance of children with learning disability matched with that of their fathers suggesting a possibility of tracing genetic inheritance with behavioral measures such as phonological awareness skills. The study opens-up a possibility of devising low cost and non-invasive protocol to explore genetics as a causative factor by clinician that would facilitate better counseling and prognosis. An investigation of performance of children with SLD and their family on phonological tasks revealed a possibility of underlying phonological skill deficits as the cause for SLD, than the inheritance of specific learning disability per se.

Key words: phonological awareness, Learning disability, genetic inheritance

The terms learning disability, learning disabilities and learning disorders (LD) refer to a group of disorders that affect a broad range of academic and functional skills including the ability to speak, listen, read, write, spell, reason and organize information. A learning disability is not indicative of low intelligence. Indeed, research indicates that some people with learning disabilities may have average or above-average intelligence. Causes of learning disabilities include a deficit in the brain that affects the processing of information.

Learning disabilities can be categorized either by the type of information processing that is affected or by the specific difficulties caused by a processing deficit. Historically the reading disorders that are acquired as a result of brain injury were investigated the most. Gradually the reading disorders of congenital origin caught the attention of medical specialists, psychologists, special educators and speech language pathologists. The term SLD (Specific Learning Disability) has been widely accepted for those disorders of congenital origin. A specific learning disability is a disorder in one or more of the central

nervous system processes involved in perceiving, understanding and/or using concepts through verbal (spoken) or written language or nonverbal means. This disorder manifests itself with a deficit in one or more of the following areas: attention, reasoning, processing, memory, communication, reading, writing, spelling, calculation, coordination, social competence and emotional maturity.

The causative factors for SLD have been debated over the decades without consensus from the researchers. The investigative research, however, made a clear distinction between acquired and congenital disorders of reading, especially with respect to their causation. The notion of SLD as being genetic in origin has been emphasized in a majority of studies (Franck's & Monaco, 2002; Schulte-Korne, 2001; Smith & Pennington, 1990; Grigorenko, 2001; Remschmidt, 1996).

Dyslexia, one of the SLDs, is a disorder of reading and spelling is a heterogeneous neurological syndrome with a complex genetic and environmental etiology. People with dyslexia differ in their individual profiles across a range of cognitive, physiological and behavioural measures

[1]*Junior Research Fellow, All India Institute of Speech and Hearing, Mysore-6, email:deepams12@gmail.com.* [2]*Professor and Head, Dept. of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore-6, email:prema_rao@yahoo.com.*

related to reading disability. Some or all of the subtypes of dyslexia might have partly or wholly distinct genetic causes. An understanding of the role of genetics in dyslexia could help in the diagnosis and treatment of children more effectively than is currently possible and also in ways that account for their individual disabilities. This knowledge will also give new insights into the neurobiology of reading and language cognition. Genetic linkage analysis has identified regions of the genome that might harbour inherited variants that cause reading disability. In particular, loci on chromosomes 6 and 18 have shown strong and replicable effects on reading abilities. These genomic regions contain tens or hundreds of candidate genes, and studies aimed at the identification of the specific causal genetic variants are emerging in more number in the recent years.

Evidences for Genetic Inheritance of SLD

Recent advances in the understanding of the genetics of SLD based on family studies show a moderate to high familiality and heritability which is evident in studies done by Silver (1971); Omenn and Weber (1978); Singer, Stewart and Pulaski (1981). They studied the pedigree of family history and reported that SLD phenotype is genetically influential. Apart from family studies, twin studies offer crucial support for an understanding of the hereditability of reading, spelling and correlated cognitive phenotypes (example: phonological and orthographic processing). Early twin studies found concordance rates of around 100% in monozygotic twins and about 50% in dizygotic twins, indicating a substantial heritability for reading disability (Zerbin-Rubin, 1967; Bakwin, 1973). Stevenson, Graham, Fredman and McLaughlin 1987), ascertained twins from the general population and found heritability of spelling disability of 0.53, which increased to 0.75 with the control on intelligence. High and significant heritability was for phonological awareness in Colorado twin study (Defries, Fulker & La Buda, 1987; Stevenson, Graham, Fredman & McLaughlin, 1987; Olson, Gillis, Rack & Fulker, 1989; Castles, Datta, Gayan & Olson, 1999).

Patrick, Pearson, Halpin and Jackson (1973) did genetic investigation in a community based population of children with mild-moderate learning disability in 'Human Genetic Unit' Edinburgh University. Age range considered was 5-12years and 13-18year. Sex ratio was 1:62 (Male: Female). 50.6% of them had family history. They performed clinical genetic studies. 4% of them had affected parents as was siblings. Highly significant genetic contribution to etiology of SLD was reported in this genetic investigation.

Different genetic models of reading and spelling disorders have been postulated and there is evidence for both polygenic and monogenic inheritance. For example, the finding that the rate of affectedness in siblings is mainly influenced by whether one or both parents are affected (Hallgren, 1950; Wolf & Melngalis, 1994; Gillis et.al 1996) can be best explained by a polygenic model. Further evidence for this model comes from the findings that siblings in family with two affected parents were more severely impaired than siblings in families with one affected parent (Wolf & Melngalis, 1994) and also provides evidences for an autosomal-dominance transmission with sex-dependant penetrance (Fisher, 1905; Stenphenson, 1907; Hishelwood, 1907; Hallgren, 1950).

A Dominant Gene for Developmental Dyslexia on Chromosome 15 and 3

Smith (1983) found a linkage of reading and spelling disorder to chromosome 15. Grigorenko (1997) reported locus on the long arm of chromosome 15. Morris, Robinson and Goldmuntz (2000)used family based associated mapping with two independent samples and suggested one or more genes contributing to reading disorder.

Hemmia, Myllyluomaa, Haltiad, Taipaleb et al (2002) stated that developmental dyslexia is a neurofunctional disorder characterized by an unexpected difficulty in learning to read and write despite adequate intelligence, motivation and education. They studied a large pedigree, ascertained from 140 families considered, segregating pronounced dyslexia in an autosomal dominant fashion. Affected status and the subtype of dyslexia were determined by neuropsychological tests. A genome scan with 320 markers showed a novel dominant locus linked to dyslexia in the pericentromeric region of chromosome 3. Nineteen out of 21 affected pedigree members shared this region identical by descent (corrected p<0.001). The new locus on chromosome 3 is associated with deficits in all three essential components involved in the reading process, namely phonological awareness, rapid naming and verbal short term memory.

Evidences for Deficiencies in Phonological Skills in SLD

Vellutino (1977), Liberman and Shankweiler (1979) and Mattingly (1980) postulated that learning disability is a language disorder and that poor readers are not aware that spoken and printed words can be segmented into individual phonemes. This inability in turn prevents them from coding information phonetically. Various

investigators have demonstrated that the ability to segment words into phonemes develops at about the time children learn to read and is highly correlated with reading achievement in beginning readers but is deficient in children with reading disability (Liberman, & Shankweiler ,1979; Bradely & Bryant, 1983;). Mattingly (1980) hypothesized that children who have little or more difficulty in understanding spoken language may be unable to abstract phonemes from spoken words, a step that is necessary for learning to read and that this inability for phonemes segmentation is because of severe language impairment (Vellutino, 1979; Tallal, 1980)

In the literature of the recent past, arguments are put forth by researchers that SLD is a specific developmental language disorder involving deficits in the underlying processes that contribute to the language disorder. And that, the manifestation of the SLD is due to the deficiencies in these underlying processes such as deficits in phonological awareness, sequencing, segmentation and naming. A synthesis of the studies that support the genetic cause for SLD and those that suggest the deficiency in the phonological skills in the SLD leads one to speculate that the SLD is invariably genetic. However, what is inherited is not the SLD itself but, the phonological processing skills, which when deficient can produce the symptoms of SLD. Doyle (1996) has shown that deficits in phonological skills are themselves the result of an inherited weakness in segmental language skills, which can be summarized as in Figure 1.

AN INHERITED WEAKNESS IN SEGMENTAL LANGAUGE SKILLS

↓

DEFICITS IN PHONOLOGICAL SKILL

↓

SPECIFIC LEARNING DISABILITY
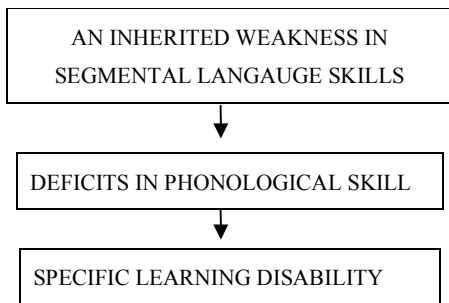
(Source: Doyle, 1996; Dyslexia an introductory guide)

Figure 1: SLD as specific developmental language disorder.

Do Behavioral Measures Tap Genetic Inheritance?

As we learn from the model (Doyle, 1996), though the causation for SLD is genetic, there are very few measures which can tap its origin. There are many tests used to screen for learning Disability in children. Phonological awareness task is the most commonly used in all the tests.

Kumar and Prema (1999) compared 2 subjects (6years/F & 21years/M) the first cousins with diagnosis of SLD, on their performance on phonological tasks. They reported that despite the age, educational and language differences, both the subjects manifested similar qualitative errors/deficits on phonological awareness tasks, suggesting possibility of inheritance of phonological skill deficits rather than SLD per se.

A retrospective study conducted by Prema and Jayaram (2001-02) to evaluate the relationship between demographic factors and reading skills in Indian children learning to read and write English reported that despite variations in demographic data the children did manifest a strong correlation between language and reading variables and not between reading and demographic variables suggesting that the underlying core issue behind SLD could be the language phenomenon which is the crucial factor. They used Early Reading Scales (ERS) in English. The test consisted of the many tasks related to phonological awareness, such as Reading (words and non-words), Rhyme recognition, Syllable stripping, Syllable oddity, Phoneme stripping and Phoneme oddity.

The review of literature suggests that a considerable percentage of children with SLD evidence genetic inheritance and that this could be tapped through family studies. Further the review suggests that SLD could be the manifestation of underlying language deficiency, the phonological skill deficits, in particular.

Phonological Awareness Training

The review of the literature suggests that improvement in the phonological awareness skills would improve reading and writing skills in individuals with learning disability.

Phonological skills involve manipulations of the phonological constituents of spoken words in tasks such as blending, segmenting and rhyming. Students who learn to read well can rhyme at approximately age 4 (Maclean, Bryant & Bradley, 1988) and blend and segment orally presented words and sounds by the end of the 1st grade (Perfetti, Beck, Bell & Hughes, 1987). But most poor readers, by the end of the 2nd grade, still cannot blend or segment words as well as normally reading younger children (Vellutino & Scanlon, 1987).

Rollanda, Jenkins, Leicester, and Slocum (1993), evaluated the effects of training in phonemic segmentation and instruction in letter names and letter sounds on kindergarten children's reading and spelling skills. Ninety students from three urban public schools in the U. S. were randomly assigned to one of three groups. The first group received training in segmenting

words into phonemes, as well as training in correspondences between letter names and letter sounds (phoneme awareness group). The second group received only the training in letter names and letter sounds (language activities group). The third group received no intervention (control group). Results indicated that phoneme awareness instruction, combined with instruction connecting the phonemic segments to alphabet letters, significantly improved the early reading and spelling skills of the children in the phoneme awareness group.

Alexander, Andersen, Heilman, Voeller and Torgesen (2007), studied the effect of Phonological awareness training and remediation of analytic decoding deficits in a group of severe dyslexics. A group of ten students with severely dyslexia ranging in age from 93 to 154 months were treated in a clinic setting for 38 to 124 hours (average of 65 hours). Pre- and post-treatment testing was done with the Woodcock Reading Mastery Test and the Lindamood Auditory Conceptualization to assess changes in phonological awareness and analytic decoding skills. Results revealed statistically significant gains in phonological awareness and analytic decoding skills.

Hence there is strong correlation between phonological awareness and learning disability. Any measure consisting of phonological awareness tasks can trace out the existence of learning disability.

Need For Phonological Awareness Measures

Although genetic investigation methods can give a significant correlation between genetic inheritance and SLD there are many disadvantages such as:

- Gene mapping is invasive as it requires, blood, hair or nail samples.
- Gene testing methods are not cost effective.
- These methods are very time consuming.
- Genetic analysis is a complex process.
- As a routine, clients and their families cannot be recommended for genetic investigations. Consequently, a genetic analysis serves only the interest of researchers and not practicing clinicians.

However, if behavioral measures with phonological awareness tasks are found suitable for tracing inheritance, these measures are,

- Cost effective.
- Practical and clinician friendly and

- Time required for testing is comparatively very less.

Aim of the Study: The present study aimed at comparing the phonological skills of families of children with SLD with that of children and adults without SLD. Study also aimed at looking for genetic inheritance in SLD through behavioral measure.

Method

Subjects: Three families of children diagnosed as having SLD were considered for the study. 20 normal children between age range of 9-14years and 10 normal adults in the age range of 28-50years were used for comparison. The families consisted of,

- Two children (Ma and Ki) who are first cousins having SLD
- Siblings (Ab and Ra) who were diagnosed as SLD
- Single child (Ka) in a family diagnosed as SLD

Criteria for subject selection

- All the subjects were selected from AIISH (All India Institute of Speech and Hearing) clinical population with provisional diagnosis as SLD and those who underwent therapeutic program for the same for minimum of one year.
- Both clinical as well as normal group of population did not exhibit any peripheral sensory or motor problems.
- All the subjects should have English as their second language.

The details of three groups of children, their siblings and parents are as shown in Table 1.

Materials: Metaphonological test developed by Prakash et.al., (2002) was used to test phonological awareness in subjects for English language. Test was modified and the reading subtest, Syllable oddity and Phoneme oddity was prepared using the textbooks for standard V- IX. This test consist of 6 subtests including Reading, Rhyme recognition, Syllable stripping, Syllable oddity, Phoneme stripping and Phoneme oddity. In Reading subtest, subjects were required to read words and non words in rows. It consists of 20 words and 20 non-words starting from simple to complex.

Except for the Reading task, all other subtests are presented via auditory only mode. In Rhyme recognition task, subjects were presented pairs of words and they were required to answer whether the words are rhyming or not. For the syllable stripping task, subjects were presented with a

Phonological Awareness in Specific Learning Disability

word and syllable which has to be deleted out of the word and pronounce the remaining sounds in the word. Eg: /Corona-ro-cona/. In the word "Corona" if we remove "ro", remaining is "Cona".

Subjects with SLD	Group I (first cousins)		Group II (siblings)		Group III (single)	Normal adults (N = 10) (5 M &	Normal children (N= 20) (10 M & 10 F)
	Ma	Ki	Ra	Ab	Ka	5 F)	
Age (in years)/sex Home language Other language	13/M E K	16/M E K	13/M K E	10/M K E	11/M K E	28-50 K E	9-14 K E
Education Medium of instruction	VI Std E	Diploma E	VII Std E	V Std E	VI Std E	UG-G K/E	V-IX E
Siblings	Brother	Brother	Brother	Brother	Brother	NA	NA

(UG= Undergraduate, G= graduate, E= English, K=Kannada, M=Male, F=Female, NA= Not applicable)
Table 1: Details of the subjects

For the subtest of Syllable oddity, subjects were presented a set of four words. They are required to print the word with odd syllable out of four words. Eg: Mesh Melt Meant Milk. Here "milk" is the odd word, as the word "milk" starts with syllable /mi/ and all other words start with "/me/".The odd syllable can occur either in the initial or final position of the word and was uniform throughout the set of words. The procedure is same for the tasks of Phoneme stripping and Phoneme Oddity except that here phonemes are tests and not the syllables.

Eg: Phoneme stripping : /Drink-d-rink/
   Phoneme oddity: /Pip Pin Hill Pig/

Parts	Tasks	No.of items	Total score	Examples
A	Reading words Reading nonwords	20 20	20+20 = 40	Treatment Nastami
B	Rhyme Recognition	12	12	Call & Wall
C	Syllable stripping	12	12	Corona-ro-cona
D	Syllable Oddity	12	12	Mesh, Melt, Meant, Milk
E	Phoneme Stripping	12	12	Drink-d-rink
F	Phoneme Oddity	12	12	Pip, Pin Hill, Pig

Table 2: Phonological awareness in English (Prakash et.al., 2002).

Every correct response was scored as "1" and incorrect response as "0". Total score for the complete test is 100. Approximate duration taken to complete the test is 45minutes. The test was administered in a single sitting for all the subjects. Table 2 gives the example of items in the test. Complete test is provided in Appendix along with the score sheet. This test was administered to all clinical population including their parents.

Results and Discussion

The data obtained for the test for both children and adults were noted in the score sheet. Maximum score for the complete test was 100. Mean was calculated for each group. The performance of the three groups of subjects and their siblings was compared with the mean scores of age matched normal children and that of parents with mean scores of adults as given in Table 3.

Table 3 shows almost equivalent mean scores for normal children and adults (90.45 & 93.1 respectively) indicate that their performance paralleled with each other. On the other hand, when the performance of three groups of children was compared with normal children and that of the first cousins (Group I), the score was lower relative to parents with normal children.

Compared to the performance of normal children, siblings (Group II) were much lower; single child (Group III) was in between the two. The higher mean scores of group I could be because of the intensive remedial training given to them for over a period of 3-4years.

The performance of parents on phonological tasks reveals interesting results too. In Group I and Group II families, performance of fathers was relatively low in comparison to mothers and that scores were almost equivalent to that of their sons despite the educational, experiential and age differences. In Group III, however, both the parents performed well in comparison to normal adults. Further analysis of performance in subtests of phonological tasks indicated that in Part A, subjects (Group I, II and III) and the fathers had more problems in reading complex non-words. While Part B (Rhyme recognition) was performed well by all of them, in Part C (syllable stripping) vowel substitutions were seen (Eg: 'Potato-to-pota' the subjects said 'poto'. In Part D (syllable oddity),

the subjects looked for spellings rather than concentrating on auditorily similar words. In Part E (phoneme stripping), the subjects deleted the wrong phoneme. (Eg: 'Drink-d-rink' they said 'Dink').

Groups	Subjects	Normal children Mean score = 90.45	Siblings	Normal adults Mean score = 93.1
I	Ma	82.0	95.0	Father = **69.0** Mother = 97.0
	Ki	90.0	87.0	Father = **49.0** Mother = 92.0
II	Ra Ab	**48.0** **40.0**	NA	Father = **67.0** Mother = 93.0
III	Ka	**60.0**	86.0	Father = 87.0 Mother = 98.0

Table 3: Mean scores on Phonological Tasks

The performance of Group II was analyzed separately on the sub-tests in comparison to that of their father and the details are as shown in Table 4. The table 4 indicates that the scores of father match with his children's scores.

When comparing the results of three groups of children (group I, II and III) with normal children and that of the first cousins, the scores were lower relative to parents of normal children. It is the clear indicator of inherited phonological deficit. This is in agreement with Doyle (1996), who stated that the manifestation of the SLD is due to the deficiencies in these underlying processes such as deficits in phonological awareness, sequencing, segmentation and naming. Also, deficits in phonological skills are themselves the result of an inherited weakness in segmental language skills.

Analysis of results of three groups of children with SLD indicated that performance on phonological awareness tasks could be graded from high to low in first cousins, single child and siblings in that order. This could be due to the remedial training given to the first cousins at very early stage for around 3-4years. This result is in agreement with Alexander, Andersen, Heilman, Voeller and Torgesen (2007) who studied the effect of phonological awareness training and remediation of analytic decoding deficits and found statistically significant gains in phonological awareness and analytic decoding skills in a group of severe dyslexics. However the performance of children with SLD did not match the normal children. The results indicate that with remedial help, the phonological awareness of these children can be facilitated yet they fail to match the normal children.

Subjects	Part B (Max 12)	Part C (Max 12)	Part D (Max 12)	Part F (Max 12)
Ra	10.0	5.0	6.0	3.0
Ab	12.0	8.0	0.0	0.0
Father	11.0	5.0	6.0	2.0

Table 4: Comparison of siblings vs. father on sub-tests.

The above findings are also supported by Rollanda, Jenkins, Leicester and Slocum (1993), who found that severity in siblings with history of SLD in family, is much higher than the other groups.

While comparing the scores of adults on phonological tasks, the performance on phonological awareness tasks of fathers was relatively lower in comparison to that of mothers. Also it was equivalent to the scores of their sons. The results strongly agree with Kumar and Prema (1999) and Prema and Jayaram (2002) who suggested that the underlying core deficits in children with SLD could be in the domain of language, the phonological deficits per se and that it could manifest similarly in families with strong genetic inheritance. Not only the overall scores of fathers matched with their sons but also the scores in individual subtests of the test did match between father and sons. This was observed in the group with both siblings exhibiting SLD. This suggests a strong possibility of inheritance. The results are also in support of Omen and Weber (1978), Silver (1971) who studied pedigree of family history and reported that SLD is genetically influenced.

Owing to the limited sample size (normal N= 10 or 20, subjects N = one or two in each group), one sample t-test (two tailed) was employed for analysis. The data of subjects and their parents was compared with the data obtained from normal children and normal adults respectively. The t values were very highly significant (children: t = 7.43, p<0.05; adults: t = 15.59, p<0.05). The results suggest that children in Group I, II and III children showed significant difference from those of normal children. Also the performance of fathers showed significant difference in comparison to the normal adult group. The findings of the present study on performance of first cousins, siblings and single child on phonological awareness tasks, support our premise that there is likelihood to trace genetic inheritance of SLD through behavioral measures.

Conclusions

The purpose of the present study was to look for genetic inheritance of SLD through behavioral measures, i.e., phonological awareness tasks. Three families of children with learning disability, their siblings and their parents were assessed for

phonological skills in English. The performance on phonological awareness tasks of the subjects along with their parents were compared with another group of normal children and normal adults respectively. The results indicate that both the qualitative and quantitative performance on phonological awareness tasks of children with learning disability matched with that of their fathers. The findings of the present study on performance of first cousins, siblings and single child on phonological awareness tasks, support our premise that there is likelihood to trace genetic inheritance of SLD through behavioral measures. The study opens-up a possibility of devising low cost and non-invasive protocol to explore genetics as a causative factor by practicing Speech-Language pathologists that would facilitate better counseling and prognosis. The performance of Group I (first cousins) subjects highlights that the severity of genetic influence could be reduced, if not entirely alleviated, by undertaking intensive remedial measures. Further studies in this direction would be important to investigate the interaction of inheritance versus environment.

References

Alexander, A. W., Andersen, H. G., Heilman, P. C., Voeller, K. K. S. & Torgesen, J. K. (2007). Phonological awareness training and remediation of analytic decoding deficits in a group of severe dyslexics. *Annals of Dyslexia*. Vol. 40, No. 1. 192-206.

Bakwin, K. (1973). The role of language as a bridge between Learning disability and psychiatric disorder. *Language, Learning and behavior disorders*. Cambridge University press. Cambridge.

Bradley, L. & Bryant, P. E. (1983). The Blackwell Reader in Developmental Psychology. *Nature*. 301, 419-421.

Castles, A., Datta, H., Gayan, J. & Olson, R.K. (1999). Varieties of developmental disorders: genetic and environemental influences. *Journal of Experimental Child Psychology*. 72, 73-94. Retrieved online at http://www.idealibraray.com.on

Doyle, F. J. (1996). *Dyslexia: an introductory guide*. Language Learning Publisher. London.

Fisher, J. (1905). Cited in Hertzig, M. E., Farber, E. A. & Payne, P.(1995). *Annual progress in child psychiatry and child development*. Psychology Press. Taylor and Francis group.

Garrette H.E. & Woodworth B.S. (1967). *Statistics in Psychology and Education*. 5th Ed, 191-193. Bombay, Vakils, Feffer and Simons Ltd.

Gilger, M. A.(1996). Selecting probands from mainstream and special schools. Cited in Raskin, Hsu, Thomson & Ellen (2000). Familial aggregation of dyslexia phenotypes. *Journal of Behavioral genetics*. Vol 30, No. 5. pg 720-734.

Grigorenko, E. L., (1997). Chromosome 6p influences on different dyslexia-related cognitive processes-further confirmation. *The American Journal of Human genetics*. Vol. 66, 2, 715-723.

Hallgren, B. (1905). Cited in Mc Manus I.C. (1991). *The genetics of Dyslexia*. The Mac Millian Press LTD. Houndmills. London.

Hemmia, J. N., Myllyluomaa, B., Haltiad, T., Taipaleb, M., Vesa, O., Timo, A., Voutilainena A. & Juha K. (2002). A dominant gene for developmental dyslexia on chromosome 3. *Journal of Medical Genetics* ; 3, 658-664.

Hinshelwood, J. (1907). Cited in Wijsman, E.M., Peterson, D. & Leutenegger, A. L. and Thomson, J. B (2000). Segregation analysis of phenotypic components of LD: nonword memory and digit span. *The American journal of Human genetics*. Vol. 67, Issue 3, 631-646.

Kennedy, E. J. & Fynn, M.C. (2003). Training phonological awareness skills in children with Down 's syndrome. *Research in Developmental disabilities*. Vol 24, 1, 44-57.

Kumar, P. and Prema, K.S. (2000). *Is specific learning disability genetic?* Scientific research paper presented in ISHACON-32 (Indian Speech and Hearing Association Conference. Secunderabad. India.

LaBuda, M.C., DeFries, J.C. & Fulker, D.W. (1986). Evidence for a genetic aetiology in reading disability of twins. *Nature*. 329, 537-539.

Laing, S. & Espeland, W. (2005). Low intensity phonological awareness training in a preschool classroom for children with communication impairements. *Journal of communication disorders*. Vol. 38, 1, 65-82

Liberman, I. Y. & Shankweiler, D. (1979). Phonology and reading disability: solving the reading puzzle. The Alphabetic principle and learning to read. University of Michigan Press. Michigan.

Morris, C. D. Robinson, S. W. & Goldmuntz, E. (2000). Family-based association mapping provides evidence for a gene for reading disability on chromosome 15q. *Human Molecular genetics*. Vol. 9, 5, 843-848.

Olson, Q.K., Gillis, J.J., Pack, J.P., Defries, J.C. & Fulker, D. W. (1989). Confirmatory factor analysis of word recognition and process measures in the Colorado reading project. *Journal of Reading and Writing*. Vol. 3, No. 3-4, pg: 235-248.

Omenn, G. S. & Weber, B. A. (1978). Dyslexia: Search for phenotypic and genetic heterogeneity. *American Journal of Medical Genetics*. Vol. 1, 3, 333-342.

Pennington., B. E. (1991). Genetics of Learning Disability. *Journal of seminars in Neurology*. Vol11, 1, 28-34.

Prema, K.S. (1998) *Reading acquisition profile in Kannada*. Unpublished Doctoral Thesis. University of Mysore, Mysore.

Prema, K. S & Jayaram, M. (2002). *Investigation of reading skills in children with reading disabilities*. Project at All India Institute of Speech and Hearing (AIISH) Research fund.

Rollanda, E. O., Jenkins, J. R., Leicester, N & Slocum, T. A. (1993). Teaching phonological awareness to young children with Learning disabilities. *Exceptional child*. Vol. 59, 145-154.

Schneider, W. & Roth, E (2000). Trainign phonological and letter knowledge in children at risk for dyslexia: A comparison of 3 kindergarten intervention programs. *Journal of Educational Psychology*. Vol. 92, 2. 284-295.

Silver, L. M. (1971). Ethylnitrosourea Mutagenesis and the isolation of mutant alleles for specific gene location in the t-region of mouse. *Genetics. .* Vol. 1, 2, 33-42

Silver, L. B., Stewart, M. A. & Pulaski, L.(1981). Minimal brain dysfunction: differences in cognitive organization of two groups of index cases and their relatives. *Journal of Leraning Disability*. Vol. 14, 8, 470-473.

Smith, R. H. (1983). Evidence for linkage and association with reading disability on 6p21.3.22. *The American Journal of Human genetics*. Vol 70, 5. 1287-1298.

Smith, S.L., Pennington, B.E. & Defries, J.C. (1992). Cited in Rice, M.L. *Towards genetics of Language*. 30-42. New Jersey: Lawrence Erlbaum associates.

Snowling, M. & Thomson, M (1991). Dyslexia integrating theory and practice. Genetics and dyslexia -an overview. 3-19. Oxford: Oxford University Press.

Snowling N & Stackhouse, J. (1991). *Dyslexia-speech and language – a practitioner's handbook,* 4-9. Oxford: Blackwell Scientific

Stevenson, J., Graham, P., Fredman, G. & McLaughlin, V. (1987). Which aspects of processing text mediate genetic effects? *Journal of reading and Writing*. Vol. 3,No. 3-4, pg: 249-269.

Tallal, P. (1980). Language and reading: some perceptual pre-requites. *Annals of dyslexia*. Vol. 30, 1, 170-178.

Velluntino, F. R. (1977). EJ167144 - Alternative conceptualization of dyslexia: Evidence in support of a verbal- deficit hypothesis. *Harvard Educational Review*, vol 47, 3, 334-354.

Wolf, J. & Melngalis, R. (1994). Selecting probands from mainstream and special schools. Cited in Raskin, Hsu, Thomson, E. J. & Ellen, M. (2000). Familial aggregation of dyslexia phenotypes. *Journal of Behavioral genetics*. Vol 30, 5, 341-357.

Zerbin-Rubin, E. (1967). An experimental investigation of SLD (Congenital word blindness): Reading and Genetics: an introduction. *Journal of Research in Reading*. Vol 29, 1, 1-10.

APPENDIX

Metaphonological Test

A. READING:

SL	WORDS	NONWORDS	WORDS	NONWORDS
1	English	Dymicna	Treatment	Posicomption
2	Mystery	Rymemo	Cruelity	Acquisition
3	Explore	Lisheng	Crucified	Mofiableodi
4	Furnace	Nastami	Fathomable	Caltechni
5	Canvas	Noroco	Prospectus	Dentpinindo
6	Chairman	Myryst	Modifiable	tusticontion
7	Courage	Apdixpen	Democratic	Tusprospect
8	Decades	Mafeo	Categorically	Pralityacti
9	Operation	Plexore	Publication	Adtraminist
10	Philateraly	Spirein	Eternity	cephalotry

B. RHYME RECOGNITION:
ILLUSTRATION:

Fame game	Mind fame
Call wall	Mind kind
Wall head	Kind game

TEST ITEMS:

1	Kill mill	7	Deep heep
2	Gate heep	8	Gate hate
3	Lift gift	9	Kill lift
4	Cable table	10	Silly hilly
5	Hate beep	11	Mill lift
6	Cable silly	12	Lable silly

C. **SYLLABLE STRIPPING:**
ILLUSTRATION:

Tomato-ma-toto
India-a-indi
River-ri-ver

TEST ITEMS:

1	Carona-ro-cana	7	Potato-to-pota
2	Manila-lla-mani	8	Holiday-day-holi
3	Dynamic-dy-namic	9	Jupiter-ju-piter
4	Gallery-lle-gary	10	Memory-mo-mery
5	Jocular-cu-jolar	11	Stamina-na-stami
6	Banana-ba-nana	12	Indigo-in-digo

D. **SYLLABLE ODDITY:**

ILLUSTRATION:

Class	Clamp	Splass	Cleft
Shadow	Shallow	Sharon	Shop
Muffle	Chappell	Cripple	Stample
Lock	Hawk	Clock	dock

TEST ITEMS:

1	Mesh	Melt	Meant	Milk
2	Went	Bent	Bond	Sent
3	Fable	Cable	Table	Stable
4	Master	Poster	Tastier	faster
5	Beat	Wheat	Site	Seat
6	Pole	Goal	Mel	Role
7	Neck	Knock	Nest	Knelt
8	Muller	Ruler	Puller	Killer
9	Bench	Belt	Boost	Best
10	Biology	Zoology	Sociology	Trinity
11	Lot	Cot	Hat	Pot
12	Lamb	Bomb	Comb	tomb

E. **PHONEME STRIPPING:**
ILLUSTRATION:

Alive-a-live
Ideal-l-idea
Open-o-pen

TEST ITEMS:

1	Drink-d-rink	7	English-l-engish
2	Egard-e-gard	8	Erupt-t-erup
3	Facula-f-cula	9	Forgo-g-foro
4	Abduct-b=aduct	10	Crawl-l-craw
5	Droop-r-doop	11	Drown-n-drow
6	Freak-r-feak	12	Epode-e-pode

F. PHONEME ODDITY:

ILLUSTRATION:

Jug	Mug	Rug	Fun
Doll	Hop	Pop	Top
Held	Gild	Bold	Mat
Just	Jump	Dung	junk

TEST ITEMS:

1	Pip	Pin	Fig	Pig
2	Bud	Bun	Bus	rug
3	Gave	Give	Hive	live
4	Lot	Cot	Had	pot
5	Pin	Sit	Sin	sip
6	Ket	Ken	Kemp	Pet
7	Disk	Damp	Dusk	husk
8	Cock	Cork	Coke	Hawk
9	Pack	Back	Lack	Punk
10	Fun	Pit	Bun	Gun
11	Freak	Break	Friend	frank
12	Dark	Mark	York	park

Effect of Caffeine on Cognitive Functions

[1]Deepti S. Rao, [2]Manasa R., [3]Haraprasad N. & [4]Prema K. S.

Abstract

Biocognition is a new and integrated approach to understand the biological basis of high-level functions including comprehension and use of speech, visual perception and construction, calculation ability, attention, memory, and executive functions in human beings. Cognitive functions such as attention and information processing are reported to improve with the intake of Caffeine, which acts as a psychoactive stimulant drug. Therefore, the present study examined the effects of caffeine on attention and information processing in college students in the age group of 18 to 21 years. Twenty one volunteers from undergraduate college were selected for the study. A series of cognitive tests including Two Choice Reaction Time, Ten-Choice Reaction Time, word reaction time, word recognition time, subtraction tests, statement verification tests, Stroop test series and vigilance tests were conducted on all the participants with the help of Cognispeed software. The reaction time for the responses was recorded in millisecond duration. A pretest-posttest design was adopted to examine the effect of caffeine and therefore, seven among the twenty one participants selected on a random basis were administered 100 milligram caffeine orally in a beverage twenty four hours after the establishment of baseline measures. The cognitive tests were repeated after thirty minutes of caffeine intake. The data obtained on cognitive functions was analyzed. The results showed differences in reaction time between the pretest and posttest measures on specific cognitive functions. The results are discussed in the light of biocognitive perspective.

Keywords: Biocognition, Cognitive functions, Caffeine, Attention, Vigilance, Information processing, Cognispeed

The term 'cognition' refers to the ability to process information and apply knowledge. The high level mechanism of cognitive functions by human brain includes comprehension and use of speech, visual perception and construction, calculation ability, attention, memory, and executive functions such as planning, problem solving, and self-monitoring. The study of the biological basis of cognition and its understanding in organisms is referred to as 'Biocognition'.

The integration between the biological brain, the mind and among different kinds of information processing systems is essential for adequate functioning of cognitive processes. Further, augmentation of cognitive capacities is also possible with a broad range of stimulant drugs like nicotine, cocaine, amphetamines and caffeine. There are research reports on the effects of each of these stimulant drugs amongst which the effect of caffeine has been extensively studied. (Williams, Savory and Leathwood, 1990; Warburton, 1995; Lorist, Snel, Kok and Maulder, 1996; Kenemans and Verbaten, 1998).

In addition to the stimulant drugs, a spectrum of factors such as medical interventions, education and training, gene therapy or neural implants are also reported to influence cognitive functions. These factors are reported to impart specific skills and thus enhance general mental faculties such as concentration, memory and critical thinking. Other forms of mental training, such as yoga, martial arts, meditation, and creativity courses are also in common use for enhancement of cognitive functions (Bostrom and Sandberg, 2009).

Dietary supplements also affect cognition. For maintaining optimal functioning of the brain, continuous supply of glucose is necessary. Increase in glucose availability, from the ingestion of sugars or the release of the acute stress hormone norepinephrine, improves memory with the effects being particularly pronounced on demanding tasks. Creatine, a nutrient that improves energy availability, also appears to benefit overall cognitive performance and reduce mental fatigue. Besides being an energy source,

[1,2&3]*Students, Department of Biotechnology, S. J College of Engineering, JSS Technical Institutions campus, Mysore-570006, email: hara.aspirer70@gmail.com.* [4]*Professor, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Manasagangotri, Mysore – 570 006, email:prema_rao@yahoo.com,.*

food can contribute to cognition by providing amino acids needed in the production of neurotransmitters, which is particularly important during periods of stress or sustained concentration.

Effects of caffeine on human body

Among all the above factors, Caffeine is widely used to improve alertness. Caffeine is found in adequate quantity in tea, coffee, chocolate, many soft drinks, and pain relievers. The world's primary source of caffeine is Roasted coffee beans. It is a psychoactive stimulant drug that stimulates the central nervous system at the higher level. It results in increased alertness, faster and clearer flow of thought and better coordination of body movements.

Caffeine can act as a central nervous system stimulant. However, the extent to which it stimulates depends on the dose of caffeine. Caffeine can cause increased neural activity, which can lead to a change in behavior. By conducting scans and tests, researchers have found that caffeine enhances cognitive capabilities by stimulating areas of the brain associated with attention and short-term memory. However, studies also report that people who consume caffeine more regularly are tolerant to many of its effects (Dixit, Vaney and Tandon, 2006). Several studies have reported the positive effects of caffeine consumption on cognitive dimensions which are related to patterns of caffeine consumption in conjugation with socio-demographic variables, educational levels, substance use (Alcohol, Cigarettes, or Tranquilizers), life style, clinical variables etc. Research has shown that consumption of approximately 300 mg caffeine per day results in slower rate of decline of cognitive abilities. Such increased cognitive abilities are reported to be effective for a longer period of time in older Individuals and these beneficial effects also appear to increase with age. However their effects on college students are not investigated in detail (Ritchie, Carriere, de Mendonca, Portet, Dartigues, Rouaud, Barberger-Gateau and Ancelin, 2007).

Mechanism of caffeine

Caffeine has a number of effects on the body, but the one that is relevant here is that it blocks adenosine receptors in the brain. These receptors help prepare the body for sleep by curbing the chatter between nerve cells and by widening blood vessels to increase the flow of oxygen. On the surface of brain, the difference between adenosine and caffeine is difficult to assess. But after consumption of caffeine which acts as a stimulant, it attaches itself to the receptors and adenosine is

shut out (Figure 1). Thus by blocking adenosine, caffeine enhances memory by increasing the amount of neuron activity or by releasing neuromodulators, facilitating constriction of blood vessels, increase in attention and the synaptic changes that underlie learning.

Studies have shown that, Caffeine mainly acts by blocking adenosine receptors and thus brings about changes in the levels of various neurotransmitters like dopamine, adrenaline and glutamate. The A1 type of adenosine receptors have been linked to dopamine D1 receptors and A2A with dopamine D2 receptors (Lorist and Tops, 2003). The A1 receptors have been found to be associated with regulation of alertness. Mesopontine cholinergic neurons are associated with regulation of arousal level and are under tonic A1 receptor control. Of various dopamine receptors isolated in brain, D1, D2, D4 and D5 have been found in hippocampus. Activation of D1and D2 receptors in hippocampus has been found to improve acquisition and retention of working memory (Packard and White, 1991). Caffeine exercises positive influence on cognitive functions namely, reaction time, vigilance and various other automatic and controlled information processing systems. It has also been shown to improve higher cognitive functions including working memory, selective and divided attention (Koppelstatter, 2005).

Assessment of cognitive functions

There are many methods employed for assessment of cognitive functions. The assessment procedures vary from simple observation to questionnaire survey and tests, paper- pencil and motor measures, quantitative electroencephalography (QEEG) and event related potentials or the state-of-the-art technology that uses MRI, fMRI or neuroscan (Deslandes, Veiga, Cagy, Piedade, Pompeu, and Ribeiro, 2005). The most user friendly approach to cognitive assessment is the computer based tests and software that help to measure reaction time on cognitive tests with an accuracy of millisecond duration. One such software that is widely used for cognitive assessment is the 'Cognispeed' (Revonsuo and Portin, 1995).

Objective of the study

Intensive research has been carried out on the beneficial effects of Caffeine. However the effect of moderate dosage (100 mg) of caffeine in the un-habituated youngsters especially college students is not very much clear. The objective of the study was to examine the effect of caffeine on certain cognitive functions such as attention, working memory, semantic processing and on
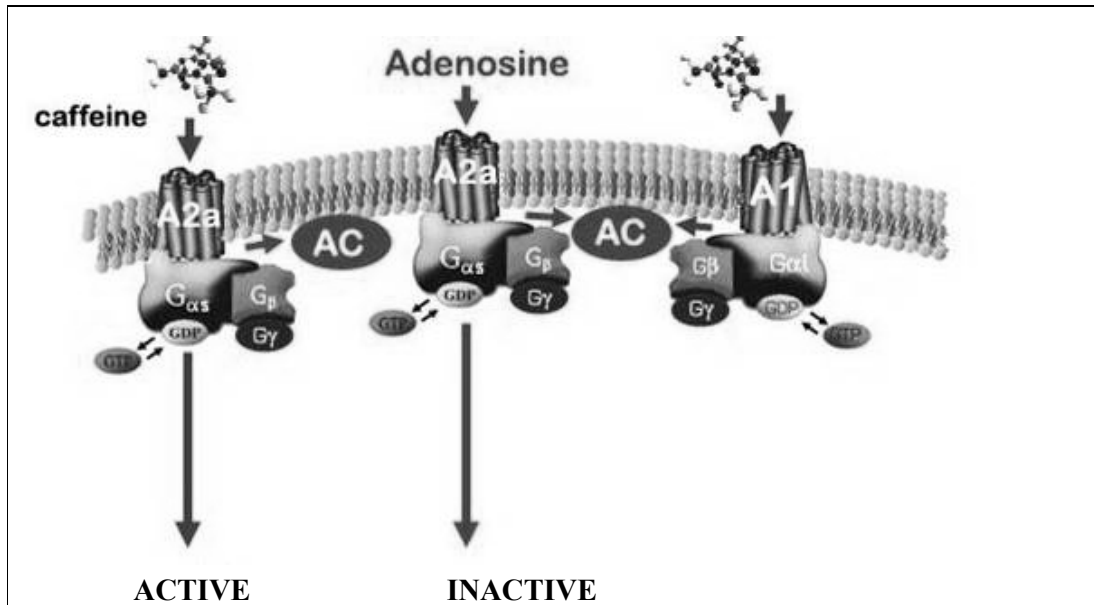
Figure 1: Mechanism of caffeine

stroop tasks on college students in the age group of 18-21 years.

Method

The present study was conducted at the All India Institute of Speech and Hearing, Manasagangothri, Mysore, India. The study group comprised of 21 normal, healthy young undergraduate students in the age group of 18–21 years. The participants had no history of head injury, epilepsy, hearing impairment, migraine, sleeping problems, drug abuse (nicotine, alcohol and opium) and or psychological problems. Written consent was taken from the participants prior to the study.

All the participants were instructed to have adequate sleep and to abstain from caffeine containing substances for at least 48 hours prior to the testing. All the participants were subjected to cognitive assessment by employing Cognispeed software. The details of the tasks for assessment of various cognitive processes in the software are listed below. The performance on the vigilance test, a test that assesses the sustained attention of an individual, is taken as a measure of baseline attention to compare the performance of participants in the posttest under the effect of caffeine on other cognitive tasks that are described below.

Cognispeed software

The Cognispeed software developed by Revonsuo and Portin (1995) is a software for scientific research work. The software contains several separate tests which can be used to measure reaction time and percent correct responses (accuracy). One of the central ideas in the software is the separation between automatic and controlled information processing. For studying controlled information processing which demands conscious effort, this software offers programs for measuring reaction time for working memory, speed and decision making while the tests for choice reaction time are indicators of attentional functions. The subtraction test involves sustained attention as well as working memory and the statement verification task requires semantic processing in addition to attention and working memory. The Stroop task, on the other hand, requires inhibition and facilitation of attention and semantic processing depending on the specific task. For example, in the color naming test automated meaning processing must be inhibited. Table 1 gives an outline of the tests.

Design of the study

2 X 2 mixed group design was employed for the purpose of baseline study. Pretest-posttest design was adopted to compare the performance of participants on cognitive tests before and after the consumption of caffeine.

Procedure

All the participants were tested for vigilance and cognitive skills in a quiet room in the forenoon of a weekend. Participants selected for the posttest were requested to report for the test again the next day. They were informed that caffeine will be given by way of instant coffee and were again instructed not to consume any caffeinated food stuff for another 24 hours. All the participants in the posttest group were administered with 100

milligram of caffeine in the form of a beverage (Nescafe Instant classic), the dose that is considered as moderate, and is known to produce significant effects (Dixit, Vaney, and Tandon, 2006). The test was conducted 30 minutes after

the administration of caffeine since the optimum time for the effect of caffeine is reported to be between 15 minutes and 45 minutes after consumption. (Fagan, Swift and & Tiplady, 1988).

Sustained attention	Automatic processing	Controlled processing	Tests for Stroop effect Facilitation and interference
Vigilance test	Two-choice reaction Ten-choice reaction Word reaction time	Subtraction Statement verification tests	Word reaction Congruent words Incongruent 1 Incongruent 2 Automatic semantic processing1 Automatic semantic processing2

Table 1: Tests for cognitive functions

The test was conducted in Language Science Laboratory of the Department of Speech Language Sciences at the All India Institute of Speech and Hearing, Mysore. All the participants were given uniform instructions for each of the tests. Trials with the test stimuli were given for familiarization of the tasks and procedure. The participants were required to press a button on the keyboard of a computer system in response to the target stimulus. Test battery for cognitive assessment included baseline vigilance test, reaction time tests, controlled processing tests and Stroop tests.

The mean scores for reaction time in milliseconds and mean percent correct responses for each of the above tests were obtained for all the participants. The group mean score for reaction time and group mean for percent correct responses for all the tests was also compiled for further statistical analyses. The data was subjected to statistical analyses using SPSS 10 for Windows.

Results and Discussion

The objective of the study was to examine the effect of caffeine on cognitive function. The data obtained from the participants was analyzed using non-parametric statistics. Analysis was carried out to examine:

a. Between group comparison: Performance of the participants - non caffeine (14 No.) and caffeine group (7 No.) on tests of vigilance and cognitive function.

b. Within group comparison: Performance of the seven participants on tests of cognitive

function before and after consumption of caffeine.

Two-independent 't' test was employed to evaluate the performance of the group on tests of vigilance and tests of cognitive function. Results revealed that there was no significant difference between the two groups (P >0.05) on all the above tests. Despite the difference in the number of participants in the two groups, no significant difference was found between the two groups either on vigilance test or on cognitive tests, suggesting that the group was uniform in its characteristics.

Performance of the caffeine group on tests of cognitive function before and after consumption of caffeine was examined by employing 2-related 't' test for within group comparison. The results indicated that there was a significant difference on **percent correct response** for specific cognitive tests such as automatic processing (Two choice percent correct) and semantic processing (Statement verification test), while for automatic semantic processing (Stroop interference effect), there was a significant difference for **both mean RT and percent correct response** (P<0.05) (Table 2 and Figure 2).

