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A SURVEY OF VOICE RELATED CONCERNS IN ELDERLY COLLEGE TEACHERS

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Abstract

Elderly teachers may suffer impacts in voice due to prolonged use of voice for teaching, and changes that occur at old age. The study aimed to profile voice related concerns in elderly teachers by compiling the health status, life style, their knowledge about the voice changes, their voice characteristics which consequently affect their communication in daily life. The study was carried out among 150 teachers in three phases that included development of questionnaires, pilot study to validate the questionnaire and survey of voice related concerns in elderly college teachers. On analyzing the life style and general health, there were no significant changes in voice as a result of smoking, consumption of alcohol, carbonated drinks and non vegetarian diet. Most of the subjects reported of adequate water intake and involved in regular physical exercises. Subject who reported difficulty in hearing (42%), swallowing (22%) and gastric problems (42%) were prone to develop changes in voice. Female subjects who had problems related to menopause reported to have changes in voice. Individuals with adequate knowledge on aging effects of voice were able to identify changes in their voice. Speaking with increased effort was one of the frequently reported symptoms. Subjects who reported to have voice changes were upset (negative emotion, & possibly affected quality of life) and problems in daily communication were expected. Results of this study highlighted various aspects on voice concerns of elderly teachers. Health related issues and life style factors may be considered as risk factors to develop voice problem in them. It is important to improve knowledge on lifestyle patterns and factors contributing to voice changes in the elderly to facilitate and accept age related changes in voice. Results of this study will aid to sensitize speech pathologists regarding the voice related concerns in elderly teachers that are socio-culturally relevant.

Key words: *Questionnaire, life-style, emotional impact, voice characteristics.*

Voice disorder can be due to excessive, prolonged use of voice and due to age related structural changes in the larynx (presbyphonia). Voice problems are noted in elderly (Roy, Stemple, Merrill, and Thomas, 2007) and in teachers (Smith, Gray, Dove, Kirchner and Heras, 1997). Boominathan, Rajendran, Nagarajan, Seethapathy and Gnanasekar (2008) reported based on a survey of voice problems in professional voice users, that teachers have more vocal symptoms and voice problems than persons in other occupations. Rowan and Gore (2005), stated that age related dysphonia is characterized by change in pitch, increased strain, voice breaks, vocal tremor, breathiness, instability, reduced loudness, change in voice, vocal fatigue, physical fatigue, and inadequate breath support for speaking. Teacher's voice problems are described as tired, weak or effortful voice and physical discomfort while speaking (Smith, Lemke, Taylor, Kircher, and Hoffman, 1998).

Opportunities are available that allow the teachers to remain in teaching even after retirement. Further, in 2007, The Union Ministry of Human Resource Development had instructed the University Grants Commission (UGC) to increase the retirement age for teachers from 62 to 65 years. Elderly teachers may be more prone for developing and sustaining voice problems due to excessive stress and prolonged use of voice for teaching, and also due to the changes that are occurring at old age. Since there is a rise in population of elderly teachers in India and the likelihood of voice problems in them is also expected to be high.

The authors are unaware of earlier studies that report voice related concerns of this unique vulnerable professional voice user group – elderly college teachers. The present study aimed to profile the voice related concerns of elderly college teachers by compiling the health status, life style, vocal habits and methods (aids, etc) used to project voice in classrooms, their knowledge about the age related changes, their voice characteristics which consequently affect their communication in daily life situation and the emotional impact due to changes in voice using a survey method. This in turn would help to facilitate and to create awareness among the elderly teachers to preserve their voice at their older age. It will also sensitize speech pathologists regarding the voice concerns and voice problems in elderly teachers that will prove handy in clinical practice.

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Method

The study was carried out in three phases which included the development of questionnaires, pilot study to validate the questionnaire and the survey of voice related concerns in elderly college teachers. In the first phase, two questionnaires were developed. The first questionnaire (Appendix I) was developed to address voice related concerns in elderly teachers. It consisted of demographic data and 33 questions (8 open ended and 25 close ended questions). The eight open ended questions collected information on health and life style. The 25 close ended questions addressed five sections (general health, knowledge and awareness of the developmental changes, factors affecting voices in elderly, voice characteristics, its effect on communication in daily situations and the emotional impact caused due to changes in voice). Internal consistency of the questionnaire was 0.658 on using Cronbach's alpha coefficient (α). The second questionnaire (Appendix II) was developed to judge the inter rater reliability between teachers and their students. The ten questions included voice related symptoms perceived by students in their teachers' voice during lectures and the severity of voice symptoms were based on the frequency of occurrence ranging from never to always.

During the second phase, a pilot study was conducted on 15 elderly teachers with 30 of their students (2 students for 1 elderly teacher) to judge the inter-rater reliability in perceiving the voice characteristics of the elderly teachers. Intra class correlation coefficient analysis was carried out to judge inter-rater reliability. Since the results obtained from the pilot study indicated good inter-rater reliability the survey was continued with elderly college teachers alone. In phase three, Questionnaire 1 was distributed to 300 teachers of various colleges in India. Of the 300 teachers approached, only 150 elderly teachers (Male: 115; Female: 35) were involved in the study, who had a minimum of fifteen years of experience in teaching and currently used their voice for a minimum of two hours per day for teaching.

Each section of data was analyzed for gender difference, frequency of the problem reported and by comparing various sections with changes in voice. Pearson's chi- square test of significance was used to estimate gender differences in responses to sections I to V. Odds ratio was used to estimate the risk of developing change in voice consequent to health problems, effect of knowledge of aging in identifying changes in voice and to estimate the changes in voice and its risk of impacting communication in daily situations.

Results

The study aimed to profile life style patterns, medical history, health status, knowledge of "age related changes", voice characteristics, emotional impact caused due to the changes in voice on communication in daily life in elderly college teachers. In section I (Life style and general health), 33.9% of males reported to have the habit of smoking and 41.7% of male subjects reported the habit of consuming alcohol occasionally. However, no significant change in voice was reported as a result of smoking and alcohol consumption (table 1). Table 2 reveals that 55.7% of males and 37.1% of females consumed carbonated drinks. The percentage of consumption of non-vegetarian food was comparatively higher in both genders. Yet, no significant changes in voice were reported as a result of consumption of carbonated drinks and non vegetarian diet.

Table 1: *Number of subjects reported to be involved in social habits and its effect on changes in voice*

Social habits		Changes in voice				p - value
		Present		Absent		
		#	%	#	%	
Smoking habit	Yes	26	27.1	13	24.1	0.69
	No	70	72.9	41	75.9	
Alcohol consumption	Yes	29	30.2	19	35.2	0.53
	No	67	69.8	35	64.8	

Table 2: *Common food preferences reported by the elderly teachers and its effect on changes in voice*

Food habits		Changes in voice				p - value
		Present		Absent		
		#	%	#	%	
Carbonated drinks	Yes	41	51.4	36	47.4	0.23
	No	33	48.6	40	52.6	
Non–vegetarian foods	Yes	45	62.2	43	50.3	0.36
	No	29	37.8	33	49.7	

79.6% of males and 56.5% of females reported adequate and frequent intake of water (at least 2 liters per day) to avoid vocal fatigue. It was also reported that 70.4% of males and 65.7% of females involved in regular physical/ breathing exercise to keep them physically fit. Diabetes and elevated blood pressure were commonly reported health problems in elderly teachers. On analyzing the data obtained on difficulty in hearing (Table 3), 45.2% of males and 31.4% of females reported to have difficulty in hearing. The gradual decline in hearing in old age, initially in the higher frequencies may influence excessive vocal use in elderly. Table 4 illustrates that when the subjects had difficulty in hearing, changes in voice were reported. The risk estimate

based on odds ratio revealed that a subject who reported difficulty in hearing was 2.28 (lower: 1.12 & upper: 4.62) times prone to develop changes in voice.

Table 3: *Frequency of difficulty in hearing reported in elderly teachers (males & females)*

Frequency	Males		Females		Total	
	#	%	#	%	#	%
Never	63	54.8	24	68.6	87	58.0
Rarely	18	15.7	5	14.3	23	15.3
Sometimes	27	23.5	6	17.1	33	22.0
Frequent	5	4.3	0	0.0	5	3.3
Always	2	1.7	0	0.0	2	1.3
Total	115	100.0	35	100.0	150	100.0

Table 4: *Comparison between occurrence of difficulty in hearing and its effect on changes in voice*

Difficulty in hearing	Changes in voice				p - value
	Yes		No		
	#	%	#	%	
Yes	47	49.0	16	29.6	0.02*
No	49	51.0	38	70.4	

* (p<0.05) – statistically significant

In the present study it was found that 21.7% of males and 22.9% of females reported to have difficulty in swallowing (Table 5). Shamburek and Farrar (1990) also stated that the incidence of dysphagia along with voice problem is seen in elderly. Significant difference (p = 0.04) was obtained between individuals who reported difficulty in swallowing and changes in voice. From table 6 it was noted that individuals who reported swallowing difficulty reported to have changes in voice. The risk estimate revealed that a subject who reported difficulty in swallowing was 2.49 (lower: 1.00 & upper: 6.21) times prone to develop changes in voice.

Table 5: *Frequency of elderly teachers (males & females) reported to have difficulty in swallowing*

Frequency	Males		Females		Total	
	#	%	#	%	#	%
Never	90	78.3	27	77.1	117	78.0
Rarely	14	12.2	7	20.0	21	14.0
Sometimes	11	9.6	0	0.0	11	7.3
Frequent	0	0.0	1	2.9	1	0.7
Always	0	0.0	0	0.0	0	0.0
Total	115	100.0	35	100.0	150	100.0

Table 6: *Comparison between subjects who reported to have difficulty in swallowing and its effect on changes in voice*

Difficulty in swallowing	Changes in voice				p - value
	Yes		No		
	#	%	#	%	
Yes	26	27.1	07	13.0	0.04*
No	70	72.9	47	87.0	

* (p<0.05) – statistically significant

It was found that 60% of the males and 68.6% of the females reported to have gastric problems. Individuals who reported to have gastric problem also reported to have changes in voice and subject who reported to have gastric problem was 2.20 times prone to develop changes in voice.

Table 7: *Frequency of elderly teachers (males & females) suffering from heart burn or gastric problems*

Frequency	Males		Females		Total	
	#	%	#	%	#	%
Never	46	40.0	11	31.4	57	38.0
Rarely	27	23.5	14	40.0	41	27.3
Sometimes	31	27.0	7	20.0	38	25.3
Frequent	11	9.6	1	2.9	12	8.0
Always	0	0.0	2	5.7	2	1.3
Total	115	100.0	35	100.0	150	100.0

Table 8: *Comparison between subjects who reported to have gastric problem and its effect on change in voice*

Gastric problems	Change in voice				p – value
	Yes		No		
	#	%	#	%	
Yes	66	68.8	27	50.0	0.02*
No	30	31.3	27	50.0	

* (p<0.05) – statistically significant

In the present study, out of 35 females 25.7% reported to suffer from problems related to menopause. It was found that when elderly female subjects had problems related to menopause, they reported to have changes in voice as shown in table 9.

Table 9: *Female subjects reported to suffer from issues related to menopause and its effect on voice*

Problems related to menopause	Changes in voice				p – value
	Yes		No		
	#	%	#	%	
Yes	09	39.1	0	0.0	0.01*
No	14	60.9	12	100.0	

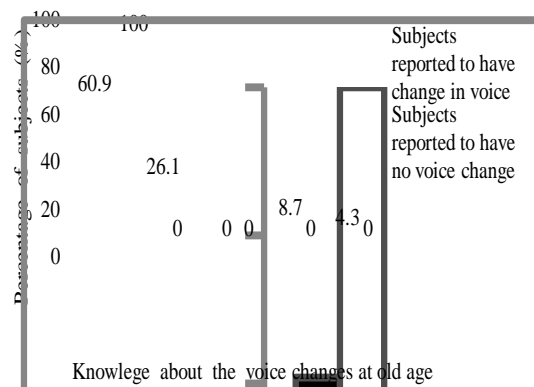* (p<0.05) – statistically significant

Figure 1: *Comparison between knowledge of voice change at old age and change in voice*

The second section addressed about the knowledge about voice changes due to aging. It was found that 86.1% of males and 94.3% of females reported to have the knowledge about the changes in voice occurring at old age.

Table 10 tabulated the knowledge about changes in voice occurring at old age and reported changes in voice. Results revealed that when knowledge of changes in voice was present, the ability to identify voice change was 4.29 (lower: 1.51 & upper: 12.20) times more than individuals with lack of knowledge. It was found that 79.1% of males and 88.6% of females reported to have the knowledge of factors affecting/ influencing voice change at old age.

Table 10: *Knowledge about changes in voice occurring at old age and change in voice*

Knowledge about changes in voice occurring at old age	Change in voice				p – value
	Yes		No		
	#	%	#	%	
Present	90	93.8	42	77.8	0.00*
Absent	06	6.3	12	22.2	

* (p<0.05) – statistically significant
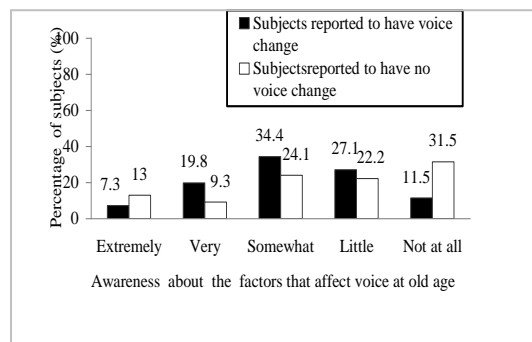
Figure 2: *Comparison between awareness about the factors that voice at old age and subjects with and without voice problem*

Table 11: *Knowledge about factors that affect/ influence voice at old age and change in voice*

Knowledge about factors that affect/ influence voice at old age	Changes in voice				p – value
	Yes		No		
	#	%	#	%	
Present	85	88.5	37	68.5	0.00*
Absent	11	11.5	17	31.5	

* (p<0.05) – statistically significant

Results revealed that when knowledge of factors affecting voice at old age was present, the ability to identify change in voice was 3.55 times more than individuals with lack of knowledge.

In section III, the voice characteristics reported by elderly teachers were documented (Figure 3). It was found that significant difference (p=0.04) was reported across gender for speaking with

increased effort (female subjects reported to have more problem than male subjects). Section IV analyzed the emotional impact due to changes in voice and is tabulated in table 12. The results indicated that subjects who reported to have change in voice had varying impacts on their 'emotional status' due to voice change.
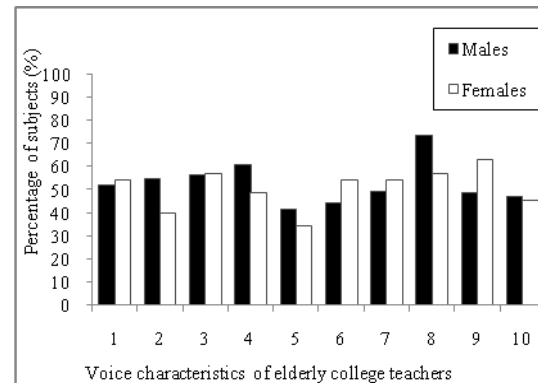
Figure 3: *Comparison of voice characteristics reported in elderly teachers across gender*

(1 - Change in voice; 2 - Variation of voice in a day; 3 - Change in pitch; 4 - Loss of voice after prolonged speaking; 5 - Tremulous voice; 6 - Rough voice; 7 - Difficulty in speaking aloud; 8- Getting tired while speaking for long; 9- Speaking with increased effort; 10- Running short of breath)

Table 12: *Change in voice reported by elderly college teachers across gender*

Change in voice	Males		Females		Total	
	#	%	#	%	#	%
Yes	73	63.5	23	65.7	96	64.0
No	42	36.5	12	43.3	54	36.0
Total	115	100.0	35	100.0	15	100.0

No significant difference (p = 0.80) was observed between male and female subjects.
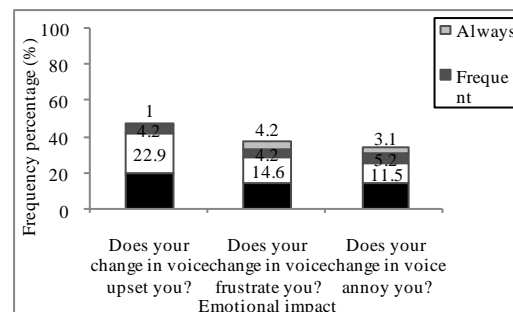
Figure 4: *Frequency of change in voice reported by elderly teachers and its emotional impact*

The final section addressed the effect of changes in voice on daily communication. Subjects reported to have a negative effect on their communication due to their voice problem. However, no significant difference was noticed across gender. A significant difference was reported for all the aspects of communication in

daily situations as mentioned in table 13 except for trouble being heard in noisy situations. This shows that the elderly teachers were able to accept the changes in their voice due to aging. Odds ratio (table 14) was used to estimate the risk for developing problem in communication in

daily situation in individuals who reported to have changes in voice. The results revealed that when individuals reported change in voice, problems in day to day communication was expected.

Table 13: *Comparison of change in voice and its effect on communication in daily situation*

Communication in daily situation		Change in voice				p - value
		Yes		No		
		#	%	#	%	
Trouble being heard in noisy situation	Yes	62	64.6	32	59.3	0.51
	No	34	35.4	22	40.7	
Difficulty identifying on phone	Yes	44	45.8	09	16.7	0.00*
	No	52	54.2	45	83.3	
Others asking for repetition	Yes	59	61.5	16	29.6	0.00*
	No	37	38.5	38	70.4	
Voice changes affecting job performance	Yes	27	28.1	04	7.4	0.00*
	No	69	71.9	50	92.6	
Change in voice annoying family and friends	Yes	28	29.2	04	7.4	0.00*
	No	68	70.8	50	92.6	
Changes in voice restricting personal and social life	Yes	32	33.3	01	1.9	0.00*
	No	64	66.7	53	98.1	

* (p<0.05) – statistically significant

Table 14: *Risk estimate value for effect of voices change on communication in daily situation*

Communication in daily situations	Risk estimate value
Trouble being heard in noisy situation	1.08
Difficulty identifying on phone	1.54
Others asking for repetition	1.59
Change in voice affecting job performance	1.50
Change in voice annoying family and friends	1.51
Change in voice restricting social life	1.77

Discussion

Elderly teachers reported several health related issues and life style factors that influenced changes in voice. Some of the reported factors were smoking, consumption of alcohol and carbonated drinks, inadequate water intake, intake of spicy foods and lack of regular physical exercises. Since smoking has a deleterious effect on the mucosa of the larynx (Schwartz et al., 2005), it can lead to decreased vibratory efficiency and in turn change in voice in these subjects. However, no significant change in voice was reported as a result of smoking and alcohol consumption. Since consumption of carbonated drinks dehydrates the vocal folds (Chang, 2007), it is speculated that subjects who consumed carbonated drinks may develop voice problems.

In the present study, consumption of non-vegetarian food was higher in both genders. Ng (2000) also reported that increased intake of non vegetarian (spicy) food can lead to heart burn in turn causing laryngopharyngeal reflux. Increased and frequent intake of water was necessary especially in tropical countries like India (Boominathan, Chandrasekhar, Ravi & Krupa, 2009). Gastric problem and heart burn can result in symptoms such as hoarseness, chronic cough with a mucous-sticking sensation (Amirlak, Mudd, & Shaker, 2009). Similar findings were reported in the present study which suggested that subjects reported to have changes in voice with varying frequency of gastric problems.

In addition, National Institute on Deafness and Other Communication Disorders (2008) suggested that practices of breathing exercises are important to support voice projection and to improve breath control. However, results of this study revealed that changes in voice were reported even in subjects who practiced regular physical exercises.

Other interesting findings were, elderly teachers who reported difficulty in hearing and swallowing were more prone to develop changes in voice. The findings of the present study supported the findings of Davis (2004), who stated that during menopause vocal fold tissue dries and leads to dryness of throat, frequent throat clearing and hoarseness. These life style factors and health related issues may be considered as risk factors to develop voice problem in elderly teachers.

Individuals with adequate knowledge of aging effects on voice were able to identify changes in their voice. It is important for elderly teachers to improve knowledge on various life style patterns and the factors contributing to voice changes in old to facilitate and accept age related changes in voice. Boominathan, Chandrasekhar, Nagarajan, Madraswala and Rajan (2008) stated that sensitizing teachers through vocal hygiene program is essential to protect their voice and to stay healthy (vocally).

Elderly teachers are more prone to developing voice problem due to work pressure, stress and prolonged use of voice in teaching and age related changes. Female teachers reported of more changes in voice than male teachers. The results of the present study supported the findings obtained by Miyazaki, Mizumachi and Niyada (2009) which stated that voice characteristics of elderly include pitch change, loss of voice, tremor in voice, roughness, reduced loudness, voice fatigue, and reduced breath while speaking. Most of the elderly teachers who reported to have changes in voice had a negative effect on emotional response to voice change and day to day communication. Similar findings were reported in a study done by Leeuw and Mahieu (2003) which stated that age related vocal changes are associated with psychological dysfunction in daily life.

Conclusion

Elderly teachers are more vulnerable to developing voice problems. Therefore, it is important for elderly teachers to improve knowledge on various life style patterns and the factors contributing to voice changes in old age to facilitate and accept age related changes in voice. Most of the elderly teachers who reported to have changes in voice had a negative effect on emotional response to voice change and day to day communication. Results of this study highlighted various aspects of lifestyle, voice use, risk factors, emotional and communication impairment due to voice changes in elderly teachers. This information will aid to sensitize speech pathologists regarding voice related concerns in elderly teachers that are socio-culturally relevant.

References

Amirlak, B., Mudd, P. A., & Shaker, R. (2009). *Reflux laryngitis.* Retrieved March 29, 2010, from http://emedicine.medscape.com/ article/864864-overview

Boominathan, P., Chandrasekhar, D., Nagarajan, R., Madraswala, N. Z., & Rajan, A. (2008). Vocal hygiene awareness program for professional voice users (Teachers). *Asia Pacific Journal of Speech, Language and Hearing*, *11*(1), 39-45.

Boominathan, P., Chandrasekhar, D., Ravi, S., & Krupa, M. (2009). Impact of 'Vocal hygiene programme in professional voice users (Teachers). *Journal of Indian Speech and Hearing Association*, *23,* 10-18.

Boominathan, P., Rajendran, A., Nagarajan, R., Seethapathy, J., & Gnanasekar, M. (2008). Vocal abuse and vocal hygiene practices among different levels of professional voice users in India: A survey. *Asia Pacific Journal of Speech, Language and Hearing*, *11*(1), 46-53.

Chang, C. Y. (2007). *Tips to maintain a healthy voice.* Retrieved March 27, 2010, from http://www.fauquierent.net/tips.htm.

Davis, J. L. (2004). Voice change is overlooked menopause symptom. *Menopause Health Center.* Retrieved April 5, 2010, from http://www.webmd.com/menopause/news/20040316/voice-change-is-overlooked-menopause-symptom

Leeuw, I. V., & Mahieu, H. F. (2003). Vocal aging and the impact on daily life: A longitudinal study. *Journal of Voice, 18* (2), 193-202. doi:10.1016/j.jvoice.2003.10.002

Miyazaki, T., Mizumachi, M., & Niyada, K. (2009). Acoustic analysis of breathy and rough voice characterizing elderly speech. *Journal of Advanced Computational Intelligence and Intelligent Informatics, 14*(2), 135–145.

National Institute on Deafness and Other Communication Disorders. (2008). *Taking care of your voice.* Retrieved April 10, 2010, from http://www.healthfinder.gov/ orgs/hr2449.htm

Ng, T.Y. (2000). Adult voice disorders. *The Hong Kong Practitioner, 22*, 71-79.

Rowan, M. G., & Gore, J. L. (2005). Acoustic – perceptual correlates of voice quality in elderly men and women. *Journal of Communication Disorders, 39*(3), 171-184.

Roy, N., Stemple, J., Merrill, R. M., & Thomas, L. (2007). Epidemiology of voice disorders in the elderly: Preliminary findings. *The Laryngoscope*, *117*, 1- 6.

Schwartz, S. R., Cohen, S. M., Dailey, S. H., Rosenfeld, R. M., Deutsch, E. S., Gillespie, M. B. et al. (2009). *Clinical practice guideline: Hoarseness (Dysphonia), 141,* 1-31.

Shamburek, R. D., & Farrar, J. T. (1990). *Oropharyngeal dysphagia.* Retrieved March 29, 2010, from http://en.wikipedia.org/wiki/Oropharyngeal_dysphagia.

Smith, E., Gray, S. D., Dove, H., Kirchner, L., & Heras, H. (1997). Frequency and effects of teachers' voice problems. *Journal of Voice, 11*(1)*,* 81-87.

Smith, E., Lemke, J., Taylor, M., Kircher, H. L., & Hoffman, H. (1998). Frequency of voice problems among teachers and other occupations. *Journal of Voice, 12*(4), 480-488.

Union Ministry of Human Resource Development (2007, March 18). Central universities teachers welcome new retirement age. *The Hindu.*

Appendix – I

Questionnaire for elderly college teachers

Name:　　　　　　　　　　　　　　　　　　　Age/ Gender:

Date:　　　　　　　　　　　　　　　　　　　Designation:

No. of years of experience:　　　　　　　　　Hobbies:

No. of hours of voice use for teaching in a day:

Any other profession:

Use of amplification or public address system:

How would you rate ambient noise levels in your work environment? (Low, Tolerable, Loud)

Health and life style:

1. Do you smoke or have you ever smoked?
2. Do you consume alcohol or have you ever consumed it?
3. Do you consume carbonated drinks; if yes is it occasionally/ frequently? Mention the frequency of intake.
4. Are you a vegetarian or non-vegetarian?
5. How many glasses of water do you consume in a day? Mention the frequency of intake.
6. Specify the duration of exercise you do every day to keep physical fitness.
7. Are you under any medications; if yes specify the drugs, its dosage, purpose & duration of medication?
8. Have you undergone any vocal surgery; if yes specify its purpose & period of surgery?

No.	Section I: General health	Never	Rarely	Some times	Frequent	Always
01	Do you have difficulty in hearing?					
02	Do you have difficulty in swallowing?					
03	Do you suffer from heartburn or gastric problems?					
04	Do you suffer from problems related to menopause? (If applicable)					

No.	Section II: Knowledge of aging	Extremely	Very	Some what	Little	Not at all
05	Do you know about the voice changes occurring at old age?					
06	Are you aware of the factors that affect/ influence your voice due to aging?					

No.	Section III: Present voice characteristics	Never	Rarely	Some times	Frequent	Always
07	Do others recognize changes in your voice?					
08	Does your voice vary throughout the day?					
09	Do you recognize changes in your pitch while speaking?					
10	Do you lose your voice after prolonged speaking?					
11	Does your voice sound tremulous?					
12	Does your voice sound rough?					
13	Do you have difficulty in speaking aloud?					
14	Do you have difficulty in speaking aloud?					
15	Do you speak with increased effort?					
16	Do you run short of breath when you speak?					

No.	Section IV: Emotional impact	Never	Rarely	Some times	Frequent	Always
	Do you have change in your voice? If yes,					
17	Does your change in voice upset you?					
18	Does your change in voice frustrate you?					
19	Does your change in voice annoy you?					

No.	Section V: Communication in daily situations	Never	Rarely	Some times	Frequent	Always
20	Do you have trouble being heard in noisy situations?					
21	Do people have difficulty in identifying you on the phone?					
22	Do people ask for repetition?					
23	Does your voice affect your job performance?					
24	Does your voice annoy your family and friends?					
25	Do you feel your voice restricts your personal and social life?					

Appendix – II

(Questionnaire for students)

Name: Age/ Gender: Date:

Course: Year: College:

Teachers' Name: No. of hours of lecture/ week:

No.	Present voice characteristics	Never	Rarely	Some times	Frequent	Always
01	Do you recognize changes in your teachers' voice?					
02	Does his/ her voice vary throughout the day?					
03	Do you recognize changes in his/ her pitch while speaking?					
04	Does your teacher lose his/ her voice after prolonged speaking?					
05	Does his/ her voice sound tremulous?					
06	Does his/ her voice sound rough?					
07	Does he/ she have difficulty in speaking aloud?					
08	Does he/ she get tired when speaking for long?					
09	Does he/ she speak with increased effort?					
10	Does he/ she run short of breath while speaking?					

AN EVALUATIVE STUDY OF VOCAL HYGIENE AWARENESS PROGRAM IN PROFESSIONAL VOICE USERS (PROSPECTIVE TEACHERS)

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Abstract

Vocal hygiene education program addresses the importance of proper care of vocal fold tissue suggesting certain changes in behaviors, patterns, life style and diet. It is an effective method to create awareness, reduce vocal abuse and prevent onset and progression of voice problems among the teachers and other professional voice users. The effectiveness of such sensitization programs has not been documented in the Indian context. The present study aimed to evaluate the short-term effect of a vocal hygiene awareness program among the teacher training students in Mysore city. The program consisted of three consecutive sessions on anatomy of voice production, causes of voice disorders and vocal hygiene tips to teachers, delivered audio-visually by experienced speech language pathologists. A basic questionnaire consisting of 10 questions (one open ended and nine close ended) was prepared, which was divided into three sections based on different areas of voice. The questionnaire was administered prior to and after the sensitization program. The efficacy was determined based on participant's ability to answer the questions. The results showed that the average percent scores improved from 58% (pre-test) to 73% (post-test) after attending the program. Further studies that address other voice care domains in the questionnaire like vocal and non-vocal practices, diet, and classroom management and the long-term effect of such programs have to be addressed to understand the effectiveness of such programs.

Key words: *Teacher, awareness, voice education, vocal hygiene, voice disorders*

Teachers are at high risk for developing voice problems due to their professional demands for excessive voice usage. Teachers report voice problems at a rate nearly three times that of members of other randomly selected professions (Smith, Gray, Dove, Kirchner & Heras, 1997). In a study conducted in India, 49% of teachers reported voice problems (Boominathan, Rajendran, Nagarajan, Seethapathy & Gnanasekar, 2008). Prolonged voice use for verbal instruction in the presence of background noise is the primary cause of voice problems among the members of this profession (Smith, Lemke, Taylor, Kirchner & Hoffman, 1998). Other causes include improper dietary habits, medical conditions, stress, anxiety and psychological factors. Deviant voice qualities, inability to sustain phonation, vocal fatigue, pain during phonation and throat irritation are some of the reported voice problems resulting from these causes (Yiu, 2002; Boominathan et al., 2008). Owing to professional demands, voice problems in teachers lead to reduced effectiveness at work (Sapir, Keidar & Mathers- Schmidt, 1993). In addition, voice problems reportedly interfered with future job options (Smith et al., 1998). However, teachers do not always seek professional help unless the impact of the voice problem worsens (Smith et al., 1998). Voice

disorders in teachers affect their students learning and the community immensely (Calas, 1989).

There is an old dictum 'Prevention is better than cure' and it still holds well even in the modern world. Several authors have addressed the importance of the prevention of voice disorders among those who work in vocally demanding occupations, such as teachers (e.g. Fritzell, 1996; Verdolini & Ramig 2001; Morton & Watson 2001a; Yiu, 2002; Roy, Merrill et al., 2004). Marge (1991) has identified two types of prevention. Primary prevention refers to elimination of something that might cause a voice disorder. For example, quitting smoking is a preventive act in-order to prevent future occurrence of voice disorders, while secondary prevention involves early detection and treatment of voice disorders. There is another level in the prevention called tertiary prevention, also called as rehabilitation, which includes physical, psychosocial and vocational measures taken to restore the patient back to or near normal condition.

Several studies have reported on the outcome of vocal hygiene education and voice training for subjects who do not suffer from voice disorders but who belong to the risk groups for such

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problems. Kaufman and Johnson (1991) developed a preventative voice program for teachers including a videotape and a booklet in which the anatomy and physiology of voice production, common voice pathologies, prevention strategies and early warning symptoms for voice disorders were provided. According to the authors, the program received a positive response from the teachers; however, no further evaluation of the effectiveness of the program was made. Bistritsky and Frank, (1981) found improvements in awareness of voice function and self-evaluation of voice in a group of teachers who attended vocal hygiene programs. In a prospective experimental study by Chan (1994) concerning the effects of preventive vocal hygiene education for daycare center teachers, the participants attended a 90-minute workshop session and followed a vocal hygiene regimen for two months. The results indicated that the participants showed significant voice improvement compared to daycare center teachers who did not participate in the vocal hygiene education program.

Duffy and Hazlett (2004) investigated the primary prevention of occupational dysphonia among 55 training teachers, who were randomly assigned to three groups, including control, indirect and direct group. The vocal performance of the three groups was measured at two points: first before any teaching or training began, and again after the first teaching practice. Acoustic and self-perceptual measurements were used to assess the multidimensional outcomes. The self-rating scores varied in agreement with the acoustic results. The acoustic results showed deterioration from first to second measure for control group, improvement for direct group and no change for the indirect group. The study indicated that the training had been effective. Boominanthan et al., (2008) conducted vocal hygiene awareness program aimed at educating professional voice users regarding prevalent voice use, abuse, and misuse and address ways to prevent voice problems. Their study investigated the efficacy of a program on vocal hygiene education designed for schoolteachers in Chennai. Sixty-five teachers were asked to complete a questionnaire twice i.e., before and after one month (post education) and the results showed teachers had better awareness after the program.Boominathan, Chandrashekhar, Ravi and Krupa (2009) evaluated the impact of Vocal Hygiene Awareness Program (VHAP) based on knowledge gained, implementation of vocal hygiene practices and concern for prevention of voice problems. Thirty-two teachers who attended VHAP two years back were asked to complete a questionnaire, which was based on the contents of VHAP. The authors found that

the majority of teachers followed dietary modifications, vocal tips and were not following classroom modifications. The authors concluded that VHAPs were effective in increasing knowledge, modifying practices and adapting a positive attitude. The above study addressed the impact of the VHAP and had not assessed the immediate sensitivity of the program.

In both the studies conducted by Boominathan et al., (2008 and 2009), the number of participants included was less in number and were practicing teachers. The effectiveness of the sensitization program immediately after the program was not appraised. In addition, there is a death of literature and empirical data on the effectiveness of sensitization program on prospective teachers in the Indian context. Hence, the present study aimed to evaluate the effectiveness of VHAP in student teachers in Mysore city. Also, this study was not intended to measure any behavioral changes because of vocal hygiene lectures.

Method

The current study was carried out in three phases. Phase 1 involved development of the questionnaire to assess the effectiveness of orientation program to the participants. Phase 2 involved administration of the developed questionnaire followed by a detailed presentation on voice anatomy, causes of voice disorders and prevention and care of voice with demonstration. Phase 3 involved re-administration of the questionnaire soon after the sensitization program.

Phase 1: Development of the questionnaire

A questionnaire (shown in Appendix 1) consisting of 10 questions was prepared. Out of these questions, nine were closed ended and had multiple-choice answers and one was open-ended question. The questionnaire was divided into the following sections:

(i) Demographic data

(ii) Section A - had questions related to anatomy of voice production mechanism.

(iii) Section B - had questions related to causes of the voice disorders.

(iv) Section C - had questions related to preventive voice care.

Phase 2: Administration of the questionnaire

Participants:

320 trainee teachers (154 females and 166 males) who are native Kannada speakers, from five B. Ed colleges in Mysore city, participated in the study. The age of the participant ranged from 21 years to 26 years (Mean age: 23.5 years). None of the subject reported any of the following:

exposure to previous vocal hygiene education, a history of voice disorder, a psychosomatic or psychiatric history, a history of endocrinal or neurological disorder, or significant hearing loss.

Procedure:

The questionnaire was administered twice i.e. just prior to and after vocal hygiene program. The participants of the program were asked to complete pre-test questionnaire before the commencement of the lecture cum demonstration program. The aim was to measure the baseline awareness level on different aspects of voice and voice production systems. The filled questionnaires were collected back before the subjects attended vocal hygiene lectures, which were conducted in same premises by experienced speech language pathologists. The post-test was given after an hour of conclusion of the lectures to evaluate the efficacy of the program. The teachers took about 10 minutes to complete the questionnaire. The efficacy was gauged based on participant's ability to answer the same questions, post lectures and demonstration.

Vocal hygiene lecture and demonstration program

The program consisted of three consecutive sessions on (a) anatomy of voice production, (b) causes and management of voice problems and (c) vocal hygiene tips to teachers, delivered audio visually by experienced speech language pathologists. The program consisted of 3 sessions; each lasting for 30-40 minutes of audio-visual presentation and demonstration. The first presentation covered aspects of voice production (brief overview of voice production). The risk factors, common causes for voice problems, sources of voice misuse/abuse, and overuse in teachers included vocal and non-vocal habits, classroom voice habits, general and dietary influences on voice were presented during the second presentation. The last session discussed the management, vocal hygiene and voice care tips, guidelines, Do's and Don'ts for efficient voice use particularly for teachers.

Scoring

Responses of the participants were separately scored for pre- and post-test. The percentages of each correct choice of answers given by the participants were calculated.

Statistical Analyses

Statistical package for social sciences (SPSS) software-version 15 was employed for statistical analyses. The percentages of correct answers for each question given by the participants at pre- and post-test were compared. To compare the significance of percent responses, Chi-square test of significance was used.

Results and discussion

Section A: Analyses of the answers obtained for the questions regarding the voice production mechanisms

Table 1 shows the trainee teachers' knowledge on the voice production systems that was poor during pre-test and improved during the post-test. After the three sessions of sensitizing program, 98% of the trainee teachers reported breathing is important for voice production. 69% of the trainee teachers reported that the vocal folds were the vibrating structure responsible for voice production and 79% of the student teachers knew the pitch range used by women, children, was high in general and adult males it was low, in particular. There was a reduction in the percentage of teachers who chose 'lungs and trachea' as responsible for voice modification, instead of 'throat and mouth'. This may be attributed to the emphasis given in the lecture on the anatomy of voice source alone than resonatory and articulatory system, which might have contributed to chose wrong answer.

Table 1: *Trainee teachers' pre- and post-test scores on voice production mechanism*

Q No.	Questions probed	Pre-test (%)	Post-test (%)
1	Importance of voice production	95.9	98.1
3	Vibrating structure for voice production	64.3	69.3
4	Modification of voice	65.3	59.4
5	Adult male pitch	36.9	78.8

Table 2 shows the percentage of trainee teachers who were aware of the terminology used for voice production system. 69% of the student teachers responded correctly after the orientation program as *'larynx'* for the second question, which was the only open-ended question in the questionnaire.

Table 2: *Trainee teachers' pre- and post-test scores on open-ended question*

Q No.	Question probed	Pre-test (%)	Post-test (%)
2	Another term for voice box	25.3	68.7

Results of Chi-square test revealed that the scores obtained in pre-test for the questions 1, 2, and 3 were significantly different from the post-test scores. The improvement in the scores can be attributed to the increased knowledge gained about the voice production systems, after attending the lecture.

Section B: Analyses of the answers obtained for the questions regarding the causes of voice problems

Table 3 reveals that the trainee teachers' knowledge on the causative factors for voice disorders. 71% of trainee teachers were aware that the voice problem is the most common in teaching community. Their awareness about the susceptibility of voice problems in females teachers increased after the audio-video presentation.

Table 3: *Trainee teachers' pre- and post-test scores on causes of voice disorder*

Q No.	Question probed	Pre-test (%)	Post-test (%)
6	Voice problems are common	64.3	71.2
7	Causes of voice disorder	47.9	83.4
8	Cough and throat clearing	57.2	64.1

The student teachers were sensitized about the causes for voice disorders and 83% of them reported that the vocal practices like shouting, smoking and consuming alcohol were the main causes for voice difficulties in the post-test. Results of Chi-square test revealed that the scores obtained in pre-test for the questions 6, 7, and 8 were significantly different from the post-test scores suggesting that the awareness program enhanced the participants' knowledge on causes of voice disorders at 0.05 level.

Section C: Analyses of the answers regarding the preventive voice care

Table 4 shows the trainee teachers' knowledge about the preventive voice care prior to- and after presentation. 83% of the teacher trainees awareness about the role of voice/speech therapist, improved after the orientation program. The scores increased from 48% (pre-test) to 83% (post-test) which could be attributed to the knowledge gained in the audio-video demonstration given by experienced speech-language pathologists about the early identification, prevention and management of voice problems in teachers by voice/speech therapists. Results of Chi-square test revealed that the score obtained in pre-test for the questions 9 was significantly different from the post-test score.

Table 4: *Trainee teachers' pre- and post-test scores on preventive voice care*

Q No.	Question probed	Pre-test (%)	Post-test (%)
9	Professional who deals with voice problems	47.9	83.4
10	Use of gesture or non-vocal sounds	63.7	61.7

62% of the trainee teachers reported that the usage of gestures or non-vocal expressions damage the vocal folds instead of protecting the vocal folds. Though, the score for this question has reduced from pre-test (64%) to post-test (62%), after the orientation sessions, but there is no statistical significant difference seen between the scores. The reduced scores could be attributed to the less emphasis given on the non-verbal communication aspects in the lectures or because of the position of this question, which occurred as the last in the questionnaire. Overall, comparison of the pre- and post-test scores revealed an average of 15% increase, which was statistically significant at 0.01 level.
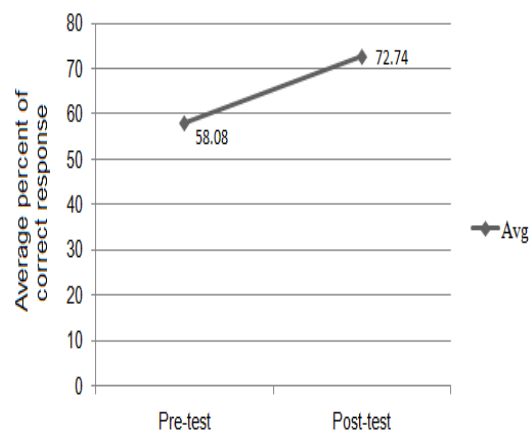
Figure 1: *Average (overall) improvement of percent scores between pre- and post-test.*

Figure 1 shows the overall (average) improvement in percent scores between pre- and post-test performance. Of all the areas probed (section A, B and C), the increased percent of scores suggesting that the trainee teachers' awareness of voice production system, causes of voice disorders and preventive voice care were better after attending the program. The results are in consonance with the findings of Boominathan et al, (2008) study who reported that there was 9% increase in the post-test percent scores in teachers. The higher percent score in the present study may be a short-term effect and further, the long-term effect (practice) in the real life needs to be evaluated. Chan (1994) reported that the kinder-garden teachers showed improvement in voice after attending vocal hygiene awareness program. In addition, Duffy and Hazlette (2004) reported significant improvement in multi-dimensional voice outcome of teachers who attended training than those teachers who did not attend. The present study findings are in agreement with the studies of Chan (2008), and Duffy and Hazlette (2004) who found improvement in voice performance or knowledge after attending voice related training programs.

Summary and Conclusions

The current study aimed to investigate the short-term effect of a vocal hygiene awareness program among teacher training students in Mysore city. The awareness program consisted of three sessions namely, anatomy of voice production, causes of voice disorders and voice care tips for class-room teachers which were delivered audio-visually by experienced speech-language pathologists. A questionnaire was administered prior to and after the sensitization program. The results indicated that the average (overall) percent scores improved from 58% (pre-test) to 73% (post-test). This increased percent scores after the awareness program suggested that the student trainees' awareness on voice and its disorders and its preventive care were better after attending the program. The increased percent score also reflects the immediate short-term memory effects of the participants and the long-term effects and its practices in the daily life need to be assessed. Very few questions and less number of voice care domains were considered in the questionnaire which can become the limitations of the study. Further studies need to address on more voice care domains in the questionnaire like vocal and non-vocal practices, diet, and classroom management.

References

Boominathan, P., Chandrasekhar, D., Nagarajan, R., Madraswala, Z., & Rajan, A. (2008). Vocal

hygiene awareness programme for professional voice users (teachers): An evaluative study from Chennai. *Asia Pacific Journal of Speech, Language and Hearing, 11* (1), 39-45.

Boominathan, P., Chandrasekhar, D., Ravi, S., & Krupa M (2009). Impact of 'Vocal Hygiene Awareness Programme' in Professional Voice Users (Teachers). *Journal of Indian Speech and Hearing Association*, 23, 10-18.

Boominathan, P., Rajendran, A., Nagarajan, R., Seethapathy, J., & Gnanasekar, M. (2008). Vocal abuse and vocal hygiene practices among different level professional voice users in India: A survey. *Asia Pacific Journal of Speech, Language and Hearing, 11* (1), 47-53.

Boone, D.R. (1983). *The Voice & Voice Therapy* (3rd ed.). New York: Prentice Hall, INC, Englewood Cliffs.

Bistritsky, Y., & Frank, Y. (1981) In Mattiske, J. A., Oates., & K. M. Greenwood (1998). Vocal problems among teachers: A review of prevalence, causes, prevention and treatment. *Journal of Voice, 12* (4), 489-499.

Calas, M. (1989). In J. A. Mattiske; J.M. Oates, & K. M. Greenwood (1998). Vocal problems among teachers: A review of prevalence, causes, prevention and treatment. *Journal of Voice, 12* (4), 489-499.

Chan, R.W. (1994). Does the voice improve with vocal hygiene education? A study of some instrumental voice measures in a group of kindergarten teachers. *Journal of Voice, 8,* 279-291.

Duffy, O. M., & Hazlett, D. E. (2004). The Impact of Preventive Voice Care Programs for Training Teachers: A Longitudinal Study, *Journal of Voice*, 18(1), 63–70.

Fritzell, B. (1996). Voice disorders and occupations. *Logopedics Phoniatrics Vocology, 21,* 7–11.

Kaufman, T.J., & Johnson, T.S. (1991). An exemplary preventative voice program for educators. *Seminars in Speech and Language, 12,* 40–48.

Morton, V. & Watson, D.R. (2001a). Voice in the classroom. A re-evaluation. In P.H. Dejonckere (Ed.), *Occupational voice: Care and cure* (pp. 53–69). Hague: Kugel Publications.

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

Roy, N., Merrill, R.M., Thibeault, S., Gray, S.D., & Smith, E.M. (2004). Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices. *Journal of Speech, Language, and Hearing Research, 47,* 542-551.

Smith, E., Gray, S.D., Dove, H., Kirchner, L., & Heras H. (1997). Frequency and effects of teachers' voice problems. *Journal of Voice, 11,* 81–87.

Smith, E., Kirchner, H.L., Taylor, M., Hoffman, H., & Lemke J.H. (1998). Voice problems among teachers: Differences by gender and teaching characteristics. *Journal of Voice, 12,* 328–334

Verdolini, K., & Ramig, L.O. (2001). Review: Occupational risks for voice problems. *Logopedics, Phoniatrics, Vocology, 26,* 37–46.

Yiu, E.M. (2002). Impact and prevention of voice problems in the teaching profession: Embracing the consumers' view. *Journal of Voice, 16,* 215–228.

Acknowledgement

Appendix 1

Department of Speech-Language Sciences
Orientation Programme for Prospective teachers on 'Conservation of Voice'

Name: College:
Class: Date:

Pre-Test / Post test

Please, answer all the questions.

Section A:
1. _____ is very important for voice production
   (a.   breathing   b. eating   c. bathing).

2. Voice box is also called as _____

3. The vibrating structure responsible for voice production is _____
   (a. vocal folds   b. lips   c. ary-epiglottic folds)

4. Voice is modified by _____
   (a. Lungs & treachea   b. stomach & lever   c. throat & mouth)

5. The pitch/tone used by an adult male is _____
   (a. Mid   b. Low   c. High)

Section B:

6. Voice problems are very common among, _____
   (a. Accountant   b. School-teachers   c. Librarians)

7. What are the main causes for voice disorders. Put a tick (√) mark against the appropriate answer.
   Running   *Smoking*
   Screaming   *Alcohol*
   Chanting   *Jumping*

8. Severe cough and frequent throat clearing lead to _____ problem
   (a. improve   b. damage   c. preserve).

Section C:

9. The professional who is responsible for improving voice/speech is _____
   (a. Physiotherapist   b. Occupational therapist   c. Speech therapist)

10. Use of gestures or non-vocal sounds can _____ the voice/vocal folds.
    (a. Protect   b. damage   c. harm)

AWARENESS OF PARENTS ON THE NATURE OF CLEFT LIP AND PALATE (CLP): AN EXPLORATORY STUDY

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Abstract

Cleft lip and palate (CLP) is a congenital anomaly which requires a multidimensional medical care by multidisciplinary team of professionals. Extensive information and appropriate knowledge is required for the parents of Child with CLP. This study is an endeavor to assess the parental awareness of the condition of cleft lip and palate. The present study is aimed to assess the parental awareness on nature of CLP on various aspects such as cause, associated problems, assessment and treatment of CLP. 30 parents of children with CLP who visited the unit of structural orofacial anomalies (USOFA), All India Institute of Speech and Hearing (AIISH), Mysore served as participants of the study. A Questionnaire was developed with five subdivisions on seven domains which consisted of five myths and five facts. The participants were asked to mark YES or NO for correct or incorrect statements respectively. On exploring the responses, the results revealed that the parents having a child with CLP believe more in the myths about the causes rather than facts and the awareness on treatment schedule and the role of team members are limited. The results also indicate better awareness on the associated problems and also showed a greater need to sensitize the parents on assessment and treatment of CLP. The results obtained could be attributed to the facts that the medical guidance provided for the parents having child with CLP was limited or in spite of having the child with CLP, the efforts taken to understand the condition is not adequate. The results of the present study warrant developing more systematic programs towards creating awareness on CLP among parents and various health care professionals.

Key words: Cleft lip and palate, parental knowledge, parental awareness

Cleft lip and palate (CLP) is one of the most commonly seen congenital anomalies after congenital cardiac anomalies (Wyszynski, 2002). The exact incidence of CLP is not available in India, because of the lack of an established registry for craniofacial deformities. The last dedicated multicenter study involving three cities in India and 94,906 births was conducted between 1994 and 1996 (World Health Organization, 2001). The present incidence of cleft deformities however is around 1 in 650 live births in India, which translates to around 30,000 new patients every year (Raju, 2000).

CLP is a heterogeneous condition resulting in varieties of associated problems. These irregularities vary greatly in terms of extent of the cleft and other characteristics (Sinko, Jagsch, R., Prechtl, V., Watzinger, F., Hollmann, K., & Baumann, A 2005). CLP deformities are completely correctable and provide the client a chance to get back into normalcy with predictable quality of life. Depending on the severity and the variability of the cleft, the families need to cope with speech therapy, ear infections, learning disabilities, and other associated problems and treatment

CLP requires a multidimensional medical care by multidisciplinary team of professionals. The management team not only consists of professionals, but also consists of non professional members (family members/parents). An integrated system of delivery of care enables the individuals within the team to function in an interdisciplinary way so that all aspects of health care for the cleft condition can be delivered. Counseling by all professionals play a very important role in shaping the beliefs, attitudes, and concerns of the parents. These teams of professionals should demonstrate a belief in the child's ability to cope with the challenges of cleft lip and palate. Being a part of the team extensive information and appropriate knowledge is required for the parents of child with CLP. The incidence of CLP has remained the same and the associated benefits too have not been utilized solely due to the lack of awareness among the parents or the various health care providers themselves.

Parents of children with disabilities or chronic illnesses, including orofacial clefts, have been surveyed to determine their needs, concerns, and sources of stress. Results from the survey on parents of children with cleft lip and/or cleft palate and other diagnoses by Horner , M., Bartsch, A., Trimbach, G., Zobel, I., & Witt, E. (1987) indicated that rehabilitation program service should include help with the financial burden of having a child with a birth defect, recreation for the child, child care, and counseling options for the family and parents. It

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suggests that the professionals should give parents adequate information early in the course of treatment and in multiple sessions which increase parental retention of information and to promote the process of coping (Broder & Trier, 1985; Hafner , M. M., Rawlins, P., & Giles, K. 1997).

The family environment is an important factor in the rehabilitation of a child with a facial cleft. The attitudes, expectations and degree of support shown by parents are likely to have an enormous influence on a child's perception of their cleft impairment (Bull & Rumsey, 1988; Lansdown, R., Lloyd, J., & Hunter, J. 1991). Pannbacker and Scheuerle (1993) evaluated parental attitudes towards the treatment of their child's cleft palate. They found that 36% of parents wished for more participation in their children's treatment decisions, and a large percentage (65%) thought that their help was only slightly effective or ineffective.

Young (2001) examined the type of information required by the parents and desire when being informed after delivery that their newborn has a cleft. The results showed that parents wanted the informer to be sure to cover topics such as feeding methods and home management. They also reported that information on subjects such as etiology and repair of the cleft can be reported until follow-up visits.

Byrnes, A. L., Berk, N. W., Cooper, M. E., & Marazita, M. L. (2003) reported that parents wanted health care providers to ''Be in greater control of the informing conversation, to show more caring and confidence, to show more of their own feelings, to give parents more of an opportunity to talk and show feelings, to make a greater effort to comfort parents, to provide more information, to initiate more of a discussion about the association between clefts and mental retardation/ learning disabilities, and to provide more referrals to other parents during the informing interview.''

White, Eiserman, Beddoe, and Vanderberg (2006) studied the perceptions, expectations, and reactions to cleft lip and palate surgery in native populations as a pilot study in rural India. 52 families were given a15-item questionnaire designed to elicit from parents general knowledge concerning cleft lip and palate, beliefs regarding its causation, and expectations of what surgery would accomplish. Shorter second and third questionnaires were administered after the screening process and after surgery. The results revealed that 64% of parents did not limit their child's social interaction and were not ashamed to be seen in public. 26% exercised some constraints, and 10% kept their

children totally isolated, not permitting them to leave the house or attend school. Regarding causation, the vast majority (84%) ascribed the cleft to ''God's will'' and 10% to sins committed in past lives. Only one parent had acknowledged the influence of genetics, although several had a positive family history. Environmental factors were not considered as an issue. Most families expected their child's life to be better when the facial deformity was corrected. Marriage prospects were the main concern, more so for girls than boys. Educational opportunity was a second strong theme. Authors concluded that a greater understanding of the beliefs and expectations was gained by means of the study.

Latta, L. C., Dick, R., Parry, C., & Tamura, G. S. (2008) carried out a qualitative study on parental responses to involvement in interdisciplinary teaching sessions and found that parents valued participation with the team in decision making about their child's care, as well as being able to communicate with the practitioners and understand the plan of care. Professionals have noted the benefits of parental involvement and, in fact, are encouraged by the American Cleft Palate Association (2008) to ''Ensure the family/caregiver and patient have opportunities to play an active role in the treatment process''. To further involve parents in the treatment process and to increase satisfaction, it is important to assess the level of understanding by the parents on the nature of CLP condition.

This study is an endeavor to assess the parental awareness of the condition of cleft lip and palate. Awareness is the state or ability to perceive, to feel, or to be conscious of events, objects or sensory patterns. It is important for the parents to understand the facts and myths about the causes, associated problems, about diagnosis and treatment issues of CLP. Thus, the there is a need to carry out explorative study on the awareness of Indian parents about the child with CLP. The present study is carried out to sensitize the parents of child with CLP on nature of CLP, various issues related to the information on facts and myths with respect to various domains, in order to focus during counseling ,which thus ultimately improves the treatment outcomes.

Objective
To assess the parental awareness on nature of CLP on various aspects such as causes associated problems, assessment and treatment of CLP.

Method
Participants

The present study included 30 parents of children with CLP who visited the unit of structural orofacial anomalies (USOFA), All India Institute

of Speech and Hearing (AIISH), Mysore. The children of participants included in the study were in the age range of 2 to 15 years. Among them 5 children had unrepaired CLP and 25 of them had undergone surgery for cleft lip/ cleft palate. Consent was obtained from the participants to take part in the study.

Questionnaire

The questionnaire was developed with five subdivisions on seven domains such as causes, associated problems, evaluations, treatment (General, surgery, and speech therapy), and general nature of CLP. Each domain had ten statements which consisted of five myths and five facts. The response for each of the question was close ended and binary choice of 'YES or NO' was provided.

Procedure

The parents were given the prepared questionnaire and were briefed about each statement. Parents were also given information to ask for clarification if any. The questionnaire was filled by each participant. The parents were asked to mark YES or NO for correct or incorrect statements respectively. After the survey, parents were educated regarding the nature of CLP and they were provided with keys containing the correct answers.

The data from 30 participants was analyzed using SPSS software (version 16). The percentage of correct and incorrect responses for each domain was calculated. Comparison across domains was made with the help of repeated measure ANOVA. The values were then tabulated and depicted through the graphical representation.

Results and Discussion

a) **To estimate the awareness of parents within the various domains on nature of CLP (various aspects such as causes, associated problems, assessment and treatment of CLP).**

  i. Etiology

Questions in this domain were intended to assess the knowledge of the parents regarding the etiology for CLP. The results revealed that the parents believed more in the myths than the facts causing CLP. On frequency analysis, it was found that among the statements related to the facts, 95.5% of parents believed that insufficient intake of Vitamin A and Folic acid could lead to CLP followed by 81.8% of parents reported that fall of mother during pregnancy may be the cause of CLP. 50% of the parents believed CLP could occur due to previous miscarriages and abortions and only 45.5% of parents believed that CLP is due to heredity and also believed that

if the mother's age is more than 30 years during pregnancy then it could also lead to CLP.
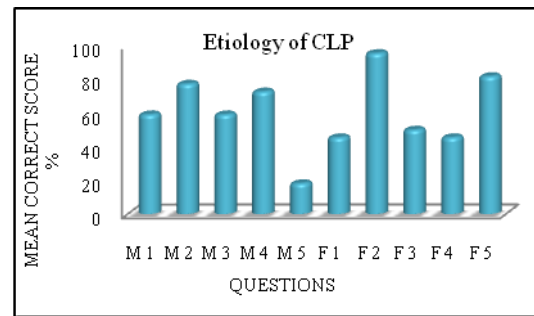
Graph 1: *The mean percentage distribution of the participant's response on etiology of CLP*

Many parents felt the myths to be the actual cause for CLP. 77.3% parents had responded to ultra sound scanning at 5 month of gestational period could lead to CLP and 72.7% of parents felt that the cause of the cleft is due to past sin in life. The present results support the findings by White, Eiserman, Beddoe, and Vanderberg (2006) who reported that 84% of parents in their study reported God`s will and 10% reported the past sins had caused CLP in the child. 59.1% of parents felt that eclipse and excessive vomiting might have been the cause for CLP. 18.2% of parents felt that mother's smoking and drinking habits had no effect in leading to CLP as shown in above graph 1. These results indicated that the parents need to be oriented regarding the etiological factors that could cause CLP in children.

  ii. Associated Problems

Domain on the associated problems focused on assessing the parental knowledge on the associated problems in the child with CLP. On frequency analysis, it was found that 95.5% of parents reported that their child had difficulty in sucking and drinking milk. Parents also felt that 90.9% of the time the child could have problems in pronouncing certain sounds and 54.5% of parents responded that the child with CLP may develop inferiority complex. 45.5% of parents reported that their child speaks through the nose.
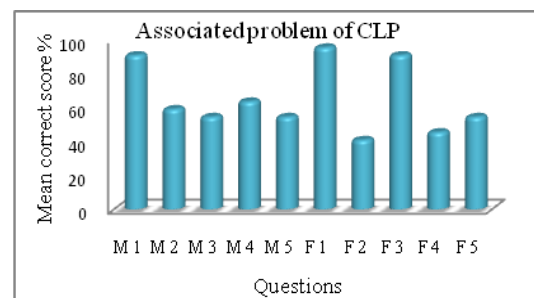
Graph 2: *The mean % distribution of the participant's response on associated problems of CLP*

The responses for the myth statements showed that good percent of parents (90.9%) felt that their child could have difficulty in attending and concentrating towards work, 63.6% of parents reported that child with CLP will not have dental problems and 59.1% parents felt that the child with CLP will have problems to perform up to the age matched peer group. 54.5% of parents said the children with CLP could have problem in walking and running and will not develop difficulty in speaking. The results of the present study shows that there is a need to educate the parents about the problems which child with CLP may face as it grows so the parents can provide a strong psychological and overall frame to the child.

iii. Assessment

On this domain, the parental knowledge on the assessment of child with CLP was explored. The percentages of correct responses marked by the parents showed that a good percentage (95.5%) of parents reported that the speech and language assessment was very important for child with CLP. 81.8% of parents reported that the family support could be extended through counseling and 50.5% of parents reported that psychological assessment was required for child with CLP. 45.5% of parents reported that regular dental check up and hearing screening is required for the child with CLP.
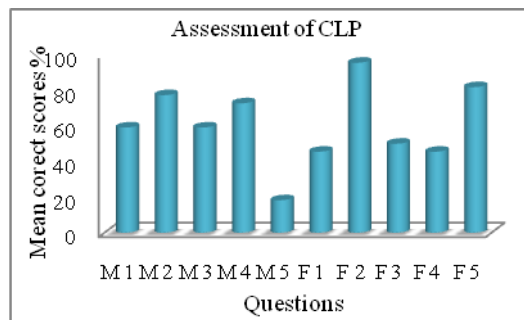

Graph 3: *The mean percentage distribution of the parent's response on assessment of CLP*

The responses given by parents for the incorrect statements indicated that 77.3% of parents believed that the testing of CLP is done only once a year and 72.7% of them believed that the social worker will help in correcting the feeding problems in children with CLP. 59.1% of parents felt that child with CLP will be assessed by only one doctor and they also believed that plastic surgeon would help in correcting the dental problems. 18.2% of parents felt that testing for reading and writing in CLP was very important (shown in graph 3). The finding of the present study supports the findings by young (2002); Broder and Trier (1985); Hafner et al. (1997); Pannbacker and Scheuerle (1993), and Latta et

al. (2008). These results revealed that the parents have to be more educated regarding the assessment and treatment of child with CLP.

iv. General Treatment

The domain on general treatment covers the questions pertaining to the general issues pertaining to treatment of CLP. The results of this study indicated that the parents of children with CLP are not sensitized about the general treatment procedures for child with CLP.

In accordance with the graph 4, it is seen that 68.2% of the parents reported that the feeding problems can be corrected by providing feeding aids and surgery helps to reduce the food particles coming out from the nose (nasal regurgitation). 54.5% of the participants reported that dental treatment can be initiated by 2 years of age. 45.5% of parents believed that prosthesis can be used if the surgery performed was not successful. 50% of them reported that modified feeding bottles can be used to feed the baby with CLP.
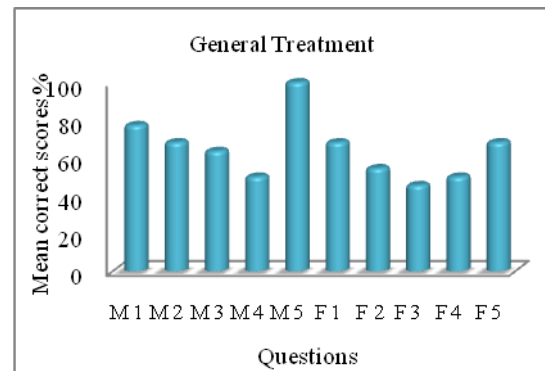
Graph 4: *The mean % distribution of the participant's response on general treatment of CLP*

From the section pertaining to the myth related to CLP, it is seen that 100% of parents had believed that attending speech therapy regularly improves speech and 77.3% of parents felt that family members help is not required while providing therapy for child with CLP. 68.2% of parents felt that training the child with CLP at home is not required and 63.6% of them said that academic performances will not improve after psychological treatment. 50% of parents believed that attending speech therapy and prosthesis fitting was not very much important. These results revealed that the parents have to be oriented towards the long term treatment related to CLP. The result of the present study is supported by the findings of young (2002); Broder and Trier (1985); Hafner et al. (1997); Pannbacker and Scheuerle (1993), and Latta et al. (2008).

v. Surgery

Questions on surgical details were formulated to explore the knowledge among parents. It was shown that 90.9% of the parents reported that surgery is important for normal speech and language development and 81.8% reported that the surgery of the palate can be done when the child is 6 months old. 63.85 % of parents reported that the child has to be hospitalized for a week approximately after surgery and 45.5% reported that surgery of the palate is not always successful and 31.8% surgery of palate always does not lead to normal speech.
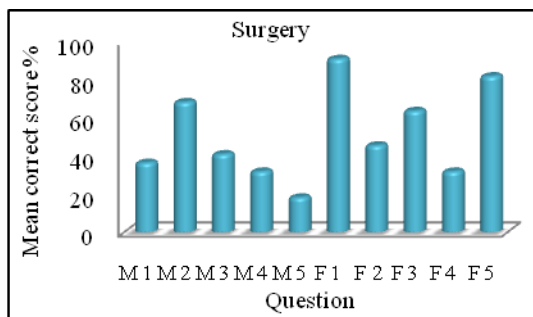
Graph 5: *The mean percentage distribution of the participant's response on surgery of CLP*

The section related to myths on surgery indicated that 68.2% of the parents reported that surgery for the palate can be done as many times as possible and 40.9% of parents felt that Hb count and weight is not an important issue for surgery. 36.4% of parents reported that surgery of lips is done after one year and 31.8% of parents reported that fistula always leads to speaking difficulty. 18.2% of parents reported that surgery is free of cost in all government hospitals (as shown in graph 5).

vi. Speech Therapy

This domain assessed the knowledge of parents related to speech therapy. Among the statements related to facts 81.8% of the parents reported that speech therapy is always required after surgery. 59.1% of parents felt that speech therapy will reduce the air flow through the nose and 50% reported that tablets and medicines will not help to get better speech. 45.5% of parents reported that speech problems cannot be corrected by plastic surgeons and 31.8% felt that speech problems cannot be corrected through black magic.

Among the subjects 90.9% of parents reported that speech problems can be corrected within six days and 81.8% parents stated that pronunciation problems can be corrected only through surgery. 54.5% of population thought that speech therapy can be started only after 5 years of child's age and 45.5% of parents believed that speech

therapy will help to close fistula. 36.4% of parents believed that speech therapy can be given by teachers as shown in the above graph 6. These results revealed that the there is a greater need for the parents to be oriented towards the importance of various aspects about speech therapy.
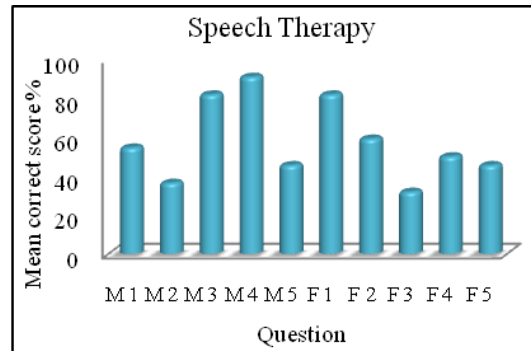
Graph 6: *The mean % distribution of the participant's response on speech therapy of CLP*

vii. General

This domain had questions regarding general information on CLP. The results show that the parents believed less in facts when compared to myths. 63.6% of the parents reported that pediatrician is one of the team members of CLP, 54.5% felt dentists are also members of CLP and engineers have no role to play in CLP team. 50% of parents stated that general physician's consultation is also required for a child with CLP. 22.7% of parents stated that social workers also have to play in a CLP team.
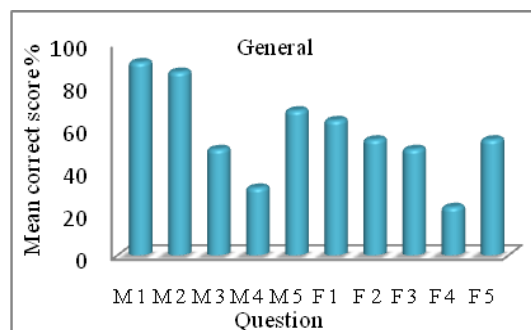
Graph 7: *The mean percentage distribution of the parent`s response on general aspects of CLP*

As shown in graph 7, the percentage of correct responses on myth statements obtained were that 90.9% of parents reported that skin doctor's advice is required for child with CLP and 86.4% of them reported that fortune tellers also have a role in CLP rehabilitation team. 68.2% of parents reported that prosthodontist are not CLP team members and 50% of parents reported that nurses are not team members of CLP. 31.8% parents reported that family members do not have a role in CLP team.

B) *To estimate the awareness of parents across the domains on nature of CLP (various aspects such as causes, associated problems, assessment and treatment of CLP).*

30 parents of children with CLP were administered questionnaire consisting of ten questions on seven domains. Comparison across the domains was done using repeated measures ANOVA, and there was significant difference ($p<0.005$) seen between domain in surgery and general information. On comparing the average scores across the domains, average of 5 to 6 scores were obtained as shown in below table 8 suggesting that there is a need for the parents to be educated across all the domains. The mean values are shown in the below graph 8, it can be noticed that the parents had a better knowledge on domains about associated problems, assessment, and general information when compared to rest of the domains.
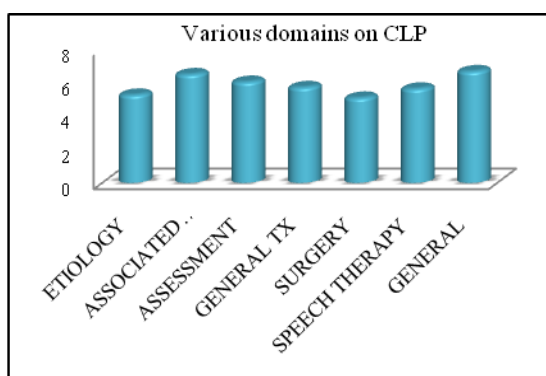
Graph 8: *The mean % of response on nature of CLP on various aspects of CLP*

The results of the present study add to the established results of the previous studies carried out by Broder and Trier (1985), Horner *et., al.* (1987), Pannbacker and Scheuerle (1993), Hafner *et al.,* (1997), Young (2001), White, Eiserman, Beddoe, and Vanderberg (2006), Latta *et al.*, (2008) that there is a greater need for the parents to know the facts on various domains on CLP. The percentage of parents reporting the myths to be correct statements shows that there is need to educate the parents on various facts on nature of CLP.

Overall results from the present study show that there is a greater need for the parents to know the facts on various domains on CLP. The results obtained could be attributed to the facts that the medical guidance provided for the parents having child with CLP was limited or in spite of having the child with CLP, the efforts taken to understand the condition is not adequate. This shows that there is a need for education of the health care professionals. The results are in concordance with findings from the study by Johansson and Ringsberg (2004) as well as that of Grow and Lehman (2001). As these authors state, the findings from the studies such as these can serve as part of the education for multidisciplinary health professionals that is currently lacking.

Thus it can be concluded that the findings from the study warrant the SLP to develop more systematic programs towards creating awareness on CLP in various culture and communities. It is also important for speech language pathologists to have knowledge on the parent's awareness on CLP as parents play an important role in identification and management of CLP. Also to further address this issue, birth and treatment hospitals should implement standard education and training regarding the care of patients with orofacial clefts. Perhaps, as participants mentioned, information should be created or provided about an existing online resource that addresses the etiology of clefting, surgeries, postsurgical care, feeding limitations and tips, and other crucial information.

References

American Cleft Palate-Craniofacial Association (2008, Accessed November 10, 2009). Standards for cleft palate and craniofacial teams. Retrieved from http:// www.acpa-cpf.org.Broder, H., Trier, W. C. (1985). Effectiveness of genetic counseling for families with craniofacial anomalies. *Cleft Palate Journal, 22* (3), 157–162.

Bull, R., & Rumsey, N. (1988). The social psychology of facial disfigurement. *Journal of cross cultural psychology. 17.* 99-108.

Byrnes, A. L., Berk, N. W., Cooper, M. E., & Marazita, M. L. (2003). Parental evaluation of informing interviews for cleft lip and/or palate. *Pediatric, 112*, 308–313.

Grow, J. L., & Lehman, J. A. (2002). A Local perspective on the initial management of children with cleft lip and palate by primary care physicians. *Cleft Palate Craniofacial Journal, 39*(5), 535–540.

Hafner, M., Bartsch, A., Trimbach, G., Zobel, I., & Witt, E. (1987). Parental reactions following the birth of a cleft child. *Journal of Orofacial Orthopedics, 58* (2), 124–133.

Horner, M. M., Rawlins, P., & Giles, K. (1987). How parents of children with chronic conditions perceive their own needs. *MCN: American Journal of Maternal Child Nursing, 12*, 40–44.

Johansson, B., & Ringsberg, K. (2004). Parents' experiences of having a child with cleft lip and palate. *Journal of Advanced Nursing, 47*(1), 165–173.

Lansdown, R., Lloyd, J., & Hunter, J. (1991). Facial deformity in childhood: severity and psychological adjustment. *Child Care Health Development, 17,* 165-71.

Latta, L. C., Dick, R., Parry, C., & Tamura, G. S. (2008). Parental responses to involvement in rounds on a pediatric inpatient unit at a teaching hospital: a qualitative study. *Academic Medicine, 83*, 292–297.

Pannbacker, M., & Scheuerle, J. (1993). Parents' attitudes toward family involvement in cleft palate treatment. *The Cleft Palate-Craniofacial Journal, 30*(1), 87–89.

Raju, S. (2000). In search of a smile-study of children born with cleft lip and palate in India. Tata Institute of Social Sciences: Mumbai. Available from: http://www.smiletrain.org [last cited on 2009 Aug 15]

Simon, K. (2004). Psychological issues in cleft lip and palate. *Clinics in Plastic Surgery, 31*(2), 347-52.

Sinko, K., Jagsch, R., Prechtl, V., Watzinger, F., Hollmann, K., & Baumann, A. (2005). Evaluation of Esthetic, Functional, and Quality-Of-Life Outcome in Adult Cleft Lip and Palate Patients. *Cleft Palate–Craniofacial Journal, 42* (4), 355-361.

White, R. C., Eiserman, W., Beddoe, M., & Vanderberg, R. (2006). Perceptions, Expectations, and Reactions to Cleft Lip and Palate Surgery in Native Populations: A Pilot Study in Rural India. *Cleft Palate–Craniofacial Journal, 42* (5), 560-564.

World Health Organization. (2001). Global registry and database on craniofacial anomalies: Report of a WHO registry meeting of craniofacial anomalies. WHO library cataloguing.

Wyszynski, D. F. (2002). Cleft lip and palate. In Elavenil, et al. (2010). Origin to treatment.(pp. 458-67). Oxford: Oxford University Press.

Young, J. L. (2001). What information do parents of newborns with cleft lip, palate or both want to know?. *Cleft Palate Craniofacial Journal, 38*(1). 55–58.