Two choice percent correct	Incongruent2 percent correct	Automatic semantic processing mean RT	Statement verification test percent correct
0.05	**0.03**	**0.04**	**0.02**

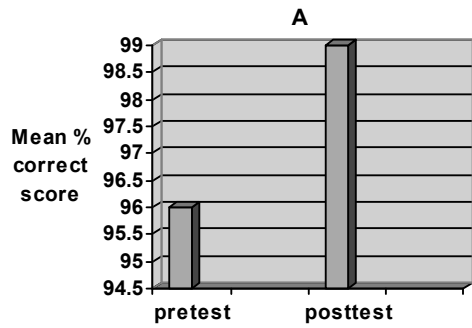**Table 2**: Pre and Post test scores of significance in the Experimental group

A

Figure A: Mean percent correct score   for two-choice reaction task (A)
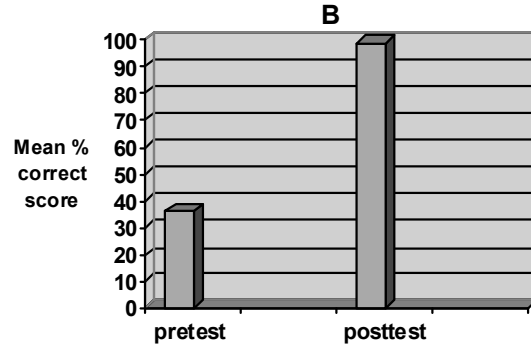
B

Figure B: Mean percent correct score for Incongruent 2 task
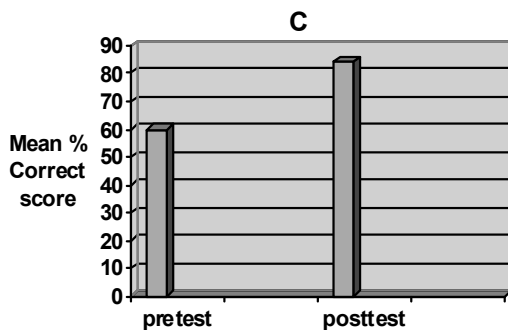
C

Figure C: Mean percent correct score for statement verification task
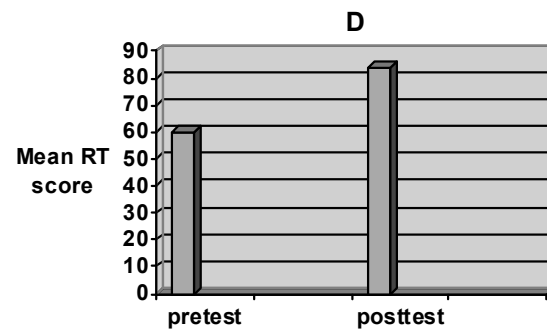
D

Figure D: Mean reaction time for semantic processing tasks

Figure 2: Effect of Caffeine on cognitive tasks

Analysis of the results of the study indicates that performance on cognitive tests did show a significant difference before and after consumption of caffeine. Although, the speed with which the tests are performed, i.e., the reaction time (RT) did not show significant difference (except on automatic semantic processing), the accuracy of response was significantly better on test of automatic processing, statement verification and incongruent words. These results are well substantiated by the fact that the participants of the study were equally vigilant even before consumption of caffeine and hence, intake of caffeine did not influence the mean RT or the speed of the test performance. However, the significant difference on percent correct response or accuracy of response on tasks that involve short term memory (also known as working memory) such as statement verification test and colour word incongruent test of Stroop task (Table 2) appear to be the most significant finding of the study. Since the capacity of short term memory depends on the speed of transmission of neurotransmitters,

caffeine intake, as explained earlier, appears to have over ruled the adenosine receptor activity, thus enhancing the accuracy of response on tasks that demand short term memory.

In order to confirm the above observation, performance on subtraction test and statement verification test was further compared in both before and after caffeine conditions. Since statement verification involves holding the statement in short term memory before exercising the command, it is quite likely that there could be differences in performance on the above two tests. Therefore, a 2-related 't' test was employed on scores of statement verification test and subtraction test in both before and after caffeine condition. The results showed a significant difference in percent correct response ($P < 0.4$) suggesting that the statement verification test which is a task to assess semantic processing, in addition to short term memory showed a significant difference with caffeine consumption.

Majority of the studies reviewed earlier have reported enhancement of cognitive function with intake of caffeine. In the present study which employed Cognispeed to assess general cognitive processes, semantic processes and Stroop effect, it was observed that there was a significant effect of caffeine on the accuracy of response and not on the speed of response; short term memory and not on the general cognitive function. The most interesting finding that emerged out of this small scale study is that there was a striking difference in performance on tasks involving short term memory (also known as working memory) as well as semantic processing. The results indicate that intake of caffeine exercised significant effect on these two specific cognitive functions amongst many other functions under study. The results of the present study are crucial from the perspective of study of biocognition as more studies of similar kind would help in understanding and evolving strategies for enhancement of accuracy of response and short term memory. The results of this study can be meaningfully applied in many fields such as education, IT/BT/Corporate/ Management/defense sectors for specific activities that demand semantic processing and short term memory for efficient work output besides its relevance in the rehabilitation of persons with communication disorders and children with special needs.

References

Bostrom, N. & Sandberg, A. (2009). Cognitive Enhancement: Methods, Ethics, Regulatory Challenges. *Science and Engineering Ethics*. Future of Humanity Institute, Oxford Unviersity.

Deslandes, A.C., Veiga, H., Cagy, M., Piedade, R., Pompeu, F & Ribeiro, P. (2005). Effects of Caffeine on the electrophysiological, cognitive and motor responses of the central nervous system. Brazialian Journal of Medicine and Biological Research, 38(7); 1077-1086.

Dixit A., Vaney N. & Tandon O.P. (2006). Evaluation of cognitive brain functions in caffeine users: A P3 evoked potential study. *Indian J Physiol Pharmacol*. 50 (2). 175-180.

Fagan, D., Swift, C.G, & Tiplady, B. (1988). Effects of Caffeine on viglilance and other performance tests in normal subjects. *Journal of Psychology*. 2(1) 19-25

Koppelstätter, Poeppel, T.D., Siedentopf, C.M., Ilka Haala, Anja Ischebeck, Mottaghy, F.M., Rhomberg,P., Verius,M., Golaszewski,S.M., Kolbitsch,C., Felber, S.R & Krause,B.J. Coffee Jump-starts Short-term Memory (2005, December 12) Radiological Society of North America. *ScienceDaily*.

Lorist, M..M., & Tops, M. (2003). Caffeine, Fatigue and Cognition. *Brain Cogn.* 53(1): 82–94.

Packard, M.G & White, N.M. (1991). Dissociation of hippocampus and caudate nucleus memory systems by post-training intracerebral injection of dopamine agonists. *Behav Neurosci*. 105: 295–306.

Ritchie, K., Carriere, I., de Mendonca, A., Portet, F., Dartoigues, JF., Rouaud, O., Barberger-Gateau, P., & Ancelin, M.L. (2007). The Neuroprotective effects of Caffeine. *Neurology*. 69: 536-545

White N.M., Packard M.G., & Seamans J. (1993). Memory enhancement by post-training peripheral administration of low doses of dopamine agonists: possible autoreceptor effect. *Behav Neural Biol*. 59: 230–241.

Acknowledgements

The Organization and Processing of Verbs and Nouns in the Mental Lexicon

[1]Gopee Krishnan, [2]Shivani Tiwari & [3]Rajashekar Bellur

Abstract

The organizational as well as the processing differences between grammatical classes of words (e.g., verbs & nouns) have recently become a topic of interest among psycholinguists, researchers into language acquisition, and aphasiologists. Previous studies have shown that verbs, as a class, are more complex compared to nouns. Although this is the case, whether the difference between nouns and verbs lies at an organizational or processing level has not been thoroughly investigated. In this context, the objective of the current study was to probe into this issue by employing a semantic association judgment paradigm in a group of 25 normal subjects. The dependent variable (reaction time - RT) of nouns and verbs showed faster RT for the semantically associated pairs compared to the unassociated pairs, replicating previous similar results using nouns. Although, the verb pairs too showed such a tendency, the overall RT required for verbs was more than that for nouns. In addition, the analysis of the error data further revealed the complex interaction of the semantic attribute in nouns and verbs. Based on these findings, we argue that both nouns and verbs have similar organizational principle within the mental lexicon, yet with definite processing differences between the two, as indicated by the RT differences and error analysis.

Key words: Grammatical class, Transitivity, Complexity, Mental lexicon, Semantic feature density

The study of word categories in language processing has been a prominent topic in psycholinguistic research, since categories like nouns and verbs provide a window to the cognitive bases of grammatical class distinctions (Kauschke & Stenneken, 2008). A major line of evidence for the differential lexical organization of verbs from nouns has primarily come from the grammatical-class-specific impairments resulting from brain damage. For example, as early as in 1961, Fillenbaum, Jones, and Wepman reported verb production impairments in Broca's aphasia followed by an overwhelming number of case studies reporting either selective noun or verb retrieval deficits (Caramazza & Hillis, 1991; Shapiro, Shelton, & Caramazza, 2000; Laiacona & Caramazza, 2004). Though there are conflicting evidences on the anatomical locus of verb retrieval skills in the brain (see Cappa & Perani, 2003, for a discussion), in general, it is evident that either nouns or verbs could be differentially impaired following brain damage, reflecting the possible differences either in the organization and/or processing of these two grammatical classes of words.

Another source of evidence for the noun-verb difference comes from developmental studies. For instance, the vocabulary of very young children includes mainly nouns, while verbs are present in a very limited number (Gentner, 1982; McNamara, 1972; Nelson, 1973). The possible interpretation for this advantage for nouns compared to verbs lies in the greater conceptual complexity of verbs compared to nouns. The lesser complexity of nouns leads to the earlier acquisition of the names for nouns than for verbs (Gentner, 1982; McNamara, 1972). The categories for nouns are more natural than those for verbs; they often refer to the perceptual properties that tend to cohere and form natural conceptual categories. Thus, the name of an object would be learned by mapping a linguistic label to a preexisting conceptual category (Gentner, 1981; Gentner & Boroditsky, 2001). Verbs, instead, express mostly relational meanings, and therefore their meanings are more dependent on the context, and are more easily subject to changes, according to the nouns they relate.

The differential organization of nouns and verbs poses an interesting question on the

[1]Asst. Professor, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Karnataka, India, email:brain.language.krishnan@gmail.com.[2]Lecturer, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University,[3]Professor and Dean, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Karnataka, email:b.raja@manipal.edu,.

organizational architecture of the mental lexicon. In normal subjects, there has been a wealth of data on this assumption, primarily derived from reaction time studies using object names. Over and again, it is stated in the literature that those concepts that share similar features are closely located in the mental lexicon. Findings from priming studies have been considered as strong evidence for this assumption. In semantic priming, the latency to name an item significantly reduces when it is preceded by a semantically related, but not an unrelated item. This observed phenomenon has been explained based on the *spreading activation theory* (Collins & Loftus, 1975; Dell, 1986). For example, when naming the picture of a dog, the subject has to recognize the picture and select the appropriate semantic concept. At this point, it is noteworthy to assume that the concept of an item (for e.g., *dog*) is stored as a set of features such as has a *tail*, *pet*, *animal*, *faithful* etc. These features spread their activation to the corresponding lexical node '*dog*' in the lexical layer. However, the individual features of this feature bundle are not only possessed by the concept *dog*, but also by others concepts, say, for e.g., *cat*. Therefore, we can presume that while naming the picture of a *dog*, the features that are common to the other concepts activate their corresponding lexical node partially. Under normal circumstances, the speaker selects the lexical node with highest level of activation (*dog*). The partially activated lexical node (for e.g., *cat*), therefore does not get selected to the output. The selected lexical node (*dog*) in turn, spreads its activation to the phonological layer in order to select the phonemes that constitute the word DOG. These selected phonemes are then fed to the speech articulatory unit for the production (Caramazza, 2000; Krishnan & Tiwari, 2008). As mentioned above, such facilitatory effects of the semantically associated words have majorly come from studies using nouns as stimuli.

Although using nouns are certainly relevant to studies of lexical memory, it only represents part of adults' lexical knowledge, and theories and tools developed to investigate semantic organization must generalize beyond the noun class (Vigliocco, Vinson, Damian, & Levelt, 2002).

Nouns are arguably easier because they tend to be more concrete, or more easily imaginable than verbs (Chiarello, Shears, & Lund, 1999), and it is known that concrete words have a processing advantage over abstract words in different tasks (de Groot, Dannenburg, & van Hell, 1994). This advantage has been explained in many ways. One explanation, based on the dual coding theory (Paivio, 1971, 1986) is that concrete words can be represented both in an imaginable as well as in a verbal-propositional manner, whereas abstract words are represented only in the latter manner. That is, the concrete words are dually coded in the memory, unlike the abstract words. According to the second interpretation, the concrete words are at an advantageous position owing to the interrelations these words can make among the concrete concepts. Such interrelations among concrete concepts are due to the increased availability of relevant meaning relations. However, when such relations are made experimentally available by a sentence context, even abstract words showed equal processing as that of the nouns (Schwanenflugel, Harnishfeger, & Stowe, 1988). The concrete nature of nouns is also evident from various other studies (e.g., Bleasdale, 1987) as well as from various experimental paradigms such as eye movement tracking (Juhasz & Reyner, 2003), electrophysiological correlates (Kounios & Holocomb, 1994), and from brain activation (e.g., Binder, Westbury, McKiernan, Possing, & Medler, 2005). Therefore, from such evidences, it is apparent that the extrapolation of the findings from studies using nouns to the verbs may not be valid as there are definite differences between these two grammatical classes.

In the literature, however, a few studies have investigated into the nature of verb processing. For example, Roelofs (1992) studied the semantic interference effect (SIE) in verb naming. The SIE is usually elicited with a picture-word interference paradigm. In this paradigm, the subjects are required to name pictures with the distracter words embedded on them. In Roelofs' (1992) study, the reaction times of naming verb pictures (e.g., *eating*) were greater when the distracter word was a semantically related verb (*drinking*). This finding was in accordance with similar observations from studies using nouns. From this finding, Roelofs argued that the selection principles behind the nouns and verbs were essentially the same. Similar findings were also reported by Collina and Tabossi (2003).

Tabossi and Collina (2002) studied fourteen classes of verbs of intuitive and semantic sets using a picture word interference paradigm. These authors used an intuitive criterion for verbs as they believed that the verbs may be organized in the mental lexicon based on an abstract intuition of the category items (e.g., *run*, *walk*, and *jump* – as quoted by the authors). In this study, the distracters were part of the response set and each word was paired with two distracter verbs: one semantically related to the target and the other, unrelated. The results obtained, however failed to show the semantic interference effects either in the semantic or in the intuitive sets. The reason for the

failure of this study to replicate Roelofs' (1993) study was attributed to the difference in the transitivity nature of the verbs used in the study. In Roelofs (1993) study, most of the verbs used were intransitive, whereas majority of the verbs in Tabossi and Collina's (2002) experiments were transitive in nature.

In 1998, Schriefers, Teruel, and Meinshausen addressed the semantic interference effect in verbs in the sentential context. In addition to this, these authors also addressed the extent to which the semantic interference effect arises for both transitive and intransitive verbs. Their results revealed that the transitivity attribute of the verb affected the magnitude of the semantic interference effect (SIE). With respect to the sentential context, the SIE for transitive verbs was observed only when they occupied the initial position in the utterance, whereas no SIE was seen for intransitive verbs irrespective of their position in the sentence. Thus, the apparently simple explanation of Roelofs (1993) was complicated by Schriefers et al. (1998) study. In yet another study by Schnur, Costa, and Caramazza (submitted, cited from Tabossi & Collina, 2002) the semantic interference effect in verb production was investigated in three experiments. Although these authors observed the SIE, when the transitive and intransitive verbs were analyzed separately, the SIE was inconsistent.

It is apparent from the available studies in the past that the investigations addressing the nature of verb processing in the mental lexicon are apparently less. In addition, the available studies are insufficient to explain the organizational as well as the processing differences between nouns and verbs. Moreover, the semantic interference effect has failed to replicate the results across the studies, and this failure could partly be attributed to the transitivity nature of the verbs used across the studies. Finally, owing to the inherent nature of the verbs, being less concrete and more complex, a mere extrapolation of the findings from nouns may not provide reliable insights about the organization as well as processing of verbs in the mental lexicon. Further, no studies have attempted to investigate whether the difference between nouns and verbs lies at the organizational and/or at the processing level between them.

Aim of the study

In the context of such lacunae in our understanding about the organizational and/or processing difference between nouns and verbs, the present study aimed at investigating into this issue by employing a different paradigm – the semantic association judgment. In this paradigm,

the participants were required to judge the presence or absence of semantic association between the words of the stimulus pairs. This paradigm has been effectively used in previous studies (e.g., Krishnan & Tiwari, 2008).

Objectives of the study

Specifically, the objective of the study was to compare the semantic association judgment times (here, the reaction time – RT) of semantically associated and unassociated nouns with that of verbs.

Working hypotheses

The working hypotheses of the current study were:

- A common trend across the nouns and verbs, both in the semantically associated and unassociated conditions may be indicative of a comparable organization of these two grammatical classes in the mental lexicon.

- If a considerable difference in the RT between nouns and verbs is observed, it may be indicative of the difference in processing demand between these two grammatical classes of words.

Method

Stimuli

For the purpose of the current study, a pool of verb pairs was generated by asking a group of five subjects to list out all the possible verbs in English. This pool was further examined to categorize them based on the concreteness (imageability), and transitivity attributes. From this filtered pool, we generated 14 semantically associated and 13 semantically unassociated, concrete, and transitive verb pairs. The nouns stimuli were selected from a previous pool (Krishnan & Tiwari, 2008) of semantically associated and unassociated nouns pairs. Twenty seven noun pairs (14 associated & 13 unassociated) were selected for the current study. From the total of 54 pairs, four pairs (one each from the four conditions) were used as trial items. In addition, both the noun as well as verb pairs were selected carefully such that all the items were concrete and, therefore, highly imaginable. *With respect to the verbs, only transitive verbs were selected for the current study.* Therefore, the material consisted of 50 critical items (excluding the trial items) belonging to four different conditions as follows: semantically associated nouns (n = 13) (e.g., *cat-dog*), semantically unassociated nouns (n = 12) (e.g., *stone-spoon*), semantically associated verbs (n = 13) (e.g., *eat-drink*), and semantically unassociated verbs (n =

12) (e.g., *beg-slip*) (See Appendix A for the stimulus pairs).

Participants

Twenty-five graduate students (mean age = 21 years, SD = 2) from Manipal University volunteered to participate in the current study, with English as their medium of instruction starting at the age of 4-5 years. All subjects were right-handed and had normal or corrected-to-normal vision.

Procedure

The subjects were made to sit in a dimly lit, soundproof room and verbal instructions were given about the task. This was followed by the presentation of training items and the subjects were made familiar with the task and the response. The stimulus presentation through the computer was controlled by DMDX reaction time software (Forster & Forster, 2003). We used the procedure employed by Krishnan and Tiwari (2008) to obtain the reaction times. However, in the present study, the stimuli were randomized and grouped into two blocks of 25 each. At the end of the first block, a rest period (one minute) was given and for each subject, and the testing was completed in a single session.

Results

Response latency

For the statistical analysis of the response latencies, the RTs of incorrect responses were eliminated. The data were analyzed using SPSS 16 software for windows. The mean RT for semantically associated noun pairs was 757.08 ms (SD = 153.2), and for the semantically unassociated noun pairs, it was 900.73 ms (SD = 237.47). Similarly, the mean RT for the semantically associated and unassociated verbs were 812.82 (SD = 192.9) and 935.83 ms (SD = 256.01), respectively. On an average, the subjects took lesser time to respond to noun pairs compared to verbs. The results also showed that the subjects responded faster to the semantically associated conditions compared to semantically unassociated conditions (Figure 1).

In order to find the interaction between the types of grammatical classes (noun & verb) versus the semantic condition (associated & unassociated), the data were submitted to Two-way Analysis of Variance (ANOVA). The results of the analysis showed a significant main effect for the semantic condition (F (1, 96) = 9.73, $p < 0.05$). However, there was no significant main effect observed for the word type (nouns vs. verbs) (F (1, 96) = 1.13, $p > 0.05$). Although, the comparison between the two variables (word type vs. semantic association) revealed a meager interaction between the two (see Figure 1), it did not reach the significance level (F (1, 96) = 0.058, $p > 0.05$).
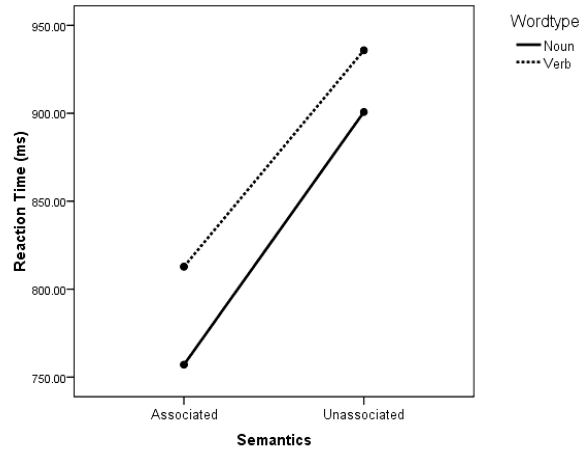

Figure 1: Mean reaction times as function of semantics and the word type.

In order to find out the difference between the associated nouns versus verbs as well as the unassociated nouns versus verbs, paired sample *t*-tests were performed using SPSS 16. The results revealed significant difference between nouns and verbs in the associated condition (t (24) = -2.63, $p < 0.05$), but not in the unassociated condition (t (24) = -1.314, $p > 0.05$).

Errors

The total number of responses inclusive of both nouns and verbs in the semantically associated and unassociated conditions were 1250 (25 subjects x 50 items). The distribution of errors across the four conditions was as follows: semantically associated nouns - 15/325 (4.6%; Mean = 0.6; SD = 0.64), semantically unassociated nouns - 39/300 (13%; Mean = 1.56; SD = 1.38), semantically associated verbs - 43/325 (13.26%; Mean = 1.72; SD = 0.93), and semantically unassociated verbs - 31/300 (10.33%; Mean = 1.24; SD = 0.97). We analyzed the variance (Two-way ANOVA) of the errors with respect to their semantic attribute (associated vs. unassociated) and word type (noun vs. verb). There were no significant main effects either for the semantic attribute (F (1, 96) = 1.38; $p > 0.05$) or for the word type (F (1, 96) = 3.84; $p > 0.05$). However, the interaction between these two variables was quite significant (F (1, 96) = 12.47; $p < 0.05$) (Figure 2).
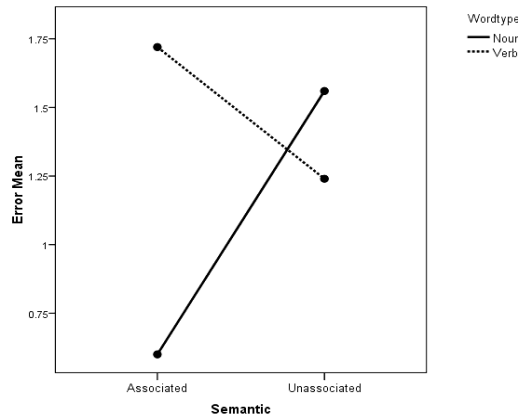
Figure 2: Mean errors as a function of semantics and grammatical classes

In order to find out the difference in mean error rates between the associated nouns versus verbs as well as the unassociated nouns versus verbs, paired sample *t*-tests were performed using SPSS 16. The results revealed significant difference between nouns and verbs in the associated condition (t (24) = -4.96, $p < 0.05$), but not in the unassociated condition (t (24) = -1.138, $p > 0.05$).

Discussion

The goal of the present study was to investigate into the organizational as well as processing difference between nouns and verbs in the mental lexicon. For this task, we employed a semantic association judgment (similar to Krishnan & Tiwari, 2008) in a group of 25 normal subjects.

Response Latency

As evident from our results, the response latency was shortest in the case of semantically associated pairs compared to the unassociated pairs. In the domain of nouns, the current results replicated the previous findings reported by Krishnan and Tiwari (2008). Similarly, the semantically associated verbs too showed advantage over the unassociated verbs. In general, both nouns and verbs were judged faster in the semantically associated condition compared to the unassociated condition. We had hypothesized that a common trend in both nouns and verbs in the semantically associated and unassociated conditions would be indicative of the similarity of organization between these two grammatical classes in the mental lexicon. The current observations were congruent with this hypothesis. Therefore, we argue that both nouns and verbs have similar organizational pattern in the mental lexicon. Roelofs (1993) has also reported similar findings, although she used a

different paradigm in her investigation (i.e., semantic interference effect).

Addressing our second hypothesis, that is, a significant difference in RT between the nouns and verbs would be indicative of the differences in the processing demand between these two types of words, has also been supported by the current study. From the results (see Figure 1), it is apparent that the verbs were slower compared to nouns irrespective of the semantic condition. Although various researchers have reported processing difference between nouns and verbs (e.g., Bird, Franklin, & Howard, 2000), by employing a different paradigm, the current study provided further support for the increased processing difficulty of verbs compared to nouns.

Combining the above two major observations on the organization as well as the processing of nouns and verbs, there emerges the picture of the mental lexicon where both nouns and verbs have similar organizational principles with increased processing demand (as evidenced by increased RT) for verbs compared to nouns. Although this was the case, there were some additional and vital observations from the current study.

An interesting observation from the current study was that when the two grammatical classes of stimuli were collapsed (nouns & verbs), the semantic condition showed a significant main effect. However, when the two semantic conditions (associated & unassociated) were collapsed, the grammatical word class did not show any significant main effect with respect to the reaction time (F (1, 96) = 1.13, $p > 0.05$). Further, the interaction between the nouns and verbs, although present, was meager and it did not reach the significant level (but, see the error data, below). These findings reveal that with respect to the organization of the mental lexicon, the semantic association among the members of the lexicon is vital than their grammatical classes. That is, irrespective of the grammatical class, the semantically associated pairs were judged faster compared to the unassociated pairs. However, such a finding was not observed when both semantically associated and unassociated word pairs were combined and compared between nouns and verbs. Therefore, this interpretation shows that the processing difference between nouns and verbs arises at the semantic level. The earlier observation that nouns are processed faster compared to verbs, may therefore be interpreted as the influence of the semantic attribute. Hence, the apparent processing difference (as indicated by the RT differences) between nouns and verbs could be attributed to the semantic attributes. In this context, the claim that the reduced semantic

features contributing the increased reaction time difference between nouns and verbs (Bird et al., 2000) gains further support from the present study.

Furthermore, the comparison between the semantically associated nouns and its verb counterparts showed an apparent difference between the two (nouns were judged faster compared to verbs (t (24) = -2.63, p < 0.05).However, in the unassociated condition, the paired comparison did not reveal such a difference between nouns and verbs (t (24) = -1.314, p > 0.05). Such a difference only in the semantically associated condition, favoring the nouns compared to the verbs is in support with the arguments of Bird et al. (2000). These authors reported that verbs have fewer semantic features compared to nouns. According to the spreading activation theory (Collins & Loftus, 1975; Dell, 1986), fewer semantic features (which are shared by the stimulus pairs) apparently delay the semantic association judgment (see Krishnan & Tiwari, 2008, for an explanation). The absence of a significant difference in RT in the semantically unassociated nouns and verbs may be explained based on the same principle. That is, the absence of adequate overlapping (or shared) semantic features between nouns and verbs in the semantically unassociated condition might have resulted in insignificant difference between the two word types.

Error analysis

The error analysis too revealed some interesting findings between nouns and verbs. Although there was no significant main effect for the word type as well as the semantic condition, the interaction between these two variables was significant (F (1, 96) = 12.47; p < 0.05). That is, when the nouns showed fewer errors, the verbs showed more in the associated condition. This pattern was reversed in the semantically unassociated condition, where the verbs showed fewer errors compared to nouns (See Figure 2). This finding appears paradoxical and a little difficult to explain with the available information on the organizational structure of the mental lexicon. Yet, we attempt an explanation for this as follows. From the Figure 2, it is apparent that, in general, the subjects showed more errors in the semantically associated verbs as well as in the unassociated verbs and nouns. We attribute these findings to the 'semantic feature density'.

By the term 'semantic feature density', we refer to the number of semantic features that are available to a given semantic concept. The denser the features are, the more concrete the semantic item is. In this regards, based on the previous evidences, it may be argued that the verbs have relatively lesser number of semantic features (e.g. Bird et al., 2000). We further argue that, the processing time (RT) and the accuracy (error rate) are influenced by the semantic feature density, perhaps, in two contrasting ways. First, increased number of *overlapping* or *shared* semantic features increases the processing speed (i.e., smaller RTs) as well as the accuracy (i.e., lesser errors). This is typically noticed in the case of semantically associated nouns. However in the case of semantically associated verbs, the increased number of errors could be attributed to the lesser number (compared to the nouns) of semantic features, although they were *overlapping* or *shared*). In the unassociated condition, the error rates showed some vital findings. That is, verbs exhibited fewer errors compared to nouns *(although, the error rates did not significantly differ from each other).* We argue that the explanation for this seemingly paradoxical finding is again the semantic feature density. That is, the nouns are expected to have more number of semantic features compared to verbs. In the semantically unassociated condition, the mere possession of dense semantic features (which are *non-overlapping* or *unshared*) would tax the mental lexicon, resulting in more errors. The lesser number of errors in the case of unassociated verbs (compared to their noun counterparts) may be attributed to the generally lesser number of (unshared) semantic features, and consequently, reduced processing demand in the mental lexicon. Interestingly, our results further indicated that such taxing affects principally the accuracy rather than the processing time, as the RT in the unassociated nouns was lesser than that of the unassociated verbs.

In essence, it may be argued that the number of overlapping semantic features increases the efficiency of the mental lexicon, resulting in quicker and more accurate judgments (e.g. semantically associated nouns), whereas lesser overlapping (or shared) semantic features increases the judgment time (compared to their noun counterparts) as well as error rate (e.g. semantically associated verbs). Similarly, the increased number of non-overlapping features would compromise the accuracy of the processing, rather than its speed (e.g., semantically unassociated nouns)

Finally, the stimuli used in the current study were carefully selected so that all the nouns and verbs used were concrete in nature. In addition, all the verb pairs were transitive in nature. Hence, the finding of the current study is applicable to concrete nouns and (transitive) verbs. Future studies may compare the organization as well as processing difference between abstract nouns and

verbs and both transitive and intransitive verbs by employing different paradigms for experiment.

Conclusions

In summary, the findings of the present study revealed several vital observations with respect to the organization as well as the processing of nouns and verbs in the mental lexicon. A similar trend between processing of nouns and verbs (as revealed by the RTs) supports a resemblance in their organizational structure in the mental lexicon. Yet, the processing was more demanding for verbs compared to nouns, supporting our second hypothesis. In addition, the error analysis data revealed the influence of the semantic feature density (shared or unshared features) and its differential effects on nouns and verbs.

References

Binder, J. R., Westbury, C. F., McKiernan, K. A., Possing, E. T., & Medler, D. A. (2005). Distinct brain systems for processing concrete and abstract concepts. *Journal of Cognitive Neuroscience, 17*(6), 905-917.

Bird, H., Howard, D., & Franklin, S. (2000). Why is a verb like an inanimate object? Grammatical category and semantic category deficits. *Brain and Language*, 72, 246–309.

Bleasdale, F. A. (1987). Concreteness-dependent associative priming: Separate lexical organization for concrete and abstract words. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*(4), 582-594.

Cappa, S. F., & Perani, D. (2003). The neural correlates of noun and verb processing. *Journal of Neurolinguistics, 16,* 183-189.

Caramazza, A. (2000). Minding the facts: A comment on Thompson-Schill et al.'s "A neural basis for category and modality specificity of semantic knowledge". *Neuropsychologia*, 38, 944-949.

Caramazza, A., & Hillis, A. E. (1991). Lexical organization of nouns and verbs in the brain. *Nature, 349*, 788-790.

Chiarello, C., Shears, C., & Lund, K. (1999). Imageability and distributional typicality measures of nouns and verbs in contemporary English. *Behavior Research Methods, Instruments, & Computers, 31*, 603-637.

Collina, S., & Tabossi, P. (2003). Semantic interference effects in the production of verbs: The role of the response set. *The Mental Lexicon, 2,* 65-78.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*(6), 407-428.

de Groot, A. M. B., Dannenburg, L., & van Hell, J. G. (1994). Forward and backward word translation by bilinguals. *Journal of Memory and Language, 33*, 600-629.

Dell, G. S. (1986). A spreading activation theory of retrieval in sentence production. Psychological Review, 93, 283 – 321.

Fillenbaum, S., Jones, L., & Wepman, J. (1961). Some linguistic features of speech from aphasic patients. *Language and Speech, 4,* 91–108.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. Behavior Research Methods, Instruments, & Computers 35, 116–124.

Gentner, (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. A. Kuczaj (Ed.), Language development: Vol. 2. Language, thought, and culture (pp. 301-334). Hillsdale, NJ: Erlbaum.

Gentner, D. (1981). Some interesting differences between verbs and nouns. *Cognition and Brain Theory, 4*, 161-178.

Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. Kuczaj (Ed.), *Language Development* (Vol. 2, pp. 301-303). Hillsdale, NJ: Erlbaum.

Gentner, D., & Borodinsky, L. (2001). Individuation, relativity, and early word learning. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development*. New York: Cambridge University Press.

Juhasz, B. J., & Rayner, K. (2003). Investigating the effects of a set of intercorrelated variables on eye fixation durations in reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 1312-1318.

Kauschke, C., & Stenneken, P. (2008). Differences in noun and verb processing in lexical decision cannot be attributed to word form and morphological complexity alone. *Journal of Psycholinguistic Research, 37*(6), 443-452.

Kounios, J., & Holcomb, P. J. (1994). Concreteness effects in semantic processing: ERP evidence supporting dual-coding theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 804-823.

Krishnan, G., & Tiwari, S. (2008). The Semantic Association in the Mental Lexicon. *Journal of All India Institute of Speech and Hearing, 27*, 44-48.

Laiacona, M., & Caramazza, A. (2004). The noun/verb dissociation in language production: Varieties of causes. *Journal of Cognitive Neuropsychology, 21*(2-4), 103-123.

McNamara, J. (1972). Cognitive basis of language learning in infants. *Psychological Review, 79*.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development, 38*.

Paivio, A. U. (1971). *Imagery and verbal processes*. Hillsdale, NJ: Erlbaum.

Paivio, A. U. (1986). *Mental representations: A dual coding approach*. New York: Oxford University Press.

Roelofs, A. (1992). A spreading-activation theory of lemma retrieval in speaking. *Cognition, 42*, 107 – 142.

Roelofs, A. (1993). Testing a non-decompositional theory of lemma retrieval in speaking: Retrieval of verbs. *Cognition, 47*, 59-87.

Schnur, T., Costa, A., & Caramazza, A. On the usefulness of semantic interference effect for studying verb production. (Submitted).

Schriefers, H., Teruel, E., & Meinshausen, R. M. (1998). "Producing simple sentences: Results from picture-word interference experiments". *Journal of Memory and Language, 39*, 609-632.

Schwanenflugel, P. J., Harnishfeger, K. K., & Stowe, R. W. (1988). Context availability and lexical decision for abstract and concrete words. *Journal of Memory and Language, 27*, 499-520.

Shapiro, K., Shelton, J. R., & Caramazza, A. (2000). Grammatical class in lexical production and morphological processing: evidence from a case of fluent aphasia. *Cognitive Neuropsychology, 17*, 665-682.

Tabossi, P., & Collina, S. (2002). The picture word interference paradigm: conceptual effects in the production of verbs. *Rivista di Linguistica, 14.1*, 27-41.

Vigliocco, G., Lauer, M., Damian, M. & Levelt, W. (2002). Semantic and syntactic forces in noun phrase production. *Journal of Experimental Psychology: Learning, Memory and Cognition, 28*, 46-58.

Vigliocco, G., Vinson, D. P., Damian, M. F., & Levelt, W. J. M. (2002). Semantic distance effects on object and action naming. *Cognition, 85*, B61-B69.

Door – Lock	Thread – Stove	Sweep – Mop	Clap – Fly
Pen – Ink	Iron – Shoe	Bring – take	Cough – Crawl
Bed – Night	Key – Nose	Cook – Eat	Swim – Speak
Window – Curtain	Tree – Switch	Draw – paint	Dip – Hit
Table – Bench	Knife – Feather	Wash – Wipe	Jump – Salute
Road – Vehicle		Cut – paste	

Appendix - A

Semantically Associated Nouns	Semantically Unassociated Nouns	Semantically Associated Verbs	Semantically Unassociated Verbs
Bread – Butter	Soap – Phone	Pick – Drop	Hit – wash
Pencil – Eraser	Stone – Lion	Read – Write	Smoke – grab
Ring – Finger	Room – Kite	Throw – Catch	Beg – Slip
Apple – Mango	Chair – Spoon	Punish – Cry	Tie – Slip
Bank – Money	Pipe – Shirt	Eat – Drink	Bathe – Draw
Fish – Water	Boat – Ball	Write – Draw	Shave – Push
Bag – Book	Moon – Leaf	Drop – Break	Chew – Chase

Lexical Processing in Bilingual Children: Evidence from Masked Phonological Priming

[1]Gopi Sankar R., [2]Jasmine Malik & [3]Jayashree C Shanbal

Abstract

Earlier, the general idea was that bilinguals had two mental lexicons: one for the first language and one for the second. In addition, a language switch mechanism controlled which lexicon was active. In recent years, however, evidence has accumulated showing that the initial stages of visual word recognition are largely language independent and that the assumption of independent lexicons may not be true. The aim of the present study is to explore visual word recognition in bilinguals through a masked phonological priming experiment. The participants consisted of 30 Kannada-English bilingual children in the age range of 10-12 years. The test material consisted of a total of 40 words in Kannada and 40 words in English. These were studied in 4 different priming conditions which included 10 semantically related prime (SR), 10 semantically unrelated prime (SUW), 10 non-words (NW) and 10 orthographically related nonword prime (OR). The findings of the study are further discussed with evidence from language-selective access models of bilingual word processing and phonological models of lexical processing.

Literature strongly suggests that the pattern of acquisition of literacy in bilingual children is different from that of monolingual children. Bialystok, Luk and Kwan (2005) opined that bilinguals may be transferring the reading skills acquired in one language to learn to read in the other. Studies have been conducted at various levels to understand the processing of information in bilinguals at phonological, lexical and syntactic levels. Understanding of lexical level processing is important as this may explain processing at a conceptual level in understanding any language. Empirical research has been conduct to understand what the lexicon itself contains, in terms of lexical form and lexical semantics. Potter, So, Von Eckardt and Feldman (1984) have hypothesized that some lexical representations for both languages may be integrated, while other representations may be separated. They suggested that the lexical form may be distinct for two languages, but the lexical semantics for the two languages may be integrated. Other researchers claimed that the lexical forms may be integrated (Van Heuven, Dijkstra, & Grainger, 1998), in that the semantic representations still may mostly be integrated, although they may be affected by their usage and by the context in which they appear.

There have been many theories and models proposed in order to study lexical processing in different bilingual populations across the world.
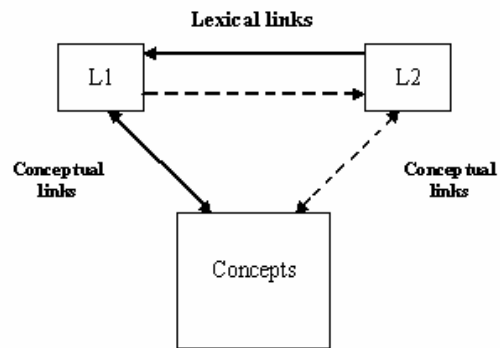
Researchers have attempted to understand how

Figure 1: Revised hierarchical model
(Source: adapted from Kroll and Stewart, 1994)

the lexical representations are accessed in the bilinguals. Particularly, researchers examined the mental lexical representations of the learners to see whether or not this condition would enable the representations for both languages to be accessed in the same way. A few who suggested that the lexicon was separated by the distinct languages in bilinguals did not support that the words could be accessed in the same way. This led to the creation of the models of selective and non-selective access. Selective access means that a bilingual can only access the lexicon from one language at a time. Non-selective access means that the

[1]*Research officer, Department of Clinical Services, All India Institute of Speech and Hearing, Mysore. email:sankaj2002@yahoo.co.in. [2]Post-graduate Student (SLP), All India Institute of Speech and Hearing, Mysore-06. [3]Lecturer in Language Pathology, Dept of Speech-Language Pathology, All India Institute of Speech and Hearing, Mysore-06*

bilingual can access the lexicon from both languages at the same time (cited in Locke, 2008). Van Heuven et al. (1998) suggested of combining the model of integrated lexicon with non-selective access. Kroll and Sunderman (2003) have also suggested that it is possible for learners to have one integrated lexicon represented in the mind and a non-selective mode of access. The representation of the lexicon and the mode of accessing the lexicon have been found to be the two key components of better understanding the makings of the bilingual lexicon (Eileen, 2008).

A few of the widely accepted models have been delineated in the following sections. Some of these models include the Revised Hierarchical Model (Kroll & Stewart, 1994) and Bilingual Interactive Activation Model (Grainger, 1998). Kroll and Stewart (1994) suggested the revised hierarchical model, which purports the directional asymmetry of L1 and L2 lexical processing (see figure 1).

Figure : Revised hierarchical model

(Source: adapted from Kroll and Stewart, 1994)

It proposes that learners evolve in their lexical processing. They use word association at low proficiency, but then develop to utilize concept mediation as their proficiency rises. The model merges the word association and concept mediation alternatives into a single model in which the strength of the connections between words in L1 and L2 and concepts is proposed to take on different values. The initial dependence on L1 to mediate access to meaning for L2 words is assumed to create strong lexical level connections from L2 to L1. However, at a lexical level, the connections from L1 to L2 are not assumed to be particularly strong because there is little need for the learner to use L2 in this way. Likewise, the model assumes that connections between words and concepts are stronger for L1 than for L2. A number of empirical findings support the predictions of the revised hierarchical model. Learners are more likely to conceptually mediate when they have a higher level of proficiency because they do not have to rely on lexical inter-language connections (Talamas, Kroll and Dufour, 1999). The shift from word association to concept mediation is dependent upon fluency level. Although the processing between L1 and L2 languages becomes increasingly similar as the proficiency level of L2 rises, Talamas et al. (1999) claimed that the connection between L1 words and concepts will almost always be stronger than L2 words and concepts due to the strong initial connection for L1 words and concepts.

The Bilingual Interactive Activation model is a computational model that analyzes word recognition. This model was proposed by Dijkstra and Van Heuven (1989) and Grainger and Dijkstra (1992). It is based on the Interactive Activation model of McClelland and Rumelhart (1981). The Bilingual Interactive Activation model claims that the lexicon of the bilingual is not separated, but integrated. It also claims that lexical access is non-selective. This means that, according to this model, even in the initial stages of word recognition, the bilingual can theoretically activate a word from either language in their lexicon. However, something must account for the fact that bilinguals are able to select a word for a given language. Language selection occurs because of language nodes. These language nodes work to suppress the language that is not being targeted with a top-down influence. Although these nodes may not be activated in the first stages of word recognition, they are triggered later on so that a bilingual can appropriately select the language they wish to use.

Phonological information generated from the printed word does influence early, automatic processes in visual word recognition (Berent & Perfetti, 1995; Ferrand & Grainger, 1994; Lukatela & Turvey, 1994; Van Orden, Pennington, & Stone, 1990; Ziegler & Jacobs, 1995). These data have seriously compromised the hypothesis according to which only orthographic codes mediate contact with lexical representations in the recognition of printed words (e.g., Baron, 1973; Forster, 1976; Humphreys & Evett, 1985) and suggest on the contrary that phonology plays a central role in visual word recognition (e.g., Carello, Turvey, & Lukatela, 1992; Lukatela, Lukatela, & Turvey, 1993; Lukatela & Turvey, 1994; Van Orden et al., 1990; Ru benstein, Lewis, & Rubenstein, 1971). Recently, Lukatela, Van Orden, pointed out that although there is now abundant evidence for the role played by phonological codes in visual word recognition, there is no clear-cut positive evidence for the role played by orthographic codes (other than subserving phonological code activation).

Need for the Study

There is much debate over how the bilingual lexicon functions in the brain. Past studies have analyzed how bilinguals' access and store lexical information with the hope of better understanding how the bilingual lexicon operates. However, the debate still remains over whether or not the bilingual lexicon is composed of one conjoined unit or two distinct parts, one for each specific language. On a practical level, it is known that more proficient bilinguals do not seem to have a problem accessing words from a specific language

when needed. Yet, at the same time, bilinguals also have shown the ability to code-switch, where they are able to access both languages almost simultaneously. These concrete examples serve to further the debate over how it is that the bilingual lexicon is stored and operated. In order to explore processing in bilingual children, an experimental paradigm need to be designed which taps the route to process meaningful words as well as non-meaningful non-words in a primed condition in the two languages.

Aim of the Study

The aim of the present study was to investigate lexical processing in bilingual children with a semi-syllabic language background but learning to read and write an alphabetic language in school. This was done using a masked phonological priming task widely recommended in literature.

Method

Participants

The participants were 30 Kannada-English normal bilingual children in the age range 10-12 years of age. All the children spoke Kannada as their first language (L1) and English was the medium of instruction in school. Kannada was taught as first language (L1) subject in school and English was taught as second language (L2) subject in school. All the children were screened using the WHO disability checklist (Singhi, Kumar, Malhi, & Kumar, 2007) for any sensory, motor or cognitive impairments, delayed acquisition of motor and verbal skills, communication difficulties and presence of other related ailments.

Test Material / Instruments

The test material consisted of a total of 40 high frequent words in Kannada and 40 high frequent words in English. These words were selected from text books following Karnataka state syllabus. These were words were rated as high frequent words by three experienced speech-language pathologists. The study was conducted using these words in four different priming conditions,

1. *Condition 1:* 10 semantically related prime (SER). For e.g. (camel–desert)

2. *Condition 2:* 10 semantically unrelated prime (SEUR). For e.g., (camel-apple)

3. *Condition 4:* 10 orthographically related non-word prime (ORNW). For e.g.,(camel-camef)

4. *Condition 3:* 10 non-words (NW) - Non-words were constructed by changing the

final syllable of the word. For e.g., (camel-camef)

Totally 80 conditions were presented visually in black font on a white background on the middle of the computer screen. These words were presented on a computer screen using the DMDX software (Forster & Forster, 1999). It enables the measurement of reaction times to these displays with millisecond accuracy.

Procedure

Each participant was tested individually in a session lasting for about 20 minutes. At the beginning of the session, participants were seated in front of a computer. The lexical decision task was then explained to them. Practice sessions were carried out before the actual testing. Participants were instructed to ignore the first word and respond to the second word which appeared after 500 ms on the computer screen. The participants were instructed to press the keys '1' if the word was meaningful and '0' for non-meaningful word. They were instructed to respond as quickly as possible, but also told that it was acceptable to respond even after the word had disappeared from the screen.. Reaction times (RT) in milliseconds and accuracy measurements were recorded using the DMDX software.

Scoring

The responses for accuracy and reaction time (RT) in milliseconds were recorded using the DMDX software. The software automatically saves the reaction time values on a Microsoft-Excel Sheet. These reaction time measures are measured and recorded. The data was subjected to statistical analysis through the SPSS Version 16.0 software.

Results

The aim of the present study was to investigate lexical processing in bilingual children using a masked phonological priming task. Mixed ANOVA was performed to compute mean and standard deviation for the data and Duncan's post-hoc tests were done to look for statistical significance in the data. In mixed ANOVA grade was considered as independent factor. The other two factors were languages and the conditions. The results have been described as,

I.   Group comparison for accuracy measurements across languages, grades and conditions

II. Group comparison for reaction time (RT) measurements across languages, grades and conditions

I. Group comparison for accuracy measurements across languages, grades and conditions
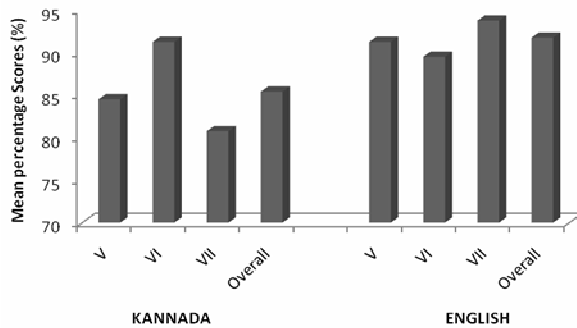

Figure 2: *Mean a*ccuracy scores (in %) across grades & between languages

Accuracy scores were calculated across the grades (grades 5, 6 and 7), between the languages (Kannada and English) and across
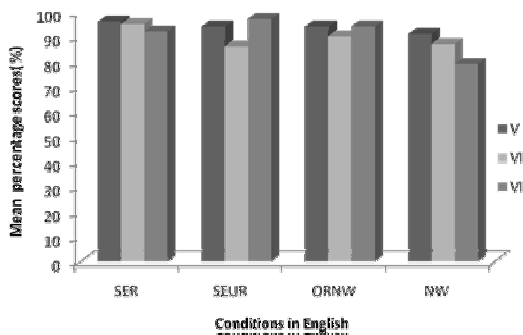

Figure 2a: Mean accuracy scores (in %) across the condition in English

conditions (SER, SEUR, NW, ORNW). Figure 1 shows reperesnetation of mean percentage scores for accuracy measurements of word recognition in children across grades and between languages. Figure 1 shows that the overall performance of childern is better in English compared to Kannada. This could be because of the regular usage and exposure of English in schools as media of instruction. This may be because the use of English (L2) more regularly for reading and writing when compared to that of kannada (L1). However, there was no significant difference found in the performance of children between the languages or across the grades.

Further, specific analysis of performance of children in terms of accuracy was done in language English and Kannada. Figures 2a and 2b show the mean accuracy scores (in %) across the condition in English and Kannada respectively.
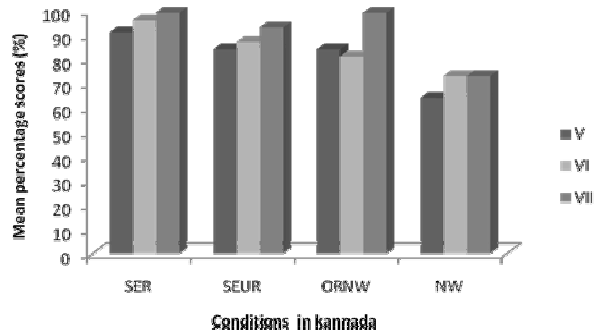
Figure 2b: Mean accuracy scores (in %) across the condition in Kannada

Figures 2a and 2b show that the performance of children is similar in English and Kannada across all grades in all the conditions, except in the nonword prime condition. The performance of children in the non-word prime condition was found to be poorer in Kannada than in English. The performance of children was found to be better on semantically realted prime condition (SER) compared to semantically unrelated prime condition (SEUR), orthographically related non-word prime cindition (ORNW) and non-word prime condition (NW) (See Figure 1 for comparison of performance of children in different cinditions).

II. Group comparison for reaction time (RT) measurements across languages, grades and conditions

Mixed ANOVA was done to compare the performance (reaction times in ms) of children across grades, between languages and across the

conditions. Table 1 shows mean and standard deviation (SD) computed for reaction times of children in English and Kannada across grades and across the conditions.

The results in Table 1 revealed that the overall mean reaction time was longer for children in grade V when compared to grade VI and grade VII in all the four conditions (SER, SEUR, ORNW and NW). A developmental trend was found in the performance of children for reaction time measurements. The statistical analysis showed an overall significant main effect in the mean reaction times across the languages i.e., $F (1, 27) = 10.68$, $p < 0.01$. The results reveled that children responded faster on tasks in English compared to Kannada (See Table 1 for mean scores across languages). The analysis also revealed a highly

Languages	Conditions	Grades					
		V		VI		VII	
		Mean	SD	Mean	SD	Mean	SD
English	SER	1370.12	258.68	1424.32	184.17	1200.71	256.02
	SEUR	1424.73	238.80	1713.65	308.98	1027.07	167.23
	ORNW	1193.26	230.68	1434.19	280.99	993.13	302.11
	NW	1955.79	1245.97	1641.17	276.46	1750.19	386.44
Kannada	SER	1573.53	230.25	1336.91	357.17	941.25	151.55
	SEUR	1807.30	364.10	1607.72	386.00	1194.57	225.42
	ORNW	1709.30	254.57	1681.93	245.19	1058.39	261.64
	NW	2511.57	633.95	2182.65	758.25	2032.09	719.50

Note: SER= Semantically related prime, SEUR= Semantically unrelated prime, ORNW= Orthographically related non-word prime, NW= Non-word prime

Table 1: Mean and SD scores of reaction times of children in English and Kannada across grades and across different conditions

significant main effect across conditions i.e., $F_{(3, 27)} =40.63$, $p <0.001$. A significant interaction effect was found across languages and conditions, i.e., $F_{(3, 27)} = 3.43$, $p< 0.05$. A significant main effect was also found across all the conditions at $F_{(2, 27)} = 19.70$, $p<0.001$. Further, Post hoc duncan test revealed that there was no significant difference in the performance of children in grades V and VI. There was a significant difference in the perfomance of children in grades V and VII at 0.05 level. Figure 1 shows the mean reaction times of children across grades, across conditions and between the langauges.
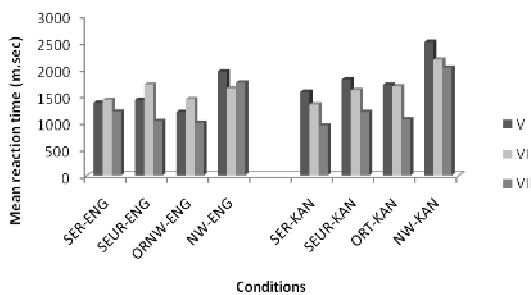
Note: SER= Semantically related prime, SEUR= Semantically unrelated prime, ORNW= Orthographically related non-word prime, NW= Non-word prime, ENG= English, KAN = Kannada

Figure 3: Mean reaction time for all four condition across the grade and language.

Figure 1 shows that within conditions, children have taken longer time to repond in the NW prime condition in both English and Kannada. Children have taken the least time in the SER prime condition in both English and Kannada. It was also observed that, there was a developmental trend found on reaction times measures of children

where the children in higher grades performed faster than the children in the lower grades. Pair sampled t-test was done to comparison was done to explore the overall difference across and within the conditions. The results revealed that, when, SER prime condition was compared with the other three conditions, there was a significant difference in reaction time measures for semantically unrelated condition and nonword prime condition at 0.05 level and 0.01 level respectively. The results revealed that in English, there was no significant difference in reaction times between SER and SEUR condition and ORNW. Whereas, there was significant difference in the performance of children between SER and NW condition. Children have taken longer time in NW prime condition compared to SER, SEUR and ORNW conditions. In Kannada, similar results were observed where children took longer time in NW condition compared to SER, SEUR and ORNW conditions.

Discussion

The aim of the present study was to investigate lexical processing in bilingual children using a masked phonological priming task. The data was analyzed for accurate responses and reaction time measurements.

The results revealed that overall Kannada-English bilingual children showed better performance in English (L2) than in Kannada (L1) (see Figures 2, 2a, 2b and 3). This was noted for both accuracy and reaction time measurements in Kannada and English. However, significant difference was found for reaction times in Kannada and English. Children took lesser time in L2 compared to L1. This could be explained using the revised hierarchical model (RHM) proposed by Kroll and Stewart (1994) (See figure 1). Kroll and Stuart (1994) reported that children took longer time in L2 naming than L1 naming. Contradicting to this study, the present study, revealed that children took longer time in L1 than L2. It can be explained hypothetically using the same model that in the present study, the participants were children in higher grades whose conceptual links may be established due to exposure to L2 reading more than L1 reading. Children in the present context study Kannada as only a subject whereas, English is studied as a subject and also a medium of instruction. Hence, the exposure is more to English reading than Kannada reading. The link between the L2 and the concepts might have become strong in these children because they are exposed to L2 language in their literacy skills much more than the L1 language. Due to this it is possible that older children need not always

process orthographic information to reading through L1 and then move to L2 and then establish a link with the concepts.

Further the results of the present study revealed that children took lesser time to respond when the target word was primed with a semantically related (SER) word than semantically unrelated (SEUR) prime, orthographically unrelated (ORNW) prime or nonwords (NW) as prime. This was found to be true for performance of children in both English and Kannada. This may be because of integrated lexical semantics and different lexical forms. Integrated lexical semantics indicates that as the target word and the prime word share the same lexical semantics, the processing is facilitated faster than when the prime is unrelated in SEUR condition. Also, RNW and NW prime words do not facilitate word recognition as they do not share the lexical semantics in terms of their relation to meaning. This finding supports Van Heuven, Dijkstra, and Grainger (1998) who reported that semantic representations may be integrated although they may be affected by their usage and the context in which they appear. Hence, despite the languages, semantic related conditions facilitate word recognition better for reading in children. These findings also support the non-selective processing in bilinguals. This means that processing in children may not be due to language specific features. These children process information in a similar way even in languages with two different orthographies. Here, children depend more on semantic information for word recognition in both English and Kannada and do not depend on the phonological information. These findings also support Kroll and Sunderman (2003) who have suggested that learners may have integrated lexical representation and a non-selective mode of access of information.

Conclusions

A better performance in L2 than L1 could be because the children under study are older children whose conceptual links may be established due to factors like exposure to L2 as it is also the medium of instruction when compared to L1 which is only learnt as a subject in school. Also a better performance for semantically related prime condition is indicative of the fact that despite the language difference, processing is more integrated for lexical semantics and access mode may be more non-selective in nature as explained by other models in literature.

Implications

- The present study helps understand that priming tasks can be used to study different

levels of lexical and sub-lexical processing in bilingual children. How does this processing differ in adult bilinguals with better proficiency in L2 will be yet another interesting question that need to be addressed with future research.

- Such experiments can be used as tasks in themselves to assess processing in monolinguals, bilinguals and dyslexias associated with them. The findings would prove crucial while understanding the mechanism in the clinical population.

- Further, what would be more interesting to note is deciding on including the phonological related tasks and semantic related tasks as part of the intervention programs for the clinical population like the SLI, children with dyslexia, etc.

References

Baron, J. (1973). Phonemic stage not necessary for reading. *Quarterly Journal of Experimental Psychology,* 25**,** 241–246.

Berent, I., & Perfetti, C. (1995). A rose is a reez: The two-cycles model of phonology assembly in reading English. *Psychological Review, 102,* 146–184.

Carello, C., Turvey, M. T., & Lukatela, G. (1992). Can theories of word recognition remain stubbornly nonphonological? Cited in Grainger, J., & Ferrand, L. (1996). Masked orthographic and phonological priming in visual word recognition and naming: Cross-task comparisons. *Journal of Memory and Language, 35,* 623-647.

Ferrand, L., & Grainger, J. (1994). Effects of orthography are independent of phonology in masked form priming. *Quarterly Journal of Experimental Psychology, 47A,* 365–382.

Forster, K. I. (1976). Accessing the mental lexicon. Cited in Grainger, J., & Ferrand, L. (1996). Masked orthographic and phonological priming in visual word recognition and naming: Cross-task comparisons. *Journal of Memory and Language, 35,* 623-647.

Forster, K.I., & Forster, I. (1999). University of Arizona. Retrieved from *http://www.u.arizona.edu/ ~kforster/dmdx/dmdx.htm* on 21.7.2008.

Grainger, J., & Dijkstra, A. (1992). On the representation and use of language information in bilinguals. In R. Harris (Ed.), *Cognitive processing in bilinguals* (pp.207-220). Amsterdam: Elsevier. Cited in Eileen Locke, B.A.(2008) The Effects of Exposure Type on Lexical Processing in Low-level Bilinguals. Mater thesis submitted to Texas Tech University.

Grainger, J., & Ferrand, L. (1996). Masked orthographic and phonological priming in visual word recognition and naming: Cross-task comparisons. *Journal of Memory and Language, 35,* 623-647.

Humphreys, G. W., & Evett, L. J. (1985). Are there independent lexical and nonlexical routes in word processing? An evaluation of the dual route theory of reading. *The Behavioral and Brain Sciences,* 8, 689–740.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language, 33,* 149-174.

Kroll, J. F., & Sunderman, G. (2003). Cognitive processes in second language learning and bilinguals: the development of lexical and conceptual representations. In C. Doughty and M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 104-129). Malden, MA: Blackwell Publishing.

Lukatela, G., & Turvey, M. T. (1994). Visual lexical access is initially phonological: 2. Evidence from phonological priming by homophones and pseudoho-mophones. *Journal of Experimental Psychology: General,* 123**,** 331–353.

Lukatela, G., Lukatela, K., & Turvey, M. T. (1993). Further evidence for the phonological constraints on visual lexical access: TOWED primes FROG. *Perception & Psychophysics,* 53, 461–466.

McClelland, J. L., & Rumelhart, D. F. (1981). An interactive activation model of context effects in letter perception, Part 1: An account of basic findings. *Psychological Review, 88*, 375-405.

Potter, M. C., So, K. F., Von Eckardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals*. Journal of Verbal Learning and Verbal Behavior, 23,* 23-38.

Rubenstein, H., Lewis, S. S., & Rubenstein, M. A. (1971). Evidence for phonemic recoding in visual word recognition. *Journal of Verbal Learning and Verbal Behavior,* 10, 645–657.

Singhia, P., Kumar, M., Malhi, P., & Kumar, R. (2007) Utility of the WHO Ten Questions Screen for Disability Detection in a Rural Community—the North Indian Experience. Journal of Tropical Paediatrics, 83, 6, 383-387.

Talamas, A., Kroll, J. F., & Dufour, R. (1999). Form related errors in second language learning: A preliminary stage in the acquisition of L2 vocabulary. *Bilingualism: Language and Cognition, 2*, 45-58.

Van Heuven, W. J. B., Dijkstra, A, & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language*, *39*, 458-483.

Ziegler, J. C., & Jacobs, A. M. (1995). Phonological information provides early sources of constraint in the processing of letter strings. *Journal of Memory and Language,* 34, 567–593.

Standardization of Receptive Expressive Emergent Language Skills for Kannada Speaking Children

[1]Madhu.K, [2]Deepa M.S., [3]Suhas .K., [4]Harshan Kumar & [5]Shyamala Chengappa

Abstract

Language development is a process that starts early in human life, when a person begins to acquire language by learning it as it is spoken and by imitation. Child language development moves from simple to complex. Many tests have been developed to assess language in toddlers. Even though they have been developed many decades back, they are still in practice in almost all clinics in India. But the tests need to be revised and standardized because children are observed to be developing many skills at very early years of age. The present study was undertaken to standardize REELS (Receptive Expressive Emergent Language Scales – Bzoch and League 1971.) for children exposed to Kannada language. 720 children from all over Karnataka with age range of 0-3yrs served as subjects for the study. The children were divided into different age ranges 0-3 months to 33-36months. The milestones in REELS both receptive and expressive skills were adapted (modified to suit south Indian context of Kannada), numbered and used for the study as questionnaire that was administered to the parents/caregivers. The responses were tabulated and analyzed. The results collected from all three regions of North, South and Coastal Karnataka was gathered and standard deviation was calculated. There was highly significant differences seen in 1st to 3rd year however, the milestones did not differ significantly in the lower age group that is less than 1 year. The revised REELS contain the skills, which have been shifted to lower age group using 80% criteria. . Further the scale need to be standardized separately for rural and urban areas with equal number of skills throughout the age ranges.

Key words: Language acquisition, Developmental scales, Standardization, Validation

Language development is a process that starts early in human life, when a person begins to acquire language by learning it as it is spoken and by imitations. Children's language development moves from simplicity to complexity.

Usually, language starts off as recall of simple words without associated meaning, but as children age, words acquire meaning and connections between words are formed. In time, sentences start to form as words are joined together to create logical meaning. As a person gets older, new meanings and new associations are created and vocabulary increases as more words are learned.

Infants use their bodies, vocal cries and other preverbal vocalization to communicate their wants, need and dispositions. Even though most children begin to vocalize and eventually verbalize at various ages and at different rates, they learn first language without conscious instruction from parents or care takers. It is a seemingly effortless task that grows increasingly difficult with age. Of course, before the learning can begin, the child must be biologically and socially mature enough.

The most intensive period of speech and language development for humans is during the first three years of life, a period when the brain is developing and maturing. These skills appear to develop best in a world that is rich with sounds, sights, and consistent exposure to the speech and language of others.

There is increasing evidence suggesting that there are "critical periods" for speech and language development in infants and young children. This means that the developing brain is best able to absorb language, any language, during this period. The ability to learn a language will be more difficult, and perhaps less efficient or effective, if these critical periods are allowed to

[1]*Internship student, JSS institute of Speech and Hearing, Ooty road, Mysore-25, email:madhukarinayak@yahoo.co.in,* [2]*Junior Research Fellow, All India Institute of Speech and Hearing, Mysore-6, email:deepams12@gmail.com,* [3]*III Bsc Student, JSS institute of speech and hearing, Ooty road, Mysore-25, email:suhas_ck@yahoo.com,* [4]*ll B.Sc. StudentJSS institute of Speech and Hearing, Ooty road, Mysore-25, email:harshankumar@rocketmail.in.* [5]*Professor of Language Pathology, Dept. of Speech-Language Pathology, All India Institute of Speech and Hearing, Mysore-06, email:shyamalakc@yahoo.com.*

pass without early exposure to a language. The beginning signs of communication occur during the first few days of life when an infant learns that a cry will fetch food, comfort, and companionship. The newborn also begins to recognize important sounds in his or her environment. The sound of a parent or voice can be one important sound. As they grow, infants begin to sort out the speech sounds (phonemes) or building blocks that compose the words of their language. Research has shown that by six months of age, most children recognize the basic sounds of their native language.

Language development during these very early years of life from birth to about 2 ½ to 3 years is very dramatic and rapid. From birth to 2 ½ years is the period usually labelled as infancy and adulthood. Infants eventually recognize much of what they hear and gain more control over their speech structures. Even though they may alert to hearing a familiar word or produce a string of sounds that are almost recognizable, there abilities are still pre-linguistic, that is, they precede true language. Nonetheless, they represent the needs of conventional language behaviours.

Midway through their 1st year, infants begin to babble, playing with sound much as they play with their fingers and toes. At approximately the same age that they take there first step; many infants produce their first words. Early in their 2nd year, the babbling of the pre linguistic infant gives way to words, for most children. Once infants begun to speak, the course of language development appears to have some universal characteristics.

As in other areas of linguistic research, it is important to recognize that different constraints act upon the child's comprehension and production of a particular form. Language does not develop in isolation nor has a separate system of behaviour with special status. The behaviours that eventually evolve into recognizable language behaviour are supported by the child's whole development in the motor, cognitive, and social domains.

Each domain- motor, cognitive, and social- builds on development in the others. Although our focus is on language, it is important to view the entire process and to understand how these related domains set the stage for language to evolve.

The 1st year is an eventful one, so many changes occur so rapidly in all the domains- motor, cognitive, and social. The changes in these systems do more than precede language. These changes continuously channel infant's evaluation towards true language.

Elardo, Bradley & Caldwell (1977) employed a process-oriented research strategy to examine relations among various aspects of the early home environment and children's language development. Infants' home environments were assessed when they were 6 and 24 months old with the Home Observation for Measurement of the Environment (HOME). When 3 years of age, each child was administered the Illinois Test of Psycholinguistic Abilities. Results demonstrated that it is possible to specify some of the parameters of early experience related to certain aspects of language development. The HOME subscales "Emotional and Verbal Responsivity of Mother," "Provision of Appropriate Play Materials," and "Maternal Involvement with Child" showed the strongest overall relation to language competence. Among the 10 psycholinguistic abilities measured, auditory reception, auditory association, visual association, and grammatical closure were most strongly associated with the quality of stimulation found in the early environment.

Wright, Huston, Murphy, Peters, Piñon, Scantlin & Kotler (2002) used two cohorts of children from low- to moderate-income families, time-use diaries of television viewing were collected over 3 years (from ages 2-5 and 4-7 years, respectively), and tests of reading, math, receptive vocabulary, and school readiness were administered annually. Relations between viewing and performance were tested in path analyses with controls for home environment quality and primary language (English or Spanish). Viewing child-audience informative programs between ages 2 and 3 predicted high subsequent performance on all four measures of academic skills. For both cohorts, frequent viewers of general-audience programs performed more poorly on subsequent tests than did infrequent viewers of such programs. Children's skills also predicted later viewing, supporting a bidirectional model. Children with good skills at age 5 selected more child-audience informative programs and fewer cartoons in their early elementary years. Children with lower skills at age 3 shifted to viewing more general-audience programs by ages 4 and 5. The results affirm the conclusion that the relations of television viewed to early academic skills depend primarily on the content of the programs viewed.

Thus it has been an area of great interest for researchers to measure the language in the typically developing toddlers. As we know that language develops rapidly during the critical age period and it is important to know the domains of language which are acquired during this stage. Also the level of acquisition of language from infancy needs to be studied. Many researchers have listed the skills which are achieved across

the stages of language development. Many of these serve as tests to assess language abilities in children with language impairment.

Receptive Expressive emergent Language Scale (REELS) was given by Bzoch & League (1971) for children in the age range of 0 to 3 years. It is an untimed test although may take approximately 10 minutes. The test aimed at determining whether expressive and receptive language skills are following normal developmental patterns during first 36 months of life. The test consists of an outline of developmental stages for expressive and receptive language presented in 22 sections. There are 3 receptive and 3 expressive items per sections and these are divided across the age bands so that 12 items apply to year one, 6 items apply to year two and 4 items apply to year three.

Scales of Early Communication Skills (SECS) was given by Moog & Geers (1975) for children in the age range of 3 to 8 years. This test assesses speech and language development in children with hearing impairment. The test is divided into 4 parts; receptive language skills, expressive language skills, non-verbal receptive language skills and non-verbal expressive language skills.

3-Dimentional Language Acquisition Test (3DLAT) was given by Harlekar (1986) for children in the age range of 9 months to 3 years. The test makes a possible examination of the relation among cognition, comprehension and production skills in normal and in specific groups of language deviant children. According to age at which various aspects of language of emerge they have been divided into nine age groups which cover the age groups from 9 months to 36 months. Each age group has a range of 3 months except for last group which has average of 4 months. Three items each for expression, repetitions and cognition for every age group are selected. Hence the test includes 72 items under each section.

Prathanef & Pongajanyakul (1998) establish a Thai Speech and Language Test for Thai children between zero and 2 years of age. The authors reviewed both Thai and international speech and language development tests and studies related to factors associated with speech and language development. A Thai Speech and Language Test for children between zero and 2 years of age (TSLT2) was then formulated. The test was used with 419 typically developing Thai children in Khon Kaen, north-east Thailand.

Wiig & El-Halees (2003) gave an account of general and specific issues associated with developing an Arabic-language screening test for children aged between 3 and 12 years. The product is a screening test of verbal and related non verbal abilities with parallel components for children of preschool (3-5 years) and elementary school age (6-12 years). Normative data were collected for 750 Arabic-speaking children in Jordan and Palestine, distributed fairly equally between the ages of 3 and 12 years.

Bzoch, League & Brown (2003) took 1,112 children to revise the REELS (Receptive Expressive Emergent Language Test) according to 2000 census. It is designed to help identify infants and toddlers who have language impairments or who have other disabilities that affect language development. It is especially useful as an assessment and planning instrument in early childhood intervention programs. The first version of REELS was developed in the year 1971.

Hence it was an area of interest for researchers to measure the language in the typically developing toddlers. As we know that language develops rapidly during the critical age period, it was important to know the domains of language which is acquired during this stage. Also the level of acquisition of language from infancy was studied. Many researchers have listed the skills which are achieved at across the stages of language development. Many of these serve as tests to assess language abilities in children with language impairment.

Need for the Study

Most of the tests were developed for western population. To adopt these tests to Indian population they need to be standardized. There are several reasons to this statement of why we need to standardize. One of the important needs is the cultural variations in different parts of the globe. According to the literature socio-culture is one of the most important variable to account for the language development. Typically developing children do differ in language acquisition even when exposed to same region, so the variation in language acquisition is highly influenced by the environmental exposure to the children in different regions. Mother/caretaker interaction also varies with different socio- economic status. Socio-economic condition is lower in India as compared to western countries.

Importantly the tests which are used to assess language have been developed 3-4 decades back. Amount of stimulation along with physiological and psychological maturation is been increased as years pass. So the tests may not accurately assess the language abilities in children. Children are faster at skills in the present days as compared to the children of older

generation. So the tests need to be revised as well as standardized.

Aim of the Study

The study aimed at standardizing REELS for Kannada speaking population.

Method

Subjects: Selected for the study were a total of 720 children, in the age range of 0-3yrs from all over Karnataka. Both male and female children were considered for the study.

Selection criteria

- For the present study we considered children without any pre, peri, and post natal complications.

- Children not having any behavioural, psychological, physiological, or sensory problems.

- All children have Kannada (a Dravidian language) as their mother tongue and first language.

Material Used: Developmental milestones specified in Receptive Expressive Emergent Language Scales-REELS [Bzoch & League, 1971] were used as questionnaire for our study. REELS, is a measure of reception and expression language skills. The milestones is been divided

into 3 months intervals ranging from 0-3 months to 33-36 months. The skills mentioned in this test were taken as questionnaire for both receptive and expressive skills which were numbered and administered. As the test was developed for children in western country, direct adaptation is difficult, due to cultural variations. Hence the material was modified in order to match with cultural background of Karnataka population (See R17 and E32 in Appendix).

All children underwent informal screening for "Hearing". "Hearing" screening was done using non verbal sounds like 'clap', 'bell', 'knock'.& verbal sounds like 'name call' stimuli presented at 3 feet and at 5 feet distances.

Procedure

A total of 720 children in the age range of 0-3 years from all over Karnataka were included in the study comprising both males and females. Data was collected from 3 regions of Karnataka that is North, South, and Coastal. The samples were collected from North Hubli and Bellery district. From south it included Mysore, Mandya and Chamarajanagar and from coastal region it included Dakshina Kannada and Udupi district. Equal number of children from all these regions participated in the study. Children between 0-3 years age range were divided into 12 subgroups with 3-months interval between each consecutive groups. (0-3months to 33-36months).
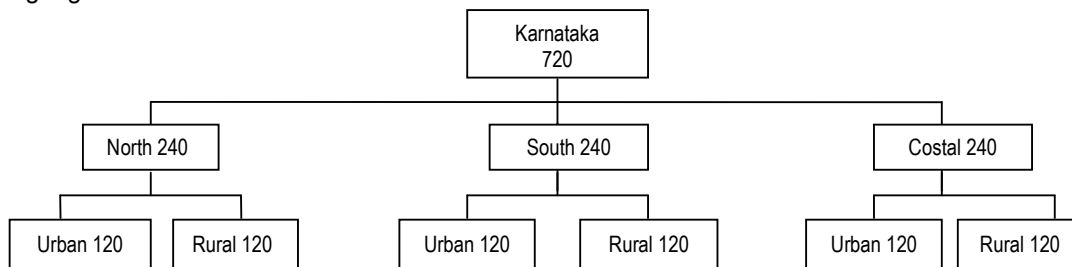
Data was collected from the hospitals, houses, and Anganvadis and play homes, depending on the availability of the children. In addition to this, a survey was done in the nearby villages for children below 3 years and data was collected. The data collection began with the Hearing and Vision screening followed by administration of the questionnaire to the parents or care takers.   Hearing screening was done informally by presenting verbal (name call) and non-verbal sounds (clap and knock) at 3ft and 5ft distances. If the child responded for 3 out of 5 times the stimuli presented, he/she was considered to have normal hearing. Similarly screening for vision was carried out. The visual screening protocol by Bishop (1989) was adopted.

Protocol was administered following the brief birth history and family history to rule out vision problems. Task used and the material required for the vision screening is depicted in table 1.

The questionnaire consisted of a total of 86 questions for both receptive and expressive language skills separately (86 x 2 = 172). The questionnaire was administered to the parents or care givers of the children (listed in the increasing order of difficulty). The procedure was same for both receptive as well as expressive skills. Administration of the questionnaire was stopped at the point where the parents or care givers reported that the particular task is not achieved by the child. The scores were noted down in the evaluation form. The evaluation form consisted of separate

columns for both receptive and expressive skills. Speech was recorded in children above 2 yrs of age. Data entered in the evaluation forms were the specific numbers corresponding to the number of questions in the questionnaire (skills achieved by the child) last fulfilled by the child.

The Screening Sequence According to the Protocol		
Task	**Materials**	**Distance**
Pupillary response	Response Light	Near
Blink Response	Hand	Near
Convergence	Light or toy	Near
Muscle Balance	Light; hand	Near
Fixation	Object: 4" x 5"	Near (8" to 18")
Fixation	Object: 1"	Near (8" to 18")
Fixation	Object: 4"	Distance (10')
Tracking	Light or toy	Near
Eye preference	(observational)	(any distance)
Shift Gaze	Two objects	Near
Visual Fields	Toy; light	Near

Table 1: The Visual Screening Sequence According to the Protocol by Bishop (1989)

Results and Discussion

The results obtained for the entire 3 regions was compiled and tabulated. The data was arranged according to specific age range starting from 0-3 months till 33-36 months. The mean, standard deviation and t-value were calculated for each of the age groups and the scores obtained in our study were compared with the normative developed in the older version of REELS (1971). The upper limit at which skills are acquired in each age range was tabulated and this depended on the number in the questionnaire, where the test has been stopped for a particular child. For example, 15-18 months in older version of REELS children could satisfy at question number '45' whereas in our study children are able to satisfy till 54th question. Tabulated scores for both receptive and expressive skills for the older version of REELS and for the present generation is been depicted in Table 2 and 3.

Table 2 shows the mean, standard deviation and t-value for receptive language skills for both older and present data. As the Table 2 depicts, there is significant difference between the skills achieved from 6-9months to 33-36months. There was no significant difference between the skills acquired at 0-3 months and 3-6monhs. The difference in the skills increased as the age progressed. Greater difference in the skills

between older and new data was seen between 1-2 years of age. The difference was very less in the first year of age and 2-3years of age falling between these two. This shows that children in present generation acquire skills earlier between 2-3years of age and it decreases as the age progresses from 3-4years of age.

Sl no	Age range	Groups	Mean	SD	t- value
1	0-3months	Old New	9 8.25	3.6	0.77 ns
2	3-6months	Old New	18 19.63	4.29	-0.11 ns
3	6-9months	Old New	27 34.17	5.67	0.00 **
4	9-12months	Old New	36 41.7	5.1	0.00 **
5	12-15months	Old New	40 44.66	7.25	0.02 *
6	15-18months	Old New	45 54.0	4.09	0.00 **
7	18-21months	Old New	49 57.18	5.18	0.00 **
8	21-24months	Old New	54 59.8	2.68	0.00 **
9	24-27months	Old New	57 62.31	3.80	0.00 **
10	27-30months	Old New	60 65.0	3.90	0.00 **
11	30-33months	Old New	63 67.7	3.50	0.00 **
12	33-36months	Old New	66 70.0	2.51	0.00 **

(old = data of REELS in 1971, New = data for present population, * = significant, ** = highly significant and ns = not significant)

Table 2: Showing mean, standard deviation and t-value for receptive language skills for both older data and the present one.

Table 3 shows the mean, standard deviation, and t- value for expressive language skills for both older and present data. As the table depicts, the differences were very less in the first year of life, but as the age progressed the difference in the skills increased. These differences are significant from 6-9months till 12-15months and are highly significant from 15-18 months till 33-36 months of age for expressive language skills. This shows that the children in the present generation acquire skills earlier between 2-3years of age and it is gradual as the age progresses from 3-4yrs.

According to both the tables 2 and 3 receptive as well as expressive language skills have improved across the decades, seemingly there is highly significant difference between the skills acquired by 1-3yrs of age. This is because language is another form of behaviour which is acquired as a response to the stimuli in the environment and then it is learnt. Children's creativity with language and level of linguistic

alignment help them in learning language. Learning is a voluntary response which is strengthened or weakened depending on positive or negative consequence. These aspects seem to be increasing in the present generations. Parental stimulation and environmental exposure seemingly are the important factors for the increased linguistic development for the present generation. Present findings are in agreement with Elardo, Bradley & Caldwell (1977) who stated that language development is dependent on early stimulation at home.

Sl no	Age range	Groups	Mean	Standard Deviation	T-value
1	0-3months	Old New	9 7.83	3.01	0.2 ns
2	3-6months	Old New	18 18.68	1.97	0.14 ns
3	6-9months	Old New	27 31.23	4.86	0.02 *
4	9-12months	Old New	36 38.84	3.67	0.03 *
5	12-15months	Old New	40 43.0	3.53	0.05*
6	15-18months	Old New	45 50.54	4.25	0.00**
7	18-21months	Old New	49 55.45	5.30	0.00**
8	21-24months	Old New	54 57.9	3.27	0.00**
9	24-27months	Old New	57 61.0	3.86	0.00**
10	27-30months	Old New	60 64.0	3.74	0.00**
11	30-33months	Old New	63 68.0	2.70	0.00**
12	33-36months	Old New	66 69.92	2.11	0.00**

(old = data of REELS in 1971, New = data for present population, * = significant, ** = highly significant and ns = not significant)

Table 3: Showing mean, standard deviation and t-value for Expressive language skills for both older data and the present one.

As we found that children achieved both expressive and receptive skills in equal amount early in life with reference of REELS I edition developed in 1971 we revised it for present generation. According to Table 2 and 3, we observe that age progressed there was highly significant difference between older and new data. This difference was minimal during first year of life but highly significant in second and third year of life. Hence our aim was to standardize and revise the test. During revision we followed 80 % criteria, that is if 80% of the children in a particular age group are passing or able to achieve a particular milestones that skill was moved to lower age group. This was done for both Receptive and Expressive skills. The modified REELS for children

who are exposed to Kannada language is as seen in the Appendix. As seen in Appendix the milestones have been shifted to the lower age groups when they are found to be achieved in 80% of the children. But we were not able to maintain equal number of milestones for each of the age ranges. That is some age range have more number of milestone and others have lesser. And also in each age ranges equal number of Receptive and Expressive skills has not been maintained.

Conclusions

The present study was aimed at standardizing REELS (Receptive Expressive Emergent Language Scales) for children exposed to Kannada language. A total of 720 children with age range of 0-3years from all over Karnataka who were exposed to Kannada language were included in the study. Data was collected from all three regions of Karnataka (North, South and Coastal). The data was tabulated and analyzed to check the significant difference between older version of REELS as compared with the present generation. Results revealed that there was significant difference seen in second to third year of life than in first year, for both receptive and expressive skills. The standardized scale has been developed, by shifting the skills that are achieved at particular age, using 80% criteria to the lower age group. As we included children from all over Karnataka, both from rural and urban areas, the scale can be administered to any children below the age 3 from any part of this region. Further the scale needs to be standardized separately for rural and urban areas. Further, equal number of receptive and expressive skills needs to be maintained throughout the age ranges.

References

Acarlar, F. and Johnston, J.R. (2006) Computer-based analysis of Turkish child language: clinical and research applications. *Journal of Multilingual Communication Disorders*,4,78-94.

Anderson, R. (1977) "The impoverished state of cross-sectional morpheme acquisition /accuracy methodology." Paper presented at Los Angeles Second Language Acquisition Research Forum, UCLA, February 1977.

Anerew, N., M. & Freckerit, Z .(2007). Association between media viewing and language development in children under 2 year age. Wasington DC. Author. 92-100

Anisfeld, M. (*1979).* Interpreting "imitative" responses in early infancy. *Science*, vol 205, No. 4402. Pg: 214-215.

Asher, J. (1965) "The strategy of the total physical response: an application to learning Russian." *International Journal of Applied Linguistics* 3: 291-300.

Asher, J. (1966) "The learning strategy of the total physical response: a review." *Modern Language Journal.* Vol. 50.Pg: 79-84.

Aslin R. N., & Pisoni D. B. (*1980).* "Effects of early linguistic experience on speech discrimination by infants: " *Child Development,*vol 51, No. 1 . Pg: 107-112.

Bishop, V. (199 1). *Preschool children with visual impairment* .(unpublished manuscript). Available online at. www.tsbvi.edu/Education/infant/ page9.htm

Brown, R. (1973) *A First Language.* Cambridge: Harvard Press.

Bzoch, R. , League, R. & Brown, L. (2002). REELS (receptive expressive emergent language scale) 1st and 3 rd edition.

Caroline, B. (1998), *Typical Speech Development*. Retrieved from http://www.speech-language-therapy.com/acquisition.html on (date).

Cazden, C. (1972) *Child Language and Education.* New York: Holt, Rinehart, and Winston

Chomsky, N. (1975). Reflections on Language. *New York: Pantheon Books.*

Clark, R. (1974) "Performing without competence." *Journal of Child Language* 1: 1-10.

Clark, H. & Clark, E.(1977) *Psychology and Language.* New York: Harcourt, Brace, Jovanovich.

Cross, T. (1977) "Mother's speech adjustments: the contribution of selected child listener variables," In C. Snow and C. Ferguson (Eds.), *Talking to Children.* New York: Cambridge University Press, pp. 151-188.

Elardo, H., Bradley, M., & Caldwell, D. (1977). The home inventory: A validation of the preschool scale for Black children. University of Arkansas at Little Rock. Fayetteville, Arkansas.

Ervin, S. (1964) "Imitation and structural change in children's language." In Lenneberg, E. (Ed.), *New Directions in the Study of Language.* Cambridge, Ma.: M.I.T. Press, pp. 163-189.

Fillmore, L. (1976) *Cognitive and Social Strategies in Language Acquisition.* Ph.D. dissertation, Stanford University.

Geetha. H. (1987). 3-Dimensional language test.Unpublished dissertation submitted to All India Institute of Speech and Hearing. University of Mysore. Mysore.

Hatch, E. (1972) "Some studies in language learning". *UCLA Workpapers in Teaching English as a Second Language* 6: 29-36.

Moog, J.,S. & Geers, A.,V. (1975). Scales of early communicatin skills(SECS).

Pinker, K. & Steven, H. (1994). *The Language Instinct: How the Mind Creates Language*. New York: Harper Collins.

Prathanef, B. & Pongajanyakul, A. (1998). Thai speech and language Test for Children between 1 and 2 year of age. *InternationalJjournal of Language & Communication Disorders.*Vol. 43, Pg: 125-140.

Reed, V. A. (2004). An introduction to children with language disorders. Allyn and Bacon. Coulbia University Press.

Steven P.S. & Robert, E. H. (2004).. *Caring for your baby and young child: birth to age 5.* American academy of paediatrics. Fotthill Blvd, La Canada.

Wiig, A., K. & El-Halees, A. (2003). Developing a Language Screening Test for Arabic-Speaking Children. Folia Phoniatrica at Logopaedica. Vol 52, No. 6, Pg: 260-274.

Story Re-tell Abilities in Preschoolers Development in Kannada-speaking English Language Learners

[1]Sarika Khurana & [2]Prema K. S.

Abstract

Story retelling has been used to evaluate the oral narratives of preschool children. Assessment of oral language abilities in preschoolers is essential for identifying children at risk for reading difficulties in later grades. The purpose of the present study is to evaluate the development of story re-tell abilities in preschool children with native language Kannada studying in schools with English as the medium of instruction, in Mysore city. The subjects consisted of 30 participants in the age range of three to six years, enrolled in Pre-kindergarten, Lower Kindergarten and Upper Kindergarten. The children were narrated a story in English using a wordless picture book and asked to re-tell the story. Their narratives were audio recorded, transcribed, segmented into C-units and analyzed using the SALT software. The narrative measures employed to evaluate the expressive language were Number of English Words (NEW), Number of Kannada Words (NKW), Number of Proper Nouns (NPN), Mean Length of Utterance (MLU), Number of Different Words (NDW) and Type Token Ratio (TTR). Comprehension abilities were assessed using a Question-Answer Task (QAT). The results indicate that both expression and comprehension abilities show an upward developmental trend in preschoolers. Their narratives were dominated by Kannada utterances in Pre-Kindergarten but in Lower Kindergarten and Upper Kindergarten, their narratives showed dominance of English utterances. Measures such as MLU, NDW and TTR were not sensitive to the developmental changes in preschool narratives whereas measures such as NEW, NKW and NPN showed significant difference between groups. The results of the present study indicate that measures such as MLU, NDW and TTR should be used with caution while evaluating language samples with less than 50 bilingual utterances.

Key words: Oral narratives, MLU, NDW, TTR, SALT software

In the last two decades, research on early literacy has shifted its focus from school-age children to preschoolers. The preschool years are critical for the development of skills such as oral language* and emergent literacy**, which facilitate reading acquisition and predict reading achievement (Lonigan, 2006; Snow, Burns and Griffin, 1998; Storch & Whitehurst, 2002; Teale & Sulzby, 1986; Whitehurst & Lonigan, 1998). Butler (2000) reported that children with oral language problems in early years are at risk for reading and writing difficulties in later grades. Therefore, assessment of oral language skills and emergent literacy in preschool children becomes very essential to identify those children who are at-risk for later reading failures. This paper evaluates the narrative abilities of preschool children in the age range of three to six years through story retelling task. The present study is a part of the doctoral research work of the first author on 'Development of Emergent Literacy in Kannada-speaking English Language Learners'.

Storytelling is clearly a social experience with oral narrative, incorporating linguistic features that display a "sophistication that goes beyond the level of conversation" (Mallan, 1991, p. 4). Narrative skills can be considered the "gateway to reading and writing" (Hirsh-Pasek, Kochanoff, Newcombe, & de Villiers, 2005, p.6). Researchers have widely used narrative assessments such as story re-tell to evaluate the oral language abilities of very young children (Curenton & Justice, 2004; Gazella &

*Oral language refers to the corpus of words in a child's vocabulary as well as his or her ability to use those words to understand and convey meaning i.e. syntactic and narrative skills (Lonigan, 2006).

**Emergent Literacy describes the skills and knowledge that young children have about reading and writing prior to beginning their formal literacy instruction in elementary school (Whitehurst & Lonigan, 1998).

[1]Junior Research Fellow, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Manasagangothri, Mysore-570 006, email:sarikakhurana71@yahoo.com. [2]Prof. of Language Pathology and Head, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Manasagangothri, Mysore-570 006, email:prema_rao@yahoo.com,

Stockman, 2003; Hewitt, Hammer, Yont & Tomblin, 2005; Leadholm & Miller, 1992; Miller, Heilmann, Nockerts, Iglesias, Fabiano & Francis, 2006; O'Neill, Pearce & Pick, 2004; Schelletter & Parke, 2004). According to the technical definition given by Labov (1972), "a narrative must contain a minimum of two sequential independent clauses on the same event or experience." Clauses in the narrative must confine to the same time, space or theme, for example, "I went to the zoo. I saw a baby elephant". Speech samples that contain unrelated utterances such as, 'I went to the zoo. I want water' would not be considered as a narrative according to Labov's definition.

Story Re-tell Task

Storytelling is a familiar discourse genre across cultures, including those without a written language. Research has indicated that oral storytelling between young children and their parents facilitate emergent literacy (Burns, Griffin & Snow, 1999). In fact, many researchers and educators believe that storytelling can contribute significantly to early literacy development (Cooper, Collins & Saxby, 1992; Glazer & Burke, 1994; Phillips, 1999). Since storytelling is popular with young children all over the world it can be used in the assessment of narrative skills.

An oral narrative is a language tool that consists of a child's spoken description of real or fictional events experienced in the past, the present or the future (Curenton & Lucas, 2007). In order to use oral narratives as an assessment tool clinicians use two elicitation techniques, story generation and story retelling. Story generation requires children to invent or recall a narrative using their own words. In story generation tasks children are shown familiar or unfamiliar pictures and asked to make up a story about what they see (Dollaghan, Campbell & Tomlin, 1990; Liles, 1993). This task allows children to be creative and original in their stories. Generating a story for the first time is not the same task as telling a story that one already knows. If speakers were familiar with a story, then asking them to talk about it would be a retelling task (Gazella & Stockman, 2003). In a story retelling task the subject is presented with a novel or a familiar story by the clinician and asked to immediately re-tell the story. Presenting a novel instead of a familiar story minimizes the effect of past experiences with the story and allows the examiner to control the stimulus input.

Wordless picture books have been widely used to elicit fictional stories from children. Stories that depict a character that encounters a problem, engages in goal-based actions to solve the problem and resolves the conflict are very popular with preschoolers (Benson, 1997; Pearce, 2003;

Shapiro & Hudson, 1991). Research has also indicated that without sequenced illustrations, preschoolers produce short and unelaborated stories (Kadaravek & Sulzby, 2000; Shapiro & Hudson, 1991). Since young children have small attention spans, wordless picture books are used to overcome the role of memory in recalling the characters or the sequence of events in the story. Interesting characters and colourful pictures make story retelling an appealing assessment tool for preschoolers. It can be used to evaluate several features of oral language such as speech intelligibility, grammatical structure, lexical diversity and formulation skills.

Measures of Story Re-tell Responses

For the assessment of narratives the story retelling or story generation task should be audio or video recorded and later transcribed verbatim. Computer programs are available for transcription and analysis of narratives (such as, CLAN, Child Language Analysis, McWhinney, 1995; SALT, Systematic Analysis of Language Transcripts, Miller & Chapman, 1993). The transcription rules vary based upon the computer program used. It is acceptable to transcribe only the child's narrative during the story retell task when the examiner only provides consistent non-leading neutral prompts (McCabe, 1997b), such as "What happened next?" or "What do you see in this picture?" Irrelevant comments, unintelligible utterances, false starts and retraces made by the child maybe deleted during transcription (Curenton & Justice, 2004).

After a narrative has been transcribed, it must be segmented into meaningful language units. While listening to a child's narrative it is often difficult to determine how to break the stream of speech into meaningful units. Manner in which utterances are segmented is essential because the mean length of the utterance (MLU[1]) depends on the way utterances have been segmented. Researchers have used several techniques for segmentation of narratives. Traditionally, some researchers used pauses and intonation patterns as cues for segmentation (Miller & Chapman, 1981) while others used word groups resembling a sentence as cues for segmentation (Lund & Duchan, 1993; Owens, 1999). Several other studies report the use of 'Communication- Units' for segmentation of the utterances produced during a narration task (Curenton & Justice, 2004; Hughes, McGillivray & Schmidek, 1997; Strong and Shaver, 1991).

---

[1] MLU is the average number of words/morphemes produced by a speaker per utterance, in a narrative.

Communication units are a segmentation method that allows a clinician to segment the narrative into grammatical units (Crais & Lorch, 1994; Loban 1976). Research has indicated a significant correlation between average C-unit length and age (Craig, Washington & Thompson-Porter, 1998). C-units are grammatical units that are based on clausal structure (i.e., subject-predicate clause). In a clause the subject is usually the noun and it is the topic of the clause (i.e., what the clause is about). The predicate is the verb phrase part of the clause, and it describes the action of the clause (i.e., what is being done). A C-unit consists of either (a) independent clause or (b) independent clause along with its dependent clause(s).

In case the speech sample is segmented into C-units, the number of words per C-unit constitutes the Mean Length of a C-unit (MLCU). Some researchers segment the speech sample into C-units but continue to use the term 'MLU' to refer to the mean length of C-units (Miller et. al, 2006). The calculation of MLU/MLCU depends critically on how utterances are segmented. Segmentation of utterances is a variable between studies that makes direct comparison of results difficult. Once the narrative is segmented into utterances and the transcripts are fed into the computer, the program analyses the narrative on several measures such as total number of utterances, total number of words, Mean Length of Utterance (MLU), number of different words[2] (NDW) and type token ratio[3] (TTR). Several studies in literature have used measures like MLU, NDW and TTR to evaluate the narrative abilities of preschool children (Gazella & Stockman, 2003; Hewitt et. al., 2005; Leadholm & Miller, 1992; Miller et. al, 2006; O'Neill et al., 2004; Schelletter & Parke, 2004).

Several studies on bilingual children have used words to calculate the mean length of utterance (Miller et. al, 2006; Schelletter & Parke, 2004) because the morpheme structure of both the languages was very different. MLU (words) is calculated as the average number of words per utterance in a given narrative. These studies show that MLU (words) and NDW can be used to evaluate oral language in young bilingual children. Besides the difference in the unit of measurement of MLU (morphemes/words), the sample size also varies from one study to the other. Most textbooks conform to Miller and Chapman's (1981)

recommendation of 50 utterances. However, 25% of Speech Language Pathologists (SLPs) in the Hux, Morris-Friehe and Sanger (1993) survey and 43% in Loeb, Kinsler and Bookbinder (2000) survey indicate using samples of fewer than 50 utterances. Eisenberg, Fersko and Lundgren (2000), report of clinicians who use less than 25 utterances for calculating MLU.