Appendix I

QUESTIONNAIRE: Awareness on Issues Related to Cleft Lip and Palate

Name:　　　　　　　　　　　**Date:**

Age:　　　　　　　　　　　　**Education:**

Profession:　　　　　　　　**Phone no:**

Email Id:

I. **The following session has the list of few conditions which may or may not be the cause for the cleft lip and palate (CLP). Please tick the appropriate one.**

Cleft lip and palate occurs due to….

Sl. No	Causes	Yes	No
1	CLP is due to the heredity (runs in the family)		
2	If the Vitamin A and Folic acid is taken less during pregnancy it increases the possibility of CLP		
3	Eclipse during pregnancy		
4	Ultrasound scanning during 5th month		
5	Previous miscarriage / abortions		
6	Excessive vomiting during pregnancy		
7	Mothers age more than 30 years during pregnancy		
8	Fall during pregnancy		
9	Past life`s sin or curses		
10	Mother smoking and drinking alcohol habits have no effect		

II. **Child born with CLP may or may not have the following problem. Please tick the appropriate one.**

The child born with CLP will always have problems such as……..

Sl. No	Associated problems	Yes	No
1	Difficulty to drink milk		
2	Dental problem		
3	Difficulty in walking and running		
4	Problem in pronouncing some sounds/words		
5	Will have cold and cough		
6	Can have inferiority complex		
7	Difficulty to perform up to their age level(low IQ… low menatal ability)		
8	Will have difficulty in attending and concentrating		
9	Will speak up to their age level		
10	CLP child speaks through nose even after surgery		

III. **Testing the child with CLP is very much important for treatment. Please tick the appropriate one.**

Do you feel that ………..

Sl. No	Assessment	Yes	No
1	Child with CLP will be examined by only one doctor		
2	Testing is done only once in a year		
3	Regular dental checkup is required		
4	Speech and language testing is very important		
5	The plastic surgeon will correct the dental problem		
6	Social worker will help in feeding problem		
7	Psychological assessment is required in CLP		
8	Hearing screening is required in CLP		
9	Family support is extended through counseling		
10	Testing reading and writing problem is important		

IV. Treatment is required the child with CLP. Please tick the appropriate one.

Do you feel that ………..

Sl. No	General	Yes	No
1	Feeding problem can be corrected by providing feeding aids		
2	Family member`s help in therapy is not required		
3	Dental treatment can be initiated by 2 years		
4	Prosthesis can be used if the surgery is not successful		
5	Training the child at home is not required		
6	Academic performance will not improve after psychological treatment		
7	Modified feeding bottles can be used to feed the baby with CLP		
8	Attending speech therapy after surgery or prosthesis fitting is not important		
9	Surgery helps to reduce the food particles coming from the nose		
10	Attending regular therapy will not be beneficial for the child		

V. Surgery

Sl. No	Surgery	Yes	No
1	Surgery for lips is done after one year		
2	Surgery is important for normal speech and language development		
3	Surgery of the palate is not always successful		
4	Palate surgery can be done as many times as possible		
5	Hb count and weight is not important consideration during surgery		
6	Surgery is free of cost in all the government hospitals		
7	After surgery child will be hospitalized for one week		
8	Surgery of the palate leads to normal speech		
9	The fistula always does not lead to speaking difficulty		
10	Surgery of the palate can be done as soon as infant is born		

VI. Speech therapy

Sl. No	Speech therapy	Yes	No
1	Speech therapy can be started after 5 years		
2	Speech therapy is always required after surgery		
3	Speech therapy will help to close the fistula/cleft		
4	Speech therapy will reduce the flow of air through the nose		
5	Pronunciation problem can be corrected only through surgery		
6	Speech can be corrected by black magic		
7	Speech problem cannot be corrected by plastic surgeon		
8	Tables/ tonics cannot help to get better speech		
9	Speech problems can be corrected in 6 days		
10	Therapy is given by a school teacher		

I. General

1. Did you know about the disorder before the child was born?- Yes/No
2. Do you feel you don't have enough information about CLP?- Yes/No
3. Who all can provide useful information about CLP?

SI.No		Yes	No
1.	Pediatrician		
2.	Skin doctor		
3.	Engineer		
4.	Dentist		
5.	General physician		
6.	Nurse		
7.	Social worker		
8.	Prosthodontist		
9.	Fortune teller		
10.	Others (Family and friends etc)		

Signature

EFFECT OF NEIGHBORHOOD DENSITY ON SPEECH SOUND ACQUISITION IN TYPICALLY DEVELOPING MALAYALAM SPEAKING CHILDREN AGED 1-3 YEARS

[1]Rhea Mariam Korah, [2]Sara Paul, [3]Merry E.R, [4]Seby M.M, [5]Manjula R, & [6]Gayathri Krishnan

Abstract

Speech sound production is an important aspect of the children's language. Children produce words by combining speech sounds with contrasting distinctive features. Acquisition of speech sound combinations in typically developing children is limited in the field of child phonology. The present study aimed to analyze and compare the acquisition pattern of selected target sounds and their neighboring speech sounds in Malayalam speaking typically developing children between 1 to 3 years of age with respect to: (a) Place of articulation (b) Manner of articulation. Twenty typically developing children participated in the study. They were categorized into four age groups with five children in each age group. The spontaneous or elicited speech samples of the children were audio video-recorded during unstructured free play interaction. The speech sample was phonetically transcribed in IPA by two of the investigators. All the speech sounds of Malayalam language that emerged in participants were chosen as target sounds and speech sounds occurring in their neighborhood were transcribed and analyzed for frequency of occurrence and pattern of distribution (density). Various neighborhood density and patterns were evident in the age groups studied. The neighborhood pattern in different age groups paralleled the speech sound acquisition. The results are discussed in the backdrop of acquisition of speech motor control in the spatial and temporal dimensions in the emerging articulatory control. The trend observed suggests that transcription based procedure for identifying the emerging speech sound profile of a child in terms of its neighborhood could be used as a simple, yet potential clinical tool in commenting on the maturing articulatory mechanism.

Key words*: Neighborhood density, Spatial coordinate, Temporal coordinate*

Children speaking any language in the world speak their own language in the beginning (Francescato, 1968). Acquisition of speech sounds of a language acts as building blocks for words and in turn for language acquisition. Studies have shown that children produce words by combining speech sounds with contrasting distinctive features. According to Jackobson & Halle (1956), the development of sound system in children is not only a gradual approximation of the adult phonemes one by one but includes acquisition of successive contrasts between distinctive features of maximum difference and generality. The combination of various sounds and the way in which these sound combinations are acquired in children helps in understanding the phonology of child language.

The phonological development in young children is significant in the ages of 1; 6 to 4; 0 years. The ability improves gradually with the acquisition of adult like sounds of complex phonological structures (Ingram, 1976c). During the process of acquisition of speech sounds, when a child replaces one sound with another, there is generally a system in the sound substitutions of children. These sound laws are referred to as phonological processes (Stampe, 1969). Phonological development according to Stampe

(1969) is the gradual loss of these simplifying processes until the children's words finally match their adult models. The organization of sounds in the stage of development is not only dependent on the phonological processes but also on children's active organization of the representation of words.

Netsell (1981) proposed stages of motor control for speech that takes place during the normal development of children. First, the child develops motor control for spatial aspects, then spatial-temporal coordination and finally adult-like timing of motor control, including the anticipatory movement gestures of coarticulation. Netsell (1981) suggested that the most sensitive period for acquisition of speech motor control is from 3 months to 12 months suggesting that fundamental movement routines for speech in children are established early.

Children often show phonetic variability in the pronunciation of words. According to Bynon (1968), in baby talk, a simple consonant-vowel (CV) syllable structure predominates. When this is combined with consonant harmony or assimilation, it results in more reduplicated structures like /dzidzi/ for 'horse'. Thus, the early phonological development in children is

influenced by acquisition of sound combinations and the density of speech sounds in the neighborhood.

The literature on vowel development in majority of the languages suggests that the acquisition of vowels is earlier than consonants (Templin, 1957). Many investigators report that majority of consonants are acquired by English speaking children by 6 years of age (Templin 1957; Olmsted, 1971; Prather, Hedrick & Kern, 1975; Arlt & Goodban, 1976; Fudala & Reynolds, 1986; Mowrer & Burger, 1991). In English speaking children, Templin (1957) observed that by the age of 4 years, initial position clusters and only fewer final position clusters were produced, but three member clusters and clusters containing fricatives continued to be mastered till the age of 8 years. Wellman (1931) and Snow (1963) expressed that a particular sound is not mastered in all the three positions at the same age. For example, medial /j/ is mastered by 3 years but this sound is not mastered in final position until 6 years. Children exposed to other languages were also reported to show similar although not identical sound repertoires (Locke & Pearson, 1992).

Acquisition of speech sounds by children is reported by many studies in Indian languages (Kumudavalli, 1973; Banu, 1977 and Prathima, 2009 in Kannada language; Usha, 1986 in Tamil; Padmaja, 1989 in Telugu; Banik, 1988 in Bengali and Maya, 1990 in Malayalam). All these studies reported a similarity in the acquisition of speech sounds by children speaking these Indian languages with that of English. However, most of the sounds were reported to be acquired earlier when compared to English.

Maya (1990) studied 240 Malayalam speaking children in the age range of 3-7 years. She reported that they acquire /s/, /r/, /l/, /f/, /tʃ/, /j/ and un-aspirated stops at an earlier age of 3-3.6 year and aspirated stops are acquired as late as 6.0 - 6.6 years. She also reported that 18 different consonants (m, n, p, ŋ, f, j, k, ɖ, v, b, t̪, g, l, ʈ, tʃ, h, ɲ) and all vowels are developed by children speaking Malayalam language by 3 years of age. There are however, no studies in Malayalam language on the speech sound acquisition before 3 years of age. The present study aims to address issues related to the acquisition of various target speech sounds and the speech sounds in the neighborhood of target sounds before the age of 3 years in Malayalam speaking typically developing children.

'Speech sound neighborhood' is a concept which defines the set of speech sounds that occur in the immediate neighborhood of a target speech sound. The investigation of speech sound neighborhood in children has important theoretical implications. It is interesting to know whether children organize speech sound neighborhoods the same way as adults. Speech sound neighborhoods in adult's lexicon are constructed based on phonemic contrasts. The core question is whether or not children, like adults have phonetic representation for words in the lexicon. It is important to study how the speech sound neighborhoods in children gradually develop into the form of adults' speech sound neighborhoods.

Studies in the field of child phonology till date have dealt with the acquisition of isolated speech sounds in different languages. There are very few studies which address the acquisition of phonemes in relation with its phoneme neighborhood, especially so in Indian languages. Such information is especially crucial in understanding the acquisition of speech sounds with the neighborhood sounds in the speech of young children. This will in turn help in taking appropriate decisions in selecting the target sound stimuli during the assessment and intervention in children with speech production errors. A comparison with the neighborhood density of phonemes in typically developing children can be instrumental in detecting early deviancies and risk for phonological disorders. In the context of motor programming disorders, where the sequencing of sounds to form words is affected, the knowledge of acquisition of speech sound combinations remain crucial for early identification and intervention. The study aims to analyze the neighborhood density of selected target speech sounds (consonants) in Malayalam language. Due to restricted data available in Malayalam language below the age of 3 years, the study considered the most frequently occurring sounds in the speech sample of the children, keeping Maya's (1990) data on acquisition of speech sounds as a reference. Since most of the speech sounds are acquired before the age of 3 years in Malayalam language (Maya 1990), this study considered four age groups between 1 to 3 years. Acquisition of sound combinations in this age group would have an implication in early identification of atypical speech productions.

Aims of the study:

To analyze and compare the acquisition pattern of the neighboring speech sounds (preceding and following positions) of selected target sounds in Malayalam speaking typically developing children between 1 to 3 years (in 4 age groups of 6 months interval) in terms of:

a) Spatial coordinate

b) Temporal coordinate

Method

Participants

A total of 20 typically developing children with native language as Malayalam, were included in this study. They were categorized into four age groups- 1.0 - 1.5 years (2F & 3 M); 1.6-2.0 years (3F & 2M); 2.1-2.5 years (4F & 1 M); 2.6-3.0 years (3F & 2 M), with five children in each age group.

The participants were selected based on the following criteria:

- None of the participants had any history of otological /neurological and / or any motoric dysfunction.

- All were native speakers of Malayalam language and were not exposed to any other language.

- They had no delay or deviancies in speech and language as on screening tests. The language development was screened using Receptive Expressive Emergent Language Scale (REELS) (Bzoch & League, 1972).

Instrument & Material:

The speech sample of the participants was audio – video recorded. A high quality digital video camera (Nikon coolpix P1) was used for video recording. Age appropriate toys were used to elicit the speech samples from the participants (Toy models of fruits, vehicles, kitchen items).

Procedure:

The children were audio video-recorded in their respective homes in individual setting during half-hour unstructured free play interaction. The child was initially desensitized for the presence of camera. While recording the speech sample, the recorder was kept away from the child's sight. A quiet room away from the traffic and other environmental noises was chosen for recording. It was ensured that the recording of speech samples was carried out during the active period of the child's activities and did not interfere with the sleeping and feeding schedules of the child. The sample was elicited from children within a span of 4-5 sessions. The first session aimed at rapport building and the successive sessions aimed at collecting spontaneous speech. Spontaneous or elicited speech samples and interactions of the participants with the family members were also video recorded. The recording of the samples continued till a representative sample of client's speech was obtained.

Analysis:

The numbers of words selected for analysis were dependent on the total meaningful vocabulary of the child. A vocabulary of approximately 50 words was expected from children in the age range of 1-2 years and vocabulary of 50-300 from children in the age range of 2-3 years. A total number of 50 intelligible words were selected for transcription (IPA- Broad Transcription) and analysis in 1 to 2 year old children and 100 intelligible words was selected for transcription (IPA- Broad Transcription) and analysis in 2 to 3 year old children. While selecting these words, it was taken into cognizance that the words were within the vocabulary of the given child. Gender was not considered for analysis since most of the studies have not reported a gender bias in terms of phonological acquisition of speech sounds. The speech sample was phonetically transcribed in IPA (Broad transcription) by two of the investigators, which was later verified for agreement in notations between the two investigators. The inter judge agreement was above 85% for all transcribed samples. Transcriptions that were not agreed upon by the two investigators were verified from literature and by consulting an experienced linguist. The contextual reference in which the utterances were made was also noted down for later reference. The words analyzed from the transcribed samples consisted of true words within the vocabulary of the child. From these words all the speech sounds in Malayalam language that emerged in each group of participants were chosen as target sounds. While doing so, attention was paid to see that the chosen utterances were produced correctly by the children and were within the order of acquisition of speech sounds in Malayalam language. By 3 years of age, all vowels and few consonants are reported to be acquired in Malayalam language (Maya 1990). Hence these sounds (m, n, p, ŋ, f, j, k, ɖ, v, b, ʈ, g, l, t, tʃ, h, ɲ) were selected as target sounds for all the groups. These sounds were grouped based on place and manner of articulation as shown in Table 1. The place of occurrence of the target sound, viz., initial, medial and / or final positions were noted. In this study, the neighborhood sounds were defined as those speech sounds which preceded and / or followed the target sounds. If there were two target syllables in a given intelligible word utterance, both were considered. The neighborhood of the target syllables were obtained and were compared across the age groups. Scatter plots were plotted based on frequency of occurrence of neighborhood combinations. A 35% cut off criteria was selected for the same as this was found to be the most common point for all neighborhood combinations.

Table 1: *Sounds selected for analysis of neighborhood density*

Place of articulation	Manner of articulation
Bilabials-m, p, b	Stops- p, b, ʈ ,d̪ , k, g, ʈ
Labiodentals-v, f	Fricatives- f, h
Dentals- ʈ	Affricates- tʃ
Alveolars- n, l	Nasals-m, n,ŋ,ɲ
Palatal – j, tʃ , ɲ	Glides-v, j
Retroflex – ʈ ,d̪	Laterals-1
Velar – k, g, ŋ	
Glottal – h	

Results and Discussion

The results are discussed under the following sections:

1. Neighborhood density in spatial coordinate.

Table 2 and Figures 1 to 4 show the frequency of occurrence of different target sounds and their neighborhood sounds across age groups according to their place of articulation (spatial co ordinate). In the age range of 1-1.5 years, it is found that the frequency of occurrence of combinations of phonemes is greater for palatals than for bilabials (Fig 1). The pattern in the linear plot suggests that similar sounds with same place of articulation are mostly combined to form meaningful words in the early stages. Visible phonemes present more neighborhood combinations as compared to non visible phonemes. For example, bilabials and labiodentals have a larger number of neighborhood phonemes when compared to velars and alveolars. This could be due to the hierarchy of acquisition of sounds in a given language, wherein, the back consonants are acquired much later owing to the neuro-motor maturation of the tongue.

Many studies have reported early acquisition of bilabials, since they are the easiest and more visible sounds. Neighborhood density is higher for palatals suggesting that tongue -palate motor executions in the space-time dimension seem to be explored more by children in this age group. The findings in Fig 1-4 suggests similarity in terms of place of articulation as a crucial factor that probably dictates the pattern of neighborhood density. Indirectly it may be suggesting that while children are acquiring more than one sound at a time, there is an evolving motor program for sounds that are similar in their place of articulation. This is evident from rich neighborhood density in pre and post positions for bilabials and labiodentals compared to the velar sounds.
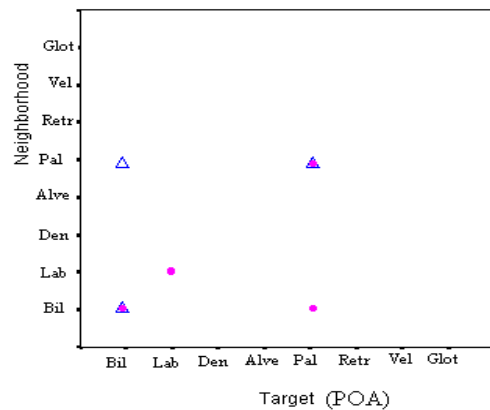

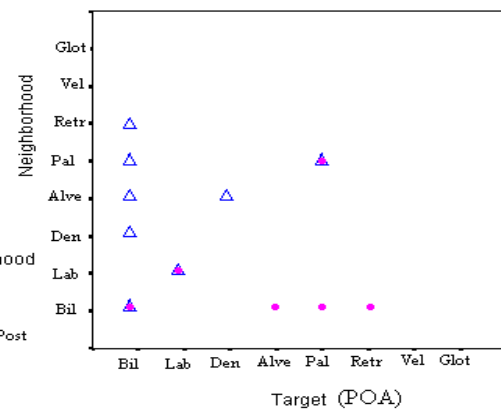Figure 1 : Neighbourhood density in 1- 1.5yrs.
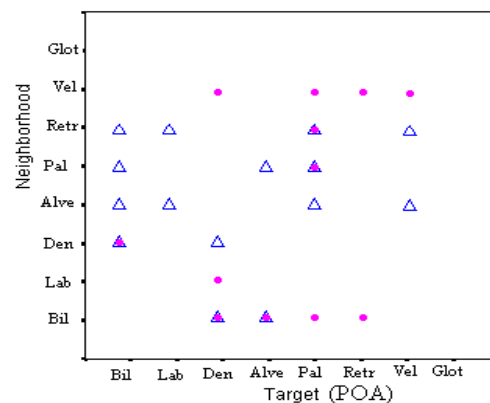

Figure 2 : Neighbourhood density in 1.6-2yrs

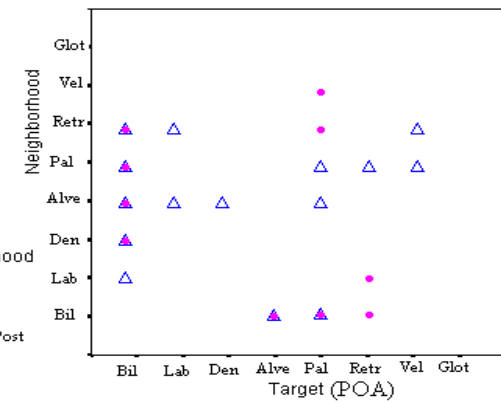
Figure 3: Neighbourhood density in 2-2.5 years

Figure 4: Neighbourhood density in 2.6-3 years

Table 2: *Frequency of occurrence of target sounds and their neighborhood according to place of articulation (spatial coordinate) across all the four age groups*

Place of articulation	Age (years)	Bilabial		LabioDental		Dental		Alveolar		Palatal		Retroflex		Velar		Glottal	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Bilabial	1.0-1.5	13	13	2	3	0	0	0	0	2	11	0	0	0	0	0	0
	1.6-2.0	19	21	0	0	5	6	18	7	24	4	12	1	3	9	0	0
	2.1-2.5	8	8	5	8	14	22	8	20	4	32	6	20	3	6	0	0
	2.6-3.0	3	3	3	25	10	12	29	19	23	27	11	20	7	4	0	0
Labio Dentals	1.0-1.5	2	2	12	12	0	0	0	0	0	1	0	0	0	0	0	0
	1.6-2.0	1	3	16	13	2	0	1	0	0	2	3	0	0	1	0	0
	2.1-2.5	5	3	5	5	7	2	0	10	4	4	3	15	0	2	0	0
	2.6-3.0	6	3	3	3	4	1	4	11	3	3	4	18	2	4	0	0
Dental	1.0-1.5	0	0	0	0	8	8	0	0	5	0	0	0	0	0	0	0
	1.6-2.0	6	12	1	0	7	8	1	2	5	2	3	3	2	4	0	0
	2.1-2.5	27	13	10	0	9	10	6	6	5	5	9	2	12	0	0	0
	2.6-3.0	6	5	1	2	3	6	2	12	2	2	5	8	0	1	0	0
Alveolar	1.0-1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.6-2.0	8	23	0	1	0	14	8	7	2	6	0	3	3	0	0	1
	2.1-2.5	16	12	8	0	6	5	4	5	7	11	3	3	7	8	0	0
	2.6-3.0	13	10	8	0	4	1	6	7	21	5	6	3	5	4	0	1
Palatal	1.0-1.5	11	2	1	0	0	5	0	0	10	10	0	0	0	2	0	0
	1.6-2.0	5	26	0	0	1	3	4	1	28	27	1	2	0	3	0	0
	2.1-2.5	27	4	3	4	5	7	8	10	11	11	10	13	15	4	0	0
	2.6-3.0	22	19	4	5	4	2	7	27	9	11	11	6	15	4	0	0
Retroflex	1.0-1.5	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0
	1.6-2.0	4	13	0	2	1	2	0	3	2	2	3	0	0	2	0	0
	2.1-2.5	18	4	8	1	4	5	0	6	5	8	2	1	13	4	0	0
	2.6-3.0	15	8	15	3	4	3	1	7	8	11	3	3	8	6	0	0
Velar	1.0-1.5	0	0	0	0	0	0	0	0	4	0	0	0	1	1	0	0
	1.6-2.0	2	3	0	0	1	2	4	2	5	3	3	0	5	5	0	0
	2.1-2.5	3	5	1	0	3	7	6	13	5	14	4	26	10	8	0	0
	2.6-3.0	4	6	0	1	0	0	6	8	3	19	2	20	3	3	0	0
Glottal	1.0-1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.6-2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2.1-2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2.6-3.0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

As an extended thought it may also be reasoned that the motor programs are probably operating on the dimensions of visibility and proximity in terms of placement of articulators. As compared to 1.0-1.5 year old children, in 1.6-2.0 old children, the neighborhood density clearly point to a shift from palatals to alveolar combinations. In the spatial coordinate, palatal region was

dominant in 1.0-1.5 year old children and there is a shift to alveolar region in the 1.6-2.0 age group. The change in the dimensions of the oral cavity itself as a part of growth may also be a contributing factor in this shift. In the 2.1-2.5 years group, there seems to be a scatter in terms of the neighborhood density as all possible combinations are programmed and executed in speech. The only exceptions seen in this figure is the programming of labiodentals with dentals and velars. Glottal sounds as neighborhood sounds are denser in 2.6- 3.0 year age group.

Overall, initially more homogenous sound combinations are observed while in the later age groups, a variety of sound combinations emerge.

2. Neighborhood density in temporal coordinate

The manner of articulation (time coordinate) has a linear, less dense neighborhood compared to the place of articulation as is evident from Tables & Figures 5-8. Stops have a denser neighborhood compared to other sounds. In the younger age groups, fricatives and laterals have not occurred with any target sounds as neighbors. This finding is consistent with those reported in literature (Templin, 1957) where children are reported to acquire these phonemes at a later age. In 1.6-2.0 year old children, dense neighborhood patterns are observed for stops and laterals. All combinations of sounds in terms of manner (time coordinate) were observed in this group except that of trills.

Table 3: *Frequency of occurrence of target sounds and their neighborhood according to manner of articulation (temporal coordinate) across all the four age groups*

| Manner of articulation	Age (years)	Stops		Fricatives		Affricates		Glides		Nasals		Laterals		Trills	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Stops	1.0-1.5	18	13	2	3	1	11	10	0	0	0	0	0	0	0
	1.6-2.0	35	47	5	4	3	4	0	23	20	26	3	19	0	0
	2.1-2.5	94	89	13	13	11	12	4	28	30	45	3	22	0	3
	2.6-3.0	42	49	28	39	15	20	1	18	18	45	5	37	3	9
Fricatives	1.0-1.5	2	2	12	12	0	0	0	1	0	0	0	0	0	0
	1.6-2.0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	2.1-2.5	15	19	5	5	0	0	1	3	3	11	0	3	0	0
	2.6-3.0	14	20	3	5	2	1	0	2	5	8	2	6	1	2
Affricates	1.0-1.5	11	1	0	0	10	10	0	0	0	0	0	0	0	0
	1.6-2.0	6	3	0	0	26	26	0	0	5	1	1	4	0	0
	2.1-2.5	14	14	0	0	5	5	1	2	1	3	2	3	0	0
	2.6-3.0	21	9	2	1	7	7	1	3	1	21	0	1	0	0
Glides	1.0-1.5	0	8	1	0	0	0	0	0	0	0	0	0	0	0
	1.6-2.0	27	3	13	13	0	0	0	0	0	2	0	1	0	0
	2.1-2.5	28	7	2	1	2	1	1	1	3	4	5	1	0	0
	2.6-3.0	19	2	2	1	0	2	0	0	5	11	4	4	0	0
Nasals	1.0-1.5	0	0	0	0	0	0	0	0	5	5	0	0	0	0
	1.6-2.0	20	25	0	2	1	4	0	0	16	18	4	7	0	0
	2.1-2.5	32	32	14	7	1	6	3	6	21	24	1	13	1	0
	2.6-3.0	39	16	6	5	21	3	9	5	20	33	10	9	1	4
Laterals	1.0-1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1.6-2.0	14	2	1	4	0	0	0	0	6	6	2	3	0	0
	2.1-2.5	10	4	2	0	2	3	1	5	5	1	0	1	0	0
	2.6-3.0	13	2	5	1	1	0	3	3	5	2	5	3	0	2
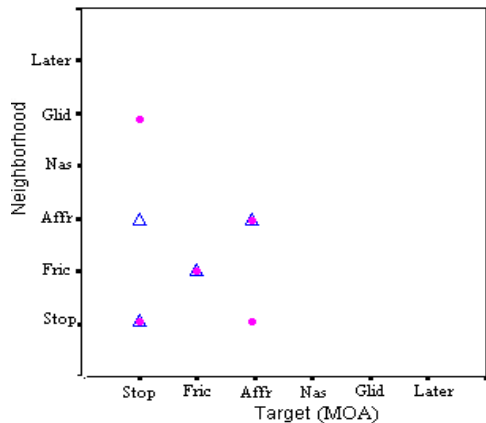
Figure 5 Neighboorhood density in 1-1.5yrs
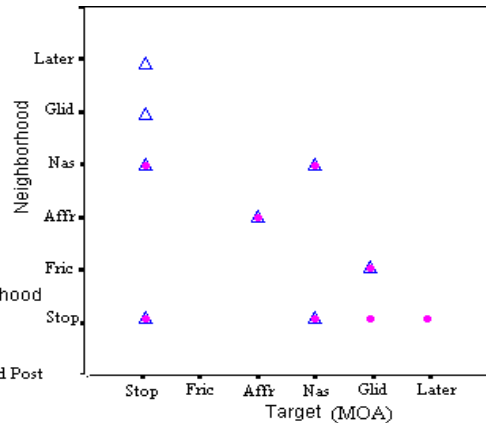
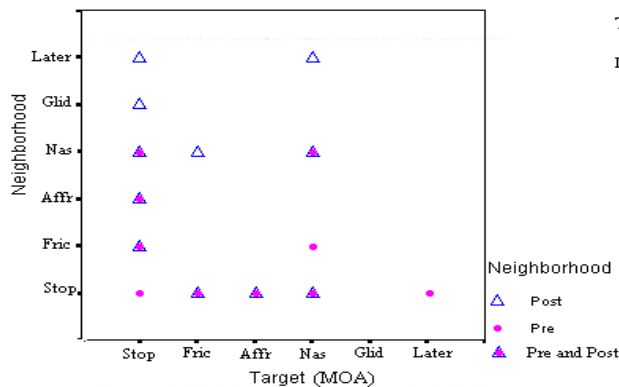Figure 6: Neighboorhood density in 1.6-2yrs
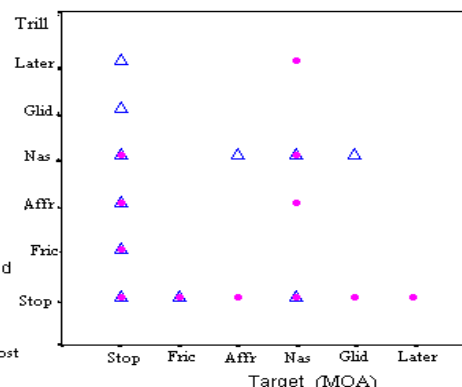

Figure 7: Neighborhood density in 2-2.5yrs

Figure 8: Neighborhood density in 2.6-3yrs

All the target sounds in the temporal coordinate (manner) except fricatives showed reduplicated combinations. The neighborhood density for sounds in the temporal coordinate (manner of articulation) showed an increase with age, as may be seen from Figures 3 and 4. Temporal neighborhood for fricative sounds seems to emerge beyond the age of 2.1-2.5 years. In 2.6-3.0 year old children, fricatives are placed in the neighborhood of stops and nasals as the initial combinations. The results point strongly to the fact that the last occurring neighborhood in 2.6-3.0 year old children seems to be that of fricatives, whereas all other target phonemes are acquired in pre and post neighborhood positions in the spatial coordinate by this age.

3. Neighborhood density of geminates

Table 4: *Target geminate sounds*

Bilabials	Alveolar	Dentals	Palatals	Retroflex	Velar
pp, mm, bb	nn, ll, tt, ss, nt	t̪t̪, nt̪	ɲdz, ɲɲ	ʈʈ, ɭɭ, ɳʈ, ɳɳ	kk, ŋk

The above table represents the geminate sounds which were selected as targets in this study based on the findings of Maya (1990). The results of analysis of neighborhood density for geminates for the four age groups are represented in the Figures 9 – 12. From the figures it is evident that, the only geminate in the age group of 1.0-1.5 is a combination of palatal and bilabial sounds. This pattern of acquisition is not similar to that observed in the place and manner of articulation. Though neighborhood increases with increase in age, a clear linear acquisition of combinations like that seen in the case of place (spatial) and manner (temporal) of articulation is not seen. The pattern seen in geminates, seem to be more horizontal than linear. That is, a phoneme is combined with all possible combinations as it is acquired irrespective of

similarity. Thus as a bilabial is acquired, it is geminated with all possible other phonemes to make geminate sounds of that particular language irrespective of the place of articulation. In the backdrop of the results observed in the space-time coordinates in figures 1 to 8, the pattern in geminates suggests that the geminate neighborhoods were mostly in the succeeding position of the targets than preceding the targets. This could be because of simple syllabic structures acquired by children in which geminates occur rarely in the initial positions. Another point of interest is that at the age of 3 years, few combinations were still not present probably because of the evolving pattern in the development of articulation sounds.

4. Comparison of results across age groups

The results across age groups are represented in the figures 13 and 14. The combinations seen at the age range of 1-1.5 years are seen even at the age of 3 years, but with a lesser frequency of occurrence. The target groups showed a gradually increasing pattern of combinations with increase in age in both place and manner (space and time coordinates).All neighborhood combinations were achieved by 3 years of age both with respect to place and manner of articulation as seen in the figures 1 to 8. The results also show a dense group of combinations emerging as age advances in terms of place of articulation. The same is not evident in the manner of articulation. Hence the neighborhood density closely matches with what is reported for acquisition of speech sounds in typically developing Malayalam speaking children (Maya, 1990), more in terms of place of articulation than in terms of manner of articulation.
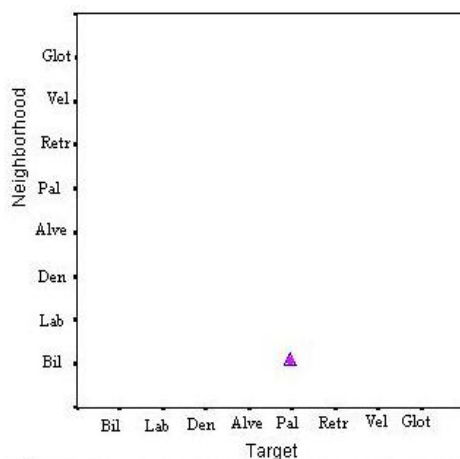

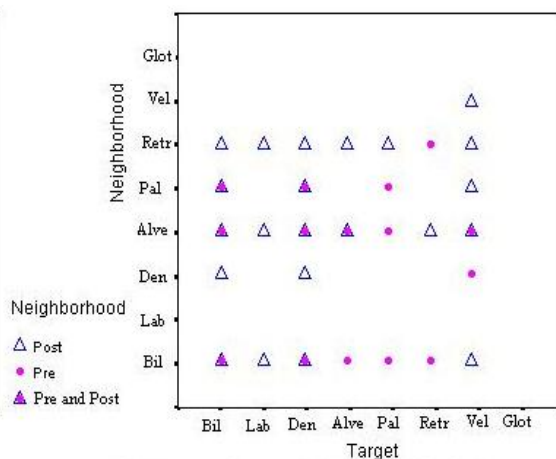Figure 9:Geminate Neighbourhood density in 1-1.5 years

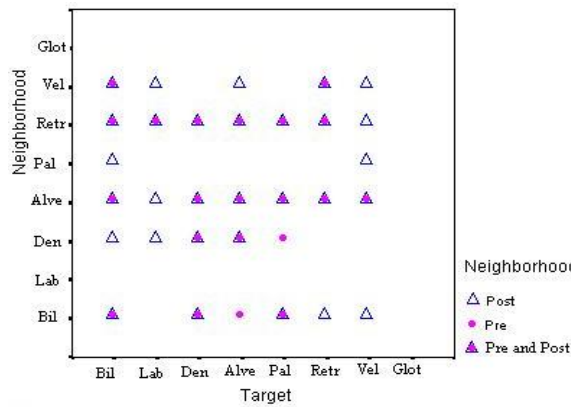Figure 10:Geminate Neighbourhood density in 1.6-2 years

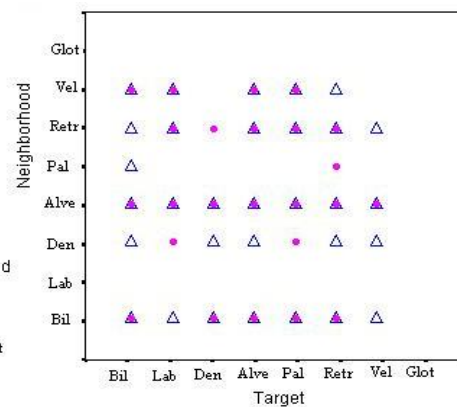Figure 11 : Geminate Neighbourhood density in 2-2.5years

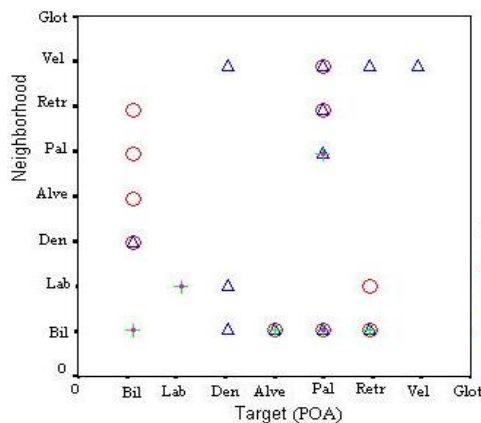Figure 12 :Geminate Neighbourhood density in 2.6-3 years

Figure 13: Preceding neighborhood combinations
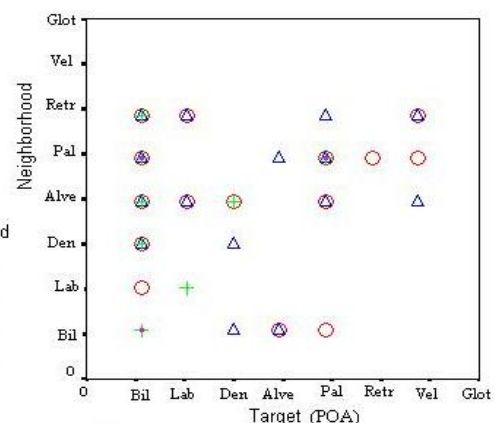
Figure 14: Succeeding neighborhood combinations

It is of interest then to see whether the development of articulation as recorded by the previous study (Maya, 1990) in Malayalam speaking children was favored more towards the place of articulation as a criterion rather than manner of articulation. The spatial dimensions (place of articulation) seem to mature before the temporal dimension (manner of articulation). Many studies have supported similar observations based on the use of sophisticated experimental paradigms using Kinematic traces (Easton, 1972; Kuehn & Moll, 1976; Fowler, 1980; Saltzman & Kelso, 1987; Guenther, 1992; 1994).

The 1.0-3.0 year old children acquire a considerable amount of phonological skills (Ingram, 1976c). Speech sounds are acquired in combinations than as individual sounds. There are specific combinations of sounds that are acquired first rather than acquisition of individual sounds such as bilabials with bilabials /palatals and stops with stops /affricates etc. Various neighborhood patterns appear with advancement in age. The neighborhood in different age groups studied pointed to a clear parallel to that of speech sound acquisition pattern. For example, with respect to the place of articulation, bilabials being the earliest achieved sounds, also appeared as the major neighborhood

for the target groups in that particular age group. An emerging pattern was evident in terms of acquisition of sound combinations also. Sounds seemed to be combined more based on the similarity of place of articulation than the manner of articulation. Amongst the spatial neighborhood, palatals showed a denser neighborhood than any other class of phonemes even from a very young age of 1.0-1.5 years. This is probably suggestive of the ability of children as young as 1.0-1.5 year to select a reference in the spatial coordinate system of oral cavity. Initially the reference seems to be concentrated in the palatal area. The initial coordinate in the articulatory system seems to be the palatal sounds, to which other sounds are anchored to create new neighbors. In this process of neighborhood choice, two factors, viz., similarity and visibility seem to play a crucial role in deciding the type of neighborhood sounds. Sounds that are more visible and those that are similar were combined initially, suggesting that may be these are easily acquired by children because of the dual mode advantage. That is, children not only get auditory and visual feedback for visible front consonants (bilabials and labiodentals) compared to back consonants, they also seem to be maturing more in the spatial dimension due to a correlatory maturation of the proprioceptive (somato sensory) channel (Fry,

1968; Locke, 1986; Vihman, 1993; Browman & Goldstein, 1992; Kent, 1992; Menn, Markey, Mozer & Lewis,1993).

Coady and Aslin (2003) and Storkel (2004), suggested that words with higher frequency of occurrence were acquired first compared to less frequently occurring sounds. The neighborhood patterns that emerged in this study needs to be compared with the frequency of occurrence of sounds in children in Malayalam language in order to study the relationship if any between the factors of neighborhood density and frequency of occurrence of sounds in children in Malayalam language. This can be taken up as an extension of this study as it is beyond the scope of this study. The findings are in agreement with other studies which support that there is a specific sound law operating in children's speech (Jespersen, 1922), early acquired combinat-ions are retained although newer combinations appear in later ages (Bynon, 1968), a high degree of reduplicated combinations are seen, which can be attributed to the consonant harmony or assimilation (Bynon, 1968) and the sound combinations are richer in terms of place rather than the manner (Logan, 1992). Intriguingly, the trill sounds as neighborhood sounds even in the age range of 2.1–2.5 years points to the need for introspection and verification of articulatory acquisition data reported in the literature (Maya, 1990).

Summary and Conclusion

Speech sound production is an important aspect of the children's language and it refers primarily to the gradual mastery of speech sound form within a given language. The present study aimed to investigate the acquisition of neighborhood of speech sounds in Malayalam speaking children aged 1-3 years. The results obtained revealed that the acquisition of speech sounds follow a specific pattern which parallels the individual speech sound acquisition as reported in Malayalam language. Similarity in place and manner of articulation plays an important role in speech sound acquisition and its phonology. Thus to conclude, the neighborhood of the various speech sounds are influenced by the developing speech motor control. Children from 1-3 years, speaking Malayalam language did not show arbitrary phonological combinations but followed a specific pattern in terms of neighborhood density of consonants.

Implications

The trend observed in the study clearly points to the fact that a transcription based procedure of identifying the emerging sound profile of a child in terms of its neighborhood could be used as a simple, yet potential clinical tool in measuring/ commenting on the maturing articulatory

mechanism in terms of the space and time coordinates. This probably can serve as a window to the understanding of the exact nature of speech motor control in the articulatory mechanism in space and time dimension.

References

Arlt, P. B., & Goodban. (1976). Comparative Study of Articulation Acquisition as Based on a Study of 240 Normals, Aged Three to Six. *Language, Speech, and Hearing Services in Schools*, 7, 173-180.

Banik, A. (1988). Articulation test in Bengali. Unpublished dissertation, University of Mysore, Mysore.

Banu, T. (1977). Articulatory acquisition in Kannada. A study of normal children 3-3.6 years. Unpublished dissertation, University of Mysore, Mysore.

Browman, C. P., & Goldstein, L. (1992). Tiers in articulatory phonology, with some implications for casual speech. In J. Kingston & M. E. Beckman (Eds.), Papers in laboratory phonology I: Between the grammar and physics of speech (pp. 341-376). Cambridge: Cambridge University Press.

Bynon, J. (1968). Berber nursery language. *Transactions of the Philological Society,* 107-161.

Bzoch, K., & League, R. (1972). Receptive-Expressive Emergent Language Scale, Baltimore. Md: University Park Press.

Coady, J. A., & Aslin, R. N. (2003). Phonological neighbourhoods in the developing lexicon. *Journal of Child Language, 30*, 441-469.

Easton, T. A. (1972). On the normal use of reflexes. *American Scientist, 60,* 591-599.

Fowler, C. A. (1980). Coarticulation and theories of extrinsic timing. *Journal of Phonetics, 8,* 113-133.

Francescato, G. (1968). Speech perception and the basis of articulation. *Folia Linguisitica, 2,* 3-4.

Fry, D. B. 1968. The phonemic system in children's speech. *British Journal of Disordered Communication, 3,*13-19.

Fudala, J. B., & Reynolds, W. M. (1986). *Arizona Proficiency Scale: Second Edition*. Los Angeles: psychological Services.

Guenther, F. H. (1992). Neural models of adaptive sensory-motor control for flexible reaching and speaking. Unpublished doctoral dissertation, Boston University, Boston.

Guenther, F. H. (1994). A neural network model of speech acquisition and motor equivalent speech production. *Biological Cybernetics, 72*, 43-53.

Ingram, D. (1976c). Current Issues in child phonology. In D. Morehead and A. Morehead (Eds.), *Normal and Deficient Child Language (*pp. 143). Baltimore, Md: University Park Press.

Jakobson, R., & Halle, M. (1956). *Fundamentals of Language (pp. 87).* The Hague: Mouton & Co.

Jesperson, O. (1922). *Language, Its Nature, Development and Origin (pp.90,133,183).* London: Allen & Unwin.

Kent, R. (1992). The biology of phonological development. In *Phonological development: models, research, implications* (pp. 65-89). Ferguson, C. A., L. Menn, and C. Stoel-Gammon, Timonium, MA: York Press.

Kuehn, D. P., & Moll, K. L. (1976). A cineradiographic study of VC and CV articulatory velocities. *Journal of Phonetics, 4,* 303-320.

Kumudavalli, S. (1973). The relationship between articulation and discrimination of Kannada speech sounds. Unpublished dissertation, University of Mysore, Mysore.

Locke, J. L., & Pearson, D. (1992). Vocal Learning and the emergence of phonological capacity. In C. A. Ferguson, L. M., & Gammon, C. S (Eds.), *Phonological Development: Models, Research, Implications.* Parkton: Md:York Press.

Locke, J. L. (1986). Speech perception and the emergent lexicon: an ethological approach. In *Language Acquisition* edited by Fletcher, P. & M. Garman, 240-250.

Logan, J. S. (1992). A computational analysis of young children's lexicons (Tech.Rep. No. 8). Bloomington, In: Speech Research Laboratory, Dept. of Psychology, Indiana Univ.

Maya, S. (1990). An Articulation test battery in Malayalam. Unpublished dissertation, University of Mysore, Mysore.

Menn, L., Markey, K. L., Mozer, M., and Lewis, C. (1993). Connectionist modeling and the microstructure of phonological development: a progress report. In de Boysson-Bardies, B. and et al. *Developmental Neurocognition: Speech and Face Processing in the First Year of Life* (pp. 421-433) Dordrecht: Kluwer.

Mowrer, D. E., & Burger, S. (1991). A comparative analysis of phonological acquisition of consonants in the speech of 2 ½ -6 year-old Xhosa and English-speaking children. *Clinical Linguistics and Phonetics, 5*, 139-164.

Netsell, R. (1981). The acquisition of speech motor control: A perspective with directions for research. In R. Stark (Ed.), *Language Behaviour in Early Infancy and Childhood* (pp.127-156).New York: Elsevier/North Holland.

Olmsted, D. (1971). *Out of the mouths of babes.* The Hague, The Netherlands: Mouton.

Padmaja, B. (1989). Telugu Articulation Test. Unpublished dissertation, University of Mysore, Mysore.

Prather, E. M., Hedrick, D. L., & Kern, C. A. (1975). Articulation development in children aged two to four years. *Journal of Speech and hearing Disorders, 40,* 179-191.

Prathima, S. (2009). Articulatory acquisition in Kannada speaking urban children- 3-4 years. Unpublished dissertation, University of Mysore, Mysore.

Saltzman, E. L., & Kelso, J. A. S. (1987). Skilled actions: A task-dynamic approach. Psychological *Review*, 94, 84-106.

Snow, K. (1963). A detailed analysis of articulation responses of normal first grade children. *Journal of Speech and Hearing Research, 6*, 277-290.

Stampe, D. (1969). The acquisition of phonetic representation. In Binnick, A Davison, G. Green and J. L. Morgan (eds*) Papers from the Fifth Regional Meeting, Chicago Linguistic Society*. pp. 126, 133.

Storkel, H. L. (2004). Do children acquire dense neighbourhoods? An investigation of similarity neighbourhoods in lexical acquisition. *Applied Psycholinguistics, 25*, 201-221.

Templin, M. C. (1957). *Certain language skills in children: Their development and interrelationships.* Institute of Child Welfare, Monograph 26. Minneapolis, MN: University of Minnesota Press.

Usha, D. (1986). Tamil Articulation Test. Unpublished dissertation, University of Mysore, Mysore.

Vihman, M. M. (1993). Variable paths to early word production. *Journal of Phonetics, 21*, 61-82.

Wellman, B. (1931). In Winitz, H (Eds.), (1969), *Articulatory acquisition and Behavior.* New York: Appleton- Century Crofts.

EFFECT OF PALATAL PROSTHESIS ON FEW SPECTRAL PARAMETERS OF SPEECH IN CLEFT LIP AND PALATE: A CASE STUDY

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Abstract

Rehabilitation of speech disorders in the cleft lip and palate population requires teamwork of plastic surgery, palatal prosthesis, and behavioral therapy. The present study is an attempt to provide an insight on the effect of the palatal prosthetic management in cleft lip and palate. Systematic outcome studies of the effectiveness of palatal prosthetic appliances are required to document towards the evidence based practice. The study is aimed to investigate the acoustical parameters (Energy concentration, formant frequencies F1 and F2.) of speech with (during various stages of preparation) and without palatal prosthesis and to compare with the acoustic parameters of the control subject. This study also examines the velopharyngeal closure with and without using the palatal prosthesis. Materials used for acoustic analysis are repetition of three unaspirated stop consonants in the context of vowel /a/ was considered as the stimuli (/pa/, /ʈa/, and /ka/) and for physiological analysis image of the velopharyngeal closure of the phonation of /a/ was considered. The individual, aged 17 years male with huge palatal fistula was recommended for palatal prosthesis by the cleft palate team members. Age and gender matched control subject was considered as a control subject in the study. The experimental subject was fitted with the palatal obturator and extension and elevation of the prosthesis was provided in various stages to achieve the velopharyngeal closure. Pratt software was used to extract the spectral aspects of speech during the stages. Velopharyngeal closure was evaluated using nasoendoscopy. The acoustic parameters were extracted before and after fitting at various stages of fitting of prosthesis with different elevation or extension of the obturator and compared with normal subject. The result indicates difference in F1, F2 and energy concentration between the control subjects. The variation in formants was also observed with and without prosthesis.

Key words: Prosthesis, Acoustic analysis, Perceptual analysis.

Speech is the key to human existence. Speech production is a process where the concepts, ideas and feelings are converted into linguistic code, linguistic code into neural code and neural code into muscular movements and finally muscular movement leads to acoustic signal (Ainsworth, 1975). Disturbance in any of these chain of events lead to disordered speech production.

Cleft is an abnormal opening or a fissure in an anatomical structure that is normally closed. A cleft lip and palate is the result of the failure of the parts of the lip and roof of the mouth to come together early in the life of the fetus. Clefts vary in length and width depending on the degree of fusion of the individual structures. The acoustical and perceptual parameters of speech characteristics also vary depending on the extent of the cleft.

The speech of experimental subjects with cleft palate is primarily characterized by abnormalities in nasal resonance. This is a direct result of unoperated cleft / fistula and or velopharyngeal dysfunction. The individuals with velopharyngeal dysfunction cannot either adequately or consistently close the velopharyngeal port during speech leading to nasal escape of sound energy. In addition, there may be articulatory errors, including compensatory articulations and reduced voice quality resulting in poor speech intelligibility (McWilliams, Morris & Shelton, 1990; Kuehn & Moller, 2000; Kummer, 2001; Peterson-Falzone, Hardin-Jones & Karnell, 2001; Bzoch, 2004).

Speech problems exhibited by experimental subjects with cleft palate can be studied by acoustical, perceptual and physiological methods. Acoustic analysis offers the opportunity to observe the speech patterns resulting from simultaneous and sequential interactions of phonation, resonation and articulation as these occur in real time speech production. Spectrographic data have been used frequently to study cleft palate speech (Horii, 1980).

The formant frequencies of a speech sound are directly dependent on the shape and size of the vocal tract. They are largely responsible for the characteristic quality of the speech sound. The formants enable to recognize different speech sounds which are associated with different

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positions of the vocal tract (Ladefoged, 1962). According to Stevens (1998), in the production of stops in initial pre-vocalic position, there is a change of the vocal tract configuration from that of the complete closure for stops to the shape of the following vowel. The release of the vocal tract obstruction results in changes in the cross-sectional area of the vocal tract constriction which is associated with a corresponding change in formant frequencies. The changes in formant frequencies depend on the place of oral constriction. Hence the formant frequency is an important parameter to study the cleft palate speech.

The vowels in normal speech are characterized by a well defined formant pattern in wide band spectrograms. But in experimental subjects with cleft palate or velopharyngeal dysfunction vowels are characterized by nasalization (Fant, 1970). The acoustic effects of nasalization vary across speakers and phonetic contexts. The acoustic correlates of vowel nasalization include appearance of the low frequency nasal formant below F1 of the non nasalized counterpart, a weakening and small frequency increase of F1, a reduction of the overall energy, a reduction of F2 amplitude and an increase in the formant bandwidth. The overall effect is nasalized vowels sound less intense, more weighted with low frequency energy and more uniform in the distribution of energy in the mid frequencies (Philips & Kent, 1984). F1 for the nasal vowel is less prominent than for the oral vowel and is surrounded by shallow valleys. F1 region for the nasal vowel is less intense and flatter. These effects reflect the greater damping for the nasal vowel and addition of nasal formants and antiformants. The nasal vowel typically has a low frequency resonance below F1 is called as nasal murmer.

The rehabilitation of individuals born with cleft lip and palate and related craniofacial anomalies require coordination of plastic surgery, prosthetic intervention and behavioral therapy. A multidisciplinary approach is essential to achieve optimum results. Definitive prosthodontic treatment is usually one of the final therapies instituted and it must attempt to alleviate any anatomical and functional deficiencies that may remain after the gamut of other treatment is essentially completed. Residual palatal deficiencies may remain after surgical treatment, which would necessitate placement of obturator prosthesis. Also, selected cleft palate patients with gross deficiencies of palatal tissues are best treated prosthodontically, without surgical intervention (Bhat, 2007).

With the advances in techniques for fabrication of speech appliances, this treatment may be a routine option in the rehabilitation of persons with velopharyngeal dysfunction / palatal insufficiency, which may provide socially acceptable speech and consequently improve the individual social relationships. Speech appliances are used to facilitate speech by separating the nasopharynx from the oropharynx and help to reduce nasal air emission and improve speech intelligibility. Several investigators have advocated the use of speech bulbs as an effective treatment either as an alternative to surgery or as a secondary procedure to improve velopharyngeal closure (Pinborough-Zimmerman, Canady, Yamashiro & Morales 1998; Reisberg, 2000; Tachimura, Nohara, Fujita, & Wada, 2002). Only few investigators have tried to analyze the influence of speech appliance on acoustics of speech (Shelton & Blank, 1984; Henningson & Isberg 1987).

Lindblom, Leuker and Pauli (1977) and Lubker (1979) have compared the nasal and non nasal sounds produced by a speaker with cleft palate with and without wearing a palatal appliance. The results indicated that the vowels produced with the obturator were more distinct than those produced without. McGrath and Anderson (1990) reported a review of the outcome management of two hundred persons with cleft palate and found that 95% were able to overcome both hyper-nasality and nasal emission distortions in speech through prosthetic management. Jian, Ningyi, and Guilan, (2002) investigated the effect of a temporary obturator to treat VPI and found that velopharyngeal closure can be greatly improved by using a temporary oral prosthesis and speech training.

Tachimura, Kotani, and Wada (2004) studied the effect of palatal lift prosthesis on children with repaired cleft palates exhibiting hypernasality or nasal emission of air without any compensatory articulation and found that with palatal lift prosthesis decrease the nasalance score for speakers with repaired cleft palate with affected velopharyngeal function. Pinto, Dalben, and Pegoraro-Krook, (2007) conducted a study on 27 experimental subjects with unoperated cleft palate/ or operated cleft palate with velopharyngeal insufficiency (VPI) after primary palatoplasty, treated with speech prosthesis suitable to their dental needs, and the speech was recorded with/ without porsthesis. The samples were blindly evaluated by 5 speech pathologists and results concluded that speech Intelligibility may be improved by using appropriate speech prosthesis.

Perceptual analysis was widely used to study the efficacy of the prosthesis (Subtelny, Sakuda & Subtelny, 1966; Pinto, Dalben, & Pegoraro-Krook, 2007). But, acoustical analysis is an

important aspect to be studied in cleft lip and palate. In literature several studies (Curtis, 1968; Maeda, 1982; Watterson & Ehanuel, 1981; Schwartz, 1971; Ericsson, 1980; Seunghee, Hyunsub, Zhi, & Kuehn, 2004) have been done on acoustic analysis in children with cleft lip and palate.

There are few studies done in the Indian context to investigate the effect of obturator on speech characteristics. Pushpavathi and Sreedevi (2004) analyzed the speech of a experimental subject with submucous cleft palate who was recommended palatal lift prosthesis. The acoustical parameters were studied by obtaining formant frequencies F1 and F2 with and without prosthesis. The results indicated that F2 was higher with prosthesis compared to the without prosthesis condition. The nasoendoscopy also revealed a better velopharyngeal closure with the prosthesis. But there is dearth of studies for proving efficacy of prosthesis using acoustical and physiological parameters.

The present study is a part of the longitudinal study of a project aimed to evaluate the effect of prosthesis on acoustical and perceptual characteristics of speech. Hence, this is a preliminary attempt to study the effect of using prosthesis in terms of acoustical findings and physiological measurements. The purpose of this study is to present a case report of an individual with palatal insufficiency with wide fistula and was fitted with a palatal obturator. This study is aimed to evaluate the effect of palatal prosthesis on some spectral characteristics of speech by evaluating acoustic and physiological characteristics of speech across the stages of adaptation to the prosthesis.

Objectives of the study

To investigate the difference in:

a) First and second formant frequencies between experimental subject with cleft palate without prosthesis (S1) and with prosthesis (S5) and a control subject.

b) Energy concentration at F1 between a experimental subject with cleft palate without prosthesis (S1) and with prosthesis (S5) and a control subject

c) First and second formant frequencies with and without palatal prosthesis (across stages of adaptation to the prosthesis with different elevation / extension of the obturator to the velar portion of the palate).

d) Energy concentration at F1 with and without palatal prosthesis (across stages of adaptation to the prosthesis with different elevation/ extension of the obturator to the velar portion of the palate).

e) To examine the velopharyngeal closure with and without prosthesis through nasoendoscopy

Method

Experimental subject

A 17 year-old male with congenital cleft lip and palate and moderate retardation served as experimental subject of the present study. He underwent plastic surgery for cleft lip at the age of 3 years. Since he had a wide palatal cleft, the surgery for the palate was not successful due to lack of tissue which lead to palatal fistula. On speech evaluation by speech language pathologist, he was diagnosed to have hypernasality and misarticulations. The cleft palate team constituting of plastic surgeon, orthodontist, prosthodontist, speech pathologist and psychologist recommended for the prosthetic management. The prosthodontist provided palatal obturator only to the anterior portion of the hardpalate to the experimental subject and gave two weeks time to get adjusted to it. Then, the prosthesis was extended to the velar portion of the palate and provided one month time to get adapted. During this one month, based on the feedback from the experimental subject and perceptual analysis of speech, prosthodontist made modifications to the velar section of the prosthesis till adequate velopharyngeal closure was achieved.

Recordings of the speech samples were done before and across the various stages of adaptation to the prosthesis. The experimental subject was evaluated during the adaptation stages of the prosthodontic management in terms of acoustical and physiological measurements as described in the procedure below. An age and gender matched control subject was chosen and speech recording was done to extract the data for the acoustic analysis.

Figure 1: *Wide palatal fistula*

Figure 2: *Final Prosthesis*

Figure 3: *Palatal prosthesis in Situ*

Procedure

Speech sample was obtained from the experimental subject at various stages during adaptation to the prosthesis as follows:

- Stage 1(S1): Before initiating the prosthetic management (Pre-treatment recording)

- Stage 2(S2): After providing anterior part of the palatal prosthesis.

- Stage 3(S3): After providing extension to the obturator to the velar portion of the palate and using the same for two weeks.

- Stage 4(S4): After one month of usage of the palatal obturator with velar extension

- Stage 5(S5): After doing the necessary modifications based on the experimental subject's feedback and using the obturator with velar extension for one month.

All the speech samples were recorded after the experimental subject got adjusted to the prosthesis.

Stimulus and Recordings for Acoustic Analysis

The study aimed to extract the first and second formant frequencies and their energy concentrations. Three unaspirated stop consonants in the initial position and in the context of vowel /a/ were considered as the stimuli (/pa/, /ʈa/ & /ka/). The experimental subject was seated comfortably in a sound treated room and was asked to repeat /pa/, /ʈa/ & /ka/ five times at his comfortable level. The stimuli were recorded using the *PRAAT 5.1* software, sampling size is 44,000, and the formant frequencies (F1 and F2) of the vowel and energy concentration at first formant (E1) were extracted

and analyzed. The same procedure was used for age and gender matched control subject.

Analysis

The following analysis was done before and across the stages of adaptation to the prosthesis

Step I: Acoustical Analysis

Speech samples were carried out for acoustical analysis to obtain the formant frequencies F1 and F2 of vowel /a/ and energy concentration at F1. The lowest band of continuous stretch of darkness at the lowest end of the spectrogram was denoted as F1. The next higher band with a noticeable stretch of darkness was denoted as F2.

Step II: Physiological evaluation

To study the physiological aspects of velopharyngeal closure using *NASOENDOSCOPY - CS 400*, this provides the visual display of the velopharyngeal closure. The experimental subject was asked to phonate vowel /a/ and the images of velopharyngeal closure were captured without prosthesis (S1) and with prosthesis (S5). Later the recorded images were correlated with acoustical findings.

Results and Discussion

The study aimed to analyze the effect of palatal obturator on some spectral and physiological aspects of the speech of an experimental subject with huge palatal cleft with VPD and comparing the same with the control subject.

A) Comparison of F1 and F2 between experimental subject and control subject in S1 and S5 conditions.

The formant frequencies F1 and F2 were measured for vowel /a/ across the three phonetic contexts /p/, /ʈ/ & /k/. The comparison was made between S1 and S5 conditions of experimental subject with the control subject in the formant frequencies F1 and F2. The results are depicted in Table 1 and Figure 4.

Table 1: *F1 & F2 of experimental subject and control subject in S1 and S5 conditions.*

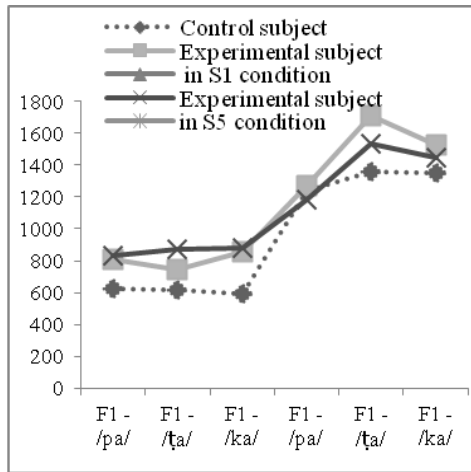| Subject	F1 (Hz)			F2 (Hz)		
	/pa/	/ʈa/	/ka/	/pa/	/ʈa/	/ka/
Control subject	627	614	589	1236	1360	1348
Experimental subject in S1 condition	812	745	854	1274	1711	1529
Experimental subject in S5 condition	836	870	880	1183	1532	1450

Figure 4: *F1 & F2 of experimental subject and control subject in S1 and S5 conditions.*

In general, the results revealed that the experimental subject exhibited high F1 and F2 in both S1 and S5 conditions compared to the control subject. However, high F1 is observed in S5 than in S1, and low F2 is observed in S5 than in S1. The variations in the F1 and F2 depend on the oral tract configuration based on the placement of the tongue. These variations in the F1 and F2 across the stimuli can be attributed to the contextual effect. The tongue placement for /ʈ/ and / k/ is more towards the mid and the posterior part of the palate. The experimental subject might have narrowed and retracted the tongue towards back of the oral cavity during the production of the target syllables, leading to high F1 in both S1and S5 conditions. This is possible because he had a cleft of the palate he might have developed compensatory articulation (pharyngeal plosive) by moving the base of the tongue back to articulate against the posterior pharyngeal wall. This result supports the findings by Fant (1973) who stated that retraction of the tongue increases the first formant comparatively to the other formant frequencies. Stevens and House (1955) also reported a high F1 with the articulatory event characterized by a narrow tongue constriction by a few centimeters above the glottis and an unrounded large mouth opening. Hence, the variation in the formant frequencies can be attributed to the variations in the articulation by the experimental subject. These results are also supported by the findings of Vasanthi (2001) who reported higher F1 and lower F2 in cleft palate speaker compared to the normal speaker. Even after using prosthesis (S5 condition) high F1 is noted, resulting from compensatory articulation. To eliminate compensatory articulation regular speech therapy is necessary along with prosthetic management (Arndt, Shelton, & Bradford, 1963; Pinto, Dalben, & Pegoraro-Krook, 2007).

B) Comparison of energy concentration (E1) at F1 between experimental subject in S1 and S5 conditions and control subject.

The energy concentration (E1) was measured at F1 for /a/ vowel across the three phonetic contexts /p/, /ʈ/ & /k/. The measurements were done between the control subject, and experimental subject in S1 and S5 conditions. The results are shown in the following Table 2 and Figure 5.

Table 2: *Energy concentration (E1) of, experimental subject in S1 and S5 conditions and control subject.*

Subject	Energy concentration (E1) in dB		
	/pa/	/ʈa/	/ka/
Control subject	56	55	57
Experimental subject in S1 Condition	71	70	69
Experimental subject in S5 Condition	70	66	67
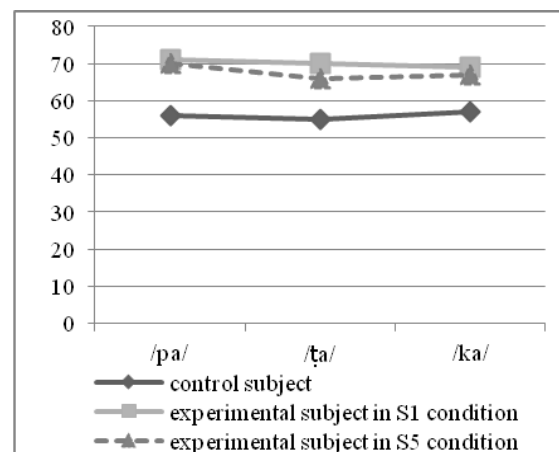
Figure 5: *Energy concentration (E1) of experimental subject in S1 and S5 conditions and control subject.*

The results indicate that E1 was high in experimental subject both in S1 and S5 compared to the control subject. Though the energy concentration in experimental subject was relatively reduced from S1 to S5, it was still higher than the control subject. This may be because, the experimental subject used loud pattern of habitual voice to achieve intelligible speech. Most of the subjects with cleft lip and palate attempt to speak with wide opening of the mouth to improve the oral resonance quality which inturn increases the loudness. The results support the findings of Zraick and Case (1999) who found the correlation of nasality, pitch and loudness reported that perception of increased nasality was related to increased loudness and an increase or decrease in pitch.

C) Comparison of F1 and F2 without prosthesis (S1) and the across the stages (S2 to S5) of adaptation by the experimental subject.

The F1 and F2 for vowel /a/ were measured across the stimuli /pa/, /ṭa/ & /ka/.The measurements were done without prosthesis (S1) and across the stages of adaptation (S2 to S5) to the prosthesis to find the differences in the first formant frequencies. The results are given in the following Table 3 and Figure 6.

In general, the results indicated that the F1 for all the stimuli increased from S1 to S3, however, decreased from S3 to S5. Overall there is a slight increase in the F1 with prosthesis (fifth recording). The first formant depends on the

height of the tongue and the constriction of the pharynx (Jacobson & Halle, 1956). The variations in the formant frequency can be attributed to the alterations in the constriction of the oral cavity and the tongue placement in the process of adaptation at various stages of the prosthesis. However the drastic increase in the F_1 between the first and the second recordings may be due the presence of anterior part of the obturator occupying anterior part of the fistula. This might have altered the movement of the tongue due to the presence of the prosthesis. The experimental subject might have altered the rate and movement of tongue which might have influenced the F1.

Table 3: *F1 and F2 for vowel /a/ across stimuli and across stages of adaptation to the prosthesis*

Stimuli	F1 (Hz) in Conditions					F2 (Hz) in Conditions				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
/pa/	812	1085	1049	927	836	1274	1282	1241	1329	1183
/ṭa/	745	982	1103	870	870	1711	1657	1765	1550	1532
/ka/	854	995	1175	942	880	1529	1570	1586	1443	1450
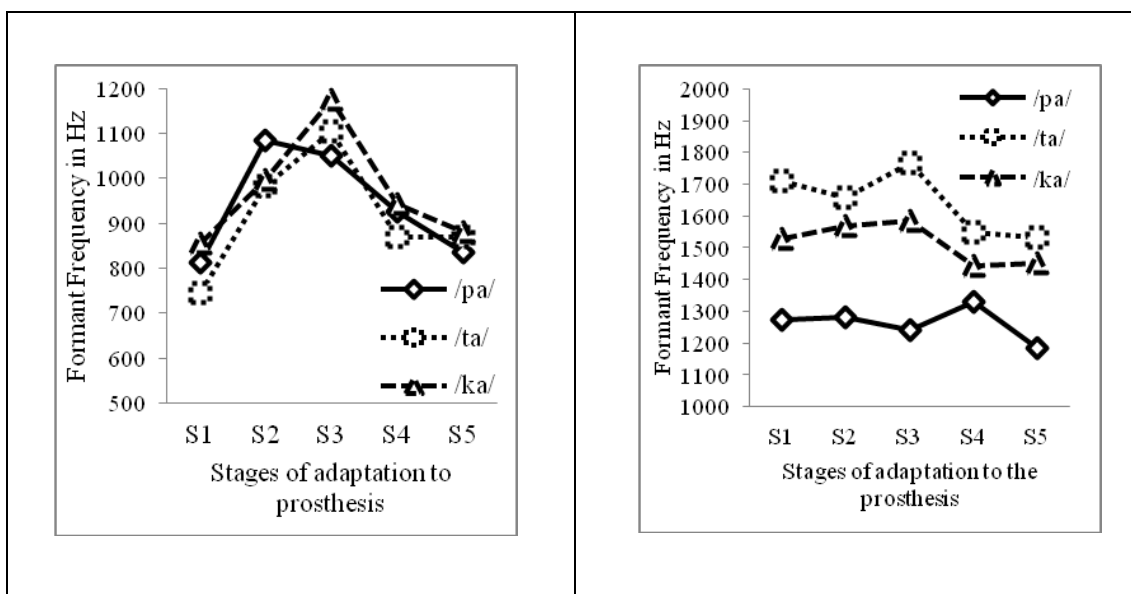
Figure 6: *F1 and F2 for vowel /a/ across stimuli and across stages of adaptation to the prosthesis*

These results are in contradiction to the findings of Pushpavathi and Sreedevi (2004) who reported a reduction in the first formant frequency with prosthesis in a submucous cleft palate individual. The difference in the result may be attributed to the nature of the cleft. According to Casal et.al, (2002) there are significant differences in the spectral characteristics exhibited by the experimental subject with various types of cleft lip and palate.

The results support the findings of Philips and Kent (1984) reported that the acoustic effects of nasalization vary across speakers and phonetic contexts.

The results indicate slight variations in F2 across the stages of adaptation to the prosthesis. Overall there is a decrease in the F2 with prosthesis (fifth recording) than without prosthesis (first recording). The variations in F2 can be observed across the phonetic contexts, where the lowest F2

was denoted in the context of /pa/ followed by /ka/ and /ta/. This may be due to the backing of the tongue towards the velar section of the prosthesis during the production of the stimuli. With the presence of the extended velar portion of the prosthesis, experimental subject might have attempted to articulate the vowel at the posterior portion of the oral cavity. The F2 depends on the tongue advancement in the oral cavity. This supports the findings of Fant (1973) who correlated the medium or low F2 with the velar and the pharyngeal articulation. However, the results are in disagreement with the findings of Pushpavathi and Sreedevi (2004) who reported an increase in the second formant frequency using prosthesis in a submucous cleft palate experimental subject. This can be attributed to the nature of the cleft and compensatory mechanism adopted by the experimental subject.

D) Comparison of E1 between without prosthesis (S1) and the across the stages of adaptation (S2 to S5) to the prosthesis by the experimental subject.

The energy concentration was measured E1 for vowel /a/ across the three phonetic contexts. The measurements were done without prosthesis S1 and across the stages (S2 to S5) of adaptation to the prosthesis to find the differences in the energy concentration. The results are shown in the following Table 5 and Figure 7.

Table 5: *E1 for vowel /a/ across stimuli and across stages of adaptation to the prosthesis*

Stimuli	E1 (dB) in Conditions				
	S1	S2	S3	S4	S5
/pa/	71	71	69	72	70
/ta/	70	69	67	70	66
/ka/	69	70	68	70	67
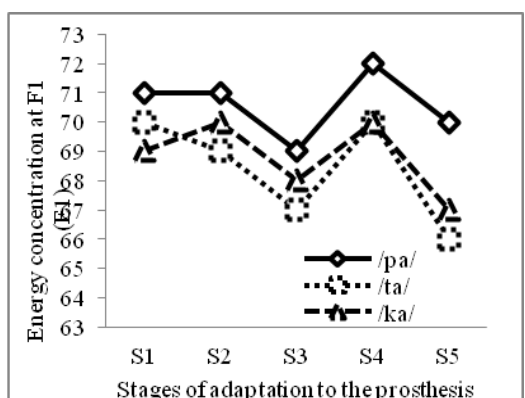
Fig 7: *E1 for vowel /a/ across stimuli and across stages of adaptation to the prosthesis.*

In general the results indicated that the energy concentration decreases from S2 to S5. This indicates that, the experimental subject loudness

decreases as he got adopted to use the prosthesis. This result supports the findings by Pushpavathi and Sreedevi (2004) who reported the reduced energy concentration with the prosthesis than without prosthesis in a submucous cleft palate.