Other popular measures to evaluate oral language in young children are NDW and TTR, which measure the lexical diversity in narratives. Lexical diversity is a measure of expressive vocabulary size (Klee, 1992; Miller, 1991; Watkins, Kelly, Harbers & Hollis, 1995). Lexical diversity is influenced by the presence of language impairment (Goffman & Leonard, 2000), elicitation procedure (Gazella & Stockman, 2003), and a child's age (Miller, 1991). Several studies suggest that NDW is a better measure of semantic development than TTR (Miller, 1991; Watkins et. al., 1995). Literature also reports that NDW is a reliable measure of lexical development not only in preschoolers but even older children (Owen & Leonard, 2001; Richards & Malvern, 1997).

Story Re-tell Measures in Bilingual Children

Assessments of narratives have been reported frequently in monolingual children and seldom in bilingual children (see Gutierrez-Clellen, 2002). Studies investigating narratives of bilingual children have found them to be less advanced than matched monolingual children on a variety of measures (Shrubshall, 1997). Comparing narratives in both languages of Spanish-English bilinguals, Gutierrez-Clellen (2002) found differences in the recall and comprehension of a story, such that the children showed better performance in the language used in the classroom (L2- English) as opposed to Spanish (L1). Schelletter & Parke (2004) did not find any difference between the English-dominant and the German-dominant groups in terms of MLU and number of word types. The German-dominant group outperformed the English-dominant group in terms of their ability to use synonyms of verbs and in terms of errors. The narrative task employed in the above studies includes narrative re-tells, where the child was given a story model that had to be reproduced, and spontaneous narratives.

Research on bilingual language acquisition in India is still in the infancy stage. Patnaik & Mohanty (1984) reported that bilinguals perform better on cognitive, linguistic and meta-linguistic skills when compared to monolinguals. This view was also supported by Sreedevi & Shyamala (2005) that bilinguals have better narrative abilities when compared to monolinguals.

---

[2] NDW is the number of different words produced by the speaker in a narrative.

[3] TTR is the ratio of NDW versus the total number of words produced by the speaker in a narrative.

In the absence of any reported literature on story re-tell abilities of preschoolers in the Indian context, the present research aims at studying the development of narrative skills in Kannada-speaking English Language Learners in the age range of 3-6 years. To meet this objective a story re-tell task was employed which was part of the Battery of Emergent Literacy Assessment (BELA), developed for the doctoral research titled 'Development of Emergent Literacy in Kannada-speaking English Language Learners[4]'. In this task the examiner narrated a story using a wordless picture book and asked the subject to re-tell the story with the help of the picture book. The story was narrated in English by the examiner and children were free to use any (or both) language (Kannada/English) to re-tell the story. The narration was audio recorded, transcribed, segmented into C-units and analyzed for comprehension and expression of narratives using SALT software. The narrative measures were compared across groups (PKG, LKG and UKG) and correlated to study the development of story re-tell abilities in preschoolers.

Method

Participants: Thirty children in the age range of 3-6 years with normal hearing, vision and intelligence were selected from Mysore city. All subjects were native Kannada-speakers studying in preschool with English as the medium of instruction. For this study, 'preschool' refers to a school that caters to children enrolled in Pre-Kindergarten (PKG), Lower Kindergarten (LKG) and Upper Kindergarten (UKG). The subjects were divided into three groups (PKG, LKG, and UKG) of ten subjects each, based on their enrolment in the preschool. The participants were screened to rule out disability, if any, using the WHO Disability Screening Checklist (cited in Singhi, Kumar, Malhi & Kumar, 2007).

Groups	No. of Subjects	Mean age in months (age range)
PKG	10	45.60 (39-51)
LKG	10	58.20 (54-66)
UKG	10	66.60 (60-72)

Table 1. Mean Age of subjects

The present study is part of a doctoral research work, which aimed at studying the development of emergent literacy in preschoolers.

----

[4] *Since the children in this study were enrolled in preschools with English as a medium of instruction, they were referred to as 'English Language Learners'.*

The subjects for doctoral research were selected from ten preschools in Mysore city, which were evaluated for their literacy environment via a series of surveys. Parents and teachers were asked to respond to questionnaires pertaining to emergent literacy experiences of children at home and in classrooms, and the quality of books available to them in preschools. The results of the surveys indicated that preschoolers in the sample had literacy experiences that were rich in print knowledge, phonological awareness and oral language skills (Khurana & Rao, 2008; Khurana & Rao, in press).

The survey (Khurana & Rao, 2008) provided information regarding the use of English language at home. 54% of parents used Kannada for oral activities like daily conversation and storytelling while 46% parents used English. 66% of parents used English for storybook reading and other reading and writing activities while 34% of parents used Kannada. Thus indicating that majority of parents in the sample preferred Kannada for oral language activities but they used English for literacy related activities like reading and writing. The survey (Khurana & Rao, 2008) also provided information regarding the educational background of parents. Over 70% of parents had an educational qualification which was graduation (or above). Thus indicating that majority of the participants in the sample were from educated families.

Test Material: The story re-tell task used a colourful wordless picture book titled 'Mini and Kitty' that was developed as a part of Battery of Emergent Literacy Assessment (BELA), for the doctoral research. The story depicted a young girl called 'Mini' and her cat named 'Kitty'. The storybook contained eight pages (30cm x 20cm) including the title page and was spiral bound for ease of handling. The story had a simple storyline taking into consideration the concepts of very young bilingual children and it revolved around two characters, a girl and her cat. Since the story was narrated in English (second language), simple sentences were used and words chosen for narration were within the vocabulary of preschoolers. The pictures in the storybook were big in size, colourful and descriptive.

Procedure: The study was carried out in six phases- testing phase, transcription phase, segmentation phase, analysis of narrative measures, analysis using SALT software and the scoring phase.

Testing: The subjects were tested in a quiet room within the preschool premises. Each subject was tested individually in a single sitting that lasted around 15 to 20 minutes per child. The procedure

used for collecting the narrative sample was identical for all subjects. The examiner presented the child with a wordless picture book titled 'Mini and Kitty'. The picture book provided the children with a map for the story sequence and cues that helped narration. The examiner narrated the story in English and then handed the book to the child and asked him/her to look at the pictures and re-tell the story. During the re-tell the examiner provided neutral prompts like "What do you see in this picture?" or "What happened next?" Children's responses were audio recorded using the Olympus Digital Voice Recorder WS 100.

Transcription: The examiner listened to the audio recording and transcribed each narrative verbatim. The transcriptions were first recorded orthographically using broad transcription. Then the transcriptions were typed on the computer using the SALT (Systematic Analysis of Language Transcripts) conventions. Since the examiner provided neutral consistent prompts to all subjects, only the child's utterances were transcribed.

Segmentation: Preschool children produce very few utterances when compared to older children. Their utterances are characterized by grammatically incorrect or incomplete phrases. In case of children acquiring two languages simultaneously, the size of the narration sample might be even smaller. Craig, Washington & Thompson-Porter (1998) suggest that while segmenting narratives into C-units, even utterances that do not adhere to a clausal structure can still be considered in the analysis if they are responses to a question or a part of dialogue. In the present study, since the examiner prompted the child to describe what is seen in the picture, the child's responses relevant to the narration task (even ones that do not adhere to the clausal structure) were considered for analysis. The orthographically transcribed utterances were segmented into C-units, employing rules for segmentation specified in the SALT software.

Analysis of Narrative Measures: The present study aimed to evaluate the expressive and comprehensive abilities of preschool children via the story re-tell task. The narrative measures employed to evaluate the expressive abilities were NEW (Number of English Words), NKW (Number of Kannada Words), NPN (Number of Pronouns), Total 1[5], MLU (Mean Length of Utterance), NDW (Number of different Words) and TTR (Type Token Ratio). The narrative measure employed to

evaluate the comprehension abilities was QAT (Question-Answer task). The total oral language score of the narratives was represented by Total 2[6].

Analysis using SALT software: The segmented transcripts were typed onto the computer using SALT conventions specified in the software. The SALT software was used to analyze the transcripts for NEW, NKW, NPN, MLU, NDW and TTR. SALT software has reference database for English but not for Kannada. Hence, in order to analyze the bilingual language sample containing English and Kannada words, a Kannada word list was prepared containing all the Kannada words used by all the subjects in the sample.

Scoring: A scoring pattern with different weights for English and Kannada was adopted in the larger study for doctoral work in order to study the development of oral language skills in Kannada and English. Since the story narration was in English and children in the sample were acquiring literacy in English, it was assigned a weight higher than Kannada. English was assigned a weight of '3', Kannada was assigned a weight of '2' and Proper Nouns (such as Mini and Kitty), which were used with both languages, were assigned a weight of '1'. The product of the raw scores and the weights provided the weighted score for that measure. For example, if the raw score of NEW (No. of English Words) is 20, the weighted NEW would be 60 (20 x 3) and if the raw score of NKW (No. of Kannada Words) is 8, the weighted NKW would be 16 (8 x 2).

Similarly, the weighted scores were calculated for all the subjects for NEW, NKW and NPN. These weighted scores were then compared across groups (PKG, LKG and UKG) to study the developmental pattern of the two languages separately in the story re-tell task. Narrative measures such as MLU, NDW and TTR were evaluated based on the raw scores. These measures were calculated for both the languages together and the raw score indicated a bilingual score. Since the number of utterances in the sample were limited, a weighted score for these measures was difficult. These scores were compared across groups (PKG, LKG and UKG) to evaluate the development of bilingual narratives in preschool children.

The data was subjected to statistical analysis using SPSS Version 16.0 software. The data was

---

[5] *Total 1 is the sum of NEW, NKW and NPN. It represents the total expressive score for the story re-tell task*

[6] *Total 2 is the sum of QAT and Total 1. It represents total oral language score, which is the sum of expressive and comprehension score for the story re-tell task.*

analyzed using ANOVA and Correlation statistics, and the narrative measures were compared across groups and correlated to evaluate the development of narratives in preschool children.

Results

The purpose of the present research was to study the development of story re-tell abilities in Kannada-speaking children studying in preschools with English as the medium of instruction. The results of the study are discussed with the objective of:

- Studying the development of narrative measures from Pre-KG through UKG

- Identifying the narrative measures for story re-tell task by examining the correlation amongst the narrative measures under study

Comparison of Narrative Measures across PKG, LKG and UKG

The narrative measures were compared across groups to find out the developmental trend of narrative abilities in preschool children. Table 2 presents the descriptive statistics for the sample of 30 participants. Mean, Standard Deviation (SD) and the 95% confidence interval for mean (lower

and upper boundary) were calculated for all the groups (PKG, LKG, UKG). Mean values of narrative measures showed an upward trend from pre-kindergarten to lower and upper kindergarten children. The SD was wide for majority of narrative measures with maximum SD for the lower kindergarten participants.

The data was subjected to One-way ANOVA (Table 3) to compare the narrative measures across the groups (PKG, LKG, and UKG). It was observed that a significant difference existed between NEW (Number of English Words), Total 1 (NEW+NKW+NPN), QAT (Question-Answer Task) and Total 2 (Total 1 + QAT). The F values are presented in Table 3. The F values indicate that narrative measures such as NEW, QAT and Total 2 show a significant difference across the three groups. NKW (Number of Kannada Words) and NPN (Number of Proper Nouns) did not show significant difference across groups. The scores were also analysed using Duncan's Post Hoc test to evaluate the developmental trend for the measures that showed significant difference across groups. The results indicated that although a significant difference was observed from PKG to LKG for narrative measures such as NEW, Total 1, QAT and Total 2, the difference between LKG and UKG was not significant for these measures.

Narrative Measures		Mean	Standard Deviation	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Weighted NEW Score	PKG	31.8	20.11	17.41	46.19
	LKG	69.9	49.90	34.19	105.61
	UKG	69.9	35.81	44.28	95.51
Weighted NKW Score	PKG	22.0	13.13	12.61	31.39
	LKG	32.2	33.94	7.92	56.48
	UKG	22.4	16.22	10.80	33.99
Weighted NPN Score	PKG	3.7	4.52	0.46	6.94
	LKG	4.0	4.19	1.00	7.00
	UKG	6.1	4.12	3.15	9.05
Total 1	PKG (NEW+NKW+NPN)	57.5	17.50	44.98	70.02
	LKG	106.1	41.92	76.11	136.09
(Weighted Scores)	UKG	98.4	31.62	75.78	121.02
QAT	PKG	4.3	2.11	2.79	5.81
	LKG	5.6	1.42	4.57	6.62
	UKG	6.6	1.35	5.63	7.56
Total 2	PKG	61.8	16.25	50.18	73.42
(Total 1+ QAT)	LKG	111.7	42.51	81.29	142.11
	UKG	105.0	32.27	81.91	128.09
MLU	PKG	2.07	.84	1.47	2.68
	LKG	3.11	1.36	2.14	4.09
	UKG	2.99	1.06	2.23	3.76
NDW	PKG	19	8.31	13.25	25.16
	LKG	27	10.10	20.07	34.53
	UKG	25	6.92	20.25	30.15
TTR	PKG	.63	.12	.55	.72
	LKG	.63	.07	.58	.68
	UKG	.63	.11	.55	.71

Note. PKG = Pre-Kindergarten, LKG = Lower Kindergarten, UKG = Upper Kindergarten, NEW = Number of English Words, NKW = Number of Kannada Words, NPN = Number of Proper Nouns, QAT = Question Answer Task, MLU = Mean Length of Utterance, NDW = Number of Different Words, TTR = Type Token Ratio

Table 2: Mean and Standard Deviation for the three groups (PKG, LKG and UKG); N=30

Narrative Measures	F value
NEW (No. of English Words)	3.47*
NKW (No. of Kannada Words)	.63
NPN (No. of Proper Nouns)	.93
Total 1 (NEW+NKW+NPN)	6.68**
QAT (Question-Answer Task)	4.79*
Total 2 (TOTAL 1+QAT)	7.07**
MLU (Mean Length of Utterance)	2.62
NDW (No. of Different Words)	2.42
TTR (Type Token Ratio)	.001

Note. NEW = Number of English Words, NKW = Number of Kannada Words, NPN = Number of Proper Nouns, QAT = Question Answer Task, MLU = Mean Length of Utterance, NDW = Number of Different Words, TTR = Type Token Ratio

* Significant at the 0.05 level, ** Significant at the 0.01 level

Table 3: F values at degrees of freedom (2, 27) across PKG, LKG, UKG

Since NEW, NKW and NPN together (Total 1) showed a significant difference across groups, the percentage of these utterances was calculated and plotted on a graph. The X axis represents the groups (PKG, LKG and UKG) and the Y-axis represents the percentage of utterances. The illustration (Figure 1) shows the increase in NEW and the decrease in NKW with advancing grade (PKG to LKG and UKG). NPN did not show a significant difference across groups.

Correlation among the Narrative Measures

In order to identify the narrative measures for story re-tell task, the data was subjected to correlation study. Table 4 presents the bivariate correlations amongst the narrative measures

under study. Pearson's correlation coefficient was calculated and the results indicate that the groups (PKG, LKG, UKG) correlate with NEW, Total 1, QAT and Total 2. NEW correlates with the groups, NKW, MLU, NDW, Total 1 and Total 2. NKW correlates with NEW and NDW. NPN correlates with MLU and QAT. Total 1 correlates with the groups, with NEW, MLU, NDW and Total 2. QAT correlates with the groups, NPN, MLU and Total 2. Total 2 correlates with the groups, NEW, Total 1 and QAT. MLU correlates with NEW, NPN, Total 1, QAT and Total 2. NDW correlates with NEW, NKW, Total 1, Total 2 and MLU. TTR shows a negative correlation with almost all variables except NKW, although this correlation is not significant.

Discussion

This research aimed at studying the development of story re-tell abilities in children from Pre-KG through UKG. The study also aimed at identifying the narrative measures for story re-tell task by examining the correlation amongst the narrative measures under study. Kannada-speaking preschoolers acquiring literacy in English were evaluated on the story re-tell tasks. The results show a significant difference across grades (Table 3) from Pre-KG through UKG indicating that story re-tell tasks can be used to study the development of narrative skills in preschool children. This is in consonance with other studies reported in literature (Curenton & Justice, 2004; Gazella & Stockman, 2003; Hewitt, Hammer, Yont & Tomblin, 2005; Leadholm & Miller, 1992; Miller, Heilmann, Nockerts, Iglesias, Fabiano & Francis, 2006; O'Neill, Pearce & Pick, 2004; Schelletter & Parke, 2004).

Variable	1	2	3	4	5	6	7	8	9	10
1. Groups	-									
2. NEW	.392*	-								
3. NKW	.007	-.392*	-							
4. NPN	.233	-.007	-.107	-						
5. Total1	.450*	.864**	.170	.041	-					
6. QAT	.510**	.319	-.116	.544**	.333	-				
7. Total 2	.468**	.865**	.161	.067	.999**	.376*	-			
8. MLU	.325	.379*	.188	.431*	.568**	.675**	.591**	-		
9. NDW	.278	.409*	.463*	.091	.727**	.316	.730**	.658**	-	
10. TTR	-.008	-.261	.288	-.325	-.143	-.262	-.153	-.070	.248	-

Note. NEW = Number of English Words, NKW = Number of Kannada Words, NPN = Number of Proper Nouns, QAT = Question Answer Task, MLU = Mean Length of Utterance, NDW = Number of Different Words, TTR = Type Token Ratio

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed)
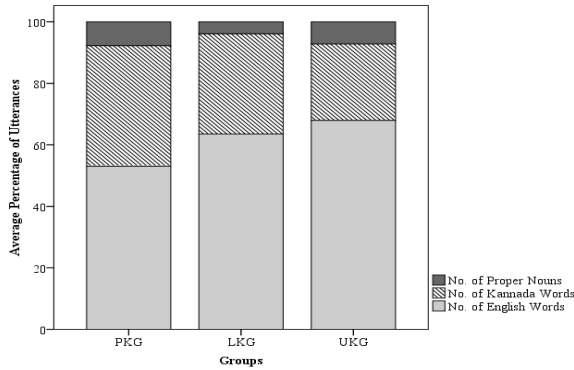
Table 4: Bivariate Correlations

Figure 1: Average percentage of Utterances across groups (PKG, LKG and UKG

The narratives of children in the sample from PKG show dominance of the native language Kannada, which is spoken at home and in their immediate environment. But, a dominance of English in their narratives was evident in those children from LKG and UKG indicating an improvement in their expressive abilities in the English language. The results of the question-answer task show an increase in comprehension abilities across groups indicating an improvement in English comprehension as children move from pre-kindergarten to lower and upper kindergarten. This indicates that oral language abilities of Kannada-speaking English Language Learners show a developmental trend with advancing grade (PKG to LKG and UKG).

The above findings are further supported by the descriptive analysis of the data. The wide range of SD of participants is similar to the results of other studies evaluating story re-tell abilities that have reported a wide range of SD for narrative measures. (Gazella & Stockman, 2003; Hewitt et. al., 2004). The wide SD within groups observed in the present study could be attributed to age differences within subjects in each group leading to wide range of utterances. There are no strict age restrictions for enrolment in preschools in Mysore city; hence children in each group have a wide age range. The maximum age in the LKG group is 66 months, which is the mean of the UKG group. This accounts for higher scores for the LKG group when compared with the UKG group on some narrative measures (Total 1, Total 2, MLU and NDW). Another factor that can explain the wide range in SD is the nature of response in the present study. Since subjects in this study were allowed to re-tell the story in either of the languages under study, the responses varied in their length, complexity as well as choice of language.

Most studies that evaluate the narratives of bilingual children elicit and record the narrative task separately in each language (Gutierrez-Clellen, 2002; Schelletter & Parke, 2004). The children in the above cited studies were instructed by the investigators to use 'one language only' while re-telling the story, which might have inhibited their natural narration ability. In the present study an effort was made to investigate bilingual utterances 'as a whole' instead of narrations in two separate languages. Majority of bilingual children enter preschools with limited knowledge of their second language (English, in this study), which is compensated by an increased use of the native language (Kannada, in this study) in their narratives. As oral language proficiency increases in their second language, their narratives also show a shift from native to second language (which is the language of instruction), which is clearly evident from the results of the present study.

With reference to the developmental trend for each of the narrative measures of story re-tell task, MLU, NDW and TTR did not show a significant developmental trend across groups. This can be attributed to the small number of utterances in the sample. Researchers recommend at least 50 utterances in a sample for measures such as MLU to be reliable (Miller & Chapman, 1981) but some researchers have reported using MLU for samples less than 25 utterances (Gazella & Stockman, 2003). In the studies cited in this article, these measures were evaluated mostly with monolingual subjects and in case of bilingual subjects they were evaluated on narrative samples recorded separately for each language. The results of the present study indicate that narrative measures such as MLU, NDW and TTR are not sensitive to the developmental progression in story re-tells of bilingual children when they are used to analyze bilingual utterances less than 50 in number.

Although the number of utterances elicited by the story re-tell in the present study is less than 50, the sum of measures such as NEW, NKW and NPN (Total 1) showed a significant difference across groups. NKW and NPN did not independently show a significant difference but when they were added to the NEW scores, the sum showed a significant difference between groups. Different weights were assigned to each language for the calculation of these measures and the weighted scores exhibited a significant trend across languages. English was weighted higher than Kannada since the story was narrated by the examiner in English and the subjects were acquiring literacy in English. This indicates that in cases where narratives are bilingual in nature, each language can be analyzed separately and

the weighted scores can be successfully employed to evaluate the developmental progression of languages across groups.

Results of the comprehension abilities were similar to the results of the expressive abilities of preschoolers. QAT (Question-Answer Task), the measure of comprehension ability, showed a significant difference across groups. When QAT was summed-up with expressive narrative measures like NEW, NKW and NPN, to give a total oral language score (Total 2) a significant difference across groups was seen. The responses obtained in the QAT task were bilingual in nature ranging from single words to small phrases to complete sentences. Since it was purely a comprehension task the responses were scored based on the accuracy of the response only. The responses were not scored for their syntax and no weights were assigned for the language used. This indicates that QAT can be successfully employed to record the changes in the comprehension abilities of bilingual preschool children.

Thus, results of the present study indicate that the expressive language score (Total 1), the comprehension score (QAT) and the total oral language score (Total 2), which is the sum of expressive and comprehension scores, show significant differences across groups. This indicates that even though measures such as NKW and NPN are not significant independently, when analysed with other significant measures result in significant differences across groups. Thus, for a bilingual story re-tell task, expression and comprehension measures should be analysed 'as a whole' for studying the development of narrative abilities of preschoolers.

The above premise is supported by the Pearson's correlation statistical analysis. The measures such as Total 1 (NEW+NKW+NPN) and Total 2 (QAT+Tot1) are correlated to each other and also to other measures such as NEW, MLU and NDW. Even though MLU and NDW did not show a developmental trend across groups they correlate significantly with other measures like NEW, QAT, Total 1 and Total 2. This indicates that MLU and NDW are reliable measures to quantify bilingual narratives but not sensitive to language specific developmental trends in bilingual narratives. Results of the present study also show that TTR is not significant across groups. This is in agreement with other studies in literature, which report that TTR is not as reliable as NDW to evaluate the lexical diversity of preschoolers (Miller, 1991; Watkins et. al., 1995).

The present study reveals that story re-tell tasks can be used to assess the development of narrative abilities in bilingual preschool children. This study attempted to evaluate bilingual narrative samples by segmenting them into C-units and analyzing them separately by assigning weights to both languages. The results indicate that the expressive and comprehensive abilities show a developmental trend across groups. English utterances increase while Kannada utterances decrease with increase in grade in preschool children who are Kannada-speaking English Language Learners. The comprehension abilities also increased with increasing grade. Narrative measures that were assigned weights such as NEW, NKW and NPN were sensitive to the developmental trend in bilingual narratives of preschool children. Measures such as MLU, NDW and TTR were not sensitive to changes in narrative abilities in bilingual children.

Studies on bilingual narrative analysis are very few and the ones cited in the present study have evaluated both the languages separately. Children in these studies were either asked to narrate the story in two separate sittings with a gap of one week (Gutierrez-Clellen, 2002) or were asked to narrate half of the story in one language and the other half in the other language, (Schelletter & Parke, 2004) in the same sitting. It is difficult to compare studies on narrative assessment because they differ in several parameters such as (a) native language of subjects (b) language of instruction (c) age of the subjects (d) nature of the narratives -story retelling/story generation (e) sample size- greater than or less than 50 utterances (f) unit of utterance length- morphemes/words (g) segmentation of transcripts (h) computer program used to analyze the transcripts (i) statistical procedures used for analysis and (j) cross-sectional /longitudinal study. Thus, the heterogeneous nature of studies reported in literature makes it difficult to generalize developmental trends in narratives of preschool children.

There are several caveats that must be considered when interpreting the results of this study. First, this study reports the story re-tell abilities of Kannada-speaking English Language Learners studying in preschools. Generalization to children from other language backgrounds studying in higher grades must be made with caution. Second, the emergent literacy experiences of the children in this study indicated rich literacy environments. The results may not generalize to children from environments impoverished in literacy experiences. Third, this is a cross-sectional study and does not provide information about how individual child's narrative skills change over time. The overlap in age groups did not provide a clear developmental trend which

could have been observed if this were to be a longitudinal study.

There are a number of implications of this study for assessment of narratives in bilingual preschool children. In case of language samples less than 50 utterances, alternate measures such as NEW, NKW and NPN should be used. Weighted measures employed in this study can be used for analyzing story re-tells that recorded bilingual narratives. Measures such as MLU, NDW and TTR should be used with caution while evaluating bilingual language samples less than 50 utterances. The results of this study suggest that story re-tell tasks can be used successfully to measure and analyze the expression and comprehension abilities of bilingual preschool children.

References

Benson, M.S. (1997). Psychological causation and goal-based episodes: Low income children's emerging narrative skills. *Early Childhood Research Quarterly*, 12, 439-457.

Burns, M.S, Griffin, P., & Snow, C.E. (Eds.). (1999). *Starting out right: A guide to promoting children's reading success*. Washington, DC: National Academy Press.

Butler, K.G. (2000). From the editor. *Topics in Language Disorders*, 21, iv-v.

Cooper, P.J., Collins, R., & Saxby, M. (1992). *The power of story*. Melbourne: McMillan.

Craig, H., Washington, J., & Thompson-Porter, C. (1998). Average C-unit lengths in the discourse of African American children from low-income, urban homes. *Journal of Speech, Language and Hearing Reasearch,* 41, 433-444.

Crais, E.R., & Lorch N., (1994). Oral narratives in school-age children. *Topics in* Language Disorders, 14, 13-28.

Curenton, S.M. & Justice, L. (2004). African American and Caucasian preschoolers' use of decontextualized language: Use of literate language features in oral narratives. *Language, Speech, and Hearing Services in Schools*, 35, 240-253.

Curenton, S.M. & LucasT.D. (2007). Assessing Young Children's Oral Narrative Skills. The Story Pyramid Framework. In Khara L. Pence (Ed.), *Assessment in Emergent Literacy.* San Diego: Plural Publishing.

Dollaghan, C.A., Campbell, F.C., & Tomlin, R.T. (1990). Video Narration as a Language Sampling Context. Journal of Speech and Hearing Disorders, 55, 582-590.

Eisenberg, S., Fersko, T., & Lundgren, T. (2001). The use of MLU in identifying language impairment in preschool children: A review. *American Journal of Speech Language Pathology*, 10, 323-342.

Gazella, J., & Stockman, I (2003). Children's story retelling under different modality and task conditions: Implications for standardizing language sampling procedures. *American Journal of Speech-Language Pathology*, 12, 61-72.

Glazer, S.M., & Burke, E.M. (1994). *An Integrated Approach to Early Literacy*. Boston: Allyn & Bacon.

Goffman, L., & Leonard, J. (2000). Growth of language skills in preschool children with specific language impairment: Implications for assessment and intervention. *American Journal of Speech Language Pathology*, 9, 151-161.

Gutierrez-Clellen, V.F. (2002). Narratives in two languages: Assessing Performance of Bilingual Children. *Linguistics and Education*, 13 (2), 175-197.

Hewitt, L.E., Hammer, C. S., Yont, K.M., & Tomblin, B. (2004). Language Sampling for kindergarten children with and without SLI: mean length of utterance, IPSYN, and NDW. *Journal of Communication Disorders*, 38, 197-213.

Hirsh-Pasek, K., Kochanoff, A., Newcombe, N., & deVilliers, J. (2005). Using scientific knowledge to inform preschoolers: Making the case for "empirical validity." *SRCD Social Policy* Report, 14(1), 3-19.

Hughes, D., McGillivray, L., & Schmidek, M. (1997). *Guide to narrative langue: Procedures for assessment.* Eau Claire, WI: Thinking Publications.

Hux, K., Morris-Friehe, M., & Sanger, D. (1993). Language Sampling practices: A survey of nine states. Language Speech and Hearing Services in Schools, 24 (1), 84-91.

Kadaravek, J.N., & Sulzby, E. (2000). Narrative production by children with and without specific language impairment: Oral narratives and emergent readings. *Journal of Speech Language and Hearing Research,* 43, 34-49.

Khurana, S., & Rao, Prema.K.S. (2008). Emergent Literacy Experiences at Home- A Sample Survey in Mysore City. *Language in India*, 8. Retrieved on October 4, 2008 from www.languageinindia.com.

Khurana, S., & Rao, Prema.K.S. (in press). *Emergent Literacy Experiences in* Classrooms- A Sample Survey in Mysore City.

Klee, T. (1992). Measuring children's conversational language. In S. Warren & J.

Reichle (Eds.), *Causes and effects in communication and language intervention* (pp. 315-330). Baltimore: MD: Paul H. Brookes Publishing.

Labov, W. (1972). *Socio-linguistic patterns.* Oxford, Blackwell.

Leadholm, B.J., & Miller, J.F. (1992). Language Sample Analysis: The Wisconsin guide.

Madison, WI: Wisconsin Department of Public Education.

Liles, B. (1993). Narrative discourse in children with language disorders and children with normal language. A critical review. Journal of Speech and Hearing Research, 36, 868-882.

Loban, W. (1976). Language development kindergarten through age twelve. Urbana, II: National Council of Teachers of English.

Loeb, D.F., Kinsler, K., & Bookbinder, L. (2000). *Current language sampling practices in preschools.* Poster presentation at the Annual Convention of the American Speech-Language-Hearing Association, Washington, DC.

Lonigan, C. J. (2006). Development, assessment, and promotion of pre-literacy skills. Early Education and Development, 17, 91-114.

Lund, N.J & Dunchan, J.F. (1993). Assessing children's language in naturalistic *contexts*. Englewood Cliffs, NJ: Prentice Hall.

Mallan, K. (1991). *Children as storytellers.* Newtown, Sydney: PETA.

Mc Cabe, A. (1997b). Developmental and cross-cultural aspects of children's narration. In M. Bamberg (ed.) *Narrative Development* 9pp. 137-174). London: Erlbaum.

McWhinney, B. (1995). The CHILDES project: Tools for analyzing talk (2nd ed.).

Hillsdale,, NJ:Lawrence Erlbaum. Miller, J.F., (1991). Research on Child Language Disorders: A decade of progress. Austin, TX. Pro-Ed.

Miller, J.F. (1987). A grammatical characterization of language disorder. *Proceedings of* the First International Symposium of Specific Speech and Language Disorders in Children, London, England.

Miller, J.F., & Chapman, R.S. (1981). The relation between age and mean length of utterance in morphemes. *Journal of Speech and Hearing Research*, 24, 154-161.

Miller, J.F., & Chapman, R.S. (1993). Systematic Analysis of Language Transcripts. Madison, WI: Waisman Center.

Miller, J.F., Heilmann, J., Nockerts,A., Iglesias, A., Fabiano, L., & Francis, D.J. (2006). Oral Language and Reading in Bilingual Children. *Learning Disability Research and Practice*, 21(1), 30-43.

O'Neill, D.K., Pearce, M.J., & Pick, J.L. (2004). Preschool children's narratives and performance on Peabody Individualized Achievement Test-Revised: Evidence of a relation between early narrative and later mathematical ability. *First Language*, 42 (2), 149-183.

Owens, R.E. (1999). Language Disorders: A functional approach to assessment and *intervention* (3rd ed.). Boston, MA: Allyn & Bacon.

Owens, R.E., & Leonard, L. (2001). Lexical diversity in speech of normally developing

and specific language impaired children. Poster Presentation at the Symposium for Research in Child Language Disorders, Madison, WI.

Patnaik, K., & Mohanty, A.K. (1984). Relationship between metalinguistic and cognitive development of bilingual and uniligual tribal children. *Psycho-Lingua*, Vol. 14, No. 1, pp 63-70.

Pearce, W.M., (2003). Does the choice of stimulus affect the complexity of children's oral narratives? Advances in Speech and Language Pathology, 5, 95-103.

Phillips, L. (1999). The role of storytelling in early literacy development. Retrieved October 2008 from http://www.australianstorytelling.org.au/txt/childhd.php

Richards, B., & Malvern, D.D. (1997). Quantifying lexical diversity in the study of *language development.* Reading, UK: University of Reading, New Bulmershe Papers.

Schelletter, C., & Parke, T. (2008). Using Story Re-tell in Bilingual Assessment.

Academic Exchange Quarterly, 8(3). Retrieved March 2009 from http://www.rapidintellect.com/AEQweb/5jan2768j5.htm.

Shapiro, L.R., & Hudson, J.A. (1991). Tell me a make-believe story. Coherence and cohesion in young children's picture elicited narratives. *Developmental Psychology*, 27, 960-974.

Sreedevi, S., & Shymala, K.C. (2005). Narrative skills in monolinguals and bilingual children: An exploratory study. *Student Research at AIISH, Mysore: Articles based* on *dissertation one at AIISH*, Part-B, Vol. 3, 2004-2005.

Shrubshall, P. (1997). Narrative, Argument and Literacy: A Comparative Study of the Narrative Discourse Development of Monolingual and Bilingual 5-10-Year-Old Learners. *Journal of Multilingual and Multicultural Development*, 1, vol.18 (5), 402-421.

Singhi, P., Kumar, M., Malhi, P., & Kumar, R. (2007). Utility of the WHO 10 questions screen for disability detection: The north Indian Experience. Journal of Tropical Paediatrics, 53(6), 383-387.

Snow, C., Burns, S. & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington DC: National Academy Press.

Storch, S., & Whitehurst, G. (2002). Oral language and code related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology,* 38, 934-947.

Strong, C.J, & Shaver, J.P. (1991). Stability of cohesion in spoken narratives of language- impaired and normally developing school-age children. *Journal of Speech and Hearing Research,* 34, 95-111.

Teale, W.H., & Sulzby, E. (1986). Emergent literacy as a perspective for examining how young children become writers and readers. In W.H. Teale & E. Sulzby (Eds.) *Emergent literacy: Writing and reading* (pp 7-27). Norword, NJ: Ablex.

Watkins, R., Kelly, D., Harbers, H., Hollis, W. (1995). Measuring children's lexical diversity: Differentiating typical and impaired language learners. *Journal of speech and Hearing Research*, 38, 1349-1355.

Whitehurst, G.J., & Lonigan, C.J. (1998). Child development and emergent literacy. *Child Development*, 69, 848-872.

Stimulus-Dependent Processing Strategies in the Cognitive System: Evidence from Lexical Decision of True- And Non-Words

[1]Shivani Tiwari, [2]Gopee Krishnan & [3]Rajashekar Bellur

Abstract

The cognitive models of word processing have gained considerable attention in the recent past. Such models have been successful in explaining a large number of observations in both normal and disordered word processing. Whether the cognitive system employs a serial or parallel processing has been overwhelmingly debated in the field cognitive linguistics. In this context, the present study attempted to investigate the processing capabilities for true words as well as the legal and illegal non-words, using a lexical decision task in a group of normal subjects. The results revealed that the true words were processed faster compared to non-words. In addition, the comparison of lexical decision time for legal and illegal non-words revealed a statistically significant difference between the two sets. We argue that the parallel processing strategy facilitates faster processing and it is employed in the processing of true words while serial processing is employed in legal and illegal non-words. This may be considered as an evidence for the stimulus-dependent processing strategies employed by the cognitive system while processing written stimuli.

Key words: Serial and Parallel processing, Legal and illegal non-words, Written word processing, Lexical decision, Stimulus-dependent strategies

The recent models of language processing have made significant contributions to our understanding on the underlying processes in many complex cognitive tasks such as naming, reading, writing etc. One of the most influential models of single word processing is postulated by Patterson and Shewell in 1987. This model has been successful in explaining most of the normal as well as disordered linguistic processing not only in the primary linguistic tasks such as speaking and understanding but also in the secondary linguistic domains such as reading and writing.

The ability to read letter strings requires the translation of visual codes (orthography) into pronunciations (phonology), with meaning (semantics) emerging when the pronunciation corresponds to a known word. During the course of learning to read, knowledge of the sound associated with sub-word letter units is established, which enables the pronunciation of new words that the reader has never encountered. In the experimental settings, these novel words-like strings are referred to as pseudowords (Price & Michelli, 2005).

Lexical decision paradigm

One of the most commonly employed paradigms in the psycholinguistic research is the lexical decision task (LDT). In this task, the subjects are required to make a quick decision whether the given string of letters constitute a true word or a non-word (Wagenmakers, Zeelenberg, Steyvers, Shiffrin, & Raaijmakers, 2004). While performing this task, the subject first extracts the visual features of the letters as well as the relative position of the letters in the letter strings (Dijksrta, 2007). This is essentially a stage of visual word recognition. Once the visual features have been recognized, the subject then makes an 'Orthographic Input Lexicon' (OIL) – an abstract representation of the visual word image. Following this stage, the subject matches the activated unit from OIL with the semantic system to find the best match. The lexical decision is said to have taken place as soon as the subject finds a corresponding entry in the semantic system that matches with the activated OIL (Southwood & Chatterjee, 2000).

Although lexical processing appears smooth with the above explanation, there are certain conditions where the entire word processing system can be taxed by the stimulus quality. For instance, when the letter string does not constitute a familiar word (e.g. *kitthougue* – meaning sinistral) – be it a true- or non-word – the subject

fails to form an OIL representation. In this context, the subject is forced to select a sublexical (phonological) route, where s/he converts each grapheme into its corresponding phoneme and then combines them to read the word. Evidently, since the letter string being either an unfamiliar true word or a non-word, there is no corresponding activation at the semantic/conceptual level. This simplifies the lexical decision task as the subject does not have to search the corresponding entries in the mental lexicon. However, there are some caveats to this arguably simple explanation.

The word processing becomes quite laborious in the case of letter strings that form a 'pronounceable' word – be it a (unfamiliar) true word or a non-word. The non-words, as a class, could be of two different types: *legal* and *illegal*. The legal non-words are those words that appear like true words. That is, they follow the phonotactic principles of the given language, and therefore, are pronounceable like true words (e.g., in English, *Lenit*). The illegal non-words, on the other hand, do not follow the phonotactic rules, and therefore, are non-pronounceable (e.g., in English, *Lomkn*). The processing of these two types of non-words is different from that of the true words, as they do not have the corresponding semantic representations in the mental lexicon. In addition, the processing of legal and illegal non-words could be different from each other. In the case of legal non-words, the subjects generate the OIL due to their lexical resemblance (i.e., word-like appearance). However, the illegal non-words do not generate the OIL due to their non-lexical nature (Kinoshita & Lupker, 2007).

The above-mentioned assumptions can be explained using one of the widely-acknowledged word processing models proposed by Patterson and Shewell (1987).

As indicated in Figure 1, a true word (e.g., *Latin*) is primarily processed through the semantic route A. In a LDT, the subject makes a *YES* response after the corresponding entry in the lexicon has been activated by the word string *Latin*. However, in addition to the initial feature extraction, this requires two stages of processing: an initial formation of the OIL followed by a semantic search. These two processes are performed at the expense of increased reaction time. In the case of a legal non-word (*Lenit*), pathway B is presumed to be activated, as the legal non-words do not have their corresponding entries in the semantics. Yet, owing to their lexical resemblance, an OIL is generated. In this context,

it is possible to assume that the reaction time (RT) for LDT would be highest for legal non-words. The reasons for this assumption are that (a) the letter string appears lexical, and therefore generate an OIL, and (b) this forces the subject to search the entire semantic system before an accurate *NO* response is made. Such an extended semantic search would invariably increase the LDT for legal non-words. In contrast to this, the illegal non-words (*Lomkn*) fail to generate an OIL owing to their poor lexical semblance. In this context, we can expect the shortest RT for LDT in the case illegal non-words as the subject is able to make a faster response even without the formation of OIL and the subsequent semantic search.
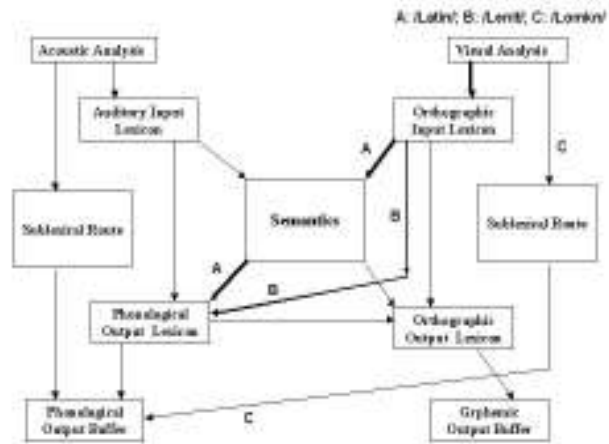

Figure 1: Schematic representation of the processing pathways of three different types of written stimuli using Patterson and Shewell's (1987) word processing model.

Serial vs. parallel processing in the cognitive system

Whether the cognitive system employs a serial or parallel processing strategy is a matter or extensive debate in the field of cognitive linguistics. The proponents of serial processing models (e.g., Coltheart & Rastle, 1994; Rastle & Coltheart, 1999; Kwantes & Mewhort, 1999) assume that the bottom-up processing in word processing is strictly serial in nature. That is, recognizing as well as deciding the lexical nature of a letter string is assumed to be in the following strict serial order: initial coding of the letter features, recognizing the letters and their relative positions in the letter string, identifying a visual word (orthographic input lexicon), semantic activation etc. In contrast to the serial processing, the proponents of parallel processing models a (e.g., McClelland & Rumelhart, 1981; Howard,

1991) assume that the processing spreads parallelly to multiple levels, simultaneously. That is, for example, extracting the letter features of a given letter in a string would simultaneously activate its corresponding entries at the letter, word, and the conceptual levels. This facilitates a quicker processing of the stimulus items in a task like lexical decision. With this brief description of the processing strategies in written word processing, we proceed to the aim of the current study.

Aim of the study

The present study aimed at investigating into the nature of lexical processing of three different groups of written stimuli (letter strings) viz. the true words, legal non-words, and illegal non-words using a lexical decision paradigm.

Assumptions of the study

We argue that if the RT for lexical decision task (RT_{LDT}) were highest for legal non-words and shortest for illegal non-words with the true words between these two, it may be considered as a strong evidence for the serial processing in the cognitive system. If any divergence from this distribution of LDT RTs is noticed, it may be considered as strong evidence against the serial processing strategy, perhaps supporting the parallel processing strategy.

Working hypothesis

Specifically, in account of the serial stage processing, we hypothesized that:

The legal non-word LDT_{RT}> true word LDT_{RT} > illegal non-words LDT_{RT}

Method

Participants

Twenty students of Manipal University (10 males & 10 females; Mean age = 20 years, SD = 2) were selected for the current study. The subjects were fluent English speakers with the medium of instruction being English from the LKG level, although their native language was not English. None had any history of neurological/psychiatric illness in the past. All subjects were right-handed and had normal or corrected-to-normal vision.

Stimuli

The stimuli consisted of 30 items (see Appendix) in three categories: true words (e.g. *Latin*), legal non-words (e.g. *Lenit*), and illegal non-words (e.g. *Lomkn*). Each category had 10 items each. The stimuli were balanced for the visual complexity by keeping the number of graphemes constant across them. All stimuli were rated by a group of five normal subjects on their lexical attribute (true vs. non-word; legal vs. illegal non-word).

Procedure

The participants were made to sit comfortably in a quiet room. They were instructed to look at the letter series displayed on the computer monitor. They were asked to press the '*m*' button of the keyboard as soon as they saw the displayed letter series represented a true word. If the letter series did not make a true word, '*n*' button press was required. Instructions were provided to rest their middle and index fingers on buttons '*m*' and '*n*', respectively, in order to avoid the time lag while reaching the fingers to the buttons during each trial. Following these instructions, they were given three trial items before the commencement of the actual test items. The stimuli were presented through DMDX reaction time software (Forster & Forster, 2003). In each trial, a '+' appeared on the center of the computer screen for 500 ms. It was followed by a blank screen for 500 ms. At the end of this period, the stimulus was presented. Each stimulus lasted on the computer monitor for 2000 ms. The reaction time clock was set synchronous with the appearance of the letter strings on the screen. All the stimuli were randomized and the subject completed the experiment in a single session without any break. The entire data collection for a single subject lasted less than 10 minutes. Using SPSS (version 16) software for Windows, the reaction time and error data were subjected to separate One-way ANOVA to find out the difference in processing across the three types of stimuli.

Results

Reaction time

To analyze the reaction time difference among the three stimulus conditions, only accurate responses were considered. The descriptive statistics (Mean and Standard Deviation) for the true, legal and illegal non-words are given Table 1. The mean LDT for the true words (e.g., *Latin*) was shortest compared to the illegal non-words (e.g., *Lomkn*), which in turn was shorter than that of the legal non-words (e.g., *Lenit*).

Stimulus type	Mean (SD) Reaction Time (ms)
True words	639.15 (123.32)
Illegal non-words	704.12 (149.38)
Legal non-words	821.72 (180.93)

Table 1: Mean and SD of various stimulus types for a group of 20 subjects

The results of One-way ANOVA revealed a significant effect (F (2, 57) = 7.314, $p < 0.001$) across the LDT of the three stimulus types. The post-hoc (LSD) analysis showed a significant difference in LDT between the legal non-words and true words, whereas legal versus illegal non-words and illegal non-words versus true words did not show a significant difference in LDT (See Table 2).

Stimulus type	Mean RT difference	Confidence interval at 95%		Significance
		Lower	Upper	
Legal vs. Illegal Non-words	117.6	-1.77	236.97	0.055
Legal Non-words vs. True words	182.57	63.20	301.95	0.001*
Illegal Non-words vs. True words	64.97	-54.39	184.35	0.054

*Significant at 0.001 level

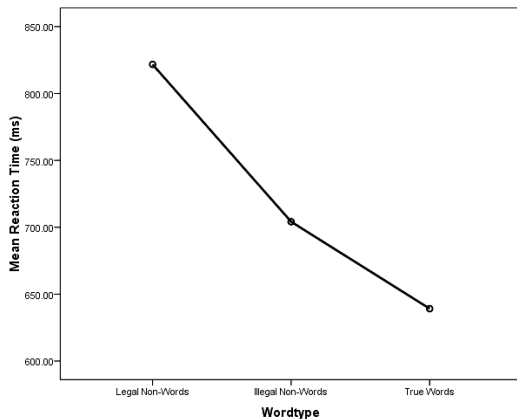**Table 2:** Pair-wise (post-hoc) comparison of reaction times across the three stimulus types.

Figure 2: The mean reaction times as a function of the stimulus types

Error analysis

The mean (and SD) of the errors (Table 3) across the subjects in the three experimental conditions were obtained. The error means were subjected to One-way ANOVA, using SPSS 16 for Windows.

The results of One-way ANOVA of the error means reveled a significant effect (F (2, 57) = 12.938, $p < 0.001$) across the errors in three stimulus types. The post-hoc (LSD) analysis showed that the errors in the legal non-words were significantly different from both the true words as well as the illegal nonwords. However, the difference in mean

error rate was not significant between the true words and the illegal non-words.