Physiological Measures

The physiological assessment was done through the nasoendoscopy. The nasoendoscopy was used to measure the velopharyngeal closure during the first stage (S1) and the fifth stage (S5). The images were taken when the experimental subject phonated /a/ in both the conditions. The findings of the physiological measures revealed a good velopharyngeal closure with the prosthesis. The image S1 (Fig 8) showed gap of the velopharyngeal closure and S5 showed a good closure condition. The closure S5 (Fig 9) condition might have lead to the better results in speech which was reflected in the results obtained for formants F1, F2 and energy concentration at F1. This result support the findings of Jian, Ningyi, and Guilan, (2002) who reported improvement in velopharyngeal closure by using a temporary oral prosthesis and speech training.
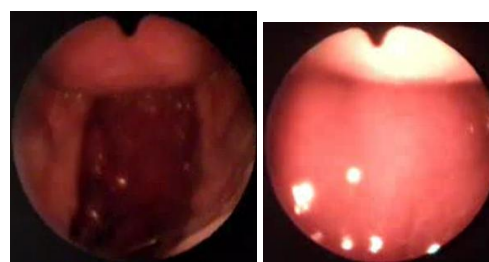
Figure 8: *Open velopharyngeal port in S1 condition* Figure 9: *Closed velopharyngeal port in S5 condition*

Conclusions

The present study investigated the effect of palatal prosthesis on few spectral characteristics of speech. A 17 year old boy with palatal fistula was considered as a experimental subject. He was recommended palatal prosthesis. In order to investigate the effect of palatal prosthesis, the formants frequencies F1, F2 and energy concentration (E1) was measured across phonetic contexts in control subject and experimental subject with prosthesis across the different adaptation stages. Overall, the results indicate that, the formants and energy concentration was different in control subject compared to experimental subject across conditions. The difference in acoustic values across conditions S1 to S5 suggested that the experimental subject is achieving better speech compared to S1 condition. The analyses of the same parameters are required after the experimental subject is completely rehabilitated to use the prosthesis and attends speech therapy. The findings are

preliminary in nature to conclude on the efficacy of the prosthesis. But, the study may add to the existing literature on the efficacy of palatal prosthesis in the rehabilitation.

References

Ainsworth, W. A. (1975). Intrinsic pitch factors in vowel judgment. In Fant, G., & Tatham (Eds), *Auditory analysis and perception* .p 103-113, London. Academic press.

Arndt, W. B., Shelton, R. L. & Bradford, L. (1965). Articulation, voiceand obturation in persons with acquired and congenital palate defects. *Cleft Palate Journal, 2:* 377–383.

Bhat, A. M, (2007). Prosthetic rehabilitation of a completely edentulous patient with palatal insufficiency. *Indian Journal of Dental Research, 18*: 35-37.

Bzoch, K. R. (2004). Introduction to the study of communicative disorders in cleft palate and related craniofacial anomalies. In: Bzoch KR, ed. *Communicative Disorders Related to Cleft Lip and Palate.* Austin TX: Pro-Edition.

Curtis, J. F. (1968). Acoustics of speech production and nasalization. In: Spriesterbach D, Sherman D, eds. *Cleft Palate and Communication*. New York: Academic Press; 1968.

Casal, C., Dominguez, C., Fernandez, A., Sarget, R., Martinez-Celdran, E., Sentis-Vilalta, J., & Gay-Escoda. C. (2002). Spectrographic measures of the speech of young children with cleft lip and cleft palate, 54, 247-257.

Ericsson, G. (1979-1980): "An acoustic investigation of production of plosives by cleft palate speakers" PERILUS Report 11, Dept of Linguistics, Stockholm University, pp.95-110.

Fant G. (1973). *Speech sounds and features* .Cambridge. The M.I.T. Press.

Fant, G. (1973). *Acoustic theory of speech production* (2 Edn.). Mouton, The Hague.

Henningson, G., & Isberg. (1987). Influence of palatal fistulas on speech and resonance .*Folia Phonetrica, 39*: 183-191.

Horii, Y. (1980). An accelometric approach to nasality measurement: A preliminary report. *Cleft Palate Journal, 17*: 254-261.

Jian, S., Ningyi, L., & Guilan, S. (2002). Application of obturator to treat velopharyngeal incompetence. *China Medical Journal, 115:842–* 845.

Kuehn, D. P., & Moller, K. T. (2000). Speech and language issues in the cleft palate population: The state of the art. *Cleft Palate-Craniofacial Journal, 37*: 348-383.

Kummer, A. W. (2001). Velopharyngeal dysfunction (VPD) and resonance disorders. In A. W. Kummer (Ed.), *Cleft palate and craniofacial anomalies: Effects on speech and resonance* (pp. 145–176). San Diego, CA: Singular/Thomson Learning.

Ladefoged, P. (1962): Subglottal activity during speech. Proceedings of the Fourth International Congress. *Phonetic Science*, 247-265.

Lindblom, B., Luker, J., & Pauli, S. (1977). An acoustic- perceptual method for the quantitative evaluation of hypernasality, *Journal of Speech and Hearing Research, 20*: 485-486.

Lubker, J. F. (1979). Acoustical-perceptual methods for evaluation of defective speech .in N.J.Lass (Ed). *Speech and language: Advances in basic research and practice*, Vol 11, Academic press: New York.

Maeda, S. (1982). Acoustic correlates of vowel nasalization: a simulation study. *Journal of Acoustics Society of America, 72*: S102.

McWilliams, B. J., Morris, H. L., & Shelton, R. L. (1990). *Cleft Palate Speech* (2nd ed.). Philadelphia: BC Decker.

McGrath, C. O., & Anderson, M. W. (1990). Prosthetic treatment of velopharyngeal incompetence. In: Bardach J, Morris HL, eds. *Multidisciplinary Management of Cleft Lip and Palate.* Philadelphia: Saunders; 1990.

Peterson-Falzone, S. J., Hardin-Jones, M. A., & Karnell, M. P. (2001). *Cleft palate speech*. St. Louis, MO: Mosby.

Philips, B. J., & Kent, R. D. (1984). Acoustic-phonetic description of speech production in speakers with cleft palate and velopharyngeal disorders. In N. J. Lass (Ed)., *Speech and language: Advances in basic research and practice*, Vol. 11, Academic press: New York.

Pinborough-Zimmerman, J., Canady, C., Yamashiro, D. K., & Morales, L. (1998). Articulation and nasality changes resulting from sustained palatal fistula obturation. *Cleft Palate Craniofacial Journal, 35*: 81–87.

Pinto, J. H. N., Dalben, G. D. S., & Pegoraro-Krook, M. I. (2007). Speech intelligibility of patients with cleft lip and palate after placement of speech prosthesis. *Cleft Palate-Craniofacial Journal, 44* (6): 635-641.

Pushpavathi, M., & Sreedevi, N. (2004). Effect of palatal lift on speech acoustics. *Proceedings of NSA -2004*, 39.

Reisberg, D. J. (2000). Dental and prosthodontic care for patients with cleft or craniofacial conditions. State of the Art. *Cleft Palate Craniofacial Journal, 37*: 534–537.

Seunghee, H.A., Hyunsub, S., Zhi, M., & Kuehn, D. P., (2004). An Acoustic study of the temporal characteristics of nasalization in children with and without cleft palate. *Cleft Palate–craniofacial Journal,* September, Vol. 41 No. 5 - 535- 543

Shelton, R. L., & Blank. (1984). Oronasal fistulas, intraoral air pressure and airflow during speech. *Cleft palate Journal, 21*: 91-99

Schwartz, M. (1971). Acoustic measures of nasalization and nasality, pp. 798-804 in Cleft Lip and Palate: Dental and Speech Aspects (Grabb, Fb senstein, & Bzoch, 4s.).

Stevens, K. N. & House, A. S. (1955): Development of a quantitative description of vowel articulation. *Journal of Acoustical Society of America*, 27, 484-493.

Stevens, K. N. (1998). Acoustic phonetics. Cambridge, MA: MIT Press. (Bibliographical annotation by Malone 2000.)

Subtelny, J. D., Sakuda, M., & Subtelny, J. D. (1966). Prosthetic treatment for palatopharyngeal incompetence: research and clinical implications. *Cleft Palate Journal. 3:* 130–158.

Tachimura, T. T., Nohara, K. N., Fujita, Y., & Wada, T. (2002). Change in levator veli palatine muscle activity for patients with cleft palate in association with placement of a speech-aid prosthesis. *Cleft Palate Craniofacial Journal*, 39:503–508

Tachimura, T. T., Kotani, Y., & Wada, T. (2004) Nasalance scores in wearers of a palatal Lift Prosthesis in Comparison with Normative Data for Japanese. *Cleft Palate Craniofacial Journal, 41(3):*315–319 cx

Vasanthi (2001). Some acoustic aspects in the speech of cleft palate speakers. *Research at AIISH. Dissertation Abstract.* Vol IV,158

Watterson, T. H., Ehanuel, F. (1981). Effects of oral-nasal coupling on whispered vowel spectra. *The Cleft Palate Journal, 18*: 1,24-38.

Zraick, R.I. & Case, J.L. (1999). Cited in, Evaluation of speech and voice: Patients with craniofacial Anomalies. Invited seminar at the Annual Convention of the Arizona Speech-Language-Hearing Association, Mesa, A. Z.

EFFECTS OF CHEMICAL IRRITANTS ON VOICE
AND SUBSYTEMS – AN ACOUSTIC ANALYSIS

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Abstract

Good voice quality is always vital for all individual at their occupation and in their environment to accomplish communication act. Many individuals due to their occupation are at greater risk of developing voice problems and other subsystem problems. The present study investigates the long term effect of irritants on voice quality and other subsystem function. Two groups of participants were participated in the present study. Experimental group had 43 participants (mean age- 43.56 years) who were working in a latex manufacturing factory and had a minimum experience of 10 years. Control group consisted of forty three individuals (mean age- 40.5years). Subjects performed monologue, s/z ratio, phonation duration of /a/, /i/, /u/ and reading meaningful words which included /a/, /i/, and /u/ in a VCV context. Praat software was used to analyze live voice acoustically with sampling frequency 44 kHz. A stop watch was also used to measure the phonation duration and s/z ratio. Paired sample t- test was carried out and it showed that participants in the experimental group showed significantly lower values for F0, SFF and jitter indicating an affected phonatory system. This was further confirmed by significantly short MPD values in experimental group. Result confirms that exposure to irritants for a longer time will result in vocal pathologies. Effects of irritants on voice can have significant impact on individual voice which in turn causes various pathologies in larynx and other sub system. This will have direct impact on occupation and social life. The present results will help speech language pathologist to provide good vocal hygiene measures and to reduce exposure time to irritants and also to monitor the effect of therapy for this kind of voice abnormalities.

Key words: Irritants, Ammonia, Jitter, Shimmer, F0

Voice is the sound produced by the vibrating vocal folds (Aronson, 2009). This sound is shaped by the vocal tract into a unique acoustic form that allows the listener to recognize the speaker. It is the primary instrument through which most of them project their personalities. It is a combination and interaction of the mechanisms of respiration, phonation, resonance, and articulation (Schneider, 2007).Voice disorders result from faulty structure or function somewhere in the vocal tract in the process of respiration, phonation, or resonance. Voice disorder exists when one or more aspects of the voice such as loudness, pitch, quality, or resonance are outside the normal range for the age, gender or geographic background of the speaker. When the voice changes in any negative way it is said to be dysphonic. One of the ways to record and analyze the dysphonic is through acoustic analysis. Acoustic analysis helps us to understand normal voice production and deviations altering the normal voice state (Scalassara, 2007). Acoustic analysis gives account of frequency features, intensity features and perturbation features (Pribuisiene & Uloza, 2006).

Good voice quality is always essential for all individual at their work and in their environment to accomplish communication act. Many individuals by the very nature of their occupations are at a greater risk of developing voice problems and laryngeal pathologies (Vanhoudta & Thomas, 2008). The common vocal pathologies seen in an occupational setting includes laryngitis, vocal polyp, vocal nodule and contact ulcer (Vilkman, 2004). These disorders could be a result of bacterial or viral infections, by excessive use of voice or by chemical irritants.

There are numerous studies on the effect of chemical irritants on voice and its subsystems. National Institute of Occupational Safety and Health (1997) recognized exposure to sulphuric acid is not only a risk factor for the development of carcinoma of larynx but also disorder of laryngitis. Williamson (1995) reported 58% of people who inhaled steroids had some dysphonia or throat symptoms when compared to their control subjects. Perkner (1998) described vocal cord dysfunction due to general irritants in 11 individuals exposed in their working environments. Tanturri (1988) described a case of freon gas that resulted in oedematous pharyngolaryngitis. Exposure to irritants is associated with asthma symptoms (Ramon, 2005) and accompanied by lower respiratory tract dysfunction and other pulmonary diseases (Prezant, 2008). The Present study carried out to

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investigate the effect of chemicals like ammonia and sulphuric (H_2So_4) acid on latex manufacturing factory workers where these chemicals are used heavily. The association between exposure of these irritants and its effect on vocal quality and subsystems are investigated.

Method

Participants

Two groups of forty three male participants in the age range of 35 to 48 years (mean age 43.56 years) took part in the study. Experimental group (EG) consisted participants who were working in a latex manufacturing factory and had a minimum experience of 10 years. All the participants were exposed to these irritants for at least 8 hrs a day. All were native speakers of Malayalam with no history of speech and language impairment or neurological or psychiatric disease. Control group (CG) consisted of forty three individuals with age range of 30 to 50 years (mean age 40.5 years). The Inclusion criteria consisted of Individuals with no history of speech, language and hearing disorders, individuals with no history of allergy and frequent rhinitis and individuals with any exposure to any such previous experiments.

Equipments

The study was conducted in a sound treated room. Voice samples were recorded using Sony vaio laptop with frontech external microphone. Praat software version 5.1.22 (Weenink & Boersma, 2009) was used to analyze live voice acoustically. The sampling frequency used was 44 kHz. A stop watch was also used to measure the phonation duration and s/z ratio.

Procedure

A brief history was taken for the purpose of obtaining demographic data, the duration of exposure to irritants per day and subjects experience of their voice quality in daily communication. Participants were seated comfortably. The microphone was placed 3 inches away from the subject's mouth. Subjects were asked to perform four tasks which included monologue, s/z ratio, maximum phonation duration of /a/, /i/, /u/ and reading meaningful words which include /a/, /i/, and /u/ in VCV context.

Acoustic Analysis

Acoustic parameters such as fundamental frequency (FO), speaking fundamental frequency (SFF), jitter percent, shimmer dB and harmonic to noise ratio (HNR) were determined from the recorded sample. Further statistical analysis was done using SPSS software.

Results

The acoustic analysis of voice included measurement of fundamental frequency, speaking fundamental frequency, jitter, shimmer, harmonics to noise ratio, phonation duration and s/z ratio.
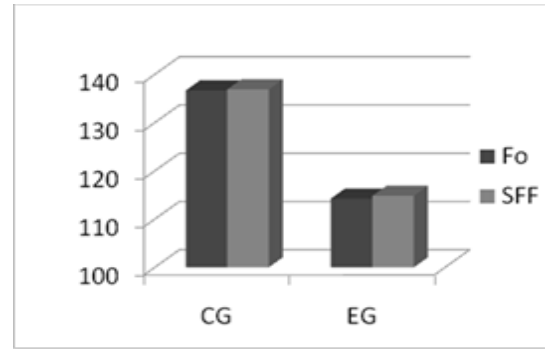
Figure 1. *Mean values of control group (CG) and experimental group (EG) for fundamental frequency (F0) on phonation task, and speaking Fundamental Frequency (SFF) on monolog task.*
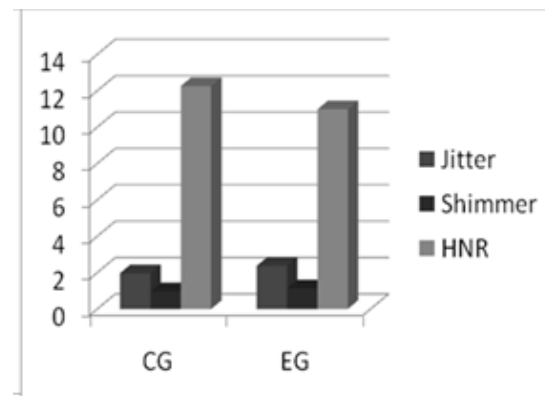
Figure 2. *Mean perturbation values in terms of jitter and shimmer and also shows mean values of Harmonic to Noise ratio (HNR).*
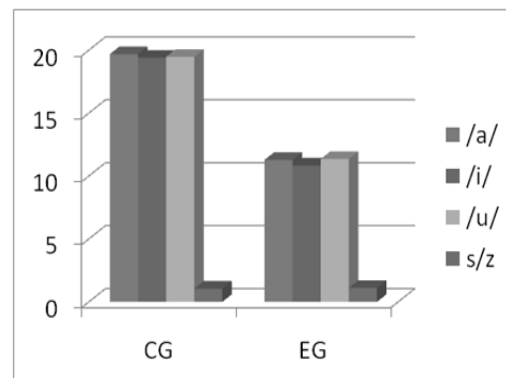
Figure 3. *Mean values of phonation duration (PD) of /a/, /i/ and /u/ and also the mean s/z ratio.*

Paired sample t- test was carried out between two groups, results revealed significant difference for

parameters like F0 (figure 1), SFF (figure 1) and Jitter (figure 2). Subjects in the experimental group showed significantly lower values for F0 (mean= 114.26 Hz, SD=12.82, p<0.001), SFF (mean=114.83 Hz, SD= 12.63, p<0.001) and jitter (mean=2.37, SD=0.7276, p<0.01), than the control group, indicating an affected phonatory system. This was further confirmed by significantly short maximum phonation duration (/a/=11.28sec, /i/=10.83sec and /u/=11.35sec) values in experimental group. However measures such as shimmer (figure 2) and HNR (figure 2) didn't not significant value across two groups Values obtained on s/z ratio testing although not statistically significant (p=0.387), were lower in the experimental group (mean /s/= 9.14 sec and mean /z/= 7.85 sec) when compared to control group (mean /s/=20.84 sec and mean /z/=19.03sec).

Discussion

Present study attempted to highlight the effect of chemical irritants on vocal quality and respiratory subsystem. It was reported in earlier studies that pulmonary diseases caused by irritants inhalation have effect on acoustic measures of voice including maximum phonation time, frequency, and amplitude perturbation parameters (Dogan, 2007). The differences in acoustic parameters may be due to abnormal mucosal wave symmetry/periodicity, glottic closure, mucosal quality and mucosal wave amplitude/magnitude resulting from irritants inhalation (Gallivan, 2007). Exposure to irritants along with other factors such as prolonged shouting reduced fluid intake and dehydrating agents results in vocal fold pathologies (Bradley, 2010). Laryngitis may also cause huskiness, reduced pitch, loss of part of the range of the voice These abnormalities could result in vocal perturbations which are evident in terms of pitch and amplitude. The possible causes will include inhalation of H_2So_4 and ammonia acid for a considerable duration. Long term inhalation of these irritants will results in hoarseness, tightness of throat, cough and pain (Agency for Toxic Substances and Disease Registry, 1999). But the physical characteristics of the phonatory system was not visually studied which is one of the limitation of this study.

Inhalations of irritants convey variety of effects to the airway ranging from mucous membrane irritation to respiratory diseases (Allan, 2006). The complications may include nasal symptoms, wheezing and breathlessness, and reduced spirometric lung function (Sripaiboonkij, Phanprasit & Jaakkola, 2007). And the extent of disease depends on the exposure time and amount of irritants in the environment which in turn reduce lung capacities (forced expiratory

volume and vital capacity) which are important for sustained phonation activities and other respiratory measures. Present study showed a significant reduction in respiratory and phonatory aspects with reduced phonation duration, /s/ and /z/. One possible factor that could have influenced results of the present study was the exposure time to these irritants which was more than 10 years in each of the participants. And the adverse effect of such irritants can lead to different vocal pathologies. Study confirms previous research showing affected phonatory and respiratory system due to long term exposure to irritants.

Conclusions

The study results clearly states that exposure to irritants for a longer time will have a significant impact on individual voice which in turn causes various pathologies in larynx and other sub system. The results of the study has direct impact on occupation and social life and will help SLP to provide good vocal hygiene measures and to reduce exposure time to irritants. Further the results highlight the importance for careful evaluation of those exposed to potentially harmful chemical irritants irrespective of preventive measures. And these measures can used to monitor the effect of therapy for this kind of voice abnormalities. Future research can be focused on correlating acoustic changes with anatomical status of the individual using direct visualization techniques such as endoscope or stroboscope.

Reference

Aronson, E. (2009). Clinical voice disorders. *Thieme, 2009* - Medical – 301.

Allan, P. (2006). Vocal Cord Dysfunction: Etiologies and Treatment. *Clinical Pulmonary Medicine, 13, 2*, 73-86.

Bradley, P. J. (2010). Voice Disorders: Classification, *Otorhinolaryngology, Head and Neck Surgery, European Manual Of Medicine, 7, 555-562, DOI: 10.1007/978-3-540-68940-9_60.*

Dogan, M. (2007). Subjective and Objective Evaluation of Voice Quality in Patients with Asthma. *Journal of Voice, 21, 2,* 224-230. DOI:10.1016/j.jvoice.2005.11.003.

Gallivan, G. (2007). Inhaled Corticosteroids: Hazardous Effects on Voice- An Update. *Journal of Voice 21, 1, 101-111.*

Ramon, M. (2005). Asthma, chronic bronchitis, and exposure to irritant agents in occupational domestic cleaning: a nested case-control study. *Occupational and environmental medicine, 6,* 598-606.

Prezant, D. (2008). Upper and lower respiratory diseases after occupational and environmental disasters. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized*

Medicine, *75, 2,* 89–100*.* DOI: 10.1002/msj.20028.

Pribuisiene, R., & Uloza, V. (2006). Perceptual and Acoustic Characteristics of Voice Changes in Reflux Laryngitis Patients. *Journal of Voice, 20,1,* 128-136.

Pekner, J. (1998). Irritant-Associated Vocal Cord Dysfunction. *Journal of Occupational & Environmental Medicine: 40, 2,* 136-143.

Schneider, S. L. (2007). Voice Therapy for the Professional Voice. *Otolaryngologic Clinics of North America", 40, 5,*1133-1149.

Scalassara, P. R. (2007). Relative entropy measures applied to healthy and pathological voice characterization. *Applied Mathematics and Computation 207, 1,* 95-108*.* DOI: 10.1016/ J.Amc. 2007. 10. 068.

Sripaiboonkij, P., Phanprasit, W., & Jaakkola, M. S. (2007). Respiratory effects of occupational exposures in a milk powder factory. *European respiratory journal, 31, 4,* 807-814. DOI: 10.1183/09031936.00106407

Tanturri, G., Pia, F., & Benzi, M. (1988). A case of edematous pharyngolaryngitis in a man occupationally exposed to inhalation of Freon gas. *La medicina del lavoro, 79(3),* 219-22.

Vanhoudta, I., & Thomas, G. (2008). The background biopsychosocial status of teachers with voice problems. *Journal of Voice, 65, 4,* 371-380, doi:10.1016/j.jpsychores.2008.03.020.

Vilkman, E. (2004). Occupational Safety and Health Aspects of Voice and Speech Professions. *Folia phoniatrica et logopaedica, international journal of phoniatrics, 56, 4,* 220-253, DOI: 10.1159/000078344.

Williamson, I. (1995). Frequency of voice problems and cough in patients using pressurized aerosol inhaled steroid preparations. *European respiratory journal, 8, 4,* 590-592.

ELECTROGLOTTOGRAPHIC ANALYSIS IN INDIVIDUALS WITH CHRONIC LARYNGITIS DURING SPEECH TASK

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Abstract

Electroglottography (EGG) is a method to monitor the vibrations of the vocal folds by measuring the varying impedance to a weak alternating current through the tissues of the neck. Non-invasive measures of vocal fold activity are useful for describing normal and disordered voice production. Measures of open, closed and speed quotient from glottal airflow and electroglottographic (EGG) waveforms have been used to describe timing events associated with vocal fold vibration. There are very few studies in western context and no Indian studies were done using speech task. The aim of the present study was to analyze the laryngeal behavior of individuals with chronic laryngitis using electroglottograph on reading voiced passage and to compare with normal individuals. 10 adults with chronic laryngitis and 10 age and gender matched normal adults in the age range of 30 – 40 years participated in the present study. All the recorded samples were analyzed for contact quotient (CQ), open quotient (OQ) and speed quotient (SQ). Results indicated that there was significant statistical difference between normal and abnormal group on all the three EGG quotients for voiced passage reading task. These results also suggested that the closed duration during vocal fold vibratory pattern was longer in individuals with chronic laryngitis and open duration was reduced thereby reducing the speed quotient which indicates the asymmetry of vocal fold vibration during reading passage task in these individuals. It also suggest that connected speech context, as in passage reading, can give better representation, due to the fact that passage is more representative to one's daily speech characteristics than sustained phonation. The laryngeal measures obtained from connected speech context offer a more accurate representation in differentiating normal versus pathological voices. Implications of the findings are discussed and topics for further exploration are identified.

Voice is the "Laryngeal modulation of pulmonary air stream, which is then further, modified by the configuration of the vocal tract" (Micheal & Wendahl, 1971). Voice is the result of breath under pressure from lungs causing the approximated vocal cords to perform the rhythmic excursions of separation and closure (Greene, 1980). The ultimate aim of the research on normality and abnormality is to enforce a procedure which will eventually bring back the voice of an individual to normal or optimum level.

Hanson, Gerratt, and Berke (1990) reported that the majority of the phonatory dysfunctions are associated with abnormal vibrations of vocal folds. Hence analysis of vibration of vocal folds in terms of different parameters constitutes an important aspect to be considered in the diagnosis and differential diagnosis of the voice disorders.

Hirano (1981) stated that, "acoustic analysis may be one of the most attractive method for assessing phonatory function or laryngeal pathology because it is non-invasive and provides objective and quantitative data. However, Hanson et al. (1990) reported that the acoustical measurements cannot necessarily have a direct physiological correspondence to abnormal glottal activity.

The study of the voice in both health and disease relies on knowledge of the vibratory pattern therefore, it is important to have techniques that permit the analysis of this pattern (Kent, 1997). There are several instruments and procedures which use either invasive or non-invasive techniques to analyze the vocal fold vibrations. They include stroboscopy, ultrasound glottography, ultra high speed photography, photoglottography, electroglottography and inverse filtering, etc.

Electroglottography (EGG) provides a non-invasive and simple measure of vocal fold contacting behaviours in phonation. The EGG waveform reflects the amount of transverse impedance at the laryngeal level. The amount of impedance decreases as vocal fold contact increases (Rothenberg & Mahshie, 1988). Therefore, an EGG waveform provides an indirect measure of the relative degree of vocal fold contact in phonation. It denotes vocal fold contacting behaviours in terms of the time and rate of glottal closure and opening (Baken & Orlikoff, 2000). The internationally recommended orientation of EGG waveform is

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that an upward-going waveform corresponds to an increasing vocal fold contact area. An acute rise in the EGG waveform corresponds to the quick closing of the vocal folds and is followed by a gradual decline in the waveform (Baken, 1992) which is associated with the separation of the vocal folds as the pressure below the glottis is higher than above, and the natural tendency of the vocal folds to return to their equilibrium position. EGG has been used extensively to investigate vocal fold vibratory functions in normal adults and in adults with pathological voice disorders (Childers, Smith & Moore, 1984; Dejonckere & Lebacq, 1985). The relation between the impedance of the EGG and underlying physiology of the vocal folds has been well documented by several investigators (Childers et al. 1984).

EGG does not interfere with phonation (Fourcin, 1986; Kelman, 1981). EGG certainly reflects the vibratory cycle of the vocal folds with fairly high fidelity. Irregularities of the EGG thus correspond to the irregularity in the vibratory pattern of the vocal cords. The output signals of EGG convey information regarding the contact area of the vocal folds (Koster & Smith, 1970). So, EGG could be useful for investigating the glottal condition during the closed phase.

Some authors argue that voice samples gathered from either sustained phonation or syllable repetition tasks for EGG measurements are not sufficient to represent daily, functional connected speech (Higgins & Saxman, 1993). Connected speech tasks may reveal more distinct phonatory patterns than sustained vowel phonation due to the different laryngeal mechanisms involved such as coarticulation and intonation (Hong & Kim, 1997). However, whether the use of connected speech for EGG measurements provides a better representation of normative data as sustained vowel phonation in measure of vocal fold contact has yet to be proved (Ma & Love, 2010).

Ma, and Love (2010) conducted a study to find out the age and gender effects during sustained phonation and connected speech using EGG. The authors found that there was a significant statistical main effect of speech task for fundamental frequency regardless of age and gender. Interestingly, the mean fundamental frequency obtained from passage task was significantly higher than that obtained from the phrase task (about one semitone difference). This was attributed to the nature of speech stimuli in the two tasks. The more prosodic and emotional variations involved in reading a story passage (North Wind and the Sun) than in an isolated short phrase (''A baby boy'') could have contributed to the higher mean fundamental

frequency in the passage task. For contact quotient, significant age-by-gender interaction effect was found only in the passage task but not in the phrase task. The results suggest that connected speech context of longer duration, as in passage reading; can give a better representation of contact quotient measure than reading a short phrase. Therefore, these authors reported that one should make use of connected speech stimulus, preferably at passage level, in EGG evaluation for a better representation of vocal fold vibrating behaviours.

In Indian context, Balakrishna (1993) reported that good voices are characterized by high closed quotient (CQ) and low fundamental frequency (F0), low open quotient (OQ) and low speed quotient (SQ) on phonation task. These results indicated that CQ, OQ and SQ can be used as indicators of glottal efficiency. Chandrashekar (1987) compared the EGG quotients across normals and dysphonics. He found significant difference between dysphonics and normals in which, dysphonics had lower OQ and higher SQ indicating prolonged closing time. Predictive value of EGG in voice disorders was studied by Ahluwalia and Prakash (2001) and they reported overall predictability of 69.3% with high sensitivity for mass lesions and mobility disorders of vocal cord. Several studies were done to find out the normative values of EGG quotients for different age groups and also for different voice disorders using phonation task.

Attempts to document voice quality by EGG are recognised and computerized methods to obtain information about vibratory perturbations and vibratory frequency of the vocal folds have been described in literature. However, several studies measured EGG by using phonation as task. There are very few studies in Western context and no Indian studies were done using speech task. Sustained phonation or syllable repetition tasks for EGG measurements are not sufficient to represent daily, functional connected speech. Using speech task for analysis of laryngeal behaviour provides an insight into the laryngeal activity during normal conversation and in connected speech. Colton, Casper and Leonard (2005) evaluated 1,158 voice patients and reported laryngitis as one of the fifth most frequently occurring pathological condition. Therefore, there is a great need to study the laryngeal behaviour or vibratory patterns of vocal folds during speech task preferably reading passage in individuals with chronic laryngitis.

Aim of the study

The present study was conducted with the aim of analyzing the laryngeal behaviour of individuals with chronic laryngitis using electroglottograph

while reading voiced passage and to compare with normal individuals.

Method

Participants: 10 adults with chronic laryngitis diagnosed by a Speech language pathologist and otolaryngologist and 10 age and gender matched normal adults in the age range of 30 – 40 years participated in the present study. Voice evaluation of chronic laryngitis participants revealed as having moderate level of hoarseness and reduced loudness. All the subjects were native Kannada speakers had more than 12 years of formal education and they could read Kannada. All the normal participants were judged perceptually as normal vocal quality by a speech – language pathologist and they had no speech, language and hearing problems.

Instrumentation   and   Procedure: Electroglottographic analysis was done using Electroglottograph, Model - 6103 manufactured by Kay elemetrics. Each participant was seated comfortably in an upright position. The participant's skin over the thyroid lamina was cleaned using alcohol swab to remove any skin oil and to maximize electrode-to-skin contact. The two electrolaryngographic surface electrodes, which were attached to a neckband, were then placed externally on the participant's neck on each side of the thyroid lamina.

The neckband was sufficiently tight as to ensure adequate electrode-to-skin contact. Before the actual recording, each participant was asked to sustain the vowel /a/ for 3 seconds at his/her most comfortable pitch and loudness. The Laryngeal waveform displayed on the computer screen was then inspected until a clear waveform with the largest amplitude was captured. This procedure was performed to ensure the electrode placement was correct and the most optimal Lx signal was captured. A weak high frequency signal of 0.5 – 10MHz of low voltage of 0.5V was passed through one of the gold plates and was recorded by the other electrode.

All the participants were asked to read a Kannada passage which consists of all voiced consonants, which was developed at All India Institute of Speech and Hearing, Mysore in the year 1985. This passage was selected to avoid the effect of unvoiced consonants on laryngeal behaviour. Reading a passage with voiced consonants will give better response compared to connected speech which consists of both voiced and voiceless consonants.

Data analysis and measures: All the recorded samples were analyzed using electroglottograph for contact quotient, open quotient and speed quotient. Contact quotient (CQ), which is used to measure the degree of vocal folds approximation

during reading task; open quotient (OQ), which is the proportion of the period during which the glottis is open to the total period, and speed quotient (SQ), which is used to measure the ratio of opening and closing durations.

Results and Discussion

The present study was conducted with the aim of comparing EGG quotients of normal and abnormal voice on reading passage task. For this, three comparisons were done, that is, comparison of CQ, OQ and SQ of normals with abnormal group.

1. Comparison of contact quotient between normal and abnormal voice

Comparison of contact quotient was done using independent samples t – test to find out the significant difference between the two, normal's and abnormal. Results showed that there is a significant difference [t (18) = 0.824; p<0.05] in CQ values. The mean and S.D of CQ of normal and abnormal participants is given in table 1.

Table 1: *Mean and S.D of CQ of normal and abnormal participants.*

Group	N	Mean	Standard Deviation
Normals	10	46.86	2.96
Abnormal	10	48.23	4.35

The above results show that the mean CQ is higher in abnormal voice group than in normal group. This indicates prolonged closed duration in abnormal group when compared to normal group. However, the standard deviation is more in abnormal group indicating within the group variability in individuals with chronic laryngitis. The graphical representation of mean and S.D of contact quotient of normal and abnormal participants is shown in Figure 1.
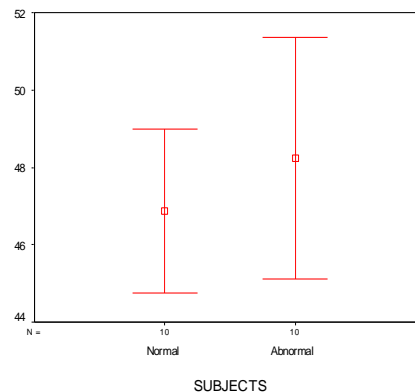
Figure 1: *Error bar graph representing mean and S.D of CQ of normal and abnormal groups.*

2. Comparison of open quotient (OQ) between the normals and the abnormals

Comparison of open quotient was done using independent samples t – test to find out the

significant difference between the two, normal's and abnormal. Results showed that there is a significant difference [t (18) = 0.896; p<0.05] in OQ values. The mean and S.D of OQ of normal and abnormal participants is given in table 2.

Table 2: *Mean and S.D of OQ of normal and abnormal participants.*

Group	N	Mean	Standard deviation
Normals	10	53.13	2.96
Abnormal	10	51.67	4.23

The above results show that the mean OQ is lower in abnormal voice group than in normal group. This indicates reduced open duration of vocal folds in abnormal group when compared to normal group. However, the standard deviation is more in abnormal group indicating within the group variability in individuals with chronic laryngitis. The graphical representation of mean and S.D of open quotient of normal and abnormal participants is shown in Figure 2.
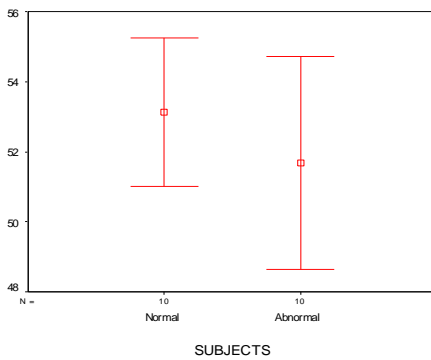
Figure 2: *Error bar graph representing mean and S.D of OQ of normal and abnormal groups.*

3. *Comparison of speed quotient between the normals and the abnormals*

Comparison of speed quotient was done using independent samples *t* – test to find out the significant difference between normals and abnormal. Results showed that there is a significant difference [t (18) = 1.707; p<0.05] in SQ values. The mean and S.D of SQ of normal and abnormal participants is given in table 3.

Table 3: *Mean and S.D of SQ of normal and abnormal participants.*

Group	N	Mean	Standard deviation
Normals	10	343.07	94.56
Abnormal	10	261.84	117.00

The above results show that the mean SQ is lower in abnormal voice group than in normal group. However, the standard deviation is more in abnormal group indicating within the group variability in individuals with chronic laryngitis. The graphical representation of mean and S.D of

speed quotient of normal and abnormal participants is shown in Figure 3.
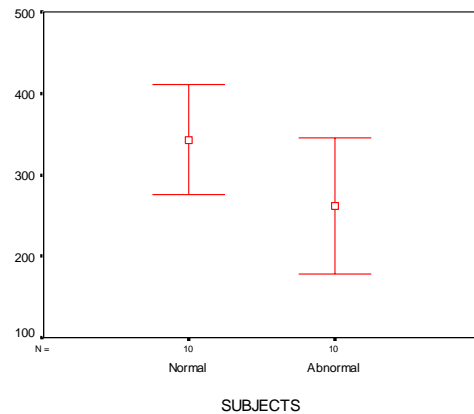
Figure 3: *Error bar graph representing mean and S.D of SQ of normal and abnormal groups.*

Discussion

EGG provides an indirect measure of vocal fold contacting behaviour in phonation and speech tasks. The main objective of the present study was to investigate the vocal fold vibratory behaviour in normals and in individuals with chronic laryngitis while reading a voiced passage. This study was also aimed to study whether reading a voiced passage task can be used during EGG analysis in clinical settings.

The present study found significant statistical difference between normal and abnormal group on all the three EGG quotients, indicating that reading voiced passage task can be used to differentiate between normal and abnormal voices. These results also suggested that the closed duration during vocal fold vibratory pattern was longer in individuals with chronic laryngitis and open duration was reduced thereby reducing the speed quotient which indicates the asymmetry of vocal fold vibration during reading passage task in these individuals.

Chronic laryngitis is a condition with thickened and dry epithelium that may lead to tissue changes such as nodules, polyps or hypertrophy of laryngeal epithelium if untreated. Hence early identification and rehabilitation is absolutely necessary. Laryngitis affects the cover of the vocal folds by increasing the stiffness, but may have little effect on the mass of the vocal folds. Colton et al. (2005) conducted stroboscopic findings in individuals with chronic laryngitis. They noted a jerk like movement of the mucosal wave, in which the wave appears to travel along part of the surface at one speed, then changes its speed for the remainder of its travel. The vocal folds showed increased asymmetry and periodicity with reduced mucosal waves and reduced amplitude. There shall be greater than

normal spectral noise in the voice of the individuals with chronic laryngitis.

The results are also possibly due to the nature of speech stimuli (voiced passage) that was used in the present study. These results suggest that connected speech context, as in passage reading, can give better representation of contact, open and speed quotient measures than sustained phonation task. The present findings offer some supports to the use of connected speech over sustained vowel prolongations as test materials in evaluating vocal fold vibratory behaviours. It also suggests that laryngeal measures obtained from connected speech are more accurate than those obtained from sustained vowel prolongation in classifying normal and abnormal voices. This may be due to the fact that connected speech is more representative to one's daily speech characteristics than sustained phonation and hence, laryngeal measures obtained from connected speech context offer a more accurate representation in differentiating normal versus abnormal voices. Ma and Love (2010) found that there is slight difference between in laryngeal behaviour on reading passage task and reading phrase tasks, as short phrase may not give adequate phonemic and prosodic representations of an individual's use of voice in connected speech. In this regard, Fourcin and Abberton (2008) recommended test materials of two minutes in duration for EGG evaluation in connected speech context. The present study support the use of connected speech, preferably at reading passage level, in electroglottographic evaluation for a better representation of vocal fold vibrating behaviours and these results also support the studies by Higgins and Saxman (1993); Hong and Kim (1997); and Ma and Love (2010) that supports the use of connected speech in electroglottographic evaluation.

Conclusion and future research

This paper is an attempt to give a state of art report of objective analysis of voice in clinical settings using speech task. Acoustic data are considered most important for patient reinforcement and assessment outcomes. Electroglottography can objectify dysphonia in individuals with chronic laryngitis and is a suitable noninvasive tool for tracking long-term progress. EGG quotients best represents the vocal-fold dysfunction in individuals with chronic laryngitis. In conclusion, this study contributed to the existing literature by further understanding the vocal fold vibratory pattern in connected speech in normals and abnormal voices. Results also encourage the use of connected speech context at passage level for more accurate and reliable evaluation of vocal

fold vibratory patterns. However, the classification accuracy for measures from reading passage task was not compared with that of phonation task in the present study. Therefore, future research is warranted by including both phonation and speech tasks in the analysis and also to check the accuracy of classification by using speech stimulus with various quotients of EGG and also waveform morphology. It would also be interesting to replicate the study with other clinical voice disorders to investigate if similar findings would be generalized to all the pathological groups especially in the Indian context.

References

Ahluwalia, H., & Prakash, B. (2001). Predictive value of Electroglottography in voice disorders. *Indian Journal of Otolaryngology and Head & neck surgery. 53*(4), 289 – 290.

Baken, R. J. (1992). Electroglottography. *Journal of Voice*, *6*, 98-110.

Baken, R. J., & Orlikoff, R. F. (2000). *Clinical measurement of speech and voice (2nd edn.)* San Diego: Singular publishing group, Inc.

Balakrishna, M. N. (1993). *Contact quotient as a glottal efficiency indicator*. Unpublished master's dissertation submitted to University of Mysore, Mysore.

Chandrashekar, K. R. (1987). *EGG in dysphonics*. Unpublished master's dissertation, University of Mysore, Mysore.

Childers, D. G., Smith, A. M., & Moore, G. P. (1984). Relationship between electroglottograph, speech, and vocal cord contact. *Folia Phoniatrica*, *36*, 105-118.

Colton, R. H., Casper, K J., & Leonnard, R. (2005). *Understanding voice problems: a physiological perspective for diagnosis and treatment,* San Diego: Singular Publishing Group.

Dejonckere, P. H**.,** & Lebacq, J. (1985). Electroglottography and vocal nodules. An attempt to quantify the shape of the signal. *Folia Phoniatrica*, *37*, 195-200.

Fourcin, A. J. (1986). Electrolaryngographic assessment of vocal fold vibration. *Journal of Phonetics*, *14*, 435-442.

Fourcin, A., & Abberton, E. (2008). Hearing and phonetic criteria in voice measurement: clinical applications. *Logopedics Phoniatrics Vocology*, *33*, 35-48.

Greene, M.C.L. (1980). *The Voice and Its Disorders.* Philadelphia, PA: JB Lippincott.

Hanson, D.G., Gerratt, B.R., & Berke, G.S. (1990). Frequency, intensity, and target matching effects on photoglottographic measures of vocal quotient and speed quotient. *Journal of Speech and Hearing Research, 33*, 45-50.

Higgins, M.B., & Saxman, J. H. (1993). Inverse-filtered air flow and EGG measures for sustained vowels and syllables. *Journal of Voice*, *7*, 47-53.

Hirano, M. (1981). *Clinical examination of voice*. New York: Springer- Verlag.

Hong, K.H., & Kim, H.K. (1997). Electroglottography and laryngeal articulation in speech. *Folia Phoniatrica*, *49*, 225-233.

Kelman, A.W. (1981). Vibratory pattern of vocal folds. *Folia Phoniatrica, 33*, 73-99.

Kent, R, D. (1997). *The Speech Sciences*. San Diego: Singular Publishing Group.

Koster**,** J.P., & Smith**,** S. (1970). An interactive model for the voice source. *Folia Phoniatrica, 22*, 92-99.

Ma, E. P. M., & Love, A. L. (2010). Electroglotto-graphic evaluation of age and gender effects during sustained phonation and connected speech. *Journal of voice*, vol. *24*(2), 146-152.

Micheal, J. F., & Wendahl, R. (1971). Correlates of voice production. In L. E. Travis (Eds.), *Handbook of Speech Pathology and Audiology*, chapter 18 (pp 465-480), Englwood cliffs, NJ: Prentice- Hall.

Rothenberg, M., & Mahshie, J. J. (1988). Monitoring vocal fold abduction through vocal fold contact area. *Journal of Speech and Hearing Research*, *31*, 338-351.

Acknowledgement

FEEDING DIFFICULTIES IN CHILDREN WITH FAILURE TO THRIVE (FTT): AWARENESS OF CHARACTERISTICS OF FTT IN URBAN & RURAL MOTHERS / FEMALE CAREGIVERS

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Abstract

*Failure to thrive (FTT) is a medical condition*http://en.wikipedia.org/wiki/Failure_to_thrive - cite_note-0 *which may also affect the development of communication skills in children. The study aimed to investigate the awareness level of diagnostic and rehabilitation facilities of children with FTT among the mothers/ female caregivers of their children. Two questionnaires were prepared and administered on 14 urban and 17 rural mothers/ female caregivers of children with FTT. Analysis of their responses revealed that the rural and urban mothers/ female caregivers seemed to be aware of those features in FTT which were more overt/ easily noticeable. A significant result obtained was that only one mother was aware of the term FTT. It is concluded that awareness of FTT management in both urban and rural mothers/ female caregivers is lacking significantly. The rural mothers/ female caregivers need to be sensitized on issues related to feeding as this can lead to inadequate nutrition and therefore FTT. This should be included as a routine part of the newborn screening program.*

Key words: Failure to thrive, Feeding, Questionnaire, Awareness, Urban/rural

Failure to thrive (FTT) is a medical termhttp://en.wikipedia.org/wiki/Failure_to_thrive - cite_note-0 which denotes poor weight gain and physical growth failure over an extended period of time in infancy and does not imply any abnormal intellectual, social, or emotional development. FTT includes characteristics such as reduced weight which is consistently below 3rd to 5th percentile for a given age and/ or progressive decrease in weight to below 3rd to 5th percentile for a given age and/ or a decrease in the percentile rank of two major growth parameters of poor weight gain and physical growth failure in a short period (Bithoney, Dubowitz, & Egan, 1992).

The cause of FTT could be any identified medical condition (organic) or related to environmental factors (nonorganic). Irrespective of the cause, the symptoms relate to inadequate nutrition. Some of the common etiologies of FTT are delayed physical growth and cognitive development (Kristiansson, & Fallstrom, 1987; Corbett, Drewett, & Wright, 1996). Many children also present mixed etiologies such as a medical disorder, family stress (poor parent child relationship, psychosocial factors in mother and others) (Gahagan, & Holmes, 1998). The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (2000), describes several psychological conditions in infants and children suffering from FTT. According to this classification, the term 'Reactive Attachment Disorder of Infancy or Early Childhood' is used to describe the psychological damage caused by extreme emotional neglect. Either of the two extremes of parental attention (neglect or hypervigilance) can lead to this condition. The stress can compound the feeding problem and aggravate FTT. Abnormal pathophysiology such as inadequate caloric intake, inadequate absorption, excess metabolic demand, or defective utilization is also cited under etiology.

The severity of a child's under-nutrition/ malnutrition can be determined most easily by using the 'Gomez' criteria in which the child's current weight for age is compared with the expected weight (50th percentile) at that age. FTT is considered severe if the weight is less than 60 percent of expected, moderate if the weight is 61 to 75 percent of the expected and mild if the weight is 76 to 90 percent of the expected (Powell, 1988). Diagnosis and intervention carried out in time helps preventing malnutrition, developmental delays and other sequels of FTT. A thorough client history is the best guide to establish the etiology of FTT, in deciding the direction of further evaluation and management. All children with failure to thrive need additional calories for catch-up growth (typically 150 percent of the caloric requirement for their expected and not actual weight). Few need laboratory investigation to ascertain the cause. Hospitalization is rarely required and is indicated only for clients with severe degree of FTT whose safety is a concern. A multidisciplinary approach is recommended when FTT persists despite intervention or when it is severe (Casey, Wortham, & Nelson, 1984; Morice-Trejos, Jiménez-Soto, Fonseca-Fallas, & Alfaro-Mora, 1989; Schmitt, & Mauro, 1989; Lopez, & Schumann, 1997). Traditionally, a multidisciplinary team for FTT management includes physicians, nurses, dietitians, social workers, and psychologists (Maggioni, & Lifshitz, 1995).

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Children with FTT are more often reported to be at risk for adverse outcomes such as short stature, behavior problems, and developmental delays (Oates, Peacock, & Forrest, 1985; Kristiansson, & Fallstrom, 1987; Heffer, & Kelley, 1994; Corbett, Drewett, & Wright, 1996; Gahagan, & Holmes, 1998; Metallinos-Katsaras & Gorman, 1999). There is limited number of studies on children with FTT, each with different definitions and designs, rendering it difficult to comment with certainty on the long-term results of FTT (Drotar, & Robinson, 1999). In addition, it is often difficult to disentangle the effects of FTT from those of the high-risk environments in which FTT often occurs (e.g., poverty, high family stress, and poor parental coping skills) (Gahagan, & Holmes, 1998; Sherry, 1999). To decrease the risk of adverse effects, it is important to recognize and treat FTT as early as possible.

Ascertaining the child's developmental status at the time of diagnosis is important because children with FTT are reported to have a higher incidence of developmental delays than the general population (Rider, & Bithoney, 1999). A complete physical examination is essential to rule out: (1) dysmorphic features suggestive of a genetic disorder impeding growth; (2) underlying disease that may impair growth; (3) factors related to child abuse; and (4) effects of malnutrition (Wissow, 1990; Rider, & Bithoney, 1999).

There is no study known to the investigator that addresses the FTT condition in Indian population and relates it to the area of communication disorders. This study attempts to address the mothers or female caregivers of potential children with the condition of FTT with varying communication disorders with respect to their knowledge about the condition of FTT, its characteristics, identification and management.

Early childhood is a critical period for growth and development, and early intervention for any child with FTT will maximize the potential for better outcomes (Metallinos-Katsaras, & Gorman, 1999). Ignorance and unawareness of such a critical and important factor in the child health care may lead to irreversible, irreparable damages to the child's body and mind. FTT being a condition which presents a number of concomitant associated problems is likely to stimulate the interest for a speech- language pathologist because communication impairment in a child could have its root in the general health of the child. Any deprivation in feeding and related issues reflects on the development of various milestones such as physical, social / adaptive and speech language skills. Since FTT can lead to risk in communication development, it should be listed as one of the prime areas of focus in the routine clinical practice of a speech language pathologist. However, the current trend in clinical practices of speech- language pathologists in India gives no scope for focused attention on dysphagia management in general. It is natural then to expect that FTT as a condition is quite often ignored although it is known to present risk for acquisition of speech and language skills of children. Among children with communication disorders, those who have cerebral palsy, severe grade mental retardation , pervasive developmental disorders, seizure disorders and other developmental delays are more likely to present symptoms of FTT (Oates, Peacock, & Forrest, 1985; Morice-Trejos, Jiménez-Soto, Fonseca-Fallas, & Alfaro-Mora, 1989). In this study a specific checklist was compiled to check if awareness of FTT differed in urban and rural mothers/ female caregivers in terms of their knowledge on various aspects of FTT.

Clinical implication of FTT as a co-morbid or associated problem existing with any other medical/ non medical condition including that of communication disorders is not an area which is much explored. FTT as an independent or associated condition is a very important clinical issue in India because of increased susceptibility of children to conditions such as poverty, malnutrition and infections, poor living conditions and unhygienic practices, atleast in some parts of the population. Levels of literacy have a major influence on the lifestyle of any population. Literacy level of women in India, though has improved to a considerable extent, is yet to reach an optimum level (The National Literacy Commission Census, 2001). This study included mothers/ female caregivers as participants as they spend more time with their children. The study attempted to understand the level of mothers'/ female caregivers' awareness of the causes, characteristics, diagnosis and management of FTT.

Aims of the study

To investigate the awareness level of urban and rural mothers/ female caregivers of children with various communication disorders such as cerebral palsy, mental retardation, pervasive developmental disorders and the multiple disabled with respect to:

• The characteristics of FTT
• Procedures/ methods used in the coping/ management of FTT.

Method

The study was conducted in three phases:

Phase 1: Preparation of the questionnaire for gathering information on feeding difficulties.

Since no standard questionnaire on FTT was

available, two questionnaires were prepared by the investigators compiling the questions and test domains addressed by Meerapriya (2009), Banumathy (2008) and Vani (2008) in their individual studies. The first one was a close ended questionnaire that was framed in English based on literature survey and reported clinical studies. Each question carried a close ended option as "Yes" or "No". Questionnaire on Clinical Characteristics of FTT is provided in APPENDIX A. The questions incorporated in this questionnaire included the following domains:

1) Oral Mechanism Examination. This was included as a screening measure to rule out any structural inadequacy and not functional adequacy.

2) General history of the client related to feeding:
   a. Medical and related
   b. Behavioral and related

3) History related to oral motor abilities and

4) Specific issues with respect to feeding and related information.

The second questionnaire was prepared to assess awareness of diagnostic issues & rehabilitation of FTT amongst the mother's/ female caregivers. This section included 22 questions in English to tap the awareness of mothers / female caregivers

regarding issues related to identification, management, nutritional modifications required and referrals for their words. The structure and content of this questionnaire is shown in APPENDIX B.

Phase 2: Administration of the questionnaires (Appendices A & B) on parents of children with communication disorders.

Participants in the study:
The study included 31 mothers / female caregivers of children with communication disorders below the age of 12 years (Table 1). Care givers on this clinical population was selected as the literature reports a higher prevalence of FTT in them (Oates, Peacock, & Forrest, 1985; Morice-Trejos, Jiménez-Soto, Fonseca-Fallas, & Alfaro-Mora, 1989). Only mothers / female caregivers were included as majority of children availing clinical services at the place of study were accompanied by mothers / female caregivers. The criteria for the selection of mothers / female caregivers as participants were based on their children as follows:

- Children should present with communication disorders such as cerebral palsy, mental retardation, pervasive developmental disorders and multiple disabilities as diagnosed by an experienced speech language pathologist. The severity of the condition was not considered as a variable.

Table 1: *Distribution of children with respect to sex and disorder*

Disorder in the children of mothers/female caregivers	Children of the mother/female caregivers						Total
	Urban			Rural			
	Male	Female	Total	Male	Female	Total	
Cerebral Palsy	1	2	3	1	3	4	7
Mental retardation	2	2	4	3	2	5	9
Pervasive developmental disorder	3	-	3	2	1	3	6
Multiple disability	2	2	4	2	3	5	9

- Children should present feeding and related problems of any degree, which has affected the normal feeding pattern of the child in terms of quantity or quality of intake.
- Children should not be suffering from any other serious medical conditions that might affect the ability to thrive.

The criteria for the classification of mothers/ female caregivers under the urban and rural category were based on a checklist including the following factors which was administered by the principal investigator.
- Information on socio- economic status and overall standard of living
- If they were living in a town or city
- If she was literate and is willing to educate children too.

- If the town/ city in which she lives runs on electricity, has conveniences for tap water and if sanitary facilities are present.
- If the family lives near a high density of human-created structures and resident people
- If the city/ town has advanced civic amenities, opportunities for education, facilities for transport, business and social interaction
- If the family receives the benefits of man's advancements in the areas of science and technology
- If the family is not dependent on the environment for their day to day functions, well being and work.
- If businesses in the city/ town stay open late into the evenings

- If the city/ town has traffic and pollution problems

Mothers/ female caregivers who answered positively to most of the questions were classified as urban and those who did not were classified as rural. There were a total of 14 urban mothers/ female caregivers and 17 rural mothers/ female caregivers.

Procedure:

The mothers/ female caregivers were given the questionnaire individually and were asked to answer each question on the questionnaire as "yes" or "no". In case of rural mothers/ female caregivers (illiterates/ semi literates), clinician who provided speech- language therapy for their children and who spoke the native language of the family assisted them to answer the checklist. The clinician asked the questions in their respective native language.

Phase 3: Analysis of the responses to the two questionnaires.

A score of '1' was assigned to a question which was answered in favor of awareness and '0' for those questions answered not in favor of awareness. The total scores obtained by each participant were computed and the group total and mean scores were derived. The raw scores were converted to percentage score to facilitate comparison of the performance of the mothers / female caregivers to the various subsections of the two questionnaires. The data was treated with suitable statistical procedures.

Results and discussion

The results are discussed under two sections:

1. Comparison of awareness level of the characteristics of FTT in urban and rural mothers/ female caregivers of children with various communication disorders: cerebral palsy, mental retardation, pervasive developmental disorders and the multiple disabled.
2. Comparison of awareness level of procedures/ methods used in the coping/ management of FTT in children across the urban and rural mothers/ female caregivers of children with various communication disorders: cerebral palsy, mental retardation, pervasive developmental disorders and the multiple disabled.

Section 1: *Comparison of awareness level of the characteristics of FTT in urban and rural mothers/ female caregivers of children with various communication disorders: cerebral palsy, mental retardation, pervasive*

developmental disorders and the multiple disabled.

Table 2 shows the comparison of mean percentage responses of mothers/ female caregivers from rural (N=17) and urban (N=14) groups on the different sections of the questionnaire. The results provided in Table II shows that the mothers/ female caregivers of children with cerebral palsy who came from an urban background were better aware of the oral motor abilities [urban (mean, standard deviation =28.21, 4.44); rural (mean, standard deviation= 21.15, 4.97)] and feeding issues [urban (mean, standard deviation= 18.70, 2.49); rural (mean, standard deviation=15.47, 5.71)] than their rural counterparts. Higher scores on general history was more evident in the rural population of children with cerebral palsy [urban (mean, standard deviation= 8.63, 2.96); rural (mean, standard deviation= 9.71, 3.51)]. This could imply that the rural mothers were more aware of factors related to general history of their children's condition than specific issues related to feeding and oral motor abilities of their children.

In comparison the trend was different for awareness levels of characteristics of FTT in mothers/ female caregivers of children with mental retardation when compared to that of children with cerebral palsy. There were more positive answers for questions on oral motor abilities in the rural population [urban (mean, standard deviation= 26.92, 8.88); rural (mean, standard deviation= 33.85, 3.22)]. There were also more positive answers for questions on general history in the rural population [urban (mean, standard deviation= 6.76, 2.94); rural (mean, standard deviation= 9.18, 3.37)]. Feeding issues follow a similar trend as that of cerebral palsy with more positive answers for the urban population.

The trend observed for children with pervasive developmental disorders was different from that followed in the two clinical populations of cerebral palsy and mental retardation. Here, awareness for aspects of general history in the urban population was more than the rural [urban (mean, standard deviation= 11.76, 5.13); rural (mean, standard deviation= 9.02, 3.60)] where as issues on feeding [urban (mean, standard deviation= 8.87, 1.50); rural (mean, standard deviation= 13.19, 1.50)] received a higher score in rural when compared to urban. For oral motor abilities, the urban groups had poorer scores than the rural [urban (mean, standard deviation=16.67, 5.88); rural (mean, standard deviation= 21.79, 2.22)].

Table 2: *Mean and standard deviation of urban and rural children with CP, MR, PDD and MD to the different sections in the questionnaire.*

Categories of questions		CP	MR	PDD	MD
GH	Urban	8.63 (2.96)	6.76 (2.94)	11.76 (5.13)	5.59 (1.76)
	Rural	9.71 (3.51)	9.18 (3.37)	9.02 (3.60)	7.29 (4.66)
OMA	Urban	28.21 (4.44)	26.92 8.88)	16.67 (5.88)	35.58 (5.77)
	Rural	21.15 (4.97)	33.85 (3.22)	21.79 (2.22)	27.69(13.16)
FDG	Urban	18.70 (2.49)	15.47 2.66)	8.87 (1.50)	21.40 (4.41)
	Rural	15.47 (5.71)	14.10 3.12)	13.19 (1.50)	13.673.60)
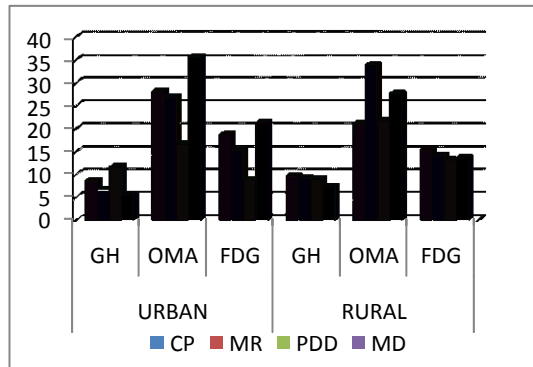
Figure 1: *Mean and standard deviation of urban and rural children with CP, MR, PDD and MD to the different sections in the questionnaire.*

*Note: CP= Cerebral palsy, MR= Mental Retardation, PDD= Pervasive Developmental Disorders, MD= Multiple Disabled, GH= General History, OMA= Oral Motor Abilities, FDG= Feeding

The group of mothers / female caregivers of children with multiple disabilities followed a similar trend as that of cerebral palsy with more awareness for general history in the rural population [urban (mean, standard deviation= 5.59, 1.76); rural (mean, standard deviation= 7.29, 4.66)], whereas oral motor abilities [urban (mean, standard deviation= 35.58, 5.77); rural (mean, standard deviation= 27.69, 13.16] and feeding issues [urban (mean, standard deviation= 21.40, 4.41); rural (mean, standard deviation= 13.67, 3.60)] being more prominent in the urban population.

The points of interest as gathered from Table 2 and Figure 1 is that the groups of mothers/ female caregivers of cerebral palsy and multiple disability groups both show a similar trend whereas those of children with mental retardation and pervasive developmental disorder groups both show different trends. On the whole it is evident that the urban population had more positive awareness on aspects of oral motor abilities [urban (mean, standard deviation= 27.47, 9.03); rural (mean, standard deviation= 26.9, 8.92)] and feeding issues [urban (mean, standard deviation= 16.44, 5.45); rural (mean, standard deviation= 14.13, 3.57)]. On the other hand the rural mothers/ female caregivers were

better aware of aspects related to general history than the urban population [urban (mean, standard deviation= 7.89, 3.70); rural (mean, standard deviation= 8.72, 3.63)].

Rural population may be more susceptible to different medical, psychological and socio-economic factors than the urban population. The lack of awareness and sometimes their ignorance may lead to various problem behaviors in their children. Their belief of bearing more number of children, more hands for work and more earning for the family may put the mother onto risk of malnutrition during pregnancy with lack of sufficient food for the entire family.

This may lead to complications during delivery and adversely affect the new born. The serious complications and even mild ones may put an infant to the category of failure to thrive. Also, as the number of members of a family increases, there is less individual attention and interaction given to each child. This also is a recognized cause of FTT as reported in the literature (Wissow, 1990).

Cerebral palsy children are known to have feeding difficulties. The severity of this condition varies with the extent of brain damage. The feeding difficulties put them into the high risk category of FTT. As reported in the literature, FTT may lead to developmental delays in both motor and communication domains (Metallinos-Katsaras & Gorman, 1999).

The mother/ female caregivers of pervasive developmental disorders group had a more clear awareness of the factors relating to general history of the child in the urban population. This calls for attention of the speech language pathologists to collect a careful and detailed history from this population. Also, it is seen that children with mental retardation have more issues with oral motor difficulties than feeding issues and history in the rural population.

From the results of this study it seems like the mothers or female caregivers know the important details of their children with respect to general history and oral motor abilities. It is probable that from mothers' point of view these are most

evident and easily noticeable features in their children's disorders, because of the associated symptoms and medical issues that have always caught their attention. Compared to the other sections of feeding and oral motor abilities, general history may have more scope for obtaining relevant information from parents. The lesser awareness for oral motor issues could probably be due to the fine nature of these movements which in turn receive very little attention from the parents. Feeding problems as is known is a problem by itself or may be associated with other conditions.

Despite the different trends seen in the responses of the mothers / female caregivers of different clinical groups such as Cerebral Palsy, Mental Retardation, Pervasive developmental disorders and Multiple disabilities, the scores clearly point to the existence of FTT as a factor in each of these client groups. Thus the factors that lead to FTT should be carefully observed and brought under control by the professionals dealing with this clientele. Though identification of FTT is primarily recognized as the domain of a pediatrician, suspected cases can be screened over similar questionnaires and appropriate referrals can be made by any professional.

The sensitivity of the questionnaire is established as different trends were evident among the responses of mothers/ female caregivers of different clinical populations. Thus, it may be assumed that similar questionnaires with a detailed probe into the various suspicious domains of FTT are good enough to be used with the clinical population for further testing and assessments. Questionnaires have the advantage of being user friendly and can be self rated if needed. This may save time of the professional and also avoid unnecessary/ unavoidable comments and questions that may evoke feeling of guilt if asked in a direct interview session.

When it is a problem by itself, it receives more attention than otherwise. When it exists as an associated problem, feeding is believed to get better with alleviation of symptoms of the primary disease and may go unmanaged for a long time. Thus, the mothers or the female caregivers form a very important part of the rehabilitation team. A questionnaire filled by them can be highly reliable than any other source of information. They are the individuals who spend most of their time with the child and observe every behavior of the infant. Another point of emerging interest is that the rural or urban mothers and caregivers did not differ significantly in this aspect. They still remained as the most reliable sources as they provided valuable information about the various domains screened for FTT.

Section 2: *Comparison of awareness level of procedures/ methods used in the coping/ management of FTT in children across the urban and rural mothers/ female caregivers of children with various communication disorders: cerebral palsy, mental retardation, pervasive developmental disorders and the multiple disabled.*

From the responses of the mothers / female caregivers in this section, it was evident that very few mothers/female caregivers of children with communication disorders knew about the term 'Failure To Thrive' and about the methods to cope or manage with this condition. There was only 1 mother who answered positively for awareness of FTT and its coping strategies out of the 31 others mothers/ female caregivers who participated in this study. This mother belonged to the highly literate urban population group and she was exposed to this concept as she resided abroad for a significant long time.

Urban population is more educated and more financially well placed compared to the rural population (The National Literacy Commission Census, 2001). Awareness of different existing clinical conditions, literacy and education and increased facilities keep the urban population vigilant to such conditions. An early identification and management puts the urban population on a better stand than rural population.

FTT is identified as a very important factor and that which is given immediate attention in the western countries. Organic FTT is given immediate medical help and non organic FTT's are identified at the earliest and appropriate measures are taken. The lack of awareness of this condition in India puts a large number of our newborns at risk especially when our country is more susceptible to the causes of FTT due to the social and economic conditions of different sectors of our population. The number of professionals who are aware and aim to identify and diagnose this condition is not known.

Though many of them know about the problems and complications of feeding problems, the management of these is neglected due to limited awareness. This puts a larger number of infants into risk. Thus, creating awareness about FTT can be a major initial step in any speech-language therapy clinic. This should be done through education of parents and through proper counseling. This should be made a routine part of the newborn screening. Awareness should be created among professionals about the early identification and management options available

to them. This knowledge is expected to be low in India. Feeding problems cannot be managed only by the family. The underlying cause of these problems should be dealt with proper professional guidance such as from a pediatrician. Although it is beyond the scope of this study as a future direction of interest it would be worth understanding the awareness level of FTT as a important clinical entity even within the medical fraternity other than pediatrician who do not directly deal with the physical growth of the child and rehabilitation specialists such as speech- language pathologists, occupational therapists, physiotherapists etc.

Conclusions

The results point to an urgent need to include 'Failure to Thrive' assessment and identification at an early stage in infants and children. This may help the professionals involved in the primary prevention of FTT in the clinical conditions such as cerebral palsy, pervasive developmental disorders, mental retardation and multiple disabilities. Though these conditions cannot be prevented by controlling the causes of FTT, the associated problems that may hamper the progress of the child because of existence of FTT in a child can be brought into control by controlling this condition. Also, there is a need to know more about the status of FTT in India. More awareness should be created among the common men and also the professionals who form a rehabilitation team to help those children with communication disorders. There should be a greater emphasis to include questions about feeding in the general interview to collect the history of the client. Counseling the new mother or prospective mothers on this condition will help us bring a large number of conditions under control.

Implications

This study addressed an area that has been scarcely researched from the communication rehabilitations point of view. The questionnaire prepared in identifying children with FTT was sensitive as it identified significant differences across the urban and rural population interviewed for the study. The different responses provided by mothers / female caregivers of different clinical groups throw light on the differential awareness level regarding various issues related to feeding in general and FTT in specific.

References

American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders* (4th edn). Washington DC: American Psychiatric Association.

Banumathy N. (2008). Investigation for Subgroups in Developmental Apraxia of Speech. Unpublished thesis, University of Mysore, Mysore: Karnataka.

Bithoney, W. G., Dubowitz, H., & Egan, H. (1992). Failure to thrive/ growth deficiency, *Pediatric Review*, 13, 453-460.

Casey, P. H., Wortham, B., & Nelson, J. Y. (1984). Management of children with failure to thrive in a rural ambulatory setting: Epidemiology and growth outcomes, Clinical Pediatrics, 23(6), 325-330.

Corbett, S. S., Drewett, R. F., & Wright, C. M. (1996). Does a fall down on centile chart matter? The growth and developmental sequelae of mild failure to thrive, *Journal of Pediatrics*, 85, 1278-1283.

Drotar, D., & Robinson, J. (1999). Researching failure to thrive: Progress, problems, and recommendations. In Kessler, D.B., & Dawson, P. (Eds). *Failure to Thrive and Pediatric Undernutrition: A Transdisciplinary Approach* (pp 77-95). Baltimore: Brookes.

Gahagan, S. & Holmes, R. (1998). A stepwise approach to evaluation of undernutrition and failure to thrive, *Pediatric Clinics of North America*, 45, 169-187.

Heffer, R. W., & Kelley, M. L. (1994). Nonorganic failure to thrive: Developmental outcomes and psychosocial assessment and intervention issues, *Research in Developmental Disabilities*, 15, 247-268.

Kristiansson, B., & Fallstrom, S. P. (1987). Growth at the age of 4 years subsequent to early failure to thrive, *Child Abuse & Neglect,* 11, 35-40.

Lopez, R. F., & Schumann, L. (1997). Clinical health problem: Failure to thrive, Journal of American Academy of Nurse Practitioners, 9(10), 489-493.

Maggioni, A., & Lifshitz, F. (1995). Nutritional management of failure to thrive, *Pediatric Clinics of North America*, 42, 791-810.

Meerapriya C. S. (2009). Clinical Protocol for Assessment of Swallowing in Adults. Unpublished Dissertation, University of Mysore, Mysore: Karnataka.

Metallinos-Katsaras, E., & Gorman, K. S. (1999). Effects of undernutrition on growth and development. In Kessler, D.B., & Dawson, P. (Eds). *Failure To Thrive and Pediatric Undernutrition: A Transdisciplinary Approach* (pp 37-64). Baltimore: Brookes.

Morice-Trejos, A. C., Jiménez-Soto, Z., Fonseca-Fallas, R., & Alfaro-Mora, F. V. (1989). Treatment of the child with growth retardation (Failure to thrive), *Boletin Medico Del Hospital Infantil De Mexico*, 46(8), 567-571.

Oates, R. K., Peacock, A., & Forrest, D. (1985). Long-term effects of nonorganic failure to thrive, *Pediatrics*, 75, 36-40.

Powell, G. F. (1988). Nonorganic failure to thrive in infancy: An update on nutrition, behavior, and growth, *Journal of the American College of Nutrition*, 7, 345-353.

Rider, E. A., & Bithoney, W. G. (1999). Medical assessment and management and the organization of medical services. In Kessler, D.B., & Dawson, P. (Eds). *Failure To Thrive and Pediatric Undernutrition: A Transdisciplinary Approach* (pp. 173-194). Baltimore: Brookes.

Rupela, V. (2008). Assessment of Oral Motor, Oral Praxis and Verbal Praxis Skills in Persons with Downs Syndrome. Unpublished thesis. University of Mysore, Mysore: Karnataka.

Schmitt, B. D., & Mauro, R. D. (1989). Nonorganic failure to thrive: An outpatient approach, *Child Abuse & Neglect*, 13(2), 235-248.

Sherry, B. (1999). Epidemiology of inadequate growth. In Kessler, D.B., & Dawson, P. (Eds). *Failure To Thrive and Pediatric Undernutrition: A Transdisciplinary Approach*(pp 19-36). Baltimore: Brookes.

The National Literacy Commission Census. (2001). Retrieved on November 18, 2010 from http://indiabudget.nic.in/es2001-02/chapt2002/chap106.pdf.

Wissow, L. S. (1990). Failure to thrive and psychosocial dwarfism. In Wissow, L.S. (Ed). *Child Advocacy for the Clinician: An Approach to Child Abuse and Neglect* (pp 133-157). Baltimore: Williams & Wilkins.

Appendix A

Questionnaire on clinical characteristics of children with Failure To Thrive (FTT)

(*Note:* The caretakers or the clinician can fill up the details in this part of the questionnaire. In illiterate group of clients, this part of the information will be entered by the clinician after reviewing the medical reports of the clients if available)

A] Oral mechanism examination (structural and functional adequacy)
[Adopted from Meerapriya (2009) and Banumathy (2008)]

Structure	Appearance	Movement
Lips	• Normal • Cleft (repaired / unrepaired) • Deviated • Scar	Observe for symmetry / asymmetry during ➤ Retraction ➤ Protrusion • Overall function of lips: ➤ Normal ➤ Abnormal
Teeth	• Normal • Missing • Supernumerary • Overbite • Underbite • Cross bite • Others	--
Jaw	• Micrognathia • Macrognathia • Occlusion defects ➤ Neutrocclusion ➤ Distocclusion ➤ Mesiocclusion	Observe for the following during opening and closing: ➤ Symmetrical ➤ Asymmetrical ➤ Exaggerated & jerky ➤ Slow and laborious • Deviations to Lt / Rt
Tongue	• Normal • Microglossia • Macroglossia • Tongue tie • Fissured	Observe if normal or abnormal during: • Elevation (front and back) • Retraction • Protrusion • Lateral movements • Retroflexion
Hard Palate	• Normal • Cleft (Repaired / Unrepaired) • Fistula • Arched (High / Low)	--
Soft Palate	• Normal • Cleft (Repaired / Unrepaired / Submucous) • Short	On phonation observe for elevation of the soft palate. Record if it is: • Symmetrical • Asymmetrical • Deviated to Rt / Lt

Uvula	• Normal	
	• Absent	
	• Cleft (Repaired / Unrepaired)	--
	• Bifid	
	• Elongated	
Nose	• Normal	--
	• Abnormal	

B] General history of the client related to feeding

Sl. No.	*Items*	*Yes*	*No*
	Medical and related		
1.	Does the child / your child have any of the following endocrinal abnormalities:		
	• Hypothyroidism		
	• Hyperthyroidism		
	• Diabetes		
	• Growth hormone deficiency		
	• Cretinism		
	• Pituitary tumors		
	• Genital abnormalities with glandular dysfunctions		
	• Any other		
2.	Does the child / your child have any of the following Gastrointestinal disorders:		
	• Gastroesophageal reflux		
	• Celiac disease		
	• Milk protein allergy		
	• Pancreatic insufficiency		
	• Inflammatory bowel disease		
	• Pyloric stenosis		
	• Any other		
3.	Does the child / your child suffer from any of the following cardiac disorders:		
	• Congestive heart failure		
	• Congenital anomalies of heart		
	• Murmur		
	• Any other		
4.	Does the child / your child suffer from any of the following pulmonary disorders:		
	• Brochopulmonary dysplasia		
	• Asthma		
	• Cystic fibrosis		
	• Any other		
5.	Does the child / your child suffer from any of the following infectious diseases:		
	• HIV		
	• Parasitic infections		
	• Tuberculosis		
	• Any other		
6.	Does the child / your child suffer from any of the following metabolic disorders:		
	• Galactosemia		
	• Methylmalonic academia		
	• Tyrosinemia		
	• Any other		
7.	Does the child / your child suffer from any of the following renal disorders:		
	• Renal tubular acidosis		
	• Chronic urinary tract infections		
	• Chronic renal insufficiency		
	• Any other		
8.	Does the child / your child suffer from any of the following syndromes:		
	• Down syndrome		
	• Turner syndrome		
	• Russell-Silver dwarfism		
	• Fetal alcohol syndrome		
	• Any other		
9.	Does the child / your child present abnormalities in the bowel movements:		
	• Number of times of stool passage		
	• Quality of stool		

- Any other
10. Does the child / your child present abnormalities in passage of urine:
     - Number of times of urination
     - Quality of Urine (E.g., Foul smell etc)
     - Any other
11. Does the child / your child have following breathing problems:
     - Short breath
     - Rapid breathing
     - Abnormal or erratic breathing rate
     - Noisy breathing/ Stridor
     - Wheezing / Crackles
     - Any other
12. Does the child / your child have a history of one or multiple episodes of pneumonia?
13. Was the child hospitalized for breathing related problems in the past?
14. Does the child / your child have a positive history of:
     - Medical illness/es
     - Surgery/ies
15. Does the child / your child have abdominal lumps / masses / growths?
16. Does the child / your child have / present any of the following:
     - Persistent diaper rash
     - Skin bruising
     - Unexplained scars in the genital area
     - Any other
17. Does the child / your child have skin rashes on the:
     - Face
     - Lips
     - Other parts of the body
     - Any other
18. Does / Did the child / your child have yellowish discoloration of skin/ jaundice?
     - At birth
     - After birth
     - After 3 months (specify)
19. Was the child / your child exposed to / suffer from any of the following types of poisoning:
     - Lead poisoning
     - Manganese poisoning
     - Any other

Behavioral and related

20. Does the child / your child have normal mental abilities?
21. Does the child / your child have poor poor eye contact?
22. Does the child / your child have poor poor attention span?
23. Does the child / your child exhibit any of the following behavioral problems:
     - Head banging
     - Temper tantrums
     - Aggression
     - Repetitive rocking of the body
     - Any other
24. Does the child / your child present overactivity / hyperactivity?
25. Does the child / your child show poor social interaction skills such as lack of smile, lack of interest in environment?
26. Does the child / your child present history of snoring or stops breathing when sleeping?
27. Does the child / your child show signs of irritability, distractibility?
28. Does the child / your child bite him/herself or others?
29. Does the child / your child constantly put things into his/her mouth?
30. Does the child want to taste everything, including any non food items?

C] History related to oral motor abilities
[Adopted from Meerapriya (2009) and Vani (2008)]

Sl. No.	Items	Yes	No
1.	Does the child / your child present chewing difficulty?		
2.	Does the child / your child present oral/ nasal regurgitation? (swallowed food comes out of nose or mouth)		
3.	Does the child / your child present drooling? (saliva out of mouth)		

4. Does the child / your child have uneven teeth with respect to size, shape and position?
5. Does the child / your child present any of the following:
    - Weakness in the oral muscles
    - Slow oral movements
    - Incoordinated movements of the oral structures
    - Facial/lingual asymmetry
    - Paralysis or paresis of tongue/ lips /jaw
    - Any other
6. Does the child / your child have poor lip seal due to any of the following:
    - Paralysis or paresis of lips
    - Macrolabia
    - Drooling
    - Jaw drop (Hypotonia in the lower jaw)
    - Scars in the lips
    - Injury in the lips
    - Any other
7. When touched on face/cheeks/lips, does the child / your child show:
    - Insensitivity to touch
    - Oversensitivity to touch
    - Discomfort
    - Avoidance
    - Any other
8. Does the child / your child present a history of delay or deviancy in acquiring the following oral skills:
    - Biting
    - Chewing
    - Swallowing
    - Blowing

D] Specific issues with respect to feeding and related information

Sl. No.	Items	Yes	No
1.	Does the child / your child show abnormal food preferences?		
2.	Does the child / your child have food allergies/ bad reactions to some foods?		
3.	Does the child / your child refuse to eat and/or drink?		
4.	Does the child / your child prefer not being fed by you? (parents)		

5. Does the child / your child not demonstrate clear signs of the following:
    - Cues the caregiver, including interaction through vocalization and smiles
    - Cues for need for a break or rest.
    - Opens the mouth in anticipation of food
    - Stop crying when the caregiver attempts to sooth
    - Display of some tension at beginning of feeding and decrease in tension once feeding has begun
    - Show periods of alertness during the feeding
    - Respond to the caregiver's attempts to communicate and interact
    - Look in the direction of the caregiver's face then the caregiver talks
    - Mold into the contours of the caregiver's body
    - Suck and make feeding sounds following feeding attempts by the caregiver
6. Does the child / your child demonstrate any of the following during feeding session?
    - Irritability
    - Crying
    - Frenzy
    - Inconsolability
    - Rapid changes in emotional state
    - Restlessness
    - Drowsy
    - Strained alertness
    - Panicked alertness
    - Hyper alertness
    - Diffuse sleep or awake states
    - Staring
    - Frequent gaze aversion

- Strained fussing or crying
- Silent crying

7. Does the child / your child show any of the following motor signs?
    - Flaccidity in trunk, extremities and / or face.
    - Hypertonicity in trunk, extremities and/or face.
    - Hyperextension of the legs
    - Hyperextension of the arms and hands
    - Arching the body as a whole
    - Fisting
    - Increased facial grimaces
    - Frantic, diffuse activity of the extremities
    - Frequent twitching of the body parts

8. As a parent / caregiver do you not attend to the following signs given by your child during feeding?
    - Respond in a contingent manner to the child's cues
    - Sooth or quiet a distressed infant
    - Demonstrate warmth and affection towards the child communicate a positive feeling tone
    - Foster cognitive growth through touch, movement, and talking
    - Delay stimulating or responding until the infant signals readiness

9. Does the child / your child show the following signs of stress in feeding when being fed by the parent / caregiver?

    Signs of moderate Stress:
    - Sighing
    - Yawning
    - Sneezing
    - Sweating
    - Hiccupping
    - Tremoring
    - Startling
    - Gasping
    - Straining

    Signs of major stress:
    - Frequent or prolonged coughing
    - Spitting up
    - Gagging
    - Choking
    - Color changes (Cyanosis - blueness of skin)
    - Respiratory pauses
    - Irregular respirations

10. Does the child / your child have trouble handling liquids more than the solids?

11. Is the child / your child a messy eater, that is, he/she frequently spills during feeding?

12. Is the child / your child not able to:
    - Hold straw with lips
    - Grasp cup with lips
    - Suck liquid with lips
    - Chew the food
    - Clear the residual food in the mouth using tongue movements

13. Does the child / your child have a limited food selection in terms of taste?

    Eats only particular foods:
    - Hot
    - Cold
    - Sweet
    - Sour
    - Salty
    - Spicy
    - Bitter

14. Does the child / your child have a limited food selection?

    Eats only particular foods:
    - Soft

- Semi solid
- Thin liquid
- Thick liquid
- Crunchy
- Spicy
- Hard

15. Does the child / your child show:
- Poor appetite during feeding
- Fussy while feeding
- Bored/disinterested while eating

16. During feeding, does food get stuck in between the child's / your child's teeth?

17. During feeding, does the child / your child take:
- Longer time to feed
- Less quantity of food in a given time

18. Does the child / your child cough:
- During feeding
- After feeding

19. If the child is being breast fed, is the lip seal of the child inadequate on the nipple?

20. If the child is bottle fed, is the suck-swallow breathing rhythmic pattern inadequate?

21. Does the child / your child not show vertical munching movements even for easily dissolvable solids?

22. Does the child / your child not show rotator movements of the jaw while chewing solid food?

23. When drinking liquids, does the child / your child not drink water in 4-5 consecutive swallows?

24. When drinking liquids or eating solid food does the child / your child not maintain adequate lip seal?

25. During drinking or eating solids, are the up-down tongue movements performed inadequately?

26. Does the child / your child not open his/her mouth when food is presented on a spoon?

27. Does the child / your child not drink from a cup placed near the lips and held by an adult?

28. Does the child / your child show any signs of stress before, during, or after feeding?

29. During the process of feeding, are the oral protective reflexes abnormal with respect to:
- Rooting
- Sucking
- Coughing
- Gagging

30. Does the child / your child show hyper or hyposensitivity or aversive responses to oral input?

31. Does the child / your child assume inadequate / bad posture while feeding?

32. Does the child / your child show noisy breathing during or after feeding sessions?

33. Does the child / your child tire easily during feeding (even before consuming adequate intake)?

34. Does the child /your child show discomfort if the following are present during the feeding period:
- Bright lights,
- Noisy surroundings
- Running TV
- Movements of siblings or others

35. While feeding the child / your child, are the following behaviors observed:
- *Tongue-tip elevation*: the tip of the tongue is held firmly against the hard palate behind the upper alveolar ridge potentially interfering with nipple insertion (if breast or bottle fed) or with insertion of spoon or fed with fingers (if fed orally).
- *Tongue retraction:* The tongue sits back in the mouth, well behind the alveolar ridges causing poor contact between the tongue and the nipple (if breast or bottle fed) or spoon or fed with fingers (if fed orally), to stimulate appropriate tongue movements. Strong neck hyperextension can also contribute to tongue retraction by pulling the tongue back into the mouth.
- *Tongue protrusion:* The tongue pushes outward instead of moving in the normal wavelike anterior-posterior pattern. The tongue may compress the nipple, with

little suction generated, leading to inefficient sucking. This pattern may be seen in children who have sucked on endotracheal tubes and those with low tone.

- *Excessive Jaw Excursion*: The jaw moves in a greater range than expected and the movement is poorly graded. Tongue contact on the nipple may be poor, diminishing both compression and suction. Lip seal can also be compromised, further impairing sucking.

36. Does the child / your child not continue smoothly into inspiration/expiration cycle after the swallow effort?

37. Does the child / your child attempt to breathe through mouth or through the nose during swallow phase?

38. Does the child / your child not exhale smoothly post swallow and comfortably holds breath during swallow for a minimum period of 5 seconds?

39. Does the child / your child show the following:
- Clear the throat frequently after every swallow by coughing
- Take sips of water after every bolus intake
- Requires the food to be modified to thin liquids to facilitate swallow
- Requires more time between two spoons of food
- Requires more time to swallow one bolus
- Hoarse/wet/gurgly voice quality after every swallow
- Post nasal drainage during the feeding session
- Excessive phlegm in the throat during the feeding session
- Requires 100% supervision or assistance during each bolus intake of the feeding process
- Sneezes frequently after feeding

40. Does the child / your child chew or swallow ineffectively due to lack of awareness of food in the mouth?

41. Is the child / your child unaware of pooled saliva and drooling

42. Is the child / your child unaware of food stuck in the teeth or on side of lips/face?

43. Does the child / your child spit up or vomit frequently while feeding?

44. Do you not see laryngeal elevation during swallow in the child / your child?

45. Does the child / your child experience a burning sensation in the mouth/throat/chest post swallow?

46. Do you observe burping/ belching or frequent hiccups in the child / your child?

47. Does the child / your child regurgitate after lying down or gag towards the end/after meals?

48. Does the child / your child complain of a feeling of a lump/congestion in the chest or pain/pressure/discomfort in the chest after eating or drinking?

49. Does the child / your child pocket food in the mouth while eating?

50. Does the child / your child pocket food in anterior or lateral sulcus after swallow?

Appendix B

QUESTIONNAIRE TO ASSESS AWARENESS OF DIAGNOSTIC ISSUES & REHABILITATION OF CHILDREN WITH FAILURE TO THRIVE (FTT)

(*Note:* The caretakers or the Clinician can fill up the details in this part of the questionnaire. In illiterate group of clients, this part of the information will be entered by the clinician after reviewing the medical reports of the clients if available)

Sr. No.	Items	Yes	No
1.	Are you aware of the term "*Failure to Thrive*" (FTT)? **If the answer to question No 1 is 'YES', please proceed to the following questions from No 2.** **If the answer to question No 1 is "NO", then you may stop here without proceeding to answer any of the questions from No. 2**		
2.	Do you know that the incidence of malnutrition in FTT individuals is high?		
3.	Do you know that as a result of not receiving adequate nutrition, your child can suffer from growth retardation?		
4.	Do you know that medication can also reduce the stiffness of the muscles and help them relax?		
5.	Do you know that a physiotherapist can help with contractures? (As the muscles are stiff and not much movement is made, the muscles do not stretch and sometimes stop growing. They become fixed in an abnormal position)		
6.	Do you know that surgery will be required if your child is not able to rest the heel		

and walks on his/ her toes

7.   Do you know that a suitable orthotic device (like braces) can stretch and exercise the muscles and enable it to grow?

8.   Have you consulted a specialist doctor for all the gastrointestinal/ cardiac pulmonary endocrine/ renal disorders?

9.   Are you aware of any special feeding and assistive devices to help you and your child?

10. Do you use such feeding devices?

11. Have you consulted an Occupational therapist for any of your child's problems?

12. Is your child meeting the daily nutritional requirement standards?

13. Does your child consume from all the 5 major food groups? (Carbohydrates, meat, fruits, vegetables, dairy, fats and oils)

14. Do you feed your child often?

15. Is your child taking any supplementary nutrition in the form of tablets? (multi-vitamins etc)

16. Is your child getting enough exercise?

17. Is your child attending any speech/physio/occupational therapy?

18. Do you seek the advice of medical professional for your child periodically?

19. Is your child's weight becoming normal/ is already normalized according to his/her age and gender requirements?

20. Are you aware that your child's nutritional needs are different from others children and that your child requires special treatment?

21. Is there a high-risk environment in which FTT often occurs? (e.g., poverty, high family stress, and poor parental coping skills)

22. Is your child's juice consumption limited to 8 –16 oz per day?

INTONATION CONTOURS IN THE SPEECH OF INDIVIDUALS WITH BROCA'S APHASIA

[1]Gouri Shanker Patil, & [2]Manjula R.

Abstract

The study acoustically examined the nuclear tones and terminal intonation contours in individuals with Broca's aphasia vis-à-vis the neurologically normal participants. Ten individuals with Broca's aphasia who spoke Kannada as mother tongue participated in the study along with 10 age and gender matched neurologically normal individuals. They narrated a picture card while their utterances were audio recorded using a digital tape recorder. The Computerized Speech Lab (CSL) 4400 software was used for generating intonation contours from the utterances of participants. The nuclear tones were analysed in terms of traditional classification of rise, fall, rise-fall, fall-rise, rise-fall-rise, fall-rise-fall, and level contour whereas the terminal contours analysis included rise, fall, and level contours. The results revealed presence of similar types of nuclear contours in both groups of participants. However, the terminal contours had occurred more frequently in within-sentence intonation units in individuals with Broca's aphasia suggesting that were using this as a device to indicate utterance continuity, owing to a limited output in terms of utterance length. The intonation contour analysis results suggest that individuals with Broca's aphasia are able to signal variations in F0 and they are able to utilise effectively the prosodic features of nuclear and terminal contours in discourse.

Key words: *nuclear tones, terminal contours, discourse.*

Intonation involves the occurrence of recurring pitch patterns, each of which is used with a set of relatively consistent meanings, either on single words or on groups of words of varying length (Cruttenden, 1986). Grammatical constituents of any level up to a sentence consist of separate intonation units having their own meaningful tune. The intonation unit encapsulates a functional, coherent segmental unit, be it syntactic, semantic, or informational (Cruttenden, 1997; Hirst & Di Cristo, 1998; Silber-Varod, 2005). The intonation contours consist of two types of tonal specification - tones which have a prominence-lending function, referred to as 'nuclear tones' and those which delimit intonational phrases, referred to as 'boundary tones' or 'terminal contours' (Pierrehumbert, 1980; Beckman & Ayers, 1994). The nuclear tones are associated with the nuclear stress syllables of intonation units while the boundary tones are found at the edges of intonation units. Palmer (1922), one of the pioneers to have done a systematic analysis of the nuclear tones and their configurations in English language described 4 types as falling, high rising, falling-rising, and low rising. Variations were later reported by other investigators. For example, Kingdon (1958), described 5 types of nuclear tones in English language as rising, falling, falling-rising, rising-falling, and rising-falling-rising, and Halliday (1967) also described 5 tones which included falling, high rising, low rising, rising-falling-rising, and falling-rising-falling. Three types of phrase-final contours which are commonly

reported and they include level, falling, and rising tones (Ambrazaitis, 2005). An additional boundary tone was observed in German language as falling-slightly-rising contour (Ambrazaitis, 2005). The falling boundary contour may suggest utterance finality like in a declarative statement as in English (Hirschberg, 2002), or the conclusion of an argument, or categoricalness as in German (Peters, 1999; 2000; Ambrazaitis, 2005). The final rises are suggested to be used as an index of social relations between participants wherein the final rises indicate 'authoritativeness' (Horvath, 1985), index of turn-taking in narratives (Guy & Vonwiller, 1989), request for response (Ladd, 1996), marker to describe and express opinion (Horvath, 1985), or clue to speaker's attitude as being friendly or attentive (Guy & Vonwiller, 1989). Other reported pragmatic functions of the final rises include issuing warnings or threats and astonished utterances (Peters, 1999; Ambrazaitis, 2005) and polite offers (Grice & Baumann, 2002; Ambrazaitis, 2005).

Intonation contours in Indian Languages

There are few studies on the nature of intonation in Indian languages (Sethi, 1971; Nataraja, 1981; Ravisankar, 1987). In Kannada language, which is a non-tonal language spoken in southern state of India, very few studies have addressed the feature of intonation, although there are studies, which investigated the nature of intonation in emotive utterances (Manjula, 1979; Nataraja, 1981; Nandini, 1985). Other studies report the linguistic nature of intonation in various modes

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such as questions, statements, narration, and simulated dialogues, and its association with the segmental constituents of Kannada language (Rathna et al., 1976; Rathna et al., 1982; Patil, 1984; Manjula, 1997; Krishna, 2002). The features of intonation such as the initial and terminal contours, peak F0, excursions of F0, declination of F0, tonal groups, the relationship of all these features with the segmental correlates of the linguistic units and others have been addressed in these studies. Patil (1984) noted falling pitch at the terminal segments for non-polar questions while Manjula (1997) reported rising and falling terminal contours for Y-N and WH- interrogatives in Kannada language. In another study Nataraja (1981) found falling and rising contours at the end of sentences for different emotions in four Indian languages constituting Kannada, Tamil, Gujrati, and Hindi. In Telugu language, 7 types of nuclear pitch movements viz., low fall, high fall, low rise, high rise, fall-rise, rise-fall, level tones, and 3 types of terminal contours i.e., falling, rising, and level tones have been identified (Girija & Neeraja, 2003). In a study involving contrastive analysis of Hindi and Malayalam language, Geethakumary (2002) inferred that both these languages are characterized by 4 pitch levels and 3 terminal contours. The pitch levels found to occur were Extra high, High, Mid, and Low while the terminal contours included rising, falling, and level tones. Specific intonation patterns that express different attitudes were reported in Malayalam language (Asher, 1997; Girish, 2004). A less extended fall conveyed politeness, rise-fall tone expressed annoyance, fall-rise expressed dissatisfaction or doubt, low level tone suggested differences, high level tone issued a warning (Asher, 1997). A low falling tone on declaratives and a low rising tone on interrogatives are reported to be the characteristic boundary tones in Tamil language (Ravisankar, 1987). Sadanand and Vijayakrishnan (1993, 1998) outlined a three-way tonal contrast in Punjabi language - neutral, falling tone, and falling-rising tone.

Tonal deficits in individuals with aphasia

In tonal languages, the tones assume a phonemic function. A small variation in tonal contour brings about a change in meaning of the utterance. Thus, there is an increased probability that the LHD aphasics are prone to tone production deficits. T' sou (1978) in a case study of Cantonese-English bilingual conduction aphasic, reported that the client had difficulty in producing the low falling tone. Tonal productions were reportedly compromised in

aphasic individuals in Mandarin (Naeser & Chan, 1980; Packard, 1986) and Norwegian languages (Moen & Sundet, 1996). In order to determine the nature and extent of tonal deficits in aphasia, Gandour, Petty, and Dardarananda (1988) carried out an acoustic perceptual study of lexical tone in Thai. In all types of aphasics, the tonal confusion was predominant between the mid and low tone, which was possibly due to similarities in height and shape of F0 contours. In a severe Broca's aphasic client, the low tone was virtually indistinguishable from mid tone. Overall, the results suggested a positive relationship between severity of aphasia and tone production. In a subsequent study, Gandour, Ponglorpisit, Khunadorn, Dechongkit, Boongird, Boonklam, and Potisuk (1992) recruited additional number of brain-damaged participants (11 right-brain-damaged nonaphasics, 9 fluent aphasics, 8 non-fluent aphasics, and 4 aphasics with subcortical lesions) to evaluate the tonal contrasts. The results were similar to the previous findings, in the sense that tonal productions of brain-damaged individuals demonstrated accuracy rate in excess of 93% except for the non-fluent aphasics whose scores recorded 85% accuracy. Contrasting findings by Gandour, Ponglorpisit, Potisuk, Khunadorn, Boongird, and Dechongkit (1997) implied that some aspects of intonation are preserved in brain-damaged individuals regardless of site of lesion. In their study, individuals with RHD and LHD aphasia could produce lexical tone contrasts at different positions in a sentence in Thai language. Besides, the brain-damaged individuals produced final lowering effect similar to the normal controls.

It may be noted that little research was carried out in non-tonal languages concerning intonation contours in individuals with Broca's aphasia. Thus the study aimed to evaluate nuclear and terminal contours in the speech of individuals with Broca's aphasia.

Method

Participants

Individuals with Broca's aphasia
The experimental group constituted 10 individuals with Broca's aphasia. The diagnosis was based on neurological evaluation including neuro-imaging reports and test results of Kannada version (Karanth, Ahuja, Nagaraja, Pandit, & Shivashankar, 1990) of Western Aphasia Battery (Kertesz, 1982). The participants had undergone speech therapy for a minimum of 4 months to a maximum of 2 years. The clinical and demographic profile of individuals with Broca's aphasia is given in table 1.

Table 1: *Clinical and demographic profile of individuals with Broca's aphasia*

subject	sex/age (in years)	no. of years of formal education (pre-morbid)	time post-onset at the time of recording (in years)	therapy duration (in years)	WAB aphasia quotient	Etiology (CT scan findings)
GP	M/45	12	2.0	2.0	39.20	Left MCA territory infarct
RK	M/47	15	1.0	0.6	44.30	Left MCA territory infarct
MH	M/51	17	0.8	0.8	43.84	Left frontal and parietal infarct
NJ	M/52	7	1.1	0.5	47.08	Left frontal and parietal infarct
RS	M/55	5	0.8	0.8	41.84	Left MCA territory infarct
MG	M/55	15	0.6	0.4	44.64	Left MCA territory infarct
TN	M/56	12	1.4	0.6	49.12	Left frontal and parietal infarct
SD	M/59	12	1.3	1.0	45.84	Left MCA territory infarct
TR	M/60	19	2.6	1.2	38.62	Left MCA territory infarct
VK	M/60	10	2.2	1.5	40.12	Left MCA territory infarct

Note. WAB - Western aphasia battery, CT - Computerized tomography, MCA - Middle cerebral artery.

The factors considered for selection of individuals with Broca's aphasia in the study were:

- Native speakers of Mysore-Bangalore dialect of Kannada language.
- Participants whose expressive speech consisted of at least phrases. The expressive speech ability was determined by results of 'Spontaneous Speech' sub-section of Kannada version of Western Aphasia Battery (Karanth, Ahuja, Nagaraja, Pandit, & Shivashankar, 1990; Kertesz, 1982).
- All the participants had right hemiparesis.
- All the participants were right-handed individuals in the pre-morbid period and mostly used left-hand during post-morbid period due to right hemiparesis.
- All the participants reportedly had normal visual acuity or had corrected vision.

Neurologically normal control group

It consisted of 15 normal male participants in the age range of 45 - 60 years. In order to determine age related variations in the selected acoustic measures, the control group was further divided into three subgroups: 45 - 50 years, 51 - 55 years, and 56 - 60 years. Five participants were included in each of these age groups. This was also done to establish the confidence intervals for the selected temporal and F0 measures in the normal control group against which the measures

obtained by participants in the experimental group were compared. The participants did not present any previous history of neurological damage, which was ascertained by information provided by the participants and/or the caregivers. Participants included right-handed individuals who were native speakers of Mysore-Bangalore dialect of Kannada language.

Stimulus

The stimulus consisted of a picture which depicted a market scene. The selected picture stimulus is part of a standardized test called the Linguistic Profile Test in Kannada language (Karanth, 1980).

Procedure

The participants were tested individually either in home or clinic situations. Prior to actual recording of speech sample, the investigator demonstrated narration of picture using another stimulus to each subject. All participants were given sufficient time to formulate the utterances and get familiarised about the picture to be narrated. The picture stimulus was placed in front of participants. The participants were instructed to observe the activities depicted in the picture and verbally describe as many events, things, activities etc. as possible about the picture. The speech sample was recorded in a single trial for normal control participants but the recording had to be carried out in one or two

sittings for participants with Broca's aphasia, owing to difficulties in understanding instructions. Specifically, individuals with Broca's aphasia initially resorted to gross description of picture stimulus. They were asked to describe the picture giving finer details and the sample was rerecorded. The recording was carried out with minimal distraction in a quiet environment. The duration of recording extended from 3 - 5 minutes across participants. The participants' utterances were recorded using Sony MZ R-55 digital tape recorder with a uni-directional microphone placed at a distance of about 10 cm from the mouth.

Analysis

The recorded utterances were transcribed by the investigator using The International Phonetic Alphabet (revised to 1993, updated 1996). Later, the investigator and another speech pathologist independently identified the intonation units occurring in the utterances of individuals with Broca's aphasia and normal controls. The perceptual criteria adopted for demarcation of intonation units were: presence of at least one stressed syllable, significant pause between intonation units, phrase final lengthening, anacrusis, and pitch reset (Cruttenden, 1986). The item-by-item inter-judge reliability coefficient 'Alpha' for identification of intonation units in the speech of individuals with Broca's aphasia was found to be 0.9704 and in normal control participants it was 0.9506. The judgment task was repeated after 3 weeks time by the investigator and other judge to establish intra-judge reliability. The item-by-item intra-judge reliability coefficient 'Alpha' for the investigator was found to be 0.9902 in the speech of individuals with Broca's aphasia and 0.9807 in normal control participants. For the other judge it was found to be 0.9804 in the speech of individuals with Broca's aphasia and 0.9801 in normal control participants. The intonation units that were not agreed upon by the two judges were not considered for final analysis.

Later, the utterances of participants were transferred through line feeding to Computerized Speech Lab (CSL) Model 4400 (Kay Elemetrics) for the purpose of acoustic analysis. The speech signal was digitized at a sampling rate of 16000 Hz. For the purpose of pitch analysis, F0 range was set between 70-350 Hz and the window frame length of analysis was 25 ms. The intonation contours were extracted using pitch extraction algorithm of CSL software. The intonation contour analysis in terms of nuclear and terminal contours was based on visual inspection of the contours seen on nuclear stressed syllable and final syllable of each intonation unit, respectively. The widely used

ToBI approach to intonation analysis in other languages of the world such as English (Beckman and Hirschberg 1994), German (Grice et al., 2005), Korean (Jun, 2000), and Japanese (Venditti, 1995) is language specific. It may not be generalised to Kannada language. Therefore, intonation analysis in this study adopted an approach which is based on the system of analysis in English language promulgated by Palmer (1922), Kingdon (1958), and Halliday (1967). The nuclear contours were analysed in terms of rise, fall, rise-fall, fall-rise, rise-fall-rise, fall-rise-fall, and level contour. The operational definitions of these types of nuclear contours are given below:

1) The rise type nuclear contour was defined as the rising contour occurring on nuclear stressed syllable (Kingdon, 1958).

2) The fall type nuclear contour was defined as the falling contour occurring on nuclear stressed syllable (Palmer, 1922; Kingdon, 1958).

3) The rise-fall nuclear contour was defined as a contour consisting of a compound contour in which there is an initial rise followed by a falling contour on nuclear stressed syllable (O'Connor & Arnold, 1961).

4) The fall-rise nuclear contour was defined as a contour consisting of a compound contour in which there is an initial fall succeeded by a rising contour on nuclear stressed syllable (O'Connor & Arnold, 1961).

5) The rise-fall-rise nuclear contour was defined as a complex contour consisting of a rising, falling, and then rising contour on nuclear stressed syllable (Halliday, 1967).

6) The fall-rise-fall contour was defined as a complex contour consisting of a falling, rising, and falling contour on nuclear stressed syllable (Halliday, 1967).

7) The nuclear level contour was defined as a contour occurring on nuclear stressed syllable whose contour was relatively flat.

The terminal contours were analysed in terms of rise, fall, and level contour. The operational definitions of terminal contours were as follows (Cruttenden, 1986):

1) The rise type of terminal contour was characterised by a rising tonal pattern.

2) The fall type of terminal contour was characterised by a falling tonal pattern.

3) The level type of terminal contour was characterised by a relatively flat tonal pattern.

The data was obtained and compared between groups of individuals with Broca's aphasia and normal controls.

Results

The study aimed to evaluate nuclear and terminal contours in spontaneous narrative discourse speech of individuals with Broca's aphasia and compare these features with those of normal controls.

Nuclear tones in intonation unit

The nuclear tones observed in either subject groups were rise, fall, rise-fall, fall-rise, and level contour (see table 2). The complex nuclear contours including rise-fall-rise and fall-rise-fall were not observed in any of the participants of either group. In individuals with Broca's aphasia, the rising nuclear contour occurred with mean percentage frequency of 38.26% while the mean percentage of falling nuclear contour was 20.92%. The mean percentage frequency occurrence of rise-fall contour was 27.50%. The fall-rise and level contour were less common, occurring with corresponding mean percentage of 8.27% and 5.01%. In normal controls too, the rising contour was more frequent than other type of contours. It occurred with mean percentage frequency of 43.96%. The falling contour followed rising contour in terms of percentage frequency of occurrence. It recorded mean percentage frequency of 30.10%. The combination contours rise-fall and fall-rise occurred less frequently with mean percentage frequency of 19.56% and 2.7% respectively. The level contours occurred with mean percentage frequency of 3.6%.

Table 2: *Mean percentage frequency occurrence of types of nuclear contour*

Groups	Rise	Fall	Rise-fall	Fall- rise	Rise-fall-rise	Fall-rise-fall	Level contour
Experimental	38.26	20.92	27.50	8.27	0.00	0.00	5.01
Control	43.96	30.10	19.56	2.70	0.00	0.00	3.60

Terminal contour in intonation unit

The terminal contours in intonation units were analysed in terms of rising, falling, and level type of contours. All 3 types of terminal contours were observed in individuals with Broca's aphasia and normal controls (see table 3). In participants with Broca's aphasia, the rising terminal contours were more common than falling contours. The rise type contours occurred with mean percentage frequency of 51.52% while the fall type contours occurred with mean percentage of 45.37%. Whereas in normal controls a reverse pattern was noticed. The rising contour occurred with a mean percentage frequency of 44.92% while the falling contour was 51.66%. The frequency of occurrence of level contour was low in either group of participants.

Table 3. *Mean percentage frequency occurrence of types of terminal contour*

Groups	Rise	Fall	Level contour
Experimental	51.52	45.37	3.00
Control	44.92	51.66	3.38

Discussion

It is observed that with regard to realisation of different types of nuclear tones, the individuals with Broca's aphasia displayed proficiency which was on par with those of normal controls. They could effect fluctuations in F0 and lend melody to speech. The lesser frequency of occurrence of level contours together with higher percentage occurrence of other types of contours in the speech of individuals with Broca's aphasia lends further evidence that their speech was not monotonous. Some of the nuclear tones configurations observed in normal controls of the present study were also reported in English language by Palmer (1922), Kingdon (1958), and Halliday (1967). It is reported to occur in Telugu (Girija & Neeraja, 2003) language which has a close relationship with Kannada, since the two languages belong to the Dravidian language family. However, the complex nuclear contours like rising-falling-rising and falling-rising-falling observed by Halliday (1967) in English language were not seen in the present study.

Individuals with Broca's aphasia could produce varied nuclear tones configurations similar to those of normal controls. Few researchers in tone languages indicated tone production deficits in individuals with aphasia. Packard (1986) found significant errors in tones produced by Chinese non-fluent aphasic speakers, while, Gandour et al. (1988) demonstrated absence of Thai low versus mid contour distinction in the tones produced by a client with Broca's aphasia. In another study, Gandour et al. (1992) recorded tonal accuracy of 85% in individuals with non-fluent aphasia. Similar deficits were reported in individuals with Broca's aphasia concerning phonological distinction of Norwegian Pitch Accent 1 versus Accent 2 (Moen & Sundet, 1996). In contrast, Gandour et al. (1997) found preserved distinctions in lexical contour at different positions in a sentence produced by participants with LHD aphasia. In contrast to the

tone production deficits reported in various tone languages, individuals with Broca's aphasia in this study presented intact ability to signal tonal modulations. However, direct comparison of results of this study with investigations in tone languages is not possible because the language under study is a non-tone language.

The results of terminal contour analysis suggest that individuals with Broca's aphasia presented increased number of rising contours relative to normal controls. It should be noted that rising contours are usually observed in yes/no interrogatives or in utterances suggesting continuity (Essen, 1964; Meinhold, 1967; Caspers, 1998, 2001; Gilles, 2000, 2003; Dombrowski & Niebuhr, 2005). In declarative sentences containing two or more intonation units, the final intonation unit is usually characterized by a falling contour to signal that the sentence is complete. The rising contours that were noticed in individuals with Broca's aphasia occurred in intonation units that were within sentences. They were not observed in final intonation units of sentences. Figure 1 gives an instance of such findings in individuals with Broca's aphasia. In a sample sentence spoken by MJ, a client with Broca's aphasia - /hudga belun koltiddane/ (boy is purchasing balloon), 3 intonation units are observed. The terminal contours of first two intonation units portray rising pattern, suggesting utterance continuity whereas the final intonation unit of a sentence is marked by a rising-falling contour indicating the statement has ended.
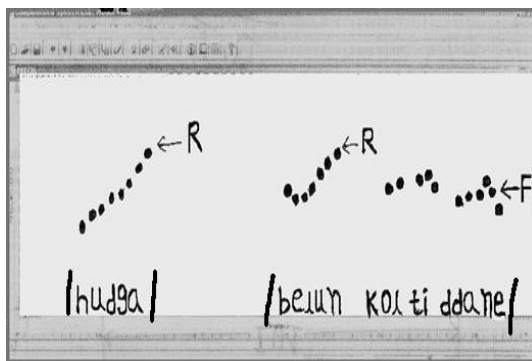
Note. R - rising contour; F – falling contour.

Figure 1. *Intonation contour of a sample sentence spoken by MJ - a client with Broca's aphasia.*

The findings suggest that individuals with Broca's aphasia used the rising contours to indicate that their utterance is incomplete (Gandour & Baum, 2001; Danly & Shapiro, 1982; Danly, Cooper, & Shapiro, 1983; Kent & Rosenbek, 1982). The continuation rise served to

maintain sentence coherence (Gandour & Baum, 2001). It should be noted that individuals with Broca's aphasia presented specific difficulty in the expression of larger units of utterances. They could produce only short utterances. In order to compensate for this, they were probably using rising terminal contours to indicate to the listeners that the utterance is not complete and there is something more to come.

Some of the terminal contours such as rising and falling contours found in normal controls of the study were similar to those reported in English (Cruttenden, 1986), German (Gibbon, 1998; Ambrazaitis, 2005), Kannada (interrogatives) (Manjula, 1997; Patil, 1984), Tamil (Ravisankar, 1987), Telugu (Girija & Neeraja, 2003), Hindi (Geethakumary, 2002), and Malayalam (Geethakumary, 2002). In present study, the level terminal contour characterized by relatively flat contour was also observed. This was also reported in Telugu (Girija & Neeraja, 2003), Hindi (Geethakumary, 2002), and Malayalam (Geethakumary, 2002) languages. Even though there were differences some intrinsic variables such as age and extrinsic variables like formal education, therapy duration, and post-onset duration of aphasia, all participants were able to produce only phrase to simple sentence level utterances. The study did not find any correlation between the aforementioned variables versus occurrence of either nuclear tones or terminal contours.

Conclusions

The intonation contour analysis results suggest that individuals with Broca's aphasia are able to signal variations in F0 as evidenced by the types of nuclear tones and terminal contours exhibited by these individuals. Both groups of individuals exhibited rise, fall, rise-fall, fall-rise, and level nuclear tones. The combination nuclear tones such as rise-fall-rise and fall-rise-fall were not seen in either groups. Concerning the terminal contours, both groups of participants presented all types of terminal contours including rise, fall, and level contours. However, some differences were observed in individuals with Broca's aphasia as against normal control individuals. Most notably, the terminal contours in individuals with Broca's aphasia occurred with a greater frequency than in normal controls. The variations were also observed between the two groups in terms of relative frequency of occurrence of each type of nuclear tones. The rise and fall types of nuclear tones were higher in normal controls compared to individuals with Broca's aphasia. Overall, the results reveal that individuals with Broca's aphasia are able to utilise effectively the prosodic features of nuclear

and terminal contours in discourse especially the manner in which they used terminal contours to convey utterance continuity.

References

Ambrazaitis, G. (2005). Between fall and fall-rise: Substance-function relations in German phrase-final intonation contours. *Phonetica, 62,* 196-214.

Asher, R. E. (Ed.). (1997). *Malayalam.* London : Routledge.

Beckman, M. E., & Ayers, G. M. (1994). *Guidelines for ToBI Labelling.* Unpublished Manuscript, Ohio State University.

Beckman, M. E., & Hirschberg, J. (1994), *The ToBI Annotation Conventions.* Retrieved January 15, 2007, from www.ling.ohiostate.edu/~ tobi/ame_tobi/annotation_conv entions.html.

Caspers, J. (1998). Who's next? The melodic marking of question versus continuation in Dutch. *Language and Speech, 41(3/4),* 375-398.

Caspers, J. (2001). Testing the perceptual relevance of syntactic completion and melodic configuration for turn-taking in Dutch. In P. Dalsgaard, B. Lindberg, & H. Benner (Eds.), *Proceedings of the 7th European Conference on Speech Communication and Technology* (pp.1395-1398). Aalborg, Denemarken: Center for Person kommunikation.

Cruttenden, A. (Ed.). (1986). *Intonation.* Cambridge: Cambridge University Press.

Cruttenden, A (Ed.). (1997). *Intonation* (2nd ed.). Cambridge: Cambridge University Press.

Danly, M., & Shapiro, B. (1982). Speech prosody in Broca's aphasia. *Brain and Language, 16,* 171-190.

Danly, M., Cooper, W. E., & Shapiro, B. (1983). Fundamental frequency, language processing, and linguistic structure in Wernicke's aphasia. *Brain and Language, 19,* 1-24.

Dombrowski, E., & Niebuhr, O. (2005). Acoustic patterns and communicative functions of phrase-final F0 rises in German: Activating and restricting contours. *Phonetica, 62(2-4),* 176-195.

Essen, O. von. (Ed.). (1964). *Grundzüge der hochdeutschen Satzintonation* (2nd ed.). Ratingen: Henn.

Gandour, J., & Baum, S. R. (2001). Production of stress retraction by left- and right-hemisphere-damaged patients. *Brain and Language, 79,* 482-494.

Gandour, J., Petty, S. H., & Dardarananda, R. (1988). Perception and production of tone in aphasia. *Brian and Language, 35,* 201-240.

Gandour, J., Ponglorpisit, S., Khunadorn, F., Dechongkit, S., Boongird, P., Boonklam, R., & Potisuk, S. (1992). Lexical tones in Thai after unilateral brain damage. *Brain and Language, 43,* 275-307.

Gandour, J., Ponglorpisit, S., Potisuk, S., Khunadorn, F., Boongird, P., & Dechongkit, S. (1997). Interaction between tone and intonation in Thai after unilateral brain damage. *Brain and Language, 58,* 174-196.

Geethakumary, V. (2002). A contrastive analysis of Hindi and Malayalam. *Language in India, 2 (6)*

Gibbon, D. (1998). Intonation in German. In D. Hirst & A. Di Cristo (Eds.), *Intonation systems: A survey of twenty languages* (pp. 78-95). Cambridge: Cambridge University Press.

Gilles, P. (2000). Intonation der Weiterweisung. *In List, 20,* 1-35.

Gilles, P. (2003). Die Intonation von Abschluss und Weiterweisung in deutschen Regionalvarietäten: Funktionale und phonetische Analysen; habil. diss. University of Freiburg.

Girija, P. N., & Neeraja, M. (2003). Intonation knowledge for declarative Telugu sentences. Retrieved August 21, 2006, from http://www.colips.org/conference/coc osda2003/ proceedings/intsingoct17.pdf

Girish, P. M. (2004). Social aspects of moods in Malayalam. Retrieved August 21, 2006, from http://www.languageinindia.com/aug2004/sociom ood1.html

Grice, M., & Baumann, S. (2002). Deutsche Intonation und GToBI. *Linguistische Berichte,191,* 267-298.

Grice, M., Baumann, S., & Benzmüller, R. (2005). German intonation in autosegmental-metrical phonology. In S-A. Jun (Ed.), *Prosodic typology: The phonology of intonation and phrasing.* Oxford: Oxford University Press.

Guy, G., & Vonwiller, J. (1989). The high rising tone in Australian English. In P. Collins & D. Blair (Eds.), *Australian English: The language of a new society* (pp. 2134). St. Lucia: University of Queensland Press.

Halliday, M. A. K. (Ed.). (1967). *Intonation and grammar in British English.* Mouton, The Hague.

Hirschberg, J. (2002). Communication and prosody: Functional aspects of prosody. *Speech Communication: Special Issue on Dialogue and Prosody, 36,* 31–43.

Hirst, D., & Di Cristo, A. (1998). A survey of intonation systems. Retrieved October 16, 2005, from http://www.lpl.univ-aix.fr/~hirst/articles /1998%20Hirst&DiCristo.pdf.

Horvath, B. (Ed.). (1985). *Variation in Australian English.* Cambridge: Cambridge University Press.

Jun, S-A. (2000). K-ToBI (Korean ToBI) labeling conventions: Version 3. *Speech Sciences, 7,* 143-169.

Karanth, P. (1980). *A comparative analysis of aphasic and schizophrenic language.* Ph.D thesis, University of Mysore.

Karanth, P. Ahuja, G. K., Nagaraja, D., Pandit, R., & Shivashankar, N. (1991). *Language disorders in Indian neurological patients - A study in neurolinguistics in the Indian context* (Project No. 5/8/10-1 (Oto)/84-NCD-1 IRIS Cell). New Delhi:Indian Council of Medical Research 8403810.

Kent, R., & Rosenbek, J. C. (1982). Prosodic disturbance and neurologic lesion. *Brain and Language*, 15, 259-291.

Kertesz, A. (Ed.). (1982). *The western aphasia battery.* New York: Grune & Stratton.

Kingdon, R. (Ed.). (1958). *The groundwork of English intonation*. London: Longman.

Krishna, G. (2002). *Stress in Kannada words in narrative discourse.* Unpublished M.Sc dissertation, University of Mysore.

Ladd, D. R. (Ed.). (1996). *Intonational phonology.* Cambridge: Cambridge University Press.

Manjula, R. (1979). *Intonation in Kannada: Some aspects.* Unpublished M.Sc dissertation, University of Mysore.

Manjula, R. (1997). *Aspects of Kannada intonation in discourse - interrogatives.* Ph.D thesis, University of Mysore.

Meinhold, G. (1967). Progrediente und terminale Intonationsverläufe im Deutschen. *ZPSK, 20,* 465-478.

Moen, I., & Sundet, K. (1996). Production and perception of word tones (pitch accents) in patients with left and right hemisphere damage. *Brain and Language, 53,* 267–281.

Naeser, M. A., & Chan, S. W. C. (1980). Case study of a Chinese aphasic with the Boston Diagnostic Aphasia Exam. *Neuropsychologia, 18*, 389-410.

Nandini, H. M. (1985). *Some prosodic aspects in Kannada*. Unpublished M.Sc dissertation, University of Mysore.

Nataraja, N. P. (1981). Intonation in four Indian languages under five emotional conditions. *Journal of All India Institute of Speech and Hearing, 12,* 22-27.

O'Connor, J. D., & Arnold, G. F. (Eds.). (1961). *Intonation of colloquial English.* London: Longman.

Packard, J. L. (1986). Tone production deficits in nonfluent aphasic Chinese speech. *Brain and Language, 29,* 212-223.

Palmer, H. (1922). *English intonation with systematic exercises*. Cambridge, UK: Heffer.

Patil, C. (1984). Intonation contours of Kannada. In B. B. Rajapurohit (Ed.), *Acoustic studies in Indian languages,* CIIL, Mysore.

Peters, B. (1999). Prototypical Intonation Patterns in German Read and Spontaneous Speech. *AIPUK, 4, 1-175.*

Peters, B. (2000). Individual and gender-specific differences in the prosodic shaping of German read and spontaneous speech. In H. D. Schlosser (Ed.), *Sprache und Kultur (Forum Angewandte Linguistik. Band 38)* (pp. 153-162). Frankfurt: Lang.

Pierrehumbert, J. B. (1980). *The phonology and phonetics of English intonation*. Ph.D thesis, Massachusetts Institute of Technology (Published 1988 by Indiana University Linguistics Club).

Rathna, N., Nataraja, N. P., & Samuel, G. (1976). Identification of context based on intonation of test sentences. *Paper presented in the Indian Speech and Hearing Association Conference.*

Rathna, N., Nataraja, N. P., & Subramanyaiah, M. G. (1982). A study of prosodic aspects of Kannada language. *Journal of All India Institute of Speech and Hearing, 5,* 7-24.

Ravisankar, G. (1987). *Intonation of Tamil*. Ph.D thesis, Annamalai University.

Sadanand, K., & Vijayakrshnan, K. G. (1993). Pitch patterns associated with the glottal fricative in Punjabi: A preliminary investigation, In C. Rama Rao et al. (Eds), *Osmania papers in linguistics* (pp. 19). Hyderabad: Osmania University.

Sadanand, K., & Vijayakrishnan, K. G. (1998). High tone in Punjabi: A case of deaspiration and tonogenesis. *CIEFL Occasional Papers in Linguistics,* 7.

Sethi, J. (1971). *Intonation of statements and questions in Punjabi*. Hyderabad: CIEFL.

Silber-Varod, V. (2005). *Characteristics of prosodic unit boundaries in spontaneous spoken Hebrew: Perceptual and acoustic analysis*, M.A thesis, Tel-Aviv University.

T' sou, B. K. (1978). Some preliminary observations on aphasia in a Chinese bilingual. *Acta Psychologica Taiwanica, 20,* 57-64.

Venditti, J. J. (1995). Japanese ToBI labeling guidelines. *Ohio State University Working Papers in Linguistics, 50,* 127-162.

PHONOTACTIC PATTERNS IN CONVERSATIONAL SPEECH OF TYPICALLY DEVELOPING CHILDREN AND CHILDREN WITH PHONOLOGICAL IMPAIRMENT: A COMPARISON

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Abstract

Typically developing children learn the phonotactic rules as they grow, whereas children with phonological impairment show phonetic as well as phonotactic limitations. The study aimed to analyze and compare the phonotactic patterns in conversational speech samples for syllable length, word shape, word length and integrity of phonotactic patterns in Hindi speaking typically developing children and children with phonological impairment. Participants were assigned to two groups. Group I (Study group) consisted of 4 Hindi speaking children with phonological impairment in the age range of 3 to 5 years. Group II (control group) consisted of 20 age matched typically developing children. Conversational speech sample was collected from each of the children from each group. 100 utterances were selected and transcribed using IPA. The transcribed sample was analyzed and percentage occurrence of various syllable shape, word shape, word length was calculated. Results revealed that the syllable shapes that were evident in both the groups were CV, CVC, VC, V, CCV, CVCC and VCC. No significant difference between the groups in terms of word length was observed. Monosyllabic structures were found to be more frequent when compared to bisyllabic structures and tri-syllabic words in both the groups. Error analysis revealed no mismatch between the syllable shapes of the target word and ones produced except few instances in CVC and CCVC structures. No significant difference between the syllable shape and word shape were observed in both the groups suggesting that the phonotactic integrity in subjects with phonological impairment was preserved.

Key words: *Phonotactic patterns, syllable shape, word shape, phonetic integrity.*

All possible sequences or types of sounds and morphemes do not occur in any single language. These restrictions are called 'phonotactics' or 'distributional constraints' by the structuralists and morpheme structure (MS) rules (Halle, 1968) or morpheme structure conditions (Stanley, 1967) by the generative phonologists. Words derive their structure not only from the sounds they include, but also from the organization of those sounds within the word. This organization is nothing but the phonotactic rules of the word, which describe the shape and sequence of its elements (Velleman, 1998). Languages spoken all over the world have their own phonotactic structure. Every language in the world has certain preferred word and syllable pattern, as well as patterns that are not preferred or even allowed. In generative phonology, two main functions are assigned to a morpheme structure: the 'possible' and 'impossible'. This explains why specific redundant patterns are seen in the lexicon of languages with regard to their segments and sequences of segments.

Typically developing children implicitly learn the rules of their language including phonotactic patterns as they develop. The most interesting and fascinating aspect of language development is the rapidity and apparent ease with which children acquire adult like form and rules of their native language. On the other hand, many children with disordered phonologies experience phonotactic as well as phonetic limitations. While dealing with individuals with disordered phonology, major focus has been on individual sounds and not on how these sounds interact in the word i.e. phonotactic patterns. Many investigators (Bernhardt, 1994; Bernhardt & Stoel- Gammon, 1994; Velleman, 1998, and Velleman, 2002) have stressed the importance of addressing assessment and treatment of phonotactic errors in children with disordered phonologies. Ingram (1978) stressed the need to focus on syllable and word structures while correcting the phonological process errors in children, as the errors observed in such children is basically a reflection of errors in the syllable or word structures. For example, simplification of syllable structure gives rise to consonant cluster reduction and final consonant omission, deletion of unstressed syllable and reduplication suggests poor word integrity. Ingram (1978) further stated that the segmental complexity experienced as difficulty in executing a variety of speech sounds within the word interacts very closely with the complexity of the given syllable in terms of its shape and this in turn could harm the word processes that are evidenced as harmony patterns. As segmental complexity increases, syllable complexity may decrease and vice versa.

Many investigators have observed that phonological development in early years of a child is exclusively word or syllable based and

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does not refer to the segmental level. Velleman (1998) cites that many speech language clinicians observe that children of any age are able to generalize much better when sounds are targeted at syllable and / or word level rather than in isolation. Thus, before initiating a speech remediation program for children with impaired phonology it is essential to have a sound knowledge about the phonotactic constraints in a given language and how it develops in typically developing children.

As children grow older, they learn more complex syllable and word shapes. It is often seen that children with disordered phonology show developmentally inappropriate or unusual phonotactic constraints. Hence, it is essential to know how these patterns are developed in typically developing children in order to facilitate comparison between normal and disordered population. India is a multilingual country with 114 languages belonging to four distinct linguistic families: Indo-Aryan, Dravidian, Tibeto-Burman and Austro-Asiatic. The phonotactic structure of most of these languages is not known. Addressing this issue is especially relevant when it comes to the question of rehabilitation of children exhibiting phonological impairments. In this study a preliminary attempt is made to analyze the emerging phonotactic patterns in Hindi speaking typically developing children in the age range of 3 to 5 years in spontaneous elicited mode of communication and compare the same with the pattern seen in children with phonological impairment in the same age range. Studies in this direction are very scarce in Indian languages. Vani and Manjula (2006) and Neethipriya (2007) studied the phonotactic patterns in typically developing children speaking Kannada and Telugu languages respectively. But these studies did not attempt to compare the phonotactic patterns seen in typically developing children with the patterns seen in phonologically impaired children. The present study aims to analyze the phonotactic patterns seen in typically developing Hindi speaking children in the age range of 3 to 5 years and compare the same with the phonotactic patterns of age matched children with phonological impairment. Specifically, the phonotactic patterns of syllable shape, word shape, word length and integrity of phonotactic patterns in conversational speech samples of Hindi speaking typically developing children and children with phonological impairment were compared.

Method

Subjects: The participants included 2 groups based on whether they had a phonological impairment:

Group I (Study Group) consisted of 4 native speakers of Hindi with phonological impairment in the age range of 3 to 5 years with age appropriate language skills. The subjects were screened for age appropriate speech, language skills based on history, clinical observation and language assessment tool (LPT-Hindi, Karanth, 1984). The subjects were also screened for sensory impairment (hearing loss and/or visual impairment) and cognitive-linguistic deficits based on clinical observation. Oral mechanism examination (OME), and test for diadochokinetic rate of speech was carried out. Oro- motor deficits, developmental deficits and behavioral problems were assessed in the clinical observation session.

Group II (Control group) comprised of 20 typically developing individuals, matched for age and gender of the subjects in the experimental group. They were screened for any sensory motor abnormalities or impairments in structural or functional aspects of speech. All participants were native speakers of Hindi.

Material and Procedure: An informed consent was obtained in writing from the parents/ caregivers of all the subjects. Conversational speech samples were collected from each child in a quiet room. Interaction with the child involved asking questions to the child regarding his/ her daily activities and indulging in general conversation using toys and pictures appropriate to their mental age. Speech was recorded (Sony-MZ-55) using a digital voice recorder with an external microphone. For the purpose of phonotactic analysis, a portion of each speech sample, that is, at least 100 fluent utterances per child was transcribed using broad transcription IPA (International Phonetic Alphabet).

Analysis: The speech samples of the subjects were transcribed using broad IPA. A sample of 100 fluent utterances per child was selected and the words were analyzed for different syllable shapes, word shapes and syllable length. The occurrence of various syllable shapes, word shapes and clusters were calculated using the formula given by Velleman (1998):

$$\frac{\text{No. of CV syllables}}{\text{total no. of syllables}} \times 100 = \text{Percentage of CV syllables}$$

$$\frac{\text{No. of monosyllabic words}}{\text{Total no. of words}} \times 100 = \%\text{monosyllabic words}$$

$$\frac{\text{No. of initial Consonant Cluster}}{\text{Total no. of Consonant Cluster}} \times 100 = \% \text{ initial Consonant cluster}$$

Similar analysis was carried out for various syllable shapes, word shapes and presence of different clusters. After the percentage was calculated for each type of syllable shapes, group means were calculated separately for the groups of subjects for comparison. Further, the word lengths were analyzed for different word shapes. An error analysis was carried out wherein the phonological errors (syllables and words) from the speech sample of the study group were analyzed separately for different syllable and word shapes.

Results and Discussion

The speech samples of all the subjects in both study and control group were analyzed by the first investigator for different phonotactic patterns. Intra-judge and inter-judge reliability measures were carried out. Intra-judge reliability included the first investigator repeating the process of transcription on 10% of the sample after a week. Inter-judge reliability measure involved an experienced Speech Language pathologist who was oriented and provided training to analyze phonological processes, transcribe 10% of the sample. Both the reliability measures were found to be above 85%. The results are presented under the following sections:

I. Comparison of syllable shapes in the speech of typically developing children and children with phonological impairment

II. Comparison of word shape and word length in the speech of typically developing children and children with phonological impairment

III. Comparison of phonotactic integrity in the speech of typically developing children and children with phonological impairment

I. Comparison of syllable shapes in the speech of typically developing children and children with phonological impairment:

The type and frequency of occurrence of various syllable shapes in the speech samples of typically developing children (TD) who served as the control group and the children with phonological impairment (PI) were computed. The mean percentage occurrence of various syllable shapes and the SD was also computed. The same is shown in Table 1 and Figure 1. The different syllable shapes that were evident in the samples included: Vowel (V), Consonant-Vowel (CV), Vowel-Consonant (VC), Consonant-Vowel-Consonant (CVC), Consonant-Consonant-Vowel (CCV), Consonant-Vowel-Consonant-Consonant (CVCC), Consonant-Consonant-Vowel-

Consonant (CCVC) and Vowel-Consonant-Consonant (VCC).

As is seen from Table 1 and Figure 1, the syllable shapes which were observed to be the most frequently occurring pattern included the V, CV, VC, and CVC. Mann Whitney U Test was carried out to compare the mean percentage scores of the two groups. A significant difference was seen in V syllable shape at $p<0.05$. No significant difference in the other syllable shapes was evident between the two groups. This suggests that the mean percentage occurrences of various syllable shapes (except V) were similar in both the groups studied.
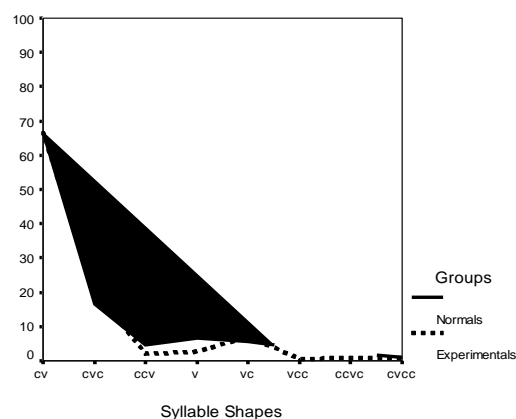
Figure1: *Mean percentage occurrence of syllable shapes in TD and PI groups*

Table 1: *Mean percentage occurrence of different syllable shapes in TD and PI group*

Syllable Shape	TD Mean % occurrence	SD	PI Mean % occurrence	SD
V	6.70	2.05	2.68	0.74
CV	66.97	5.93	66.90	3.65
VC	5.48	1.59	6.98	2.57
CVC	16.46	4.50	20.66	2.11
CCV	4.50	2.07	2.0	1.68
CVCC	0.85	0.39	0.92	0.48
CCVC	0.00	-	0.69	-
VCC	0.00	-	0.64	-

II. Comparison of word shape and word length in the speech of typically developing children and children with phonological impairment.

The mean percentage occurrence of different word shapes and the mean percentage occurrence of word length were computed and the same is represented in Table 2 and Figures 2, 3 & 4. The word length in the words spoken by the group of children in both the groups was limited to the following: Monosyllables, Bisyllables and Tri-syllables. It is interesting to note that all these were evident in both PI as well as TD group. Further, in the monosyllable structures, the CV and CVC occurred more frequently and in both

the groups compared to the other syllable shapes that are listed in Table 2. In the Bisyllabic group, the CV, CV chains occurred more frequently compared to the other word shapes. In tri-syllable group, only two patterns (CV,CV,CV & CVC,CVC,CVC) were evident in both the groups. It can be inferred that there seems to be a developmental trend seen in both the groups of subjects and the pattern of word shapes that emerged in both the groups were the same.
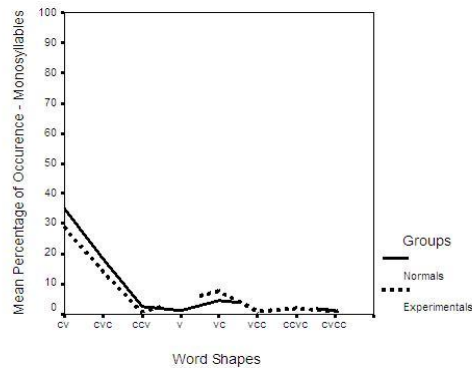
Figure 2: *Percentage occurrence of Monosyllabic words in the TD and PI groups*
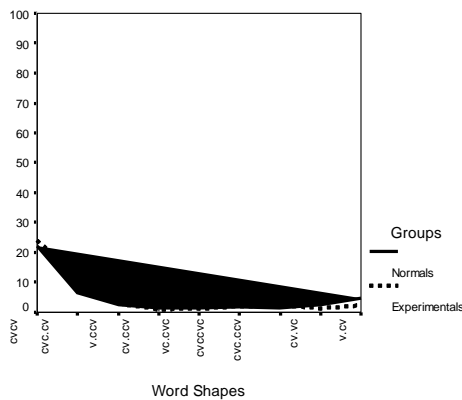
Figure 3: *Percentage occurrence of Disyllabic words in the TD and PI groups*
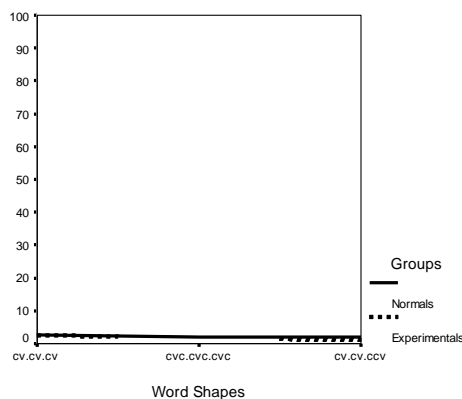
Figure 4: *Percentage occurrence of Tri-syllabic words in the TD and PI groups*

It is evident that in typically developing children as well as children with phonological impairment who were in the age range of 3 to 5 years, the word shapes that were acquired were restricted to tri-syllables. Since the study did not include children in the higher age groups, it is not possible to comment on the acquisition of syllable lengths such as quadric, penta and other polysyllables. However, the trend observed up to 5 years (the upper age limit of children studied speaking Hindi language) is similar to that reported in Kannada speaking children (Vani & Manjula, 2006) and Telugu speaking children (Neethipriya, 2007).

The results in this study is different from the observation of Vani and Manjula, (2006) in Kannada speaking children and Neethipriya (2007) in Telugu speaking children, who commonly observed that in monosyllable word shapes CV followed by VC and CVC occurred in that order. In the Hindi speaking children of both groups in this study only CV and CVC occurred in a hierarchy. The VC structures were seen less frequently in both the groups. This suggests that the PI group of children showed a pattern which is similar to that of their normal counterparts (TD), further supporting the observation that acquisition of the word shape of the native language was not deviant in these children. The frequency of occurrence of consonant clusters CCVC in Mono syllables and CCV, CVC in tri-syllables were very few in both the groups, suggesting that they were emerging patterns in Hindi speaking children. This trend is similar to what is reported in Kannada and Telugu by Vani and Manjula, (2006) and Neethipriya (2007) respectively.

III. Comparison of phonotactic integrity in the speech of children with phonological impairment.

An error analysis was carried out for the phonological errors seen in PI group, to see if the errors at syllabic level in a word matched with the expected syllable shape of that word. This is represented in Table 3. All the four children in the PI group showed no mismatch between the target syllable shape and the ones produced by them in most instances except in one to two instances in CCV and CCVC clusters. This suggests that for simple syllable shapes such as CV, VC and CVC, the phonotactic representations were preserved as per the language norms in these children, suggesting a mature phonotactic ability or integrity in these children just like their normal counterparts.

Table 2: *Mean percentage occurrence of shape and length of words in TD and PI children*

Word Length	Word Shape	TD Mean	TD SD	PI Mean	PI SD
Mono-syllable	V	1.42	0.50	0.00	-
	CV	35.10	5.43	29.00	5.83
	VC	4.50	2.39	7.75	4.11
	CVC	18.55	5.31	14.25	2.87
	CCV	2.50	1.46	1.0	-
	CCVC	1.33	0.57	2.0	1.41
	CVCC	0.00	-	1.0	-
	VCC	0.00	-	1.0	-
Di-syllable	CV, CV	22.05	6.71	24.00	
	CV,CCV	1.70	1.05	1.00	4.69
	V,CV	5.00	2.00	2.33	-
	V,CCV	2.69	1.19	3.00	0.57
	CVC,CV	6.60	4.24	11.33	-
	CVC,CVC	1.53	0.64	2.00	2.30
	CCV,CVC	1.66	0.57	0.00	-
	VC,CV	2.00	0.89	3.0	2.16
Tri-syllable	CV,CV,CV	2.53	1.06	3.66	-
	CVC,CVC,CVC	0.00	-	2.00	2.88

Table 3: *Phonotactic integrity in the speech of children with phonological impairment*

Misarticulated Syllable	Target Syllable CV	VC	CVC	CCV	CCVC
CV	28	-	-	-	-
VC	-	15	-	-	-
CVC	-	-	28	-	-
CCV	1	-	1	-	-
CCVC	-	-	2	-	2

However, the few instances of scatter observed in the clusters CCV and CCVC suggests the possibility of an emerging/ maturing syllable shapes, thus reflecting on a delay in the acquisition of the higher order syllable shapes such as clusters. To generalize this observation, speech samples of more subjects with PI would be required.

Conclusions

The study revealed a distinct pattern of development of various syllable shapes, word shapes and word length in Hindi speaking typically developing children in the age group 3 to 5 years. When the data was compared with that of children with Phonological Impairment, no significant difference was seen in the syllable shapes and word shapes. The syllable shape which was most prominent in both the group was CV, followed by CVC and then VC. In terms of shapes and length of word, similar pattern was seen in both the groups. Monosyllabic words occurred more frequently, followed by disyllabic and tri-syllabic words. The similarity in terms of syllable shape, word shape and word length between TD children and PI children suggests that phonotactic repertoire in the PI children was not impaired although they did not meet the set

norms in terms of phonological patterns of the language. Very few consonant clusters were exhibited by children in both the groups which included CCV, VCC and CCVC, by the age of 5 years which probably implies that these were yet to mature / or were emerging structures in the developmental sequence. An error analysis of the misarticulated segments in the words of the PI group also revealed that there was clear phonotactic integrity, and the misarticulated segments were more of a phonological nature.

Implications of the Study

There has been no study carried out so far on the Phonotactic patterns in typically developing Hindi speaking children. This study has not only provided phonotactic information in terms of syllable shapes, word shapes and word length in Hindi speaking TD children between 3-5 years but it has allowed for comparison of the phonotactic patterns of Hindi speaking children with phonological impairment. The comparison has shown that phonological and not phonotactic errors predominated in children with PI. However, the inclusion of less number of subjects in the PI group does not facilitate generalization of results. The study needs to be replicated with more number of subjects in TD as well as PI group.

References

Bernhardt, B. (1994). *The prosodic tier and phonological disorders.* San Diego: Singular Publishing Inc.

Bernhardt, B., & Stoel-Gammon, C. (1994). Non-linear phonology: Introduction and clinical application. *Journal of speech and Hearing Research,* 37(1), 123- 143.

Halle, M. (1968). *The sound pattern of English*. New York: Harper and Row Inc.

Ingram, D. (1978). The role of the syllable in phonological development. In A. Bell, J.B. Hooper, (Ed). *Syllable and Segments* (pp 143-155). Amsterdam: North-Holland Publishing.

Neethipriya, N. (2007). *Aspects of phonotactics in Typically Developing Telugu Speaking Children.* Unpublished Masters Dissertation submitted to University of Mysore.

Stanley, R. (1967). Redundancy rules in Phonology. *Language*. Vol43. 393-436.

Vani. R., & Manjula, R (2006). *Phonotactic Development in Kannada: Some Aspects and Future Directions.* Language Forum, Vol 32, No. 1-2, Pp 83-93.

Velleman, S.L. (1998). *Making phonology functional: What should I do first?* Boston: Butterworth-Heinenmann.

Velleman, S.L. (2002). Phonotactic therapy. *Seminars in Speech and Language*, 23, 43-56.

SPEECH RHYTHM IN KANNADA SPEAKING CHILDREN

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Abstract

*Rhythm is a systematic temporal and accentual patterning of sound. Speech rhythm refers to the way languages are organized in time. The present study investigated the differences in the type of speech rhythm, in typically developing, Kannada speaking children in the age groups of 3-4 years, 8-9 years, and 11-12 years. Sixty children (10 girls and 10 boys in each of the three age groups) participated in the study. A five-minute speech sample was elicited using simple pictures/cartoons developed by Nagapoornima (1990) in 3-4 year old children; for children in the older age groups, pictures depicting simple stories developed by Rajendra Swamy (1991) adapted from Panchatantra were used. These speech samples were analyzed using PRAAT 5.1.14 software. Vocalic (V) and Intervocalic (IV) durations were measured. The durational difference between successive vocalic and intervocalic segments were calculated and averaged to get Pair wise Variability Index. Comparison of PVIs of the above age groups with Kannada speaking adults indicated that 3-4 year old children had syllable-timed rhythm pattern; 8-9 year and 11-12 year old children was mora-timed rhythm. Intervocalic PVI reduced from younger to older age group whereas vocalic PVI showed no such trend. Results obtained are discussed with reference to the rhythm types in each age group and establishing a continuum in development of spe*ech rhythm.

Key words: *Speech Rhythm, Vocalic, Intervocalic, Pair wise Variability Index, mora-timed, syllable-timed.*

Rhythm is the systematic patterning of timing, accent and grouping in sequences of events. The study of speech rhythm has become a key challenge in speech technology since most of automatic speech processing systems have to cope with the variability of speech rate and rhythm and their consequences both on the segmental units and suprasegmental organization of speech. Languages differ in characteristic rhythm (Pike, 1945; Abercrombie, 1967) though no consensus has emerged on how the undoubted differences in rhythmic structures should be captured (Cutler, 1991). The Rhythm Class Hypothesis states that each language belongs to one of the prototypical rhythm classes known as stress-timed, syllable-timed or mora-timed.

When a language has simple syllabic structure, for e.g. VC or CCV, the durational difference between the simplest and most complicated syllable is not wide. This durational difference may be less than 330 ms. Under these circumstances, the rhythm of the language is said to be a fast syllable-timed rhythm. If the syllabic structure is still simpler, for e.g. VC or CV, then the durational difference between syllables is negligible the rhythm of such language is a mora-timed language. When a language has complex syllabic structure, for e.g. V and CCCVCC, the durational difference between syllables can be very wide. In such a condition one has to use a slow stress-timed rhythm.

The development of concept on rhythm measurement initiated with the concept of isochrony i.e. successive syllables are said to be of near-equal length or interval between stresses are said to be equal in length. The first attempt to test Rhythm Class Hypothesis was made by Abercrombie (1967) by using the average syllable duration, but was found not to be effective in classifying rhythm types. Roach (1982) used a different measure – inter-stress interval (ISI). However, ISI also did not seem to classify languages on the basis of rhythm. Ramus, Nespor & Mehler (1999) found that a combination of vocalic durations (% V) and Standard Deviation of consonant intervals (ΔC) provided the best acoustic correlate of rhythm classes.

The Pair-wise Variability Index (PVI) is a quantitative measure of acoustic correlates of speech rhythm which calculates the patterning of successive vocalic and intervocalic (or consonantal) intervals, showing how one linguistic unit differs from its neighbour (Low, 1998). The PVI can be calculated "raw" (intervocalic PVI), where the differences between successive pairs of units are averaged. The raw Pairwise Variability Index (intervocalic PVI) is used for rhythmic analysis of intervocalic durations. Low, Grabe & Nolan (2000) developed normalized Pairwise Variability Index (vocalic PVI) for rhythmic analysis of vocalic durations. Normalisation involves expressing each difference as a proportion of the average of the two units involved. Table 1 summarizes the basic characteristics of each language class regarding relative values of vocalic PVI and intervocalic PVI.

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Table 1: *Summary of basic characteristics of rhythm class based on vocalic PVI and intervocalic PVI.*

	Intervocalic interval (IV)	Vocalic interval (V)
Stress-timed	High	High
Syllable-timed	High	Low
Mora-timed	Low	Low

In the Indian context, the data collected so far is mostly on adults and data on speech rhythm in children are limited. Savithri, Jayaram, Kedarnath & Goswami (2006) found Kannada[†] to be a mora-timed language (low PVIs) in adults. They report intervocalic PVI values between 35.90 and 52.10 with a mean of 46.18 and vocalic PVI values between 41.80 and 54.36, with a mean of 46.95 in reading samples.

Savithri, Johnsirani & Ruchi (2008) studied speech rhythm in normal and hearing-impaired children in the age range of 5-10 years. The mean PVI values for normal children were 15.70 (intervocalic) and 62.49, whereas for the hearing-impaired children, (intervocalic) they were 20.54 and 67.14, respectively. The results indicated high vocalic PVI and low intervocalic PVI values in both the groups. Therefore, the rhythm pattern remained unclassified and could not be placed in any of the rhythmic classes (stress-timed, syllable-timed, or mora-timed). The results also showed that syllabic structure used by the children was simpler in the acquisition stage of rhythm patterns. Hence there is a need to develop normative data for understanding the development of rhythm pattern in children.

Savithri, Sreedevi, Deepa & Aparna (2011) investigated the rhythm in 3-4 year old typically developing children. The results showed that mean vocalic PVI was 61.27 and mean intervocalic PVI was 77.82. In this group, rhythm wais classified as syllable-timed as the mean intervocalic PVI was more than mean vocalic PVI. On similar lines the same authors investigated rhythm in 11-12 year old Kannada speaking girls and found high vocalic PVI (60.75) and the low intervocalic PVI (53.72).

[†] Kannada is one of the major Dravidian languages of India, spoken predominantly in the state of Karnataka. Native speakers are called Kannadigas, number roughly 50 million, making it the 27th most spoken language in the world. It is one of the scheduled languages of India and the official & administrative language of the state of Karnataka. Kannada (n.d) *In Wikipedia Online. Retrieved from http://www. wikipedia.com.*

However, the difference was not significant and the rhythm was mora-timed.

The present paper is a part of a project which investigated the differences in the type of speech rhythm, if any, between typically developing 3-4 year, 8-9 year, and 11-12 year old Kannada speaking boys and girls.

Method

Subjects: Sixty native Kannada speaking, typically developing children in the age range of 3-4 years, 8-9 years, and 11-12 years (10 girls and 10 boys in each age group) participated in the study. All subjects were screened to rule out structural and/or functional deficits in speech, language, and hearing.

Test Material: A five-minute speech sample was elicited from each subject. Simple pictures/cartoons developed by Nagapoornima (1990) were used in 3-4 year old children. Pictures depicting simple stories developed by Rajendra Swamy (1991) adapted from Panchatantra were used for children in the older age groups (8-9 years and 11-12 years).