Stimulus type	Mean (SD) Errors
True words	0.45 (0.51)
Illegal non-words	0.25 (0.44)
Legal non-words	1.75 (1.61)

Table 3: Mean and SD of various stimulus types for a group of 20 subjects

Stimulus type	Mean error difference	Confidence interval at 95%		Significance
		Lower	Upper	
Legal vs. Illegal Non-words	1.5	0.85	2.14	< 0.001
Legal Non-words vs. True words	1.3	0.65	1.94	< 0.001*
True words vs. Illegal non-words	0.2	-0.44	0.84	0.535

*Significant at 0.001 level

Table 4: Pair-wise (post-hoc) comparison of reaction times across the three stimulus types.
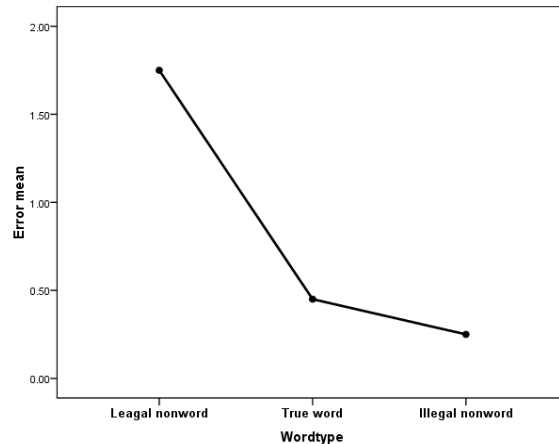
Figure 3: The mean error rates as a function of stimulus types

Discussion

The experiment reported in the current study aimed at investigating into the nature of lexical processing in three groups of written stimuli: the true words, legal non-words, and illegal non-words, using a lexical decision task. A group of 20 subjects participated in the study.

Reaction time

Considering the LDT of the three groups of stimuli, as seen in Figure 2, the legal non-words (e.g., *Lenit*) required the maximum time compared to illegal non-words (e.g., *Lomkn*) and true words

(e.g., *Latin*). However, the RT of the legal non-words showed significant difference only with that of the true words, not with illegal non-words. The possible mechanism for this increased RT in the case of legal non-words may be attributed to the combination of non-semantic and legally plausible (lexical) nature of such stimuli. For the participants to make a lexical decision of a legal non-word stimulus, an exhaustive search of the lexicon is required. That is, only after a complete search of the mental lexicon, a lexical decision (of *NO*) can be made for legal non-lexical words (Murray & Forster, 2004). This process is performed definitely at the cost of increased reaction time. In addition to this, the legally plausible nature of the stimuli would further delay the search, due to their resemblance to true words. In this context, the subjects were forced to search entire lexicon to find out the conceptual representation of these word-like letter strings, at the cost of extended reaction time. Thus, this finding supports our assumption that the legal non-words would exhibit highest RTs.

In the case of lexical decision for illegal non-words (e.g., *Lomkn*), the aforementioned mechanism may not hold true. That is, before an accurate judgment (of *NO*) is made, the subjects should search the entire lexicon, requiring higher RT for lexical decision. However, the legally implausible nature of these stimuli is expected to terminate the search at an early stage (at the level of OIL) as the letter string does not constitute a pronounceable word, thereby preventing the necessity for the subsequent semantic search. In our experiment, the illegal non-words exhibited shorter reaction times compared to the legal non-words, approving such kind of facilitation in the lexical processing.

In clear contrast to our hypothesis based on the serial stage processing, the absolute reaction time of the true words (e.g., *Latin*) were shortest among the three stimulus conditions. Theoretically, we expected a middle stage for true words as they essentially involve the activation of corresponding entries at the OIL and the subsequent search in the mental lexicon at the cost of increased RT. Employing the serial model of lexical processing, this finding is difficult to explain. It was assumed that the true words would require longer time compared to the illegal non-words. The reason for such an assumption was that the true words have a semantic representation in the mental lexicon as well as they are legally plausible words. The presence of a semantic representation in the mental lexicon would invariably require the search and subsequent conceptual activation before a lexical decision is made. This search process is invariably at the cost of reaction time. However, in

the case of illegal non-words, the implausible nature of the stimulus (unlike in legal non-words) was assumed to prevent the lexical search for their corresponding semantic representation even before it is commenced. That is, the word processing was expected to be terminated at an early state, as the letter strings did not constitute plausible words. However, such an assumption was proved wrong from the current results. Though the difference was statistically not significant, the illegal non-words required more time for the lexical decision irrespective of their lexically implausible nature compared to the true words.

The results of the present study were, thus only in partial agreement with the hypothesis we generated. That is, congruent with our predictions, the legal non-words showed highest RT relative to the other two stimulus conditions. However, with respect to the illegal non-words and true words the obtained results disproved our prediction. That is, unlike we assumed, the true words showed shortest reaction times compared to the illegal non-words. This observation is quite incongruent with the tenets of serial stage processing (as the processing of true words involve activation at OIL and subsequent semantic search unlike illegal non-words, invariantly at the cost of RT). Irrespective of such processing demands, the facilitation of the true words may be taken as an evidence for the parallel processing in the cognitive system. In parallel processing systems, the information flows to nodes at multiple levels, i.e., to the lexical, semantic, phonological etc. (e.g., McClelland & Rumelhart, 1981; Howard, 1991). Therefore, it may be considered that while processing the true words, cognitive system calls for a parallel processing strategy whereas in the case of non-words, a serial processing strategy may be employed. This may be considered as an evidence for the stimulus-dependent strategy employed by the cognitive system.

Error analysis

The mean error rates in the three experimental conditions revealed some interesting findings. As Figure 3 indicates, the highest error rate was observed in the legal non-words, paralleling their reaction time finding. However, the true words, unlike their reaction time data, showed more errors than the illegal non-words, although the difference in error rates between the true and illegal non-words were not statistically significant (result here). Therefore, the reason for the reduced error rate in illegal non-words may be attributed to the absence of OIL formation in these words. That is, the lexically implausible nature of illegal non-words helps the subjects to make more accurate

120

decision, although they required slightly more processing time than the true words, as evidenced by the RT data. It may, therefore be possible to infer that in the case of true and illegal non-words, there existed a *speed-accuracy trade-off*. That is, true words were faster in processing with slightly elevated error rates, whereas the illegal words were more accurate in processing with slightly elevated processing time compared to true words. Interestingly, such a speed-accuracy trade-off was not observed in the case of legal non-words, perhaps owing to their non-semantic as well as lexically plausible natures.

One possible criticism for the explanation of the facilitation of the true words compared to non-words (both legal as well as illegal) may be the frequency effect (Oldfield & Wingfield, 1965; Shatzman & Schiller, 2004). That is, it is arguable that subjects perform faster in the case of true words since such words are more familiar than non-words. Although, such a criticism may be difficult to reject on the grounds of the comparison between words and non-words, it simply fails to explain the RT difference between legal and illegal non-words. That is, without regard to the pronounceable nature of legal words compared to illegal ones, it is apparent that neither of these occurs in the day-to-day life. Hence, we argue that the familiarity effect alone fails to explain the observed findings in the current study. Finally, we caution that such a facilitation of true words through the parallel processing may be seen only in skilled readers, as children, in their period of mastering the reading skills, often rely on the sublexical or phonological route (Frith, 1985). Hence, it may be interesting to study how such developing children perform the same task used in the current study.

Conclusions

The present study, using lexical decision task in a group of normal subjects, provides empirical evidences for the stimulus dependent allocation of the processing strategies in the cognitive system. In the case of true words, the system employed a parallel processing strategy which was quicker than the serial processing employed in the case of non-meaningful stimuli.

References

Coltheart, M., & Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual-route models of reading. *Journal of Experimental Psychology: Human Perception and Performance, 20*(6), 1197-1211.

Dijkstra, A. (2007). Task and context effects in bilingual processing. In I. Kecskes & L. Albertazzi (Eds.), *Cognitive aspects of bilingualism*. Dordrecht: Springer.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall & M. Coltheart (Eds.), *Surface Dyslexia: Neuropsychological and Cognitive Studies of Phonological Reading*. London: Lawrence Erlbaum.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. Behavior Research Methods, Instruments, & Computers 35, 116–124.

Howard, D. (1991). Letter-by-letter readers: Evidence for parallel processing. In D. Besner & D. W. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 34-76). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kinoshita, S., & Lupker, S. J. (2007). Switch costs when reading aloud words and nonwords: Evidence for shifting route emphasis. *Psychonomic Bulletin & Review, 14*(3), 449-454.

Kwantes, P. J., & Mewhort, D. J. K. (1999). Evidence for sequential processing in visual word recognition. *Journal of Experimental Psychology: Human Learning and Memory, 25*(2), 376-381.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effect in letter perception: Part 1. An account of basic findings. *Psychological Review, 88*(5), 375-407.

Murray, W. S., & Forster, K. I. (2004). Serial Mechanisms in Lexical Access: The Rank Hypothesis. Psychological Review, 111(3), 721-756.

Oldfield, R. C., & Wingfield, A. (1965). Response latencies in naming objects. *Quarterly Journal of Experimental Psychology, 17*, 273-281.

Patterson, K. E., & Shewell, C. (1987). Speak and spell: dissociations and word-class effects. In M. Coltheart, R. Job & G. Sartori (Eds.), *The cognitive neuropsychology of language*. Hillsdale, NJ: Lawrence Erlbaum.

Price, C. J., & Mechelli, A. (2005). Reading and reading disturbances. *Current Opinion in Neurobiology, 15,* 231-238.

Rastle, K., & Coltheart, M. (1999). Serial and strategic effects in reading aloud. *Journal of Experimental Psychology: Human Perception and Performance, 25*(2), 482-503.

Shatzman, K. B., & Schiller, N. O. (2004). The word frequency effect in picture naming: Contrasitng two hypotheses using homonym pictures. *Brain and Language, 90*, 160-169.

Southwood, M. H., & Chatterjee, A. (2000). The interaction of multiple routes to oral reading: Evidence from Dissociations in Naming and Oral Reading in Phonological Dyslexia. *Brain and Language, 72*, 14-32.

Wagenmakers, E. J. M., Zeelenberg, R., Steyvers, M., Shiffrin, R., & Raaijmakers, J. G. W. (2004). Nonword repetition in lexical decision: Support for two opposing hypothesis. *The Quarterly Journal of Experimental Psychology, 57 A (7)*, 1191-1210.

Acknowledgments

Appendix – Stimuli

True Words	Legal non-words	Illegal non-words
Latin	Lenit	Lomkn
Pants	Pomak	Pxuvt
Break	Bitan	Bxopl
Cycle	Cemos	Cwbuk
Radio	Rolen	Ryltk
Diary	Dopan	Mwxip
Ivory	Insok	Daqtr
Mouse	Mesat	Mkstu
Keep	Kropt	Kvlir
Queen	Quamp	Qgcoh

Speech and Language Development, Cognitive Ability and Literacy Skills in Children Identified with Learning Disabilities: A Comparative Study.

[1]Smita Desai, [2]Chandralata Sharma & [3]Kritika Nair

Abstract

The purpose of this study is to explore the links between speech & language development, cognitive ability and literacy skills (reading and written language) of students identified with Learning Disabilities (dyslexia). A group of 30 children with Learning Disabilities, aged 8-12 years, with a history of Speech and Language Difficulties (delay/impairments) (SLD) were compared on measures of Word Reading, Reading Comprehension and Writing skills with a group of 30 children with Learning Disabilities but with no history of Speech and Language Difficulties (delay/impairments) (nSLD). Results indicated that the mean standard scores of the SLD group were lower than the nSLD group across the test measures of Verbal IQ, Performance IQ, Global IQ and Word reading. The t-test showed significant differences between the two groups on the PIQ & GIQ (p<0.05). No significant difference was seen between the two groups on the measures of word reading, reading comprehension and writing skills. These findings have valuable implications for planning intervention programs for children with speech and language difficulties and learning disabilities.

Keywords: Academic achievement, Word reading, Reading comprehension, Written language

Abbreviations: Learning Disabilities (LD), group with Speech and Language Difficulties (delays/impairments) (SLD), group with no Speech and Language Difficulties (delays/impairments) (nSLD), Reading Disabilities (RD), Verbal Intelligence Quotient (VIQ), Performance Intelligence Quotient (PIQ), Global Intelligence Quotient (GIQ)

Exposure to language begins right from birth. Thereafter, it becomes one of the chief means of communication. Successful language development aids adequate communication and literacy development. Language may be thus viewed as a tool necessary for successful academic and social/behavioural achievement. It is considered vital to the development of children's social skills, cognitive abilities, and academic outcomes (Bishop, 1997). This notion would indicate that young children with poor language skills would be at risk for later learning and social problems. (Tomblin, Zhang, Buckwalter & Catts, 2000). There is evidence that language difficulties and learning difficulties have a significant negative impact on children's education (Hay, Elias, Fielding-Barnsley, Homel & Frieberg, 2007).

In their review of children's acquisition of reading, Whitehurst & Lonigan (1988) proposed a developmental continuum between young children's language skills and their later reading and comprehension skills. Children's early language development is considered to be a developmental precursor and a good predictor of children's early reading development as well as their meta-linguistic awareness, alphabet, and book concepts (Saada-Robert, 2004).

Links between language development and literacy are also evident in retrospective studies of children with diagnoses of developmental dyslexia. It is well established from epidemiological studies that delays and difficulties are more common in children with dyslexia than in control samples of children without reading difficulties (Snowling, Bishop & Stothard, 2000). Studies focusing on the precursors of dyslexia in the preschool years point to delays in the acquisition of oral language skills including vocabulary and grammatical expression as well as phonological deficits. From the perspective of a language disability, studies of children with speech-language difficulties frequently report a high incidence of reading difficulties (Gallagher, Frith & Snowling, 2000). Children who have problems in both oral language

[1,2&3]Drishti, A Learning Center, 205-206 Midas Chambers, Off New Link Rd, Andheri (W), Mumbai – 400053, email:smita@drishtionline.com.

and phonological processing are at the greatest risk of failure (Catts, Fey, Zhang, & Tomblin, 1999).

Catts, Fey, Tomblin & Zhang (2002) have indicated that the majority of children with speech and language delays suffer a double reading disorder, i.e. the operation of both their reading development pathways (phonological & semantic) is compromised. It is thus expected that children with weak semantic skills would encounter difficulties in word recognition, especially difficulties in reading and spelling irregular words, as well as reading comprehension. When faced with more written vocabulary in the later years, these children encounter greater difficulties than the normally developing readers as they do not have the resources that allow them to proceed to adult fluency (Scarborough & Dobrich, 1990). "The critical age hypothesis", i.e. 'children whose early language impairments resolve between 5 and 6 years of age or by the time they begin to receive formal reading instruction are not at risk" proposed by Bishop & Adams (1990) would also play a role in the reading outcome and long term literacy outcome for children with language delays and impairment.

Stothard, Snowling, Bishop, Chipchase & Kaplan (1998) reported significant differences in nonverbal and verbal ability between children with developmental speech-language difficulties and controls. Snowling, Bishop & Stothard (2000) reported that the group with speech-language impairments performed worse than the control group on tests of spelling and reading comprehension and that the literacy outcomes were poor for those with PIQ less than 100.

Purpose of the study

This study aims to explore the relationship between speech and language development, cognitive functioning & literacy skills (reading & writing) of two samples of students, both identified with language based learning disabilities. One sample of students has a history of Speech and Language Difficulties (delay/impairment) (SLD), whereas the other has no history of Speech and Language Difficulties (delay/ impairment) (nSLD).

Method

Research sample

Demographic data and data from standardized evaluations were studied for this total sample of 60 students identified with Learning Disabilities. Of these, one group of 30 students had a history of speech and language difficulties (delays/ impairment) (SLD). The other group of 30 students had no history of speech and language difficulties (delays/ impairment) (nSLD).

The children had been earlier identified with Learning Disabilities on the basis of the following operational criteria: History of poor academic performance (below 40% aggregate) or failure across past 1-2 academic years, assessed intelligence quotient in the average-above average range, assessed reading and/or writing achievement which is 1 year or more below age level, deficits in information processing skills (auditory processing, visual processing, memory).

In the total sample, there were 50 males and 10 females. In the sample group with speech and language difficulties (SLD), there were 24 males and 6 females, while in the group with no history of speech and language difficulties (nSLD) there were 26 males and 4 females.

The age range extended from 8.0-12.0 years. The grade placement extended from grade 2-7 (as some of the children had either started schooling late due to speech and language difficulties or had repeated one or more academic year). All the children were from an urban population. These children were referred to the center for assessment by parents or other referral sources i.e. the treating speech and language pathologist/ pediatrician/ neurologist or the school system. They were mainly referred for low academic achievement or specific difficulties in coping with the academic curriculum.

None of the children in the research sample had presence of Hearing impairment, neurological difficulties or Autistic spectrum Disorder. These issues had been screened out as a part of the entire psycho-educational assessment

Procedure

The present study was carried out at Drishti, a referral center for assessments & therapy in Mumbai. This study is a retrospective analysis of demographic data and psycho-educational assessment data of children identified with learning disabilities, collected approximately between the period 2006-2008. History of speech and language development and consequent difficulties was available from the case history data. Psycho-educational assessments had been individualized to suit the presenting complaint. Assessment tools used were formal and standardized. Selective data from these assessments was analyzed for the present study. Assessment areas analyzed for this study were cognitive functioning and literacy skills of Reading (word reading & reading comprehension) & written language (spellings, syntax, and written expression).

Materials

Demographic and developmental data was collected using a case history form filled out by parents. The assessment data studied was across the areas of cognitive functioning and academic achievement. The selective data presented in this study includes the composite scores from the following tools.

Case History Form: A detailed case history of the referred student was gathered either by asking the parent to fill up the case history form, or with the assessing psychologist filling up the form through parental interview (when the parent was unable to do so independently). Parents were then quizzed regarding the important details presented by them in the form. The case history form included demographic data, developmental history of child (birth history, achievement of motor and speech milestones, medical history), educational and occupational status of parents, family history of disability, educational history, social/psychological history, environmental background information.

Weschler Intelligence Scale for Children-Indian adaptation (WISC)(Bhatt, M; 1973)

This test measures the verbal as well as non-verbal intelligence of the student using the verbal and performance scales. The sub-test scaled scores range from 0-20 with an average of 10. Composite scores include the Verbal IQ, Performance IQ and the Global IQ. Test retest reliability coefficients are reported to be ranging between 0.81-0.97. Inter-test correlations are seen to be in the range of 0.70-0.86.

Woodcock-Johnson Psycho-educational Battery-Revised (WJ-R) (Woodcock, R & Johnson, M; 1989-1990)

The WJ-R is a wide range comprehensive set of individually administered tests for measuring cognitive abilities, scholastic aptitude and achievement. This test yields age equivalent and grade equivalent scores for all the sub-tests. The sub-tests can be grouped into reading, written language, and math clusters. None of the sub-tests are timed tests. Standard scores (SS), Percentile ranks (PR), age equivalent scores and grade equivalent scores are computed. The reliability coefficients for the subtests range from 0.85-0.95; correlations with other measures of achievement are reported as ranging from .50-.60.

Results and Discussion

The purpose of this study was to examine the relationships between the variables of speech and language development, cognitive functioning and literacy skills in two groups of children identified with LD; one group with a history of speech and language difficulties (SLD) (N=30) and the other group with no history of speech and language difficulties (nSLD) (N=30).

Table 1 indicates the gender distribution across the two groups. In both the groups it is seen that the number of males is greater. This was a randomly referred and studied sample.

Group	Male	Female	Total
SLD	24	6	30
nSLD	26	4	30

SLD – Speech & Language Difficulties
nSLD – No Speech & Language Difficulties

Table 1: Gender Distribution

Table 2 provides an overview of the distribution of the demographic variable of age. The age of the 60 children who formed the study sample ranged from 8.0 years to 12.0 years. In the nSLD group, the age group of 11.1-12.0 yrs. was seen to have the highest number of students (N=15), while in the SLD group the highest number was seen in the 8.0-9.0 yrs age group (N=10). This indicates that a greater number of referrals for the SLD group took place much earlier than the group with nSLD. A very small percentage of the nSLD group was referred for academic difficulties in the age group of 8-9 years.

Age Group (SLD)	N	%	Age Group (nSLD)	N	%
8.0 -9.0	10	33.3	8.0 – 9.0	1	3.3
9.1 – 10.0	4	13.3	9.1 -10.0	5	16.6
10.1 – 11.0	9	30	10.1 – 11.0	9	30
11.1 – 12.0	7	23.3	11.1 – 12.0	15	50
Total	30	100%	Total	30	100%

*SLD – Speech & Language Difficulties
*nSLD – No Speech & Language Difficulties

Table 2: Age Distribution

Table 3 indicates the grade wise distribution of students across the two groups. It is seen that although the age distribution is from 8-12 years, the grade distribution extends from grade 2 to grade 7. This is seen because a number of children with speech and language difficulties commenced schooling late, whereas others repeated one grade or more. The largest number of children in the nSLD group were from grade 5, while those from the SLD group were from grades 4 and 6.

Cognitive functioning of the sample was studied through the use of a standardized measure of intellectual functioning. Table 4 shows the mean IQ scores for both the groups. The mean VIQ, PIQ & GIQ scores for both the groups were in the average range. Although the scores for the nSLD group were higher, the difference between

the two groups was significant only for the PIQ and GIQ (p<0.05). These results are partially in accordance with a study by Stothard, Snowling, Bishop, Chipchase, & Kaplan(1998) which showed significant differences in non-verbal and verbal ability between children with and without speech-language disorders/impairments.

SLD			nSLD		
Grades	N	Percentage	Grades	N	Percentage
II	1	3.3	II	1	3.3
III	8	26.6	III	0	0
IV	9	30	IV	4	13.3
V	3	10	V	12	40
VI	9	30	VI	9	30
VII	0	0	VII	4	13.3
Total	30	100%	Total	30	100%

*SLD – Speech & Language Difficulties
*nSLD – No Speech & Language Difficulties

Table 3: Grade Distribution

Variable	Mean	SD	t	df	Sig.
VIQ SLD group nSLD group	95.3 99.5	1.66 1.95	1.57	29	0.06 (NS)
PIQ SLD group nSLD group	100.26 104.23	1.75 1.78	1.80	29	0.04*
GIQ SLD group nSLD group	97.7 102.06	1.39 1.75	2.04	29	0.02*

*p<0.05; NS – Not Significant

Note: VIQ: Verbal Intelligence Quotient; PIQ: Performance Intelligence Quotient; GIQ: Global Intelligence Quotient

Table 4: Mean IQ scores and Significance of difference in IQ scores between SLD and nSLD group

SLD: N = 30; nSLD: N = 30

Table 5 shows the mean standard scores for both the groups on the subtests of Letter-word reading, Passage (reading) comprehension, Writing samples (written expression) and Dictation (spellings and syntax). The SLD group had marginally higher scores on the subtests of Writing samples and Dictation (Spellings & Syntax). However, there was no significant difference seen between the two groups on these measures.

The results of this study correlate with the results reported by Magnusson & Naucler (1990), where within the age, sex, nonverbal IQ matched pairs, it was the language disordered children whose spelling skills were more advanced. Relatively good skills in phonological processing and grammatical understanding seems to contribute to performance in spellings and semantics (Bishop & Adams, 1990). Children with language delays and impairments having PIQ 100 and above were seen to have spelling levels that

are average for their age (Snowling, Bishop & Stothard, 2000). In cognitive terms, it is not clear what mechanism could account for the relationship between non-verbal ability and reading skill. It was speculated that relative strengths in the language resources of vocabulary and comprehension skills could be facilitating better word reading and spelling skills.

Variable	Mean	SD	t	df	Sig.
LWR SLD Group nSLD Group	85.4 90.2	1.87 2.62	1.40	29	0.08(NS)
PC SLD Group nSLD Group	79.73 79.9	1.49 2.07	0.05	29	0.47(NS)
WS SLD Group nSLD Group	80.16 77.06	2.32 2.93	-0.81	29	0.21(NS)
DICT SLD Group nSLD Group	81.33 80.66	1.57 1.77	-0.25	29	0.40(NS)

NS – Not Significant

Note: LWR: Letter-Word Reading Subtest; PC: Passage Comprehension subtest; WS: Writing Samples subtest; Dict: Dictation subtest

Table 5: Significance of difference in achievement test scores between SLD and nSLD groups

SLD: N = 30; nSLD: N = 30

Tables 6 & 7 present the correlations between cognitive ability and literacy skills in this sample. In both the groups, the relationship between reading skills and verbal ability is seen to be stronger than that with the non-verbal ability.

The correlation between VIQ and letter word identification for the SLD group was significant (p<0.05) whereas that for the nSLD was not. The corresponding correlations for reading comprehension for the two groups were significant (p<0.05). The relationship between verbal ability and reading comprehension seems stronger than between VIQ and word reading for this sample. Studies (Frith, 1985; Snowling 1987) have shown that for children with language delays and impairments, basic decoding skills may develop normally in the early years, but can later show a relative decline in terms of word recognition skills. Greater links are seen between VIQ and the skills of spellings, syntax, and written expression than between PIQ and these literacy skills.

The relationship between letter word reading and reading comprehension was significant for both the groups (p<0.01). The inter-correlations between letter word identification subtest (word reading), Dictation subtest (spellings & syntax) and the Writing samples subtest are significant for both groups (p<0.01).

	VIQSLD	PIQSLD	GIQSLD	LWSLD	PCSLD	WSSLD	DICTSLD
VIQSLD Pearson Correlation Sig (1-tailed)	1.000 .	.277 .069	.779** .000	.332* .037	.541** .001	.303 .052	.345* .031
PIQSLD Pearson Correlation Sig (1-tailed)	.277 .069	1.000 .	.811** .000	.114 .275	.350* .029	.293 .058	.144 .224
GIQSLD Pearson Correlation Sig (1-tailed)	.779** .000	.811** .000	1.000 .	.264 .080	.543** .001	.369* .022	.309* .048
LWSLD Pearson Correlation Sig (1 tailed)	.332* .037	.114 .275	.264 .080	1.000 .	.621** .000	.675** .000	.746** .000
PCSLD Pearson Correlation Sig (1-tailed)	.541** .001	.350* .029	.543** .001	.621** .000	1.000 .	.427** .009	.574** .000
WSSLD Pearson Correlation Sig (1-tailed)	.303 .052	.293 .058	.369* .022	.675** .000	.427** .009	1.000 .	.607** .000
DICTSLD Pearson Correlation Sig (1-tailed)	.345* .031	.144 .224	.309* .048	.746** .000	.574** .000	.607** .000	1.000 .

**Correlation is significant at the 0.01 level (1-tailed), *Correlation is significant at the 0.05 level (1-tailed)
Note: VIQ: Verbal Intelligence Quotient; PIQ: Performance Intelligence Quotient; GIQ: Global Intelligence Quotient
Note: LWR: Letter-Word Reading Subtest; PC: Passage Comprehension subtest; WS: Writing Samples subtest; Dict: Dictation subtest

Table 6: Corelations Between cognitive ability and Literacy skills – SLD SLD: N = 30

	VIQNSLD	PIQNSLD	GIQNSLD	LWNSLD	PCNSLD	WSNSLD	DICTNSLD
VIQNSLD Pearson Correlation Sig (1-tailed)	1.000 .	.490** .003	.884** .000	.142 .227	.454** .006	.458** .005	.486** .003
PIQNSLD Pearson Correlation Sig (1-tailed)	.490** .003	1.000 .	.837** .000	-.047 .402	-.009 .482	.208 .135	.190 .157
GIQNSLD Pearson Correlation Sig (1-tailed)	.884** .000	.837** .000	1.000 .	.040 .416	.259 .084	.384* .018	.388* .017
LWNSLD Pearson Correlation Sig (1 tailed)	.142 .227	-.047 .402	.040 .416	1.000 .	.657** .000	.594** .000	.787** .000
PCNSLD Pearson Correlation Sig (1-tailed)	.454** .006	-.009 .482	.259 .084	.657** .000	1.000 .	.708** .000	.717** .000
WSNSLD Pearson Correlation Sig (1-tailed)	.458** .005	.208 .135	.384* .018	.594** .000	.708** .000	1.000 .	.768** .000
DICTNSLD Pearson Correlation Sig (1-tailed)	.486** .003	.190 .157	.388* .017	.787** .000	.717** .000	.768** .000	1.000 .

**. Correlation is significant at the 0.01 level (1-tailed), *. Correlation is significant at the 0.05 level (1-tailed)
Note: VIQ: Verbal Intelligence Quotient; PIQ: Performance Intelligence Quotient; GIQ: Global Intelligence Quotient
Note: LWR: Letter-Word Reading Subtest; PC: Passage Comprehension subtest; WS: Writing Samples subtest; Dict: Dictation subtest

Table 7: Corelations Between cognitive ability anEd Literacy skills – nSLD nSLD: N = 30

Conclusions

Thus, the findings of the present study, vis-à-vis the cognitive abilities of the two groups, indicate a significant difference in the PIQ & GIQ, but not in the VIQ.

Differences in the literacy skills between the two groups were not statistically significant. This could be attributed to the age range of the sample (8-12 years) where the difficulties in early speech and language development have perhaps been compensated for by a consequent increase in the language skills of vocabulary and semantics. The 'critical age hypothesis' could also have played a role where some of the children of the SLD group had been give early intervention and have thus overcome specific language based difficulties. This has important implications for intervention program planning.

These findings have to be handled with caution as the study has been conducted on a small sample. A larger study in the Indian context could have valuable implications for literacy instruction and remedial education programs for children with learning disabilities.

References

Bhatt, M.C. (1973). Weschler;s Intelligence Scale for children (Indian adaption). Ahmedabad: Bhatt

Bishop, D. V., & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. *Journal of child Psychology and Psychiatry,* 31, (1027 – 1050).

Bishop, D.V.M. (1997). Uncommon understanding: Development and disorder of language comprehension in children. Hove, U.K: Psychological Press.

Catts, H.W., Fey, M.E., Zhang, X., & Tomblin, J.B. (1999). Language basis of reading and reading disabilities: Evidence from a longitudinal investigation. *Scientific studies of reading*, 3, (331 – 362).

Catts, H. W., Fey, M.E., Tomblin, J.B., & Zhang, X. (2002). A longitudinal investigation of reading outcomes in children with language impairments. *Journal of Speech, Language, and Hearing Research,* 36, (948 – 958).

Frith, U. (1985). Beneath the surface of developmental Dyslexia. In K. Patterson, M. Coltheart, & J. Marshall (Eds.), Surface dyslexia: *Neuropsychological and cognitive studies of phonological reading* (pp. 301 – 330). London: Lawrence Erlbaum.

Gallagher, A., Frith, U., & Snowling, M.J. (2000). Precursors of literacy delay among children at genetic risk of dyslexia. *Journal of Child Psychology and Psychiatry*, 41, 203-213.

Hay, I., Elias, G., Fielding-Barnsley, R., Homel, R., & Freiberg, K. (2007). Language Delays, Reading Delays, and Learning Difficulties. *Journal of Learning Disabilities,* 40 (400 – 409).

Magnusson, E., & Naucler, K. (1990). Reading & Spelling in language disordered children-linguistic and metalinguistic prerequisites: Report on a longitudinal study. *Clinical Linguistics and Phonetics,* 4, 49-61.

Saada-Robert, M. (2004). Early emergent literacy. In T. Nunes & P. Bryant (Eds.), *Handbook of children's literacy* (pp. 578 – 598). Dordrecht, the Netherlands: Kluwer.

Scarborough, H.S., & Dobrich, W.(1990). Development of children with early language delay. *Journal of Speech and Hearing Research*, 33, (70 - 83).

Snowling, M. (1987). Dyslexia: A cognitive developmental perspective. Oxford: Blackwell.

Snowling, M,J., Bishop,D., Stothard, D. (2000). Is Preschool Language Impairment a Risk Factor for Dyslexia in Adolescence? *Journal of Child Psychology and Psychiatry,* 41, (587 – 600).

Stothard, S.E., Snowling, M.J., Bishop, D.V.M., Chipchase, B.B., & Kaplan, C.A. (1998). Language impaired preschoolers: A follow-up into adolescence. *Journal of Speech, Language, and Hearing Research,* 41, (407 – 418).

Tomblin, J. B., Zhang, X., Buckwalter, P., & Catts, H.(2000). The Association of Reading Disability, Behavioural Disorders, and Language Impairment among Second-grade Children. *Journal of Child Psychology and Psychiatry,* 41, (473 - 482).

Whitehurst, G. J., & Lonigan, C. J. (1988). Child development and emergent literacy. *Child Development*, 69, (848 – 872).

Woodcock, R.W., & Johnson, M.B. (1989, 1990). Woodcock Johnson Psycho- Educational Battery – Revised. Allen, TX: DLM Teaching Resources.

Barriers in Optimizing Home Training Programs for Children with Developmental Disabilities

Venkatesan S.

Abstract

Given the contemporary emphasis on promoting "barrier-free" and "disability-friendly" social living conditions for persons with disabilities as ordained in the PWD Act (1995) and UNCPRD; the present study was undertaken to elicit information on the perceived "barriers" by caregivers/parents on a home training program for their kids with developmental disabilities. A 25-item "Family Barriers Identification Scale" exclusively developed for this study was used to determine perceived/reported impediments either as their own "self", "in others" and/or in their "environment" that came in the way of optimizing the intervention programs for these children. The results show reported "barriers" for caregivers originate from their unfriendly "environments" rather than from "themselves" and/or "others". Among the reported "environmental" barriers are "shortage of reading materials on child training/care", followed by "lack of institutional facilities", "inadequate teaching materials", "lack of professional advice/guidance", etc. The reported barrier from within "themselves" include defeatist attitudes that there are "no felt returns on their investment of efforts or energies" or that they "do not have the knowledge, skill or felt competence" to handle their own kids with developmental disabilities in their home settings. The "other" sources of barrier are "presence of problem behaviors in the child", "ill health of the child", "demands for child care from other kids", "inadequate supports from spouse", "inadequate supports from neighborhood", etc. The results are discussed on the basis of available literature and their implications for further refinement/application with part three of International Classification of Functioning, Disability and Health (ICF) (WHO, 2001). The results are also discussed in relation to counseling caregivers on home based training programs for their kids with developmental disabilities.

Keywords: Barriers, Home Training, Developmental Disabilities, Parents/Caregivers

The difficulties experienced by persons with disabilities are increasingly being argued as the making of oneself or others; rather than, due to the primary condition. A facilitative, barrier-free and non-impeding mind-set in and around the affected person is likely to significantly shrink the struggles of their daily living. The contemporary thrust on "human rights model" against the traditional "medical/disease model" of understanding the disabled is a growing momentum in the right direction all the world over. The attempt is to diminish the barriers of their social existence (Venkatesan, 2002). The Persons with Disabilities (Equal) Opportunities, Protection of Rights & Full Participation) Act (1995) as well as Article 9 of United Nations Convention on Rights of Persons with Disabilities (UNCRPD) has an agenda in the same direction for removal of physical, social or environmental barriers impeding integration and mainstreaming of individuals with disabilities in our country. Beginning its initial proclamation on the

need for 'creation of barrier free environment' (under first chapter on 'preliminary'), the PWD Act gives directives on 'removal of architectural barriers from school, colleges or other institutions' (section 30b in chapter five on 'education'), and from 'any/all places of public utility (that) shall be made barrier-free' (with examples under sections 44-46 in chapter eight on 'non-discrimination'). The UNCRPD clearly mandates 'accessibility' as responsibility of the State 'to enable persons with disabilities to live independently and participate fully in all aspects of life…on an equal basis with others, to the physical environment, transportation, information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas. These measures shall include the identification and elimination of obstacles and barriers to accessibility'.

Home training programs for kids with

Professor, Department of Clinical Psychology, All India Institute of Speech and Hearing, Mysore: 570 006, Karnataka, email:psycon_india@yahoo.co.in.

developmental disabilities through identified caregivers/parents in their own home settings is a recognized effective procedure for service delivery by rehabilitation professionals (Venkatesan, 2003; Kohli, 1989; Bubolz and Whiren, 1984; Bhuvsar, 1981). In this procedure, the professionals make themselves available at fixed timings for consultation by parents on what they "could do" or "ought to do" for management of their kids with development disabilities in their own home settings. Based on such professional dispensations, the parents may or may not follow some of their advice or suggestions (Peshawaria, 1989; Parikh and Yadav, 1979). While there is no denial on the need and importance of home based training programs for young kids with developmental disabilities; in actual clinical practice, it is seen that such programs are of help only to certain categories of caregivers/parents. In a previous and related study, it was found that more than half of the initial populations of parents on a home training program for their children dropped-out before the end of first month from their start-up (Venkatesan, 2003). Some of the possible reasons for this attrition identified by various investigators are related to difficulties in transportation of their child to the place of service delivery, behavior problems in the child, other demands of daily living, economic, physical or social burden, etc. (Venkatesan and Das, 1994; Mehta, Bhargava and Pandey, 1990; Mehta and Ochaney, 1984). In the background of these circumstances, it was considered useful to undertake a comprehensive investigation on the felt or reported "barriers" by caregivers/parents in optimization of home training programs for their kids with developmental disabilities.

Objectives

Develop and standardize a "Family Barriers Identification Scale" (FBIS) exclusively for the purpose of identifying impediments in the day-to-day home management of kids with developmental disabilities;

Administer the developed FBIS on samples of parents/caregivers of kids with developmental disabilities who are, both, on a regular home based behavior remediation program as well as those outside it;

Identify any specific patterns in the reported "barriers" by the parents/caregivers with respect to their experience in home management of their kids with developmental disabilities; and, evaluate the patterns of reported "barriers" in parents/caregivers in relation to variables like sex or diagnostic condition of the children with developmental disabilities.

Method

Sample

The study was undertaken by drawing respondents (parents/caregivers of preschool children with developmental disabilities) from 'Department of Clinical Services' at All India Institute of Speech and Hearing, Ministry of Health and Family Welfare, Government of India, located in Mysore, Karnataka (India). The following inclusion/ exclusion criteria were adopted for drawing a sample of 89 kids with developmental disabilities included in this study:

i) Only cases of children with developmental disabilities below age range of six years of mental or chronological ages was included;

ii) various categories of preschool children with developmental disabilities including delays in developmental milestones, sensory handicaps, cerebral palsy, learning disorders, specific speech delays, "at risk" cases, multiple handicaps, autistic disturbances, etc., were included;

iii) preschool aged children with developmental disabilities having associated problems like attention deficit-hyperactivity disorders, autistic features, problem behaviors, seizure disorders, etc., were included; and,

iv) preschool aged children with developmental disabilities on a regular home training program, and also, those outside were included as part of the sample in this study.

Procedure

The study was carried out on a sample of 89 children (Mean Age: 69.52 months; SD: 40.11) with identified diagnosis of developmental disabilities such as, specific or pervasive developmental delays, mental retardation, autistic disorders, emotional disturbances, cerebral palsy, etc. There were 62 males and 27 female kids with developmental disabilities. The sample included 31 cases with single diagnosis and 31 children with more than one diagnosis related to their developmental disabilities. Among the included cases, there were 32 children on a regular home training program and the remaining 57 cases were not on any such periodic program.

The "Family Barriers Identification Scale" (FBIS) is a 25-item scale to elicit possible reasons on why parents/caregivers are unable to implement or optimize their child's potential through home training programs. The scale lists various possible "barriers" or "deterrents" frequently reported as coming in the way of optimizing home training program for children with

developmental disabilities. Some of the items enlisted in the scale are "busy occupational schedule of caregivers", "ill health of the child", "lack of institutional facilities", etc. The 25 items in the Scale are classified into three broad domains of reported barriers, viz., "*self as barrier*", "and *others as barrier*" and/or "*environment as barrier*". The respondents are free to choose any or all items in the Scale which best describe their predicament when it comes to handling their own children with developmental disabilities in their own home settings. The Scale has also a provision to rank order the chosen reasons.

Scoring is done by simply counting the total number of "barriers" (N*) as reported by respondents as well the "weighted ranks" (WR) as the sum total of the rank weights designated by the respective respondents. The maximum score on this scale for any given respondent will be 25 A high score indicates more "barriers" felt by the respondents or caregivers of children with developmental disabilities.

SNo.	Reported Barrier	NHT Cases (N: 57)		HT Cases (N:32)		Total (N:89)	
		N*	WR	N*	WR	N*	WR
	Self as Barrier						
1.	Busy occupational schedule	13	53	14	40	27	93
3.	Expecting natural/spontaneous improvements of my child	6	43	12	58	18	101
5.	Ill health of self	1	1	9	34	10	35
14	Multiple responsibilities in caregiver	5	17	14	82	19	99
15	No felt returns on my investment of effort or energies	11	27	21	95	32	122
16	No free time from domestic or household chores	8	17	12	45	20	62
17	No interest or motivation in self	3	14	2	7	5	21
18	No knowledge, skill or felt incompetence in self	12	34	20	80	32	114
20	Search for alternative or short cut therapies	3	18	3	11	6	29
25	Unrealistic appraisal of my child's capacities	5	40	7	39	12	79
	Subtotals (1)	67	264	114	491	181	755
	Percentages	**34.0**	**32.5**	**30.2**	**31.7**	**31.5**	**32.0**
	Others as Barrier:						
2.	Demands for child care from other kids	7	42	6	36	13	78
4.	Ill health of child	6	20	15	71	21	91
6.	Inadequate supports from in laws	3	17	6	29	9	46
7.	Inadequate supports from neighborhood	3	16	8	53	11	69
8.	Inadequate supports from siblings	-	-	2	14	2	14
9.	Inadequate supports from spouse	2	7	10	47	12	54
19	Presence of problem behaviors in the child	12	37	37	84	49	121
24	Uninvited interference by others	3	17	4	29	7	46
	Subtotals (2)	36	156	88	363	124	519
	Percentages:	18.3	19.2	23.3	23.5	21.6	22.0
	Environment as Barrier:						
10.	Inadequate teaching materials	20	75	31	113	51	188
11	Lack of institutional facilities	21	86	39	113	60	199
12	Lack of professional advice/guidance	15	62	29	116	44	178
13	Low priority for home training program	2	2	12	70	14	72
21	Shortage of money	6	26	14	71	20	97
22	Shortage of reading materials on child training/care	23	102	40	158	63	260
23	Too many or frequent visitors at home	7	39	11	53	18	92
	Subtotal (3)	94	392	176	694	270	1086
	Percentages:	**47.7**	**48.3**	**46.6**	**44.8**	**47.0**	**46.0**
	Grand Total (1+2+3)	197	812	378	1548	575	2360

(NHT: Non Home Training Cases; HT: Home Training Cases)(X^2:2.1514; df: 2; p:0.3413; NS)

Table: 1 Distribution of Reported "Barriers" By Families In Relation To Home Training Variable

The informants were required to identify any or all those "barriers" (as given in the list) that come in their way of home training and also rank order them according to their evaluation of preferences. The results of major "barriers" reported by parents or caregivers in this sample in relation to various variables like sex of the informant, cases attending home based training and those not attending such a program and cases with single or multiple diagnoses

Results and Discussion

The results indicates that the present sample of 89 parents/caregivers in this study have reported the presence of 575 (Mean: 6.46) "barriers" as interfering in smooth realization of individual rehabilitation objectives that they were guided to work in their home settings. The specific form, nature, number, type, locus or origin of the reported barriers varies. For the convenience of analysis, the types of 'barriers' or "deterrents" frequently reported as coming in the way of optimizing home training program for children with developmental disabilities were classified into three broad source domains, viz., "*self as barrier*", "and *others as barrier*" and/or "*environment as barrier*" respectively.

(a) Sources of Barrier

A greater percent of the reported "barriers" for caregivers appear to originate from their unfriendly "environments" (N: 270 out of 575; 47.0 %) rather than from "themselves" (N: 181 out of 575; 31.5 %) and/or "others" (N: 124 out of 575; 21.6 %). Among the reported "environmental" barriers are "shortage of reading materials on child training/care" (N: 63; WR: 260; 10.9 %), followed by "lack of institutional facilities" (N: 60; WR: 199; 10.4 %), "inadequate teaching materials" (N: 51; WR: 188; 8.9 %), "lack of professional advice/guidance" (N: 44; WR: 178; 7.7 %), etc.

SNo.	Reported Barrier	Males (N: 62)		Females (N:27)		Total (N:89)	
		N*	WR	N*	WR	N*	WR
	Self as Barrier						
1.	Busy occupational schedule	18	47	9	46	27	93
3.	Expecting natural/spontaneous improvements of my child	13	67	5	34	18	101
5.	Ill health of self	7	26	3	9	10	35
14	Multiple responsibilities in caregiver	15	82	4	17	19	99
15	No felt returns on my investment of effort or energies	21	86	11	36	32	122
16	No free time from domestic or household chores	15	43	5	19	20	62
17	No interest or motivation in self	3	14	2	7	5	21
18	No knowledge, skill or felt incompetence in self	23	74	9	40	32	114
20	Search for alternative or short cut therapies	3	11	3	18	6	29
25	Unrealistic appraisal of my child's capacities	7	43	5	36	12	79
	Subtotal (1)	125	493	56	262	181	755
	Percentage:	30.2	29.6	34.8	37.8	31.5	32.0
	Others as Barrier:						
2.	Demands for child care from other kids	6	43	7	35	13	78
4.	Ill health of child	16	79	5	12	21	91
6.	Inadequate supports from in laws	9	46	-	-	9	46
7.	Inadequate supports from neighborhood	10	60	1	9	11	69
8.	Inadequate supports from siblings	1	6	1	8	2	14
9.	Inadequate supports from spouse	11	51	1	3	12	54
19	Presence of problem behaviors in the child	38	88	11	33	49	121
24	Uninvited interference by others	6	39	1	7	7	46
	Subtotal (2)	97	412	27	107	124	519
	Percentage:	23.4	24.7	16.8	15.4	21.6	22.0
	Environment as Barrier:						
10.	Inadequate teaching materials	36	135	15	53	51	188
11	Lack of institutional facilities	42	132	18	67	60	199
12	Lack of professional advice/guidance	33	121	11	57	44	178
13	Low priority for home training program	10	58	4	14	14	72
21	Shortage of money	13	62	7	35	20	97
22	Shortage of reading materials on child training/care	46	189	17	71	63	260
23	Too many or frequent visitors at home	12	64	6	28	18	92
	Subtotal (3)	192	761	78	325	270	1086
	Percentage:	46.4	45.7	48.4	46.8	47.0	46.0
	Grand Total (1+2+3)	414	1666	161	694	575	2360

(*X^2: 3.2654; df: 2; p: 0.195; NS)

Table 2: Distribution of Reported "Barriers" By Families in relation to Gender Variable.

The parents perceive "themselves" also as "barrier" (N: 181; WR: 755; 31.5 %) with defeatist attitudes that there are "no felt returns on their investment of efforts or energies" (N: 32; WR: 114; 5.6 %) or that they "do not have the knowledge, skill or felt competence" (N: 32; WR: 114; 5.6 %) to handle their own kids with developmental disabilities in their home settings. There are also self-centric reported barriers like their own "busy occupational schedule", "no free time from domestic or household chores", "multiple responsibilities as caregivers", etc.

The parents also perceive "other" sources of barrier (N: 124; WR: 519; 21.5 %), such as, "presence of problem behaviors in the child" (N: 49; WR: 121; 8.5%), "ill health of the child" (N: 21; WR: 91; 3.7 %), "demands for child care from other kids" (N: 13; WR: 78; 2.26 %), "inadequate supports from spouse" (N: 12; WR: 54; 2.09%), "inadequate supports from neighborhood" (N: 11; WR: 69; 1.91%), etc. (Table One). These findings are supported by available Indian literature on similar lines (Turnbull and Turnbull, 1986; Tangiri and Verma, 1992: Thressiakutty and Narayanan, 1992; Venkatesan and Das, 1994).

A comparative distribution of reported 'barriers' by caregivers on a home based training program (N: 32) as well as those not on such a program (N: 57) reveals no significant differences (p: 0.3413; NS). In other words, they all reportedly share similar patterns, or number of 'barriers' from their environments, others or themselves.

(b) Gender of Disability

The distribution of reported 'barriers' by families as coming in the way of optimizing home training program is seen to be similar irrespective of the gender of the child with disability. However, on closer inspection of the actual types of reported barriers, it is seen that parents of female kids with disabilities report slightly greater 'environmental barriers' (N: 48.4; WR: 46.8), and 'self as barrier' (N: 56; WR: 26.2) than 'others as barrier' (N: 16.8; WR: 15.4) in contrast to boys with disabilities-whose problem behaviors, greater ill health, or the lesser supports from others, come in the way of optimizing the benefits of home training for such children (Table Two). However, these differences are not statistically significant (p: 0.195; NS).

(c) Type of Disability

The type of disability in the child appears to be a significant variable in influencing the distribution of reported "barriers" by parents/caregivers. There are greater environmental barriers (N: 99; 54.1 %) for children with multiple handicaps as compared to kids with single handicaps (N: 171; 43.6 %). There are more behavior problem in children with single handicaps (N: 33; WR: 83) than in children with multiple handicaps (N: 16; WR: 38). Caregivers of children with single handicaps reportedly feel greater ill health of self, lack motivation in self, find themselves more incompetent to handle their kids than parents of children with multiple handicaps. This could also be possibly because they expend greater energies and efforts than parents of children with multiple handicaps-who must have relatively given up hopes or aspirations about their child. Such findings are corroborated repeatedly by several earlier studies (Jain and Sathyavathi, 1969; Sequiera et al, 1990; Madhavan and Narayanan, 1992).

(d) Psychometric Properties

A two week test retest reliability exercise was attempted on a sub sample of 35 respondents. The pretest score (N: 35; Mean: 6.23; SD: 1.08) on number of reported barriers as against the re-test score (N: 35; Mean: 627; SD: 1.05) is not found to be statistically significant (p: > 0.05). There is also a very high correlation coefficient between the repeat measures is 0.9965. In sum, this study highlights the feasibility of developing a "Family Barriers Identification Scale" (FBIS). It demonstrates the reliability and validity of the tool to offer itself as an useful device for planning, pre-counseling and programming home based interventional therapies for children with developmental disabilities.

In sum, there is a demonstrable need and possibility for development of an objective measure to elicit the family barriers in implementation of home based training programs for children with developmental disabilities. These trends are promising and futuristic in view of the ongoing emphasis by International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) as 'a universal human experience' by shifting the focus of disability from 'cause' to 'impact' that it has upon an individual's functioning in the familial, social, or environmental context. Thereby, the FBIS shows an potential for further refinement and application in consonance with part three of ICF dealing on 'environmental factors', especially the formats on 'support and relationships' (e3) and 'attitudes' (e4). Such investigations are likely to evolve as objective functional assessment scales for national/international disability reporting, clinical and epidemiological use and studies for social policy in the disability sector. Such measures can help throw light on specific patterns in the needs of affected families as well that must be addressed by professionals for creating a 'barrier-free' environment and optimization of habilitation

programs for these children within their home   settings.

SNo	Reported Barrier	Single (N: 58)		Multiple (N:31)		Total (N:89)	
		N*	WR	N*	WR	N*	WR
	Self as Barrier						
1.	Busy occupational schedule	18	77	9	16	27	93
3.	Expecting natural/spontaneous improvements of my child	13	74	5	27	18	101
5.	Ill health of self	9	35	1	-	10	35
14	Multiple responsibilities in caregiver	15	86	4	13	19	99
15	No felt returns on my investment of effort or energies	23	103	9	19	32	122
16	No free time from domestic or household chores	14	45	6	17	20	62
17	No interest or motivation in self	5	21	-	-	5	21
18	No knowledge, skill or felt incompetence in self	24	87	8	27	32	114
20	Search for alternative or short cut therapies	5	26	1	3	6	29
25	Unrealistic appraisal of my child's capacities	10	68	2	11	12	79
	Subtotal (1)	136	622	45	133	181	755
	Percentage:	34.7	36.5	24.6	20.3	31.5	32.0
	Others as Barrier:						
2.	Demands for child care from other kids	10	58	3	20	13	78
4.	Ill health of child	14	69	7	22	21	91
6.	Inadequate supports from in laws	6	23	3	23	9	46
7.	Inadequate supports from neighborhood	8	48	3	21	11	69
8.	Inadequate supports from siblings	1	8	1	6	2	14
9.	Inadequate supports from spouse	8	38	4	16	12	54
19	Presence of problem behaviors in the child	33	83	16	38	49	121
24	Uninvited interference by others	5	36	2	10	7	46
	Subtotal (2)	85	363	39	156	124	519
	Percentage:	21.7	21.3	21.3	23.9	21.6	22.0
	Environment as Barrier:						
10.	Inadequate teaching materials	32	113	19	75	51	188
11	Lack of institutional facilities	38	126	22	73	60	199
12	Lack of professional advice/guidance	29	130	15	48	44	178
13	Low priority for home training program	9	55	5	17	14	72
21	Shortage of money	15	86	5	11	20	97
22	Shortage of reading materials on child training/care	37	150	26	110	63	260
23	Too many or frequent visitors at home	11	61	7	31	18	92
	Subtotal (3)	171	721	99	365	270	1086
	Percentage	43.6	42.3	54.1	55.8	47.0	46.0
	Grand Total (!+2+3)	392	1706	183	654	575	2360

(X^2:6.97; df: 2; p: 0.03; S)

Table 3: Distribution of Reported "Barriers" By Families in relation to Type of Disability

References

Bhuvsar, H. (1981). Home bound training programs. Mental Health Review. 5. 2. 23-24.

Bubolz. M.M., and Whiren, A.P. (1984). The Family of the Handicapped: An Ecological Model for Policy and Practice. Family Relations. 33. 5-12.

Jain, S.P. and Satyavathi, K. (1969). A preliminary note on the problems in the family with a mentally retarded child. Transactions of All India Institute of Mental Health. 9. 23-29.

Kohli, T. (1989). Impact of home, center based training program in reducing developmental deficiencies of disadvantaged children. Indian Journal of Disability & Rehabilitation. 4. 2. 65-74.

Madhavan, T., and Narayan, J. (1992). Impact of intervention on the parental perceptions and expectations of their mentally retarded children. The Indian Journal of Social Work. 43. 2. 191-201.

Mehta, M., and Ochaney, M. (1984). Mental Retardates: Involving mothers in operant conditioning program. Indian Journal of Clinical Psychology. 11. 2. 45-49.

Mehta, M., Bhargava, M., and Pande, P. (1990). A proposed model for the behavior training of mentally handicapped children through parent participation. Indian Journal of Disability and Rehabilitation. 4. 1. 1-8.

Parikh, J.B., and Yadav, R. (1979). Developing and evaluating a program for the parents of the developmentally handicapped children. Indian Journal of Mental Retardation. 12. 1&2. 63-70.

Peshawaria, R. (1989). Parent involvement in the training and management of their mentally handicapped persons. Journal of Personality and Clinical Studies. 5. 2. 217-221.

Sequiera, E.M., Rao, P.M., Subbukrishna, D.K., & Prabhu, G.G. (1990). Perceived burden and coping styles of mothers of mentally handicapped. NIMHANS Journal. 8. 1. 63-67.

Seshadri, M., Verma, V.K., Verma, S.K., & Pershad, D. (1983). Impact of a mentally handicapped child on the family. Indian Journal of Mental Retardation. 473-478.

Tangiri, P., & Verma, P. (1992). A study of social burden felt by mothers of handicapped children. Journal of Personality and Clinical Studies. 8. 1&2. 117-120.

Thressiakutty, A.T., and Narayan, J. (1990). Parental perceptions of problems and expectations regarding their mentally retarded children. Indian Journal of Disability and Rehabilitation. 4. 2. 54-63.

Turnbull, A.P., & Turnbull, H.P. (1986). Families, professionals and exceptionality. Columbus, OH: Merrill.

Venkatesan, S., & Das, A.K. (1994). Reported Burden on Family Members in Receiving/ Implementing Home Based Training Programs for Children with Mental Handicaps. Journal of Psychological Researches. 38. 1 & 2. 39-45.

Venkatesan, S. (2002). "Government Initiatives for Persons with Disabilities in India: Some Contemporary Trends, Problems & Issues". Social Change. September-December. 32. 3 & 4. 151-180.

Venkatesan, S. (2004). "Efficacy of Home Training Program in Skill Enhancement of Children with Developmental Disabilities". Indian Journal of Clinical Psychology. 31. 2. 121-127.

Use of Personal Music System: Does it Cause Hearing Loss or Tinnitus?

[1]Geetha C., [2]Nazneen Gangji, [3]Shwetha Krishnan & [4]Rajashekhar B.

Abstract

The present study aimed to investigate the prevalence of tinnitus and hearing problem, and the relationship between tinnitus, hearing loss and amount of music exposure in subjects using personal music system over a period of time. Eighty-nine subjects who use personal music system with head phones answered a questionnaire which contained 11 questions related to the amount of use of personal music system, tinnitus and hearing loss. Pure Tone Audiometry and Tympanometry were done in these subjects. Results revealed the prevalence of tinnitus in 20% of the subjects and hearing loss in 7.2% of subjects (either loss at 4 kHz loss and/or at 8 kHz). Further, 15.3% of the subjects with tinnitus were associated with hearing loss at 8 kHz, and the remaining 84.7% with tinnitus had normal hearing. No statistically significant differences found between the hearing thresholds of subjects with tinnitus and without tinnitus, between the groups differing in amount of exposure. It is suggested that recreational music does cause tinnitus and could be injurious to hearing. Hence, emphasis on creating awareness and educating the youngsters on the prevention of ear and hearing related problems by the use of personal music system is warranted.

Key words: Music, Tinnitus, Hearing loss, Questionnaire

It is now well accepted, that constant exposure to loud noise will cause injury and damage to hearing over time. There has been extensive research on hearing loss and tinnitus associated with occupational noise exposure (Axelsson & Barrenas, 1992; Dias, Cordeiro, Corrente & Gonçalves, 2006; Mrena, Ylikoski, Mäkitie, Pirvola & Ylikoski, 2007; Rubak, Kock, Koefoed-Neilson, Lund, Bonde & Kolstad, 2008). Nevertheless, there has been a growing concern about the hearing loss and tinnitus related to exposure to leisure activities and loud music.

West and Evans (1990) investigated the effect of exposure to amplified music on hearing and reported early damage to hearing in young adults aged between 15 and 23 years. Jokitulppo Bjork and Akaan-Pentilla (1997) investigating the effect of leisure noise, on the hearing of Finnish teenagers estimated that 50% of teenagers were exposed to levels of leisure noise which could be harmful to hearing.

The risks of noise related hearing loss by the use of personal music systems has been studied for personal cassette players (Meyer-Bisch, 1996; Mostafapour, Lahargoue & Gates, 1998; Rice, Breslin & Roper, 1987; Turnnen - Rise, Flottorp & Tvete, 1991), portable compact disc players (Fligor & Cox, 2004), and digital music systems (i.e., iPods, MP3 devices) (Hodgetts, Rieger & Szarko, 2007; Williams, 2005). Levels from personal music systems have been reported to be as low as approximately 80 dBA (Williams, 2005) to as high as 121 dBA (Fligor & Cox, 2004).

The number of persons using the MP3 players has increased drastically over the last few years. Recent report on the prevalence of personal music system use revealed that over 90% of the participants who completed the survey reported using a personal music system (Torre 3rd, 2008). The possible reasons for this being the portability of MP3 players and the availability of downloadable music. Even in India, with the changing trend and culture, the rate of usage of MP3s or personal music systems is growing, day to day.

Due to the obvious close coupling to the ear that results in the use of a personal stereo player or MP3 players, there has been considerable discussion and concern regarding its effects on hearing of the regular use of these devices (Carter, Waugh, Keen, Murray, & Bulteau, 1982; Catalano & Levin, 1985; Rice et al, 1987; Clark, 1990;

[1]*Lecturer, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal university, Manipal, Karnataka-576104, email:geethu172001@yahoo.co.in,,* [2&3]*BASLP, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka-576104.,* [4]*Professor and Head, Department of Speech and Hearing, Manipal College of Allied Health Sciences, Manipal University, Manipal, Karnataka-576104., email:b.raja@manipal.edu.*

Meyer-Bich, 1996; LePage & Murray, 1998). However, the studies concerning the effect of exposure to music on hearing have revealed mixed results.

Further, there are hardly any studies addressing the occurrence of tinnitus after music exposure in contrast to the large number of publications concerned with hearing loss and music, and tinnitus caused by noise induced hearing loss (Axelsson & Prasher, 2000). These studies related to noise induced hearing loss reported that tinnitus patients have often been exposed to noise (Axelsson & Barrenas, 1992), but not always as it can be a result of some other cause (Savastano, 2004), and noise-exposed workers often have tinnitus (Coles, 1981; Sulkowski, Kowalska, Lipowczan, Prasher, & Raglan, 1999; Axelsson & Prasher, 2000; Palmer, Griffin , Syddall, Davis, & Pannett, 2002; Sindhusake, Golding, Newall, Rubin, & Jakobsen, 2003), however, tinnitus may not be seen in noise-exposed workers if they have normal hearing (Chung, Gannon, & Mason, 1984; Sallustio et al, 1998).

However, the question 'does the same trend hold good even in music, as music is a most wanted signal?' remains unanswered. In addition, in the Indian context, there are no reports available on tinnitus and hearing loss related to music. Hence, this study investigated the occurrence of tinnitus in subjects exposed to music through personal music system and the relationship among tinnitus, hearing loss and music exposure. The purpose of the present study is to find out the prevalence of tinnitus in subjects who use personal music systems with ear phones or head phones, to find out the relationship between hearing impairment and tinnitus in these subjects; to verify the association between tinnitus and amount of exposure to music and to find out the relationship between the amount of exposure to music and hearing loss

Method

The present required administration of a questionnaire prior to hearing evaluation. Hence, the method entailed three stages.

Stage 1: Construction of Questionnaire:

A Questionnaire (Appendix) consisting of 11 questions was constructed. Some questions on the duration of the use of personal music system and on the level or volume at which the user listens to were included in the questionnaire. The volume across various personal music systems is not uniform and hence, a question to assess the subjective judgement on the loudness perceived

was included in the questionnaire. Participants were asked to indicate if the loudness they feel at the volume you usually play it on was whether soft, medium or loud. It is only the subjective perception. Only through objective measures such as measuring SPL in the ear canal through probe microphone measures, as done by Torre 3rd (2008), one can come to know whether the exposure level is uniform or not as volume across various personal music systems are not uniform. However, in the present study objective measurement of SPL was not done.

In addition, questions on presence of tinnitus, whether the tinnitus was continuous or intermittent, duration of tinnitus if intermittent (tinnitus was considered pathological if th participants reported of either continuous or intermittent tinnitus which lasts for more than five minutes more than once a week as suggested by Dauman and Tyler (1992)), frequency of occurrence of tinnitus, presence of hearing loss, presence of blocking sensation after listening to music and frequency of visit to rock concerts/discos was also included. Questions related to the previous history of hearing loss not related to exposure to music, ear pain or ear infection were also included in the questionnaire.

Stage 2: Administration of Questionnaire

The participants were graduate students of Manipal University in the age range of 17 to 25 years. Randomly selected 142 participants were asked whether they listened to music through personal music system with head phones or not. Eighty-nine participants who said "yes" for this question were given the questionnaire and asked to fill the required information. Of the 89 participants who used personal music system, 75 participants presented with no previous history of ear infection or ear discharge were included in stage 3.

Stage 3: Hearing Evaluation

Hearing evaluation included routine Pure Tone Audiometry and Immittanc audiometry. A calibrated MA 53 two channel clinical audiometer was used to perform Pure Tone Audiometry and a clinical GSI – Tympstar to analyze the middle ear status. Hearing evaluation was carried out in a double walled sound treated room.

Air conduction thresholds were obtained using the routine procedure for the frequencies 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz, and bone conduction thresholds were obtained for the frequencies 250 Hz, 500Hz, 1 kHz, 2 kHz and 4 kHz. Routine tympanometry and acoustic reflex thresholds were determined. Data obtained from the subjects who had 'A' type of tympanogram with

reflexes present only were considered for further analysis.

In this study,4 out of 75 participants with 'C' type tympanograms indicating the presence of conductive pathology and data of two subjects who had used the personal music system for less than one year and less than an hour in a day were eliminated.

Results

Computation of the data revealed that 62.67% of the young population use personal music system with headphones. The data obtained from the 69 participants were analyzed using Statistical Package for Social Sciences (SPSS), Version 11.5. The findings are as follows:

1) Prevalence of Tinnitus

20% of the participants experienced tinnitus, out of whom, 9% experienced continuous type of tinnitus and 11%, intermittent type of tinnitus (Figure 1). However, the frequency of occurrence of tinnitus was much lesser in the participants who experienced intermittent tinnitus.
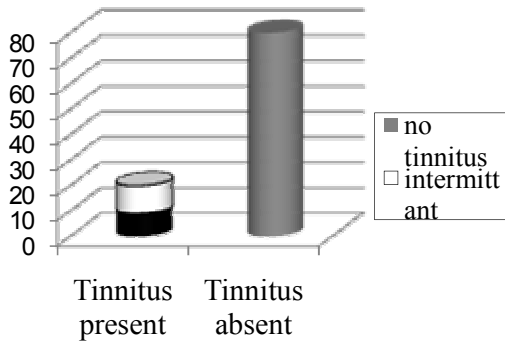
FREQUENCY (Hz)	EAR	TINNITUS	MEAN	S.D
250	Right	Present	11.9231	6.93375
		Absent	9.4643	5.85263
	Left	Present	13.4615	9.21607
		Absent	10.5357	6.22886
500	Right	Present	12.3077	5.99145
		Absent	12.2321	4.85421
	Left	Present	14.2308	7.31612
		Absent	11.4286	5.45346
1000	Right	Present	9.6154	6.60225
		Absent	10.0893	5.26490
	Left	Present	12.3077	5.25015
		Absent	10.4464	4.88753
2000	Right	Present	11.1538	4.63404
		Absent	9.1071	4.77752
	Left	Present	10.3846	5.57582
		Absent	10.1786	4.76391
4000	Right	Present	8.8462	4.63404
		Absent	9.4643	8.01581
	Left	Present	9.2308	6.72252
		Absent	8.5714	5.53619
8000	Right	Present	11.9231	10.71184
		Absent	9.0179	5.98632
	Left	Present	10.7692	12.04958
		Absent	8.1250	5.27106

Table 1: Mean and Standard Deviation of hearing thresholds for participants with and without tinnitus in the right and left ear
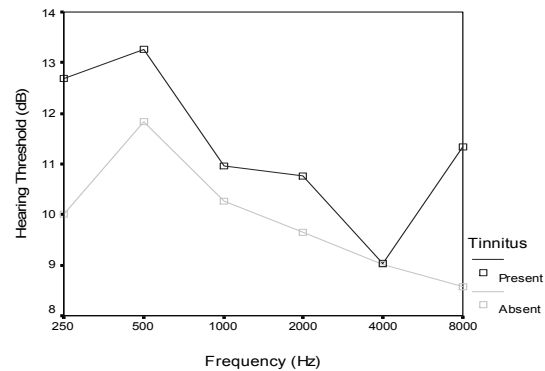

Figure 1: Percentage of participants with tinnitus (continuous and intermittent) and without tinnitus

Figure 2: Comparison of hearing thresholds of participants with and without tinnitus

2) Relationship between the Tinnitus and hearing thresholds across frequencies

From Figure 2, it can be observed that, the hearing thresholds of participants who reported to have tinnitus tended to be higher than the participants with no tinnitus, although the result of the repeated measures of ANOVA indicated statistically no significant difference between the participants with and without tinnitus [$F_{(1,134)}$ = 3.22, p > 0.05]. Nevertheless, statistically significant difference was present in hearing thresholds across different frequencies between the participants with and without tinnitus [$F_{(5, 6790)}$ = 4.674, p < 0.05].

There were no significant interaction effects between the frequencies and the participants with and without tinnitus [$F_{(5,670)}$ = 0.951, p > 0.05]. However, qualitative analysis revealed that 20% of the participants had tinnitus and 7.2% hearing loss either loss at 4 kHz and/or at 8 kHz. Out of 20% who had tinnitus, only 15.3% were associated with hearing loss, i.e., loss at 8 kHz, and 84.7% had normal hearing.

3) Association between the Tinnitus and amount of exposure

For the purpose of analysis, the amount of life time usage of the personal music system was calculated in terms of hours. Based on the net number of hours of exposure, three groups were

made randomly and there was no theoretical basis for this. The participants who had life time exposure (net number of hours) of 100 to 5000 hours were included in the Low exposure Group; those who had exposure of 5000 to 9000 hours were included in the Medium exposure Group; and those who had exposure of 9000 hours or above were included in the High exposure Group. Table 2 shows the number of participants with and without tinnitus in each group.

		Amount of Exposure to Music			Total
		Low exposure Group	Medium exposure Group	High exposure Group	
Tinnitus	Present	20	6	0	26
	Absent	88	18	6	112
Total		108	24	6	138

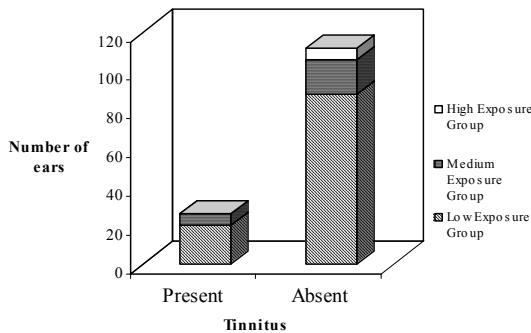**Table 2:** Association between the tinnitus and amount of exposure

Figure 3: Comparison of number of ears with and with out tinnitus between the groups

Results of the analysis of association between the tinnitus and the amount of exposure indicated that there was significantly a larger number of subjects who reported of tinnitus as well as no tinnitus were in the low exposure group, as depicted in Figure 3, as compared to the medium exposure group. There were no participants in the high exposure group with tinnitus. Chi Square test revealed no significant association ($p > 0.05$) between these two variables.

4) Relationship between hearing thresholds and the amount of lifetime exposure

There was no difference between the mean hearing thresholds across the different frequencies, as it is depicted in table 3. The results of the repeated measures of ANOVA also revealed no statistically significance difference between the three groups [$F_{(2, 132)} = 0.285$, $p > 0.05$]. The hearing thresholds at high frequencies are slightly higher for the high exposure group in the left ear as evident in figure 4, though not statistically significant. Hearing thresholds across the frequencies did not show any statistically

significant difference [$F_{(5, 660)} = 1.349$, $p > 0.05$] and no interaction effects between hearing thresholds across different frequency and the groups [$F_{(10,660)} = 0.788$, $p > 0.05$] as well as between the hearing thresholds between the two ears across frequencies [$F_{(5, 660)} = 0.327$, $p > 0.05$].

Frequency (Hz)		Right Ear			Left Ear		
		Low exposure Group	Medium exposure Group	High exposure Group	Low exposure Group	Medium exposure Group	High exposure Group
250	MEAN	9.8148	10.8333	8.3333	11.2963	10.8333	8.3333
	SD	6.58493	4.17424	2.88675	7.01650	7.33402	2.88675
500	MEAN	12.3148	12.0833	11.6667	12.0833	12.5000	11.6667
	SD	5.11315	5.41812	2.88675	5.60061	5.83874	2.88675
1000	MEAN	9.5370	11.2500	13.3333	10.5556	11.6667	11.6667
	SD	5.43126	6.07716	2.88675	5.29031	3.89249	2.88675
2000	MEAN	9.8148	7.5000	11.6667	10.1852	9.5833	13.3333
	SD	4.85283	3.98862	5.77350	5.04349	4.50168	2.88675
4000	MEAN	9.0741	10.4167	10.0000	8.3333	9.5833	11.6667
	SD	6.14864	12.51514	5.00000	6.06568	3.96481	5.77350
8000	MEAN	9.2593	10.4167	11.6667	8.6111	8.3333	10.0000
	SD	7.48630	6.20056	2.88675	7.48689	5.77350	.00000

Table 3: Mean and Standard Deviation (SD) values of hearing thresholds across frequencies between the three groups of amount of life time exposure
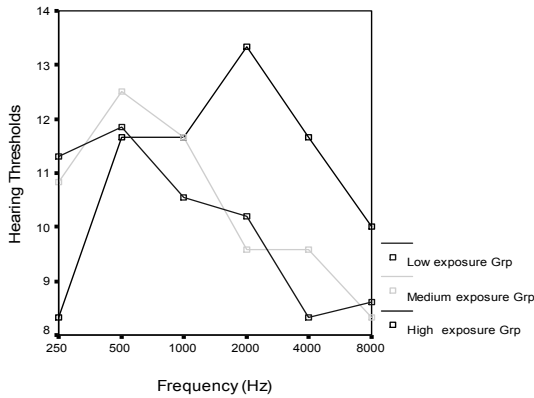

(a)
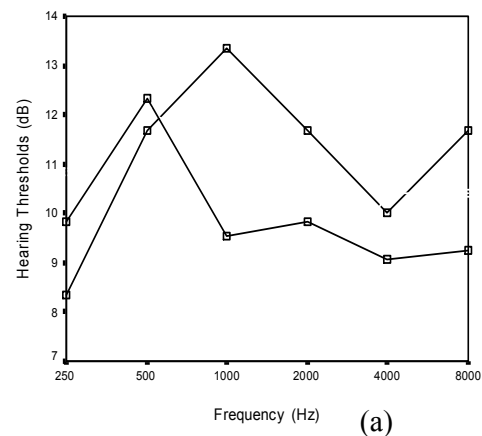
Figure 4: Comparison of right ear (a) and left ear (b) hearing thresholds across the groups differing in amount of life time exposure to music

Discussion

The current study examined the risk of tinnitus and hearing loss due to exposure to music through personal music system. The results revealed that 20% of the subjects complained of tinnitus, though majority of them (11%) experienced intermittent and infrequent tinnitus (temporary tinnitus), contrary to the results of Jokitulppo et al. (1997) who reported of 70% of temporary tinnitus. This could be due to the majority of the subjects in the present study used medium level volumes; hence they may have lesser risk. However in the present study, 9% of the subjects had permanent tinnitus.

There was no statistically significant interaction effect between the presence of tinnitus and hearing thresholds, i.e., out of 20% with tinnitus, 84.6% had normal hearing, which is similar to the results found even for the noise exposure by Rubak et al (2008), who reported that the risk of tinnitus increased with noise exposure if hearing handicap was present. According to them, there was no indication that even long-term noise exposure above 80 dB(A) increased the risk of tinnitus if hearing was normal. This suggests that cochlear damage due to noise exposure (either occupational noise or music) most often results in both hearing handicap and tinnitus.

There was no statistically significant difference between the presence of tinnitus and the amount of exposure, between the hearing thresholds across different frequencies and amount of exposure, between the presence of tinnitus and hearing thresholds. However, 7.2% of subjects presented with either 4 kHz loss and/or 8 kHz hearing loss. This is contrary to the results of Mercier and Hohmann (2002) who reported

hearing loss in 11% of the 700 individuals tested. The reason for this could be that, in the present study, the number of subjects in the low exposure group was much higher when compared to the other two groups. Further, majority of our subjects set the volume of the system to medium level and rarely visited discos and rock concerts.

Further, the pattern of hearing loss in music exposed groups is similar to that is seen generally in occupational noise exposure, i.e., loss at high frequencies, especially at 4 kHz. This suggests the underlying possible pathology is similar irrespective of the type of signal, whether music or any other type of noise.

Conclusions

The study intended to investigate the effect of exposure through personal music system on tinnitus and hearing loss and to investigate the relationship between tinnitus and hearing loss in the participants exposed to music. 20% of the participants who were exposed to music complained of tinnitus, either continuous or intermittent and 7.2% of subjects presented with either 4 kHz loss and/or 8 kHz hearing loss, which is lesser than those reported in other studies. Further, the duration of exposure did not have any effect on the presence of tinnitus and hearing loss. However, similar to noise, music exposure also causes tinnitus, which may not be associated with hearing loss, and more research is needed to test the risk of developing hearing loss in these participants with tinnitus due to exposure to noise, and it should be done on a larger population.

From this study, it can be concluded that recreational music does cause the problem of tinnitus and can be injurious to hearing, though, there are no statistically significant difference or association found between any of the variables. Thus, emphasis should be given on creating awareness and educating the youngsters, as more than 50% of them are reported to be using such personal music systems, on the prevention of ear and hearing related problems.

References

Axelsson, A. & Prasher D. (2000). Tinnitus induced by occupational and leisure noise. *Noise Health, 8*, 47-54

Axelsson, A. & Barrenas, M. L. (1992). Tinnitus in noise-induced hearingloss. In A.L. Dancer, D. Henderson, R.J. Salvi & R.P. Hamernik (eds.) *Noise-induced Hearing Loss.* St. Louis: Mosby Year Book, pp.269 - 276.

Carter, N. L. , Waugh, R.L., Keen, K., Murray, N. & Bulteau, V.G. (1982). Amplified music and young people's hearing. *Medical Journal of Australia*, *2*, 125 - 128.

Catalano, P. J. & Levin, S. M. (1985). Noise-induced hearing loss and portable radios with headphones. *International Journal of Pediatric Otorhinolaryngology, 9*, 59 - 67.

Chung, D. Y., Gannon, R.P. & Mason, K. (1984). Factors affecting the prevalence of tinnitus. *Audiology, 23*, 441 - 452.

Clark, W.W. (1990). Amplified music from stereo headsets and its effect on hearing. *Hearing Instrument, 41*, 29 - 30.

Coles, R.R. (1981). Epidemiology of Tinnitus. (ed.) Tinnitus (Ciba Foundation symposium 85). London: Pitman Books Ltd., pp.16 - 34.

Dauman, R. and Tyler, R.S. (1992). Some considerations on the classification of tinnitus. In: J-M. Aran & R. Dauman (eds.), *Proceedings of the Fourth International Tinnitus Seminar* (pp. 225-229). Bordeaux, France. The Netherlands: Kugler & Ghedini Publications.

Dias, A., Cordeiro, R,, Corrente, J. E. & Gonçalves. C. G. (2006). Association between noise-induced hearing loss and tinnitus. *Cad Saude Publica, 22(1),* 63-68.

Fligor, B. J. & Cox, L. C. (2004). Output levels of commercially available portable compact disc players and the potential risk to hearing. *Ear & Hearing*, *25*, 513 - 527.

Hodgetts, W. E., Rieger, J. M.& Szarko, R. A. (2007). The effects of listening environment and earphone style on preferred listening levels of normal hearing adults using an MP3 player. *Ear & Hearing, 28*, 290 - 297

Jokitulppo, J. S., Bjork, E. A. & Akaan-Pentilla, E. (1997). Estimated leisure noise exposure and hearing symptoms in Finnish teenagers. *Scandinavian Audiology, 26 (4)*, 257 - 262.

LePage, E. L. & Murray, N. M. (1998). Latent cochlear damage in personal stereo users: a study based on click-evoked otoacoustic emissions. *Medical Journal of Australia*, *169*, 588 - 59.

Mercier, V. & Hohmann, B.W. (2002). Is electronically amplified music too loud? what do young people think?. *Noise Health, 4 (16)*, 47-55

Meyer-Bisch, C. (1996). Epidemiological Evaluation of Hearing Damage Related to Strongly Amplified Music (Personal Cassette Players, Discotheques, Rock Concerts) - Highdefinition Audiometric Survey on 1364 Subjects. *Audiology*, *35*, 121 - 142.

Mostafapour, S. P., Lahargoue, K. & Gates, G. A. (1998). Noise-induced hearing loss in young adults: the role of personal listening devices and other sources of leisure noise. *Laryngoscope*, *108*, 1832 - 1839.

Mrena, R., Ylikoski, M., Mäkitie, A., Pirvola, U. & Ylikoski, J. (2007) Occupational noise-induced hearing loss reports and tinnitus in Finland. Acta Otolaryngolagica, 127(7), 729-735.

Palmer, K. T., Griffin , M. J., Syddall, H. E., Davis, A. & Pannett, B. (2002). Occupational exposure to noise and the attributable burden of hearing difficulties in Great Britain. *Journal of Occupational Environmental Medicine*, *59*,634 - 639.

Rice, C. G., Breslin, M. & Roper, R. G. (1987). Sound levels from personal cassette players. *British Journal Audiology*, *21*, 273 - 278.

Rubak T., Kock, S., Koefoed-Neilson B., Lund, S. P., Bonde, J. P. & Kolstad, H. A. (2008). The risk of tinnitus following noise exposure in workers with hearing loss or normal hearing. *International journal of audiology*, *47(3)*, 109 -114

Sallustio, V., Portalatini, P., Soleo, L., Cassano, F., Pesola, G., Lasorsa, G et al. (1998). Auditory dysfunction in occupational noise - exposed workers. *Scandinavian Audiology, 48*, 95 - 110

Savastano, M. (2004). Characteristics of tinnitus: Investigation of over 1400 patients. *Journal of Otolaryngology*, *33*, 248 - 253.

Sindhusake, D., Golding, M., Newall, P., Rubin, G. & Jakobsen, K. (2003). Risk factors for tinnitus in a population of older adults: The Blue Mountains hearing study. *Ear & Hearing*, *24*, 501 - 507.

Sulkowski, W. , Kowalska, S. , Lipowczan, A. , Prasher, D. & Raglan, E. (1999). Tinnitus and impulse noise - induced hearing loss in drop - forge operators. *International Journal of Occupational Medicine and Environmental Health*, *12*, 177 - 182.

Torre P 3rd (2008). Young adults' use and output level settings of personal music systems . *Ear & Hearing* ,*29(5)*, 791 - 9.

Turnnen - Rise, I., Flottorp, G. & Tvete, O. (1991). Personal cassette players ('Walkman'). Do they cause noise-induced hearing loss?. *Scandinavian Audiology*, *20*, 239 - 244.

Williams, W. (2005). Noise exposure levels from personal stereo use. *International Journal of Audiology*, *44*, 231 - 236

West P. D. B. & Evans E.F. (1990). Early detection of hearing damage in young listeners resulting from exposure to amplified music. *British Journal of Audiology. 24,* 89-103.

Appendix

Questionnaire for Assessing Listening Habits

Name: Age: M/F:

Do you use a personal music system? Yes / No:

If yes kindly answer the following questions.

1. How long have you been using the system for?

2. How many days in a week do you listen to music?

3. How many hours in a day do you listen to music?

4. At what level of volume do you listen to? Max Vol. Available:

5. How do you feel the loudness level is, at the volume you usually play it on?

    a) Soft   b) Medium   c) Loud

6. Do you have any other listening habits such as going to rock concerts or going to disco techs?

    - If yes, How frequently?

7. Do you feel any blocking sensation in your ear after listening to music?

8. Do you have history of ear pain or ear infection?

9. Do you have a history of hearing loss?

    - If yes:
        - ✓ Since when do you have?
        - ✓ Do you feel your loss is due to exposure to listening to music?

10. Do you experience any ringing sensation in either of your ears?

11. If yes, is it continuous?. If it is not continuous, how often you have ringing sensation?

Consumer Satisfaction Index of Caregivers of Individuals with Communication Disorders

[1]Ridhima Batra, [2]Gnanavel K. & [3]Goswami S. P.

Abstract

Consumer satisfaction index or CSI is a rating scale used to express how effective are the services of a professional and/or the institute. A questionnaire with 20 questions was prepared and administered on 130 parents /caregivers of persons with various communication disorders to calculate the CSI for speech, language and hearing services. In group wise analysis, the HL group was most satisfied (73.92%) whereas the MR group was least satisfied (68.09%). The question wise analysis showed that the parents/ caregivers were "very much satisfied" with the fees structure, usefulness of the clinical services at work place/ school, amount of time and support provided by the family members. The areas in which they were "satisfied" included the overall services provided, the number of days per week provided for therapy, counselling, home training provided, improvement in communication skills, the approach of the Institute staff, information regarding various concessional facilities provided by the Government, barrier free environment of the Institute, availability of other medical professionals and usefulness of orientation programs and educational materials. The "fairly satisfied" areas included the time, duration and attention provided during evaluation and therapy, and information provided about the clinical condition during evaluation. These were the gray areas which need to be strengthened for effective delivery of clinical services by the Institute. However, there was no domain in the questionnaire in which "not satisfied" response was obtained. This shows that the Institute is successful in delivering clinical services to the persons with communication disorders. Though this was an exploratory study, the results have reflected the consumer satisfaction index of the Institute as 72%.

Keywords: Clinical services, Institute, questionnaire, evaluation, Speech and Language therapy

Consumer satisfaction is used to assess performances of health services in the community. There is a one to one relationship between consumer satisfaction and treatment outcomes. The consumer satisfaction plays an important role in growth and for the betterment of profession. Additionally, this helps the professionals to augment their appeal and increase consumer satisfaction level.

It is imperative that professionals should strive to satisfy the stakeholders with their services. Satisfied consumers usually return and follow up more often and tell other people about their experiences and the quality clinical services they received. This helps to spread awareness about the clinical services provided, so that the rehabilitation can be provided at an early age. This is the best, cost effective mode to create awareness about the clinical services of the institute so as to reach the public who can avail such services.

In consumer satisfaction research, professionals seek the views of the persons on a variety of issues that will show how effective are the services of the professionals working in an organization/ institution.

Consumers express their satisfaction in many ways. In open-ended questioning they use descriptive terminologies such as delighted, extremely satisfied, very dissatisfied etc. Rating scales are used in surveys where numbers are given to express the level of satisfaction. The lowest number indicates extreme dissatisfaction and the highest shows extreme satisfaction. The scores that are obtained in consumer satisfaction surveys are used to calculate a consumer satisfaction index (CSI). The average or mean score of satisfaction given to each element represents strengths and weaknesses which inturn helps to improve services rendered by the

[1]II M.Sc. (SLP). All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:canif_ridhima@yahoo.co.in., [2] II M.Sc. (SLP), All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:vel13feb@gmail.com., [3]Reader & Head, Department of Speech Language Pathology, All India Institute of Speech and Hearing, Manasagangothri, Mysore- 570006, email:goswami16@yahoomail.com.

professionals.

The management of a person with communication disorder involves the family members, and professionals, who work as active team members to improve their quality of life. Rehabilitation refers to services such as early detection of the disability, the proper diagnosis and the prompt treatment. Professionals are well trained and experienced in their specialties, and are prepared to meet all the needs of the persons with communication disorders.

Fellendorf (1975) studied the effectiveness of education and health care services to young hearing impaired children and their parents. He reported that the common complaints of parents of hearing impaired children were the lack of communication with the physician and clinician. This was mainly the result of the vocabulary used by the specialist and the limited time spent with the parents during consultation. The result can be parental failure to follow instructions and possibly irreversible damage to the child's development of speech, language and listening skills.

Satisfaction with disclosure of the diagnosis of an autistic spectrum disorder was investigated by Brogan and Knussen (2003) by using a self-report questionnaire. On a rating of satisfaction, 55% indicated that they were satisfied or very satisfied with the disclosure. It was found that the parents were more likely to be satisfied when given written information, opportunity to ask questions, and when their suspicions/doubts were cleared by professionals. These factors were combined into a global index of satisfaction.

Cox, Robyn, Alexander, and Genevieve (1999) prepared Satisfaction with Amplification in Daily Life (SADL) questionnaire for the hearing aid users. 90% critical difference was obtained for the various scores that ranged from 0.9 to 2.0 score intervals on a 7-point rating scale. The questionnaire yielded a global satisfaction score indicating that the SADL scale was clinically acceptable and comprehensive to provide a valid assessment.

In an evaluative study done by Woodward, Santa-Barbara, Levin and Epstein (1978), 279 families having children with academic and/or behavioral problems were given a family satisfaction questionnaire to assess several aspects of the families' satisfaction with services received. Very little dissatisfaction was expressed regarding the availability of services (less than 7%), but a sizeable proportion of families (45%) did not feel that the services provided were comprehensive and adequate.

Parental satisfaction with the process of disclosure of disability was investigated by Slope and Turner (1993) by interviewing 103 parents of children with severe physical disability. Only 37 % of parents were satisfied with the disclosure. Parents were more likely to be satisfied if, they felt that the professional carrying out the disclosure was sympathetic, understanding, approachable, and communicative. These results demonstrated the importance of the parent-professional interaction and an increased emphasis on communication skills in medical training.

In a study done by Hasnat and Graves (2000), interviews with parents of children with developmental disabilities regarding their experiences at the time of disclosure was done. Their level of satisfaction with the process was carried out which was found to be high (82.6%). The major determinants of parental satisfaction with disclosure were directness, understanding of parental concerns and good communication on the part of the disclosing professional, and receiving a large amount of information.

All the above mentioned studies have reported about the satisfaction level of different disordered groups but there are very limited studies wherein a comparison has been made between different disordered groups or measured the satisfaction of caregivers of individuals with communication disorders at institute level. Thus a need arises to assess the consumer evaluation of speech and hearing services provided at institute level for different speech, language and hearing disorders.

Aim of the study

To calculate consumer satisfaction index (CSI) for the speech, language and hearing services provided to individuals with communication disorders.

Objectives of the study

To assess the consumer satisfaction of caregivers of individuals with communication disorders receiving clinical services at the All India Institute of Speech and Hearing, Mysore. This would help to understand how successful the Institute is in delivering clinical services to people with communication disorders. This would also give an insight into the areas those need to be strengthened for effective delivery of clinical services by the institute.

Method

Subjects: 130 parents /caregivers of persons with communication disorders mainly Delayed Speech and Language with hearing impairment (50),

mental retardation (20), cerebral palsy (15), articulation disorder (15), learning disability (10), autism (10) and aphasia (10) participated in the study. Only those parents /caregivers were included who were availing the clinical services for more than a month. All the parents/caregivers included in the study were literate and belonged to middle socio-economic status. Mostly mothers participated in the study as they accompanied their children more commonly than the fathers did.

Material: A questionnaire was prepared to estimate the consumer satisfaction of speech, language and hearing services provided to individuals with communication disorders. The questionnaire included 20 questions, each having four choices for the answers [1= not satisfied, 2= fairly satisfied, 3= satisfied and 4= very much satisfied]. The last question was an open-ended question in which the parents/ caregivers were asked to give any suggestions which they feel would help the Institute to improve upon the clinical services. The questionnaire is given in appendix-I.

The questions asked were regarding the satisfaction and type of services provided by the institute. The various domains of questionnaire were:

- Time and attention provided during evaluation and therapy.
- Duration and number of days per week provided for speech and language therapy.
- Information provided about the clinical condition by the clinician during evaluation and therapy.
- Home training program provided.
- Improvement in persons' communication skills.
- Fees structure for evaluation and therapy.
- Approach of the Institute staff.
- Information given about the various concessional facilities provided by the Government of India or Government of Karnataka.
- Barrier free environment of the Institute.
- Availability of services provided by the other medical professionals.
- Usefulness of speech language therapy at school or work place.
- Usefulness of various orientation programs and educational materials.
- Amount of time spent by the parents with their child at home.
- Support provided from the other family members.

Analysis: Two fold analysis of the questionnaire was carried out. First, a group wise analysis was performed using Kruskal Wallis H Test and Mann Whitney Test to see which disordered group people were more satisfied and which group people were less satisfied with the clinical services of the Institute.

Secondly, a question wise analysis was done to see in which domains of the questionnaire, the parents/ caregivers were very much satisfied, satisfied, fairly satisfied or not satisfied.

Results

The results of the study are presented under the following two headings:

1. Group wise analysis
2. Question wise analysis

1. Group wise analysis

In this section, scores were assigned to the four responses [1= not satisfied, 2= fairly satisfied, 3= satisfied and 4= very much satisfied] and a total score for each questionnaire was calculated with a maximum score of 76 (19 questions X 4). The mean and the percentage score was obtained for each group which is tabulated and is shown in table-1:

GROUPS	MEAN (S.D)	MEAN PERCENT(%)
HL	56.18(4.91)	73.92
LD	55.40(3.53)	72.89
ART	55.067(5.36)	72.45
AUT	54.80(3.88)	72.10
APHASIA	54.00(3.55)	71.05
CP	53.467(6.12)	70.35
MR	51.75(6.18)	68.09
Total	54.7231(5.22	72.00

[HL- hearing impaired group, MR- mental retardation group, CP- cerebral palsy group, ART- articulation group, LD- learning disability, AUT- autism group and APHASIA- aphasia group].

Table 1: Group Summary

It is obvious from table-1 that the mean percentage was highest for the HL group (73.92%) whereas lowest for the MR group (68.09%). The overall mean percentage was 72% which reflects the overall consumer satisfaction index of the Institute.

Also, a comparison was made between the different disordered groups using the following non-parametric tests:

i. **Kruskal Wallis H Test** was done which showed that there is a significant difference between the seven groups ($p < 0.05$).

ii. To study the pair wise difference between the groups, **Mann Whitney Test** was done. The results revealed that there is a significant

difference between the responses given by MR and HL group (p<0.05), MR and ART group (p<0.05), MR and LD group (p<0.05), and MR and AUT group (p<0.1).

iii. The mean and standard deviation of all the groups are graphically represented in graph 1. It can be clearly seen from the error bar graph that the mean of the responses of the HL group are significantly higher than all the other groups whereas mean of the responses of the MR group are significantly lower. Also, the responses of the ART, LD and AUT group are almost similar.
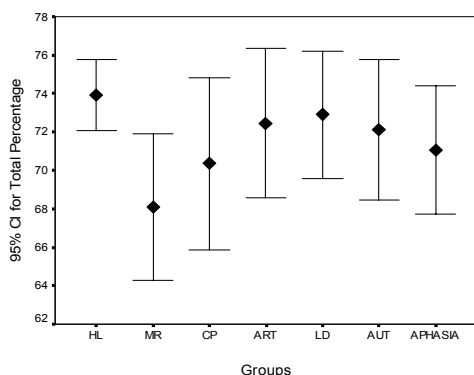
Graph 1: The mean and standard deviation of all the groups.

2. **Question wise analysis:** The results are discussed under the following headings based on the choice of ratings i.e very much satisfied, satisfied, fairly satisfied, not satisfied.

Very much satisfied: All the questions were analyzed separately and the results showed that out of 19 questions the consumers stated that they were very much satisfied for five questions (question numbers 10, 11, 16, 18 & 19). Table-2 shows the total frequency and percentage of responses for these questions.

Question no.	Frequency	Percent %
Q 10	79	60.8
Q 11	84	64.6
Q 16	51	39.2
Q 18	45	34.6
Q 19	50	38.5

Table 2: Very much satisfied

The aspects for which the parents/ caregivers were very much satisfied included:

a) The fees structure for evaluation and therapy (Q 10 & Q 11)

b) Usefulness of the clinical services at work place/ school (Q 16)

c) Amount of time spent at home by the parents (Q18) and

d) The support provided by the family members (Q 19).

Satisfied: The parents/caregivers reported that they were satisfied with the services in 11 domains which are listed below.

a) Overall services provided by the Institute (Q 1 & Q 2),

b) Number of days per week provided for speech and language therapy (Q 5),

c) Information provided about the clinical condition by the clinician during therapy (Q 7),

d) Home training program provided (Q 8),

e) Improvement in persons' communication skills (Q 9),

f) Approach of the Institute staff (Q 12),

g) Information given about the various concessional facilities provided by the Government of India or Government of Karnataka (Q 13),

h) Barrier free environment of the Institute (Q 14),

i) Availability of services provided by the other medical professionals (Q 15) and

j) Usefulness of various orientation programs and educational materials (Q 17).

The total frequency and percentage of responses for these questions is presented in Table-3.