Procedure: Speech samples were collected from one subject at a time. They were instructed to see the pictures carefully and describe them. Prompting was used at times when the child did not respond. Speech samples were audio-recorded using a digital voice recorder (Olympus-WS-100) at a sampling frequency of 16 kHz.

Acoustic analyses: The speech samples were transferred onto the computer and analyzed using PRAAT 5.1.14 software (Boersma & Weenik, 2009). The pauses were eliminated by using the same software. This was done in order to get an appropriate measure of the vocalic and intervocalic segments. The Vocalic (V) and Intervocalic (IV) segments were highlighted using a cursor and durations were measured. Vocalic measure refers to the duration of a vowel/semivowel/diphthong which was measured as the time difference between the onset of voicing to the offset of voicing for that vowel/semivowel/diphthong. Intervocalic measure refers to the time difference between two vocalic segments. It was measured as the time difference between the offset of the first vocalic segment to the onset of the second vocalic segment. Figure 1 illustrates vocalic and intervocalic measures in the Kannada sentence [ondu:ralli ondu ka:ge ittu].
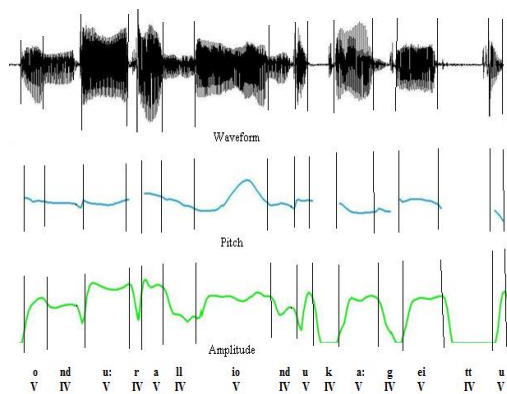
Figure 1: *Illustration of measurement of vocalic (V) and intervocalic (IV) intervals in the sentence [ondu:ralli ondu ka:ge ittu].*

The duration difference between successive vocalic and intervocalic segments were calculated and averaged to get the PVIs. Pairwise Variability Index developed by Grabe & Low (2002) was used as a measure of rhythm. The PVIs were calculated using the following formulae:

$$n\,PVI = 100 \times \left[\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1) \right],$$

Where, m is the number of intervals and d_k is the duration of the kth interval. PVIs were calculated using the above formulae in the Microsoft office excel program.

Statistical Analysis: Statistical analysis was carried out using commercially available SPSS (version 16) software. Mixed ANOVA was used to find the overall interaction between age, gender and the PVIs. T-test was used to find the significant difference between PVIs in each age group for boys and girls. Multivariate analysis was used to obtain the significant difference within the gender for PVIs across age groups.

Results and Discussion

3-4 year old children: The vocalic PVI for girls ranged between 39.09 to 76.68 with a mean of 59.38 and the intervocalic PVI ranged from 74.05 to 91.49 with a mean of 85.22. The vocalic PVI in boys ranged between 46.28 to 96.17 with a mean of 63.16 and the intervocalic PVI ranged from 61.54 to 81.63 with a mean of 70.43. The intervocalic PVI was significantly higher [t (19) = 3.995; p < 0.01] than the vocalic PVI in both the genders. The mean vocalic PVI was 61.27 and the mean intervocalic PVI was 77.82. Hence the rhythm can be classified as syllable timed in this age group. Figure 2 shows PVIs in both girls and boys.
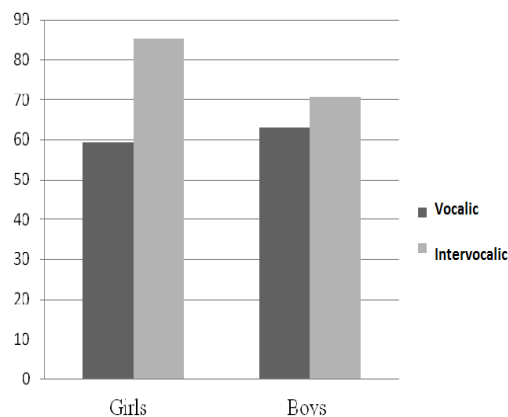
Figure 2: *PVI values in 3-4 year old girls and boys.*

8-9 year old children: Vocalic PVI values in girls ranged between 47.49 to 90.55 with a mean of 57.07 and intervocalic PVI values ranged from 41.37 to 79.45 with a mean of 54.54. vocalic PVI values in boys ranged from 49.45 to 63.37 with a mean of 58.78 and intervocalic PVI values ranged from 41.22 to 69.10 with a mean of 54.33. Though mean vocalic PVI was higher than intervocalic PVI the difference was not significant [t (19) = 0.295, p > 0.05]. Hence, rhythm can be classified as mora-timed. Figure 3 shows intervocalic PVI and vocalic PVI values in 8-9 year old girls and boys.
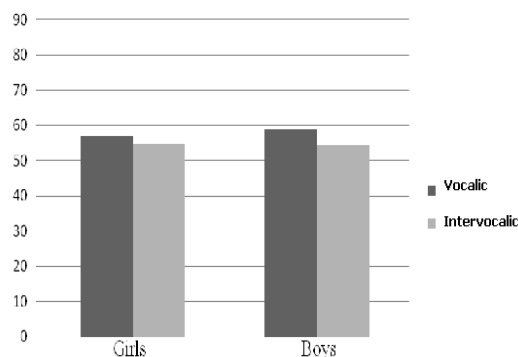
Figure 3: *Intervocalic PVI and vocalic PVI values in 8-9 year old girls and boys.*

11-12 year old children: The vocalic PVI values for girls ranged from 37.0 to 84.09 with a mean of 60.75 and the intervocalic PVI values ranged from 38.3 to 84.01 with a mean of 53.72. The vocalic PVI values in boys ranged between 44.62 to 69.51 with a mean of 59.73 and the intervocalic PVI values ranged from 38.3 to 84.01 with a mean of 43.12. The results indicated higher vocalic PVI compared to intervocalic PVI in both the genders. However, the difference was not significant (t (29) = 1.808; p > 0.05). Hence, rhythm can be classified as mora-timed. Figure 4 shows vocalic PVI and intervocalic PVI values in 11-12 year old girls and boys.
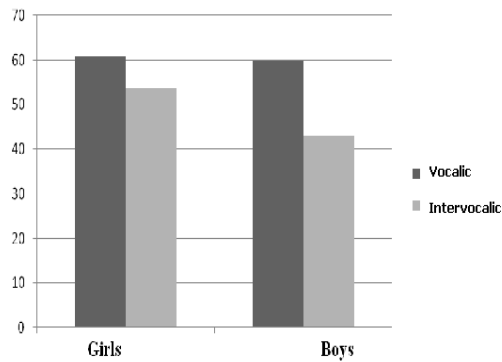
Figure 4: *Intervocalic PVI and vocalic PVI values in 11-12 year old girls and boys.*

Results of mixed ANOVA indicated significant difference between age groups [F (2) = 40.05; p < 0 .05], and gender [F (1) = 5.123; p < 0.05]. Results of Bonferroni multiple comparison, showed that 3-4 years had significantly (p < 0.001) higher PVI values than the older age groups. Mean PVI values of 8-9 years was higher

than 11-12 years but the difference was not significant (p > 0.05).

Results of multivariate analysis indicated a significant difference for intervocalic PVI for both the genders across age groups [F (2) = 0.993; p < 0.001] and no significant difference in vocalic PVI for both the genders, across age groups [F (2) = 0.958; p > 0.05]. intervocalic PVI in 3-4 year old boys were significantly higher than that in 8-9 and 11-12 year old boys; 8-9 year old boys significantly higher than that in 11-12 year old boys. In girls, intervocalic PVI was significantly higher in 3-4 years compared to older age groups. The mean intervocalic PVI value was higher in 8-9 year old girls compared to 11-12 year old girls but the difference was not significant (p > 0.05). However, intervocalic PVI decreased from 3-4 years to 11-12 years in both the genders indicating reduced consonant/ intervocalic duration. Table 2 shows vocalic PVI and intervocalic PVI in all the three age groups.

Table 2: *Mean of vocalic PVI and intervocalic PVI values in different age groups.*

	Girls			Boys			Adults (Savithri et.al, 2006)
	3-4 years	8-9 years	11-12 years	3-4 years	8-9 years	11-12 years	18-25 years
Vocalic PVI	59.39	57.07	60.75	63.16	58.78	59.73	46.95
*(SD)	(11.75)	(4.64)	(6.19)	(13.75)	(4.23)	(5.15)	
Intervocalic PVI	85.22	54.54	53.72	70.43	54.33	43.12	46.18
*(SD)	(5.21)	(8.66)	(8.65)	(6.19)	(9.29)	(6.12)	

*Standard Deviation indicated in parenthesis

In the present study the vocalic PVI and intervocalic PVI in 11-12 year old children approximated adult values (Savithri et. al., 2006). Speech samples like picture description and story narration were used in the present study whereas reading samples was used by Savithri et.al (2006). Though the material used in both the groups was different, they are comparable because both elicited monologues. The results showed that the intervocalic PVI contributed to the classification of rhythm patterns but the vocalic PVI did not. A comparison of vocalic PVI and intervocalic PVI in children obtained in the present study and adult values obtained by Savithri et.al (2006) revealed that intervocalic PVI decreased from 3-4 year to 11-12 year old children to adults. A developmental trend was observed in speech rhythm. The pattern changed from syllable timed in the younger age group to mora-timed in the older group of children which closely approximated the adult rhythm pattern. Figure 5 shows the vocalic PVI and intervocalic PVI in all three groups of children in the present study with that of adults (Savithri et. al, 2006).
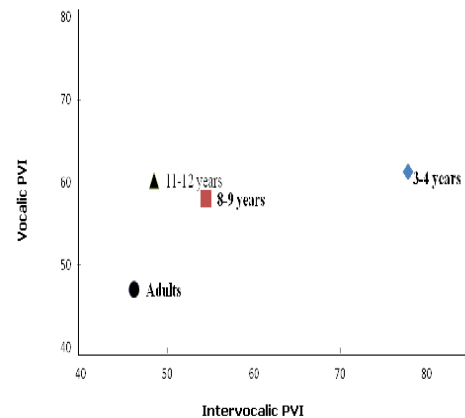
Figure 5: *PVIs in 3-4 year, 8-9 year, and 11-12 year old children and adults speaking Kannada.*

The results also indicated that the vocalic PVI was relatively stable whereas intervocalic PVI decreased with increase in age. Figure 6 shows the PVI values in Kannada and other languages of the world. The PVIs in 3-4 year old Kannada speaking children was closer to British English; those of 8-9 and 11-12 year were closer to German and adults was closer to Rumanian. British English is traditionally classified as

stress-timed and Rumanain is unclassified. However, the basis of such classification in unclear. As evident, there is no support for a strict categorical distinction between languages with high vocalic and intervocalic values and languages with low vocalic and intervocalic PVI values. Rather it appears that languages can be more or less 'stress-timed' (high vocalic PVI and high intervocalic PVI) or 'syllable-timed' (high intervocalic PVI and low vocalic PVI). The investigation of speech rhythm in children from 3-12 years is expected to provide greater details on developmental pattern of rhythm.
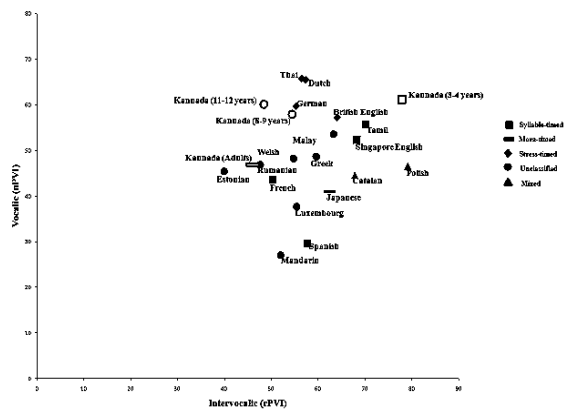
Figure 6: *PVIs in Kannada and other languages.*

Conclusion

The present study investigated speech rhythm in typically developing Kannada speaking children by measuring the vocalic and intervocalic intervals. It was found that 3-4 year old children had syllable-timed rhythm pattern. Rhythm type in 8-9 year and 11-12 year old children was mora timed. The findings of the present study indicate that there is a need to develop data on rhythm to understand the developmental pattern and design better treatment strategies for prosodic errors.

References

Abercrombie, D. (1967). *Elements of General Phonetics*. Chicago: Aldine Pub. Co.

Boersma & Weenik. (2009). PRAAT 5.1.14 software. Retrieved from *http://www.goofull.com/au/programa/14235/speedyitunes.html.*

Cutler, A. (1991). Linguistic rhythm and speech segmentation. In Sundeberg, J., Nord, L. & Carlson, R. (Eds.). Music, Language Speech and Brain. (wenner-Gren Symposium Series 59). Macmillan: Houndsmills & London, 157-166.

Grabe, E., & Low, E. L. (2002). Durational variability in speech and the rhythm class hypothesis. In C. Gussenhoven, & N. Warner (2006) (Eds.). *Laboratory Phonology, 7*, 515-546. Berlin: Mouton de Gruyter.

Low, E. L. (1998). *Prosodic Prominence in Singapore English*. Unpublished Ph.D. Thesis, University of Cambridge.

Low, E. L., Grabe, E. & Nolan, F. (2000). Quantitative Characterizations of Speech Rhythm– 'Syllable timing' in Singapore English. *Language and Speech, 43*, 377 – 401.

Nagapoornima, M. N. (1990). Dysfluencies in children: 3-4 years. M. Jayaram, & S.R. Savithri (Eds.). *Dissertation abstract: Research at AIISH*, Vol.2, pp 171-173.

Pike, K. L. (1945). The intonation of American English.Ann Arbor: The University of Michigan Press.

Rajendra Swamy, (1992). Some aspects of fluency in children: 6-7 years. M. Jayaram, & S.R. Savithri (Eds.). *Dissertation abstract: Research at AIISH*, Vol.3, pp 6-7.

Ramus, F., Nespor, M. & Mehler, J. (1999). Correlates of Linguistic Rhythm in the Speech Signal. *Cognition, 72*, 1 – 28.

Roach, P. (1982). On the distinction between 'Stress-timed' and 'Syllable-timed' languages. In D. Crystal (1986) Eds., *Linguistic Controversies* (pp. 73-79). London: Arnold.

Savithri, S. R., Jayaram, M., Kedarnath, D. & Goswami, S. (2006). Speech rhythm in Indo Aryan and Dravidian languages. Proceedings of the International *Symposium on Frontiers of Research on speech and music*, 31-35.

Savithri, S. R., Johnsirani, R. & Ruchi, A. (2008). *Speech Rhythm in Hearing-Impaired Children*. AIISH Research Fund Project.

Savithri, S.R., Sreedevi, N., Aparna.V.S., Deepa Anand. (2011). Speech rhythm in 11-12 year old Kannada speaking children. *Proceedings of International Symposium on Frontiers of Research in Speech and Music & Computer Music Modelling and Retrieval, FRSM/CMMR-2011,* 56-59.

Savithri, S.R., Sreedevi, N., Deepa Anand., Aparna.V.S. (2011). Effect of gender on speech rhythm in 3-4 year old Kannada speaking children. *Proceedings of International Symposium on Frontiers of Research in Speech and Music & Computer Music Modelling and Retrieval, FRSM/CMMR-2011,* 31-35.

Acknowledgement

VOCAL VARIATIONS IN SPEECH FOLLOWING COGNITIVE CUEING

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Abstract

Voice plays an important role in signaling speaker affect. Literature has stated many ways to elicit emotional voice sample. All of the methods that have been used have both advantages and disadvantages. The use of cognitive cues as a task elicitation method stems from cognitive-behavioral therapy and focuses on prompting the individual to think and feel about a task prior to its completion. The present study attempted to understand the usefulness of cognitive cueing in eliciting vocal changes in speech, in terms of variations in mean speaking fundamental frequency (MSF0) and related parameters and sentence duration when different emotions were employed. Sentences were constructed for five emotions: neutral, happy, anger, fear and sad and the same were graphically represented on Acards. Cognitive cues were also constructed for each of these sentences. Twenty (equal numbers of females and males) under graduate students of a college, aged between 20 to 25 years who were competent in English language use were the participants of the study. Each participant was asked to read the sentences of different emotions thrice. First trial, uncued condition: without the cognitive cues, cued condition: second and third trials, after the presentations of cognitive cues. Real Time Pitch of CSL 4500 was used for analyzing the read samples. The results in general, revealed changes in means values for the MSF0 and its related parameters and sentence duration in cued conditions compared to uncued conditions for all emotions. Therefore, it could be concluded that cognitive cueing brought about quantifiable changes in vocal attributes. Further, the results of the study strengthen the view that use of cognitive cues stimulates voice patterns that would alter speaking styles of individual. This would have practical implications in management of individuals with communication disorders and professional voice users.

Keywords: Cognitive cues, emotions, mental imagery, vocal variability

The human voice is flexible and voice quality changes in different social contexts and situations. Voice plays an important role in signaling speaker affect which can include speaker attitude, mood, emotions, etc. An emotion is a mental and physiological state associated with a wide variety of feelings, thoughts, and behavior. Emotions color the language, and can make meaning more complex. Thus speakers use their voices to express emotions and they can change their voice quality to strengthen the impression of emotions.

To classify the emotive state by a speaker on basis of the prosody and voice quality, there is the necessity to classify acoustic features in the speech as connected to certain emotions. This also implies the assumption that voice alone really carries full information about emotive state by the speaker. Generally materials from three categories are used in investigating emotional speech: spontaneous speech, acted speech and elicited speech. Spontaneous speech contains the most direct and authentic emotions, but the difficulties in collecting this kind of speech are also extensive. The acted speech is merely conforming to stereotypes of how people believe that emotions should be expressed in speech, not how emotions actually are expressed. In elicited speech the idea is that certain emotions are induced. Here the idea is that the speech shall be coloured by the emotion induced. The validity of such elicited, or induced, speech depends to a large extent on how successful the induction process was (Stibbard, 2001).

The use of cognitive-behavioral therapy is not a new concept to the field of voice training. Mental imaging has been used for many years by voice instructors and speech language pathologists to elicit vocal shape for production of song and speech in aspects such as resonant voice therapy and stuttering intervention therapy regimens (Andrews, Shrivastav, & Yamaguchi, 2000). Cognitive cueing is an approach to voice treatment that stimulates voice patterns as a way of changing speakers' voices.

Cognitive cues have been utilized when measureing voice productions (Andrews, Shrivastav, & Yamaguchi, 2000; Bohnenkamp, Andrews, Shrivastav, & Summers, 2002). The acoustic correlates of emotions traditionally investigated are pitch (fundamental frequency, both average and range), duration, intensity and voice quality (Murray & Arnott, 1993). While Andrews, Shrivastav, & Yamaguchi (2000) found no variation in the spectral parameters (MSF0) in the normal adults and an increase in duration in the 'cue' trial, Bohnenkamp, et al. (2002) found cognitive cues to be significant in increasing vocal variations. Cognitive cues have been considered as a promising task elicitation method (Andrews et al., 2000; Bohnenkamp et al., 2002).

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Studies on the effects of emotions on the acoustic characteristics have shown that average values and ranges of F0 differ from one emotion to another. The fundamental frequency can undergo variations that may not be intended or be under overt control of the speaker and hence may provide an indication of the speaker's emotional state. Thus emotional states are said to influence vocal quality as a result of changes in the muscle tonus. These changes are primarily brought about by the functioning of the sympathetic division of the autonomic nervous system.

Cowan (1936) stated that unemotional speech has a narrow pitch range compared to emotional speech, with pitch tending to be normally distributed about the average pitch level. Williams & Steven (1972) reported that in neutral situations, the sentences were generated with shorter duration than for the emotional situations. Cowan (1936) and Öster & Risberg (1986) reported that happiness resulted in an increased pitch and pitch range and a slow tempo, while Fónagy & Magdics (1963) described it as "lively". Williams & Steven (1972) observed that the average fundamental frequency for speaking in sorrow situations and found it to be considerably lower than that for neutral situations and the range of F0 was usually quite narrow. In the review of Johnstone and Scherer (2000); Scherer & Ceshi (2000), sadness was proved to decrease the mean fundamental frequency, F0 range and variability, speed and articulation rate and intensity.

Murray & Arnott (1993) found happy emotion elicited a faster or slower rate, had a higher pitch and a wider pitch range, with smooth upward inflections than neutral emotion. Comparing sad emotion with neutral emotion, it was reported that the average pitch and pitch range was slightly lower with reduced intensity and slower speech rate for sad emotion.

Scherer (1986) concluded that F0, energy and rate may be the most indicative of arousal. Arousal is defined as a subjective state of feeling activated or deactivated (Sanchez, Kirschning, Palacio, Ostrovskaya, 2005). Changes in F0 and rate of speech can be attributed to many factors such as general temperamental and personality characteristics of the individual. Rate can also be a characteristic of the mental state. Slow rate can be a characteristic of mental state such as wonder, doubt, and deep thought and sorrow while rapid tempo is associated with joy, excitement, humor and anger.

As for the emotion of fear, the generally reported features are increased mean F0 and increased F0 range. Fairbanks and Pronovost (1939) analyzed

neutral phrase spoken with different emotive expression by non-actors and reported a relatively highest pitch and a widest pitch range, the highest pitch median and noted high speech rate.

According to Stibbard (2001) anger is the emotional category where findings from both spontaneous and elicited material consistently report features such as high mean F0, wide pitch range, high energy and fast tempo. Fairbanks and Provonost (1939) analyzed neutral phrase, acted speech, and reported that anger generally is characterized by high pitch and a wide pitch range. Fónagy & Magdics (1963) using the recordings of spoken Hungarian analyzed subjectively for pitch variations and reported that anger is characterized by mid pitch and a straight rigid melody.

According to Scherer (1986) vocal parameters may be the most indicative of arousal and findings of such variations may indicate the extent of variations that can be present in the subjects who are subjected to cognitive cueing. Hence, in the present study an attempt was made to investigate whether cognitive cueing elicited changes in vocal parameters.

Method

Subjects

Twenty participants (10 males and 10 females) in the age range of 20 to 25 years were considered for this study. All the participants were under-graduate students noted to be fluent and competent in English language use. Participants were excluded if they had a velopharyngeal disorder, or were perceived by a speech language pathologist to have a voice disorder, abnormal oral-peripheral structures, or hearing loss, neurological or psychological problems.

Materials

A total of five emotions were considered in this study; happy, sad, fear, anger and neutral. Two sentences were constructed to depict each emotion and hence a total of 10 sentences were constructed. The sentences were written on A5 size cards. Then for each sentence, cognitive cues were constructed. These cues were targeted to create specific mental images for each concerned emotion.

Procedure

The participants were seated comfortably in a quiet room and instructed to read all the sentences aloud by looking at the card for familiarization. They were asked to read the sentences thrice. Trial 1, the participants were instructed to read the sentences and this was the no cue condition. In the second and third trials,

the subjects were asked to read the sentences after listening to the cognitive cues provided by the author. These were the cued condition. Cognitive cues were presented live for every sentence after the completion of the no cue condition. All the read samples were recorded on to PRAAT uploaded on the Dell Inspiron 1525 laptop computer with headset and collapsible microphone with the microphone-mouth distance of 5" – 6". Only the first and the third trials were considered for acoustic analysis.

Acoustic Analysis

The recorded samples were analyzed using the Real Time Pitch of CSL 4500. The acoustic parameters extracted were mean speaking fundamental frequency (MSF0), standard deviation of fundamental frequency (SDSF0), variability of fundamental frequency (vF0) and sentence duration.

- Mean speaking fundamental frequency (MSF0) – It is the average pitch that is used during speaking and is expressed in Hertz (Hz).

- Standard Deviation of Speaking Fundamental frequency (SD SF0) – The standard deviation reflects the frequency variability for a reasonably large time segment or passage.

- Variation of Fundamental frequency (vF0) - It is the relative standard deviation of fundamental frequency which reflects the variation of F0 within the analyzed voice sample. It is expressed in terms of %.

- Sentence Duration – It is the period of time during which the sentence is spoken, expressed in seconds.

Statistical analysis

All the extracted acoustic parameters in trials 1 and 3 were subjected to statistical analysis. Descriptive measures and repeated measure ANOVA were obtained to check for significance, if any, across the emotions, gender and conditions.

Results

The results are tabulated in tables 1 to 4.

Table 1: *Mean, standard deviation and F values for mean speaking fundamental frequency (MSF0 Hz) across emotions, gender and conditions.*

No cue condition				Cued condition				Overall variations	F	Sig
Emotion	Gender	Mean F0	SD	Emotion	Gender	Mean F0	SD			
Neutral	Female	231.0	8.9	Neutral	Female	254.1	40.3	Across emotions	5.758	0.000*
	Male	131.3	13.7		Male	131.4	16.0			
Happy	Female	218.5	13.1	Happy	Female	275.7*	56.7			
	Male	124.5	15.0		Male	151.3*	15.5			
Afraid	Female	224.0	14.2	Afraid	Female	249.0*	41.4	Across gender	9.120	0.003*
	Male	125.0	12.3		Male	134.9	27.2			
Angry	Female	231.1	14.2	Angry	Female	265.0*	37.6			
	Male	130.1	18.4		Male	152.3*	22.4			
Sad	Female	215.3	19.0	Sad	Female	220.4	26.6	Across conditions	50.682	0.000*
	Male	128.5	17.0		Male	128.0	13.3			
Total	Female	223.9	15.0	Total	Female	252.8	44.1			
	Male	127.9	15.0		Male	139.5	21.4			

Level of significance (*p<0.05)

Table 1 shows the mean values for MSF0 across emotions, gender and conditions. The overall effect between uncued and cued conditions is also portrayed. For the neutral emotion, females obtained a mean value of 231 Hz (SD=8.9) while in the cued condition, there was a significant change in the mean value to 254.1 Hz (SD=40.3). However, for males, there was no change in the mean values across the conditions.

The mean value for the happy emotion changed across conditions for both the genders. Females had a rise from 218.5 Hz (SD=13.1) to 275.7 (SD=56.7) and males had a rise from 124.5 Hz

(SD=15) to 151.3 Hz (SD=15.5) between the uncued to the cued condition.

A change in mean values for the emotion of fear was noted for both the genders. Females had an increase in the mean values from 224 Hz (SD=14.2) to 249 Hz (SD=41.4) and males had an increase from 125 Hz (SD=12.3) to 134.9 (SD=27.2) in the two conditions.

For the emotion of anger, a rise in the mean values of MSF0 is noted for both the genders. Females had a rise from 231.1 Hz (SD=14.2) to 265 Hz (SD=37.6) and males had a rise from 130

Hz (SD=18.4) to 152.3 Hz (SD=22.4) across the uncued and cued condition.

For the emotion of sadness, there was no drastic change noted in the mean values of MSF0 in females and males. Females has a mean change from 215.3 (SD=19) to 220.4 (SD=26.6) and the

males had a mean value of 128.5Hz (SD=17) to 128 Hz (SD=13.3) from the uncued to the cued condition.

An overall change is noted between the uncued and the cued condition for all the emotions [F (1, 90) = 50.689, p<0.05].

Table 2: *Mean, standard deviation and F values for standard deviation of speaking fundamental frequency (SDSF0) across emotions, gender and conditions.*

No cue condition				Cued condition				Overall variations	F	Sig
Emotion	Gender	SDSF0	SD	Emotion	Gender	SDFS0	SD			
Neutral	Female	34.2	14.0	Neutral	Female	45.5	18.8	Across emotion	3.214	0.016*
	Male	21.5	9.8		Male	14.9	5.6			
Happy	Female	37.6	10.5	Happy	Female	54.4*	28.0			
	Male	16.3	5.8		Male	26.4*	11.8			
Afraid	Female	35.8	17.0	Afraid	Female	37.1	16.5	Across gender	0.998	0.320
	Male	20.3	9.0		Male	20.6	9.3			
Angry	Female	39.6	9.6	Angry	Female	46.0	11.8			
	Male	19.4	9.3		Male	28.5	9.3			
Sad	Female	33.1	7.8	Sad	Female	26.1	6.6	Across conditions	6.101	0.015*
	Male	18.2	5.4		Male	17.6	7.9			
Total	Female	36.1	11.9	Total	Female	41.8	19.6			
	Male	19.1	8.0		Male	21.6	10.1			

Level of significance (*p<0.05)

The mean values for standard deviation in mean speaking fundamental frequency (SDSF0) across emotions, gender and conditions are displayed in table 2. For the neutral emotion, there was a slight rise in the SDSF0 from 34.2 Hz (SD=14) to 45.5 Hz (SD=18.8) for females and a fall in the mean values from 21.5 Hz (SD=9.8) to 14.9 Hz (SD=5.6).

For the happy emotion, both the groups portrayed a rise in the mean SDSF0 values from the uncued to the cued condition. Females had a rise from 37.6 Hz (SD=10.5) to 54.4 Hz (SD=28) and males had a rise from 16.3 Hz (SD=5.8) to 26.4 Hz (SD=11.8).

For the emotion of fear, both the groups did not have much change in the SDSF0 values. Females had a mean value of 35.8 Hz (SD=17) in the uncued trial and 37.1 Hz (SD=16.5) in the cued trial. Males had a value of 20.3 Hz (SD=9) in the

uncued condition and a value of 20.6 (SD=9.3) in the cued condition.

For the emotion of anger, there is a rise in SDSF0 from the uncued to the cued trial. Females had a mean value of 39.6 Hz (SD=9.6) in the uncued trial and 46 Hz (SD=11.8) in the cued trial. Males had a value of 19.4 Hz (SD=9.3) in the uncued condition and 28.5 Hz (SD=9.3) in the cued condition.

For the emotion of sadness, there was no drastic change of the mean SDSF0 values from the uncued to the cued condition. Females had a change from 33.1 Hz (SD=7.8) to 26.1 Hz (SD=6.6) and males had a change from 18.2 Hz (SD=5.4) to 17.6 Hz (SD=7.9)

There was an overall change in SDSF0 between the cued and the uncued conditions [F (1, 90) = 6.101, p<0.05]. There was also a change across emotions [F (1, 90) = 3.214, p<0.05].

Table 3: *Mean, standard deviation and F values for variation in fundamental frequency (vF0) across emotions, gender and conditions*

No cue condition				Cued condition				Overall variations	F	Sig
Emotion	Gender	Mean vF0	SD	Emotion	Gender	Mean vF0	SD			
Neutral	Female	14.1	5.2	Neutral	Female	16.8	5.4	across emotions	2.302	0.065*
	Male	15.5	5.2		Male	11.4	3.8			
Happy	Female	16.7	4.7	Happy	Female	17.5	6.1			
	Male	12.1	3.3		Male	16.2*	6.1			
Afraid	Female	13.4	1.8	Afraid	Female	13.7	6.9	across gender	0.007	0.933
	Male	14.8	5.0		Male	12.7	2.9			
Angry	Female	16.7	3.7	Angry	Female	16.6	2.7			
	Male	13.6	3.7		Male	17.9*	5.4			
Sad	Female	15.0	3.8	Sad	Female	12.9	4.0	across conditions	0.226	0.636
	Male	13.8	4.3		Male	12.8	5.1			
Total	Female	15.2	4.1	Total	Female	15.5	5.4			
	Male	13.9	4.4		Male	14.2	5.2			

Level of significance (*p<0.05)

The mean values for variation in speaking fundamental frequency (vF0) across emotions, condition and gender are displayed in table 3. It was observed that there was no significant change for vF0 across the conditions [F (1, 90) = 0.636, p<0.05] and across gender [F (1, 90) = 0.933, p<0.05] but a significant change is noted across emotions [F (1, 90) = 0.065, p<0.05]. For the neutral emotion, there was a slight rise in the vF0 from 14.1 (SD=5.2) to 16.8 (SD=5.4) for females and a fall in the mean values from 15.5 (SD=5.2) to 11.4 (SD=3.8).

For the happy emotion, both the groups portrayed a rise in the mean vF0 values from the uncued to the cued condition. Females had a change from 16.7 (SD=4.7) to 17.5 (SD=6.1) while males had a rise from 12.1 (SD=3.3) to 16.2 (SD=6.1).

For the emotion of fear, both the groups did not have much change in the vF0 values. Females had a mean value of 13.4 (SD=1.8) in the uncued trial and 13.7 (SD=6.9) in the cued trial. Males had a value of 14.8 (SD=5) in uncued condition and a value of 12.7 (SD=2.9) in the cued condition.

For the emotion of anger, there is a rise in vF0 from the uncued to the cued trial. Females had a mean value of 16.7 (SD=3.7) in the uncued trial and 16.6 (SD=2.7) in the cued trial. Males had a rise in vF0 values from 13.6 (SD=3.7) in the uncued trial to 17.9 (SD=9.3) in the cued condition.

For the emotion of sadness, there was no drastic change of the mean vF0 values from the uncued to the cued condition for males. Females had a slight decrease in vF0 from 15.0 (SD=3.8) to 12.9 (SD=4).

Table 4: *Mean, standard deviation and F values for sentence duration (seconds) across emotions, gender and conditions.*

No cue condition				Cued condition				Overall variations	F	Sig
Emotion	Gender	Mean Duration	SD	Emotion	Gender	Mean Duration	SD			
Neutral	Female	1.7	0.6	Neutral	Female	2.0	0.8	across		
	Male	1.4	0.5		Male	2.2	0.7	emotion	1.765	0.143
Happy	Female	2.4	0.3	Happy	Female	2.5	0.3			
	Male	2.2	0.1		Male	3.0	0.4			
Afraid	Female	2.3	0.3	Afraid	Female	2.8	0.3	across	5.230	0.025*
	Male	2.2	0.4		Male	3.1*	0.7	gender		
Angry	Female	2.0	0.5	Angry	Female	2.2	0.3			
	Male	1.9	0.5		Male	2.2	0.7			
Sad	Female	2.0	0.4	Sad	Female	2.8	0.5	across	77.095	0.000*
	Male	2.0	0.3		Male	2.7	0.9	conditions		
Total	Female	2.1	0.5	Total	Female	2.5	0.6			
	Male	2.0	0.5		Male	2.6	0.8			

Level of significance (*p<0.05)

The mean values for sentence duration across emotions, gender and condition. is shown in table 4. As shown above there is a significant difference in the overall mean values the uncued and cued conditions [F (1, 90) = 77.095, p<0.05] and also a change across gender [F (1, 90) = 5.230, p<0.05]. For the neutral emotion, there was a difference of 0.3 seconds between the uncued and cued conditions in females and a change of 0.8 seconds in males.

For the happy emotion, there was no change in the mean sentence duration in females while there was a rise from 2.2 (SD=0.1) to 3.0 (SD=0.4) seconds in males.

For the emotion of fear, males had an increase in mean sentence duration from 2.2 seconds (SD=0.4) to 3.1 (SD=0.7) while females had a rise only by 0.5 seconds.

For the emotion of anger, both the groups did not show a significance difference in the sentence duration across the two conditions.

For the emotion of sadness, there was an increase in the duration for both the groups. Females had a rise in mean values from 2.0 seconds (SD=0.4) to 2.8 seconds (SD=0.5) while males had a rise from 2seconds (SD=0.3) to 2.7 seconds (SD=0.9).

Graph 1(a) shows the variation in mean speaking fundamental frequency for different emotions across the 'no cue' and 'cued' condition. Graph 1(b) shows the variation in sentence duration for different emotions across the conditions.

(a)   (b)
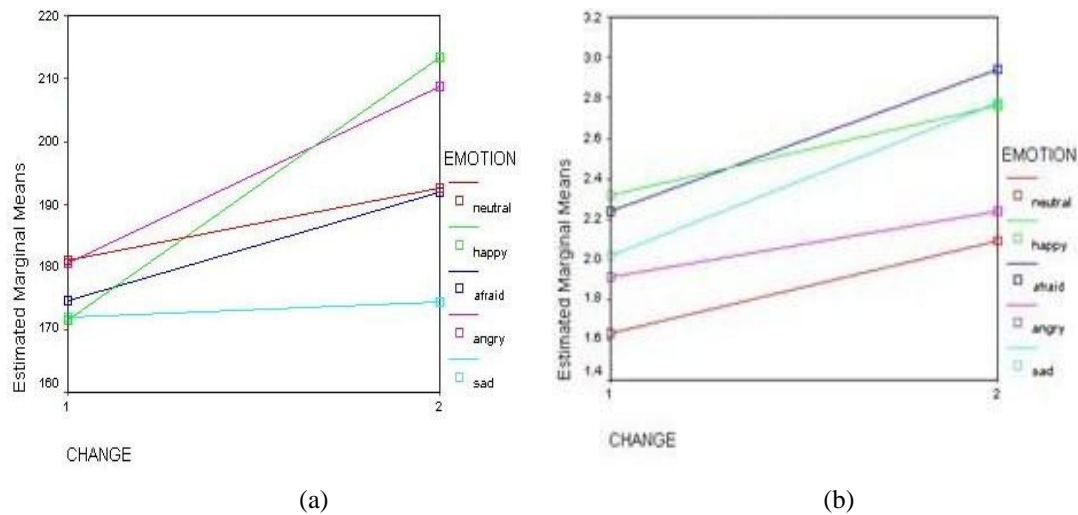
Graph 1: *Variation in mean speaking fundamental frequency across emotions for 'no cue' and 'cued' conditions*

Discussion

As seen in the tables above, the acoustic parameters varied across the five emotions; neutral, happy, afraid, angry and sad. Variations were noted even across the two conditions, uncued and cued conditions. The graphs (a) and (b) show the variations in MSF0 and sentence duration between the conditions with respect to the emotions. A statistical difference between the emotions and conditions were also noticed.

For *neutral emotion*, the MSF0 and mean sentence duration is lesser than for the other emotions. This was seen as less variation for the neutral emotion in the 'no cue' and 'cued' conditions. Females obtained a significant change in the mean MSF0 value from the uncued to the cued condition. However, for males, there was no change in the mean values across the conditions. Experiments have proved that in unemotional speech such as that of neutral emotion, there will not be much change present in the MSF0 and its related parameters. Cowan (1936) stated that unemotional speech has a narrow pitch range compared to emotional speech, with pitch tending to be normally distributed about the average pitch level. Williams & Steven (1972) also reported that in neutral situations, the sentences were generated with shorter duration than for the emotional situations. The significant variations in MSF0, in females can be because of the cognitive cue that was used. This indicates that females were more expressive in their speech compared to males. This also raises an issue of the nature of constructions of cognitive cues. For example, the sentence 'this is a pen' with the situation of talking to a child elicited more pitch variations in the subjects while the other sentence 'the tests are in the cupboard' with a situation of helping a friend find the test did not yield much variation.

By manipulating the cognitive cues presented to the subjects, the vocal parameters could be varied to suit the variations desired by the author.

For *happy emotion*, Öster & Risberg (1986) and Murray & Arnott (1993) reported an increase in pitch irrespective of gender. In the present study, there was an increase noted in MSF0 from the 'no cue' to 'cued' condition. Happy emotion yielded the highest MSF0. Davitz (1964) reported an increase in speech rate for the happy emotion. Same finding was observed in the 'no cue' and 'cued' condition especially in males. It can be thus assumed that the presentation of cognitive cues elicited vocal variability in the direction of emotions. It was evident that the subjects were influenced by the cues given to them and this influence was manifested in the overt vocal expressions.

For the emotion of *anger*, a significant difference was noted in the MSF0, SDSF0 and vF0. There was a rise in all these parameters when this emotion was elicited in both the groups. However, duration did not increase much. Fairbanks and Provonost (1939) reported that *anger* generally was characterized by high pitch which was also evident in the present study. Stibbard (2001) reported of short sentence duration for this emotion but in the present study there was an increase. There was no significant difference in the mean sentence duration between the 'no cue' and the 'cued' trial.

The MSF0 for *fear*, in the present study, was lower than that observed for anger with slower speech rate. There were also more variations in voice compared to the emotion of anger. Williams and Steven (1972) analyzed acted speech in specially written play and reported low SF0, but with occasional SF0 peaks and low speech rate and similar findings were found in the present study.

Sad emotion did not reveal considerable variation from uncued and the cued condition. This emotion yielded the lowest values in the voice parameters among all the emotions. Reduced sentence duration was also observed in the 'cued' trial when compared to the 'no cue'. But contrary reports were reported by Williams & Steven (1972) and Scherer & Ceshi (2000). Williams & Steven (1972) reported that the mean fundamental frequency for speaking in sorrow situations was considerably lower than that for neutral situations and the range of F0 was usually quite narrow. This change in F0 was accompanied by a marked decrease in the rate of articulation and an increase in the duration of an utterance. The increased duration resulted from longer vowels and consonants and from pauses that were often inserted in a sentence. Scherer & Ceshi (2000) opined that sadness was proved to possess decreased mean speaking fundamental frequency, F0 range and variability, speed and articulation rate and intensity. The patterns were contrary to the acoustic patterns in happiness in which a rise in the mentioned patterns was seen.

Scherer (1986) stated that F0, energy and rate may be most indicative of arousal. The participants in the study demonstrated greater mean values for frequency and its related parameters and sentence duration when imagery associated with the cognitive cues was utilized as the task elicitation method compared no cue condition. These parameters are bound to increase in values because when an individual reads the sentences with emotions, there will be a change in the spectral and temporal features of the speech owing to prosodic characteristics than when no emotions are attached to them. These effects warrant further controlled research.

It is interesting to speculate the implications of the study. The mental images attempted in the present study were visual imagery. One may, however, hypothesize that cognitive patterns have some functional relationship to laryngeal movement patterns. The findings of this study indicate some directions in future research concerning the nature of cognitive cueing and how laryngeal motor patterns may be influenced by different types of imagery. Thus exploration of mental practices on laryngeal maneuvers may be a promising line of research.

Conclusion

The observed outcome of the study was that there was a definite effect of cognitive cueing on the vocal variations. The quantitative analysis showed variations across the emotions considered in the study. Gender difference was also observed in the subjects owing to the known fact that females are more expressive than males.

Hence, it could be concluded that cognitive cueing brought about changes in vocal attributes which were quantified. This strengthens the view that cognitive cues could help in achieving greater variations in voice and speech thereby, making the speech more expressive.

References

Andrews, M., Shrivastav, R., & Yamaguchi, H. (2000). The role of cognitive cueing in eliciting vocal variability. *Journal of Voice, 14*(4), 494-501.

Bohnenkamp, T., Andrews, M., Shrivastav, R., & Summers, A. (2002). Changes in children's voices: the effect of cognitive cues. *Journal of Voice, 16* (4), 430-443.

Cowan, M. (1936). Pitch and Intensity characteristics of stage speech. *Archives of Speech, Supplementary, 1,* 1-92.

Davitz, J. R. (1964). *A review of research concerned with facial and vocal expressions of emotion*. The Communication of Emotional Meaning, edited by J. R. Davitz. New York: McGraw – Hill. Pp 57 – 68.

Fairbanks, G., & Pronovost, W. (1939). An experimental study of the pitch characteristics of the voice during the Expression of emotions. *Speech Monograph, 6,* 87 – 194.

Finke, R.A. (1989). *Principles of Mental Imagery*. Cambridge, MA: MIT Press.

Fónagy, I., & Magdics, K. (1963). Emotional patterns in Intonation and Music. Z. *Phonet. Sprachwiss. Kommunikationsforsch, 16,* 293-326.

Johnstone, T. & Scherer, K. R. (2000). Vocal Communication of Emotion. In M. Lewis & J. Haviland (Eds.). H*andbook of Emotions,* Second Edition (pp. 220-235). New York: Guilford Press.

McKellar, P. (1957). Imagination and Thinking. London: Cohen & West.

Murray, I. R., Arnott, J. L., (1993). Towards the simulation of emotion in synthetic speech: A review of literature on human vocal emotion. *Journal of Acoustical Society of America, 93* (2), 1097-1108.

Öster, A., & Risberg, A. (1986). The identification of the mood of a speaker by hearing impaired listeners. *Speech transmission Lab, Quarterly Progress. Stat. Rep.* 4/1986, 79 – 90

Reich, A., Mason, J., Frederickson, R., & Schlauch, R. (1989). Factors influencing fundamental frequency range estimates in children. *The Journal of Speech and Hearing Disorders*, *54*, 429-438.

Richardson, A. (1969). *Mental Imagery*. London: Routledge & Kegan Paul.

Sanchez, J. A., Kirschning, I., Palacio, J. C., & Ostrovskaya, Y. (2005) Toward mood-oriented interfaces for synchronous interaction. CLIHC'05, 23-26, Cuernavaca, Mexico.

Scherer, K. R. (1986). Vocal affect expression: A review and model for future research. *Psychological Bulletin, 99,* 143 -165.

Scherer, K. & Ceshi, G. (2000). Studying affective communication in the airport: The case of lost baggage claims. *Personality and Social Psychology Bulletin*, *26* (3).

Stibbard, R. M. (2001). Vocal Expression of Emotions in Non-laboratory Speech: An Investigation of the Reading/Leeds Emotion in Speech Project Annotation Data. Unpublished PhD thesis. University of Reading, UK.

Stibbard, R. M. (2001). Vocal Expression of Emotions in Non-laboratory Speech: An Investigation of the Reading/Leeds Emotion in Speech Project Annotation Data. Unpublished PhD thesis. University of Reading, UK.

Thomas, N.J.T. (2003) Are theories of imagery theories of imagination? An active perception approach to conscious mental content. *Cognitive Science, 23,* 207-245.

Verdolini, K. (1997). Principles of skill acquisition. Implications for voice training. In M. Hampton & B. Acker (Eds.). *The vocal vision. Views on Voice (pp. 65-80).* New York: Applause.

Verdolini, K. (2000). Case study: Resonant voice therapy. In J. Stemple (Ed.). *Voice therapy: Clinical studies* (2nd ed., pp. 46-62). San Diego, CA: Singular Publishing Group.

Williams, C. E., & Steven, K. N. (1972). Emotions and speech. *Journal of Acoustical society of America, 52* (4), 1238-1250

Appendix

Instructions ('No cue' trial): Read the sentences on the sheets.

1. This is a pen.
2. The tests are in the cupboard.
3. I got the highest IA in class.
4. The director announced a holiday today.
5. I was stuck in the lift for an hour.
6. I haven't prepared for my exams.
7. He spilt tea on my dress.
8. You made me late again.
9. He cannot walk anymore.
10. The results are out and I failed.

Instructions ('Cued' trial): Imagine these situations I am about to tell you and read the sentences after I tell you each instance.

1. Imagine you see a pen in your room. What will you feel?

2. Imagine you are taking a case in OPD and you do not know which test to administer. You seek help from the staff to find out which test to administer. You search for the test and when you find it you realize that you do not know much about the test. You administer the test in half an hour as you have a class after your postings. The next day, you're posted in therapy and your friend comes looking for you to find out where that test is kept as she /he had to administer the test since you had left out some parts of the test. How would you tell her/he where the test is kept?

3. Imagine you bunked class because of no reason at al. Your friends remind you that the teacher will be covering an important topic. You take it for granted that you have the whole night to read what was taught. But you forget to read that lesson that day. The next day, you come to class just to find that your teacher is giving you a surprise test. You are nervous. You begin to answer the test bearing the guilt that if you had listened to your friends, probably you could have answered better. The time goes by and you answer according to your previous knowledge and logic. The next day, when your teacher comes to class, she calls out your name just to say you topped the class. This means you got the highest IA for the most difficult paper. Keeping this situation in mind, read the third sentence.

4. Imagine you were busy throughout the week with the celebrations in your hostel/home. At the back of your mind you know that there is a test held the day after this celebration. You keep it aside thinking you can read for it after the celebration. The celebrations get over at 11 pm and by the time you settle down, it is 1 am. You think of sitting for studying but you doze off to wake up the next day by the intercom ringing in your corridor. You wake up with a startle and begin to get nervous. The phone keeps ringing and you answer the phone. On the other line, the watchman asks your name and class and conveys that the Director is giving all the students a day of for the wonderful show held the previous week. How would you feel?

5. Imagine you wake up late for your postings. You realize you have a case under the supervision of a staff you are very afraid of. You were once caught in an instance where you got scolded for being late by 5 minutes. You reach the clinic to find you're late by 10 minutes this time. You think of the option of going back to hostel, but you do not have enough attendance to bunk. You go ahead to the clinic to experience the first situation in room number 75. To your luck no one is there. You mark your attendance and proceed for your next situation. Your therapy room is on the first floor. The stairway is jammed by people who are painting the walls and by making children climbing the stairs with their parents. So you decide to take the lift. You enter the lift and press the switch and the lift closes to take you to your destination. All of a sudden, the lights turn off. There is utter darkness and silence. What would you do? The intercom and your mobile are not of any help. You begin to bang the door. No one hears you. 5 minute goes by; 15 minutes goes by; another 20 minutes go by; it's getting stuffy and warm and your finding it hard to breath and you are scared of the darkness. This goes on for an hour. How would you feel?

6. Imagine you are having a study leave for only 6 days and the first paper you will write is difficult for you. You begin to study for that paper. Four days before your exams you get a phone call saying your father is admitted in the ICU. You get nervous and leave for home. You reach your hometown and directly push off to the hospital where your father is. You reach there and you see

your mom terribly upset and decide to comfort her. The next day, your father recovers from his illness, would u know you prefer to stay by your father's side and still take the responsibility of the hospital dealings? You realize that you have to get back to hostel as you have your exam the next day and when you reach, you are nervous because you do not know what you're to write for the exams. How would you feel?

7. Imagine today is your birthday. You had a blast with your friends the previous night. And you are looking forward to meeting your classmates the next day. You go for postings wearing an expensive dress your father had got you. It is your favorite shade and you are looking so adorable in it. Your friends give you gifts and make you feel very special. You decide to treat them in the canteen. As you enter, your other friends sing you the birthday song. You treat them. You then get a phone call from your best friend back in your home town and to your surprise, they give you the news that they will be in front of your institute gate in an hour. How would you feel? You tell this news to your friends sitting closest to you. That moment, a friend you are not very fond off, comes to wish you and grabs a seat next to you. While he/she talks to you, he/she accidently spills tea on your favorite dress. Instead of asking you for forgiveness, he/she gives a very care free attitude. How would you feel?

8. Imagine you picked up a quarrel with you friend as he/she spoilt you dress. You decide to go to hostel and change your dress. But when you

are back to the clinic, you realize your case sent a complaint about you to the clinical coordinator. You are called for and you get scolded. You feel so terrible and begin to think this day should not have existed. You go to your chamber and on the way you meet your friend who caused the calamity. How would you feel?

9. Imagine you are posted in OPD. You wait for a case file to land on the table. As you wait, you see a very familiar face among the patients who are waiting. You get a case file and get this patient you feel *u know*. The boy is on a wheel chair and cam along with his mother. You behind to take the case history and over the course of the interview, you realize he was your best friend in school. Time and distance brought separation between you both. You are excited you met him and his mother after several years. You used to be at his home on the weekends to play. On the other hand, you r filled with remorse as he is on a wheel chair. You get to know your friend met with an accident and was diagnosed as having 'global aphasia'. You remember how talented he was. How would you feel?

10. Imagine you are having trouble studying motor speech disorders paper. You study very hard. You write your exam with the expectation you will pass. The days go by and finally the day of the results arrives. You and your classmates run to the notice board to see the results. To your utter disappointment you failed. All your other friends passed. You are left out. You had worked so hard. How would you feel?

VOWEL IDENTITY AND INTELLIGIBILITY AT THREE DIFFERENT PITCH LEVELS IN INDIAN CLASSICAL SINGING

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Abstract

Singing is ubiquitous in human society, and it is unique among music performance as being the only form to combine music with language. Intelligibility is an important aspect of communication during singing performance. Listener, Environment, Music and pitch are related factors that have been reported to affect the perception of song. Present study was aimed to determine differences in vowel identification and intelligibility scores obtained for speech and singing samples sung across different pitches of Hindustani and Carnatic singers. The target words were recorded in speaking and singing (low, mid and high pitches) conditions, followed by preparation of target stimuli. Twenty Speech Language Pathologists carried out identification task and intelligibility rating of the vowels and the scores were subjected to statistical analysis. The findings from the study indicated that in vowel identification task, the listeners did not show much difference in identifying vowels sung by two groups (Hindustani and Carnatic). On perceptual analysis of intelligibility of these vowels sung and spoken, all the spoken vowels obtained rating of good in both groups whereas the intelligibility was rated as poor for sung vowels especially at high and low pitches which could be due to the elevated laryngeal level and depression of the larynx during high and low pitches. Overall Vowel identification scores were poor for Carnatic singers when compared to Hindustani singers. This difference could be attributed to the use of different vocal tract configuration for their respective style of singing and rhythmical pattern.

Key words: Singing, Vowel Identification, Carnatic, Hindustani

Singing is ubiquitous in human society, and it is unique among music performance as being the only form to combine music with language. Much has been written on music's similarities to and differences from language (Meyer 1956, Sloboda 2005), but communicating the sung text is clearly much more similar to language communication than mere musical expressivity. Many people attending concerts sung readily state that they are unable to understand the words being sung, suggesting for a closer look at the intelligibility of sung voice. Speech intelligibility can be defined as the "degree of clarity with which one's utterances are understood by the average listener" (Nicolosi, Harryman, & Kresheck, 1989). Connolly (1986) stated that "among the factors necessary for successful oral communication, intelligibility is clearly one of the most fundamental".

One of the main factors underlying the singer's ability to sing in such a way that 'the text is intelligible to the listener', is the singer's vocal technique (Falkner, 1994 & Adams, 1998). Vocal pedagogy emphasizes smoothness of tone, dynamic and pitch range, and power, considering the voice as another musical instrument, but also stressing the importance of diction. This underlies communication, arguably the singer's foremost responsibility, whatever language the singer is using. Furthermore, environmental factors such as acoustic and within music variables such as clarity of word setting can also affect intelligibility. The musician's focus, then, is the performer's ability to convey the sense of the words he or she is singing and the influence of the environment and the music.

One of the potential goals of song communication is for listeners to gain some level of understanding of the message being communicated. In a language with which the listener is familiar, this involves understanding the individual words, and therefore the intelligibility of those words is of paramount importance. This raises two questions: How intelligible are sung lyrics? And what are the causes of the loss of intelligibility? Existing research has already shown that listeners have significant difficulty in discriminating different sung vowels. This is especially apparent for tones with relatively high fundamental frequencies as might be sung by a soprano. Other factors affecting the intelligibility includes articulation, diction, enunciation, breathing and phrasing, communicating text, expression, stage presence; voice quality and range; listener-related eleven factors including attention; desire to understand words; familiarity with language; hearing ability, environment-related thirteen factors including distraction; access to text; visibility of singer(s); acoustic and music- and

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words-related seven factors including genre; relationship between music and words; repetition etc.

During speech, vowel targets are reached only briefly and are influenced by co -articulation. During singing, however, the vowel must be prolonged according to the rhythmic duration of the word, prescribed by the composer. Hence, the ability to hold a relatively constant vocal tract configuration must become highly developed in the singer. Additionally, which vowel configuration is chosen, and which vowel is perceived by the listener, will determine the conveyance of the meaning of the word. If the vowel sound is inaccurate, so might be the received meaning.

The study of vowel intelligibility during singing has a rather rich history. Typically, as the fundamental frequency rises during singing by women, the first formant will begin to rise ahead of the fundamental frequency to preserve beauty and loudness but not preserve vowel intelligibility. (John & Pierre, 1962, Howard & William, 1968 Sundberg, 1999; Harry, Ana & Kenneth, 2000) The typical finding is that higher sung frequencies tend to have lower vowel intelligibility. (Morozov, 1964; Titze, 1982; William, 1967; Nicole, 1985; Martha & Charles, 1990).

Smith and Scott (1980), for example, studied the intelligibility of vowels produced by a trained soprano in operatic conditions. Ten listeners were asked to discriminate four similar English vowels produced at different pitch levels. Smith and Scott found that the intelligibility of isolated vowels for pitches above F5 was reduced by 50% compared with the same vowels sung at C#5. That is, they demonstrated a dramatic reduction in intelligibility for high sung vowels. When sung with a raised larynx (as might be done in popular music styles) the intelligibility between C#5 and F5 dropped only 10 percent, but then dropped more dramatically as the pitch height increased. Benolken and Swanson (1990) carried out a similar experiment with a trained operatic soprano student. The soprano produced twelve different vowels (both sung and spoken). Twenty-eight phonetically untrained listeners were asked to judge the isolated vowels by comparing them to target words. The results of Benolken and Swanson replicated the earlier work of Smith and Scott: American English sung vowels become increasingly difficult to discriminate as the fundamental frequency is increased.

Hollien, Mendes-Schwartz and Nielsen (2000) also carried out an intelligibility study of sung vowels. They employed eighteen professionally trained male and female singers. Each singer recorded three isolated vowels at two pitch levels and two loudness levels. Listeners included voice teachers, phoneticians, speech pathology students and untrained undergraduate students. In total, some fifty listeners were asked to identify the vowel and also identify the sex of the singer, he found that few vowels are correctly identified when the fundamental frequency reaches or exceeds the typical first formant. In general, incorrectly identified vowels tend to be confused with central vowels. Burleson (1992) speculated that apart from the difficulties involved in discriminating vowels, other aspects of phonology might be expected to contribute to problems in intelligibility rhythmic aspects of prosody, such as word stress, might also be disrupted by musical settings. However, Burleson did not produce an empirical demonstration of such disruptions.

The work of Smith and Scott (1980), Benolken and Swanson (1990), and Hollien, et al. (2000) has admirably demonstrated the problem of fundamental frequency on the intelligibility of vowels. While vowel discrimination is a very important aspect of language perception, there are many other elements that contribute to language intelligibility.

From the singer's point of view, communicating text is only one aspect of their performance, but it is arguably one of the most important. Singing training encompasses many technical aspects, including both vocal technique and diction, with the emphasis on the latter being on developing clarity of diction (Falkner, 1983 & Adams, 1998). The literature suggested that the low pitch sung vowels would be identified more often, and there would be a larger proportion of correct identifications when sung by the male singers. Various articles attempt to define the role played by pitch, intensity, rate of production, and vibrato in the comprehension of vowels and consonants (Husson, 1957, 1958; Cornut and Lafon, 1960; Howie and Delattre, 1962; Scotto, 1972, 1978, 1981; Germain & Seassau, 1982). Here we limit our study to the influence of pitch on the intelligibility of sung vowels in singing.

Most popular forms of music involve the human voice. In nearly all cultures, singing is one of the preeminent forms of music making. In the present study the question was whether there was recognition of sung lyrics. In other words, how well the listeners identify the intended sung vowels or how intelligible will be the vowel sound perceived during singing. It was found that no attempts were made in Indian classical singing to study the vowel identification scores, which contributes to the need for present study.

Thus the present study was carried out to look at Vowel intelligibility achieved by Indian classical singers of two different styles.

Objectives of the study

1. To compare the vowel intelligibility of spoken and sung vowels between two groups of Indian classical singers (Hindustani and Carnatic)

2. To compare the spoken and sung vowel intelligibility across different pitches in two groups of Indian classical singers (Hindustani and Carnatic).

Method

The study was carried out in the following steps;

Step 1-Development of target words

Three cardiac /a/ /i/ and /u/ vowels which are present in Hindi and Kannada were considered for the present study. Lists of words having a mean length of three syllables were prepared in Kannada and Hindi language which contained the 3 target vowels. The stimulus items in the task were subjected to familiarity check by 5 native speakers of the both languages using a 3 point rating scale (not familiar, familiar and very familiar) in class room teaching. Those items which were rated as not familiar were excluded and a final list of 18 items were made in both languages.

Step 2- Recording of the target words

Participants

Eight trained classical singers were recruited to generate the experimental stimuli. This consisted of four Hindustani singers whose mother-tongue was Hindi (2 males and 2 female singers) and the other group consisted four Carnatic singers whose mother-tongue was Kannada (2 male and 2 female singers). All singers had 10-12 years of singing training and reported they still pursue singing as their profession.

Instrumentation and recording procedure

A microphone SSD-HP 202 dynamic stereo mic 105 dB/mV was mounted on a stand, the height of which was adjusted for each singer participant, the mic was connected to a PC for recording. A Master Key Chromatic Pitch Instrument (Wm. Kratt Co. A-440) was used for giving the predetermined pitches to the subjects. Stimuli were recorded in a 200-seat auditorium/recital hall, the recordings made in these circumstances considered to be similar in reverberation and ambience to standard recital recordings.

Each of the singers was requested to perform the following tasks in their respective language.

Task I: **Speaking**

In the first task, singers were asked to say the word list in the same manner as how they naturally speak. They were instructed to speak in the same way as they might normally speak and not attempt to enunciate the words more clearly or less clearly than you would in normal theatrical declamation.

Task II: Singing

Each subject sang the list of 18 words in the order in which they were assigned and in their respective style of singing. Each word was sung in 3 different pitches low, mid, and high with reference to singing range of pitch without reaching the falsetto. Each singer stood approximately eleven inches from the microphone with no attempt being made to control head position during the recording. Singers were instructed to sing them as you might normally sing and not attempt to enunciate the words more clearly or less clearly than you would in your ordinary singing. A practice trial was given before recording for all the singers.

Step-3 Preparation of target stimuli for testing intelligibility

The words were analyzed for vowel duration and vowels more than 500ms were considered to prepare the tokens. The vowel portions were extracted from the recorded words using PRAAT software version 5.0.47. Each isolated vowel ranged 400 to 500 ms in duration. A total of 192 vowel stimuli were extracted out of which 96 from Kannada vowels and 96 were Hindi.

Table 1: *The details of the number of tokens used at low, mid and high pitch for vowel /a/, /i/, and /u/.*

Task	HINDUSTANI SINGERS								CARNATIC SINGERS							
	LP		MP		HP		SPK		LP		MP		HP		SPK	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
/a/	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
/i/	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
/u/	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

The 96 Kannada vowels stimuli were randomized and two tracks were prepared which contained 48 vowels in random order with a gap of 8 seconds between the vowels, similar tracks were prepared in Hindi also. Finally a total of 4 tracks were prepared for perceptual analysis in 2 different languages.

Step-4 Perceptual Analysis

Judges: Total of 20 speech language pathologists (who are undergoing post graduation training) analyzed the vowel samples. These subjects formed two groups 10 native speakers of Hindi (analyzed Hindustani)and other 10 were native speakers of Kannada(analyzed Carnatic).

Procedure: Each judge was seated comfortably in a free field listening situation. . Listening tapes were presented through Speakers. They were asked to identify the vowels and transcribe it on the response sheet and were asked to rate on a three point rating scale (poor, acceptable and good) for intelligibility of each vowel.

Statistical analysis: The data obtained for identification tasks for both groups were tabulated. Descriptive analysis was carried out for the obtained data. The mean and standard deviation was calculated for both groups using SPSS version 10 Statistical analysis software. Percentage was calculated for intelligibility scores

Results

The present study aimed at determining the vowel intelligibility achieved at three different pitches by Hindustani and Carnatic singers. The identification scores and the intelligibility rating obtained from 10 Hindi and 10 Kannada judges were subjected to statistical analysis. The mean scores obtained from the listeners for identification scores is given in the table below.

Table2(a): *The mean identification scores obtained for two groups.*

		Hindustani				Carnatic			
		LP	MP	HP	SPK	LP	MP	HP	SPK
/a/: F	Mean	3.4	3.4	3.0	3.8	3.4	3.6	3.4	4.0
/i/: F	Mean	3.6	3.4	3.0	3.8	3.0	3.6	3.4	3.8
/u/: F	Mean	2.4	3.4	2.0	3.6	2.2	2.8	2.2	3.4
/a/: M	Mean	3.4	3.8	3.0	3.8	3.0	3.6	3.0	4.0
/i/: M	Mean	3.2	3.6	3.0	3.6	2.8	3.6	2.6	3.8
/u/: M	Mean	3.4	3.6	1.8	4.0	2.6	3.6	2.2	3.8

Table2 (b): *The standard deviation obtained for two groups.*

		Hindustani				Carnatic			
		LP	MP	HP	SPK	LP	MP	HP	SPK
/a/: F	SD	0.51	0.51	1.15	0.42	0.84	0.51	0.84	0.00
/i/: F	SD	0.84	0.51	0.66	0.42	0.66	0.51	0.84	0.42
/u/: F	SD	0.84	0.84	0.94	0.51	1.22	1.03	1.22	0.51
/a/: M	SD	0.51	0.42	0.66	0.42	1.22	0.51	0.94	0.00
/i/: M	SD	1.22	0.84	0.94	0.51	1.22	0.51	0.51	0.42
/u/: M	SD	0.84	0.51	1.22	0.00	0.51	0.51	0.78	0.42

Identification scores obtained from listeners who judged the vowels sung by Hindustani singers showed that the mean identification scores were 3 and greater for the vowel /a/ in all the pitches which is observed for both males and females. The vowel /i/ sung by female and male Hindustani singers had mean identification scores of 3 and greater. The vowel /u/ sung by female Hindustani singers at low and high pitch obtained mean identification scores of 2.4 and 2, whereas the scores of 3 and above in mid and speaking conditions, whereas for male Hindustani singing sample a score of 1.8 was obtained for high pitch and a score of above 3 was obtained for low, mid and speaking conditions.

Identification scores obtained from listeners who judged the vowels sung by Carnatic singers showed that the mean identification scores were 3 and greater for the vowel /a/ in all the pitches which is observed for both males and females. The vowel /i/ sung by female Carnatic singers had mean identification scores of 3 and greater, whereas male Carnatic singers obtained a mean identification scoring of less than 3 in low and high pitches. For the vowel /u/ sung by female Carnatic singers the mean identification scores were poor (below 3) except in speaking condition, whereas for vowel /u/ sung by male Carnatic singers, 3 and above scores was obtained at mid and speaking conditions whereas

poor scores obtained at both low and high pitch conditions (<2).

The intelligibility ratings which were obtained based on three point rating scale [Poor (P), Good (G) and Average (A)] was converted into percentage. The percentage scores which were obtained for Hindustani and Carnatic singers are given in table 3 and 4 respectively.

Table 3: *The intelligibility scores obtained for female and male Hindustani singers.*

		FEMALE				MALE			
		LOW (%)	MID (%)	HIGH (%)	SPK (%)	LOW (%)	MID (%)	HIGH (%)	SPK (%)
/a/	P	25	10	70	0	10	____	55	10
	A	25	50	25	15	40	35	40	30
	G	50	40	5	85	50	65	5	60
/I/	P	30	25	75	0	45	____	55	10
	A	35	40	5	10	50	55	35	20
	G	35	35	20	90	5	35	10	70
/u/	P	25	____	80	5	40	15	85	15
	A	45	60	15	20	30	30	10	10
	G	30	40	5	75	30	55	5	75

Careful observations of the above table show that all the vowels had good intelligibility rating in the speaking condition. The vowel /a/ sung by the Hindustan singers was rated as 'poor', 'Acceptable' and 'Good'. The vowel /a/ sung by the female Hindustani singers were rated as poor in 70% high pitch condition and 50% of the vowel /a/ sung by both male and female singers at low pitch was rated as good, whereas only 5% of the vowel /a/ sung at the high pitch by the male Hindustani singers were rated poor. 65% of the vowels /a/ sung at the mid-pitch was rated as good.

For the vowel /i/, 75% of the female high pitched listening stimulus, as well as 55% of male highpitched stimulus were rated poor. 80% of the vowel /u/ at high pitch sung by females were rated as poor, where as 85% were rated as poor when sung by the male singers. When vowel /u/ was sung at mid pitch 60% scores were rated as acceptable by the judges and when male sung /u/ at mid pitch 55 were rated as good. When male and female singers sung at low pitch, scores of 40%, 30% and 30% (for male) was good and 25%, 45% and 30% (for female) was rated as poor, acceptable, and good respectively.

Table 4: *The intelligibility rating obtained in percentage for Carnatic singers.*

		FEMALE				MALE			
		LOW (%)	MID (%)	HIGH (%)	SPK (%)	LOW (%)	MID (%)	HIGH (%)	SPK (%)
/a/	P	35	15	25	15	20	15	40	10
	A	35	40	55	15	50	25	40	10
	G	30	45	20	70	30	60	20	80
/I/	P	60	10	20	10	70	15	35	5
	A	25	60	60	20	20	40	55	5
	G	15	30	20	70	10	45	10	90
/u/	P	60	40	65	5	55	30	70	5
	A	25	20	20	5	25	55	20	10
	G	15	40	15	90	20	15	10	85

The above tabulated values shows the intelligibility rating rated for low, high, mid, and speaking condition by various listening judges. The vowel /a/, /i/ and /u/ were rated as good in speaking condition. The vowel /a/ when sung by female Carnatic singers was judged 55% of time as acceptable. Rating of good was assigned 45% time when sung by female and 60% when sung by male Carnatic singers. 35%, 35%, 30% and 20%, 50%, 30% was rated as poor, acceptable and good when sung by female and male singers at low pitch respectively.

For the vowel /i/ sung by the male Carnatic singer was rated as poor when sung at low pitch and 60 % was rated as acceptable at mid and high pitch. For male Carnatic singers 70% of time the rating was poor at low pitch and 45% was rated good at mid pitch and 55% was rated acceptable at high pitch condition. For the vowel /u/ sung by the female Carnatic singers was rated 65% of times poor at high pitch condition, but when sung at low pitch was rated as poor (60%). When male Carnatic singers sung vowel /u/ at low pitch, 55% of time was rated as poor and when sung at mid pitch 55% of time was rated acceptable. But at high pitch 70% was rated as poor.

Discussion

The present study aimed to compare the sung vowel intelligibility across different pitches in two groups of Indian classical singers (Hindustani and Carnatic) and also to compare the vowel intelligibility of sung vowels between two groups of Indian classical singers (Hindustani and Carnatic). Three cardinal vowels /a/ /i/ and /u/ which are present in Hindi and Kannada were considered for the present study, a total of four Hindustani singers (2 Male and 2 Female) and four Carnatic singers (2 Male and 2 Female) were made to sing and speak words consisting of target vowels to generate the stimuli. The vowels extracted from the sung and spoken words were used as stimuli. The results obtained for identification and intelligibility of vowels sung by two groups of singers is described in the previous section.

For identification task of vowel /a/ at different pitches of sung samples, good scores were obtained for males and females of both groups (mean range from 3.2 to 4). These results indicated that the identification scores did not differ across pitches and between samples of males and females singers of both groups. The vowel /i/ sung by female and male Hindustani singers and female Carnatic singers had mean identification scores of 3 and above, whereas male Carnatic singer's samples obtained a mean identification score of less than 3 in low and high pitches. The identification scores for vowel /u/ was reduced compared to the other two vowels, identification scores of vowels sung by female singers of both the groups were poor in high and mid pitches, where as in males Hindustani singers obtained poor score for vowel /u/ only in high pitch, whereas samples of Carnatic male singers obtained poor scores at low and mid pitch.

To assess the intelligibility of vowels, three point rating scale (Poor, Acceptable and Good) was provided for the judges and responses were scored in percentage. The results for intelligibility ratings for Hindustani singers indicated that, at high pitch all the vowels were judged as poor (range 55 to 85%) and only 5% was rated as good in both males and females. The intelligibility of all the vowels at low and mid pitches was rated either as acceptable (range 30 to 65%) or good (range 30 to 60%). Overall the results showed that intelligibility was good for speaking condition compared to singing. In singing, high pitch vowels were mostly rated as unintelligible compared to mid and low pitches in both males and females.

The intelligibility scores obtained for Carnatic singers for the vowel /a/ in three conditions of singing was scored as acceptable (range 35-40%) and poor (15 to 40%) for both males and females. Vowel /i/ sung by both males and females at low pitch were rated as poor (60 to70%), the same vowel sung at mid pitch was judged as acceptable (40 to 60%) and good (30-45%) whereas for high pitch for both males and females it was rated as acceptable (55 to 60%) and poor (20 to 35%). Vowel /u/ was judged as poor mostly in all singing condition (40-70%), these results indicated overall poor intelligibility scoring for sung vowels compared to speaking condition. This may be due to the elevated laryngeal level and depression of the larynx during high and low pitches respectively. These changes may affect the vocal tract configurations which in turn affects the vowel formant patterns.

Benolken and Swanson (1990) carried out a similar experiment with trained singers who produced twelve different vowels (both sung and spoken). The results showed that the American English sung vowels become increasingly difficult to discriminate as the fundamental frequency is increased. Smith and Scott (1980) studied the intelligibility of vowels produced by trained singers. That is, they demonstrated a dramatic reduction in intelligibility for high sung vowels.

The overall findings from the study imply that in vowel identification task, the listeners did not show much difference in identifying vowels sung by two groups (Hindustani and Carnatic). Identification scores obtained for both the groups showed good scores for the vowels /a/ and /i/ in different singing conditions except the scores obtained for female singers of both the groups for the vowel /u/.

On perceptual analysis of intelligibility of these vowels sung and spoken, not surprisingly all the spoken vowels obtained rating of good in both groups. In Hindustani singers for both males and females at high pitch, most of the vowels were judged as poor whereas mid and low pitch vowels were judged as acceptable. In Carnatic singers all the sung vowels were rated as poor and acceptable. This suggests that vowel intelligibility was poor for Carnatic compared to Hindustani sung vowels. These differences in intelligibility could be attributed to the fact that these two types of singers may use different vocal tract configuration chosen for their respective style of singing and rhythmical pattern. More research investigating all different vowels in different languages and types of singing is required to determine the factors which might have caused these patterns of results in the present study.

Conclusion

On comparison of the sung vowel intelligibility across three different pitches in two groups of Indian classical singers, the vowels sung at high pitches in both males and female Hindustani singers were perceived as poor, whereas in Carnatic singer's intelligibility was affected in all the pitches. On comparison of the vowel intelligibility of sung vowels between two groups of Indian classical singers, Hindustani singers were more acceptable in terms of intelligibility rating than Carnatic singers by the listeners. This shows that singing condition itself imposes a factor in perception of intelligibility. More the knowledge about the factors affecting intelligibility, the more input it can have in singing pedagogy, particularly concerning communication with the audience.

Future research indications

In future, further study of the cognitive and acoustic factors relating to intelligibility, both for the singer (e.g. vowel, pitch height) and the listener (e.g. familiarity with the genre, tiredness) can be conducted and these will take us beyond merely the beliefs of singers and listeners into more objective findings. Overall there is great scope for psychological and acoustic methods to be used to investigate this area of research.