Question no.	Frequency	Percent %
Q 1	63	48.5
Q 2	63	48.5
Q 5	53	40.8
Q 7	69	53.1
Q 8	60	46.2
Q 9	65	50
Q 12	56	43.1
Q 13	54	41.5
Q 14	45	34.6
Q 15	56	43.1
Q 17	51	39.2

Table 3: Satisfied

Fairly satisfied: The consumers stated that they were fairly satisfied for three of the questions (question numbers. 3, 4 and 6). The areas of these three questions included:

a) The time and attention provided during evaluation and therapy (Q 3)

b) Duration of speech language therapy i.e. 45 minutes (Q 4) and,

c) Information provided about the clinical condition by the clinician during evaluation (Q 6).

Table-4 shows the total frequency and percentage of responses for these questions.

Question no.	Frequency	Percent %
Q 3	54	41.5
Q 4	46	35.4
Q 6	50	38.5

Table 4: Fairly satisfied

Discussion

The results of the study have been discussed under the following two headings:

1. Group wise analysis

2. Question wise analysis

1. Group wise analysis

The group wise analysis shows that amongst all the disorders groups considered in the study, the mean percentage satisfaction level was highest for HL (73.92%) group followed by LD (72.89%), ART (72.45%), AUT (72.10%), APHASIA (71.05%), CP (70.35%) and lowest for MR (68.09%) group.

The results demonstrate that the satisfaction level of all the groups fall in a continuum with HL group falling at the top and the MR group at the bottom. The more satisfaction shown by the other groups than MR group illustrates that these groups have revealed better progress which is a sign of higher satisfaction by the parents/caregivers. The least satisfaction level of the MR group can be attributed to the fact that the MR group usually shows a slow prognosis in their communication skills due to a global delay in various skills. Thus, a more holistic approach should be used for their rehabilitation. Also, professionals need to spend more time and effort in counseling and developing better clinical strategies for children with mental retardation.

2. Question wise analysis

The question wise analysis has shown that over all consumers were either very much satisfied, satisfied or fairly satisfied with most of the clinical services of the Institute. However, the fairly satisfied areas need to be strengthened. It may also be noted that there was no domain in the questionnaire in which a not satisfied response was obtained on an average which shows that the Institute is successful in delivering comprehensive and adequate clinical services to the persons with communication disorders. The results of the study do represent the accountability shown by the Institute in maintaining the quality of rehabilitation services. These services have a positive impact in improving the quality of life for persons with communication disorders. The high consumer satisfaction index (72%) reflects that the Institute is capable of rendering prompt, proficient and skilful services by the expert professionals in the area of communication disorders.

Overall it was reported by the parents/caregivers that the help and support from health professionals enabled them to manage more effectively the condition of the persons with communication disorders. However, few areas of concern relate to the information they receive about the condition; communication between themselves and health professionals; and managing the condition at school and home.

Conclusions

An exploratory study was carried out to calculate the consumer satisfaction index for the speech, language and hearing services provided at All India Institute of Speech and Hearing, Mysore. The responses of the parents/caregivers ranged from very much satisfied to fairy satisfied. The group analysis revealed that the parents of HL group were maximally satisfied with the clinical services of the Institute whereas the parents of the MR group were less satisfied with the clinical services of the Institute which can be attributed to the slow prognosis of the communication skills in the MR group.

Though this was an exploratory study in which a small survey has reflected the 72% consumer satisfaction index of the clinical services rendered by the institute. The results have shown an above average performance of the institute in terms of clinical services. However, there are few gray areas in which the clinical services need to be reviewed to maintain and improve upon the consumer satisfaction.

Thus, it is advocated that the professionals should emphasize on evaluating themselves regularly so as to get an adequate and appropriate timely feedback about their clinical services. As the consumers are paying for the services, they have the right to get the best clinical services and it is the duty of the professionals to address the needs of the consumers which is also being addressed in the consumer protection act.

References

Brogan, C.A. & Knussen,C. (2003). The disclosure of a diagnosis of an autistic spectrum disorder: determinants of satisfaction in a sample of Scottish parents. *Autism*. March; 7(1):31-46.

Cox, Robyn, M., Alexander, & Genevieve, C. (1999). Measuring Satisfaction with Amplification in Daily Life: the SADL scale. *Ear Hearing journal*. August; 20(4):306-20.

Fellendorf, G.W. (1975). Symposium on sensor neural hearing loss in children: early detection and intervention. Delivery systems in the management of hearing impaired children. *Otolaryngologic Clinics of North America journal.* February; 8(1):187-218.

Hasnat, M.J., & Graves, P. (2000). Disclosure of developmental disability: a study of parent satisfaction and the determinants of satisfaction. *Journal of Paediatrics and Child Health.* February; 36(1):32-5.

Sloper, P., & Turner, S. (1993). Determinants of parental satisfaction with disclosure of disability. *Developmental Medicine and Child Neurology.* September; 35(9):816-25.

Woodward, C.A., Santa-Barbara, J., Levin, S., & Epstein, N.B. (1978). Aspects of consumer satisfaction with brief family therapy. *Family Process*. December; 17(4):399-407.

Acknowledgments

Appendix-I

Questionnaire

Serial no.:
Case name:
Age/Gender:
Provisional Diagnosis:
Name of the guardian:
Duration of therapy attending in AIISH:

Please answer the following questions by ticking the correct option

1. Are you satisfied with the services provided by the Institute?
   a) Not satisfied
   b) Satisfied
   c) Fairly satisfied
   d) Very much satisfied

2. What do you feel about the services provided by the Institute?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

3. Do you feel the time and attention provided to you during evaluation and therapy is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

4. Do you feel the duration of time provided to you during therapy (ie. 45 min) is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

5. Do you feel the number of days per week provided to you for therapy is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

6. Do you feel the information provided about the clinical condition by the clinician during evaluation is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

7. Do you feel the information provided about the clinical condition by the clinician during therapy is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

8. Do you feel the home training program provided by the clinician is?
   a) Not adequate
   b) Adequate
   c) Fairly adequate
   d) Very much adequate

9. Are you satisfied with the improvement in your child?
   a) Not satisfied
   b) Satisfied
   c) Fairly satisfied
   d) Very much satisfied

10. Do you feel the fees collected by the institute for evaluation is?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

11. Do you feel the fees collected by the institute for therapy is?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

12. Do you feel the approach of the Institute staff towards you / your child is?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

13. Is the information given by the clinician about the various concessional facilities provided by the Govt. of India or GOK?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

14. Is the barrier free environment of the Institute?
    a) Not adequate

b) Adequate
c) Fairly adequate
d) Very much adequate

15. Do you feel the availability of services provided by the other medical professionals at AIISH is?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

16. Do you feel that the Speech Language Therapy has helped him /her at school or at work place?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

17. Do you feel the orientation programs /educational material is helping you to know better about him/her?
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

18. Do you feel the amount of time you are spending on him/her at home is
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

19. Do you feel the support you are getting from your family in improving his / her condition is
    a) Not adequate
    b) Adequate
    c) Fairly adequate
    d) Very much adequate

20. Apart from the above mentioned question would you like to give any other suggestions to improve our services?

Temporal Modulation Transfer Function Through Analog and Digital Hearing Aids

[1]Seby Maria Manuel, [2]Rhea Mariam Korah & [3]Sandeep M.

Abstract

Temporal modulation transfer function (TMTF) is the representation of temporal resolution of the auditory system. Natural speech has amplitude variations in its envelope which needs to be properly decoded. Pathologies of cochlea as well as auditory nerve are reported to degrade the temporal resolution, in turn contributing to the poor speech perception observed in these individuals. Most of these individuals are rehabilitated through hearing aids for their reduced hearing sensitivity. Although there is a strong scientific evidence for improved hearing sensitivity with the hearing aids, just this may not be sufficient for perceiving all the cues of speech. An ideal aid should also efficiently enhance the temporal resolution which will result in better speech perception. Hence, the objectives of the study was to compare the TMTF between analog and digital hearing aids in normal hearing individuals as well as individuals with sensorineural hearing loss.A total of 21 adults were included in the study out of which 11 (20 ears) were individuals with sensorineural hearing loss (SNHL) and 10 (20 ears) were with normal hearing sensitivity. TMTF was estimated for 5 modulation frequencies; 8, 16, 32, 64, and 128 Hz, without and with hearing aids (analog and digital). The results showed reduced modulation sensitivity with the increase in modulation frequency in both the target groups and in all the experimental conditions. There was a significant difference between the TMTF of normal hearing individuals and individuals with SNHL and across 3 experimental conditions. The deficits in temporal resolution are attributed to the damage to the OHCs that leads to reduced frequency selectivity and broadening of the frequency tuning curves. The current hearing aids (analog and digital) distort the envelope of signal further adding to the already existing inherent distortions in the temporal resolutions in individuals with SNHL. Such distortions are higher in analog hearing aids. Hence, it is concluded that hearing aids with present technology does not fulfill all the requirements to enhance speech intelligibility to its best in individual with SNHL.

Key words: Temporal resolution, Modulation frequency, modulation threshold, temporal modulation transfer function

Natural speech is a complex signal which has variation in frequency and amplitude with respect to time. Every frequency band in speech can be considered to consist of a carrier signal (fine structure) and a time varying envelope. Envelope in turn contains many modulating frequencies, changing in amplitude which can be seen in temporal modulation spectrum. These variations contain the information that is essential for the identification of phonemes, syllables, words, and sentences. Dimitrijevic, Andrew, John, Picton & Terence (2004) reported the modulation properties of speech which is shown in Table l.

It is well known that auditory systems like all other sensory systems has limited temporal resolution and cannot follow temporal changes if the changes occur too rapidly (Viemeister,1979).

	Formant	Mean Frequency (Hz)	%AM
Vowels	F1	500	50
	F2	1500	34
	F3	2500	33
	F4	4000	21
Consonant-Vowels	F1	500	52
	F2	1500	51
	F3	2500	47
	F4	4000	50
Fricatives	F1	500	63
	F2	1500	57
	F3	2500	73
	F4	4000	34

Table 1: Frequency of AM for various speech sounds.

[1&2]*III B.Sc. Students, Speech & Hearing, All India Institute of Speech and Hearing, Mysore-06, email:sebymaria88@yahoo.co.in,, email:rheakorah@yahoo.com, [3]Lecturer, Department of Audiology, All India Institute of Speech and Hearing, Mysore-06, email:msandeepa@gmail.com*

Earlier investigations (Drullman, Festen & Plomp, 1994; Shanon, Zeng, Kamath, Wygonski, & Ekelid, 1995; Xu, Thompson & Pfingst, 2005) have demonstrated that consonant identification and sentence intelligibility could be achieved only if temporal modulation cues are as low as 50 Hz. Thus, any otological condition that restricts that temporal resolution below 50 Hz is expected to affect the perception of speech. Furthermore Drullman et al. (1994) reported that consonants, especially the stops suffer more from temporal smearing than vowels.

One such condition where the deficits in temporal resolution are frequently reported is cochlear pathology. Along with the reduction in hearing sensitivity, individuals with sensorineural hearing loss (SNHL), secondary to cochlear pathology possess deficit or reduction in temporal resolution (Hescot, Lorezi, Debruillex, & Camus, 2000), spectral resolution (Rawool, 2006) and speech perception in noise. These factors need to be considered during hearing aid trial for a successful fitting. Hence, it is important to determine whether hearing aids contribute in enhancing temporal resolution along with improving audibility.

Temporal resolution can be assessed through several methods like gap detection test (Forrest & Green, 1987, Samelli & Schochat, 2008, among others), speech perception in interrupted noise (Stuart, 2005) and temporal modulation transfer function (TMTF). However, the modulated signal used to estimate TMTF involves envelope, periodicity and fine structure, which in turn could help better in understanding the ability to perceive the amplitude variation of continuous speech.

Briefly, TMTF involves measurement of a 'Modulation Transfer Function' (MTF), an empirical function which measures the ability to follow or resolve sinusoidal amplitude modulation to the frequency of that modulation. The psychophysical measure of this function is the modulation threshold, and is usually defined as the depth of modulation necessary to just discriminate between a modulated and an unmodulated waveform as reported by Viemeister, (1979). Basically, MTF can be considered as a quantitative description of resolution. According to Drullman et al. (1994), perception of modulation varies with different modulation frequencies and lower modulation frequencies has its role in identification and higher modulation frequencies in discrimination of the signal

TMTF is reported to be abnormal in individuals with sensorineural hearing loss in most of the studies (Hescot et al., 2000; Bacon & Viemeister, 1985; Ajith & Jayaram, 2004).

However, Moore, Glasberg and Bacon (1987) suggested that inherent fluctuations in amplitude of a stimulus are enhanced by recruitment along with the modulation being detected in individuals with cochlear hearing loss. They reported that listeners with cochlear hearing loss have normal temporal resolution, provided the signal is at comfortable levels. Hence, according to the results of Moore, Glasberg and Bacon, a hearing aid that compensates for the hearing sensitivity is sufficient to enhance the temporal resolution and in turn speech intelligibility. However, direct experimental evidence to this notion is not available. Hence, the primary purpose of the present study was to compare the TMTF with and without hearing aids at most comfortable levels of loudness. The second purpose was to compare TMTF between analog and digital hearing aids.

Objectives of the Study

The primary objective of the study was to compare the TMTF between analog and digital hearing aids. The secondary objective was to compare the TMTF between normal hearing individuals and individuals with sensorineural hearing loss, in unaided and aided conditions.

Method

Participants

Clinical Group

The experiment was conducted on 11 individuals with unilateral or bilateral sensorineural hearing loss. The participants of the study were tested monaurally and a total of 20 ears were tested. The participants were in the age range of 20 to 60 years. The hearing loss was either mild or moderate in its degree and was post lingual in its onset. The pattern of hearing loss was either flat across frequencies or gradually sloping from 250 Hz to 8000 Hz. Speech identification scores were obtained using Speech identification test in Kannada, developed and standardized by Vandana (1998). In all the individuals, the scores were proportional to the degree of hearing loss indicating that the hearing loss is predominantly due to cochlear pathology. Immittance evaluation showed type 'A' tympanogram with either presence or absence of acoustic reflexes. There was no past or present neurological dysfunction that was relevant to the present study.

Control Group

The experiment was also conducted on 10 individuals with normal hearing sensitivity who were matched for age with the participants in the clinical group. A total of 20 ears were tested. Unlike those in the clinical group, all the participants in the control group had normal

hearing sensitivity (pure tone thresholds within 15 dB HL between 250 Hz and 8000 Hz) in both the ears. Participants had greater than 90% speech identification scores in quiet and did not have any significant difficulty in the speech perception in the presence of ipsilateral speech noise at 0dB signal to noise ratio. Immittance evaluation showed type 'A' tympanogram with the presence of acoustic reflexes. There was no past or present neurological dysfunction that was relevant to the study. An informed consent for participation in the study was obtained from all the participants.

Instrumentation

A computer with Daqgen software was used to generate the amplitude and frequency modulated signals. DaqGen is a stimulus signal generator portion of the upcoming Daqarta (Data AcQuisition and Real-Time Analysis) for Windows. This particular software was chosen because of 2 reasons: one, it allowed continuous signal generation with fine frequency resolution. Second, depth of modulation and the frequency of modulation could be independently controlled. A calibrated two channel *diagnostic audiometer (Orbiter-922) was* used to route the signals at uniform predefined levels and also to estimate the pure tone thresholds. A calibrated *immittance meter (Grason-stadler-TS)* was used to assess the middle ear status.

Test Stimuli

Amplitude and frequency modulated white noise was the test stimulus in the present experiment. The stimuli were generated online using Daqgen software. The software uses the following expression to modulate the signal: $m(t) = [1 + m(\sin 2iifmt)]* n(t)$, where m = modulation index$(0<m<1)$: when $m = 1$, the wave is said to be 100% modulated. Fm = modulation frequency and $n(t)$ = wide band noise. In the present study, the depth of modulation was varied in increments of 10% at 5 modulation frequencies: 8, 16, 32, 64 and 128 Hz. The modulation frequencies beyond 128 Hz were not used, as maximum modulation frequency in speech is within 128 Hz.
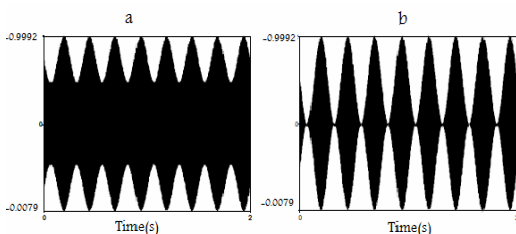

Figure 1: Sinusoidally amplitude modulated white noise at 16 Hz, (a) 50% modulation depth (b) 100% modulation depth.

Test Procedure

Only those individuals who satisfied the subject selection criteria participated in the experiment. The actual test procedure involved estimation of modulation threshold. Modulation threshold was operationally defined as the lowest amplitude modulation depth at which modulation could be detected 75 % of the time. This way, modulation thresholds were estimated at different modulation frequencies, without and with hearing aids (analog & digital). The unaided modulation thresholds were determined, followed by the aided thresholds using analog and digital hearing aids. Both were moderate gain hearing aids. The analog hearing aid was a trimmer based aid while the digital hearing aid used in the study was a multi channel aid with WDRC and noise reduction algorithm features. Electroacoustic measurements were done to determine the category of hearing aids. NAL-NL1 was the prescription formula used in the digital hearing aid for providing appropriate gain. In normal hearing individuals, a gain of 5dB was given at all frequencies. Prior to the actual test procedure, participants were familiarized with amplitude modulated signals. Familiarization stimuli were modulated by 100% of the original amplitude. Unlike in earlier studies (Bacon & Viemeister, 1985, & Hescot et al.,2000), the present study used an identification task, as it was observed that alternative forced choice discrimination task was leading to high percentage of false positives. Continuous white noise without modulation was used only to create catch trials that could help in determining the reliability of the response in each individual.

Participants were instructed to indicate whether the stimulus was modulated or not modulated. Stimuli generated by Daqgen software were routed through the audiometer. Stimuli were presented through loudspeakers at most comfortable levels (MCLs). Although presenting the stimuli at equal SPLs would have been ideal, it was not practical when normal and hearing impaired groups were being compared. Hence, it was presented at MCLs. Across individuals with sensorineural hearing loss, MCL ranged between 80 and 90 dB HL in the unaided condition, and between 40 and 50 dB HL in the aided condition. Across normal hearing individuals, MCL ranged between 40 and 50 dB HL in the unaided condition, and between 20 and 30 dB HL in the aided condition. In order to obtain the ear specific response, the participants were instructed to occlude the non-test ear during the presentation of the stimuli. Each modulated signal was presented for a duration of 1 second.

The depth of modulation was varied randomly in 10 dB steps while estimating the

thresholds. The modulation thresholds were estimated at modulation frequencies 8, 16, 32, 64, and 128 Hz.   The raw data was in percentage which was later converted to dB by applying the following formula: Modulation threshold (dB) = 20 log (m/100), where 'm' refers to the modulation threshold in percentage.

Analysis

The modulation thresholds obtained across frequencies and across individuals were analysed to compare the TMTF between normal hearing individuals and individuals with sensorineural hearing loss, to compare the TMTF between aided and unaided conditions and, to compare TMTF between analog and digital hearing aids. The raw data was statistically compared using two-way ANOVA.

Results

In the present study, there were instances when the participants could not detect modulations even when the modulation depth was 100%. Such instances were seen only when the modulation frequencies were 32, 64 and 128 Hz but not in the lower modulation frequencies. The number of such ears was different across three conditions and between the two groups. The total number of ears in the control group that could not detect the modulations at 32, 64 and 128 Hz is graphically represented in Figure 2 (a). Similarly, the total number of ears with sensorineural hearing loss that could not detect the modulations is depicted in Figure 2(b). The following observations can be made from Figure 2 (a) and 2(b).

The number of ears where modulations could not be detected increased with increase in the modulation frequency. This was true in control as well as clinical group. The number of ears where modulations could not be detected also was more when the signal was routed through hearing aids compared to that in the unaided condition and, this trend was similar in both the groups. Furthermore, among the two hearing aids used in the study, the number of ears where modulations could not be detected was more when the signal was routed through analog hearing aid compared to digital hearing aid. Hence, data of these ears in those respective modulation frequencies and conditions were considered as missing data and the statistics done in the present study does not involve these data. The raw data was analyzed on two-way analysis of variance (ANOVA) to determine whether there is a significant effect of group and conditions on modulation thresholds. Two-way ANOVA was also used, to determine whether there is significant interactions between the effect of group and conditions.
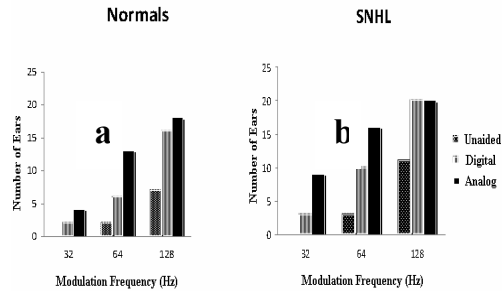

Figure 2: Total number of ears in normal hearing individuals (IIa) and SNHL (IIb) groups, where modulations could not be detected even at 100 % modulation depth.

Effect of Group on TMTF

Table II shows the mean and standard deviation of modulation thresholds in control and sensorineural group in the five different modulation frequencies. The table also shows the F value and the degrees of freedom representing the significance of difference between the groups in terms of their modulation thresholds. Results of ANOVA showed a significant effect of group on modulation thresholds in 8, 16 and 32 Hz modulation frequencies while the mean differences are not significantly different in 64 and 128 Hz. Because the number of data available at 128 Hz were only 9 (in experimental group) and 13 (in control group) in the two groups, the results were cross checked on Mann-Whitney test. Results were same as that of ANOVA. Inspection of the means revealed that the participants in the control group had better modulation thresholds compared to participants with sensorineural hearing loss. Figure III shows the comparison of TMTF between control with clinical group across 3 experimental conditions ie., unaided (IIIa) digital (IIIb), analog (IIIc).

MF	Group	Mean	SD	F	(df)
8	Control	-4.06	1.12	22.73**	1(114)
	Exptal	-3.19	1.32		
16	Control	-3.71	1.03	45.18**	1(114)
	Exptal	-2.58	1.25		
32	Control	-2.98	1.25	22.17**	1(96)
	Exptal	-1.89	1.27		
64	Control	-1.61	1.27	2.87	1(64)
	Exptal	-1.03	1.04		
128	Control	-1.30	1.23	3.45	1(23)
	Exptal	-0.22	0.42		

Note: * * - p<0.01

Table 2: Means and standard deviation (SD) of modulation thresholds in control and clinical groups across five different modulation frequencies
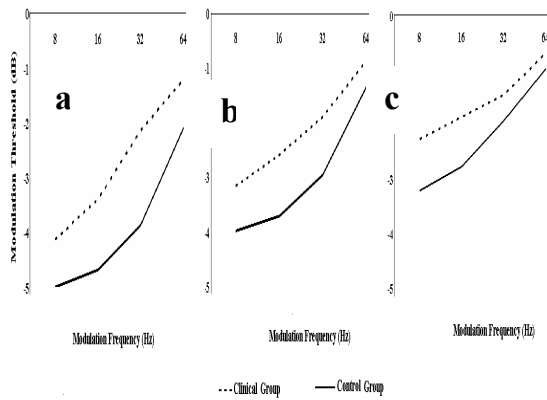
Figure 3: Comparison of TMTF between control and clinical group across 3 experimental conditions ie, unaided hearing aid (IIIa), digital hearing aid (IIIb) & analog hearing aid (IIIc).

MF	Condition	Mean (dB)	SD	F	df (error)
8 Hz	Unaided	-4.56	0.97	33.48**	2(114)
	Analog	-2.74	1.16		
	Digital	-3.57	1.07		
16 Hz	Unaided	-4.03	0.98	35.27**	2(114)
	Analog	-2.31	1.11		
	Digital	-3.10	1.11		
32 Hz	Unaided	-2.99	1.37	10.37**	2(96)
	Analog	-1.73	1.16		
	Digital	-2.44	1.27		
64 Hz	Unaided	-1.66	1.25	2.65	2(64)
	Analog	-0.88	1.05		
	Digital	-1.14	1.11		
128 Hz	Unaided	-0.78	1.03	0.60	2(23)
	Analog	-1.93	0.00		
	Digital	-1.54	1.78		

Note: * * - $p<0.01$

Table 3: Means and standard deviation (SD) of modulation thresholds in 3 experimental conditions across five different modulation frequencies.

Effect of experimental conditions on TMTF

Table III shows the means and standard deviation (SD) of modulation thresholds across 3 experimental conditions in the five different modulation frequencies. The table also shows the F value and the degrees of freedom representing the significance of difference across the conditions in terms of their modulation thresholds. Figure IV(a) and IV(b) shows comparison of TMTF across 3 experimental conditions separately for the 2 target groups. Results of ANOVA showed a significant main effect of condition on modulation thresholds in 8, 16 and 32 Hz modulation frequencies while the mean differences were not significantly different in 64 and 128 Hz. The frequencies in which thresholds were significantly different were further analyzed for pair-wise comparisons on Bonferroni post hoc test. Results of the post hoc test along with the mean thresholds (Table IV) can be summarized as follows.

1) Modulation thresholds are significantly better in the unaided condition compared to either of the aided conditions.

2) Modulation thresholds are significantly better for digital hearing aids compared to analog hearing aids.

MF (Hz)	Unaided vs Analog	Unaided vs Digital	Analog vs Digital
8	S	S	S
16	S	S	S
32	S	NS	S

S – $p<0.05$, NS – $p>0.05$

Table 4: Results of the post hoc test comparing across three experimental conditions in 8, 16 and 32 Hz modulation frequencies.
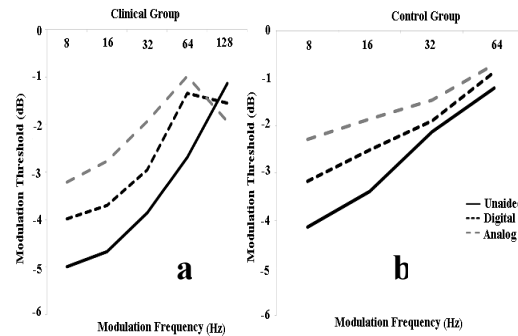

Figure 4: Comparison of TMTF across 3 experimental conditions in Normal hearing individuals (a) and individuals with sensorineural hearing loss (b).

Interaction between effect of groups and conditions

Results of two-way ANOVA (Table V) showed no significant interaction between the two independent variables (groups and the conditions) i.e, the effect of group and conditions were independent of each other. Because there was no interaction between effect of groups and conditions, comparisons within groups and within conditions were not necessary.

Modulation Frequency	F	df (Error)
8 Hz	0.036	2(114)
16 Hz	0.452	2(114)
32 Hz	2.508	2(96)
64 Hz	0.374	2(64)
128 Hz	-	0(23)

Table 5: F and degrees of freedom indicating the significance of interaction between effect groups and conditions.

Discussion

The results of the present study showed that modulation sensitivity reduced with the increase in modulation frequency. This is because, as modulation frequency increases, the amplitude fluctuations become increasingly smoothened as reported by Viemeister (1979). As a result, the subjects require greater amplitude change in order to resolve fluctuations. The result was same in normal hearing individuals as well as individuals with sensorineural hearing loss, and also is in agreement with the results of Drullman et al (1994).

The results of the present study showed that individuals with sensorineural hearing loss needed greater modulation depth to detect modulations compared to normal hearing individuals. This could be attributed to the cochlear pathology in individuals with sensorineural hearing loss. Although the modulated stimuli were presented at most comfortable levels to individuals with sensorineural hearing loss, compensating for their reduced audibility, modulation sensitivity remained poorer than that in normal hearing individuals. This is in agreement with most of the earlier studies (Hescot et al., 2000; Bacon & Viemeister, 1985; Ajith & Jayaram, 2004), but in contradiction with Moore and Glasberg (1988). The below normal TMTF in individuals with sensorineural hearing loss, even at most, comfortable levels is an evidence for the presence of deficits in temporal and spectral resolution in these individuals. The deficits in temporal resolution is attributed to the damage of physiologically vulnerable outer hair cells, the active process in the cochlea. Damage to the outer hair cells leads to reduced frequency selectivity, broadening of the frequency tuning curves which in turn results in decreased temporal resolution (Moore, 1991).

Earlier investigations have demonstrated that consonant identification and sentence intelligibility could be achieved if the modulation sensitivity is normal atleast upto 50 Hz (Shannon et al., 1995; Xu et al., 2005; Durllman, Festen & Plomp, 1994). In the present study individuals with cochlear pathology had reduced modulation sensitivity even at 8 and 16 Hz modulation frequencies. Hence, consonant identification and sentence intelligibility is expected to be degraded in these individuals. In the presence of background noise, speech is perceived based on its envelope (Tasell, 1987). In the present study, it was found that individuals with sensorineural hearing loss have problems in resolving the modulations in the envelope. Hence, it can be inferred from the present study that individuals with sensorineural hearing loss shall have problems in speech perception in noisy environments. Furthermore, temporal resolution is necessary for the perception of rhythm and segmentation of units in continuous speech (Miller, 1947). In the present study, individuals with sensorineural hearing loss had poorer modulation thresholds in lower as well as higher modulation frequencies compared to normal hearing individuals. Hence, it can be inferred that a person with sensorineural hearing loss will not be able to segment the speech units and perceive the regularity of speech (rhythm), the way normal hearing individuals do. Such a difficulty should increase with fast rate of speech.

The perception of rhythm in speech is based on the temporal changes in the speech envelope (Miller, 1947). Unlike segmentation of speech units, to perceive rhythm, normal modulation sensitivity at lower modulation frequencies is sufficient. However, in the present study, individuals with sensorineural hearing loss had poorer modulation sensitivity even at lower modulation frequencies like 8 and 16 Hz. Rhythm perception deficits reported in individuals with SNHL (Miller, 1947) are probably due to their poor temporal resolution at lower modulation frequencies, as evidenced in the present study.

Results of the present study also showed a significant effect of condition on modulation sensitivity. Irrespective of the modulation frequency and/or group, sensitivity was better in the unaided condition compared to that in the aided conditions. This difference shows the inability of hearing aids to reduplicate the envelope of the signal with 100% fidelity. With the hearing aids, both normal and hearing impaired individuals required an additional depth of about 1.5 dB to perceive the modulations. Hence, it can be concluded that though hearing aids are helping the hearing impaired in term of audibility, the present technology is not sufficient to enhance the temporal resolution in individual with cochlear pathology.

Furthermore, modulation sensitivity was poorer in analog hearing aids compared to digital hearing aids. This is because of the difference in

the type of processing of signals. With digital processing, the signal is amplified with lesser distortions in terms of its envelope compared to an analog hearing aid. Furthermore such distortions increase with the modulation frequency of the envelope. In general, modulation sensitivity reduced by about 1.5 dB in analog hearing aids compared to digital hearing aids. Hence, from these results it is recommended that a digital hearing aid be prescribed to individuals with sensorineural hearing loss, to enhance temporal resolution along with improving the audibility.

There was no significant interaction between the effect of group and condition. That means the effect of group and the effect of condition was independent of each other.

Conclusions

From the results of the present study, the following conclusions can be drawn:

1. Temporal resolution is affected in individuals with mild to moderate sensorineural hearing loss even at lower modulation frequencies.

2. Hearing aids do not help in enhancing temporal resolution to a greater extent.

3. Among analog and digital hearing aids, digital hearing aids will aid better in resolving the envelope of speech.

References

Ajith, U., & Jayaram, M. (2004). Auditory processing in individuals with auditory neuropathy. *Ear and Hearing, 25 ,*34-46.

Bacon, S. P., & Viemeister, N. F. (1985). Temporal modulation transfer functions in normal-hearing and hearing impaired subjects. *Audiology, 24,* 117 -134.

Dimitrijevic A., John M.S., & Picton T.W. (2004). Auditory steady state response and word recognition scores in normal hearing and hearing impaired adults. Ear *and Hearing, 25(1),* 68-84.

Drullman, R., Festen, J.M., & Plomp, R. (1994). Effect of temporal envelope smearing on speech reception. *Journal of Acoustical Society of America, 95(2),* 1053-1064.

Forrest, T. G & Green D. M (1987). Detection of partially filled gaps in noise and the temporal modulation transfer function. *Journal of Acoustical Society of America, 82 (6),* 1933-1943.

Glasberg, B. R., Moore, B. C. J., & Bacon, S. P. (1987). Gap detection and masking in in hearing impaired and normal-hearing subjects. *Journal of Acoustical Society of America, 81,* 1546-1556.

Hescot, F., Lorenzi, C., Debruille X., & Camus, J. F. (2000). Measurement of the temporal modulation transfer function for a single listener with cochlear hearing loss and left hemisphere damage. *British Journal of Audiology, 34,* 341-351.

Miller, G. A. (1947). The masking of speech. *Psychological Bulletin, 44,* 105-129.

Moore, B. C. J. (1991). Characterization and Simulation of Impaired Hearing: Implications for Hearing Aid Design. *Ear and Hearing, 12(6),* 154S-161S.

Moore, B. C. J., & Glasberg, B. R. (1988). Gap detection with sinusoids and noise in normals, impaired, and electrically simulated ears. *Journal of Acoustical Society of America, 83,* 1093-1101.

Rawool, V. W. (2006). The effect of hearing loss on temporal processing. *Hearing Review, 13,* 30-34.

Samelli, A. G., & Schochat, E. (2008). Study of REA on Gap Detection tests. *Otorrinolaryngology, 74* (2), 235-240.

Shanon, R. V., Zeng, F. G., Kamath, V., Wygonski, J., & Ekelid, M. (1995). Speech recognition with primarily temporal cues. *Science, 270,* 303-304.

Stuart, A. (2005). Development of auditory temporal resolution in school aged children revealed by word recognition in continuous and interrupted noise. *Ear and Hearing, 26(1),* 78-88.

Tasell, D. J. V. (1987). Speech waveform envelop cues for consonant recognition. *Journal of Acoustical Society of America, 82,* 1152-1160.

Vandana, S. (1998). *Speech identification test for Kannada speaking children.* Unpublished independent project, University of Mysore, Mysore, India.

Viemeister, N.F. (1979). Temporal modulation transfer functions based upon modulation thresholds. *Journal of Acoustical Society of America, 66(5),* 1364-1378

Xu, L., Thompson, C., & Pfingst, B. E. (2005). Relative contributions of spectral and temporal cues for phoneme recognition. *Journal of Acoustical Society of America, 117,* 3255-3267.

The Effect of Task Difficulty on the P300 Response in Children with Learning Disabilities

Shalini Arehole

Abstract

The study involved assessment of P 300, an auditory event related potential in children with learning disabilities (LD). Children with LD are known to have difficulty with challenging auditory listening tasks. Specifically, when they are tested using behavioral measures, they perform poorly if the stimulus is distorted. Therefore, the objective of this study was to determine if we can observe similar findings using auditory electrophysiological measures. P-300 recordings were obtained from Children with LD using stimuli that were difficult to discriminate and compared with the recordings from children without LD. The study revealed that P 300 latencies were significantly longer and P300 amplitudes were significantly smaller under difficult task compared to standard task for both children with LD and children without LD, however, there was no significant difference between the participant groups. When the inter-peak latencies between P3-P2 were compared between Children with LD and children without LD, a significant difference was noted in the difficult task condition. Specifically, Children with LD had significantly longer P3-P2 inter peak latency compared to children without LD for the difficult task condition. These results confirm that the strategy of stressing the auditory processing system by increasing the difficulty of the discrimination task was successful in differentiating children with LD from children without LD. However, one must use sophisticated measures such as inter-peak latency and not limit to evaluating absolute latency and amplitude of P 300 potential.

Key words: P300 potentials, Learning disability, inter-peak latency

Children who are classified as learning disabled are known to have multiple perceptual deficits. Some children with learning disability (LD) have been found to have disordered auditory perceptual processes (Public Law 94-142, 1975). This disorder is known as auditory processing disorder (APD).

APD is currently assessed through the use of behavioral tests and/or electrophysiologic measures. Although these behavioral measures have demonstrated performance deficits among children with LD (Gomez & Condon, 1999; Greenblatt, Bar, Zappulla, & Hughes, 1983; Jerger, Martin, & Jerger, 1987; Leavell, 1996; Musiek, Geurkink, & Keitel, 1982; Rigo, Arehole, & Hayes, 1998; Roush & Tait, 1984; Willeford & Bilger, 1978), their subjectivity sometimes limits their reliability. In light of the potential problems of the behavioral technique, it has been recommended that electrophysiologic measures be incorporated into the clinical assessment of APD in children with LD (Jirsa & Clontz, 1990).

The electrophysiologic technique involves the measurement of auditory evoked potentials (AEP).

AEP investigations of children with LD have used both short-latency and middle-latency exogenous potentials and long-latency endogenous potentials (Arehole, Augustine, & Simhadri, 1995; Arehole, 1995; Arehole & Rigo, 1999; Jerger et al., 1987; Kraus, Smith, Reed, Stein, & Cartee 1985; Lubar, Mann, Gross, & Shively 1992; Satterfiled, Schell, Backs, & Hidaka, 1984). Studies have shown that long-latency endogenous potentials are better able to identify APD in participants with LD than are short-latency and middle-latency potentials (Jirsa & Clontz, 1990).

The P300 response (also referred to as the P3 response) is a long-latency endogenous potential that is generated by a listener making auditory discrimination decisions. It is a broad positive peak occurring at about 300 ms after the stimulus onset. Traditionally, the standard auditory stimuli that have been used to elicit the P300 response have included two tones (the "frequent" low-frequency tone and the "infrequent" high-frequency tone) which differ in frequency by 1000 Hz or more. For example, most P300 studies have used a frequent tone of 1000 Hz and an infrequent tone of 2000 Hz (Erez & Pratt, 1992; Frank,

Professor, Department of Communication Disorders, University of Louisiana at Lafayette, P.O. Box 43170, Lafayette, LA 70504, email:shalini@louisiana.edu.

Sieden, & Napolitano, 1994; Frank, Sieden, & Napolitano, 1998; Holcomb, Ackerman, & Dykman, 1986; Mazzotta & Gallai, 1992). Other researchers have used either two tones with a frequency difference greater than 1000 Hz or have used non-tonal stimuli that are easy to differentiate (Ducan et al., 1994; Finley, Faux, Hutcheson, & Amstutz, 1985; Holcomb, Ackerman, & Dykman, 1985; Lubar, Gross, Shively, & Mann, 1990).

Behavioral tests of AP function have been successful in differentiating normal children from children with LD only when the tests have involved complex tasks that stress the auditory system (i.e., selective listening, binaural separation). Children with LD and children without LD, however, perform similarly on processing tasks that involve simple auditory stimuli. It could be hypothesized that this effect of task difficulty on the comparative performance of LD and non LD groups applies similarly to the P300 measure.

Task difficulty and its effect on P300 latency and amplitude has been studied extensively in normal subjects (Fitzgerald & Picton, 1983; Goodin, Squires, & Starr, 1983; Polich, 1987, & 1989). The effect was an increase in P300 latency and a reduction in P300 amplitude in their normal subjects. However, no investigations have evaluated the effect of increased P300 task difficulty on the comparative performance of children with LD vs children without LD.

All P300 studies that have reported on the comparative results of LD and non-LD participants have utilized the absolute latency and/or amplitude of the P300 waveform as their response measure(s). There are, however, other measures, such as inter-peak latency, that can be used to evaluate the P300 response (Jirsa and Clontz, 1990). It may be that the utilization of a more extensive array of P300 response measures may better differentiate the P300 responses of children with LD from those of children without LD.

The purpose of our study was two-fold. Our first objective was to determine whether differences in P300 latency and amplitude measures can be identified more effectively in children with LD vs children without LD when the discrimination task is made more difficult than what has been commonly employed in standard P300 protocols. Our second objective was to incorporate P3-P2 inter-peak latency difference as a response measure to determine its effectiveness in the assessment of children with LD.

Methods

Participants

Two groups of children (clinical and control) between 11.5 and 12.5 years of age participated in the study. All participants were Caucasian and from the middle socioeconomic class. No participant presented any significant otological or neurological history. All participants passed a hearing screening administered at 15 dB HL at octave frequencies 250 Hz to 8000 Hz. All participants were reimbursed $15.00 for their participation in the study. The reimbursement procedures followed those recommended by the American Psychological Association (APA, 1992). Informed consent was obtained from the parents of all participants after the experimental procedure was fully explained to both parents and participants.

The clinical group included 11 male participants identified as learning disabled by their respective school systems. The Louisiana state criterion for learning disability requires evidence of a severe discrepancy between achievement and ability as measured by performance comparisons in the student's strongest and weakest academic areas. All participants diagnosed as LD had specific problems with language and were grouped as dyslexics. The control group included 11 male participants who were reported by parents and school personnel as having no perceptual deficits or academic difficulties. These children were recruited from public school classrooms.

Equipment and Procedure

Stimulus Parameters

The P300 response was elicited and recorded using a Nicolet CA-2000 Compact Auditory Evoked Response System. The stimuli consisted of a frequent low-frequency tone presented a total of 240 times and an infrequent high-frequency tone presented a total of 60 times. The two tones were presented in a randomized sequence pre-determined by the Nicolet measurement system. The stimuli were presented binaurally through TDH 39 ear phones at an intensity of 70 dB nHL and at a rate of 0.7/s.

The P300 response was measured for each participant under two separate conditions: (1) a standard-task condition and (2) a difficult-task condition. In the standard-task condition, the frequent low-frequency stimulus was a 750 Hz tone and the infrequent high-frequency stimulus was a 2000 Hz tone (frequency difference of 1250 Hz). In the difficult-task condition, the frequent low-frequency stimulus was a 1000 Hz tone and the infrequent high-frequency stimulus was a 1500

Hz tone (frequency difference of 500 Hz). Under both conditions, all participants were instructed to keep a mental count of the number of high-frequency tones presented and report this number to the experimenter at the conclusion of each recording. All participants were capable of counting the high-frequency tones with at least a 95 % accuracy rate.
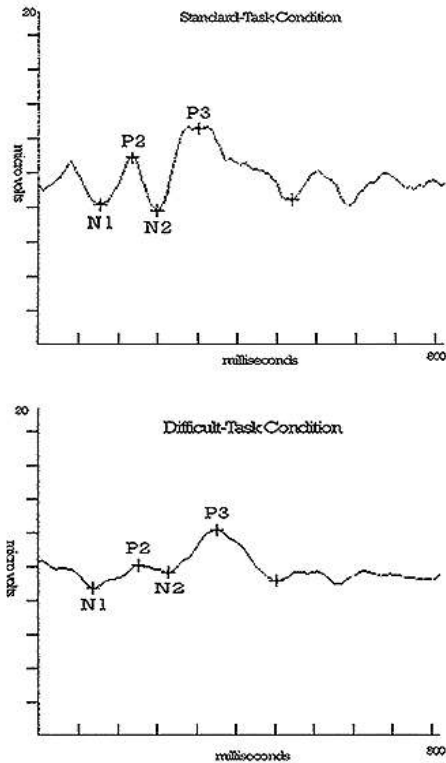
Representative Waveforms from Control Group

Figure1: Representative waveforms showing P2 and P3 in a child without learning disability, obtained in standard-task condition (top) and difficult-task condition (bottom).

Data Analysis

The P300 response measures utilized in this study included (1) absolute latency of P300 in milliseconds (2) P300 amplitude in microvolts (µV) and (3) P3-P2 inter-peak latency in milliseconds. Latencies of the P2 and P300 waves were measured at the peak of the waveform (Figure 1).

The absolute latency of P2 was identified as the largest positive wave peak occurring between 150 and 200 ms. The absolute latency of P300 was identified as the largest positive peak occurring after 250 ms. P3-P2 inter-peak latencies were calculated by subtracting P2 absolute latency from P300 absolute latency. The P300 amplitude was determined by calculating the difference in µV

between the P300 wave peak and the baseline response.Acquisition parameters
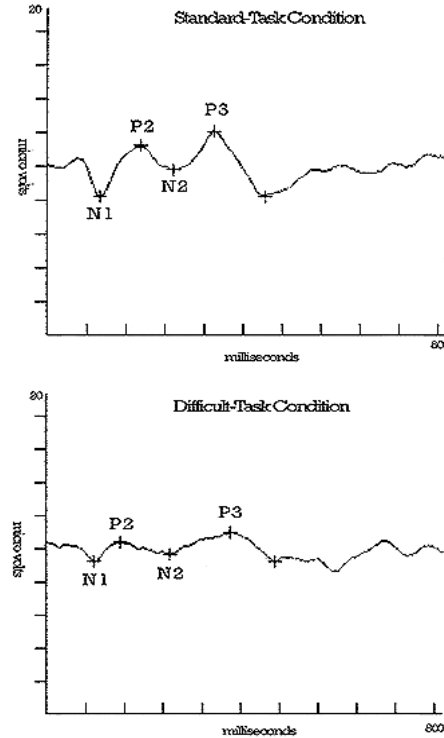
Representative Waveforms from Clinical Group

Figure 2: Representative waveforms showing P2 and P3 in children with learning disability, obtained in standard-task condition (top) and difficult-task condition (bottom).

The P300 response was recorded using standard silver-chloride disc electrodes. The electrodes were filled with electrode paste and secured to 4 scalp location: the vertex, the forehead, and behind each earlobe. This electrode array followed the international 10-20 system (Hall, 1992). Filters were set to band pass 1Hz to 100 Hz. Total of 300 artifact free trials were recorded. The artifact reject was set to automatically ignore any trials in which the ongoing EEG activity exceeded +/- 100 uV to eliminate muscle artifacts, eye blinks, and random eye movement. Time window of the recording was set at 800 milliseconds (ms).

All testing was performed in a quiet room with the subject seated comfortably in a reclining chair. A typical recording session lasted 45 minutes to 1 hour. Each waveform obtained was replicated to ensure response reliability. The data were stored on floppy disc during the test session and later retrieved for analysis.

Results

Figure 2 shows a sample of P300 waveforms recorded from a participant in clinical group obtained using both standard-task condition and difficult-task condition.

Group means and standard deviations for the three P300 response measures were calculated for both participant groups under the standard-task and difficult-task conditions.

Mixed two-factor ANOVAs were performed on group means for each of the three response measures: (1) P300 absolute latency in ms, (2) P300 amplitude in μV, and (3) P3-P2 inter-peak latency in ms. The main effects studied for each ANOVA were group (the performance of children with LD vs children from control group) and condition (performance on the standard listening task vs the difficult listening task).

P300 Absolute Latency

Group means and standard deviations for the P300 absolute latency response measure are shown in Table 1. The ANOVA revealed a significant main effect between the standard-task and difficult-task conditions ($F_{[1,39]} = 17.597$, $p < .001$). There was no significant main effect between the two participant groups ($F_{[1,39]} = 2.256$, $p > .05$) and no significant interaction ($F_{[1,39]} = 1.50$, $p > .05$).

Simple comparisons revealed that P300 absolute latencies were longer under the difficult-task condition than those obtained under the standard-task condition for both children with out LD ($F_{[1,9]} = 12.226$, $p < .01$) and children with LD ($F_{[1,9]} = 8.663$, $p < .025$). The difference in P300 absolute latencies between the control and clinical groups were not significant under either the standard-task ($F_{[1,18]} = 1.163$, $p > .05$) or difficult-task ($F_{[1,18]} = 2.570$, $p > .05$) listening conditions.

Condition	Control group	Clinical group
Standard task		
Mean	323.84	337.28
S.D.	27.54	33.31
Difficult task		
Mean	364.00	389.12
S.D.	42.49	47.46

Table 1: Group means and standard deviations in ms for P300 absolute latency

P300 AmplitudeGroup means and standard deviations for the P300 amplitude response measure are shown in Table 2. Similar to the P300 absolute latency measure, the ANOVA of P300 amplitude demonstrated a significant main effect between the standard-task and difficult-task conditions ($F_{[1,39]} = 25.596$, $p < .001$), no significant main effect between participant groups ($F_{[1,39]} = 0.262$, $p > .05$), and no significant interaction ($F_{[1,39]} = 0.289$, $p > .05$).