References

Adams, D. (1998). A Handbook of Diction for Singers: Italian, German, French. Oxford: Oxford University Press. pp 24-35.

Gregg, J. W., & Scherer, R. C. (2006). Intelligibility of Vowels in Classical Singing. *Journal of Voice, 20, (2).* 198-210.

Gregg, J., W. (2009). Intelligibility of prolonged vowels in classical singing. *Journal of Singing.* Retrieved form http://findarticles.com/p/articles/mi_6726/is_3_6 3/ai_n28405704.

Harry, H., Ana, P., Schwartz, M., & Nielsen, K. (2000). Perceptual Confusions of High-pitched Sung Vowels. *Journal of Voice,* 14, (2). 287-298.

Howard, D. N., & Tiffany, W. (1968). The Intelligibility of Song. *The NATS Bulletin 25, (2),* 22-28, 38.

Howie & Delattre, P. (1962). An Experimental Study for the Effect of Pitch on the Intelligibility of Vowels. *The NATS Bulletin XVIII, (4).* 6-9.

Johan Sundberg (1999). The Perception of Singing. In Diana Deutsch, ed., *The Psychology of Music,* 2nd ed. (New York: Harcourt Brace & Co.).

Martha, S. B., & Charles, E. S. (1990). The Effect of Pitch-related Changes on the Perception of Sung Vowels. *Journal of the Acoustical Society of America. 98, (4).* 1781-1785.

Meyer, L. B. (1956). *Emotion and meaning in music.* Chicago: University of Chicago Press.

Mithen, S. (2005*). The Singing Neanderthals: The Origins of Music, Language, Mind and Body.* London: Weidenfeld and Nicolson.

Morozov, V. P. (1964). Intelligibility in Singing as a Function of Fundamental Voice Pitch. *Akusticheskii Zhurnal, 10, (3).* 330-334;

Nicole Scotto Di Carlo., & Lamongie, A. (1985). A Perceptual Study of the Influence of Pitch on the Intelligibility of Sung Vowels. *Phonetica, 42.* 188-192.

Nicolosi, L., Harryman, E., & Kresheck, J. (1989). *Terminology of communication disorders* 3rd ed.. Baltimore: Williams & Wilkins.

Philip, D., & Ginsborg, C. (2007). Perceived factors affecting the intelligibility of sung text: Proceedings of the third Conference on Interdisciplinary Musicology (CIM07) Tallinn, Estonia, 15-19. Retrieved from http://www-gewi.uni-graz.at/cim07/

Sloboda, J. A. (2005). *Exploring the Musical Mind: Cognition, Emotion, Ability, and Function.* Oxford: Oxford University Press

Sundberg, J. (1987). *The Science of the Singing voice.* DeKalb, IL: Northern Illinois University Press.

Titze, I. (1982). Why is Verbal Message Less Intelligible in Singing than in Speech. *The NATS Bulletin* 38, (3), 37.

William, M., T. (1967). An Investigation Concerning Vowel Sounds on High Pitches. *The NATS Bulletin,* 23, (3). 8- 50.

A COMPARATIVE STUDY IN NARRATIVE DISCOURSE OF KANNADA-ENGLISH BILINGUAL NORMAL ADULTS

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Abstract

The linguistic relativity hypothesis suggests that bilinguals may actually have different thought patterns when speaking different languages, this study, which examines the narration told by individuals in two different languages, sheds further light on the validity of the hypothesis. The current study particularly explores how, when telling narratives, bilingual individuals express verbal notions through the use of the tense, aspect, and voice forms available in each of their two languages. Particularly the past tense is often used in oral narratives, specifying the typical series of events taking place in a particular sequence such as going on a trip or journey to a place. This was the target task of the present study. Here 20 normal bilingual adults were the participants and had to narrate in Kannada and English languages separately. These discourse samples were video recorded using digital handycam DCR-DVD 908. The objective was to compare and see the differences in Kannada and English language narrative discourse. The narrative discourse of these participants were subjected for T-unit analysis; the parameters included were number of clauses, number of T-units, number of words per clauses and number of words per T-unit. Thus the participant's Kannada and English narrative discourse were quantified separately. The statistical results showed significant differences for the parameter number of clauses, number of T-units and number of words per T-unit of Kannada narrative discourse when compared to English narrative discourse. These similarities and differences in their narrative discourse are further discussed in detail.

Key words: Linguistic relativity, T-unit, clauses, journey

One of the long-standing critical debates in language studies involves the relationship between language and thought processes which leads to a question- how does a particular language influence the way its speakers perceive the world. The linguistic relativity hypothesis (Whorf, 1956) claims that speakers of different languages think differently, and that they do so because of the differences in the languages they speak. A substantial amount of research has been conducted on this topic. Some studies (Brown & Lenneberg, 1954; Bloom, 1981) have offered strong evidence in favour of the linguistic relativity hypothesis, whereas others (Berlin & Kay, 1969) have resulted in findings that did not support the hypothesis, and still others (Au, 1983) have even provided evidence challenging its validity of linguistic relativity.

The study reported in this paper represents an attempt to combine some aspects of narrative studies and bilingual studies against the background of the linguistic relativity hypothesis. Studies of language acquisition and language development have focused increasingly on the structural aspects of narrative discourse (Peterson, 1990; Reilly, 1992). Learning the skills for narrative discourse is especially complicated for bilinguals to the extent that the schema (the organization of knowledge), which provides a cultural framework of events and actions and which affects memory encoding and retrieval, differs for each of the languages used. The human mind, which is influenced by a schema of pre-packaged expectations or interpretations, seems also to be under the influence of the specific linguistic systems used. The linguistic relativity hypothesis suggests that those who speak more than one language (e.g., bilinguals) may actually have different thought patterns while speaking in different languages. This study, which examines the narration by individuals in two different languages, sheds further light on the validity of this hypothesis.

This study, which compares the linguistic form/function relations in narrative discourse in two different languages, examines whether: "Bilinguals possess relatively separate linguistic rule systems for each of the two languages" or whether: "There is a common underlying rule system in a bilingual's mind." By analyzing the relationship between linguistic forms and their functions, the study attempts to bring to light specific characteristics in the narratives of bilingual individuals using the means that they have at their disposal in two different languages. The present study basically adopts Berman and Slobin's (1994) definition of "form/function." Form includes a broad range of linguistic/expressive devices. Function includes the purposes served by the forms used in narrative discourse. The current study particularly explores how, when telling narratives, bilingual individuals express verbal notions through the use of the tense, aspect, and voice forms available in each of their two languages. For instance, the present tense is often

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used in script narratives, specifying the typical series of events taking place in a particular activity such as going to a restaurant or going to a birthday party.

In picture-book narrations, on the other hand, if the task is regarded as a narrative activity (i.e., recounting of events spatially as well as temporally distant from the speaker), the past tense may be predominantly used. And the past tense is often used in oral narratives, specifying the typical series of events taking place in a particular sequence such as going on a trip or journey to a place. The narrator uses tense systematically when he or she refers to events and temporally relates them with each other. In this way, the tenses that narrators use reveal their subjective attitude towards a particular event.

Narration draws on some of the most sophisticated language skills in a person's repertoire like the use of an array of temporal, spatial, and logical relationships; the use of complex linguistic elements to refer to objects, characters and situations already mentioned or new in the story; and the use of varied linguistic mechanisms revealing the narrator's personal point of view (Labov, 1972; Karmiloff-Smith, 1980; Hickman, 1990; Bamberg & Damrad-Frye, 1991; Berman & Slobin, 1994). Narrative discourse also lends itself well to the study of the ways in which subjects use the formal linguistic devices in their repertoire to serve specific functions in communication (e.g., Berman, 1993; Hickman, 1990, 1991; Karmiloff-Smith, 1981). One main area of narrative called the syntactic complexity was examined. The measure considered for recording was the total number of syntactic units. The definition used for this measure was taken from Norbury and Bishop (2003). A single syntactic unit was classed as a full main clause and any subordinate clauses belonging to it. Simple and complex sentences were counted as one syntactic unit (e.g. 'When I was driving, others were sleeping') and compound sentences were counted as two syntactic units (e.g. 'I was driving and others were sleeping'); total number of complex sentences comprised subordinate clauses, complement clauses, verbal complements and passive constructions.

This study specifically analyzes narratives by Kannada-English bilingual adults. Comparing Kannada and English, as a matter of fact, offers an interesting study for cross-linguistic analysis, because they are such distinctly different languages. To begin with, Kannada is one of the major Dravidian languages of India and is spoken predominantly in the state of Karnataka. Numbering roughly 38 million population makes it the 27th most spoken language in the world.

Kannada having its own script is a highly inflected language with three genders (masculine, feminine, neutral or common) and two numbers (singular, plural). It is inflected for gender, number and tense, among other things (Prakash & Joshi, 1995). In case of Indian English, it comprises several dialects and is evolved during and after the colonial rule of Britain in India. English is one of the official languages of India with about ninety million speakers according to the 1991 Census of India. Clauses in English language have a subject and a verb. There are three main types of dependent clauses like noun clauses, adjective clauses, and adverb clauses, so-called for their syntactic and semantic resemblance to nouns, adjectives, and adverbs, respectively. Here, a noun is the head of the phrase. These differences make comparison of English and Kannada of great potential interest for those who research cross-linguistic development.

One of the critical requirements in this bilingual study, however, is that the degree of competence in each of the languages be equal. Many bilinguals tend to be more fluent in one language than the other. Differences in the degree of proficiency can confound the obtained results and consequently preclude meaningful comparisons. This study, after controlling for the potential problem of differing linguistic levels, addresses the following two key questions: Are there any similarities and differences used in narratives of Kannada and English discourse sample of normal bilingual adults? And what do the similarities and differences suggest about narratives told in each of the two languages? This means that either (or not) transfer of knowledge from the first language to a second language or vice versa is likely. Thus an attempt is made to check the same.

Aim

The present study aimed to compare the narrative discourse abilities between Kannada and English speaking normal bilinguals.

Method

Participants

A total of 20 neurologically intact adults in the age range of 24 to 30 years were considered for the study and were further divided into two groups each consisting of 10 individuals. Language Kannada (L1) was the native language of all the participants and learned English as L2 when they were 4 years old. Group I considered were one half of the total participants narrating in English first and then in Kannada and Group II were the other half narrating in Kannada first and then in English. These all were qualified with post graduation in Speech-Language Pathology

and Audiology. They all belonged to a middle/high socioeconomic status confirmed from readapted version of National Institute of Mental Health (NIMH) Socioeconomic Status Scale, (Venkatesan, 2009). All the participants were screened using Mini Mental Status Examination for visual perceptual and neuropsychological deficits. The language proficiency of all the participants' L1 (Kannada) and L2 (English) was closely described as vocational proficiency on administration of International Second Language Proficiency Rating (ISLPR) - Wylie and Ingram (2006) scale.

Procedure

The target task was oral narration on a topic "Journey to a place". Verbatim instruction provided was to narrate on a topic "Journey to a place" for a particular duration of 3-5 minutes using only L1. Recording was done during the same time. And later subsequent to 15 days, same participants had to repeat the same task using only L2. An important point here was, because the same participants were narrating in both Kannada and English, counter-balancing was achieved by having one half of the participants narrating in English first and then in Kannada (Group I) and the other half narrating in Kannada first and then in English (Group II). This counter-balancing was used to help cancel any effect of order of presentation. The narration was recorded using a WaveSurfer 1.5.7, computer software program. The participants were aware that their speech was being recorded. All the recordings were carried out in a quiet room with no distraction during or in between the recordings. The discourse samples of each participant were verbatim transcribed using International Phonetic Alphabet (2007) and then were evaluated using T-unit analysis as a syntactic measure (one participant's sample is presented in Appendix II). The T-unit analysis

includes a few sub-sections like number of T-units, number of words per T-unit, number of words per clauses and number of clauses.

Results

The objective of the study was to compare the narrative discourse sample across Kannada and English languages among twenty normal bilinguals. Total participants were divided into Group I and Group II to achieve counter balancing and their language samples were collected separately. Descriptive statistics were calculated for each parameters of discourse in Kannada and English among Group I, Group II and the total participants. The Table 1 shows the mean and standard deviation of both the groups and both the languages for the parameters: number of clauses, number of T-unit, number of words per clauses and number of words per T-unit separately. The major findings of the present study is, the English language narrative samples of total participants (Group I plus Group II) showed higher mean for the parameter number of T-unit, number of words per clauses and number of words per T-unit. But the Kannada language narrative samples of total participants showed higher mean for the parameter number of clauses when compared to English language narrative samples. In Group I, it is observed that the English language sample data showed greater mean value for the parameter number of clauses, number of T-units, number of words per clauses and number of words per T-unit when compared to Kannada language sample data. In Group II, it is observed that the English language sample data shows greater mean value for the parameter number of words per clauses and number of words per T-unit. And show similar mean value for number of T-unit and lesser mean value for number of clauses when compared to Kannada language sample.

Table 1: *Mean and Standard Deviation of Group I, Group II and Total participants for Kannada and English discourse parameters*

Parameters	Total participants (20 participants)		Group I (10 participants)		Group II (10 participants)	
	Mean	SD	Mean	SD	Mean	SD
Clauses- K	76.55	21.54	63.50	16.37	89.60	18.25
Clauses- E	73.65	21.77	70.20	24.77	77.10	18.98
T-unit- K	9.20	1.39	8.60	1.34	9.80	1.22
T-unit- E	9.70	1.83	9.60	2.11	9.80	1.61
Words/ Clauses -K	5.45	0.77	5.45	0.76	5.45	0.83
Words/ Clauses- E	7.33	0.97	7.52	1.01	7.15	0.94
Words/ T unit- K	42.22	11.85	36.60	8.64	47.85	12.30
Words/ T unit-E	52.30	15.81	46.70	11.89	57.90	17.80

The statistical analysis was carried in various steps; initially mixed ANOVA was administered to study the effect of language (Kannada and English) and group within each parameter of T-unit analysis of discourse. Since there were significant interactions in mixed ANOVA, to

study these interaction in detail MANOVA was administered for the effect of group within each language and each parameter. Following this, paired t test was done to compare language within each group.

Language- Group and their interaction

Mixed ANOVA was administered for comparison of languages with group as independent factor. And to see the significant differences between the Kannada and English language narrative samples irrespective of the group and also to find the differences between the groups and to check the interaction between language and the group. From Table 2, results showed there was a significant difference at 0.001 level between the languages for the parameter, number of words per clauses and number of words per T-unit. And results also show a significant difference at 0.05 level between the two groups for the parameter number of clauses and number of words per T-unit respectively. There is significant interaction shown at 0.05 level between languages and the groups for the number of clauses parameter only.

Table 2: *Results of Mixed ANOVA*

Source	F (1, 18)
No of clauses	
Language	0.54
Group	4.30 *
Language * Group	5.92 *
No of T-units	
Language	3.75
Group	1.07
Language * Group	3.75
No of words per clause	
Language	68.25 **
Group	0.31
Language * Group	0.65
No of words per T-unit	
Language	13.31**
Group	4.73 *
Language * Group	0.00

(* indicates significant difference at 0.05 level and ** indicates significant difference at 0.001 level)

Effect of group within Kannada and English language for each parameter

Since there was significant interaction between languages and the group in one of the parameters, MANOVA was administered for the effect of group within each language and each parameter of discourse to study these interactions in detail. From Table 3, the results showed significant differences at 0.05 level for the parameter number of clauses, number of T-units and number of words per T-unit respectively in

Kannada language narrative samples when compared to English language narrative samples.

Table 3: *Results of MANOVA*

Parameters	F (1, 18)
Clauses- K	11.32 *
Clauses-E	0.48
T unit-K	4.32 *
T unit-E	0.05
Words/Clauses -K	0.00
Words/Clauses- E	0.71
Words/T unit- K	5.59 *
Words/T unit-E	2.73

(* indicates significant difference at 0.05 level)

Difference between languages in Group I

Paired t-test was used to check the differences between languages and to see the significant differences between English and Kannada language samples in Group I (Kannada- English order of sample collection). In Table 4 statistical results showed no significant difference for only number of clauses but a significant difference was found for number of T-unit, number of words per clause and number of words per T-unit at 0.05 level.

Table 4: *Group I results of paired t test*

Pairs	t (9)
clak - clae	1.10
tunitk - tunite	2.53*
nwpck - nwpce	6.68*
nwptk - nwpte	4.07*

(* indicates significant difference at 0.05 level)

Difference between languages in Group II

Paired t-test was used to check the differences between languages and to see the significant differences between English and Kannada language samples in Group II (English- Kannada order of sample collection). In Table 5 statistical results showed no significant difference for number of T-units and number of words per T-unit but showed a significant difference for number of clauses and number of words per clause at 0.05 level of significance.

Table 5: *Group II results of paired t test*

Pairs	t (9)
clak - clae	2.48*
tunitk - tunite	0.00
nwpck - nwpce	5.07*
nwptk - nwpte	2.03

(* indicates significant differenoce at 0.05 level)

Discussion

The basic analysis of narration as discourse comes from research on the development of linguistic skills and its assessment using T-unit analysis in English. To check the developmental changes of any individual's narrative discourse, T-unit analysis can be used as an objective

research method. One such study is by Gutiérrez-Clellen and Hofstetter (1994); they studied syntactical complexity in the Spanish oral narratives of Puerto Rican and Mexican-American children from 5 to 9 years of age. Significant developmental differences were revealed across ages in number of words per T-unit (a main clause with all its subordinate clauses and modifiers), index of subordination (average number of clauses in a T- unit), and average frequency of relative clauses and prepositional phrases. Developmental changes were also observed in the children's ability to use complex syntax to achieve coherence in their narratives. For example, proficiency in the use of relative clauses to clarify referents and in the use of adverbial clauses to recapitulate background information is increased.

The present study reports an average length of 76.5 clauses in the Kannada narration and 73.5 in adult English narration. The results indicate that the adult bilingual narration are correlated with T-unit analysis, as well as richness and sophistication of vocabulary, narrative marking such as the use of the past tense in a sequences of individual events, cohesive devices such as the appropriate use of nouns and pronouns as referencing devices. The study identifies cross-linguistically common, possibly universal or quasi-universal features and linguistically or culturally specific features of good narration. It has been shown that in both Kannada and English, narrating an event are expected to be told in the past tense, and should be extensive and use a large number and variety of words. Similar to the present study, Berman and Slobin (1994) produced descriptions of the skills of proficient narrators in English and Spanish which show that good "frog story" by Mayer (1969) (Appendix I) narration in both languages share some characteristics in varying degrees. Proficient story-tellers, for example, use a specific anchor tense and introduce multiple variations in time from the anchor tense by indicating anteriority, durativity and simultaneity in different ways. Furthermore, proficient frog stories in both languages contain ideas richly connected in temporal, causal and concessive relations and in relations of subordination, allowing the packaging of events in blocks rather than the narration of sequences of individual events. Berman and Slobin (1994) report an average length of 45.0 clauses in the English stories and 50.8 in the Spanish stories of 9year-olds. They show these lengths growing into 75.3 clauses in adult English stories and 91.3 in adult Spanish stories.

On observation of the narrative task of both the groups, the component functional elements of a narrative can be analyzed into two basic ones: referential, those elements that relate events to the listener and orient him/her as to who and what was involved in those events and when and where they occurred; and evaluative elements, those that demonstrate the specific perspective the narrator takes on the events. The other is referential elements provide the basic organizational structure of the narrative, in the form of different types of appendages introducing and ending the stories, complicating action and resolution (composed of the basic sequence of events that makes up the story), and orientation to characters, place and time. Thus, both Kannada and English languages followed the same pattern of narrative elements. This could also be probably because of equal language proficiency in the two languages. It would be interesting however, to study these in bilingual speakers with unequal proficiency in the two languages.

Conclusions

The analysis of the measured variables showed that there was an interaction effect for one variable that is number of clause, between language and the group. The English language narrative samples of total participants showed higher mean for the parameter number of T-unit, number of words per clauses and number of words per T-unit. But the Kannada language narrative samples showed higher mean for the parameter number of clauses when compared to English language narrative samples. This could be because; in Kannada a single word can also be a clause. Apart from this, there is no difference seen between Kannada and English narrative discourse. This could also be due to the fact that all the bilingual speakers had equal proficiency in the two languages of the study. On observation and having analyzed, in a fairly detailed way, the employment of tense (and some other linguistic) forms in these bilingual adult's narrations, we can deal with questions that touch on regarding similar use of verb forms in different languages. On the one hand, a similar choice of tense forms signals that, irrespective of the language used, consecutive clauses are connected in similar ways. The form-function mapping appears to differ in different languages. In other words, we may be able to claim the following: (1) When comparable proficiency and forms are available in the two languages (e.g., the present and past tense), bilinguals deploy a similar organizational strategy in the use of tense forms. Thus all the participants used past tense to narrate the topic 'journey to a place'. (2) When comparable proficiency and forms are not available or less frequently used, bilinguals access different linguistic systems in their minds and organize

their narrations accordingly. Finally, 'journey to a place' topic narration standardizes input to the narrators, providing a kind of stimulus likely to minimize effects of culture and allowing for reliable comparisons of language use across participants and languages. As a clinical implication this narrative discourse demands control of only oral register and not involves any written or academic language register.

Acknowledgement

References

Au, T. K. (1983). Chinese and English counterfactuals: The Sapir-Whorf hypothesis revisited. *Cognition, 15*, 155-187.

Bamberg, M. & Damrad-Frye, R. (1991). On the ability to provide evaluative comments. *Journal of Child Language, 18*, 689-710.

Berlin, B., & Kay, P. (1969). *Basic color terms: Their universality and evolution*. Berkeley: University of California Press.

Berman, R. A. (1993). The development of language use: Expressing perspectives on a scene. In E. Dormi (Ed.), *Language and cognition: A developmental perspective*. Norwood, NJ: Ablex.

Berman, R. A., & Slobin, D. I. (1994). *Relating events in narrative: A crosslinguistic developmental study*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Brown, R., & Lenneberg, E. (1954). A study in language and cognition. *Journal of Abnormal and Social Psychology, 49,* 454-462.

Bloom, A. H. (1981). *The linguistic shaping of thought: A study in the impact of language on thinking in China and the West.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gutiérrez-Clellen, V. & Hofstetter, R. (1994). Syntactic complexity in Spanish narratives: A developmental study. *Journal of Speech and Hearing Research, 37,* 645-654.

Hickman, M. (1990). *The development of discourse cohesion: Coding Manual.* Nijmegen, The Netherlands: Max Planck Institute for Psycholinguistics.

Hickman, M. (1991). The development of discourse cohesion: Functional and crosslinguistic issues. In G. PierautLe Booniet & M. Dolitsky (Eds.), *Language Bases ... Discourse Bases: Aspects of Contemporary French Psycholinguistic Research.* Amsterdam: John Benjamins.Karmiloff-Smith, 1980

Karmiloff-Smith, A. (1981). The grammatical marking of thematic structure in the development of language production. In W. Deutsch (Ed.), *The child's construction of language*. London: Academic Press.

Labov, W. (1972). *Language in the inner city*. Philadelphia, PA: University of Pennsylvania Press.

Meyer, M. (1969). *Frog, Where are You?* New York: Dial Books for Young Readers.

Norbury, C. F. & Bishop, D. V. M. (2003). Narrative skills of children with communication impairments. *International Journal of Language Communication Disorder. 38,* 287-313.

Peterson, C. (1990). The who, when and where of early narratives. *Journal of Child Language, 17,* 433-455.

Prakash, P., & Joshi, R. M. (1995). Orthography and Reading in Kannada: A Dravidian Language. In I. Taylor and D. R. Olson (Eds), *Scripts and Literacy* (pp 95-108). Kluwer Academic Publishers. Netherlands.

Reilly, J. S. (1992). How to tell a good story: The intersection of language and affect in children's narratives. *Journal of Narrative and Life History, 2,* 355-377.

Venkatesan (2009). Readapted from 1997 Version NIMH Socio Economic Status Scale. Secunderabad: National Institute for the Mentally Handicapped.

Whorf, B. L. (1956). *Language, thought, and reality: Selected writings (Ed. J. B. Carroll)*. Cambridge, MA: MIT Press.

Wylie, E. & Ingram, D. E. (2006). *International Second Language Proficiency Rating (ISLPR)*. Nathan, Qld: Centre for Applied Linguistics and Languages. Mt Gravatt Campus Griffith University.

Appendix I

Story Script for Frog, Where Are You? by Mercer Mayer, 1969.

- There once was a boy who had a dog and a pet frog. He kept the frog in a large jar in his bedroom.
- One night while he and his dog were sleeping, the frog climbed out of the jar. He jumped out of an open window.
- When the boy and the dog woke up the next morning, they saw that the jar was empty.
- The boy looked everywhere for the frog. The dog looked for the frog too. When the dog tried to look in the jar, he got his head stuck.
- The boy called out the open window, "Frog, where are you?" The dog leaned out the window with the jar still stuck on his head.
- The jar was so heavy that the dog fell out of the window headfirst!
- The boy picked up the dog to make sure he was ok. The dog wasn't hurt but the jar was smashed.
- The boy and the dog looked outside for the frog. The boy called for the frog.
- He called down a hole in the ground while the dog barked at some bees in a beehive.
- A gopher popped out of the hole and bit the boy on right on his nose. Meanwhile, the dog was still bothering the bees, jumping up on the tree and barking at them.

- The beehive fell down and all of the bees flew out. The bees were angry at the dog for ruining their home.
- The boy wasn't paying any attention to the dog. He had noticed a large hole in a tree. So he climbed up the tree and called down the hole.
- All of a sudden an owl swooped out of the hole and knocked the boy to the ground.
- The dog ran past the boy as fast as he could because the bees were chasing him.
- The owl chased the boy all the way to a large rock.
- The boy climbed up on the rock and called again for his frog. He held onto some branches so he wouldn't fall.
- But the branches weren't really branches! They were deer antlers. The deer picked up the boy on his head.
- The deer started running with the boy still on his head. The dog ran along too. They were getting close to a cliff.
- The deer stopped suddenly and the boy and the dog fell over the edge of the cliff.
- There was a pond below the cliff. They landed with a splash right on top of one another.
- They heard a familiar sound.
- The boy told the dog to be very quiet.
- They crept up and looked behind a big log.
- There they found the boy's pet frog. He had a mother frog with him.
- They had some baby frogs and one of them jumped towards the boy.
- The baby frog liked the boy and wanted to be his new pet. The boy and the dog were happy to have a new pet frog to take home. As they walked away the boy waved and said "goodbye" to his old frog and his family.

Appendix II

Single Participant's Narrative Discourse Sample on a topic 'Journey to a Place'

- At present I am at the institute. I will have to travel to Bangalore tomorrow so I have to take permission for that, since I have to apply for leave. So, once I get the permission I will go home and pack whatever is necessary. Since I will be staying in Bangalore for at least 2 to 3 days, I need to pack cloths and other necessary things. Then I should finish all the work by evening itself. So since, I have to start, early morning tomorrow. So, since I have to travel early morning tomorrow I have to sleep early tonight.
- Once I am planning to get up around 5:30, so, I have to catch a bus at around 6:30 and once I get up, I will quickly get ready. I will take my stuff, since I would have already finished packing. Then I will start at around 6 'o' clock and I will catch an auto to the bus stand.
- Once I reach the bus stand. I will go to the ticket counter. I will buy the ticket and I will wait for my bus.
- I would have taken something to eat before it and some books to read on the way and some music to listen so I won't feel bored during the journey. Hopefully, the journey will be around two and half to three hours.
- And once I get on to the bus. I hopeful to find a comfortable seat and then comfortable seat, in the sense it should be in the front not too back, because if it is in the back the journey will be very terror-some, since the roads are bad, so then I am also hoping to find a seat beside a window.
- So then, I will again buy something on the way then once the journey begins. I am hopeful that journey will be smooth. There won't be any bus breakdown because I want to reach early.
- Then I will, since, I would have taken my books I have stuff to eat. Once I start my journey, I will have to usually look out of window, and since I have already got books to read, music to listen I won't be bored. I will have to listen to music and read books and in between when I feel hungry I will eat something probably, I would have got some chocolates, bread, and jam.
- By that time and they will also give a break in between/stops, since I will be sitting for almost one and half hours, I would go down and take a walk and then come back.
- Once the journey starts again and throughout the way, probably I will speak to the person next to me to just pass the time, then if there is a TV in the bus I would watch movie.
- Then by doing all these the time passes very quickly and I will reach Bangalore by around 9:30 if possible 9.

(T –unit analysis of narrative discourse-
Number of clauses: 74, Number of T Units:
11, Number of words/clauses (avg): 8,
Number of words/T   unit: 49)

APHASIA REHABILITATION IN INDIA: A PRELIMINARY SURVEY OF SPEECH-LANGUAGE PATHOLOGISTS

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Abstract

This study aimed to investigate the issues speech-language pathologists (SLPs) face in the rehabilitation of people with aphasia (PwA) in India. A survey questionnaire was distributed to 540 SLPs through e-mail. Among 437 survey recipients, 61 SLPs participated in the study. The questionnaire explored various 'client-related' and 'clinician-related' issues in the rehabilitation of PwA in addition to the sections that gleaned into the clinician and therapy characteristics, and finally the SLPs' concerns toward aphasia rehabilitation. The major 'client-related' issues highlighted were: poor economic status, distant therapy centres, poor family support and subjects' motivation, associated problems (e.g. hemiplegia), acute stage, lack of awareness about aphasia and its management in the common public. The main 'clinician-related' issues were the lack of adequate time for rehabilitation and the general inefficiency of the therapy techniques. More importantly, the survey stressed on the lack of basic epidemiological research on aphasia in India. Being a preliminary survey of first in its kind, the study revealed several basic issues in the rehabilitation of PwA confronted by SLPs in India.

Keywords: Aphasia; India; Rehabilitation; Survey; Speech Language Pathology

Introduction

Aphasia, an acquired language disorder, has been one of the most common symptoms in the acute and chronic stroke patients (Pederson, Jørgensen, Nakayama, Raaschou, & Skyhoj Olsen, 1995) and one in three stroke survivors experience aphasia (Townend, Brady, & McLaughlin, 2007). With the advances in health care, more people survive strokes but many have to cope with the physical, psychological, social, and functional sequelae, resulting in increased personal and public costs (Kaste, Palomäki, & Sarna, 1995; O'Connell, Hanna, Penney, Pearce, Owen, & Warelow, 2001). Subsequent to the initial medical risk factor work-up, most of them return to their home quickly, despite suffering from various impairments and disabilities, and often without having received any rehabilitation services to compensate them (Mayo et al., 1999; Chuang, Wu, Ma, Chen, & Wu, 2005). Considering the fact that approximately every one in three stroke survivors experience aphasia (Townend et al., 2007), it may be inferred that a considerable proportion of people with aphasia (PwA) do not receive adequate rehabilitative services.

The management of aphasia is often a challenging task to the Speech-Language Pathologists (SLPs). In India, the scenario is expectedly challenging considering the Nation's gigantic and multilingual status. Further, a review of published literature reveals an apparent dearth of information on rehabilitation of PwA in India. In this context, as a preliminary step, the present study attempted to study the issues in aphasia rehabilitation by surveying a group of SLPs in the country.

In the past, rehabilitation of PwA in the country was carried out by clinicians in nursing homes and clinics. However, this was restricted to the larger specialized national medical centres in the cosmopolitan cities (Karanth, 2002). Although the scenario has been changing with the entry of a handful of training institutions in the private sector, a good majority of PwA is still far from the reach of these centres. In the following section, we present the relevant and recent census data of the country as well as some contemporary investigations on the prevalence of stroke (in the absence of such data on aphasia) in India.

1.1. Population characteristics

Being the second most populous country in the world, India homes approximately 1028.7 million people of which 532.2 million are males. Majority of the population (72.2%) lives in rural areas. The overall literacy rate in India is 64.8%. In the urban population, the literacy rate is about 80%, whereas in the rural, it is only about 59% (Census of India, 2001). Further, the global rise in life expectancy is observed in India too, and the current elderly population (~ 76.6 million) is projected to reach about 137 million by 2021 (Johnson, 2008).

1.2. Disability in India

The National Sample Survey Organization's (2002) 58th round report on disability status of India revealed that nearly 18.49 million people are affected with some form of disability. In addition, 77% of them were residing in rural areas. Such a massive number with majority residing in rural areas pose intense challenges to the nation with respect to the financial as well as

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professional resources. In this context, it is worth mentioning that the annual per capita public health expenditure in the country is not more than Rs. 200 (~ 4 USD). With this meagre amount, the reach and quality of the public health services has been below the desirable standards (National Health Policy, 2002).

1.2.1.   Speech disability

The NSSO's 58th round report (2002) on speech disability in India reveals that about 2.15 million persons (11.65% of the total disabled population) in the country were having some form of speech impairment. The prevalence rate of speech disability (per million) in rural areas was about 220 and 193 in urban areas. In the elderly population (i.e. above 60 years), the prevalence rates showed an increase both in the rural and urban populations. The incidence rate of speech impairment increases progressively from 55 years onwards and it hovers around 5-15 in rural areas and 15-20 in urban areas in 55-60 years age group. Age group above 60 years showed incidence rate of around 20 in both rural and urban areas. Specifically, 58th round NSSO survey (2002) revealed that 35-45 percent of speech impaired population acquired it after 60 years of age. Alarmingly, the most common cause of speech impairment was paralysis both in the rural and urban elderly populations. From these, it is apparent that in the elderly population, brain damage (e.g. cerebrovascular accident - CVA) may be one of the major causes of impaired communication.

The prevalence of CVA in various geographical areas of India have shown rates ranging from 143 (Razdan, Kaul, Motta, & Kaul, 1989) to 220 per million (Dalal, 1997). In a random sample survey of major neurological disorders in East India, 486.85 per million people were found to have stroke, second only to epilepsy (557.5 per million) (Das et al., 2007). Although, there have been methodological differences in estimating the prevalence of stroke (Dalal & Bhattacharjee, 2007) (for e.g. extrapolating the prevalence rate from the hemiplegia data), these estimates provide an outlook of the prevalence of stroke in India. Similarly, the incidence rate of stroke has also been studied by various authors. For example, recently, Dalal et al. (2008) reported 456 people with first-ever stroke during their two-year period study. Their findings showed an annual stroke incidence of 145/100,000 (above 25 years of age).

CVA has been the most common cause of aphasia (Pederson et al., 1995; Townend et al., 2007). The incidence of aphasia in the acute phase of stroke in unselected community and hospital samples has been in the range of 34-38%

(Kauhanen et al., 2000). Duffy (1995) reported that approximately 27% of the population with neurogenic communication disorders possess aphasia. In India, a prospective study (Panicker, Thomas, Pavithran, Nair, & Sarma, 2003) found that 25% of people with ischemic stroke exhibited aphasia. Further, the presence of aphasia is one of the strongest predictors of poor functional recovery after stroke (Fang, Chen, Li, Huang, & Zeng, 2003) and it is often associated with patients' increased functional dependency and a high frequency of admission to the institutional care (Tennant, Geddes, Fear, Hillman, & Chamberlain, 1997). Although this is the case, there has not been any community-based, large-scale published prevalence data on aphasia in India. Yet, from the disability statistics as well as the available prevalence data on stroke, especially in the elderly population, it may be inferred that the prevalence of aphasia in India could remarkably be high.

1.3. Speech-Language Pathology services in India

Despite more than 40 years since its inception, the profession of Speech-Language Pathology in India still experiences lack of sufficient personnel to meet the needs of the communicatively handicapped population, at large. The number of speech-language pathologists (SLPs) in India is just above one thousand (www.isha.org.in). In this context, it is worth quoting "*It is regrettable that a discipline which is as heavily manpower-dependent as SLP has not expanded vigorously in a country whose major resource is its human resource*" (Karanth, 2002). The author also expressed that the clinical service delivery in the field of Speech-Language Pathology is still centred on a few educational institutions owing to their public awareness and the rich professional resources in terms of trainee student population. In the recent past, there has been a spurt of private institutions in the field of professional education, which in turn, has elevated the cost of clinical services. Yet, such institutions serve as the backbones of clinical service delivery in the field of communication disorders. But, a good majority of the population is far from such centres, hampering its access to the needy. Several training institutions have been seen clustered in specific geographical areas, further limiting their service delivery to a small portion of the disabled population. In addition, owing to the poor financial reimbursement schemes in the country (unlike in United States, Britain, etc.), the clients often pay for their medical services. In spite of the attempts of the Government of India to establish such health reimbursement schemes, currently, millions of people with disability are unable to afford the

expenses incurred from medical as well as the rehabilitative services in India. PwA are no exception to this in the country.

From the above discussion, it is apparent that aphasia has been an unexplored condition in the country. In this context, as a preliminary attempt, we decided to study the features of aphasia rehabilitation in India by surveying a group of SLPs. The main aims of the study were to fetch: (i) the professional demographics of SLPs involved in the rehabilitation of PwA; ii) the features of aphasia therapy services; iii) the issues in aphasia rehabilitation; and iv) SLPs' concerns toward rehabilitation of PwA. The outcome of this study is expected to attract SLPs' research attention to the issues in aphasia rehabilitation in India.

Methods

2.1 Participants

A group of 540 qualified SLPs' e-mail addresses were collected from Indian Speech and Hearing Association's directory. We chose to contact SLPs through e-mail as this method would reach a larger sample with minimal cost than a surface mail survey (Simmons-Mackie, Threats, & Kagan, 2005). However this method is not without limitations as it potentially surveys only those SLPs who access their electronic mail.

2.2 Survey

An initial draft of the questionnaire was prepared, which covered four domains addressing the aims (see above) of the study. Care was taken to ensure that the questionnaire contained unambiguous questions which were easy to complete in minimal time (Simmons-Mackie et al., 2005). The initial draft was refined by several piloting with the consultation of three selected professionals with more than 10 years experience in the field of aphasia rehabilitation (they were excluded from the final survey). The final version of the questionnaire consisted of 14 questions that included seven multiple choice format and remaining open-ended follow up questions. The questionnaire was preceded by a brief introduction stating its aim and a request to participate in the study (see Appendix for the introduction and the questions of the survey). The anonymity of participation was guaranteed and the survey ended with a note thanking the respondents for their inputs. Finally, with an online survey generating program (www.kwiksurveys.com) a webpage-link was generated and it was enclosed in the e-mail correspondence to the survey population. After seven days, a reminder with the link to the

survey page was sent to the study population to participate in the survey, if they had not. The responses were collected for a period of one month.

2.3 Data analysis

Responses from the survey were analyzed using descriptive statistics to find out the frequency of responses to the multiple-choice questions. The open-ended questions were analyzed descriptively by listing out the answers to each of such questions. All answers were rank-ordered according to their frequency of responses.

Results

3.1 Respondents' Demographics (Questions 1-4)

Among 540 potential participants, 103 were unreachable via e-mail as they returned 'undeliverable'. Therefore, the study involved 437 survey recipients. Of these, 61 (13.96%) participated in the survey and 53 (86.88%) respondents reported that they were actively involved in the rehabilitation of PwA. Majority of them had less than five years of experience. Figure 1a represents the distribution of SLPs based on their experience. Forty five respondents had Masters Degree and nine had PhD degree in the field of communication disorders. Remaining respondents (n = 7; 11%) had Bachelors Degree. Most of them worked in the institutional and hospital set ups (see Figure 1b for the details of work environment). The participants were encouraged to indicate if they worked in more than one setting.
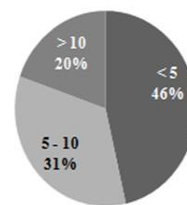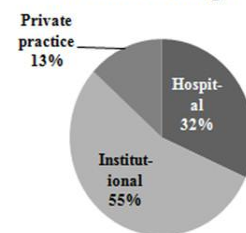
Figure1: *Distribution of SLPs based on a) experience (in years) and b) work settings*

3.2 Features of aphasia therapy services (Questions 5-6)

The participants were queried about the number of PwA attending therapy as well as the frequency of aphasia therapy sessions on a weekly basis. Fifty nine of 61 respondents (96.72%) answered these questions. Figures 2a and 2b depict the responses to them, respectively.

Figure 2: *a) Patient-flow and 2b) number of therapy sessions on a weekly basis*

3.3 Issues in aphasia rehabilitation (Questions 7-10)

Under this section, the participants were asked if they experienced any problems in the rehabilitation of PwA. All but two responded to this question and Figure 3 shows the distribution of responses.
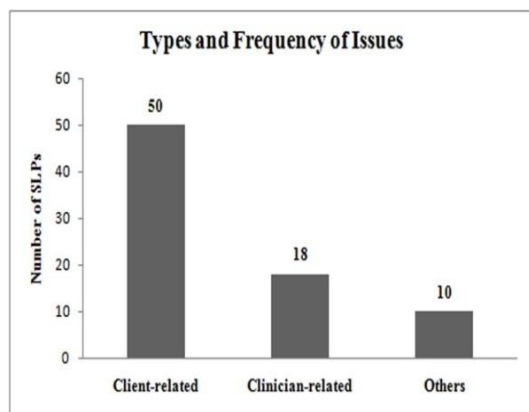
Figure 3: *Distribution of the Types and Frequency of issues in aphasia rehabilitation*

To explore the 'client-related' factors influencing aphasia rehabilitation, the participants were required to select the options provided in a multiple choice with open-ended follow up format. The options and the frequency of responses (in parenthesis) were as follows: a) acute stage (i.e., client unable to comply with speech-language therapy) – 26 (52 %); b) associated conditions (e.g. hemiplegia) – 25 (50 %); c) financial issues (i.e., client unable to attend therapy owing to poor economic status) – 32 (64 %); d) proximity of the clinics (i.e., client lives in a distant place therefore unable to avail clinical services) – 30 (60 %); e) poor family support (i.e., client and his/her problems are ignored by the family members) – 25 (50 %); f) poor motivation of the client – 23 (46 %); g) others – 4 (8 %). All four responses in the 'others' emphasized on cortical as well as subcortical lesion sites and the type of aphasia.
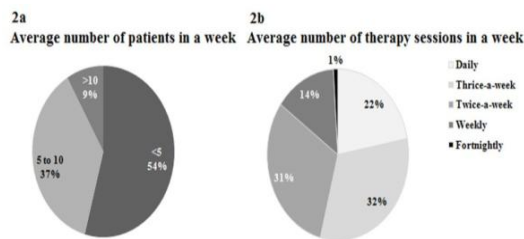
The 'clinician-related' factors were explored using a multiple choice open-ended follow up question. The options and the frequency of responses (in parenthesis) to this question were

as follows: a) lack of adequate time for rehabilitation – 18 (100 %); b) lack of time-tested treatment methods that guarantee favourable outcome following therapy – 14 (77.78 %); c) professionally do not prefer to manage persons with aphasia – 3 (16.67 %); d) others – 3 (16.67 %). The responses in the 'other' category included: i) lack of adequate hands-on practice on PwA while at a supervisory position, and ii) lack of adequate time for training due to the subjects' discharge from the hospital immediately after the medical status has been stabilized.

In the open-ended follow up section ('other issues in therapy'), three (of 10) respondents reported lack of materials for the assessment and management of PwA. The remaining responses by the individual participants stressed on following factors such as lack of: a) adequate funding; b) disability-friendly infrastructure; c) adequate home practice; d) adequate facilities in the clinics; e) adequate information provided by the medical professionals on post-stroke rehabilitation; and f) patients' knowledge on early rehabilitation.

3.4 SLPs' Concerns toward rehabilitation of PwA (Questions 11-14)

To explore the SLPs' concerns toward rehabilitation of PwA, four questions were included in the questionnaire (Questions 9 to 13). For example, 47 (77%) respondents felt that PwA were often discharged from the hospital immediately after the acute medical management, without considering their post morbid life as members of the society. Further, to seek the SLPs' opinion on setting up rehabilitation centres for PwA by the concerned authorities, 51 (83.61%) SLPs responded positively. Majority of them (43 of 51 SLPs, 84%) opined that hospitals whereas 32 (63%) felt that the Government shall set up such centres. Twenty nine (57%) indicated that non-governmental organizations could set up such rehabilitation centres for PwA and three respondents (6%) reported other centres like primary health centres and district rehabilitation centres . One respondent opined that it could be any. The respondents were encouraged to select multiple options, if deemed relevant.

Finally, the respondents of the survey were encouraged to comment on any other issues that they considered important in the rehabilitation of PwA. Sixteen of the total participants (26%) responded to this open-ended question. Table 1 provides the comments of the participants with their frequency and percentage.

Table 1: *The frequency and percentage of comments on aphasia rehabilitation (n = 16)*

	Comments	Frequency	%
1	Lack of epidemiological survey	12	75
2	Poor application of AAC system in the rehabilitation of people with aphasia	8	50
3	Issues regarding multilingualism and illiteracy	7	43.75
4	Clinicians' proficiency in the clients' mother tongue	5	31.25
5	Setting up of rehabilitation centres for persons with aphasia	5	31.25
6	Introduction of support groups for persons with aphasia	4	25
7	Social and vocational impacts of aphasia	2	12.5

Discussion

The present study investigated the issues in the rehabilitation of PwA in India. A group of 61 qualified SLPs from a total of 437 survey recipients responded to an online survey distributed through e-mail. The questions in the survey belonged to four different dimensions such as: a) demographics of the respondents; b) features of the aphasia therapy; c) issues in the rehabilitation of PwA; and finally d) SLPs' concerns toward aphasia rehabilitation. In the following section, we discuss the findings from each of these dimensions and their possible implications to future aphasia research in India.

4.1 Respondents' demographics

The results of the survey may be considered as a factual reflection of the features of aphasia rehabilitation in India as most of the respondents were actively involved in the rehabilitation of PwA. Interestingly, SLPs with less than five years of experience dominated the participant group followed by those with 5-10 years. There were only 10 respondents with more than 10 years of experience. Majority of them had obtained Masters Degree in the field of communication disorders. Although the field of speech-language pathology set out its journey more than four decades ago in the country, the last decade has witnessed an increasing number of youngsters seeking this profession, perhaps explaining the apparent majority of younger clinicians in the survey. Yet, the recent census data on speech-impaired population in the country stress on the need for an exponentially large number of SLPs as currently there is only one SLP for a million people in India. The study revealed that majority of the respondents worked

in institutional set up which was closely followed by the hospital set up. The number of respondents from the private practice as well as other sectors was comparatively meagre indicating that a fewer SLPs involved in this form of service delivery.

4.2 Features of aphasia therapy services

More than half of the respondents provided therapy to less than five PwA on a weekly basis. Yet, a considerable number of SLPs reported that weekly about 5-10 subjects availed speech-language therapy. While analyzing the data, we realized that these inputs might have been more meaningful in the context of the total number of cases attended speech-language services. The current survey did not probe into this, which we consider as a limitation of the study. Future surveys may, therefore, consider the ratio of specific clientele to the total case load. Yet, the fact that more than half of the respondents provided therapy to less than five subjects on a weekly basis indicated that the therapy was availed by only a smaller portion of the clientele. The reason for this finding may be the lack of speech-language therapy services in the vicinity of most of the affected people (see below). The observation that a considerable number of SLPs provided therapy to 5-10 subjects on a weekly basis shows that, when available, more PwA sought SLP services. The number of therapy sessions in a given week also showed a similar trend. Most SLPs provided services on a thrice-a-week followed by twice-a-week basis. The frequency of sessions attended by PwA on average was high, highlighting the increased demand for aphasia therapy in India. Again, we felt that information on location of the work setting and average distance travelled by PwA to receive rehabilitation services could have been more informative.

4.3 Issues in aphasia rehabilitation

The inputs from this section revealed certain general issues in the field of aphasia rehabilitation. Majority of the respondents reportedly experienced several 'client-related' as well as 'clinician-related' issues in the rehabilitation of PwA. Within this majority, most reported a number of 'client-related' issues (see Results). Among them, certain issues like distant rehabilitation services (Gummow, Gregory, & Macnamara, 1990) and poor transportation (MacFarlane, Collings, Graham, & MacIntosh, 1979; Karanth, 1988) have been identified to influence the cognitive rehabilitation in people with brain damage and aphasia. The inputs from this section of the current survey shed light into certain implementable strategies that could facilitate rehabilitation of PwA in India. For

example, poor family support and motivation of affected persons may be tackled by educating them on the necessity as well as benefits of post-stroke rehabilitation. Further, setting up comprehensive rehabilitation centres by the concerned authorities such as hospitals, government, and/or NGOs, where services from different rehabilitation disciplines are combined, may alleviate the distance as well as transportation issues to a large extent. In addition, this form of a comprehensive service delivery fosters the co-ordinated work of professionals from different disciplines, augmenting the overall rehabilitative outcome in people with aphasia or stroke. The existing regional health care system (including primary health centres and district hospitals) may be equipped with rehabilitation professional to meet this goal. The issues related to financial factors influencing the rehabilitation services may be addressed by introducing new public health care schemes as well as boosting the existing ones.

The major 'clinician-related' issues were (a) lack of adequate time for rehabilitation and (b) lack of time-tested treatment methods that guarantee favourable outcome following therapy. The first issue on availability of time is not surprising as a good number of the participants worked in the 'institutional' as well as in the 'hospital' set ups. Here, 'institutional' referred to the teaching institutions where the participants were often involved in several domains of work such as teaching, clinical supervision, as well as administration. This undoubtedly limits the effective time spent with the clinical population by these professionals. In this context, it is worth noting one of the respondents' inputs that the SLPs involved in the supervision of PwA do require periodic hands-on practice to keep them abreast with the rehabilitation of aphasia. Contrastively, for those who are practicing in the hospital set ups, the myriad of people with speech-language deficits often limit the amount of time devoted to individual subjects. Recently, Simmons-Mackie et al. (2005) reported that the constraints induced by the student turnover and the academic calendars have adversely affected the outcome assessment in people with aphasia. Though high-intensity speech therapy improves the outcome in PwA (Bhogal, Teasell, & Speechley, 2003), it invariably requires large number of qualified SLPs (Engelter et al., 2006). The second issue – the lack of availability of effective treatment methods – is a global issue in aphasia rehabilitation. The research on this dimension has been progressing with some favourable outcomes (e.gs. constraint-induced aphasia therapy, (Pulvermüller, 2001); semantic feature-based therapy (Boyle & Coelho, 1995).

4.4 SLPs' Concerns toward rehabilitation of PwA

In our view, the most fundamental issue pointed out by the survey respondents was the sheer lack of any published research on the epidemiology of aphasia in India. Epidemiological research aims to establish the causes, mechanisms, and natural history of illness (Wade, 1997). Any discipline dealing with any disorder has, at its foundation, the epidemiological findings reflecting the incidence and prevalence of the disorder. Abysmally, there have not been such studies in the country so far. This observation, therefore, highlights the immediate need for epidemiological research in aphasiology in the country. Further, the respondents of the survey reported that very often subjects with aphasia are discharged from the hospital without adequate counselling on post-stroke rehabilitation services including speech-language therapy. In this context, it is worth noting the input from one respondent SLP that in a city where the country's one of the oldest institutions in the field of communication disorders is located, a person with aphasia reported for speech-language therapy after three years since the onset, owing to the unawareness of such facility in the city. This essentially indicated a generalized lack of awareness about aphasia and its rehabilitation among the public and medical professionals. Improving public awareness and knowledge about aphasia and its therapy may foster motivation in the clients and their family members. Yet, this is not a nation-specific issue. For example, in a recent study, the public awareness about aphasia was observed to be significantly less compared to Parkinson's disease (PD) in the United Kingdome (Flynn, Cumberland, & Marshall, 2008). These authors suggested several reasons for low public awareness about aphasia. First, aphasia is a hidden and complex condition with varying manifestation that makes it difficult to recognize and understand. Second, the media exposure, a crucial means of public awareness, was rare in the case of aphasia compared to PD. Finally, the personal connection, a major form of awareness in PD, was also ineffective in the case of aphasia (Flynn et al., 2008). Similar finding was also reported by Mavis (2007) in Turkish population. Recently, Pauranik (2008) emphasized on the utilization of print and electronic (television and radio) media as easy ways to reach masses of people to create public awareness on neurological disorders. Awareness among the medical practitioners may be created by organizing seminars and symposia on aphasia.

The survey also emphasized on the generalized lack of application of alternate and augmentative

communication (AAC) systems in PwA as well as the multilingual nature of the population to be served. Another interesting and clinically noteworthy observation was the SLPs' proficiency in the languages of rehabilitation. This is especially important in training institutions where the trainee students from different linguistic backgrounds across the country are expected to provide therapy in their non-native languages. Considering the multilingual nature and relatively higher proportion of the illiterates in the country, such clinicians often experience intense difficulties in delivering quality services to their clientele.

Summary and future directions

Although the current study was preliminary in nature, it revealed several potential issues in the rehabilitation of people with aphasia in India. Future in-depth studies on these issues incorporating SLPs as well as PwA and their close relatives may provide us more insight into these issues. The outcomes of such studies may serve as the backbones of the policy-making by the concerned authorities towards the rehabilitation of people with aphasia in India.

References

Bhogal, S. K., Teasell, R., & Speechley, M. (2003). Intensity of aphasia therapy, impact on recovery. *Stroke, 34*, 987-993.

Boyle, M., Coelho, C. A. (1995). Application of semantic feature analysis as a treatment for aphasic dysnomia. *American Journal of Speech Language Pathology, 4*, 94-98.

Census of India (2001). Office of the Registrar General and Census Commissioner, India. Available from: URL:http://www.censusindia. gov.in/.

Chuang, K. Y., Wu, S. C., Ma, A. H., Chen, Y. H., & Wu, C. L. (2005). Identifying factors associated with hospital readmissions among stroke patients in Taipei. *Journal of Nursing Research, 13,* 117-128.

Dalal, P. M. (1997). Strokes in young and elderly: risk factors and strategies for stroke prevention. *Journal of Association of Physicians of India*, *45* (2), 125-131.

Dalal, P. M., Bhattacharjee, M. (2007). Stroke Epidemic in India: Hypertension-Stroke Control Programme is urgently needed. *Journal of Association of Physicians of India, 55*, 689-691.

Dalal, P. M., Malik, S., Bhattacharjee, M., Trivedi, N. D., Vairale, J., Bhat, P., et al. (2008). Population-Based Stroke Survey in Mumbai, India: Incidence and 28-Day Case Fatality. *Neuroepidemiology, 31*, 254-261.

Das, S. K., Banerjee, T. K., Biswas, A., Roy, T., Raut, D. K., Mukherjee, C. S., et al. (2007). A Prospective Community-Based Study of Stroke in Kolkata, India. *Stroke, 38,* 906-910.

Duffy, J. R. (1995). Motor speech disorders: Substrates, differential diagnosis, and management. St. Louis, MO: Mosby.

Engelter, S. T., Gostynski, M., Papa, S., Frei, M., Born C, Ajdacic-Gross, V, et al. (2006). Epidemiology of Aphasia Attributable to First Ischemic Stroke: Incidence, Severity, Fluency, and Thrombolysis. *Stroke, 37*, 1379-1384.

Fang, Y., Chen, X., Li, H., Huang, R., & Zeng, J. (2003). A study on additional early physiotherapy after stroke and factors affecting functional recovery. *Clinical Rehabilitation, 17*, 608-611.

Flynn, L., Cumberland, A., & Marshall, J. (2008). Public knowledge about aphasia: A survey with comparative data. *Aphasiology, 23* (3), 837-848.

Gummow, L. J., Gregory, V. R., & Macnamara, S. E. (1990). Factors influencing utilization of post discharge cognitive rehabilitation programs. Health Service Research, 25 (1), 197-211.

Indian Speech Hear Assoc. Available from: URL:http://ishaindia/.org.in/directory.html

Johnson, C. S. (2008). Ageing and Healthy Life Expectancy: Will the Extended Years be Spent in Good or Poor Health? *Journal of Indian Academy of Geriatrics, 4*, 64-67.

Karanth, P. (1988). Rehabilitation of Aphasics in India. In: Sarno MT, Woods DE, editors. Aphasia Rehabilitation in Asia and the Pacific Region. New York: World Rehabilitation Fund; p. 51-57.

Karanth, P. (2002). Four Decades of Speech-Language Pathology in India: Changing Perspectives and Challenges of the Future. *Folia Phoniatrica Logopedics, 54,* 69-71.

Kaste, M., Palomäki, H., & Sarna, S. (1995). Where and how should elderly stroke patients be treated? A randomized trial. *Stroke, 26*, 249-253.

Kauhanen ML, Korpelainen JT, Hiltunen P, Määttä R, Mononen H, Brusin E, et al. (2000). Aphasia, depression, and non-verbal cognitive impairment in ischemic stroke. *Cerebrovascular Disorders, 10* (6), 455-461.

MacFarlane, J. P. R., Collings, T., Graham, K., & MacIntosh, J. C. (1979). Day hospitals in modern clinical practice-cost benefit. *Age and Ageing, 8* (Suppl 8), 80-85.

Mavis I. (2007). Perspectives on Public Awareness of Stroke and Aphasia among Turkish Patients in a Neurology Unit. *Clinical Linguistics and Phonetics, 21* (1), 55-70.

Mayo, N. E., Wood-Dauphinee, S., Ahmed, S., Gordon, C., Higgins, J., Mcewen, S., et al. (1999). Disablement following stroke. *Disability Rehabilitation, 21*, 258-268.

National Health policy – 2002. Available from: URL: http://www.mohfw.nic.in/np2002.htm

National Sample Survey Organization. Disabled Persons in India (58th Round) (July 2002 – December 2002. Available from: URL:http://mospi.nic.in

O'Connell, B., Hanna, B., Penney, W., Pearce, J., Owen, M., & Warelow, P. (2001). Recovery after

stroke: A qualitative perspective. *J Qual Clin Pract, 21*, 120-125.

Panicker, J. N., Thomas, M., Pavithran, K, Nair, D., Sarma, P. S. (2003). Morbidity predictors in ischemic stroke. *Neurology India, 51* (1), 49-51.

Pederson, P. M., Jørgensen, H. S., Nakayama, H, Raaschou, H. O., & Skyhoj Olsen, T. (1995). Aphasia in acute stroke: Incidence, determinants and recovery. *Annals of Neurology*, *38,* 659-666.

Pulvermüller F. (2001). Brain reflections of words and their meaning. *Trends in Cognitive Science, 5* (12), 517-524.

Puranik, A. (2008). Advocacy in neurology. *Annals of Indian Academy of Neurology, 11*, 60-65.

Razdan, S., Kaul, R. L., Motta, A., Kaul, S. (1989). Cerebrovascular disease in rural Kashmir, India. *Stroke, 20,* 1691-1693.

Simmons-Mackie, N., Threats, T. T., & Kagan, A. (2005). Outcome assessment in aphasia: a survey. *Journal of Communication Disorders, 38*, 1-27.

Tennant, A., Geddes, J. M. L., Fear, J., Hillman, M., & Chamberlain, M. A. (1997). Outcome following stroke. *Disability Rehabilitation, 19*, 278-284.

Townend, E., Brady, M., & McLaughlin, K. (2007). A systematic evaluation of depression diagnostic methods for stroke survivors who have aphasia. *Stroke*, *38* (11), 3076-3083.

Wade, D. T. (1997). Epidemiology of disabling neurological disease: how and why does disability occur? *Journal of Neurology Neurosurgery Psychiatry, 63* (Suppl 1), 11-18.

Appendix

This survey is designed to explore the issues that the Speech-Language Pathologists in India face in the rehabilitation of subjects with aphasia. We welcome your wholehearted cooperation and we guarantee your anonymity of participation. You are encouraged to key-in all the issues that you come across while managing subjects with aphasia.

a. Respondents' demographics

1. Are you involved in the rehabilitation of subjects with aphasia?
   - Yes
   - No
2. How many years of experience do you have in working with subjects with aphasia?
   - Less than 5
   - 5 to 10
   - More than 10
3. In what type of setting(s) do you work? (Check all that apply)
   - Hospital
   - Institutional (and University)
   - Private practice
   - Others, please enter below
4. Did you obtain
   - Bachelors degree
   - Masters degree
   - Doctorate
   - Others, please enter below

b. Features of aphasia therapy services

5. Monthly, how many subjects with aphasia report for speech-language therapy
   - Less than 5
   - 5 to 10
   - More than 10
6. How frequently subjects with aphasia attend therapy?
   - Daily
   - Thrice-a-week
   - Twice-a-week
   - Weekly
   - Fortnightly

c. Issues in aphasia rehabilitation

7. Do you experience any problems in the rehabilitation of subjects with aphasia?
   - Yes
   - No
8. If you answered "Yes" to the previous question, what are the problems you face in the rehabilitation of subjects with aphasia? (You may select more than one option, if relevant).
   - Client-related
   - Clinician-related
   - Others, please enter below
9. If you selected "client-related" problems in the previous question, please tell more specifically about it. (You may select more than one option, if relevant).
   - Acute stage (client unable to comply with speech-language therapy)
   - Associated problems (e.g. hemiplegia)
   - Financial problems (client unable to attend therapy owing to poor economic status)
   - Proximity of clinics (client lives in a distant place, therefore unable to avail clinical services)
   - Poor family support (client and his/her problems are ignored by the family members)
   - Poor motivation of the client
   - Others, please enter below
10. If you selected "clinician-related" problems in Question No. 8, please tell us more specifically about it (You may select more than one option, if relevant).
    - Lack of adequate time for extensive training
    - Professionally do not prefer to see subjects with aphasia
    - Lack of time-tested treatment techniques that guarantee favourable outcomes following therapy
    - Others, please enter below

d. SLPs' Concerns toward rehabilitation of PwA

11. Do you think subjects with aphasia are often discharged from the hospital immediately after the acute medical management, without considering their post-morbid life as the individuals of the society?

- Yes
- No

12. Do you think the concerned authorities shall set up rehabilitation centres for subjects with aphasia?
    - Yes
    - No

13. If you answered "Yes" to Question No. 12, who do you think the concerned authorities are? (You may select more than one option, if relevant).
    - Government
    - Non-Governmental Organizations (NGOs)
    - Hospitals
    - Others, please enter below

14. Any other comments on the issues in the rehabilitation of subjects with aphasia?
    - No
    - Yes, and they are (enter below)
      Thank you very much for your participation!

Acknowledgment

COMPARISION OF TIME, SPACE AND WHOLE WORD PATTERNS IN PHONOLOGICAL PROCESSES OF 2 TO 7 YEAR OLD TYPICALLY DEVELOPING KANNADA SPEAKING CHILDREN

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Abstract

Phonological processes can be grouped to with respect to timing, articulatory space and whole word patterns (Velleman, 2003.) No study has been conducted addressing the hierarchy of appearance or disappearance of these patterns in typically developing children in Indian languages. The aim of the study is to analyze and compare the time, space and whole word patterns in conversational speech of 2 to 7 years old Kannada speaking typically developing children. The present study included 50 typically developing children in the age range of 2 to 7 year, sub-grouped into 10 groups with 5 children in each group divided in 6 months range. Conversational speech sample was collected from each of the participant. 100 intelligible utterances were selected and transcribed using IPA by the first investigator. Mean percentage of occurrence of timing, space and whole word patterns were calculated. Statistically significant differences and a decreasing trend in the occurrence of total patterns with age were observed. Timing features stabilized first by 4 years of age followed by space and whole word patterns (which prevailed even after 7 years of age), which is in line with other reported studies which are based on kinematic analysis.

Key Words: *Phonological processes, timing pattern, articulatory space pattern, whole word pattern.*

All children embark on the development of their phonological systems from the same beginnings (Stampe, 1979). Children possess a full understanding of the underlying representation of the adult phoneme system. They however have difficulties with the peripheral motor realization of the phonetic surface form which are perceived as articulation errors.

When children's speech is analyzed, clear systematic patterns are found in their erroneous approximations to adult target words (Yavas, 1998). These error patterns are uniform across children and languages. One of the most common ways of describing these error patterns that has been used since a very long time is with reference to phonological processes. Phonological processes are regularly occurring deviations from the adult speech patterns; may occur across a class of sound, a syllable shape or syllable sequence (Hodson & Paden, 1983). All the phonological processes operate to simplify adult targets. The phonological processes have been categorized into 3 groups for ease of analysis. These include; syllable structure, substitution and assimilation processes. This classification system acts as a comprehensive device for identification of the relationship between the adult target and the child's erroneous productions. Studies addressing on the normal use and suppression of phonological processes indicates that most children regardless of the language being learnt use a set of common processes early in the development of sound system. Process such as denasalization is suppressed by 2 years of age whereas epenthesis

and cluster reduction prevail even after 7 years of age (Smit, 1993; Lowe, 1996).

One more way of grouping the phonological processes is according to the fundamental patterns that underlies each one: timing, articulatory space and whole word patterns (Velleman, 2003). This method has been recommended for the description of phonological errors in persons with childhood apraxia of speech. Velleman (2003) classified the articulatory errors into space, timing and whole word errors in order to comment on the contribution of these patterns to praxis control.

This way of classifying processes is especially useful for apraxia because

- They have difficulty with sequencing; thus timing is an important issue for them

- Awareness of where the articulators are in space, self-monitoring of movement, so that they will often exhibit place processes

- They have more persistent whole-word (phonotactic, harmony) processes than other children

The specific features analyzed under timing, space and whole Word patterns according to Velleman (2003) are shown in Table1. This method of grouping the phonological processes has been incorporated in several studies for the purpose of studying phonological development, especially in children with apraxia of speech (Rupella, 2008; Bhanumathy, 2008). Significant variations are reported in a child's speech when compared to that of adults (Chermark &

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Schneiderman, 1986; Kent & Forner, 1980; Sharkey & Folkins, 1985; Smith & Goffman 1998). Variability in performance is a hallmark of early learning process for any complex motor skill (Schmidt & Lee, 1999). Greater variability in the developing motor system is an adaptive and essential feature of a system acquiring new patterns of behavior (Thelen & Smith, 1994). The transition from prelinguistic vocalizations to adult speech represents the mastery of multiple sub-systems. The remarkable behavioral accomplishment emerges in the context of rapid changes in musculoskeletal growth and neuromotor development (Kent, 1976, 1984; Kent & Vorperian, 1995; Smith, Goffman & Stark, 1995). Motor processes of speech are shaped by multiple intrinsic factors such as cognitive/linguistic and sensorimotor maturation and extrinsic factors such as auditory, visualstimulation and perceptual saliency (Green, Moore, Higushikawa & Steeve, 2000).

Amongst others, one of the variations seen in the early speech development is that of phonological processes in the speech of young children. As and when children achieve greater control over the speech sub-systems, some processes disappear and some continue to prevail. For example, denasalization as a process is said to disappear by 2 years of age whereas cluster reduction and epenthesis prevails even after 7 years (Smit, 1993; Lowe, 1996). Addressing the issue of phonological processes in typically developing children helps in the identification of a trend if any regarding the appearance and persistence of various processes, and thus facilitates comparison of children with disordered phonology.

Table 1: *Features under timing, space and whole word patterns (Velleman, 2003)*

Timing patterns	Space/ accuracy patterns	Whole-word patterns
• Voicing errors • Affrication • Deaffrication • Nasalization • Denasalization	• Fronting • Backing • Vowel deviations • (Including vowel prolongation, vowel centralization and monophthongization)	•Cluster reduction •Reduplication •Consonant harmony •Migration •Metathesis •Epenthesis •Consonant deletion •Syllable deletion

There is no study that addresses the hierarchy in which the timing, space and whole- word patterns appear or disappear in typically developing children in any of the Indian languages. It has been suggested that perhaps children achieve control of temporal parameters of speech first before the movement amplitudes are adult like, because the subtle changes in timing can significantly affect the perception of acoustic signals (Levelt, 1989; Walsh & Diehl, 1991). On the contrary, Smith & McLean- Muse (1986) argued that physical growth as well as higher order processes involving the formulation and planning of speech movement sequences, delays the acquisition of temporal control like that of adults in speech. In line with this observation, Walsh & Smith (2002) also suggested that children achieve temporal before spatial goals in speech. The spatial and temporal variability of the articulatory movements thus has an important bearing in understanding the speech motor control in the developing speech system. The observation as to which of the two dimensions, viz., temporal or spatial of articulatory system is acquired first has been addressed using kinematic data by majority of the studies (Smith & McLean- Muse, 1986; Smith & Walsh, 2002). No study has attempted to analyze the feature of time or space errors within the developing articulatory (phonological) process in children using a behavioral paradigm. This study explores and attempts to analyze the patterns of time, space and whole word errors in the speech of Kannada speaking typically developing children aged 2-7 years, based on the classification of phonological processes elaborated by Velleman (2003). Kannada is a major Indian language spoken by people in Karnataka which is one of the southern states of India. Such an attempt helps determine which of the three types of phonological features that is, timing, space and whole word patterns are acquired and / or diminish in the age range of 2 to 7 years in Kannada speaking children. The outcome of the study will help to:

- Understand the trend seen in the developing nature of timing, space and whole word patterns in the phonological processes of typically developing Kannada speaking children.

- Verify the possibilities of using a simple clinical behavioral analysis tool such as the phonological process analysis in understanding the trend in time and space motor control in the articulatory system of speech, as a substitute method instead of the most sophisticated instrumentation procedures such as kinematic analysis.

- Adopt a similar method in comparing the trend in acquisition of time-space dimensions in the phonological patterns of other Indian languages.

- Compare and verify if the trend is same in the speech of children with phonological impairment.

Hence, the specific objectives of the study were to analyze and compare the phonological processes in conversational speech of 2 to 7 years Kannada speaking typically developing children (in 6 months interval) in terms of:

a) timing patterns
b) space patterns
c) whole word patterns

Also to identify the similarities and / or differences in these patterns if any, in the selected age groups across the patterns.

Method

Subjects: 50 typically developing Kannada speaking children in the age range of 2 to 7 years were included in the study. They were divided into 10 groups with 5 children in each group divided in 6 months interval as shown in Table 2. The children were screened for age appropriate speech and language skills based on history, clinical observation and assessment tools (Kannada Language Test- RRTC, Madras & AYJNIHH, Bombay, 1990- UNICEF funded project)

All the subjects were also screened for the following:

- Sensory impairment (hearing and visual impairment) based on clinical observation

- Deviant oral structures (oral mechanism examination).

- Oro-motor deficit (test for diadochokinetic rate)

- Cognitive- linguistic deficits (clinical psychological evaluation)

- Other developmental disabilities (based on clinical observation)

- Severe behavioral problems (based on clinical observation)

All subjects belonged to middle socio-economic status and their parents had minimum educational qualification up to 12th grade. All participants were native speakers of Kannada. They were exposed to Kannada language at home and Kannada as well as English in the school.

Procedure: An informed consent was obtained in writing from the parents/ caregivers of all the subjects. Conversational speech samples were collected from each child in a quiet room at their home/school situation. Interaction with the child involved asking questions to the child regarding his/ her daily activities, narrating stories and indulging in general conversation using toys and pictures appropriate to their mental age. A pilot study was carried out on 2 children in order to assess the duration of speech sample to be recorded so as to elicit minimum of 100 fluent utterances from each child.

Table 2: *Distribution of subjects across age groups*

Age group	Age range	Male	Female	Total No. of Subjects
1	2-2.6	2	3	5
2	2.6-3	2	3	5
3	3-3.6	3	2	5
4	3.6-4	3	2	5
5	4-4.6	3	2	5
6	4.6-5	2	3	5
7	5-5.6	4	1	5
8	5.6-6	3	2	5
9	6-6.6	3	2	5
10	6.6-7	2	3	5

The outcome of the pilot study showed that a speech sample of 12-15 minutes was sufficient to elicit approximately 100 utterances. Hence, the speech sample of 15-30 minutes was collected from each child. Speech was recorded using a Sony-MZ-55 digital recorder with an external microphone and were stored in a compact disk. For the purpose of analysis, approximately one minute sample from the initial and final portion of the speech samples were not included to rule out initiation speech errors/ hesitations and fatigue effects in speech. From the selected portion of the speech sample 100 intelligible utterances per child were chosen and transcribed using broad transcription IPA (International Phonetic Alphabet). These were further subjected to analysis.

Analysis: From the transcribed speech sample, different phonological processes in the speech were analyzed and classified into space, timing and whole word errors based on the criterion proposed by Velleman (2003). The following method was used to calculate the mean percentage occurrence of different phonological processes across the age groups: The different patterns in the speech sample observed were computed for individual & mean scored for each age group.

Mean percentage of occurrence =
Total no. of patterns in the age group

$$\frac{\text{Total no. of patterns in the age group}}{\text{Number of subjects in the age group}} \times 100$$

Number of subjects in the age group

Mean percentage of occurrence of a particular pattern=
Total no. of particular patterns in the age group

$$\frac{\text{Total no. of particular patterns in the age group}}{\text{no. of subjects in the age group}} \times 100$$

no. of subjects in the age group

Results and Discussion

The speech samples collected from 50 children grouped into 10 different age groups (5 subjects per age group) with 6 month age interval from 2-7 years were transcribed by the investigator and the phonological patterns analyzed. Reliability measures were carried out which included both intrajudge and interjudge reliability. For the intrajudge reliability, the investigator selected 10% of the total sample and repeated the procedure of transcription after a week. Also to check the reliability of the transcription, interjudge reliability measures were carried which included an experienced Speech Language Pathologist transcribing 10% of the whole sample. Reliability measures were calculated based on point to point percentage of agreement. Intrajudge and interjudge reliability was found to be more than 85%.

The frequency of occurrence of the patterns across age groups were compared to identify the developmental trend if any in the frequency of occurrence of time, space and whole word patterns across age groups. The data was statistically verified using various tests. As the distribution of male and female children in different age groups were small in number, the data was not analyzed for differences in patterns across the gender. The mean scores and standard deviation of the total patterns observed in the speech samples of children in different age groups are given in the Table 3 and Figure 1.