Simple comparisons were also similar to the performance trends found for the absolute latency measure. That is, P300 amplitudes were smaller under the difficult-task condition than under the standard-task condition for both the children with out LD($F_{[1,9]} = 13.414$, $p < .01$) and children with LD ($F_{[1,9]} = 12.580$, $p < .01$). However, like the P300 absolute latency measure, the difference in P300 amplitudes between the control and clinical groups were not significant under either the standard-task ($F_{[1,18]} = 0.114$, $p > .05$) or difficult-task ($F_{[1,18]} = 0.469$, $p > .05$) listening condition.

Condition	Control group	Clinical group
Standard task		
Mean	12.50	11.79
S.D.	3.37	6.16
Difficult task		
Mean	10.19	9.17
S.D.	2.62	5.53

Table 2: Group means and standard deviations in μV for P300 amplitude

P3-P2 Inter-peak latency

Group mean inter-peak latencies and standard deviations are presented in Table 3. The ANOVA of P3-P2 inter-peak latency main effects revealed a significant difference between standard-task and difficult-task listening conditions ($F_{[1,39]} = 52.574$, $p < .001$) and no significant main effect between two test groups ($F_{[1,39]} = 3.359$, $p > .05$). Unlike the two previous response measures, there was a significant interaction ($F_{[1,39]} = 6.385$, $p < .025$).

Simple comparisons revealed a trend similar to the P300 absolute latency and amplitude measures in that P3-P2 inter-peak latency was longer under the difficult-task condition than the standard-task for both control ($F_{[1,9]} = 17.328$, $p < .01$) and clinical groups ($F_{[1,9]} = 35.250$, $p < .001$). Simple comparisons of children with out LD vs children with LD under each of the two task conditions, however, demonstrateed a pattern unlike those found for absolute latency and amplitude. For the P3-P2 inter-peak latency measure, the difference between control and clinical groups under the standard-task condition was not significant ($F_{[1,18]} = 0.733$, $p > .05$). In contrast, under the difficult-task condition, inter-peak latency was significantly longer for the children with LD when compared to control group ($F_{[1,18]} = 8.223$, $p < .025$).

Condition	Control group	Clinical group
Standard task		
Mean	143.50	147.91
S.D.	39.27	33.36
Difficult task		
Mean	183.19	230.06
S.D.	38.13	34.89

Table 3: Group means and standard deviations in ms for P3-P2 inter-peak latency

In summary, our design allowed an analysis of the effect of task difficulty on P300 absolute latency, amplitude and P3-P2 inter-peak latency, as well as a comparison of control group vs clinical group responses under each task condition. First, in regard to task condition, the results revealed that the manipulation of task difficulty did have a significant effect on all responses studied. Specifically, the two P300 latency measures (absolute latency and P3-P2 inter-peak latency) were prolonged and P300 amplitude was reduced under the difficult-task condition when compared to responses obtained under the standard-task condition for both control and clinical groups. Second, in regard to the comparison of control group vs clinical group responses under each task condition, the patterns of responses were different for the P300 absolute latency and P300 amplitude measures vs the P3-P2 inter-peak latency measure. Specifically, there was no significant difference found between participant groups for P300 absolute latency or P300 amplitude under either test condition. On other hand, when P3-P2 inter-peak latency was measured, significant differences were apparent between the two groups. While P3-P2 inter-peak latency of the two participant groups could not be distinguished under the standard-task condition, the response was more prolonged for children with LD compared to children without LD under the difficult-task condition.

Discussion

This study was designed to determine whether differences in P300 latency and amplitude measures can be identified more effectively in children with LD vs children without LD when the discrimination task is made more difficult than that commonly employed in standard P300 protocols. A second objective was to determine whether a non-traditional measure, namely, inter-peak latency, would be effective in distinguishing children with LD from children without LD.

We found that increasing task difficulty from a 750 Hz/2000 Hz to a 1000 Hz/1500 Hz discrimination requirement had the effect of increasing both P300 absolute latency and P3-P2 inter-peak latency, and reducing P300 amplitude for both the children without LD and children with LD. These findings are consistent with past studies that have measured the effect of task difficulty on P300 absolute latency and amplitude in children without LD and have been attributed to P300 responsiveness to perceptual processing demands during stimulus discrimination (Fitzerald & Picton, 1983; Goodin, Squires, & Starr, 1983; Polich, 1987, 1989).

Although the increase in task difficulty had the effect of prolonging latency measures and reducing amplitude measures, these effects were similar for each participant group when utilizing measures associated with traditional P300 protocols. That is, responses of children from control group vs clinical group could not be differentiated under either the standard or difficult-task conditions when P300 absolute latency and P300 amplitude were utilized. This same trend was not observed when the P3-P2 inter-peak latency measure was analyzed. Like the P300 absolute latency and amplitude measures, P3-P2 inter-peak latency did not distinguish the two participant groups under the standard-task condition. However, the response was significantly more prolonged for children with LD than for children from control group under the difficult-task condition. These results indicate that the strategy of stressing the auditory processing system by increasing the difficulty of the discrimination task was successful in differentiating children with LD from control group only when performance was assessed by means of a P3-P2 response measure. The technique of taxing auditory capacity to draw out processing deficits in children with LD is supported by past studies that have utilized behavioral tests of auditory processing ability (Gomez & Condon, 1999; Musiek et al., 1985; Welsh, Welsh, Healey, & Cooper 1996).

The effectiveness of the P3-P2 inter-peak latency measure has been demonstrated in studies of children with APD. The differences found in P3-P2 inter-peak latency responses of children with APD vs children without APD has been attributed to a prolongation of neural conduction time in participants with APD (Jirsa & Clontz, 1990). Our results support the assertion that similar abnormalities may be present in children with LD and may contribute to their behavioral profiles (Gomez & Condon, 1999; Musiek et al., 1985; Welsh et al., 1996).

The findings of this study indicate that P3-P2 inter-peak latency can be quite sensitive to differentiating children with LD and without LD. It is obvious that the bases for this abnormality is higher-order in nature, however, the exact

neurophysiologic and perceptual correlates to this electrophysiologic measure have not been studied extensively nor has the measure been utilized across a range of populations. To date, the Jirsa and Clontz (1990) study of children with APD is the sole report in the literature of the use of the P3-P2 inter-peak latency response as a diagnostic measure. As such, future research should focus on the replicability of our findings, the stability of this measure across varying test protocols and participant groups, and the neurophysiologic bases of the P3-P2 inter-peak response.

References

American Psychological Association. (1992). Ethical principles of psychologists and code of conduct. *American Psychologists*, *47*, 1597-1611.

Arehole, S. (1995). A preliminary study of the relationship between long latency response and learning disorder. *British Journal of Audiology*, *29, 295-298.

Arehole, S., Augustine, L.E., & Simhadri, R. (1995). Middle latency response in children with learning disabilities: Preliminary findings. *Journal of Communication Disorders*, *28*, 21-38.

Arehole, S., & Rigo, T.G. (1999). Auditory evoked potentials in low-achieving gifted adolescents. *Roeper Review*, *22*, 51-56.

Duncan, C.C., Rumsey, J.M., Wilkniss, S.M., Denckla, M.B., Hamburger, S.D., & Odou-Potkin, M. (1994). Developmental dyslexia and attention function in adults: Brain potential indices of information processing. *Psychophysiology, 31*, 386-401.

Erez, A., & Pratt, H. (1992). Auditory event related potentials among dyslexic and normal-reading children: 3CLT and midline comparisons. *International Journal of Neuroscience, 63,* 247-264.

Finley, W. W., Faux, S. F., Hutcheson, J., & Amstutz, L. (1985). Long-latency event-related potentials in the evaluation of cognitive function in children. *Neurology, 35,* 323-327.

Fitzgerald, P.G., & Picton, T.W. (1983). Event-related potentials recorded during the discrimination of improbable stimuli. *Biological Psychology,* 17, 241-276.

Frank, Y., Seiden, J. A., & Napolitano, B. (1994). Event-related potentials to an "odd-ball" auditory paradigm in children with learning disabilities with or without attention deficit hyperactivity disorder. *Clinical Electroencephalography, 25,* 136-141.

Frank, Y., Seiden, J.A. & Napolitano, B. (1998). Electrophysiological changes in children with learning and attentional abnormalities as a function of age: Event-related potentials to an "odd-ball" paradigm. *Clinical Electrocephalography, 29*, 188-193

Goodin, D. S., Squires, K. C., & Starr, A. (1983). Variations in early and late event-related components of the auditory evoked potential with task difficulty. *Electroencephalography and clinical Neurophysiology, 55,* 680-686

Gomez, R., & Condon, M. (1999). Central auditory processing ability in children with ADHD with and without learning disabilities. *Journal of Learning Disabilities, 32,* 150 -161.

Greenblatt, E.R., Bar, A., Zappulla, R.A., & Hughes, D.A. (1983). Learning disability assessed through audiologic and physiologic measures: A case study. *Journal of Communication Disorders, 16,* 309-313.

Hall, J.W. (1992). *Handbook of auditory evoked responses*. Massachusetts: Allyn and Bacon.

Holcomb, P.J., Ackerman, P.T., & Dykman, R.A. (1985). Cognitive event related brain potentials in children with attention and reading deficits. *Psychophysiology, 22,* 656-667.

Holcomb, P.J., Ackerman, P.T., & Dykman, R.A. (1986). Auditory event-related potentials in attention and reading disabled boys. *International Journal of Psychophysiology, 3,* 263-273.

Jerger, J., Martin, R.C., & Jerger, J. (1987). Specific auditory perceptual dysfunction in a learning disabled child. *Ear and Hearing, 8,* 78-86.

Jirsa, R. E., & Clontz, K. B. (1990). Long latency auditory event-related potentials from children with auditory processing disorders. *Ear and Hearing, 11,* 222-32.

Keith, R.W. (1994). SCAN:A: A test for auditory processing disorders in adolescents and adults.

San Antonio: Harcourt Brace & Company.

Kraus, N., Smith, I.D., Reed, N., Stein, L.K. & Cartee, C. (1985). Auditory middle latency responses in children: effects of age and diagnostic category. *Electroencephalography and Clinical Neurophysiology, 62,* 343-351.

Leavell, C.A. (1996). Central auditory processing and attention in children with learning/behavior problems. *Paper presented at the Annual Convention of the American Psychological Association,* August 9-12, Toronto, Canada.

Lubar, J.F., Gross, D. M., Shively, M.S., & Mann, C. A. (1990). Differences between normal, learning disabled and gifted children based upon an auditory evoked potential task. *Journal of Psychophysiology, 4,* 249-260.

Lubar, J. F., Mann, C.A., Gross, D. M., & Shively, M.S. (1992). Differences in semantic event-related potentials in learning-disabled, normal, and gifted children. *Biofeedback Self-Regulation, 17,* 41-57.

Mazzotta, G., & Gallai, V. (1992). Study of the P300 event-related potential through brain mapping in phonological dyslexics. *Acta Neurology, 14,* 173-186.

Musiek, F. E. & Guerkink, N. (1980). Auditory perceptual problems in children: Considerations for otolaryngologists and audiologists. *Laryngoscope, 90,* 262-291.

Musiek, F., Geurkink, N., & Keitel, S. (1982). Test battery assessment of auditory perceptual dysfunction in children. *Laryngoscope, 92*, 251-257.

Musiek, F.E., Gollegly, K.M., & Ross, M. K. (1985). Profiles of types of central auditory processing disorders in children with learning disabilities. *Journal of childhood communication disorders, 9,* 43-63.

Ollo, C., & Squires, N. (1986). Event-related potentials in learning disabilities. In R.Q. Cracco & I. Bodis-Wollner (Eds.), *Evoked potentials: Frontiers of clinical neuroscience* (Vol. 3, pp. 497-512). New York: Liss.

Polich, J. (1987). Task difficulty, probability and inter-stimulus intervals as determinants of P300 from auditory stimuli. *Electroencephalography and Clinical Neurophysiology, 68,* 311-320.

Polich, J. (1989). Frequency, intensity, and duration as determinants of P300 from auditory stimuli. *Journal of clinical neurophysiology, 6,* 277-286.

Rigo, T.G., Arehole, S., & Hayes, P.A. (1998). Central auditory processing abilities of low-achieving gifted adolescents. *The Journal of Secondary Gifted Education, 10*, 217-225.

Roush, J., & Tait, C.A. (1984). Binaural fusion, masking level difference, and auditory brainstem responses in children with language-learning disabilities. *Ear and Hearing, 5,* 37-41.

Satterfiled, J.A., Schell, A.M., Backs, R.W., & Hidaka, K.C. (1984). A cross sectional and longitudinal study of age effects electrophysiological measures in hyperactive and normal children. *Biological Psychiatry, 19,* 973-990.

Welsh, L.W., Welsh, J.J., Healy, M. & Cooper, B. (1982). Cortical, subcortical, and brainstem dysfunction: A correlation in dyslexic children. *Annals of Otology, Rhinology and Laryngology, 91*, 310 – 316.

Willeford, J. A. (1977). Assessing central auditory behavior in children: A test battery approach. In R. Keith (Ed.), *Central auditory dysfunction* (pp 43-72). New York: Grune and Stratton.

Willeford, J. A., & Bilger, J. (1978). Auditory perception in children with learning disabilities. In J. Katz (Ed.), *Handbook of clinical audiology* (2nd ed., pp. 410-425). Baltimore: Williams and Wilkins.

Study of Nature and Gender differences of a group of Persons Suffering from Tinnitus

[1]Sujoy Kumar Makar, [2]Rajeev Jalvi & [3]Ashok Kumar Sinha,

Abstract

Tinnitus is widespread amongst clients attending hearing clinics and has been associated with a range of physical and emotional disorders (Hallam R.S., Jakes, S.C., and Hinchcliffe, R.. 1988).Hence to understand the distress caused by tinnitus and its relationship with the nature of tinnitus so as to suggest the appropriate treatment, there is the need to study the audiological and psychological characteristics of a group of tinnitus sufferers on the basis of verbal description of tinnitus and audiological measurements of tinnitus to understand nature and gender differences. Fifty adults in the age range of 18 to 60 years with subjective tinnitus with bilateral normal hearing or pure SNHL ranging from mild to moderately severe were selected. An audiological profile of each subject was prepared on the basis of brief case history of subject, otoscopic examination, pure tone audiometry, impedance audiometry, effective masking level, was conducted for all cases. A psychological profile was developed by using Tinnitus Reaction Questionnaire (TRQ) and Nature of Tinnitus Questionnaire (NTQ). These questionnaires were translated and adopted in Hindi and Bengali language after appropriate standardization procedure. 60% reported that they do not have any idea regarding probable cause of their tinnitus. Not even a single subject in the present study reported the cause of their tinnitus as consumption of alcohol. 74% subjects of this study reported that there is no fluctuation in the pitch of their tinnitus. However, 68% reported loudness of tinnitus is fluctuating. There was a significant correlation between the impact of tinnitus and disturbance of sleep caused by it with increase in depression and anger (.483). However, no significant co-relation was seen between distressed caused by tinnitus and duration of tinnitus (-.034). The multiple nature/sounds of tinnitus had far more devastating effects or serious impact on 'tinnitus sufferers' than the single sound/nature. Gender differences were also found among tinnitus sufferers while assessing the audiological and psychological measures of tinnitus. Female subjects also reported a higher level of emotional reaction with a mean of 35.9 to their tinnitus as compared to males with a mean of 31.7. Tinnitus has resulted in multifold effects/impacts on tinnitus sufferers where it has made them feel unhappy, tense, irritable, depressed, annoyed, distressed and frustrated. It has interfered with their enjoyment, their relaxation, their sleep, and forced them to avoid quite and social situations. These studies would further help in the overall management of the patient suffering from tinnitus.

Key words: Psychological profile, Tinnitus reaction, Questionnaire, Nature of Tinnitus Questionnaire, Tinnitus sufferers

Tinnitus is widespread amongst clients attending hearing clinics and has been associated with a range of physical and emotional disorders (Hallam R.S., Jakes, S.C., and Hinchcliffe, R. 1988). Clients exhibit a wide range of reactions both physical and psychological to the presence of tinnitus. The psychological distress that are associated with tinnitus include worries, anxiety, depression, irritability, disturbance in social life, stress, tiredness, feeling of illness, disturbance in concentration, personality disorder and sleep disturbance. Besides physical and psychological distress, emotional difficulties are also an important feature of subjects living with tinnitus. Researchers have observed that people with self-reported severe tinnitus experience excessive stress which affects their emotional balance and ability to cope (Kirsch et al., 1989).

The emotional distress associated with tinnitus was suggested to be the consequences of

[1]*Clinical Supervisor, Ali Yavar Jung National Institute for the Hearing Handicapped, email:kumarmakar@yahoo.com.*
[2]*Reader and Head, Department of Audiology, Ali Yavar Jung National Institute for the Hearing Handicapped, Bandra, Mumbai.* [3]*Reader and Assistant Director, Ali Yavar Jung National Institute for the Hearing Handicapped, Bandra, Mumbai.*

the sound being perceived as threat or due to lack of control of the tinnitus sounds or noises. Thus attention to the tinnitus sounds or noises is assumed to bring about distress either because it is associated with the attribution of some threatening state of affairs or because the act of attending tinnitus interferes with activities which are more in tune with the needs of the moments. Though habituation to tinnitus noises is the normal response but this process may take weeks, months or some times years in some cases. Therefore, suffering and complaint are the exception and needs to be explained as a failure or habituation. (Hallam, Hanchcliffe, and Jakes, 1988)

Hence to understand the distress caused by tinnitus and its relationship with the nature of tinnitus so as to suggest the appropriate treatment, there is the need to study the audiological and psychological characteristics of a group of tinnitus sufferers on the basis of verbal description of tinnitus and audiological measurements of tinnitus to understand nature and gender differences.

Method

The present study proposed to develop a profile of the tinnitus sufferers by studying audiological and psychological characteristics of a group of tinnitus sufferers. This profile will enable to develop an appropriate management or remedial program for the tinnitus sufferers

Research design: - Survey type

Selection of subjects :- 50 adults with the age range between 18 years to 60 years were selected on the basis of following criteria:-

With Tinnitus in either of the ears or in both ears but without having any other associated problems like Vertigo, Headache etc. They should have subjective tinnitus, with bilateral normal hearing sensitivity or pure sensorineural hearing loss ranging from mild to moderately severe, with PTA from 10 dB HL to 70 dB HL. With normal ENT & Neurological examination.

Tool used for the study

(A) Audiological Profile:

An audiological profile of each subject will be prepared/ developed on the basis of following guidelines.

(1) Brief case history of subject including/highlighting age and gender of subject, educational qualification, details about tinnitus such as the age at onset of tinnitus, duration of tinnitus, nature of tinnitus as well as a verbal description of the tinnitus at present and any

information regarding the way the tinnitus may have changed in nature since it was first noticed, any treatment taken for tinnitus, details about hearing status like normal hearing, hearing loss, if any, then type and degree of hearing loss, age of onset of hearing loss, whether the tinnitus is associated with hearing loss, impact of both i.e. hearing loss and tinnitus on daily living and details of treatment taken for both. This will help in ascertaining the eligibility of the subject as a sample for the study.

(2) Otoscopic Examination: - Visual examination of ear canal and tympanic membrane of the both the ears were carried out with a hand-held otoscope by lifting the pinna behind and upwards. So as to determine the status of ear canal and tympanic membrane.

(3) Pure Tone Audiometry (PTA) of each subject was carried out following the standard procedure (Hudghson & Weslacke Bracketing Technique) to determine the hearing threshold by using MAICO MA-52 well calibrated dual channel audiometer with TDH –39 supra-aural headphones with MX-41 cushion in a sound treated room. With noise levels within permissible limits according to ANSI (1991) standard for maximum permissible ambient noise level.

(4) Immittance Audiometry was carried out by using GSI-38 Immittance audiometer with 226 Hz probe tone for each subject to rule out middle ear pathology, if any.

(5) For **profiling frequency** (pitch) and intensity (loudness) of tinnitus, following stimuli were presented at all frequencies using bracketing procedure. This was done by using the same audiometer so as to check whether the patient's description of the tinnitus matched with that of the measurement of tinnitus.

PureTones (Continuous, Pulse and Warble).

Noise (Narrowband, White and Speech).

The patient was then instructed verbally to first match the pitch of the tinnitus with that of the pitch of the given tone (Pure Tone/noise). At different frequencies pure tone and noise were presented through the headphones to the ear opposite to the one where tinnitus was present (i.e. contralateral ear). The subject was then asked to match the loudness of the tinnitus at the selected tone or noise. Thus using the same procedures as used for pitch matching, different intensities were presented through the headphones, till the patient matched the loudness of his tinnitus with the given intensity.

(6) The effective masking level was determined for each subject, by presenting masking signal in

ascending order (5 dB steps) until the patient indicated that his/her tinnitus is undetectable. This was the level that has effectively masked his/her tinnitus when it was presented in ipsilateral ear.

Thus with the help of above mentioned tests and procedures a complete and a satisfactory audiological profile was developed for each tinnitus sufferer.

(B) Psychological Profile

An appropriate and satisfactory psychological profile was developed by using following two questionnaires namely.

(1) Tinnitus Reaction Questionnaire (TRQ): This questionnaire was developed by Wilson, Henry, Bowen and Haralumbus 1991. This has provided the information about the impact of tinnitus on the each tinnitus sufferer in terms of distress, anxiety, depression and disturbance of personality like neuroticism, etc.

(2) Nature of Tinnitus Questionnaire: This is a modified version of "University of IOWA Questionnaire for tinnitus" developed by Stouffer J.L and Tyler Richard S. This questionnaire was used to find out the 'nature' of tinnitus of each subject. This has provided the information about the patient's description of his/her tinnitus in terms of pitch and loudness matching.

These questionnaires were translated and adopted in Hindi and Bengali language after appropriate standardization procedure. This translated questionnaires were field tested on 30 adults whose mother tongue was Hindi and Bengali respectively so as to avoid any ambiguity in the questionnaires. Each patient was seen by an otologist as well as neurologist to ensure that the nature of tinnitus cannot be corrected medically or surgically.

Procedure: Fifty adults in the age range of 18 to 60 years with a mean range of 48years 1 month who fulfilled the above criteria were selected. There were 28 males and 22 females with mean age of 48 years 5 months and 47 years 6 months respectively.

After a brief history to ascertain the eligibility of the patient as a subject of the study, they were subjected to the following test / evaluations.

Pure tone audiometry was carried out following the standard procedure to determine the hearing threshold.

To determine whether the tinnitus sounds more like a tone or more noise, one of these stimuli was presented for one minute followed by the other.

Pure Tones (Continuous, Pulse and Warble), Noise (Narrowband, BBN and Speech), and asked the patient to match the sounds most like your tinnitus.

Pitch and loudness matching of tinnitus was done following loudness balance procedure using same audiometer. To match the pitch, a pure tone/noise was presented contra laterally at a frequency well below the perceived tinnitus pitch, so that patients can easily tell the difference in pitch between the tone and the tinnitus. Tone was presented generally at 10-20 dB SL at frequencies where hearing was within normal limits and 5-10 dB SL (or less) where hearing thresholds was significantly elevated.1000 Hz is a good starting frequency. This frequency was described to the patient as a 'mid pitched tone' to provide a reference. Tones of different frequencies were then presented in octave intervals to gradually and identify the octave frequency that was closest to the perceived tinnitus pitch. Interoctave tones were then presented more closely to identify the exact tinnitus frequency. The pitch-matched tone was then compared with tones an octave higher and an octave lower, to ensure that the patient has not made the common mistake of '**octave confusion'**.

The tinnitus loudness match measured to the closet 5 dB step. Match stimuli were presented 5 dB below the threshold and increased the level in 5 dB steps until the patient reports a loudness match. The loudness matched was recorded in dB SL.

To find out the relation between 'traditional audiological pitch and loudness measures of tinnitus' and 'subjects' description of pitch and loudness of tinnitus', subject's were asked to describe the most prominent pitch of their tinnitus on 5 point scale, where 1- very low (250 Hz and below), 2-low (500 Hz) ,3- medium (1000 Hz-3000 Hz), 4-high (4000 Hz - 6000 Hz), and 5- very high (>6000 Hz). Similarly they were also asked to describe the most prominent loudness of their tinnitus on 5 point scale where 1-very faint (0 dB SL and below), 2-faint (5 dB SL), 3-medium (10 dB SL), 4- slightly loud (15 dB SL) and 5-very loud (>20 dB SL).

To measure effective masking level (EML) of tinnitus, the BBN /NBN /PT were presented to the ear with tinnitus, starting at the hearing threshold level. The level of the noise is raised in 5 dB steps until the patient cannot hear the tinnitus in the test ear. Once the tinnitus was completely masked in the test ear, the patient was asked if tinnitus can be heard in the contralateral ear. If tinnitus was not heard contralaterally, EML testing was completed and the level of the noise was unilateral EML. If the patient reports tinnitus in the contralateral ear,

then the noise was maintained at EML in the tinnitus ear, while noise in the contralateral ear was raised in 5 dB steps until the tinnitus was completely masked in that ear. At lower intensity level with BBN, tinnitus was masked completely then other stimuli.

Tinnitus Reaction Questionnaire (TRQ) and Nature of Tinnitus Questionnaire (NTQ) were administered to the patient as soon as the pure tone testing, pitch and loudness matching and effective masking level were completed. Clarifications were given whenever the patient had doubts about the questions.

On Tinnitus Reaction Questionnaire relative degree of distress for each patient was scored by adding the number marked for each item. The score obtained for each patient was then related to the patient's description of nature of tinnitus on Nature of Tinnitus Questionnaire.

However before preparing an Audiological and Psychological profile of each tinnitus sufferer, a written consent was taken from each subject.

The data was analyzed by using a standard statistical program called "**SPSS**" as well as by using percentile method, Pearson correlation, and parametric "t" test. The analyzed data was interpreted and discussed in the light of review of literature, research question and the objective of the present study.

	Percentage	
a) **Personal tinnitus history**	Yes	No
Masked by environmental noise	74	26
Problems getting to sleep	72	28
Number of sounds-single	72	28
Number of sounds-multiple	28	72
b) **Personal perception of tinnitus**		Percentage
Pitch of tinnitus	Very Low (< = 250 Hz)	06
	Low (500Hz)	22
	Medium (1000 Hz to 3000 Hz)	30
	High (4000 Hz to 6000 Hz)	32
	Very High (> 6000 Hz)	10
Pitch of tinnitus fluctuating	Yes	26
	No	74
Loudness of tinnitus	Very faint (0 dB SL and below)	04
	Faint (5 dB SL)	26
	Medium (10 dB SL)	48
	Slightly Loud (15 dB SL)	14
	Very loud (20 dB SL and above)	08
		Percentage
Loudness of tinnitus fluctuating	Yes	32
	No	68
Location of tinnitus	Left	22
	Right	24
	Both ears	54
		Percentage
Qualities best describe your tinnitus	Whistling	28
	Ringing	18
	Hissing	32
	Buzzing	38
	Humming	06
	Other	14
	Combination of two or more	28
Tinnitus becomes worse	Being in noisy place	14
	Being in quiet place	16
	Changing head position	04
	Lack of sleep	18
	When you are excited	12
	Early in morning	18
	Nothing above makes it worse	22
	Others	24
		Percentage
c) **Probable causes of tinnitus**	Yes	No
Accident	04	96
Consuming Alcohol	-	-
Consuming drugs/medicines	04	96
Noise exposure	06	94
Others	26	74
No idea	60	40

Table 1: Showing the percentage of Personal tinnitus history, Personal perception of tinnitus & Probable cause of tinnitus

Results and Discussion

The majority of sample (60%) reported that they do not have any idea regarding probable cause of their tinnitus; however 6% reported their tinnitus due to noise exposure while 4% reported it due to accident and consuming drugs (medicines). Moller (1984) reported that the cause of most forms of subjective tinnitus is a matter of speculation where as Majumdar, Mason and Gibbin (1983) stated that whistle tinnitus may accompany almost any otological disorder, its site of origin and the method of its development and generation are unknown. Similarly Coles, R.R.A (1984b) reported that tinnitus is most commonly associated with disorder or damage or

degeneration in the internal ear, most common in the form of age related hearing loss (ARHL) or noise induced hearing loss (NIHL).

Not even a single subject in the present study reported the cause of their tinnitus as consumption of alcohol. Similar observations were reported by Spitzer (1981) where, alcohol may have little or no effect on tinnitus among many individuals, but may appear to make it 'worse' in some and 'better' in others.

74% subjects of this study reported that there was no fluctuation in the pitch of their tinnitus while 68% reported that there is no fluctuation in the loudness of their tinnitus. This was in contrast to findings of Stouffer and Tyler (1990), and Kemp and George (1992) who found that a number of patients reported daily fluctuations in quality and loudness of their tinnitus and that it was associated with higher perceived levels and annoyance. However, Ross Dineen, Janet Doyle and John Bench (1996) reported that majority of their study subjects has found their tinnitus as constant.

		Statistical test	c My tinnitus has interfered with my sleep
b.	My tinnitus has led me feel depressed	Pearson Correlation	.612(**) degree of correlation
		Sig. (2-tailed)	.000 significant at .01 level

Table 2: Showing correlations between tinnitus and depression and sleep disturbance caused by it. **All the correlation are significant at the 0.01 level (2-tailed).

From the above table it can be seen that there was a significant correlation between the impact of tinnitus and disturbance of sleep caused by it with increase in depression and anger. Thus tinnitus has made these subjects more depressed which have significantly increased their levels of anger. The possible root cause for this as estimated by this researcher may be "difficulty in getting to sleep" because of presence of their tinnitus.

Impact of Tinnitus reaction	Statistical test	Duration of Tinnitus
My tinnitus has made me feel distressed	Pearson Correlation	-0.034 degree of co-relation
	sig. (2 tailed)	.813 Not significant

Table 3: Showing relationship between degree of tinnitus and its durations:

To find out the relationship between relative degree of distress and duration of tinnitus, the data was further analyzed using Pearson's correlation and t test. The results are shown in table 3.

Item	Nature of Tinnitus	
	Single nature	Multiple nature
My tinnitus has made me unhappy	13.9%	42.9%
My tinnitus has made me tense	5.6%	42.9%
My tinnitus has made me feel irritable	8.3%	42.9%
My tinnitus has made me feel angry	8.3%	14.3%
My tinnitus has led me to cry	2.8%	7.1%
My tinnitus has led me to avoid quiet situation	2.8%	50.0%
My tinnitus has led me feel less interested in going out	11.1%	35.7%
My tinnitus has led me feel depressed	5.6%	35.7%
My tinnitus has led me feel annoyed	2.8%	28.6%
My tinnitus has led me feel confused	0%	7.1%
My tinnitus has "driven me crazy"	0%	7.1%
My tinnitus has interfered with my enjoyment of life	5.6%	50.0%
My tinnitus has made it hard for me to concentrate	11.1%	42.9%
My tinnitus has made it hard for me to relax	11.1%	50.0%
My tinnitus has made me feel distressed	2.8%	35.7%
My tinnitus has made me feel helpless	2.8%	21.4%
My tinnitus has made me feel frustrated with things	2.8%	28.6%
My tinnitus has interfered with my abilities to work	19.4%	35.7%
My tinnitus has led me to despair	8.3%	21.4%
My tinnitus has led me to avoid noisy situation	16.7%	35.7%
My tinnitus has led me to avoid social situation	25.0%	28.6%
My tinnitus has led me to feel hopeless about the future	0%	21.4%
My tinnitus has interfered with my sleep	11.1%	14.3%
My tinnitus has led me to think about suicide	0%	7.1%
My tinnitus has made me feel panicky	0%	21.4%
My tinnitus has made me feel tormented	8.3%	21.4%

Table 4: Showing Tinnitus Reaction Questionnaire Score for nature of tinnitus

However, no significant co-relation was seen between distressed caused by tinnitus and duration of tinnitus (-.034). This has indicated that the length of time for which tinnitus is present has not influenced the perceived ability of the subject to cope with it which suggests that habituation to the tinnitus has not occurred. This is in contrast to the observation reported by Tyler and Baker (1983) that the level of distress caused by the tinnitus should decrease over time. However, Hallam et al., (1984) argued that there are certain individuals in whom such habituation process does not occur. This lack of habituation has been found to be associated with the personality characteristics and the presence of tinnitus.

From the above table, it can be viewed that the multiple nature/sounds of tinnitus has far more devastating effects or serious impact on 'tinnitus sufferers' than the single sound/nature. Similar findings were reported by Ross Dineen, Janet Doyle and John Bench (1996) that subject with multiple tinnitus sounds (n=40) found their tinnitus more louder (Z= -1.845, P=0.03), more annoying (z = -2.206, P=0.01), more difficult to cope with (z= -2.308, P=0.01), and had a greater level of reaction to their tinnitus as compared to subjects who reported it like a single sound.

Audiological measures of tinnitus

The four frequencies PTA ranged from 10 dB HL to 70 dB HL with mean of 53.4 dB HL and standard deviation of 17.1 for right ear, and 12.8 dB HL to 57.5 dB HL with a mean 53.4 dB HL and standard deviation 16.6 for left ear respectively.

The tinnitus frequency matching has been found to range from 125 Hz to 8000 Hz for 5 subjects with pure tone and pulse tone, speech noise for 3 subjects, narrow band noise for 35 subjects, and wide band noise for 6 subjects.

The tinnitus intensity matching was found to range from 30 dB HL to 90 dB HL in both ears with mean of 63.1 dB HL and standard deviation of 14.7 in right ear and mean of 61.7 dB HL with standard deviation of 17.1 in left ear respectively.

Total 49 subjects had measurable tinnitus while only one subject's tinnitus could not be measured because pitch and loudness was beyond audiometric limit and also she attempted to commit suicide because of her intolerable tinnitus.

The effective masking level were found to be ranged from 0 dB SL to 45 dB SL in both ears with mean of 8.5 dB SL and standard deviation of 12 in right ear and mean of 7.10 dB SL and standard deviation of 8.98 in left ear respectively.

The results are, a weak co-relation has been seen between traditional audiological measures

like pitch matching, loudness matching and subject's description of pitch and loudness of tinnitus. Similar study was reported by Hallam et al., (1988); & Dineen et al., (1993), where traditional audiological measures of tinnitus, such as pitch and loudness matching were weakly related to self reported perceived pitch and loudness level of tinnitus.

Gender differences

Gender differences were also found among tinnitus sufferers while assessing the audiological and psychological measures of tinnitus.
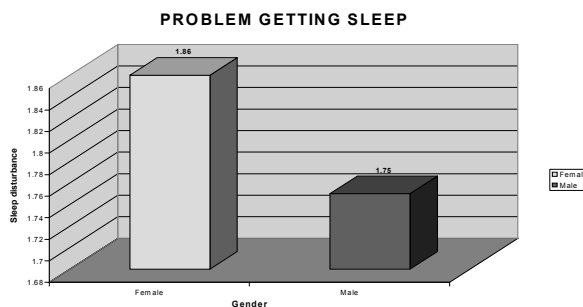
Graph 1: Showing Gender Differences in Difficulties Getting to Sleep due to Tinnitus.

Independent Samples Test

|	Levene's test for equality of varience			
	F	Sig	df	Sig. (2-tailed)
MALE	1.702	.199	42	.000 significant
FEMALE			41.652	.000 significant

**All the correlation are significant at the 0.000 level (2-tailed).

Table 5: Showing Gender Differences in Difficulties Getting to Sleep due to Tinnitus

The female had more difficulty getting sleep compaired to males as indicated by the mean score (female 1.86, male 1.65) and t-test result (t-test significant 2- tailed at .000 level). Similar study was reported by Ross Dineen, Janet Doyle et al., (1996) where female subjects indicating more difficulties in getting to sleep because of tinnitus than male subjects.

Female subjects also reported a higher level of emotional reaction with a mean of 35.9 to their tinnitus as compared to males with a mean of 31.7. This had made female subjects more frustrated than their male counterparts. In contrast to this study, Hallberg and Erlandsson (1993) reported no gender differences in regard to psychological reactions to tinnitus, such as interference with

concentration, irritability or sleep disturbances. However Ross Dineen, Janet Doyle and John Bench (1996) reported female subjects with a higher level of emotional reaction to their tinnitus as compared to males.
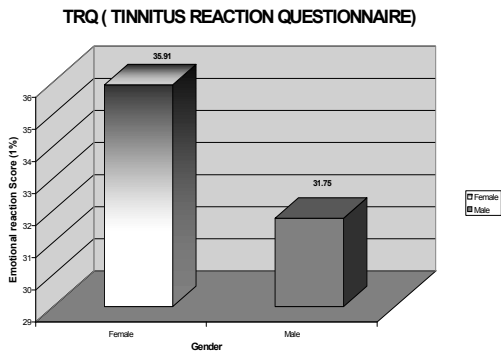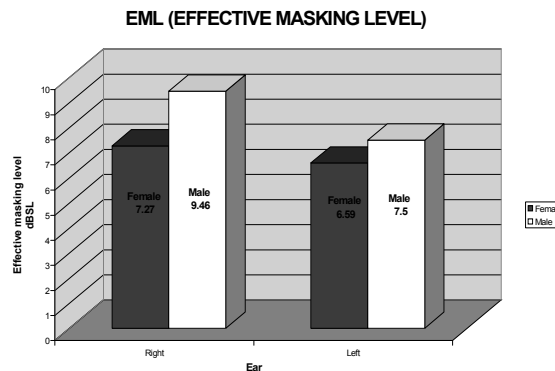

Graph 2: Showing Gender Differences in Impact of Tinnitus

Also female subjects perceived their tinnitus 'more louder' and thus 'more annoying' than their male counterparts with TRQ scores significantly higher for female subjects >35.9 than males 31.7.

The frequency to which tinnitus was matched was higher in female subjects with a mean of 3963.2 Hz and 3602 Hz for right and left ear respectively than their male counterparts with mean of 3047.6 Hz and 3228 Hz for right and left ear respectively. In contrast to this study, Ross Dineen, Janet Doyle and John Bench (1996) reported that frequency to which tinnitus was matched was higher in male subjects than female subjects with male mean of 5332 Hz and female mean of 3976 Hz respectively.

Tinnitus Intensity Matching (TIM) tended to be higher in female than male subjects with male mean for right ear and left ear as 61.88 dB HL, and 59.38 dB HL respectively with that of female mean for right ear and left ear as 64.05 dB HL and 63.41 dB HL respectively. All the correlation was significant at the 0.01 level (2-tailed). Similar findings were reported by Ross Dineen, Janet Doyle and John Bench (1996) where tinnitus intensity matching was higher in female than male subjects (male mean = 7.5 dB SL, female mean = 10.5 dB SL).

Effective masking level tended to be higher in male subjects than female subjects with male mean for right ear and left ear 9.46 dB SL and 7.50 dB SL respectively with that of female mean for right ear and left ear as 7.27 dB SL and 6.59 dB SL. In contrast to this study, Ross Dineen, Janet Doyle and John Bench (1996) reported no significant differences between female and male subjects with reference to effective masking level.

Graph 3: Showing Gender Differences in Effective Masking Level

Thus, this is an overview of audiological and psychological characteristics of a group of tinnitus sufferers.

Conclusions

Maximum subjects were able to forget about their tinnitus at times, as it was masked by environmental noises while 14% reported that it remained same even in noisy places. 72% subjects perceived their tinnitus like whistling, ringing, buzzing and hissing. 74% subjects of this study reported no fluctuation in the pitch of their tinnitus while 68% reported no fluctuation in the loudness of their tinnitus. A significant co-relation has been seen between tinnitus and annoyance as well as distressed and sleeps disturbances caused by it. Tinnitus has resulted in multifold effects/impacts on tinnitus sufferers where it has made them feel unhappy, tense, irritable, depressed, annoyed, distressed and frustrated. It has interfered with their enjoyment, their relaxation, their sleep, and forced them to avoid quite and social situations. It has affected their concentration and reduced their interest in going out.

Longitudinal study will give more comprehensive result on an audiological and psychological profile of tinnitus sufferers. These studies would further help in the overall management of the patient suffering from tinnitus.

References

Coles, R. R. A (1984a) Epidemiologyof tinnitus: (2) Demographic and clinical feature. *Journal of Laryngology and Otology* supplement 9:195-202. In Rosenhall, U. & Karlsson, A. (1991). Tinnitus in old age. Scandanavian Audiology, 20, 165-171.

Dineen. R., Doyle, J. and Bench. J. (1993). Coping strategies : an approach to understanding how people manage tinnitus. Cited in Dineen, R., Doyle, J. and Bench, J. (1997). Managing Tinnitus: Comparison of different approaches to tinnitus management training. *British Journal of Audiology, 31*, 27-38.

Hallam, R. S., Jakes, S.C., and Hinchcliffe, R. (1988). Cognitive variables in tinnitus annoyance British Journal of Clinical Psychology, 27, 213, 222. Cited in Dineen, R. Doyle, J and Bench, J (1997) Managing Tinnitus: A comparison of different approaches to tinnitus management training. *British Journal of Audiology, 31,* 27-38.

Hallam, R. S., Rachman, S., and Hinchecliffe, R. (1984) Psychological aspects of tinnitus. In Rachman S, (Ed.) Contributions of Medical Psychology. Oxford, Pergamon Press, 1984; 31 - 53. In Dineen, R., Doyle, J. and Bench, J. (1997). Managing Tinnitus: A comparison of different approaches to tinnitus management training *British Journal of Audiology, 31*, 331-334.

Hallberg, L. R., & M. Erlandsson, S. I. (1993). Tinnitus characterisitics in tinnitus complainers and non complainers. *British Journal of Audiology, 27*, 19-27.

Kemps, S. & George, R. N. (1992). Diaries of tinnitus sufferers. British Journal of Audiology, 26:382-386.

Kirsch, C. A., Blanchard, E. B. & Parnes, S. M. (1989). Psychological characteristics of individual high and low in their ability to cope with tinnitus. Psychosomatic M.Ed; 51: 209-217. Cited in Dineen, R., Doyle, J. and Bench, J. (1997). Managing Tinnitus: A comparison of different approaches to tinnitus management training. *British Journal of Audiology, 31*, 27-38.

Majumdar B, Mason S. M., and Gibbin K. P. (1983). An electrocochleographic study of the effects of lignocaine on patients with tinnitus. Clinical Otolaryngology 8: 175-180.

Moller, A. R. (1984). Pathophysiology of tinnitus. *Annals of Otolaryngol*, 93: 39-44. In Th. Lenarz (1985). Treatment of tinnitus with Lidocaine and Tocainde. *Scandanavian Audiology* and supplement 26. Third international symposium on audiological medicine. 18-21, pp. 49-59.

Ross Dineen, Janet Doyle & John Bench, (1996). Audiological & Psychological characteristic of a group of tinnitus sufferer, prior to the tinnitus management training, British Journal of audiology,1997,31, 27 - 38.

Spitzer, J. B. (1981) 'Auditory Effects on Chronic Alcoholism', Drug and Alcohol Dependence, 8(4), 317 – 35.

Stouffer, J. L. & Tyler, R. S. (1990). Characteristics of tinnitus by tinnitus patients, *Journal of Speech and Hearing Disorders*, 55, pp 439-453.

Tyler, R. S. & Baker, L. J. (1983). Difficulties experienced by tinnitus sufferers, *Journal of Speech and Hearing Disorder*s, 48,150-154.

Wilson, P. H., Henry, J., Bowen, M., and Haralambous, G. (1991). Tinnitus Reaction Questionnaire; Psychometric properties of a measure of distress with tinnitus, *Journal of Speech and Hearing Research*, 34,197-201.

Book Review

STATUS OF DISABILITY IN INDIA - 2007

Vol. 1 - Hearing Impairment
&
Deaf Blindness

Chief Editor: Dr. Shailaja Nikam*

The Rehabilitation Council of India which was established in May 1986 will soon celebrate its Silver Jubilee. Twenty five years is a short time in the life of an institution. In this short period the RCI, as it is affectionately called by all rehabilitators has done tremendous work and now as a Statutory Body is guiding, monitoring and encouraging a variety of rehabilitative endeavours. It has stimulated the establishment of new programmes, new institutions and very importantly encouraged appropriate meaningful legislation.

Among the many good things it has achieved is the publication of three books, 'Status of Disability in India – 2000, 2003 and 2007'. The latest book 'STATUS OF DISABILITY IN INDIA – 2007' was published in the year 2008. The earlier books were published as single books covering all the disabilities and they were called as 'Mahapuranas' by Mr. A.K.Sinha who was for sometime the Member Secretary of RCI. The present book is published in separate volumes, each dedicated to one or a set of related disabilities. Each volume is now handier; but it is also a 'Purana' considering its value to the readers.

The Chief Editor of the present book Dr. S Nikam has had her hands full and she has risen to the challenge admirably, if I can go by the volume on Hearing Impairment and Deaf blindness. All kudos to her!

She has had the help of sets of eminent teachers and rehabilitators to the two sections.

Their contributions are very impressive. There is no indication in the book whether the different chapters were written by different individuals or the whole contributions are a result of team work and group discussions. It would have been useful if one knew who contributed what so that one could seek more information if necessary from individual contributors.

The goal of these Status Reports seems to have slowly shifted though the original intentions have not been lost sight of. The first book was originally conceived to be a primary reference for professional people to fulfill a felt need for an 'in depth reference point.' Dr. J.P.Singh, Member Secretary desired the second book 'to take stock, change to introspect or otherwise the future as want cannot be ours'. The present book, 'Status of Disability in India – 2007' also intends to take 'stock of the present status and chart new directions'. Dr. Nikam, the Chief Editor emphasizes introspecting, questioning and modifying our efforts and she hopes that the imbalances and obvious unevenness in the welfare measures are looked into and that this would lead to greater effort to keep up with each other!

The chapters in the volume are well planned and cover valid questions. This volume when read along with the previous volumes provides a clear picture of the status of disability in India, thus amply fulfilling the purpose of the efforts of the contributors. The chapters are very well written and the contributors must be complimented on the

Ex-Director, All India Institute of Speech & Hearing, Mysore-570006.

clarity and validity of their information.

The present volume has consciously tried to continue where the older books ended and thus in general has avoided duplication. This is a good plan. The chapter on historical perspectives in Hearing Impairment has rightly included only the newer innovations such as the early intervention centers and the disability-help-line. It would have been good if all the writers had done similarly.

In general, the chapters are clear and concise and do give a fair picture of the current status. However, it is an onerous task to be concise and comprehensive at the same time. Several errors of omission and commission are bound to occur. The contributors of the present volume have not been able to escape these pitfalls.

Some information of common knowledge such as the ear and its work, the impact of hearing impairment are totally out of place here. Similarly history of rehabilitation around the world or discussion of definitions and of issues in rehabilitation could have been avoided except when they affect current status in India. Careful editing could have made even an excellently written chapter on deaf blindness shorter. As it is the section on Deaf blindness reads like an extremely well written brochure on Deaf blindness. However, much of the section is superfluous and takes attention away from the excellent analysis of the current status! (Incidentally, the Deaf blind Fredrick, the young man from Trichy who passed the preliminaries of the Indian Administrative Service should have found a place among the Indian achievers instead of being banished to a note in a running paragraph!)

Some glaring omissions that need mention are sign language and the efforts to promote it, the phenomenal increase and success in preschools, the great push to inclusive education, the increase in access to education through reservations in colleges and technical institutions, Sarva Shikshana Abhiyan and such efforts of expanded education facilities. The research referred to seem limited to that done in NIHH and all the wonderful work being done in AIISH and other centers seems to have been overlooked. Strangely the professional journals being published in the field find no mention. Stranger still the professional associations N.C.E.D and ISHA and many Associations of parents of the hearing impaired seem to be ignored.

The chapter on educational services for the hearing impaired does an excellent, though incomplete, qualitative assessment of education. Other chapters do make passing references evaluating the present status. However, status reports should make honest performance audits as a part of the introspection everyone emphasizes.

However, in *toto*, all the contributors deserve our applause for the sincerity with which they have approached their task. One can only have great regard and appreciation of their wonderful achievement.

We thank the RCI, the contributors and the Chief Editor for this book of value.

Reviewed by
Dr. N. Rathna
Ex-Director, AIISH, Mysore &
AYJNIHH, Mumbai