Table 3: *Mean scores and standard deviation of the total patterns (time, space and whole word) in different age groups.*

Age group	Age range	No. of subjects	Total patterns	
			Mean	SD
1	2.0-2.6	5	68.80	1.92
2	2.6-3.0	5	61.60	4.39
3	3.0-3.6	5	52.00	3.80
4	3.6-4.0	5	43.20	1.30
5	4.0-4.6	5	31.20	2.16
6	4.6-5.0	5	26.40	1.51
7	5.0-5.6	5	20.60	2.07
8	5.6-6.0	5	14.00	1.58
9	6.0-6.6	5	12.80	1.48
10	6.6-7.0	5	10.80	1.64
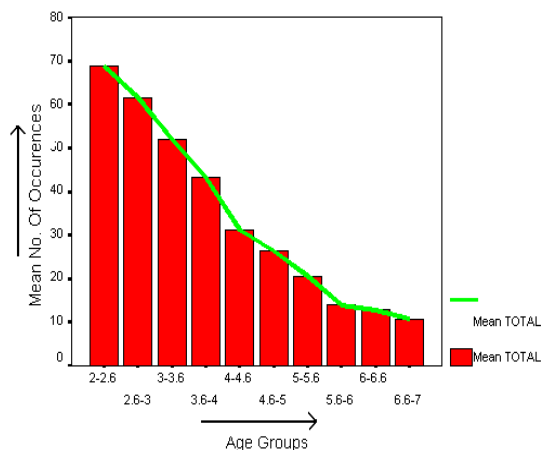
Figure 1: *Mean occurrences of total patterns (time, space and whole word) in different age groups*

Kruskal-Wallis non parametric test revealed a statistically significant difference across the age groups (χ^2 (9) =47.926, p <0.001). Further, non parametric test for 2 independent sample t- test (Mann- Whitney U test) was applied across the age groups to check whether the difference among the groups were statistically significant. The results revealed a statistically significant difference across all the age groups at p <0.05, except across the age groups 5.6-6.0 & 6.0-6.6 and 6.0-6.6 & 6.6-7.0. From table 3 and Fig 1, it is evident that the patterns show a decreasing trend with age. Such a trend is also supported by other studies in children speaking English language (Smit, 1993; Lowe, 1996). The less significant differences in the total mean occurrences of patterns in the older age groups (5.6-6.0 & 6.0-6.6 and 6.0-6.6 & 6.6-7.0) may probably be due to a gradual decline in the occurrences of the patterns. Major decline of the occurrences of processes is seen from 2 to 5 years of age, after which, the rate of decline is gradual. Overall, the variability in speech which is revealed in terms of the time, space and whole word patterns reduced drastically from 2-7 years and this signifies a gradual approximation to adult like speech, as also reported by Thelen & Smith (1994).

An attempt was made to identify the developmental trend specifically with respect to frequency of occurrence of time, space and whole word patterns across age groups. The mean and standard deviations of the three patterns are given in the table 4 and Figure 2.

Table 4: *Mean and Standard Deviations for timing, space and whole word patterns across age groups.*

Age group	Age range	N	Timing patterns		Space patterns		Whole word patterns	
			Mean	SD	Mean	SD	Mean	SD
1	2.0-2.6	5	13.00	1.87	18.40	0.54	37.40	2.40
2	2.6-3.0	5	11.00	2.91	18.60	0.89	32.00	2.54
3	3.0-3.6	5	8.60	1.67	17.40	1.81	26.00	1.58
4	3.6-4.0	5	5.20	1.30	13.80	1.48	24.40	0.54
5	4.0-4.6	5	1.20	0.83	8.60	1.14	21.00	2.00
6	4.6-5.0	5	1.20	0.44	7.20	1.30	18.00	1.00
7	5.0-5.6	5	0.00	0.00	6.60	0.89	14.00	1.41
8	5.6-6.0	5	0.00	0.00	4.60	0.54	9.40	1.14
9	6.0-6.6	5	0.00	0.00	3.60	0.54	9.20	1.30
10	6.6-7.0	5	0.00	0.00	2.40	0.54	8.40	1.51
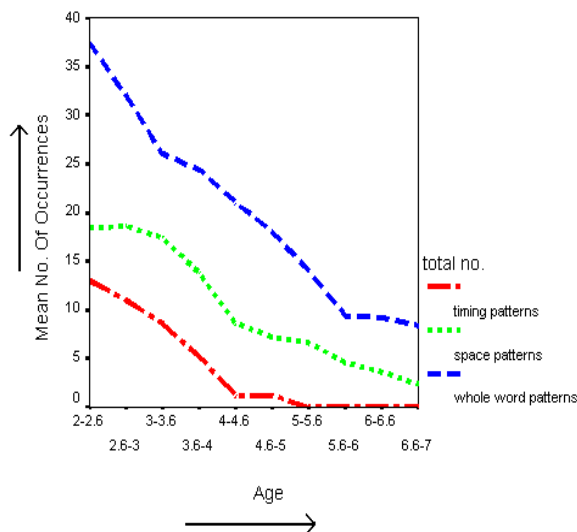
Figure 2: *Mean score of timing, space whole word pattern across age*
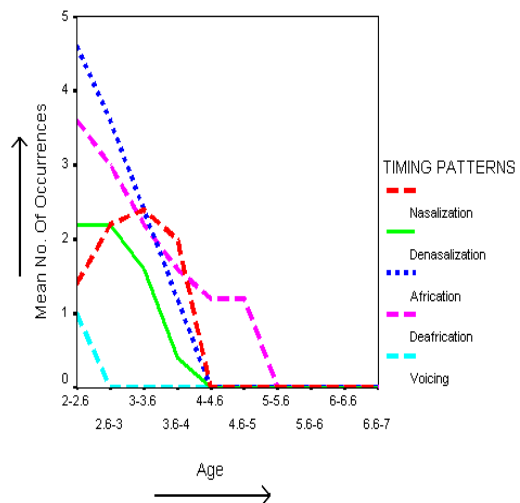
Figure 3: *Occurrences of various and patterns in timing*

a) Timing patterns: The timing patterns were observed upto 4.6-5.0 years of age. Kruskal-Wallis non parametric test was employed to check if the difference in the frequency of occurrence of timing patterns across age groups were statistically significant. The results revealed a statistically significant difference across the age groups (χ^2 (9) = 46.959, p <0.001). Hence a non parametric test for 2 independent sample t test (Mann- Whitney U test) was applied across the age groups to check whether the difference among the groups were statistically significant. The results revealed a statistically significant difference across all the age groups (p <0.05) except across the age groups (2.0-2.6 & 2.6-3.0; 2.6-3.0 & 3.0-3.6 and 4.0-4.6 & 4.6-5.0). The non significant differences for the occurrence of the timing patterns across the successive age groups reveal that the rates of decline of the time

patterns show a slow developmental trend. Timing patterns were stabilized and hence not observed after 5 years of age.

Among the timing patterns, the various prominent patterns observed included nasalization, denasalization, affrication, deaffrication and voicing patterns. The developmental patterns with respect to the frequency of occurrences across age groups for these timing patterns are shown in the Figure 3. The developmental pattern of various features in timing varied across the age groups. The nasalization feature is observed from 2.0-2.6 years of age to 3.0-3.6 years of age after which it is stable at the age of 4.6 years. The reduced frequency in the initial years can probably be due to non acquisition of nasal sounds as one of the initial sound classes. The increase in the

occurrence after this age group could probably be attributed to individual differences among the subjects considered for the study. Denasalization feature showed a gradual decline from 2.0 years to 4.0-4.6 years of age. However the simultaneous stabilization of nasalization and denasalization feature by 4-4.6years of age is an important feature observed and can be attributed to the neuromotor control of the velo-pharyngeal structures and the maturation of the voluntary coupling of oral and nasal structures. The occurrence of affrication as a pattern appeared at 2 years of age, and then decreased steeply before stabilizing at approximately 4.0-4.6 years. On the other hand, deaffrication pattern is evident from 2.0-2.6 years of age, gradually declining and stabilizing by 5.0-5.6 years. As seen from the Fig 3, deaffrication is the only feature among the timing patterns to disappear at a later age. The relatively late disappearance of affrication and deaffrication patterns can probably be accounted to the much later development of motor control of tongue movements which is essential in the production of frication. The coordinative organization of the tongue and jaw which are required for the acquisition of frication are reported to exhibit changes until the age of 8–11 years and continue to undergo refinement into late adolescence (Cheng, Murdoch, Goozee & Scott, 2007). The occurrence of the voicing pattern is also reported to stabilize by 3 years of age by Bowen (1998). Jaw which matures much earlier than the tongue contributes to most of the consonant production (Green, Moore, Higushikawa & Steeve, 2000).

b) Space patterns: As evident from the table 4 and figure 2, the mean values show that the space patterns show a developing trend, i.e. the patterns exhibited by younger age group gradually reduces with age. Kruskal- Wallis non parametric test was carried out to check if the difference in the frequency of occurrence of space patterns observed across age groups were statistically significant. The results revealed a statistically significant difference across the age groups (χ^2 (9) =46.747, p <0.001). Hence a non parametric test for 2 independent sample t-test (Mann-Whitney U test) was applied across the age groups to check whether the difference among the groups were statistically significant. The results revealed a statistically significant difference across the age groups (p < 0.05) except 2.0-2.6 & 2.6-3.0; 2.6-3.0 & 3-3.6; 4.0-4.6 & 4.6-5.0; 4.6-5.0 & 5.0-5.6; and 5.6-6.0

& 6.0-6.6. No significant difference between 2.0 to 3.6 yrs reveals that the space patterns remain consistent with respect to number of occurrences at the initial months as is evident in Fig 2. No statistically significant difference across the successive age groups like (4.0-4.6 & 4.6-5.0), (4.6-5 & 5-5.6) and (5.6-6 & 6-6.6), indicate a slow rate of decline in the mean number of occurrence at the later stages.

Within space patterns, the predominant features that were observed in the subjects were fronting, backing and vowel deviation. The same is depicted in figure 4. As it is evident from the figure 4, fronting was the most predominant pattern amongst the other space patterns. Fronting pattern remains consistent with respect to number of occurrences from 2 to 4 years of age, then shows a steady decline and continues to prevail even after 7 years of age. The predominance of the fronting pattern can be attributed to early acquisition of the front sounds (e.g. /p/, /b/, /m/, etc.) in children (Jacobson & Halle, 1956). Backing features are prevalent till 4yrs of age and shows a less and sporadic occurrence compared to fronting feature. Vowel deviations as a pattern were lesser in frequency and disappeared by 4 years of age. This may be due to early acquisition of vowels and the vowels differ from each other in terms of placement and position of articulators in the oral structures. Various studies have reported that vowels and diphthongs are acquired by 3 years of age (Rupella & Manjula, 2006).
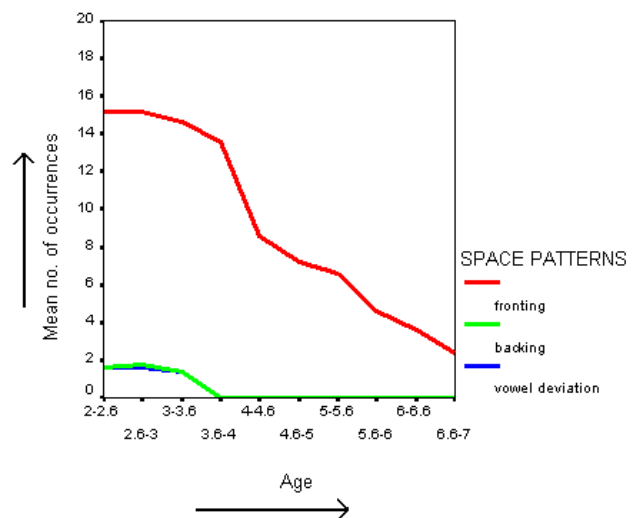

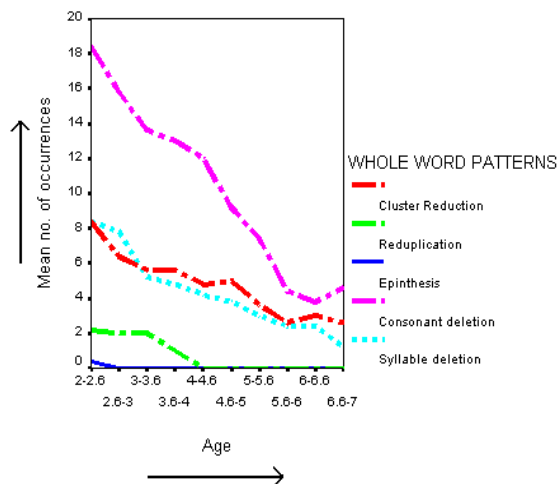Figure 4*: Occurrence of various features under space patterns*

Figure 5: *Occurrence of various features under whole word patterns.*

c) Whole word patterns: As evident from the mean scores in table 4 and figure 2, the occurrence of whole word patterns show a decreasing trend from 2 to 7 years. Unlike the timing patterns, these patterns prevail even after 7 years of age. This observation is in order with the findings by Smit (1993) and Lowe (1996). Kruskal- Wallis non parametric test was carried out to check if the difference in the frequency of occurrence of whole word patterns observed across age groups were statistically significant. The results revealed a statistically significant difference across the age groups (x^2 (9) =47.218, p <0.001). Hence a non parametric test for 2 independent sample t- test (Mann- Whitney U test) was applied across the age groups to check whether the difference of scores among the groups were statistically significant. The results revealed a statistically significant difference across all the age groups (p <0.05) except across the age groups 3.0-3.6 & 3.6-4.0; 5.6-6.0 & 6.0-6.6; 6.0-6.6 & 6.6-7.0. Occurrence of the whole word patterns decreased drastically up to 5.0-5.6 years of age. The drastic decrease in the number of occurrences till 6 years of age may be accounted to the development of the oral motor control. This observation is in line with that of Green, Moore, Higushikawa & Steeve (2000) who investigated lip and jaw co-ordination and found that the movement synchrony of articulators steadily increases with age.

The features that were observed within whole word patterns were cluster reduction, reduplication, epenthesis, consonant deletion and syllable deletion (figure 5). The developmental pattern of the various features among the whole word patterns observed reveal that the consonant deletion dominated across all age groups followed by cluster reduction, syllable deletion,

reduplication and epenthesis. Consonant deletion was seen maximally at 2 years of age, reduced drastically up to 6 years of age and later showed a sustained occurrence. For syllable deletion and cluster reduction were similar (the frequency of occurrence and rate of decrease across age groups). Reduplication was seen up to 4.0-4.6 years of age and stabilized thereafter. Occurrence of epenthesis was sporadic and did not show any growth trend like that seen for before 3years of age.

It is evident that timing patterns are stabilized first, followed by space and whole word patterns. The findings of the present study parallel the findings by Levelt (1989) and Walsh & Diehl (1991), who observed that children achieve control of temporal parameters of speech first before the movement amplitudes are adult like, because the subtle changes in timing can significantly affect perception of the acoustic signal. Smith & Walsh (2002) also suggested that children reach temporal goals before spatial goals. However Smith & McLean –Muse (1986) reported that higher order processes involving the formulation and planning of speech movement sequences delays the development of adult like duration of speech output.

Conclusions

The study revealed distinct pattern of development of various patterns such as time, space & whole word patterns and also various features within these patterns. When the data was compared across the various age groups, the frequency of occurrence showed a decreasing trend. The results revealed stabilization of the patterns wherein, the timing patterns were the first one to stabilize by 4 years of age where as space and whole word patterns prevailed even after 7 years. The order among the various timing patterns emerged as voicing, denasalization, nasalization, affrication and deaffrication. Fronting feature dominated among the space patterns across all age groups. The order of acquisition of features among the whole word patterns were epenthesis, reduplication, syllable deletion, cluster reduction and consonant deletion. In typically developing children, control of temporal parameters of speech is achieved earlier followed by space and whole word patterns.

Implications of the study

The studies which are carried out so far addressing the development of temporal and spatial dimensions of speech motor control are based on kinematic analysis. The present study is first among its kind which has considered

behavioral measures like phonological processes to imply on the speech motor control in typically developing children. Also there has been no study in any of the Indian languages that addresses the order of acquisition of time, space and whole word patterns in the phonological processes and their developmental trend in typically developing Kannada speaking children aged 2 – 7 years.

References

Bhannumathy, N. (2008). *Investigation for subgroups in developmental apraxia of speech.* Doctoral thesis submitted to the University of Mysore.

Bowen, C. (1998). Developmental phonological disorders. *A practical guide for families and teachers*. Melbourne: ACER Press.

Cheng, H. Y., Murdoch, B. E., Goozée, J. V. & Scott, D. (2007). Physiologic Development of Tongue–Jaw Coordination from Childhood to Adulthood. *Journal of Speech, Language, and Hearing Research, 50,* 352–360.

Chermark, G. D. & Schneiderman, C. R. (1986). Speech timing variability in children and adults. *Journal of phonetics, 13*, 477-480.

Green, J. R., Moore, C. A., Higashikawa, M. & Steeve, R. W. (2000). The physiologic development of speech motor control: Lip and jaw co-ordination. *Journal of Speech, Language & Hearing Research*

Hodson, B. W. & Paden, E. P. (1983). *Targeting intelligible speech.* San Diego, CA: College-Hill Press.

Jakobson, R. & Halle, M. (1956*). Fundamentals of language (2nd edn)*. The Hague: Mouton.

Kent, R. D. & Forner, L. L. (1980). Speech segment durations in sentence recitation bychildren and adults. *Journal of phonetics, 8*, 157-168.

Kent, R. D. (1976). Anatomical and neuromuscular maturation of the speech mechanism: evidence from the acoustic studies. *Journal of speech and hearing research, 19,* 421-471.

Kent, R.D. & Vorperian, H.K. (1995). *Developmental of craniofacial-oral-laryngeal anatomy: A review*. San Diego, CA: Singular publishing group.

Language and Hearing Research, 43, 239-255.

Levelt, W. J. M. (1989). *Speaking: from intention to articulation*. Cambridge, MA: MIT press.

Lowe, R. J. (1996). *Assessment link between phonology and articulation: ALPHA (rev. ed).* Mifflinville, PA: Speech and language resources.

Rupella, V. (2008). Assessment of oral motor, oral praxis and verbal praxis skills in persons with down syndrome. Doctoral thesis submitted to the University of Mysore.

Schmidt, R. A. & Lee, T. D. (1999). *Motor control and learning: A behavioural emphasis (3rd edn).* Champaign IL: Human kinetics.

Sharkey, S. G. & Folkins, J. W. (1985). Variability of lip and jaw movement in children and adults: Implication for development of speech motor control. *Journal of speech and hearing research, 28*, 8-15.

Smit, A. B. (1993). Phonological error distribution in the Iowa-Nebraska articulation norms project: consonant singletons. *Journal of speech and hearing research, 36*, 533-547.

Smith, A. & Goffman, L. (1998). Stability and patterning of speech movement sequences in children and adults. *Journal of speech, language and hearing, 41*, 18-30.

Smith, A., Goffman, L. & Stark, R. E. (1995). Speech motor control. *Seminars in speech and language,16,* 87-99.

Smith, B. L. & McLean-Muse, A. (1986). Articulatory movement characteristics of labial consonants produced by children. *Journal or acoustical society of America, 80*, 1321-1327.

Stampe, D. (1979). *A Dissertation on natural phonology*. New York: Garland.

Thelen, E. & Smith, L. B. (1994). *A dynamic system approach to the development of cognition and action.* Cambridge, MA: MIT press.

Rupella, V. & Manjula, R.(2006) Phonotactic development in kannada: Some aspects and future direction. *Language forum. 32 (1-2),* 83-93.

Velleman, S. L. (2003). *Resource guide for childhood apraxia of speech.* Clifton Park, N Y: Delmar/ Thomson Learning.

Walsh, B & Smith, A. (2002). Articulatory movements in adolescents: Evidence for protracted development of speech motor control processes. *Journal of Speech, Language and Hearing Research, 45*, 1119-1133.

Walsh, M. A. & Diehl, R. L. (1991). Formant transition duration and amplitude rise time as ques to the stop/ glide distinction. *Quarterly journal of psychology: human experimental psychology, 43(A),* 603-620.

Yavas, M. (1998). *Phonology: Development and disorders*. London: Singular Publishing Group, Inc.

COMPREHENSION AND PRODUCTION OF PREPOSITIONS BY PALESTINIAN-SPEAKING BROCA'S APHASICS

Hisham Al-Adam

Abstract

The aims of the present study were (a) to investigate the behavior of Broca's aphasics in using prepositions in Palestinian Arabic; (b) to examine whether the patterns of errors are comparable to those found in other languages and (c) to see what the findings tell us about the underlying source of preposition deficit. Spontaneous speech samples of three participants with Broca's apahasia was recorded. The results indicate that prepositions were predominantly omitted, indicating a significant dissociation between the temporal and spatial prepositions. The findings are consistent with findings from other languages. The results may contribute to neurolinguistic research across different languages, especially given that Palestinian Arabic is studied significantly less than other Arabic dialects and languages.

Keywords: Aphasia, Agrammatism, Prepositions by Palestinians with Broca's aphasia

Aphasia is defined as a disturbance in the ability to interpret and formulate language as a result of damage to certain subsystems of the brain, mainly the temporal lobe or higher up in the frontal lobe (Hickok, 2010). Expressive speech of individuals with Broca's aphasia is typically characterized as agrammatic, due to the fact that omission and substitution of functional words dominate their output (Caramazza & Zurif, 1976; Howard, 1985). Free grammatical morphemes such as determiners, conjunctions, prepositions, pronouns, and auxiliary verbs are omitted, and bound grammatical morphemes such as noun and verb inflections are substituted (Grodzinsky, Swinney, & Zurif, 1985; Grodzinsky, 1990; Gentner, 2001).

Prepositions are reported to be frequently omitted in agrammatic aphasia. Nevertheless, only relatively few studies have focused on prepositions, with the aim of identifying the underlying reasons for their deficit (Friederici, 1981; Druks & Froud, 2002; Kemmerer, 2005). The neglect of prepositions in aphasia research is surprising because prepositions are a paticularly interesting grammatical class to study. Furthermore, they share properties of both lexical and functional categories (Herskovits, 1986). This is reflected in the ongoing debate among linguists as to how to characterize them (Lindstromberg, 1998; Grimshaw, 2005). In general, review of research on prepositions in aphasia indicate that high frequency prepositions are better preserved than low frequency ones and meaningful prepositions are better preserved than meaningless prepositions (Friederic, 1981; Leikin, 2002). In fact, many definitions have been established for agrammatism. Some of these restrict it only to production. For example, Howard (1985) described agrammatism

as impairment in structural words, considering it a misuse of rules of words. However, other studies revealed comprehension disorders among agrammatic patients (Caramazza, Capasso, Capitani, & Miceli, 2005).

In their comprehensive data about the main features of agrammatism in 14 languages, Menn and Obler (1990) made it possible to explore how the closed classes are omitted or replaced by other items and how this differs from one language to another. They revealed that while free grammatical morphemes are generally susceptible to omissions, bound grammatical morphemes are mainly substituted for other items. On the other hand, bound grammatical morphemes are omitted rarely by the examined aphasics, but are usually replaced by more frequent and less marked forms. Results obtained from several studies indicate that in highly inflected languages like the Semitic languages, substitutions predominated over deletion errors (Grodzinsky, 1986).

A number of theories that aimed to explain the language deficits of agrammatic patients have been proposed. In this account, one early proposal was made by Caramazza and Zurif (1976) who indicated that agrammatic subjects display a complete breakdown in syntax. However, in their investigation of the omission of free grammatical morphemes, Menn and Obler (1990) found differences in the extent of the morphologic deficit based on the structure of the language. Similarly, individual differences pertaining to severity of the deficit, site of lesion and psychological factors, come into play.

A preposition may be defined as a connecting word showing the relation of a noun or a noun substitute to some other word in the sentence

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(Grimshaw, 2005). Basically, prepositions are special words that link nouns, pronouns, or words, acting as nouns to other parts of the sentence. For example, the preposition "on" in the sentence (the bird is on the tree) shows the relationship between the bird and the tree. Thus, prepositions reveal the relationship of time, space or other relationships between ideas. The noun or pronoun to which a preposition connects is referred to as an object of the preposition. Taken together, the preposition and the object of the preposition are called a prepositional phrase.

Prepositional phrases in Arabic are similar to those in English. For example, they indicate position [ʕala tˤtˤaːwlih] [on the table], direction [ʔila: ʔal madrasa] [to school], time [fis- sa: ʕa al xa:misa] [at five clock], means [bis sajja:rra] [by car] or agent by referring to the one doing an action with a passive voice verb [kusira alz zudʒa:dʒu min qibali aħad attˤulla:b] [The glass was broken by one of the students].

On the whole, prepositions are used to express a number of relationships including time, location, manner, means, quantity, purpose and state or condition (Lindstromberg, 1998). It is important to note, however, that the meanings of prepositions are extremely complex and multidimensional. Many studies have focused on the meanings of the spatial/locative prepositions that are in general considered to be a class of grammatical morphemes used to express static spatial relationships between objects (Bolinger, 1997; Lindstromberg, 1998). The structure of prepositions involves the thing to be located which is called the "figure," and the object which operates as a point of reference called the "ground" or "landmark." For instance, in the sentence, "the glass is on the table," the noun-phrase (the glass) serves as the figure; the noun-phrase (the table) determines the landmark and the preposition *on* specifies the nature of the spatial relationship between them as much literatures indicates (Sandra & Rice, 1995; Lindstromberg, 1998).

However, establishing a comprehensive meaning for the locative prepositions is difficult because of their high adjustment to different geometric circumstances in a spatially complex word. Many prepositions, however, bear not only spatial relationships, but also multiplicity of semantic functions. For example, in Arabic the preposition [fi:] [in] can refer not only to spatial reference like [al kita:bu fil durdʒ] [the book is in the drawer], but also to a moment in time [sajasilu fi:lqita:r assaʕaal Tha: mina] [I will arrive by train at eight o'clock].

The significance of the present study

Much research has been conducted to characterize the aspects of language and speech abnormalities of aphasics in English compared to those in Arabic. In this respect, results of studies on English are not necessarily applicable to Arabic. To the researcher's knowledge, little research has been done in this field in the Arab world and in Palestine in particular. The current study is a step towards filling this gap, particularly by studying the production and comprehension of prepositions by Palestinian speakers diagnosed with Broca's aphasia. The results of the study might have its implications for training persons with Broca's aphasia and developing assessment tests for measuring the agrammatic performance on prepositions in Arabic.

Objectives of the present study

Language in perosns with agrammatism can be characterized with impaired production of grammatical morphemes, including prepositions. In this respect, the aim of the present study is to investigate the extent of the deficit in the production and comprehension of prepositions in a group of Palestinian speakers with Broca's aphasia, and to examine whether they exhibit patterns of errors are comparable to those found in other languages. The study also aims to see what the findings tell us about the underlying source of the preposition deficit.

Method

Subjects

This study tested three male Palestinian speakers with Broca's aphasia. Palestinian Arabic was their native langauge and they were from the same region. They were all right handed with no significant history of educational problems. Subjects were diagnosed with Broca's aphasia based on both the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983) and the Bilingual Aphasia Test (Jordanian Arabic version) (Paradis, 1987). All were diagnosed with mild to moderate Broca's aphasia. Hearing was within normal limits with no evidence of dysarthria or visual impairments. The subjects were suffering from a single left hemisphere lesion for at least six months prior to testing. Clinical reports indicated that some of them displayed an earlier history of heart trouble, hypertension and high cholesterol levels.

Data Collection and Analysis

Samples of spontaneous speech were collected from all three subjects. Subjects were tested individually in a quiet room. The experimenter maintained informal conversation and gave the subjects under study an opportunity to talk freely. The questions in the semi-conducted

interview were equivalent to the questions of the Aachen Aphasia Test (AAT) (Huber, Poeck, Weniger, & Willmes, 1983). The samples were directed around the description of a situational picture –the 'Cookie Theft' picture from the Boston Diagnostic Aphasia Examination Test (BDAE) (Goodglass & Kaplan, 1983).

For the description of the *Cookie theft* picture no time limit was imposed and each subejct was seated at a table with the experimenter seated by him. As the pictures were presented, the participants were told to "Tell me everything you see happening in this (these) pictures". For example, they were instrcuted to describe the picture, saying where it takes place, who is shown in the picture and what they are doing. However, if a participant was not able to describe the picture in enough detail, assistance was often provided by giving it out in a certain way. Thus, the experimenters would ask *we:n el walad u shu ibjʕmal?* "Where is the boy and what is he doing?", but without given any direct indication of a place or the manner of an action, such as *we:n elwald waqif u shu ibjʕmal?* "What is the boy standing on, and what is he doing?".

Data were obtained in two sessions (one hour sessions). The speech samples were tape recorded and then transcribed by the investigator in a quiet room. Another trained speech-language pathologist transcribed the data separately, and the results of the two examiners were compared for interjudge reliability.

Uninterruptable neologisms, consistently used stereotypes, yes/no answer, repetitions, filler words, filler pauses and interjections were excluded from the analysis. The total number of prepositions omitted or substituted was counted. An Omission error is considered as the absence of the preposition that must appear in a well-formed sentence, while substitution error is that one included substituting one preposition for another (Tahaineh, 2010).

Results and Discussion

Table 1 presents the proportion of preposition errors made by the subjects with Broca's aphasia.

The results indicated that there were two types of preposition errors: omissions and substitutions. Approximately (61%) of the preposition errors were omissions, as shown in the following examples:

1-[zalameh …………..ʔibnu …….sajjara]
   "man his son car"

For [zalameh a:ʕid maʕ ʔibnu fis sajjarra]

 "a man (masculine) is sitting with his son in the car"

The man is sitting with his son in the car.

2-[ʔana dʒibit ilʔakel binti]
"I brought the food my daughter"

For [ʔana dʒibit ʔakel labinti]
"I brought the food to my daughter"
I brought the food to my daughter.

Table 1. *Percentage of Preposition Errors by Type. (O) refers to omissions, and (S) for substitution errors. (A) refers to the subjects with* Broca's *aphasia .*

Subject	% S	% O
A1	50	61
A2	24	42
A3	38	79

Despite the predominance of preposition deletion, there are occurrences of preposition substitution such as:

[ka:seh tiħt tittʕa:wleh]   "glass under the table"

For [ka:seh fo: ʔitʕa:wleh]
"Glass on the table"
The glass is on the table

However, apart from these omissions, the participants in some situations were randomly able to use the prepositions correctly, suggesting a deficit in but not a loss of this ability. The following examples present the correct use of prepositions:

1- [binit …… zalameh ….biftaħ…..ba:b *bi*lmufta:ħ]   "boy….man….open…door…with the key"

For/ the boy (masculine) open the door with the key

The boy opens the door with the key.

Another finding is the poor performance of the participants on the abstract concepts of prepositions. For example, their performance on a sentence like [ana anðʕuru ʔila: mustaqbalin afdʕal] [I am looking for a better future] shows that they were unable to use the preposition correctly, since it has an abstract concept, whereas their performance on a sentence like [al walad janðʕuru ʔilassajj:a:rra] [the boy is looking at the car] was relatively better than the former since this preposition refers to something concrete. Those findings are in accordance with those reported by Friederici (1981) in her investigation on the cognitive processing of prepositions in persons with Broca's aphasia. She found it is easy to access the preposition in such a sentence, "Peter is located on chair," in contrast to the sentence "Peter hopes for the summer", in which only syntax is of importance. However, controversial results have also been reported

from other investigations (Breedin, Saffran, & Coslett, 1994). These results would suggest a possible dissociation between abstract and concrete concepts, supporting the concreteness effect which has been addressed by many scholars (Martin, 1996; Friedman & Gvion, 2003).

In fact, the patterns found among the participants indicated a significant dissociation between the temporal and the spatial prepositions, suggesting a different mental representation and processing of prepositional meanings. In this regard, sentences like [dˤaʕ al kita:b ʕaltˤa:wila] [put the book on the table], were easier to comprehend than those requiring temporal correlations. In the previously mentioned sentence, the preposition [ʕala] provides information about the nature of the spatial relationships found in the entities of the sentence.

Significantly, it would be assumed that the space domain possibly provides a conceptual foundation for the temporal domain, since temporal meanings usually emerge from spatial prepositions that are gradually established through a process of semantic expansion. Further evidence for this difficulty is shown by preschool children who exhibited overlapping between "Where" questions and "When" questions by misinterpreting "When" questions as "Where" questions, e.g. answering questions like "When did your father leave?" with the answer "To the market" and after/before sequences acquisition (Clark, 1971).

In addition, this study has found evidence that there is a correlation between the agrammatic subject's impairment in processing the meanings of locative prepositions and retrieving verbs to name actions such as [tasħab ʕarab:jeh assajja:rra] [carriage is pulling car] for [tusħabu assajja:rra bilʕaraba:jeh] [the carriage is pulled by the car]. These results agree with those reported from Cappa, Sandrini, Rossini, Sosta, & Miniussi (2002) and Hillis, Wityk, Barker, & Caramazza (2003). In fact, this view implies a considerable overlap between the neural systems involved in retrieving words for actions and those that are essential for processing spatial prepositions, suggesting an important association in the neural systems required for operating and accessing both verbs and locative prepositions. Tranel, Adolphs, Damasio, & Damasio (2001) concluded that processing of the locative prepositions activates the left inferior prefrontal region. In the meantime, this region is involved in various kinds of linguistic information.

Thompson-Schill, D'Esposito, Aguirre, & Farah (1997) also present evidence for the contribution of the left inferior prefrontal region in semantic processing by facilitating and accelerating the retrieval of prepositional meanings and coordinating and monitoring the comparison of different meanings in order to retrieve and to select the appropriate one.

In addition, neurophysiological studies have emphasized that the spatial meanings of prepositions are processed in the left posterior frontal operculum and the left supramarginal gyrus which are found to be involved in the brain damaged subjects. In this account, Kemmerer and Tranel (2003) investigated the effects of the site of lesion on the spatial meanings of prepositions for aphasiac subjects. They concluded that the impaired knowledge of the spatial meanings of prepositions was mainly associated with damage in the left posterior frontal operculum, the left supramarginal gyrus and in the white matter subjacent to these areas. This is in line with neuroimaging studies which have provided valuable evidence for an interaction and correlation between site of lesion and the impaired knowledge of the spatial meanings for prepositions (Damasio, 2001).

Conclusions

The present study is the first study on the comprehension and production of prepositions by Palestinians with Broca's aphasia. Results indicate that the subjects understudy have problems with prepositions in production and comprehension. The patterns indicate a significant dissociation between the temporal and spatial prepositions, suggesting a different mental representation and processing of prepositional meanings. In addition, this study found evidence that there is a correlation between the subject's impairment in processing the meanings of locative prepositions and retrieving verbs to name actions. The results are consistent with those reported from other studies, in which prepositions having temporal domain are found to be difficult to be accessed and comprehended.

In general, the findings obtained from the present study should only be regarded as preliminary results in an area where further investigations and research are required by using larger number of subjects and stimuli in order to get a comprehensive idea about the nature of this deficit among Palestinian- speaking Brocas aphasics.

References

Breedin, S., Saffran, E., & Coslett, H. (1994). Reversal of the concreteness effect in a patient with semantic dementia. *Cognitive Neuropsychology, 11,* 617-660.

Cappa, S., Sandrini, M., Rossini, P., Sosta, K., & Miniussi, C. (2002). The Role of the left frontal lobe in action naming: rTMS Evidence. *Neurology, 59,* 720- 723.

Caramazza, A., Capasso, R., Capitani, E., & Miceli, G. (2005). Patterns of comprehension performance in agrammatic Broca's aphasia: a test of the Trace Deletion Hypothesis. *Brain and Language,* 94, 43-53.

Caramazza, A., & Zurif, E. (1976). Dissociation of algorithmic and heuristic processes in language comprehension: Evidence from aphasia. *Brain and Language*, 3, 572-582.

Clark, E. (1971). On the acquisition of the meaning of "before" and "after." *Journal of Verbal Verbal Behavior, 10,* 266-75.

Damasio, A. (2001). Neural correlates of naming actions and of naming spatial relations. *NeuroImage, 13, 1053-*1064.

Druks, J., & Froud, K. (2002). The syntax of single words: evidence from a patient with a selective function word reading deficit. *Cognitive Neuropsychology, 19,* 207–244.

Friederici, A. (1981). Production and comprehension of prepositions in aphasia. *Neuropsychologia, 19,* 191-199.

Friedmann, N., & Gvion, A. (2003). Sentence comprehension and working memory limitation in aphasia: a dissociation between semantic-syntactic and phonological reactivation. *Brain and Language, 86,* 23-29.

Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M. Gattis (Ed.), *Spatial Schemas and Abstract Though.* Cambridge, MA: MIT Press, 203-222.

Goodglass, H., & Kaplan, E. (1983). *Boston Diagnostic Aphasia Examination* (2nd ed.). Philadelphia: Lea & Febiger.

Grimshaw, J. (2005). *Words and Structure*. Stanford: CSLI Publications.

Grodzinsky, Y. (1986). Language deficits and the theory of syntax. *Brain and Language, 27,* 135-159.

Grodzinsky, Y. (1990). *Theoretical Perspectives on Language Deficits*. Cambridge: MIT Press.

Grodzinsky, Y., Swinney, D., & Zurif, E. (1985). Agrammatism: Structural deficit and antecedent processing disruptions. In M. Kean (Ed.), *Agrammatism (*pp. 65–81*)*. Orlando: Academic Press.

Herskovits, A. (1986). *Language and Spatial Cognition. An Interdisciplinary Study of the Prepositions in English.* Cambridge: Cambridge University Press.

Hickok, G. (2010). The role of Mirror Neurons in Speech and Language Processing. *Brain and Lanaguge, 112,* 1-2.

Hillis, A., Wityk, R., Barker, P., & Caramazza, A. (2003). Neural Regions Essential for Writing Verbs. *Nature Neuroscience,* 6, 19-20.

Howard, D. (1985). Agrammatism. In S. Newman, & R. Epstein (Ed.), *Current Perspectives in Dysphasia (pp.1-31).* Edinburgh: Churchill Livingstone.

Huber, W., Poeck, K., Weniger, D., & Willmes, K. (1983). *Aachener Aphasie Test (AAT).* Göttingen: Hogrefe.

Kemmerer, D. (2005). The spatial and temporal meanings of English prepositions can be independently impaired. *Neuropsychologia, 43,* 797–806.

Kemmerer, D., & Tranel, D. (2000). A double dissociation between linguistic and perceptual representations of spatial relationships. *Cognitive Neuropsychology,*17, 393-414.

Leikin, M. (2002). Locative prepositions in language acquisition and aphasia. In S.Feigenbaum & D. Kurzon (Ed.). *Prepositions in Their Syntactic, Semantic, and Pragmatic Context.* Amsterdam: John Benjamins.

Lindstromberg, S. (1998). *English Prepositions Explained*. Amsterdam: John Benjamins.

Martin, N. (1996). Models of deep dysphasia. *Neurocase, 2,* 73-80.

Menn, L., & Obler, L. (1990). *Agrammatic Aphasia: A Cross-Language Narrative Sourcebook.* Philadelphia: John Benjamin's publishing Company.

Paradis, M. (1987). *The assessment of Bilingual Aphasia*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Sandra, D., & Rice, S. (1995). Network analysis of prepositional meaning: mirroring whose mind— the linguist's or the language users? *Cognitive Linguistics, 6,* 89-130.

Tahaineh, Y. (2010). Arab EFL university students' errors in the use of prepositions. *The Modern Journal of Applied Linguistics, 2,* 76-112.

Thompson-Schill, S., D'Esposito, M., Aguirre, G., & Farah, M. (1997). Role of left inferior prefrontal cortex in retrieval of semantic knowledge: A reevaluation. *Proceedings of the National Academy of Sciences, USA, 94,* 14792–14797.

Tranel, D., Adolphs, R., Damasio, H., & Damasio, A. (2001). A neural basis for the retrieval of words for actions. *Cognitive Neuropsychology, 18,* 655–670.

CORRECT INFORMATION UNIT (CIU) AS A MEASURE OF COMMUNICATIVE INFORMATIVENESS AND EFFICIENCY IN PERSONS WITH APHASIA

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Abstract

Correct information unit (CIU) assesses the language performance in persons with aphasia. It is a rule based scoring system for measuring the communicative performance of persons with aphasia in connected speech and language which has two important aspects i.e. Communicative informativeness and Communicative efficiency (Nicholas and Brookshire, 1993). The present study aimed at identification of CIU in connected speech and language of three persons with aphasia as a measure of communicative informativeness and efficiency in the Indian context. It was found that there was a difference between the neuro-typical participants and person with aphasia in words per minute (WPM) and percent CIU per minute (% CIU). It was observed that both the groups performed better in the measure of % CIU per minute than the measure of WPM. Clinical application of the CIU analysis is certainly warranted for assessment of connected speech. Qualitative and quantitative analysis of CIU will help professionals to differentially diagnose fluent from non-fluent types of aphasia. It may also yield a stable base line performance against which, changes in connected speech with treatment can be measured.

Key Words: *Words per minute, Communication, Assessment*

Portrayal of language abilities in persons with aphasia has always been a matter of debate. This debate has been overcome primarily through the use of standardized testing instruments (Goodglass & Kaplan, 1972). However, language abilities of persons with aphasia are usually better than the scores obtained by standardized language tests. Such formal tests may not be appropriate tools for the assessment of every day language performance in persons with aphasia. This observation led the researchers to develop other tools that better reflect the communicative abilities of aphasics (Bloemert, Koster 1987). Among such tools correct information unit is also an important aspect which does provide information about the language performances of an aphasic

Correct information unit (CIU) is a rule based scoring system for measuring the communicative performance of persons with aphasia in connected speech. Communicative informativeness (CI) and communicative efficiency (CE) are the two important aspects of CIU as reported by Nicholas and Brookshire (1993). CI refers to the degree to which the speech of an individual imparts the intended message, while CE is the rate at which the message is produced for language use. The CIU analysis may yield stable baseline performance against which changes in connected speech with treatment or manipulation of experimental variables can be measured. The CIU analysis of connected speech involves measuring the rate at which the speaker produced speech and combining it with a derived measure i.e. the percentage CIU. The percentage CIU measures the combined total word count which meets the specific criteria necessary to be called as a correct information unit (CIU).

Yorkston and Beukelman (1980) reported that it is imperative to know the insight of communicative performance in persons with aphasia. Thus, the content units in the utterances of a person with aphasia should be measured. Measurement of such content units or correct information units in speech of persons with aphasia will facilitate the speech language pathologist to have an idea of the person's performance in daily language abilities, before and after treatment. Also, it will help the professionals to set the goals which are relevant to the person's communicative performance than just focusing on the language goals.

Linguistics and pragmatics are the two main aspects of CIU which have been reported in the literature by different researchers such as Shewan (1980), Saffran, Berndt and Schwartz (1989), Byng and Black (1989) Thompson (1995) have extensively studied the linguistic aspects in person with aphasia. Shewan (1988) described a more comprehensive system, the Shewan Spontaneous Language Analysis (SSLA) for the analysis of language samples generated in a picture description task. They used twelve

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variables viz. number of utterances, time, rate, length, melody, articulation, complex sentences, errors, content units, paraphasias, repetitions, and communicative efficiency. The SSLA samples performances in three components of the language system which included phonology, syntax, and semantics.

Saffran, Berndt and Schwartz, (1989) introduced the quantitative production analysis (QPA) to study the agrammatic production in persons with aphasia (same was used by Byng and Black 1989). The QPA analyzes the syntax in a finer grained manner.

Menn, Ramsberger and Helm Estabrooks (1994) gave linguistic communication measure (LCM) for analysis of transcription of aphasic and other disordered narratives. It measures the narrative output in terms of three dimensions- amount of information that is presented in words, proportion of informative to non- informative words and grammatically acceptable words in the expression. They reported that these aspects can be applied to evaluate the progress or deterioration either in research or clinical settings in a person with aphasia.

Yorkston and Beukelman (1980) Nicholas and Brookshire (1993) focused on pragmatic aspects for analyzing aphasic discourse.Yorkston and Beukelman (1980) studied 78 non brain damaged adults using "cookie theft" picture from Boston Diagnostic Aphasia Examination (BDAE, Goodglass and Kaplan, 1983), and reported that content units per minute can differentiate the speech of a person with aphasia that of non-brain damaged participants. Also, the two measures i.e. number of content units and content units per minute were found to be potentially sensitive measures of change in connected speech as a consequence of treatment.

Nicholas and Brookshire (1993) studied 20 non brain damaged persons (10 male and 10 female) and 20 persons with aphasia (18 male and 2 female) who were native speakers of English. The results of the study showed that the informativeness of the connected speech of adults with aphasia can reliably be scored, using the three measures (WPM, CIUs per min, and % CIUs) as there was a significant difference found on these three measures between the persons with aphasia   and the non-brain damaged participants.

The percentage CIU of conversational samples was compared with that of connected speech by Doyle, Goda and Spencer (1995). The results indicated that although persons with aphasia spoke with a higher percentage of CIU rate in conversational samples than in the connected speech, their performance in the conversation

samples could be predicted from their connected speech performance. They noted that measuring communicative informativeness and efficiency under conversational discourse condition is perhaps the most ecologically valid means of determining the interpersonal verbal communication abilities of persons with aphasia.

Oelschlaeger and Thorne (1999) studied a 50 year old right handed male, six years post stroke with a history of a single left hemisphere cerbro-vascular accident (CVA) with residual moderate aphasia and mild right hemiparesis. They studied the reliability and stability of CIU analysis for measuring communicative informativeness and efficiency of connected speech across time and across conversational contexts. Results suggested that reliability of CIU analysis was less than 73% for intra-rater and was less than 56% for inter-rater. The stability of the communicative efficiency and informativeness was precluded by the reliability findings, although speech rate was noted to be stable across conversations.

To conclude, two aspects i.e. linguistic and pragmatic were discussed in the literature with reference to correct information unit (CIU). Studies on Linguistic aspects done by Shewan (1980), Shewan (1988), Saffran et. al. (1989), Byng and Black (1989) Thompson (1995) stated the analysis of three components i.e. phonology, semantics and syntax can be done using tools such as SSLA, QPA. LCM. On the other hand, findings on pragmatic aspects such as Yorkston and Beukelman (1980) Nicholas and Brookshire (1993) suggested that informativeness of the connected speech of adult with aphasia can reliably score Aphasics' performance in the conversation samples.

Need for the study

CIU can be assessed using linguistic and pragmatic aspects of the language. Among all this, discourse appears to be an important aspect which can give a better perspective of CIU in persons with aphasia. Studies have reported that, analyzing the connected speech of persons with aphasia in natural conditions is preferred over standardized aphasia test, as it offers greater potential for determining their communication abilities and deficits (Larfeuli & Le Dorze, 1997; Ross & Wertz, 1999). There have been very limited research reports in this area, especially in the Indian context; hence a need was observed to provide further corroborative evidence to the existing research findings and also to measure CIUs in persons with aphasia.

Aim of the study

The aim of the present study was to identify the Correct Information Unit (CIU) in connected

speech of persons with aphasia as a measure of communicative informativeness and efficiency.

Method

A total six number of persons participated in the present study, they were further divided into two groups. Group -1 consisted of three male persons with aphasia (PWA) i.e. conduction aphasia (CA), trans-cortical aphasia (TCS) and Broca's aphasia(BA) with the mean age of 59 years, diagnosed by a qualified Speech language pathologist using Western Aphasia Battery (WAB, Kerstez & Poole, 1982). All the participants were native speakers of Kannada. (*Kannada is a language spoken in south India predominantly in the state of Karnataka*). The demographic details of persons with aphasia are shown in Table-1. Group-2 included three neuro-typical persons (NTP) i.e. N1, N2, N3 who were matched for age, gender, language, laterality and education with group-1 participants. These participants were ruled out for any obvious history of speech, language, motor and /or sensory impairment (participant N1, N2 and N3 matched with CA, TCS and BA respectively).

Table 1: *Demographic details of the persons with aphasia*

Partici-pants	Age	Type of aphasia	Cause	Educa-tional status	Hand-edness
CA	55 yrs	Conduction	Stroke	Illiterate	Right
TCS	66 yrs	Trans-cortical sensory	Stroke	MBBS	Right
BA	56 yrs	Broca's	Stroke	VII std	Right

Tasks and stimulus materials

To elicit the speech-language samples with a reasonable amount and consistency of content across speakers, the three types of task stimuli were selected. Task I as *personal information-*requests for personal information included participants name, age, occupation, family members and description of his problem. Task II as *Procedural information*, this included questions such as "Tell me how would you make tea"? and "How would you go about shaving your beard"?. Task III was p*icture description-*for this task, "cookie theft" picture from the Boston Diagnostic Aphasia Examination, BDAE (Goodglass & Kaplan, 1983) and "picnic" picture from the Western Aphasia Battery, WAB (Kertesz & Poole, 1982) were the two single pictures stimuli. Verbal instructions for the first two tasks (personal information and procedural information) were given to all the participants before the recording began. The two pictures for the picture description tasks were presented one

after the other in the vicinity of the participants. They were instructed to describe the picture.

Procedure

All testing sessions were conducted in a quiet room, free from distractions. The subject and the examiner sat side-by-side at a table that held a laptop with the Wavesurfer software and a microphone. The entire verbal interaction with each participant was audio recorded on the Wavesurfer software.

Scoring and Analysis

The obtained connected speech samples were orthographically transcribed and the total number of words and CIUs were counted using the scoring system given by Nicholas and Brookshire (1993). The rules used to score words and CIUs are provided in Appendix-I. Word and CIU counts were used to calculate two measures i.e. words per minute (WPM) which refers to the total number of words / total time taken (in minutes) and the percentage of correct information unit per minute (%CIU pm), which is the total number of CIU per minutes / total number of words per minutes $\times$ 100. In order to be included in the word count, the words had to be intelligible in context but need not be accurate, relevant or informative in relation to the elicited stimulus. For including in the CIU count, words had to be accurate, relevant and informative in relation to the elicited stimulus. Words need not be grammatically accurate to be counted as CIUs. Each CIU consisted of a single word, and only those words that were included in word count were considered for CIU count.

All the recorded speech-language samples obtained from the participants were given to three post-graduate students of Speech Language Pathology (SLP) for the analysis and calculation of the two measures i.e. WPM and % CIU pm. A mean score obtained from the three judges was used to compare the performance of both the groups across three tasks i.e. task I, II, and III using 'Mann Whitney U- test'. A descriptive analysis was done to compare the performance of each participant for both the measures across three tasks.

Results and discussion

The present study was aimed to identify the Correct Information Unit (CIU) in connected speech and language of persons with aphasia as a measure of communicative informativeness and efficiency. A total of six persons participated in the study (three persons with aphasia (PWA) and three neuro-typical persons (NTP)). Results of the participants in all three tasks for both the measures are depicted in Table 2. Two fold analyses of the samples were done to find and

compare all participants for each of the two measures i.e. WPM and % CIU pm across two groups and three tasks. The first group included person with conduction (CA) vs. trans-cortical sensory (TCS) vs. Broca's aphasia (BA); and

second group included neuro-typical persons (NTP) vs. persons with aphasia (PWA). Personal information, procedural information and picture description were the three tasks as task given to the participants of the study.

Table 2: *Results of participants in three tasks for both measures*

Tasks / Participants	TASK I		TASK II		TASK III	
	WPM	%CIU pm	WPM	%CIU pm	WPM	%CIU pm
CA	45	73%	50	64%	47	57%
N 1	78	81%	92	69%	80	88%
TCS	91	84.8%	85.2	43.5%	78.3	16%
N 2	60	86%	107	100%	97	85%
BA	39	51%	56	45.5%	16.5	75.5%
N 3	75	85%	90	75%	64	75%

1. Performance of the participants for words per minute (WPM)

A. Across group:

(a) Neuro-typical persons (NTP) vs. Persons with aphasia (PWA)

Mann Whitney-U test was used to compare the mean WPM scores of persons with aphasia

(PWA) and neuro-typical persons (NTP). As shown in Table. 3, a significant difference (p< 0.05) was found between PWA and NTP for the task II (procedural information) and there was no significant difference (p > 0.05) found between both the groups for the task I (personal information) and task III (picture description).

Table 3: *Showing mean (%) of WPM pm between PWA and NTP across tasks*

Tasks / Participants	TASK I				TASK II				TASK III			
	Mn	SD	z	Sig	Mn	SD	z	Sig	Mn	SD	Z	sig
PWA	58.3	28.4	0.65	>0.05	63.7	18.8	1.95	<0.05	47.2	30.9	1.52	>0.05
NTP	71.0	9.64			96.3	9.2			80.3	16.5		

b.) Person with Conduction (CA) vs. Transcortical sensory (TCS) vs. Broca's aphasia (BA)

Results (as depicted in Table 2) showed that the performance of person with trans-cortical sensory aphasia (TCS) was comparatively better than person with conduction aphasia (CA) and Broca's aphasia (BA). Among all the persons with aphasia, person with BA showed the poorest scores (Trans-cortical sensory (91) > Conduction (45) > Broca's (39)).

The above difference can be explained by the fact that persons with trans-cortical sensory aphasia (TCS) do not get feedback about their verbal output and also are fluent in nature, thus their overall vocabulary appears to be more. Also in the present study, it was noticed that the rate of speech of person with TCS was quite faster than the other two persons with aphasia i.e CA and BA.

As a consequence of brain damage in persons with aphasia, the verbal output is reduced in terms of quantity and this can be relate to the results shown by person with CA and BA in the present study who showed lower WPM due to their frequent pauses, effortful and slow rate of speech which can be attributed to their better feedback mechanism (Schuell & Jenkins, 1961).

Whereas, the person with TCS showed an effortless and continuous verbal output.

B. Across Task

A slight deterioration in performance of trans-cortical sensory aphasia was seen from the task I (personal information) to task III (picture description); same is also depicted in graph-1. The performance of TCS in task I i.e. personal information was found to be better than the other two tasks i.e. procedural and picture description .The WPM in speech of TCS for personal information was high (91) due to the egocentric nature of stimuli presented. In contrast lower performance in the other two tasks (procedural information, picture description) was due to the novelty of the stimuli (85.2 and 78.3 respectively). Similar findings were reported by Goswami 2004, with reference to comprehension deficits in aphasia. The performance of CA was observed to be consistent across all the three tasks (45, 50 and 47). However, in the present study BA showed much better performance in task II (56) followed by task I (39) and task III (16.5).

It was found that WPM for person with conduction aphasia (CA) and Broca's aphasia (BA) was significantly lower (45, 39 respectively) than their neuro-typical

counterparts. However, WPM was significantly higher (91) in person with trans-cortical sensory aphasia (TCS) compared to all other participants of the study in task I. In task II and task III, he showed better scores (85.2 and78.3 respectively) for WPM than the other two persons with aphasia but poorer than his neuro-typical counterpart.
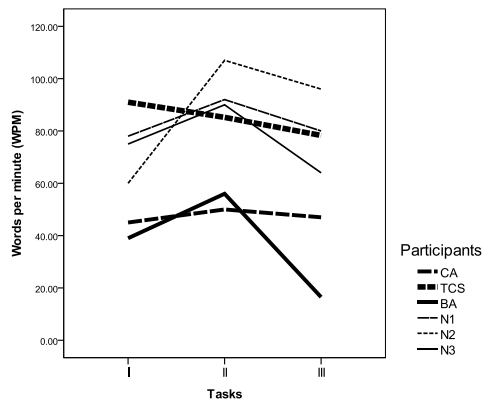
Figure 1. *Words per minute (WPM) of all participants in three tasks*

Overall, the performance of persons with aphasia (PWA) group was poorer as they scored a lower mean WPM in tasks I (58.3), II (63.7) and III (47.2) than the neuro-typical persons (NTP) group, who scored a higher mean WPM in task I (71.0), II (96.3), and III(80.3).
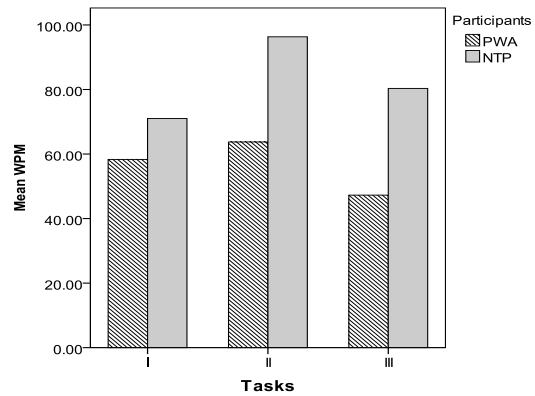
Figure 3. *Mean values for Words per minute (WPM) of two groups across tasks*

2. Performance of the participants for percentage CIU per minute (% CIU pm)

A. Across group:

(a) Neuro-typical persons (NTP) vs. Persons with aphasia (PWA)

Mann Whitney-U test was used to compare the mean scores of persons with aphasia (PWA) and neuro-typical persons (NTP) for % CIU pm. As shown in Table 4, a significant difference (p< 0.05) found between PWA and NTP for the task II (procedural information) and there was no significant difference (p> 0.05) found between both the groups for the task I (personal information) and task III (picture description).

Table 4.:*Showing mean (%) of %CIUpm between PWA and NTP across tasks*

Tasks	TASK I				TASK II				TASK III			
Participants	Mn	SD	z	sig.(p)	Mn	SD	z	sig.(p)	Mn	SD	Z	sig.(p)
PWA	69.6	17.1	1.52	>0.05	51.0	11.3	1.95	<0.05	49.5	30.4	1.52	>0.05
NTP	84.0	2.6			81.3	16.4			82.6	6.8		

On % CIU per minute, persons with aphasia performed poorer than the neuro-typical persons across all the three tasks. This shows that brain damage does influence the person's overall integrity of the brain, which in turn influences his /her linguistic activity and participation (ICFH-2001), thereby reducing the meaningful verbal output.
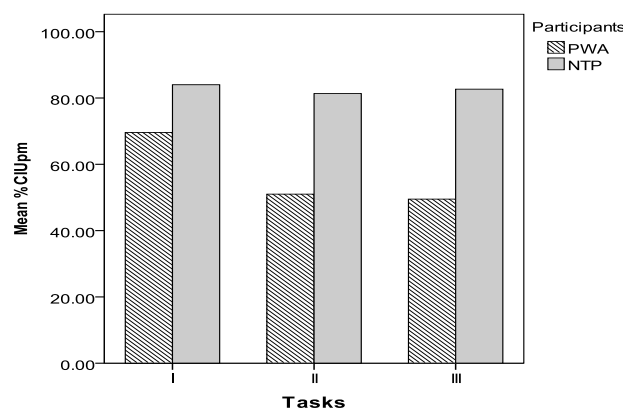
Figure 4. *Mean values for percent correct information unit per minute (% CIU pm) of two groups across tasks.*
PWA- Persons with aphasia, NTP- Neuro-typical persons, Task I-Personal information, Task II- Procedural information, Task III- Picture description.

(b) Person with Conduction (CA) vs. Transcortical sensory (TCS) vs. Broca's aphasia (BA)

Person with trans-cortical sensory aphasia (TCS) scored higher in task I i.e. 84.8% than person with Broca's aphasia (BA) and conduction aphasia (CA) i.e. 51% and 73% respectively. In task -II, performance of person with TCS and BA was approximately equal but lower than person with CA, who showed much better scores than the other two persons with aphasia. In task -III, person with BA scored highest followed by CA and the least was scored by TCS. This can be explained by the "Press of speech" (Goodglass & Kaplan, 1983) and "Jabberwocky" phenomenon found in persons with Trans-cortical sensory aphasia (Brookshire, 1997).

The content in speech of person with TCS for personal information (task I) was high, as he was able to explain about his problem appropriately without much circumlocutions due to egocentric nature of the presented stimuli which correlates with the findings of Goswami (2004) with reference to comprehension deficits in aphasia. On contrary, in the other two tasks (procedural information, picture description) which were novel to him, he showed more of jargon speech and neologism, resulting in reduced content of speech.

Further, obvious lack of topic termination, indicating pragmatic deficits was seen. The reduced content of speech in person with CA can be attributed to the presence of perseveratory behaviors, circumlocutions, self corrections, phonemic paraphasia and paraphrases in his verbal output (Kohn, 1992). Person with BA lacked initiation to respond appropriately for the targeted stimuli on his own and required frequent cueing which improved his performance in the present study.

B. Across Task

Person with CA showed slightly deteriorating performance from task I to task III, as evident from Figure 2. Person with TCS showed steeply deteriorating performance from task I to task III, which explains that the content reduces, as complexity of the task increases. Person with BA showed similar performance in task I and task II and comparatively better performance in task III. This could be attributed to his telegraphic speech which consisted of more content words (Schuell & Jenkins, 1961).

From the above findings, it can be stated that WPM and % CIU pm are the two important measures for assessing the overall quantity and quality of speech in persons with aphasia which in turn reflects the verbal communication skills.
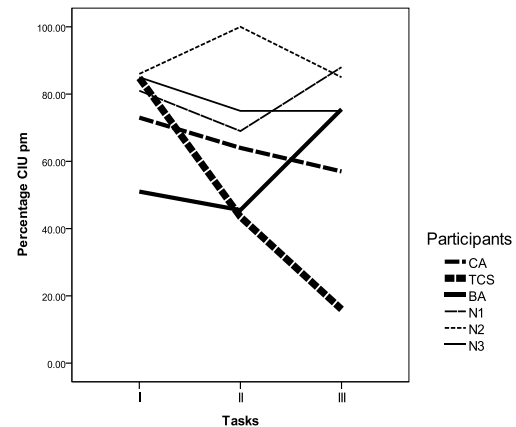
Figure 2. *Percentage CIU per minute of the participants in all three tasks*

CA- Person with conduction aphasia, TCS- Person with trans-cortical sensory aphasia, BA- Person with Broca's aphasia; N1,N2,N3- Neuro-typical counterparts of persons with CA,TCS and BA respectively; Task I- personal information, Task II- Procedural information, Task III- Picture description.

Conclusion

The present study was aimed to identify the Correct Information Unit (CIU) in connected speech of adults with aphasia as a measure of communicative informativeness and efficiency. The study consisted of three persons with aphasia (CA, TCS and BA) and three age, gender and education matched neuro-typical counterparts (N1, N2 and N3 respectively). Connected speech and language samples of all the participants were elicited using three types of stimuli such as Personal information (Task I), Procedural information (Task II) and Picture description (Task III) and were analyzed for two measures i.e. Words per Minute (WPM) and Percent CIU per minute (% CIU). Results revealed that the persons with aphasia performed significantly poorer than the neuro-typical participants for both the measures with an exception of person with TCS who performed better than all the other participants of the study for WPM in task I (personal information). Person with CA performed consistently on all the three tasks for both the measures. Person with BA showed poorest WPM than all the participants in task III (picture description) task and showed a comparable % CIU pm to the matched neuro-typical participant (N3) in the task III.

Although there was a significant difference between neuro-typical (NTP) and persons with aphasia (PWA) on both the measures, the % CIU pm discriminated normals from aphasics better than the WPM count, as none of the aphasic's performance was above the score obtained by normals for % CIU pm count.

Similar results were reported by Yorkston & Beukelman (1980), authors reported that the mean syllable per minute was related inversely to severity of aphasia, however speaking rate of the persons with aphasia group were all slower than either of the normal speakers group. In their second measure of efficiency i.e. content units per minute, reported that there was an inverse relationship between this measure of efficiency and severity of aphasia. Further none of the aphasic group achieved a rate as rapid as normal speaker. However, both normal groups produced significantly more content per minute than any of the aphasic group. To conclude, CIU is a simple and a language free tool for profiling the language components such as semantics, syntax and pragmatics. With the %CIU pm analysis the accuracy, relevance and informativeness of the words produced by an individual can be evaluated. Clinical application of the CIU analysis is certainly warranted for assessment of connected speech. Qualitative and quantitative analysis of CIU will help the professionals to differentially diagnose fluent from non-fluent types of aphasia. It may also yield a stable base line performance against which, changes in connected speech with treatment can be measured.

References

Blomert, L., Koster, C., Van Miler, H. & Kean, M-L. (1987). Verbal communication abilities of aphasic patients: The everyday language test. *Aphasiology,* 1,463-474.

Byng, S., & Black, M. (1989). Some aspects of sentence production in aphasia. *Aphasiology,* 3, 241-263.

Doyle, P.J., Goda, A.J., & Spencer, K.A. (1995). The communicative informativeness and efficiency of connected discourse by adults with aphasia under structured and conversational sampling conditional sampling conditions. *American Journal of Speech-Language Pathology,* 4(4), 130-134.

Goodglass, H., & Kaplan, E. (1972). *Boston Diagnostic Aphasia Examination.* Philaelphia: Lea and Febiger.

Goodglass, H., & Kaplan, E. (1983). *The Assessment of Aphasia and Other Neurological Disorders.* Baltimore, MD: Williams and Wilkins.

Goswami, S.P. (2004). Comprehension Deficits in Aphasics. *An unpublished Doctoral thesis submitted to University of Mysore*, Mysore, India.

Kerstez, A & Poole. (1982). *Western Aphasia Battery.* New York: Grune & Stratton.

Kohn, S. E. (1992). *Conduction aphasia.* Hillsdale, N.J: L. Erlbaum, 40–42

Larfeuli, C., & Le Dorze, G. (1997). An analysis of the word-finding difficulties and of the content of the discourse of recent and chronic aphasic speakers. *Aphasiology.* 11, 783-811.

Menn, L., Ramsberger, G., & Helm-Estabrooks, N. (1994). A linguistic communication measure of aphasic narratives. *Aphasiology,* 8, 343-359.

Nicholas, L. E., & Brookshire, R. H. (1993). A system for quantifying the informativeness and efficiency of the connected speech of non-brain-damaged adults and adults. *Journal of Speech and Hearing Research*, 36, 338-350.

Nicholas, L. E., & Brookshire, R. H. (1993). A system for scoring main concepts in the discourse of non-brain-damaged and aphasic speakers. *Clinical Aphasiology*, 21, 87-99.

Oelschlaeger, M. L. (1999). Participation of a conversation partner in the word searches of a person with aphasia. *American Journal of Speech-Language Pathology ,* 8, 62-71.

Ross, K. B., & Wertz, R. T. (1999). Comparison of impairment and disability measures of assessing severity of, and improvement in aphasia. *Aphasiology,* 13, 113-124.

Saffran, E. M., Berndt. R.S., Schwartz. M.F. (1989). The quantitative analysis of Agrammatic production: Procedure and data. *Brain and Language*, 37, (3), 440-479.

Schuell, H., & Jenkins, J. (1961). Reduction of vocabulary in Aphasia. Brain, 84, 243-261.

Shewan,C. M. (1988). The Shewan Spontaneous Language Analysis (SSLA) System for aphasic adults: Description, reliability, and validity. *Journal of Speech and Hearing Disorders*, 21, 103-138.

Shewan, C.M., & Kertesz, A. (1980). Reliability and Validity Characteristics of the Western Aphasia Battery (WAB). *Journal of Speech and Hearing Disorders* Vol.45 308-324.

Thompson, C. K., Shapiro, L. P., Tait, M. E., Jacobs, B., Schneider, S. L., & Ballard, K. J. (1995). A method for systematic analysis of Agrammatic language production. *Brain and Language*, *51*, 124–129.

Yorkston, K. M., & Beukelman, D. R. (1980). An analysis of connected speech samples of aphasic and normal speakers. *Journal of Speech and Hearing Disorders*, 45, 27-36.

Appendix I
Rules for counting words per minute (WPM) and correct information units (CIUs).
(Nicholas & Brookshire, 1993)

Prior to determining which words should be included in the count of words and CIU, delete statements that are made before or after the speaker performs the task. e.g. 'I'll start by saying' this or 'That's about it'

Rules for counting words:
- Words or partial words that are not intelligible in context e.g. he had a st..sn…stick or non word fillers (u, er, uh) should not be included.
- All the words those are intelligible in context. Count words that contain sound substitutions, omissions, distortion, or additions if the word is intelligible in context. If the incorrect production results in another real word that does not appear to be the target word, it is still included in the word count.
- Filler words and phrases, Interjection and informal terms, common contractions or simplifications of words, contraction standard and colloquial as two words.

Rules for counting correct information units (CIU):
- Words that do not see accurate in relation to the topic being discuss such as incorrect names, pronouns, numbers, actions, should not be counted as CIU.
- Repeated words, phrases and ideas are not counted in CIU.
- Conjunctive terms if used as fillers and non-specific terms (there, here, somehow) will not be counted as CIU.
- All words (nouns, adjectives, verbs, pronouns, adverbs, articles, prepositions, and conjunctions) that are intelligible in context should be counted.
- The final attempt in a series of attempts to correct sound errors and the informal terms that convey meaning to the information about the content of picture (nope, yep) should be counted as CIU.

DOUBLE DEFICIT HYPOTHESIS: THE RELATIONSHIP BETWEEN PHONOLOGICAL AWARENESS AND RAPID AUTOMATIZED NAMING IN ADOLESCENTS WITH AND WITHOUT DYSLEXIA

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Abstract

Over the past decade, a large amount of evidence has accumulated indicating that deficits in phonological awareness are closely associated with difficulties in learning to read. It is thought that deficits in phonological awareness and deficits in naming speed are additive and will produce more severe reading difficulties in the same child (Wolf & Bowers, 2001); this has been termed as "Double Deficit". The present study aimed to find out the relationship between phonological awareness and naming speed in adolescents with & without dyslexia. A total of 50 participants, of these, 20 adolescents with dyslexia and 30 normal readers, of chronological age 12 to 15 years were considered. The tests such as phonological awareness test and Rapid Automatized Naming Speed test were administered with verbal and tangible reinforcements. The obtained data was analyzed using SPSS, an Independent 't' test and correlation analysis was administered to investigate the relationship between phonological awareness and rapid naming in adolescents with dyslexics and typical group. Results of the present study showed that there is no relation between naming speed and phonological awareness, which suggests poor reading performance in adolescents with dyslexics may be due to dominant deficits in either Phonological awareness or Rapid Naming speed measure. The future implication includes-(a) there is a greater need to explore the other subtypes of LD and (b) The test batteries need to be developed in Indian languages and therapy activities on both PA and RAN should be attempted.

Key words: Phonological awareness, Rapid Automatized Naming, Learning Disability (LD), Phonological access.

Over the past decade, a large amount of evidence has accumulated indicating that deficits in phonological awareness are closely associated with difficulties in learning to read (Stanovich & Siegel, 1994; Torgesen, Wagner, Rashotte, Burgess & Hecht, 1997). However, recent research has also focused on deficits in the processes that underlie naming speed as another possible source of reading difficulties (Wolf & Bowers, 1999). This naming speed deficit is thought to provide a source of reading difficulties that is largely independent of phonological awareness difficulties. Furthermore, it is thought that deficits in phonological awareness and deficits in naming speed are additive and will produce more severe reading difficulties in the same child (Wolf & Bowers, 2001), this has been termed as "Double Deficit".

According to Swathi & Shyamala (1994) and Rama (1992) maximum numbers of learning disabled identified in India were within 6-12 years of age. Swathi and Shyamala (1994) also reported male:female ratio as 4:3. Suresh & Swapna (1997) conducted an epidemiological survey of developmental language disorders and LD among school children in Kerala. Results revealed 20 % of school children were found to be learning disabled.

Phonological awareness (PA) refers to the ability to perceive and manipulate the sub lexical sounds in words. Many longitudinal-correlational studies have shown that there is a relationship between early levels of phonological awareness and later reading skill (Wagner et al., 1997; Morris et al., 1998; Scarborough, 1998a; Lovett et al., 2000; Kirby, Parilla & Pfeiffer, 2001; Parrilla, Kirby & McQuarrie, 2004; Bishop & League, 2006). However, it is worth noting that in a careful analysis of 27 samples found in 24 studies, Scarborough (1998a) found that the power of the correlation derives from the children with strong early phonological awareness. These children rarely developed reading problems, but some of the children with weak early phonological awareness developed reading difficulties. For children learning to read in more ortho-graphically transparent languages, early levels of phonological awareness are not strong predictors of later reading difficulties (De Jong & Van der Leij, 1999; Wimmer, Mayringer & Landerl, 2000). In favor of these studies Rekha (1997) reported phonological awareness was not an important factor in children learning to read Kannada and Malayalam (Dinesh, 2002).

Sonali nag (2007) studied the pace of acquisition of orthographic knowledge and phonemic

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awareness in youngest group of Kannada readers and found a greater sensitivity to the syllable when compared with the phoneme. One possible reason for the advanced syllable awareness in this group is the salience of the unstable sound unit in the orthographic representations in Kannada. She also reported that phoneme awareness is slower to emerge in Kannada. Kannada- speaking children in Grades III and IV seem to reach a level of phoneme sensitivity that is equivalent to what is reported in younger English-speaking children.

Wolf, Bowers, and Biddle (2000) raised the issue of a general slowing deficit in discussions of poor reader's problems in rapid naming. A link between naming deficits and reading disabilities was first proposed by Geschwind (1965) and supported in a series of studies by Denckla (1972) and Denckla and Rudel (1974, 1976). This research showed that tasks measuring the speed of name retrieval of letters, digits, colors, and objects (which were termed as *Rapid Automatized Naming*) differentiated individuals with dyslexia from typical readers. Subsequently, numerous studies have documented the deficits of rapid naming skill in poor readers (Ackerman & Dykman, 1993; Badian, 1994; Bowers & Swanson, 1991; Felton & Brown, 1990; Fletcher et al., 1994; Chang & Manis, 1996; Meyer, Wood, Hart & Felton, 1998). Initially, deficits in rapid naming were viewed as part of the phonological core deficit in poor readers (Catts, 1989, 1996; Wagner, Torgesen, Laughon, Simmons & Rashotte, 1993). As such, these deficits have been widely explained in terms of problems in accessing phonological codes in memory.

In the literature, evidences that supported the double deficit hypothesis are given in four view points (Wolf & Bowers, 1999, 2000; Manis, Doi, & Bhadha, 2000). First, naming speed tasks such as the ability to rapidly name letters, have consistently predicted reading performance beyond what was accounted for by phonological awareness skills (Manis et al., 2000; Wolf & Bowers, 1999). It was this finding that led to the conclusion that the effects of naming speed on reading extend beyond phonological processing, with naming speed tapping non-phonological components of cognitive functions that are important for reading (Wolf & Bowers, 1999; Chiappe, Sringer & Siegal, 2002).

The second line of evidence comes from studies that have grouped children into different subtypes of learning disabilities based on their performance on phonological awareness tasks and naming speed tasks. These studies have demonstrated that children with deficits in both phonological awareness and naming speed have significantly lower scores on reading tasks than children with a deficit in only one of these areas (Wolf & Bowers, 1999, 2000; Lovett, Steinbach, & Frijters, 2000).

A third finding cited to support the independent contribution of naming speed skill beyond phonological awareness in predicting reading ability is that these two constructs appear to be differentially related to different aspects of reading. Specifically, phonological awareness has been found to be more strongly related to pure decoding ability, whereas naming speed appears to be more strongly related to reading fluency (Manis et al., 2000).

Litt (2010) tried to determine whether children considered being at high risk for developing reading difficulties due to weaknesses in either phonological awareness or rapid automatic naming (RAN). Measures of phonological awareness and RAN were administered to 62 children selected for Reading Recovery in the fall of 2001 within the first 2 weeks of their programs. The results demonstrated that there was a notable weakness in both phonological awareness and RAN in children. Among 62 children, only one of them was selected for intervention in the fall fell within the normal range (37th percentile or above) in both areas; 71.4% of the children performed at the 16th percentile or lower in phonological awareness, and 50.6% performed at the 16th percentile or lower in rapid naming. Thus the large percentage of Reading Recovery children with RAN weaknesses could be that the letter identification assessment is a vehicle for capturing RAN weaknesses.

Stefanou & Peck (2010) supported traditional phonics instruction through phonemic awareness and rapid naming and reported improvements in reading decoding, fluency, and comprehension of upper elementary students through instruction. Third, fourth, and fifth grade students were taught with materials containing phonological recoding, phonemic awareness, and naming activities to automatize each step of the reading process. Instruction was delivered in small reading groups by minimally trained regular and special education teachers. Reading comprehension, phonological awareness, short-term auditory memory, and rapid automatic naming were assessed. Results indicated that students in the treatment condition out-performed students in the control condition in comprehension, rapid naming, and phonemic awareness. Third grade students made larger gains in phonemic awareness and rapid naming than fourth and fifth grade students, fourth grade students out-performing fifth grade student in rapid naming. Phonological recoding was shown

to be a highly effective alternative to traditional phonics instruction. A two-year follow-up found significant increases from post-test to follow-up for rapid naming and comprehension for the treatment school (Wolff et al., 1990a, 1990b; Nicolson & Fawcett, 1994; Stringer & Stanovich, 2000). Anjana (2002) studied the efficacy of phonological training in remediation reading disabled children in the higher age range of nine to ten years. The study revealed that even children of higher age group benefit from phonic training.

Need for the Study

Most of the studies in Indian context have focused on Phonological Awareness (PA) and orthographic skills. There is ongoing debate stating whether the phonological awareness and RAN together impedes the reading ability or not. However, so far studies have not been conducted for verifying or evaluating the double deficit hypothesis in Indian context. These lacunae would have their impact on assessment and intervention aspects. Hence, there is a strong need to conduct the study in order to provide the systematic means of rehabilitation.

Aim of the Study

Although the researches pinpoint to a deficit in speed of processing in poor readers, the nature of this deficit is unclear. Most of the studies have been limited to one or two processing domains and have not included the combined measures of phonological awareness and rapid naming. Moreover, the studies were concentrated on preschool children. Thus the present study aims to find out the relationship between phonological awareness and naming speed in adolescents with and without dyslexia.

Method

Subject: A group of 20 adolescent with dyslexia (AD) in the age range of 12 to 15 years were taken for the study. The criteria should be met by the participants are as follows:

- Participants who were diagnosed as having dyslexia at AIISH, based on ERS (Ray & Potter, 1981) were included.

- Their IQ should be within normal range as per Weschler's Intelligence Scale for Children-IV (Weschler, 2003).

- They should have poor academic performance as per the teacher report.

- The language abilities were assessed using informal measures where in the information about receptive & expressive skills were collected, which was age adequate.

- All the subjects had Kannada as their mother tongue and English as a medium of instruction in schools.

- Socio economic status of middle or higher category matched

- They should not have any hearing impairment, intellectual disability or neurological dysfunction

A cross sectional sample consisted of 30 chronological age matched adolescents without dyslexia (AWD) were included. The criteria should be met by the participants are as follows:

- All the participants in the study had Kannada as mother tongue and English as medium of instruction in school.

- None of them had difficulty in reading, evidence of cognitive impairment, attention deficit, or a hyperactivity disorder as per teachers report.

- Socioeconomic status of middle or higher category was considered.

- They should not have any neurological or sensory deficit

Procedure

The overarching evaluation study included mainly the Phonological Awareness Test (Robertson, Walta & Salter, 1997) and Rapid Naming Speed test (Antonio, 1994).

Phonological Awareness: Phonological awareness (PA) refers to the ability to perceive and manipulate the sub lexical sounds in words. The Phonological Awareness test of Robertson, Walta & Salter (1997) was used to collect the information on phonological awareness skills, which includes 8 subtests namely Rhyming, Segmentation, Isolation, Deletion, Substitution, Blending, Graphemes, and Decoding of phonemes was administered. The time taken to administer the test was around 45 minutes to 1 hour. The correct response was scored as 1 and incorrect was scored as 0 with a maximum raw score of 278. Participants were instructed with examples for each subtest.

Rapid Automatized Naming (RAN): Naming speed was assessed using a subtest of Clinical Evaluation of Language Fundamentals (CELF, Semel, Wiing, & Secord, 1995). CELF consists of 4 subtests; one among them is Rapid Automatic Naming. Here the participants were asked to name colors, shapes and colours with shapes as soon as possible and time taken (in seconds) to complete the task was noted down using stop watch as s response time. The number of errors was also noted simultaneously which reflects the degree to which he/she was able to

sustain self-monitoring (accuracy) of an individual.

The tests were given to 3 trained SLP's (M.Sc. graduates with min 1year of experience) for inter-judge reliability. The test results showed 65% reliability on PA test & 70% on RAN test. Content validity of the battery was assessed by giving the data to 3 SLP's. Three major criteria such as appropriateness of the items, completeness of the items sampled & the way in which the test items assess the content was considered.

Testing took place in a calm and quiet environment. Testing of individual participant's was conducted in 20- to 60-min sessions depending on a participant's attention span and desire to continue. Testing of a given participant took place within a 2 to 3 sessions. Children were given verbal praise (e.g., "Good job," "Nice working," or "Well tried"), physical praise (e.g., high fives), and tangible reinforcements (e.g.,

stickers, chocolates) for participating in the assessments.

Results and Discussion

Obtained data was analysed using SPSS Statistics 17.0 software. Independent 't' test and correlational analysis were used to investigate the relationship between phonological awareness and rapid naming in Adolescents without dyslexia (AWD) and Adolescents with dyslexia (AD).

Phonological awareness test: Average scores of all the subtests for both the groups were analyzed using Independent 't' test and results are tabulated in table 1 & 2 and represented graphically in figure 1.

The table 1 shows that the mean and standard deviation for each phonological awareness subtest score, was high in Adolescent without dyslexia compared to the adolescent with dyslexia group, which indicates there is a poor reading ability in AD group due to deficit in phonological awareness skill.

Table 1: *Describes the mean and S.D of subtests of phonological awareness tests in Adolescents without dyslexia (AWD) and Adolescents with dyslexia (AD).*

Items	Group	N	Mean	Max.	S.D
Rhyming	Adolescents without dyslexia (AWD)	30	18.03	20	1.51
	Adolescents with dyslexia(AD)	20	14.00	30	3.49
Segmentation	Adolescents without dyslexia(AWD)	30	29.80	30	0.48
	Adolescents with dyslexia(AD)	20	21.45	30	3.99
Isolation	Adolescents without dyslexia(AWD)	30	29.96	20	0.18
	Adolescents with dyslexia(AD)	20	26.55	20	2.83
Deletion	Adolescents without dyslexia(AWD)	30	19.36	20	0.99
	Adolescents with dyslexia(AD)	20	16.60	20	4.84
Substitution	Adolescents without dyslexia(AWD)	30	9.70	20	0.65
	Adolescents with dyslexia(AD)	20	7.40	20	2.74
Blending	Adolescents without dyslexia(AWD)	30	19.43	20	1.86
	Adolescents with dyslexia(AD)	20	14.50	20	5.01
Graphemes	Adolescents without dyslexia(AWD)	30	50.96	58	2.32
	Adolescents with dyslexia(AD)	20	36.25	58	7.69
Decoding	Adolescents without dyslexia(AWD)	30	79.50	80	1.19
	Adolescents with dyslexia(AD)	20	54.25	80	12.81
Total	Adolescents without dyslexia(AWD)	30	256.40	278	3.70
	Adolescents with dyslexia(AD)	20	192.20	278	30.16

Table 2: *Independent 't' test measures in Adolescents without dyslexia (AWD) and Adolescents with dyslexia (AD).*

Items	't'	Df	P	Results
Rhyming	5.59	48	<0.001	Highly significant
Segmentation	11.38	48	<0.001	Highly significant
Isolation	6.61	48	<0.001	Highly significant
Deletion	3.04	48	<0.001	Highly significant
Substitution	4.92	48	<0.001	Highly significant
Blending	4.43	48	<0.001	Highly significant
Graphemes	9.86	48	<0.001	Highly significant
Decoding	10.77	48	<0.001	Highly significant
Total	11.58	48	<0.001	Highly significant

From the above Table 2, we can observe that there is a highly significant difference between Adolescents without dyslexia (AWD) and Adolescents with dyslexia (AD) in all the subtests of phonological awareness test.

Table 1 and 2 in the present study, clearly suggests that the poor reading skill is mainly due to the deficit in the phonological awareness skill even though there is a deficit in the RAN task. This is supported by the study Scarborough (1998a), analyzed 27 samples found in 24 studies and found that the power of the correlation derives from the children with strong early phonological awareness. These children rarely

developed reading problems, but some of the children with weak early phonological awareness developed reading difficulties.

The above finding is also supported by Stefanou & Peck (2010). They studied the traditional phonics instruction through phonemic awareness and rapid naming. The results showed that phonological recoding was highly effective alternative to traditional phonics instruction.
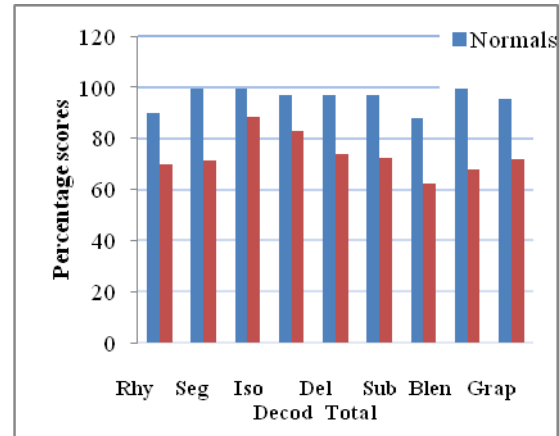
Figure 1: *Shows the percentage scores on phonological awareness tasks in adolescents without dyslexia (AWD) and Adolescents with dyslexia (AD).*

Rapid Automatized Naming: Average time taken (in seconds) to name the colors, shapes and color with shape and number of errors made were tabulated in table 3, 4 and 5 and depicted graphically in figure 2 & 3

Table 3: *Mean and SD for time taken and number errors in RAN task.*

Items	Group	Mean	S.D	t	df	P	Results
Time	AWD	105.6	8.91	10.36	48	<0.001	Highly significant
	AD	154.7	23.63				
Errors	AWD	1.83	1.20	4.54	48	<0.001	Highly significant
	AD	3.95	2.08				

Table 4: *Mean and SD for time taken and number errors on shape naming of RAN task.*

Items	Group	Mean	S.D	t	df	p	Results
Time	AWD	110.9	13.02	14.54	48	<0.001	Highly significant
	AD	174.3	17.58				
Errors	AWD	2.76	0.50	4.53	48	<0.001	Highly significant
	AD	5.20	0.61				

Table 5: *Mean and SD for time taken and number errors on color-shape naming of RAN task.*

Items	Group	Mean	S.D	t	df	p	Results
Time	AWD	128.4	10.16	15.49	48	<0.001	Highly significant
	AD	200.5	9.52				
Errors	AWD	4.26	0.63	3.56	48	<0.001	Highly significant
	AD	7.30	0.73				

From the above tables 3, 4 and 5, we can see that there is a highly significant difference between AD and AWD in terms of mean and S.D.
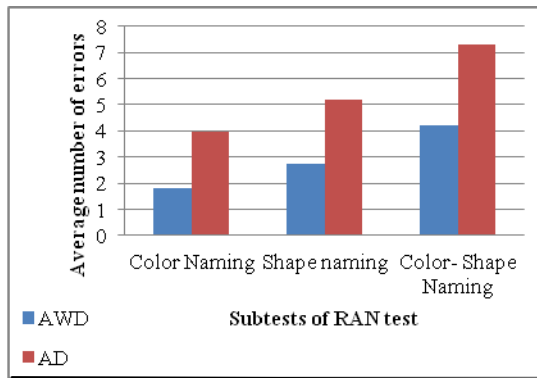
Figure 2: *Average No. of errors in RAN task by AWD and AD*
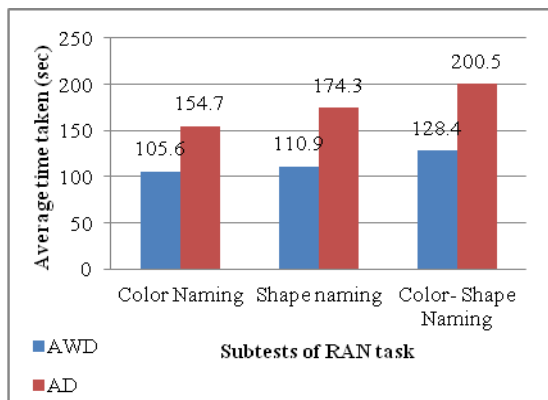
Figure 3: *Average time taken in RAN task by AWD and AD*

Rapid automatic naming (RAN) consists of the ability to quickly name a limited set of familiar objects presented in random order. In the depicted figure ii and iii of the present study, the average number of errors and the time taken was more in AD than AWD in all 3 tasks such as naming the color, shapes and color with shape suggesting that there is a deficit in rapid naming task. RAN calls upon many of the sub-skills or processes involved in reading, without demanding actual word recognition or comprehension. Suboptimal performance in any of these lower-level skills of tracking, associating an image with its verbal label, retrieving the label, inhibiting a current response to move on to the next image, as well as the coordination of all of these processes can result in poor (slow) performance on the task which in turn interfere with reading connected text. Thus, RAN tasks tap processes used during actual reading, but can identify children who might experience difficulty before they can read or would be expected to read.

The main aim of the present study was to investigate the relationship between naming speed and phonological awareness skills. In order to confirm the relationship between the 2 different task, Carl Pearson correlation co-

efficient was calculated. The results revealed that there is no significant correlation between the naming speed and phonological awareness task (p >0.05). This suggests that the higher phonological awareness scores are more likely to be associated with reading skills than lower phonological awareness scores. This assertion indicates that lower scores in PA test may be associated with a double deficit affecting the decoding ability of an individual which is a pre-requisite for reading skills (Manis et al., 2000).

The double-deficit hypothesis (DDH) suggests that Phonological Awareness (PA) and Rapid Automatized Naming (RAN) are important for reading skill, and the individual who show deficits in both PA and RAN have the most significant reading difficulties. The result of the present study revealed that there is a deficit in both phonological awareness skill and rapid Automatized naming in the adolescents with dyslexia compared to adolescents without dyslexia supporting the DDH. This is further supported by the study of Wolf & Bowers (1999), Wolf et al., (2000) and Litt (2010).

Limitation

In the present study, the test administered was in English and all of them were found to have poor reading performance in English, while the poor reading performance in Kannada was not explored. Hence, the current evidence indicates that the alphabetic orthographies like English depends on matching of phonemes to graphemes but Kannada, a Dravidian language, is an alpha-syllabary that depends on direct sound-to-symbol mapping (Bright, 1996). So the relationship between PA and RAN may be different in Kannada when compared to English. Therefore, further studies need to explore in Kannada and the present study may be replicated to identify the other subtypes of learning disability.

All the participants in the study had undergone intervention for not more than 9 months and they reported more difficulty in English than Kannada, but this aspect has not been considered in this study. Since poor performance was identified in English, an attempt was made to study the phonological awareness and rapid naming tasks solely in English.

In this study, the participants were not screened for the sub skills necessary for reading such as memory, visuo-spatial skills etc, which is one of the limitations of the study.

Conclusions

The main aim of the present study was to investigate the relationship between naming speed and phonological awareness skills using test of phonological awareness and RAN subtest

of CELF. The results of the present study showed that there is a co-morbid deficit in phonological awareness and rapid naming in an individual with dyslexia. The correlation between the two and the exact contribution of each related to poor reading performance need to be explored. And also, there is a greater need to explore the other subtypes of LD. The test batteries need to be developed in Indian languages and therapy activities on both PA and RAN should be done in future research.

References

Ackerman, P. T. & Dykman, R. A. (1993). Phonological processes, confrontational naming, and immediate memory in dyslexia. *Journal of Learning Disabilities, 26(9),* 597–609.

Anjana (2002). An efficacy study of phonic training in the remediation of the reading disabled. *An unpublished master's dissertation submitted to University of Bangalore, Bangalore.*

Badian, N. A. (1994). Preschool prediction: Orthographic and phonological skills, and reading. *Annals of Dyslexia, 44*, 3–25.

Bishop, A. G. & League, M. B. (2006). Identifying a multivariate screening model to predict reading difficulties at the onset of kindergarten: A longitudinal analysis. *Learning Disabilities Quarterly, 29*, 235–252.

Bowers, P. G. & Swanson, L. B. (1991). Naming speed deficits in reading disabilities: Multiple measures of a singular process. *Journal of Experimental Child Psychology, 51,* 195–219.

Bowers, P. G. (1995). *Re-examining selected reading research from the viewpoint of the "double-deficit" hypothesis.* Paper presented at the Society for Research in Child Development, Indianapolis, IN.

Catts, H. W. (1989). Phonological processing deficits and reading disabilities. In A. Kamhi & H. Catts (Eds.), *Reading disabilities: A developmental language perspective* (pp. 101–132). Boston: Allyn & Bacon.

Chiappe, P., Stringer, R., Siegel, L. S. & Stanovich, K. E. (2002). Why the timing deficit hypothesis does not explain reading disability in adults. *Reading and Writing, 15*, 73-107.

De Jong, P. F. & Van der Leij, A. (1999). Specific contributions of phonological abilities to early reading acquisition: Results from a Dutch latent variable longitudinal study. *Journal of Educational Psychology, 91*(3), 450–476.

Denckla, M. B. (1972). Color-naming defects in dyslexic boys. *Cortex, 8,* 164–176.

Denckla, M. B. & Rudel, R.G. (1974). "Rapid automatized naming" of pictured objects, colors, letters, and numbers by normal children. *Cortex, 10,* 186–202.

Denckla, M. B. & Rudel, R.G. (1976). Rapid automatized naming (R.A.N.): Dyslexia differentiated from other learning disabilities. *Neuropsychologia, 14,* 471–479.

Dinesh, K. (2002). Metaphonological and orthographic skills in learning disabled children. *An unpublished master's dissertation submitted to University of Mangalore, Mangalore.*

Gokani P.V. (1992). Orthographic feature in phonological awareness with relation to reading. *An unpublished master's dissertation submitted to University of Mysore, Mysore.*

Kirby, J. R., Parrila, R. K. & Pfeiffer, S. L. (2001). *Naming speed and phonological awareness as predictors of reading development.* Paper presented at the Society for the Scientific Study of Reading, Boulder, CO.

Litt, D. (2010). Do Children Selected for Reading Recovery Exhibit Weaknesses in Phonological Awareness and Rapid Automatic Naming? *Literacy teaching and learning, 14,* 89-102.

Lovett, M. W., Steinbach, K. A., & Fritjers, J. C. (2000). Remediating the core deficits of developmental reading disability: A double deficit perspective. *Journal of Learning Disabilities, 33*(4), 334–358.

Morris, R. D., Stuebing, K. K., Fletcher, J. M., Shaywitz, S. E., Lyon, G. R., Shankweiler, D. P., Katz, L., Francis, D. J. & Shaywitz, B. (1998). Subtypes of reading disability variability around a phonological core. *Journal of Educational Psychology, 90*(3), 347–373.

Manis, F. R. & Freidman, L. (2001). The relationship of naming speed to multiple reading measures in disabled and normal readers. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 65–92). Timonium, MD: York Press.

Manis, F. R., Seidenberg, M. S. & Doi, L. M. (1999). See Dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second graders. *Scientific Studies of Reading, 3*(2), 129–157.

McBride-Chang, C. & Manis, F. S. (1996). Structural invariance in the associations of naming speed, phonological awareness, and verbal reasoning in good and poor readers: A test of the double deficit hypothesis. *Reading and Writing: An Interdisciplinary Journal, 8,* 323–339.

Meyer, M. S., Wood, F. B., Hart, L. A. & Felton, R. H. (1998). Longitudinal course of rapid naming in disabled and nondisabled readers. *Annals of Dyslexia, 43,* 91–114.

Parrila, R., Kirby, J. R. & Mcquarrie, L. (2004). Articulation rate, naming speed, verbal short term memory, and phonological awareness: Longitudinal predictors of early reading development? *Scientific Studies of Reading, 8*(1), 3–26.

Rama. (1992). Handbook of Learning disability. Regional college of education. Mysore.

Rekha, D. (1997). Reading acquisition and metaphonological awareness : A longitudinal study. *Doctoral thesis submitted to university of Mysore.* Mysore.

Robertson, C. & Salter, W. (1997). *The phonological Awareness Test.* Austin, TX: Linguisystems. Inc.

Roopa. (1999). Test for reading and metaphonological skills in Malayalam. *An unpublished master's dissertation submitted to University of Mysore, Mysore.*

Scarborough, H. (1998a). Early identification of children at risk for reading disabilities. In Shapiro, B. K., Accardo, P. J. & A. J. Capute (Eds.), *Specific reading disability: A view of the spectrum* (pp. 75–119). Timonium, MD: York Press.

Schatschneider, C., Carlson, C. D., Francis, D. J., Foorman, B. R. & Fletcher, J. M. (2002). Relationship of rapid automatized naming and phonological awareness in early reading development: Implications for the double-deficit hypothesis. *Journal of Learning Disabilities, 35(3),* 245–256.

Semel, E., Wiing, E.H. & Secord, W.A. (1995). *Clinical Evaluation of Language Fundamentals-3.* San Antonio, TX: The Psychological Corporation.

Sonali nag (2007). Early reading in Kannada: the pace of acquisition of orthographic knowledge and phonemic awareness. *Journal of Research in Reading, 30,* 7–22.

Stefanou, C ., Vizy , T.W. & Barbara Peck . (2010). The Role of Phonemic Awareness, Phonological Recoding and Rapid Naming on Reading Comprehension Scores in Post-Primary Student. *Reading Intervention for Post-Primary Students, 2,* 1-21.

Stringer, R. & Stanovich, K. E. (2000). The connection between reaction time and variation in reading ability: Unraveling covariance relationships with cognitive ability and phonological sensitivity. *Scientific Studies of Reading, 4,* 41–53.

Suresh,P.A. & Swapna, S. (1997). An epidemiological survey of developmental language disorders and learning disabled among school children in Kerala. *Project report submitted to KRPLLD, CDL.*

Swathi, K. & Shyamala, K.C. (1994). Learning disability and concurrent factors ; An exploratory study. *Journal of All India Institute of Speech and Hearing, 24,* 34-39

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Burgess, S. & Hecht, S. (1997). Contributions of phonological awareness and rapid automatic naming ability to the growth of word-reading skills in secondto fifth-grade children. Scientific Studies of Reading, 1, 161-185.

Wagner, R. K. & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101,* 1–21.

Wagner, R. K., Torgesen, J. K., Laughon, P.,Simmons, K. & Rashotte, C.A. (1993). The development of young readers' phonological processing abilities. *Journal of Educational Psychology, 85,* 1–20.

Wagner, R. K., Torgesen, J. K., Rashotte, C., Hecht, S. A., Barker, T. A., Burgess, S. R.,Donahue, J. & Garon, T. (1997). Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A 5-year longitudinal study. *Developmental Psychology, 33*(3), 468–479.

Wagner, R. K., Torgesen, J. K., Rashotte, C., Hecht, S. A., Barker, T. A., Burgess, S. R., Donahue, J. & Garon, T. (1997). Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A 5-year longitudinal study. *Developmental Psychology, 33*(3), 468–479.

Wimmer, H., Mayringer, H. & Landerl, K. (2000). The double-deficit hypothesis and difficulties   in learning to read a regular orthography. *Journal of Educational Psychology, 92*(4), 668–680.

Wolf, M. & Bowers, P. G. (1999). The double deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91,* 415–438.

Wolf, M., Bowers, P. G. & Biddle, K. (2000). Naming-speed processes, timing, and reading: A conceptual review. *Journal of Learning Disabilities, 33,* 387–407.

LANGUAGE ABILITIES IN BILINGUAL CHILDREN WITH AUTISM (CWA)

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Abstract

Bilingual children with Autism (CWA) have a general language deficiency that manifests in every language and evidence is towards a positive attitude toward dual language learning. This study aims at examining the similarities and differences in linguistic characteristics between bilingual and monolingual CWA in the age range of 4-10 years, with a diagnosis of mild-moderate severity of autism and normal range of IQ with no associated deficits. The participants used language productively at least at the one word level and had been exposed to the languages since at least 15 months of age. Participants were matched based on socio-economic status on the NIMH SES Checklist (Venkatesan, 2009) and their language age on the Language Assessment Checklist (Swapna, Geetha, Prema & Jayaram, 2010). Phase I had consisted of collecting the social-demographic, educational and language proficiency by using a questionnaire developed for the purpose. In Phase II, standardized tests, semantics and syntax sections of the Linguistic Profile Test - Hindi (Karanth, Pandit, & Gandhi, 1986) and English Language Testing for Indian Children (ELTIC) by Bhuvaneshwari (2009), were administered. Both monolingual and bilingual CWA showed similar patterns of language deficits, within and among themselves. It was concluded that bilingualism had neither a positive nor negative effect on language abilities in CWA. This study supports the argument that parents' language practices are particularly influential in the case of CWA and that families should be encouraged to continue speaking their home-language, to ensure a high-quality social and language input during his/her language development.

Key words: Bilingualism, autism, language, socioeconomic status

Language is defined as a dynamical system that emerges within a social context through interactions of cognitive, neurobiological and environmental subsystems. The term bilingualism refers to individuals who use two or more languages or dialects in their everyday lives (Grosjean, 2010). Bilingualism and multilingualism are the norm rather than exception in today's world (Harris & McGhee-Nelson, 1992). It has been estimated that children who learn two languages before puberty are the majority worldwide (Tucker, 1998). Therefore, research at the interface of bilingual development and child language disorders would be relevant to a significant number of children across the globe. However, until recently, bilingual development and child language disorders have been investigated mainly in isolation of each other.

Although all bilingual children, by definition, acquire two languages, there are differences in their exposure patterns to both languages and in the social contexts in which they are acquiring those languages that influence their development. Researchers often make a distinction between simultaneous and sequential bilingualism at three years (Genesee, Paradis, & Crago, 2004). Simultaneous bilinguals are children who acquire both languages at home before the age of 3 years (often from birth) and sequential bilinguals have the first language (L1) fairly established (although not completely acquired) before they

begin to acquire the second language (L2). Bilingual children tend to be more proficient or dominant in one of their languages. The dominant language is usually the language for which they have received the greatest amount of exposure (Genesee et al., 2004).

Literature says that bilingualism is associated with more effective cognitive processing than monolingualism. The assumption is that the constant management of two competing languages enhances "executive functions" (Bialystok, 2001). Bilingual cortical organization (Kim, Relkin, Lee, & Hirsch, 1997; Perani, Paulesu, Galles, Dupoux, Dehaene, Bettinardi, 1998; Vaid & Hull, 2002; Marian, Spivey, & Hirsch, 2003), lexical processing (e.g., Chapnik-Smith, 1997; Kroll & de Groot, 1997; Chen, 1992), and phonological and orthographic processing (e.g., Macnamara & Kushnir, 1971; Doctor & Klein, 1992; Grainger, 1993; Marian & Spivey, 2003) have all been found to differ depending on bilinguals' ages of language acquisition, mode(s) of acquisition, history of use, and degree of proficiency and dominance.

Research has shown that bilingual children usually exhibit the same rates and stages of development as monolingual children with respect to phonology and grammar (Oller & Eilers, 2002; Genesee et al., 2004). With regard to vocabulary, bilinguals tend to have smaller vocabularies in each of their languages compared

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to monolingual children (Pearson, Fernandez, & Oller, 1993; Genesee et al., 2004). Chengappa & Ray (2007) compared typically developing monolingual and bilingual children's performance in Kannada, which revealed a better performance by monolinguals but no significant difference in performance.

With regard to the relationship between language impairments and bilingualism, several studies have looked specifically at the bilingual language development of children with Down Syndrome and children with Specific Language Impairment (Thordardottir, Weismer, & Smith, 1997; Kay-Raining Bird, Trudeau, Thordardottir, Sutton, & Thorpe, 2005). A comparative research on the language abilities of mono and bilingual children with Down Syndrome by Kay-Raining Bird et al., in 2005 indicated similar lexical profiles. Feltmate and Kay-Raining Bird (2008) studied the vocabulary and morphosyntactic skills of bilingual children with Down Syndrome and found no consistent effect of bilingualism. The general finding is that, if given similar opportunities, children with language impairment can indeed acquire two languages. They may acquire language at a slower pace and perhaps to a lesser extent than their typically developing bilingual peers, but they do acquire language to the same level as their monolingual peers with language learning difficulties (Kohnert, 2007).

Autism is a neurodevelopmental disorder characterized by primary impairments in social interactions, communication, and repetitive and stereotyped behaviors (American Psychiatric Association, 2000). Approximately 20% of individuals with Autism function within the normal range on IQ tests (American Psychiatric Association, 1994; Cohen & Volkmar, 1997).

Petersen's (2003) investigation of the lexical production skills of bilingual English-Chinese and monolingual English preschool-age children with autism revealed that bilingual and monolingual participants had equivalent English production vocabularies, and that bilinguals had larger conceptual production vocabularies than monolinguals. Bilingual participants had a larger number of verbs in their conceptual production vocabularies, and were found to have higher vocabulary comprehension scores and higher language scores. There were no significant differences in the size of production vocabularies and vocabulary comprehension scores. Valicenti-McDermott, Schouls, Molly, Tarshis, Seijo, and Shulman (2008) and Hambly and Fombonne (2009) concluded that bilingualism had neither a positive or negative effect on language development in preschool children with autism.

Bilingual families of CWA are often advised by child development professionals to speak only one language to their child (Kremer-Sadlik, 2005; Besnard, 2008; Leadbitter, Hudry, & Temple, 2009). Many parents and professionals believe that bilingual exposure negatively impacts language development, especially for children with autism (Hambly & Fombonne, 2009). While research has explored the impact of bilingualism and multilingualism on the language development of children with language impairments (Thordardottir, Ellis Weismer, & Smith, 1997; Kay-Raining Bird, et al., 2005; Kohnert, 2007), there is a limited amount of research on bilingualism and the autism population especially in Indian contexts. Such a study would also augment the present understanding of verbal behavior of children with autism.

Research that has examined the effect of bilingualism on children with language impairment has found that (a) children with Specific Language Impairment (SLI) do not experience more severe impairments than same age monolingual children with SLI, and (b) these children have the capacity to become bilingual (Paradis, Crago, Genesee, & Rice, 2003). Additionally, research on monolingual and bilingual children with Down Syndrome found no evidence that bilingualism had a negative effect on language development (Kay-Raining Bird et al., 2005). But there is a dearth of Indian studies investigating the same.

In the Indian context, the English-only advice causes difficulties for families as it is impossible for adults to change the language they have always spoken. There is evidence that parents in such a situation frequently mix English and the home language, and that overall the language environment may become less stimulating. Thus, the parents' level of proficiency and use of both the languages plays a major role in deciding the language environment and exposure of children with autism.

Aim of the study: This study aims at examining the similarities and differences in linguistic characteristics between bilingual and monolingual children with autism.

Objectives of the study: The current study is aimed to address the following research questions:

1. Do the English language abilities of bilingual children with autism differ from those of monolingual children with autism?

2. How do the semantic and syntactic abilities of bilingual children with autism differ from those of monolingual children with autism?

3. Do the English and Hindi language abilities of bilingual children with autism differ?

Method

Subjects: The present study was designed to compare language among three groups of CWA: Hindi monolingual (MH), English monolingual (ME), and Hindi-English bilingual (BA). All the children were in the age range of 4-10 years (6 males and 4 females). A Speech Language Pathologist along with a Clinical Psychologist confirmed the diagnosis of Autism according to the *Diagnostic and Statistical Manual for Mental Disorders–Fourth Edition* (American Psychiatric Association, 1994). All children had a mild-moderate severity of autistic symptoms on the Childhood Autism Rating Scale (Schopler, Reichler, & Renner, 1986) and an average range of IQ, as assessed by a certified Clinical Psychologist and it was ensured that they had no associated visual or hearing deficit. Monolingual participants (ME & MH) were from predominantly English/Hindi-speaking homes with exposure to the respective language since at least 15 months of age. Bilingual participants (BA) had been exposed to two languages, with one language being Hindi and the other being English, since at least 15 months of age. The participants used English or both Hindi-English productively at least at the one word level. Participants of both the groups were matched on socio-economic status based on the NIMH SES Checklist (Venkatesan, 2009) and their language age as assessed by the Language Assessment Checklist (Swapna, Geetha, Prema & Jayaram, 2010). Duration of therapeutic intervention for all the participants ranged from six months to two years.

Procedure: This study was carried out in two phases: Phase I consisted of collecting the social-demographic, educational and language proficiency by using a questionnaire developed for the purpose (attached as appendix).

Phase II consisted of administering the semantics and syntax sections of the Linguistic Profile Test - Hindi (LPT - Karanth, Pandit, & Gandhi, 1986) and English Language Testing for Indian Children (ELTIC) by Bhuvaneshwari (2009).

Results and Discussion

Sample size of the study consisted of fifteen CWA (8 males and 7 females).

Table 1: *Age and gender characteristics of the three participant groups*

Groups of Participants	Number of Participants	Gender Distribution	Chronological Age of Participants (in years)	
			Mean	Standard deviation
Bilingual Hindi-English (BA) group	5	3 Males 2 Females	7.80	1.30
Monolingual English (ME) group	5	3 Males 2 Females	6.48	2.35
Monolingual Hindi (MH) group	5	2 Males 3 Females	6.48	1.92

A comparison of the means of the participant groups revealed no significant differences between the chronological age of the participants across the three groups. Thus the groups were matched across age.
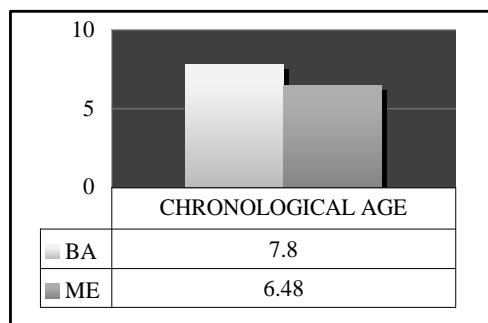
Figure 1: *Chronological age of participants across the two groups*

The three language groups (BA, ME & MH) were compared with respect to parent education scores and parent occupation scores.

Table 2: *Parental education-occupation data*

Group	Parental Education Scores		Parental Occupation Scores		Parental Income Scores	
	Mean	S.D*	Mean	S.D	Mean	S.D
BA	8.20	1.09	4.20	0.44	13	1.58
ME	8.60	1.51	5.40	2.07	13	1.58
MH	6.00	1.22	3.20	0.44	11.2	1.30

*Standard deviation

A Pearson's correlation analysis between these variables revealed a statistically significant positive correlation (0.731) between the parental education and parental occupation scores at the 0.01 level (2-tailed) for all the language groups. Studies have shown that most children in low-income families have parents without any college education and higher education leads to higher earnings (Maag & Farrar, 2002). A comparison of the means revealed no significant differences between the variables of parent education and occupation scores across BA and ME, i.e., Socioeconomic Status of the participants is

matched across the participants of these two sets. A study done by Cortina, Garza and Pinto (2000) found that bilingualism is associated with higher income. But parental education and occupation scores were found to be lowest in case of the monolingual Hindi group. A statistically significant difference was found. Cortina, Garza and Pinto (2000) found that income decreased monotonically as the ability to speak English fell, which was consistent.
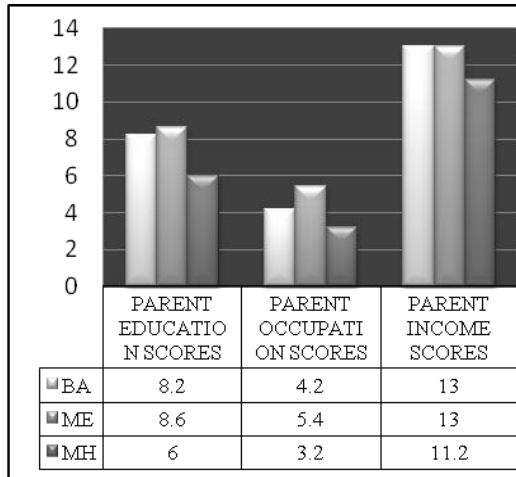
Figure 2: *Education, occupation and income scores parents' of participants*

A comparison of receptive and expressive language ages of Monolingual English (ME) CWA group in English revealed comparable scores, with slightly better receptive age means. Proficiency scores showed a slight statistically insignificant paternal advantage with greater variability in maternal proficiency scores. The receptive (0.745) and expressive (0.646) language age of the participants also showed a statistically significant positive correlation with parental education scores at the 0.05 level. It was observed that mother's and father's levels of education are significant predictors of child's language (Pancsofar & Feagans, 2006).

The participants' scores on the first four sections of the hierarchy, i.e., verbs, categories, functions and opposites are significantly greater than the

rest of the sections. CWA have serious problems learning concrete nouns (Tager-Flusberg, 1991). The ELTIC morphology and syntax sub-section scores reveal that scores of verb tenses were significantly greater than all of the other sections. CWA had difficulties using noun-related morphemes (plural -s) and production of comparative and superlative forms (Baer & Guess, 1971). A comparison of the semantics and syntax-morphology sections of ELTIC reveal significantly better semantic scores (t value = 4.863). This can be supported by research from other language impaired population of Down syndrome and SLI (Clahsen, 1991; Grimm, 1993; Grela, 2002).

Table 3: *Language Age Data of the ME CWA Group*

Language age	Mean	S.D.	Median
Comprehension	10.60	1.14	11.00
Expression	9.80	0.83	10.00
Parental proficiency			
Father's Proficiency Scores	14.20	2.48	16.00
Mother's Proficiency Scores	13.80	3.03	16.00
ELTIC Scores of Semantic Section	68.05	9.77	63.89
Verbs	82.22	12.66	77.78
Categories	73.33	18.59	77.78
Functions	73.33	25.58	77.78
Opposites	68.89	21.37	66.67
Colours & quantity	64.44	9.29	66.67
Nouns	64.44	19.87	66.67
Body parts	62.22	14.90	55.56
Prepositions	55.55	7.85	55.56
ELTIC morphology and syntax scores	32.00	13.39	26.67
Verb Tenses	55.55	15.71	66.67
Subject Verb Agreement & Negation	31.11	21.37	22.22
Sentence Repetition & Judgment	31.10	14.48	33.33
Pronouns	24.44	27.66	22.22
Plural, Comparatives & Superlatives	17.77	9.93	11.11
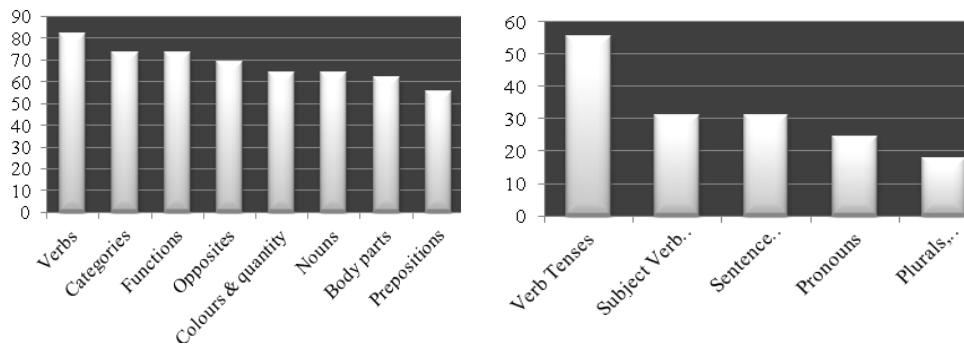
Figure 3: *ELTIC scores of ME CWA*

Monolingual Hindi (MH) CWA group:
Parental Proficiency scores were uniform across both parents.

Table 4: *Data of MH CWA*

Language Age-Hindi	MH		
	Mean	S.D.	Median
Comprehension	11.00	1.22	11.00
Expression	10.20	0.83	10.00
Parental Proficiency-Hindi			
Father's Proficiency Scores	14.40	2.30	16.00
Mother's Proficiency Scores	14.40	2.30	16.00
Semantic subsection	47.60	11.78	51.00
Naming	64.00	16.73	70.00
Semantic Discrimination	61.33	12.82	66.67
Lexical Category	53.33	12.47	53.33
Polar Questions	48.00	8.36	50.00
Paradigmatic Relations	40.00	14.14	40.00
Antonymy	36.00	16.73	40.00
Semantic Anomaly	36.00	16.73	40.00
Homonymy	32.00	10.95	40.00
Semantic Similarity	32.00	10.95	40.00
Synonymy	28.00	17.88	40.00
Syntagmatic Relations	28.00	17.88	40.00
Semantic Contiguity	22.00	14.83	20.00
Syntax subsection	34.60	9.60	37.00
Plural Forms	56.00	21.90	60.00
Transitive, Intransitives, Causatives	56.00	20.73	60.00
Predicates	56.00	11.40	60.00
PNG Markers	48.00	13.03	50.00
Case Markers	44.00	20.73	50.00
Tenses	40.00	14.14	40.00
Conjunctions, Comparative, Quotatives	36.00	15.16	30.00
Sentence Types	20.00	10.00	20.00
Participial Constructions	20.00	10.00	20.00
Conditional Clauses	16.00	11.401	20.00

The LPT semantic sub-section scores revealed that scores on the first three sections of the hierarchy, i.e., Naming, Semantic Discrimination and Lexical Category were significantly greater than the rest of the sections. Evidence from autism suggests a sparing of lexical and semantic memory (Shalom, 2003). The Syntax section showed a uniform distribution with significantly lower scores in the sections assessing Sentence types, Participial Constructions and Conditional Clauses. Roberts et al. (2004) suggested that the data supported a specific morphology deficit within more general language impairment in CWA. The autism group exhibited specific delays in grammatical complexity (Eigsti et al., 2007). A comparison of the semantics and syntax sections of LPT revealed no significant differences across the two language skill areas. Studies have found that patterns in syntax are consistent with the patterns noted for other language domains in CWA (Tager-Flusberg et al., 1990; Tager-Flusberg, 1994).

The language age scores across the two languages of the Bilingual Hindi-English (BA) group revealed that the participants were balanced bilinguals. The parental proficiency scores indicated that both the parents were Hindi Dominant bilinguals. Several case studies indicated that monolingual dominant parents had successfully raised balanced bilingual children (Kamada, 1997; Arnberg, 1987; Cunningham-Andersson & Andersson, 2004).

The ELTIC semantic sub-section scores revealed that the scores on Preposition section were significantly lower than all the other sections.
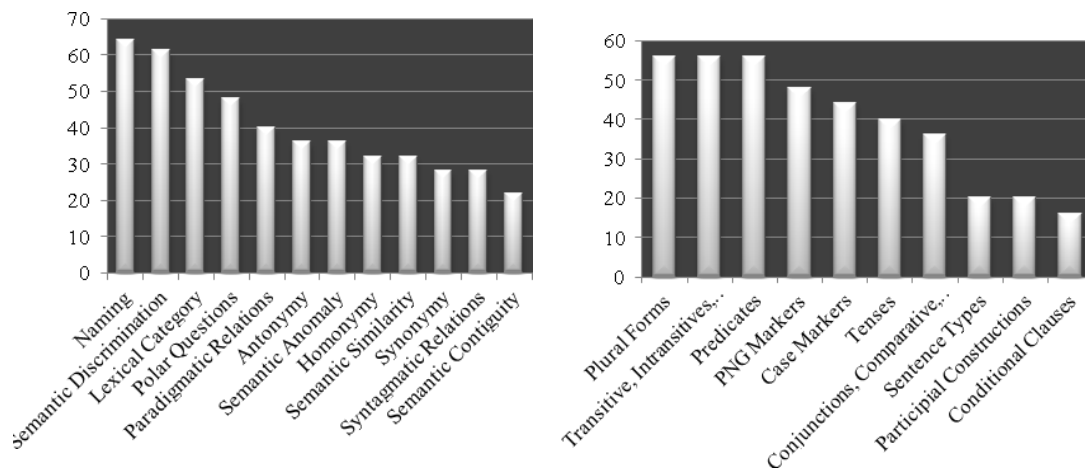
Figure 4: *LPT scores of MH CWA*

The difficulty that individuals with autism and related disorders tend to have with prepositions could be a result of deficits in cognitive processing and/or auditory delays (Hermelin & O'Connor, 1970).

Table 5: *Data of BA CWA*

Language Age	English		
	Mean	S.D.	Median
Comprehension	10.4	1.34	11.00
Expression	9.8	0.83	10.00
Parental Proficiency			
Father's Proficiency Scores	12.0	2.54	12.00
Mother's Proficiency Scores	9.2	3.63	9.00
ELTIC Semantic subsection	60.2	17.61	58.33
Verbs	71.1	16.84	66.67
Body parts	71.1	26.75	77.78
Colours & quantity	71.1	16.85	77.78
Nouns	66.6	26.05	55.56
Opposites	64.4	25.33	66.67
Functions	51.1	23.04	44.44
Categories	44.4	24.84	44.44
Prepositions	42.2	21.37	44.44
ELTIC Syntax subsection	39.5	29.62	42.22
Verb Tenses	60.0	36.51	66.67
Pronouns	60.0	54.77	100.00
Sentence Repetition & Judgement	48.8	21.66	55.56
Plural, Comparatives & Superlatives	22.2	43.74	0.00
Subject Verb Agreement & Negation	11.1	19.24	0.00

The ELTIC morphology and syntax sub-section scores reveal significantly lesser scores on Subject Verb Agreement and Negation than all of the other sections. It is possible that the burden of acquiring the two distinct systems of English and Hindi could slow down the acquisition process in bilingual children, causing them to be behind monolingual children in their overall progress in grammatical development. A comparison of the semantics and syntax-morphology sections of ELTIC revealed no significantly differences between the scores. Studies have found that patterns in syntax may be consistent with the patterns noted for other language domains in CWA (Tager-Flusberg, 1994; Tager-Flusberg et al., 1990).

The LPT semantic sub-section scores reveal that the scores of the sections assessing Semantic Anomaly, Homonymy, Lexical Category, Semantic Discrimination and Semantic Contiguity were found to be significantly weaker areas than the remaining sections of LPT. With respect to the linguistic variability inherent in a bilingual–monolingual comparison, the expectation that bilinguals will behave like monolinguals is highly suspect on both practical and theoretical grounds (Reyes, 1995; Grosjean, 1992, 1997; Hernandez, Bates, & Avila, 1994; Gutierrez-Clellen, 1996; Paradis, 1997). The LPT syntactic sub-section scores revealed a uniform distribution across all the subsections.
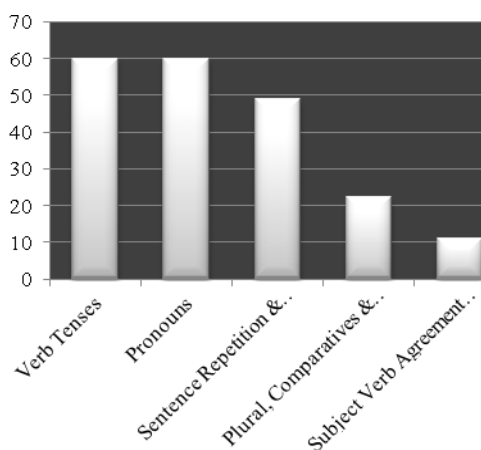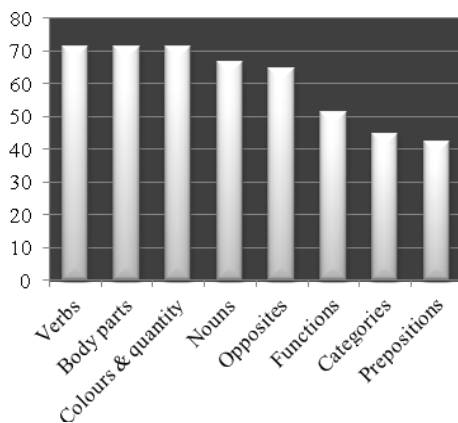
Figure 5: *ELTIC scores of BA CWA*

Dehaene et al. (1997) and Kim, Relkin, Lee, and Hirsch (1997) suggest that when the second language is not completely mastered or when it is learned late in life, differences result from syntactic but not from phonetic nor from semantic processing (Wartenburger et al., 2003). A comparison of the semantics and syntax

sections of LPT reveal no significant differences across the two language skill areas. Wartenburger et al. (2003) found that while semantic tasks were largely dependent on proficiency level; age of acquisition mainly affected the grammatical processes.
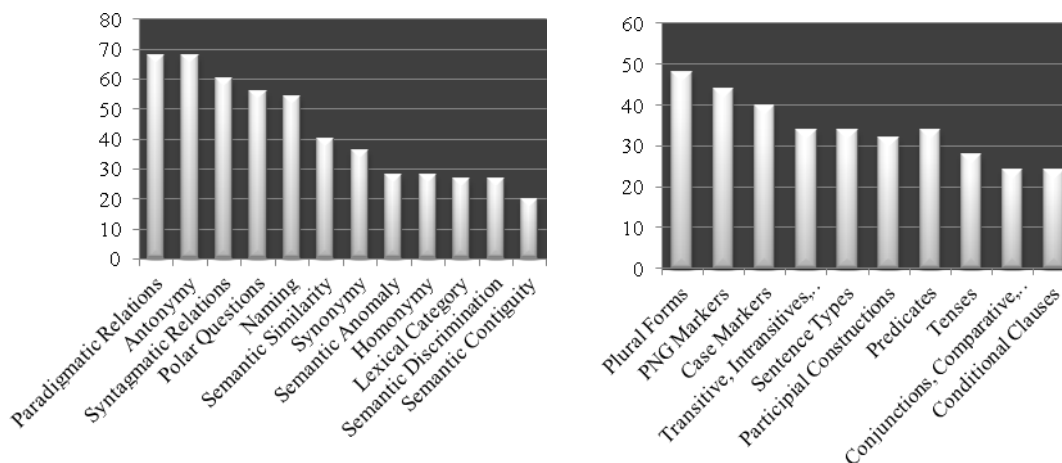
Figure 6: *LPT scores of BA CWA*

Table 6: *Data of BA CWA*

Language Age	Hindi		
	Mean	S.D.	Median
Comprehension	10.40	1.34	11.00
Expression	9.80	0.83	10.00
Parental Proficiency			
Father's Proficiency Scores	15.80	0.44	16.00
Mother's Proficiency Scores	16.00	00.00	16.00
LPT Semantics subsection	41.80	12.91	36.00
Paradigmatic Relations	68.00	22.80	60.00
Antonymy	68.00	10.95	60.00
Syntagmatic Relations	60.00	24.49	60.00
Polar Questions	56.00	16.73	60.00
Naming	54.00	17.10	50.00
Semantic Similarity	40.00	28.28	20.00
Synonymy	36.00	16.73	40.00
Semantic Anomaly	28.00	10.95	20.00
Homonymy	28.00	17.88	40.00
Lexical Category	26.66	22.60	20.00
Semantic Discrimination	26.66	29.81	6.67
Semantic Contiguity	20.00	14.14	20.00
LPT Syntax subsection	29.80	10.94	0.00
Plural Forms	48.00	30.33	40.00
PNG Markers	44.00	18.16	50.00
Case Markers	40.00	18.70	30.00
Transitive, Intransitives, Causatives	34.00	16.73	30.00
Sentence Types	34.00	11.40	30.00
Participial Constructions	32.00	13.03	30.00
Predicates	34.00	15.16	30.00
Tenses	28.00	10.95	20.00
Conjunctions, Comparative, Quotatives	24.00	11.40	20.00
Conditional Clauses	24.00	5.47	20.00

A comparison across the semantic and syntax areas of Hindi and English language of the balanced bilingual participants in this study revealed no statistically significant differences across their semantic and syntactic abilities in both the languages. There is considerable evidence of an overlap in the lexicon of bilingual children's two languages, differing from child to child (Umbel, Pearson, Fernandez, & Oller, 1992).

An across groups' comparison of Monolingual Hindi (MH) and Bilingual Hindi-English (BA) group across language age and across parental proficiency scores in Hindi showed no statistically significant differences among these variables. The most influential factor in bilingual language acquisition was the languages spoken by parents and by others with whom the child comes into contact (Romaine, 1989). The semantic section reveals significantly greater scores of the bilingual participants in the sub sections of Lexical Category, Antonymy, Paradigmatic Relations and Syntagmatic Relations. Recent research suggests that bilinguals tested in their native language outperform monolingual adults on word-learning tasks (Sheng, Bedore, & Peña, 2008). Kaushanskaya and Marian (2009) found that bilingualism facilitates word-learning performance. The comparisons on syntax section across the BA and MH group reveals significantly poorer performance of the bilingual children in the sub section of Predicates only. Grosjean (1999) had concluded that often one of the bilingual's languages is mastered only to a certain level of proficiency which surfaces as the person's inter-language (also known as within-language) deviations. The overall data reveals no statistically significant differences between the

bilingual and monolingual groups in Hindi language across both sections of Semantics and Syntax. Sheng, McGregor, and Marian (2006) found that bilingual children's semantic abilities were relatively unaffected by the exposure and use of a second language, thus putting them at an equal level with their monolingual peers.

The Monolingual English (ME) and Bilingual Hindi-English (BA) group were matched in language ages in both the receptive and expressive domains. A comparative analysis revealed differences in parents' proficiency scores across the bilingual and monolingual groups, with parents' of monolingual English participants scoring better. The statistical analysis (Wilcoxson Test) revealed that the bilingual and monolingual participants scored equally well on all the tasks of the semantic and syntax subsections of ELTIC. Research has provided evidence to state that bilinguals approach or meet monolingual levels of performance toward the end of elementary school (Oller & Eilers, 2002; Marchman et al., 2004; Gathercole & Thomas, 2005; Thordardottir et al., 2006; Gathercole, 2007; Nicoladis et al., 2007).

All language and communication domains were not equally affected in CWA. Whereas impairments were consistently observed in ''pragmatics'', ''lexical'' abilities involving individual words were generally spared (Walenski et al., 2006). In autism it has been predicted that aspects of declarative memory, in particular lexical and semantic memory, may not only be spared, but perhaps even enhanced (Walenski et al. 2006). Semantic judgment tasks require metalinguistic abilities and have been used and the findings by Doherty and Perner (1998) confirm that metalinguistic awareness deficits are related to the theory of mind.

Syntax and morphology might present as 'islands' of specific impairment in autism – a 'delay within a delay' (Roberts, Rice & Tager-Flusberg, 2004) – within the more generally impaired domain of language. Due to the phenomenon of Cross-linguistic influence (Paradis & Genesee, 1995), the two languages in a bilingual context might not be processed in isolation from each other and it could emerge as facilitation/acceleration, delay or transfer (Paradis & Genesee, 1995). But a number of researchers have also concluded that syntactic deficits are not central to the communicative impairments in ASD (Howlin, 1984).

Gawlitsek-Maidwald and Tracey (1996) argued that semantic knowledge in both of a bilingual's languages may actually cause boosts in productivity across syntactic systems. A

bilingual child catches up to his or her monolingual peers with time in which the two languages are bonded together by means of the child's cognitive and semantic processing (Gathercole, 2007). Many studies have shown that children from bilingual backgrounds tend to score lower on standardized vocabulary tests in comparison to monolingual children (Duran, 1988; Saville-Troike, 1991; O'Brien, 1992; Valdes & Figueroa, 1993; Pefia & Quinn, 1997). The reason for this seems to be that bilingual children have to learn two different labels for everything, which reduces the frequency of a particular word in either language (Ben Zeev, 1977). Pearson, Fernández, and Oller (1993) found that when they compared the total number of unique words they produced across the two languages, their scores were more comparable to the monolingual norms. A large body of research has shown that bilingual children have better cognitive and linguistic abilities compared to their monolingual peers, including higher levels of metalinguistic awareness of words (Ben-Zeev, 1977; Rosenblum & Pinker, 1983).

According to the Bilingual Advantage hypothesis, early awareness that different words can label the same concept may drive early development of semantic relations in the lexicon of the bilingual child (Cummins, 2001; Vygotsky, 1962). Hence, bilingual children may have a more developed semantic network than monolingual age-mates. Thus early childhood bilingualism may alter development of control. This increased attention and focus may enhance cognitive skills and serve as an added benefit to bilingual CWA. Bialystok and Martin (2004) suggested that the semantic structure of a bilingual person might be more hierarchical than that of a monolingual person, predicting that words exist at a higher or more abstract level than the concrete connection of simply a word and its meaning.

Conclusions

The absence of a pattern of difference in semantics and morphosyntax between mono and bilingual children provides evidence that the introduction of a second language seems to have no detrimental effect on the development of the stronger language. It was concluded that bilingualism had neither a positive or negative effect on language abilities in children with autism. This study also provides additional support for the argument that parents' language practices are particularly influential in the case of children with autism. In this respect, the results parallel the findings regarding language and developmental impairment in the studies by Paradis et al. (2003) and Kay-Raining Bird et al. (2005). The present study also adds to earlier

findings by using a systematic, comprehensive set of language test to study the combined effects of bilingualism and language impairment. The present study did not find significant evidence of a selective interaction of bilingualism and language impairment on any type of task. This study suggests that CWA have the potential to be bilingual, and that speaking Hindi at home and English in school and in therapy should not be considered a disadvantage to the language development of CWA. Support for two languages does not necessarily mean treating both in the same way at the same time, but that goals be consistent with the child's previous experiences and current and future needs (Kohnert, 2007).

Limitations

Single-language measures ignore the fact that bilingual children may choose to use different words depending on the setting, interlocutor, and context (Iglesias, 2001) as well as their cultural experiences (Peña, 2001). There are multiple outside variables including general language differences, the interrelationship of culture/language, socioeconomic status, as well as the age of participants. One must consider that languages are all very different. Therefore, the structure of the languages being learned plays a significant role in the development of a bilingual individual (Gathercole, 2007). A research study or task may be given in both languages, yet still present unseen favoritism to the underlying structure of one language or another, thereby leading to false or abated results for certain bilingual populations. Another influential environmental factor that may have had a role in the current findings is the role that socioeconomic status (SES) plays in effecting language development for children. In the present study, the possibility cannot be excluded that monolingual children could have had some knowledge of the other language. The different amount of speech-language therapy and behavioral therapy between the two groups may also be seen as a limitation. Finally, the sample size of the current study is small and it is possible that the sample may not be fully representative of the bilingual English-Hindi community in India. Anecdotal evidence tells us that there is a notion of perceived shame around having a CWA in the Asian community.

Implications and Future Directions

This study can assist early educators in developing appropriate curriculum for these children, supporting development in both languages. It shall also create awareness of the importance of testing both languages of bilinguals in order to assess true vocabulary knowledge of these children. The data of this study is valuable to evaluate more exactly the relative strengths in Hindi and English of the bilingual children. Future studies should focus on making tests as unbiased and impartial between both languages as possible (Pena, Bedore, & Rappazzo, 2003). Studies in other languages are needed to unravel whether the present findings are uniquely characteristic for Hindi-English bilingual children. There is a need to determine levels of bilingualism in greater detail. It's important to compare bilingual children with autism to normally developing bilingual children. There is a need to determine if bilingual children with Autism show evidence of enhanced executive functions. Future studies should focus on identifying the predictors of success. Investigate the possibility of facilitative cross-linguistic interactions in the morphosyntactic development of bilingual children, with and without autism.

References

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.

Arnberg, L. (1987) Raising Children Bilingually: The Preschool Years. Clevedon: Multilingual Matters.

Baer, D. M. & Guess, D. (1971). Receptive training of adjectival inflections in mental retardates. *Journal of Applied Behavior Analysis,* 4, 129-139.

Ben-Zeev, S. (1977). The influence of bilingualism on cognitive strategy and cognitive development. *Child Development, 48*(3), 1009-1018.

Besnard, C. (2008) . *The learning of foreign languages by high functioning autistic children.* Poster session presented at the annual meeting of the International Society for Autism Research, London.

Bhuwaneshwari (2009). English Language Testing for Indian Children, Dissertation submitted as a part fulfillment to the University of Mysore.

Bialystok, E. (2001). *Bilingualism in development: Language, literacy and cognition.* NewYork: Cambridge University Press.

Chapnik-Smith, M. (1997). How do bilinguals access lexical information? In A. de Groot & J. F. Kroll (Eds.), *Tutorials in bilingualism* (pp. 145–168). Mahwah, NJ: Erlbaum.

Chengappa, S. & Ray, J. (2007) A tachistoscopic study of monolingual and bilingual children. *Journal of All India Institute of Speech and Hearing*, 26, 86-93.

Chen, H. C. (1992). Lexical processing in bilingual or multilingual speakers. In R. J. Harris (Eds.),

Cognitive processing in bilinguals (pp. 253–264). Amsterdam: Elsevier.

Clahsen, H. (1991). *Child Language and Developmental Dysphasia*. Amsterdam: John Benjamins

Cohen, D. J., & Volkmar, F. R. (1997). *Handbook of Autism and Pervasive Developmental Disorders* (Eds.). New York: John Wiley & Sons.

Cortina, J., Garza, R., & Pinto, P.M. (2000). No Entiendo: The Effects of Bilingualism on Hispanic Earnings. http://www.stat.columbia.edu/~gelman/stuff_for_blog/rudy.pdf

Cummins, J.: 2001, Negotiating Identities: Education for Empowerment in a Diverse Society, (second edition), California Association for Bilingual Education, Los Angeles.

Cunningham-Andersson, U. and Andersson, S. (2004) Growing up with Two Languages: A practical Guide, Routledge

Dehaene, S., Dupoux, E., Mehler, J., Cohen, L., Paulesu, E., Perani, D., et al. (1997). Anatomical variability in the cortical representations of first and second languages. *Neuroreport*; 8: 3809-15.

Doctor, E., & Klein, D. (1992). Phonological processing in bilingual word recognition. In R. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 237–252). Amsterdam: Elsevier.

Duran, E. (1988). Teaching the moderately and severely handicapped student and autistic adolescent: With particular attention to bilingual special education. Springfield, IL: Charles C. Thomas Publisher.

Eigsti, I.M., Bennetto, L. & Dadlani, M.B. 2007. Beyond Pragmatics: Morphosyntactic Development in autism. *J Autism Develop Disord*, Vol.37, No.3,(September, 2007), pp.1007-1023. ISSN 0162-3257.

Feltmate, K., & Kay-Raining Bird, E. (2008). Language learning in four bilingual children with Down syndrome: A detailed analysis of vocabulary and morphosyntax. *Canadian Journal of Speech-Language Pathology and Audiology, 32,* 6-20.

Gathercole S. E. (2007). Working memory and language. In G. Gaskell (Ed.), *Oxford Handbook of Psycholinguistics*. Oxford University Press.

Gawlitzek-Maiwald, & Tracy, R. (1996). "Bilingual Bootstrapping." *Linguistics 34-5*, 901-926.

Genesee, F., Paradis, J. & Crago, M. (2004). *Dual language development & disorders: A handbook on bilingualism & second language learning.* Baltimore: Paul H. Brookes Publishing Co.

Grainger, J. (1993). Visual word recognition in bilinguals. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 11–26). Amsterdam: John Benjamins.

Grimm, H. (1993). Patterns of Interaction and communication in Language Development Disorders . In G.Blanken , J. Dittman, H. Grimm, J.D. Marshall, & C.W. Wallesch (Eds.), *Linguistic disorders and pathologies: An international handbook* (pp. 691-711). Berlin: de Gruyter.

Grosjean, F. (1982). *Life with Two Languages: An Introduction to Bilingualism*. Cambridge, Mass: Harvard University Press, 370.

Grosjean, F. (1989). The bilingual as a person. In Titone, R. (Ed.), *On the Bilingual Person*. Ottawa: Canadian Society for Italian Studies.

Grosjean, F. (1992). Another view of bilingualism. In Harris, R. (Ed.). *Cognitive Processing in Bilinguals*. Amsterdam: North-Holland.

Grosjean, F. (1997). The bilingual individual. *Interpreting*, *2*(1/2), 163-187.

Grosjean, F. (1998). Transfer and language mode. *Bilingualism: Language and Cognition*, *1*(3), 175-176.

Grosjean, F. (1999). Bilingualism: a communicative competence in its own right. *Educateur Magazine*, *12*, 18-21.

Grosjean, F. (2010). *Bilingual: Life and Reality*. Cambridge, MA: Harvard University Press.

Gutiérrez-Clellen, V. F. (1996). Language diversity: Implications for assessment. In K. N. Cole, P. S. Dale, & D. J. Thal (Eds.), *Assessment of communication and language* (pp. 29–56). Baltimore, MD: Paul H. Brookes.

Hambly, C., & Fombonne, E. (2009). *The impact of bilingual exposure on the expressive language of children with autism spectrum disorders.* Poster session presented at the annual meeting of the International Society for Autism Research, Chicago.

Harris, R. J., & McGhee-Nelson, E. M. (1992). Bilingualism: Not the exception any more. In R. Harris (Eds.), *Cognitive processing in bilinguals* (pp. 3–14). Amsterdam: Elsevier.

Hermelin, B. &. O' Connor, N. (1970). *Psychological experiments with autistic children*, by Oxford, New York, Pergamon Press.]

Hernandez, A., Bates, E., & Avila, L. (1994). On-line sentence interpretation in Spanish-English bilinguals: What does it mean to be "in between"? *Applied Psycholinguistics, 15,* 417-446.

Iglesias, A. (2001). Narrative transcription accuracy and reliability in two languages. Topics in Language Disorders, 28, 178–188.

Kamada, L. (1997). *Bilingual Family Case Studies (Vol. 2). Monographs on Bilingualism No. 5.* Japan: Japan Association of Language Teachers Bilingualism Special Interest Group.

Karanth P., Pandit, & Gandhi, (1986). Normative Studies of Language Development in Children. Report of the Workshop on Developmental Norms for Children, NIPCCD: New Delhi.

Kay-Raining Bird, E., Trudeau, N., Thordardottir, E., Sutton, A., & Thorpe, A. (2005). The language abilities of bilingual children with Down syndrome. *American Journal of Speech-Language Pathology, 14,* 187-199.

Kim, K. H. S., Relkin, N. R., Lee, K. M., & Hirsch, J. (1997). Distinct cortical areas associated with native and second languages. *Nature, 388,* 171–174.

Kohnert, K. (2007). *Language disorders in bilingual children and adults*. San Diego, CA: Plural Publishing Inc.

Kim, K. H. S., Relkin, N. R., Lee, K. M., & Hirsch, J. (1997). Distinct cortical areas associated with native and second languages. *Nature*, 388, 171–174.

Kremer-Sadlik, T. (2005). To be or not to be bilingual: Autistic children from multilingual families. In J. Cohen, K. T. McAlister, K. Rolstad, & J. MacSwan (Eds.), *Proceedings of the 4th International Symposium on Bilingualism* (pp. 1225-1234). Somerville, MA: Cascadilla Press.

Kroll, J. F., & de Groot, A. M. B. (1997). Lexical and conceptual memory in the bilingual: Mapping form to meaning in two languages. In A. de Groot & J. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 169–199). Mahwah, NJ: Erlbaum.

Leadbitter, K., Hudry, K., & Temple, K. (2009). *Does bilingualism affect language development in young children with autism?* Poster session presented at the annual meeting of the International Society for Autism Research, Chicago.

Maag, L., & Farrar, M. J. (2002). Early language development and the emergence of a theory of mind. *First Language*, 22, 197–213.

Macnamara, J., & Kushnir, S. (1971). Linguistic independence of bilinguals: The input switch. *Journal of Verbal Learning and Verbal Behavior*, 10, 480–487.

Marian, V., Blumenfeld, H. K., & Kaushanskaya, M. (2003). Developing a language experience and bilingual status questionnaire. Poster presented at the annual meeting of the Midwestern Psychological Association, Chicago.

Marian, V., & Spivey, M. (2003). Competing activation in bilingual language processing. *Bilingualism: Language and Cognition*, 6, 97–115.

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eye tracking and brain imaging. *Brain and Language*, 86, 70–82.

Oller, D.K., & Eilers, R. E. (2002). *Language and literacy in bilingual children*. Clevedon, England; Multilingual Matters.

Pancsofar, N., & Feagans L. (006) Mother and father language input to young children: Contributions to later language development. *Journal of Applied Developmental Psychology*, 27:571–587.

Paradis, M. (1997) The cognitive neuropsychology of bilingualism. In A. de Groot & J. Kroll (eds.), *Tutorials in bilingualism: psycholinguistic perspectives* (pp. 331-354). Hillsdale, NJ.: Lawrence Erlbaum.

Paradis, J., Crago, M., Genesee, F., & Rice, M. (2003). French-English bilingual children with SLI: How do they compare with their monolingual peers? *Journal of Speech, Language, and Hearing Research, 46,* 113-127.

Paradis, J. & Genesee, F. (1995). Language differentiation in early bilingual development. *Journal of Child Language*, *22*, 611–631.

Paul, R., & Cohen, D. (1985). Comprehension of indirect requests in adults with autistic disorders and mental retardation. *Journal of Speech and Hearing Research, 28*, 475–479.

Pearson, B. Z., Fernandez, S. C., & Oller, R. E. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning, 43,* 93-120.

Pefia, E., & Quinn, R. (1997). Task familiarity: Effects on the test performance of Puerto Rican and African American children. *Language, Speech, and Hearing Services in Schools,* 28, 323-332.

Peña, J.M. (2001). Bilingualism under threat in Navarre. Navarre government Language policy. *Contact bulletin* 17 (2): 8.9. Brussels, European bureau for lesser used Languages.

Perani, D., Paulesu, E., Galles, N. S., Dupoux, E., Dehaene, S., Bettinardi, V. (1998). The bilingual brain: Proficiency and age of acquisition of the second language. *Brain*, 121, 1841–1852.

Petersen, J.M. (2003). Lexical skills in bilingual children with Autism Spectrum Disorder (Master's thesis). Retrieved from http://circle.ubc.ca/

Reyes, B. A. (1995). Considerations in the assessment and treatment of neurogenic disorders in bilingual adults. In H. Kayser (Ed.), *Bilingual speech language pathology. An Hispanic focus* (pp. 153-182). San Diego, CA: Singular Publishing, Inc.

Roberts, C., Baynham, M., Shrubshall, P., Barton, D., Chopra, P., Cooke, M. Hodge, R., Pitt, K., Schellekens, P.,Wallwce, C., Whitfield, S. (2004) English for Speakers of Other Languages (ESOL) - Case Studies of Provision, Learners' Needs and Resources London: NRDC.

Roberts, J.A., Rice, M.L., & Tager-Flusberg, H. (2004). Tense marking in children with autism. *Applied Psycholinguistics, 25*(3), 429-448.

Rosenblum, T. and Pinker, S. (1983). Word magic revisited: Monolingual and bilingual children's understanding of the word-object relationship. *Child development*. 54.773-780.

Ruffman, T., Slade, L., Rowlandson, K., Rumsey, C., & Garnham, A. (2003). How language relates to belief, desire, and emotion understanding. *Cognitive Development*, 18, 139–158.

Saville-Troike, M (1991) Teaching and Testing For Academic Achievement: The Role of Language Development. NCBE Focus: Occasional Papers in Bilingual Education, Number 4, Spring 1991.

Schopler, E., Reichler, R. J., & Renner, B. R. (1986). *The Childhood Autism Rating Scale (CARS)*. Los Angeles: Western Psychological.

Shalom Lappin (2003), "Semantics" in R. Mitkov (ed.), *The Handbook of Computational Linguistics*, Oxford University Press, Oxford, pp. 91-111.

Sheng, L., McGregor, K. K., & Marian, V. (2006). Lexical-semantic organization in bilingual children: Evidence from a repeated word

association task. *Journal of Speech, Language, and Hearing Research, 49*, 572-587.

Sparrow, S. (1997). Developmentally based assessments. In D. J. Cohen & F. R. Volkmar (Eds.), *Handbook of autism and pervasive developmental disorders* (2nd ed., pp. 411–447). New York: Wiley.

Swapna, N., Jayaram, M., Prema, K.S., & Geetha, Y.V. (2005-2006-2010). ARF Project undertaken under AIISH, Mysore.

Tager-Flusberg, H., Calkins, S., Nolin, T., Baumberger, T., Anderson, M., & Chadwick-Denis, A. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. Journal of Autism and Developmental Disorders, 14, 281–289.

Tager–Flusberg, H. (1994). Dissociations in form and function in the acquisition of language by autistic children. In H. Tager–Flusberg (Ed.), *Constraints on language acquisition: Studies of atypical children* (pp. 175–194). Hillsdale, NJ: Erlbaum.

Tager-Flusberg, H. (2000). The challenge of studying language development in children with autism. In L. Menn & N. Bernstein Ratner (Eds.), *Methods for studying language production* (pp. 313–331). Mahwah, NJ: Erlbaum.

Thordardottir, E. T., Weismer, E.S., & Smith, M. E. (1997). Vocabulary learning in bilingual and monolingual clinical intervention. *Child*

Language Teaching and Therapy, 13(3), 215-227.

Tucker, G. R. (1998). A global perspective on multilingualism and multilingual education. In J. Cenoz & F. Genesee (Eds.), *Beyond bilingualism: Multilingualism and multilingual education* (pp. 3–15). Clevedon: Multilingual Matters.

Vaid, J., & Hull, R. (2002). Re-envisioning the bilingual brain using fMRI. In F. Fabbro (Eds.), *Advances in the neurolinguistics of bilingualism* (pp. 315–355). Udine, Italy: Forum.

Valicenti-McDermott, M. D., Schouls, M., Molly, G., Tarshis, N., Seijo, R., & Shulman, L. H. (2008). *Language skills in young children with autism spectrum disorder (ASD): Are there differences between monolingual English and bilingual English-Spanish toddlers?* Poster session presented at the annual meeting of the International Society for Autism Research, London.

Venkatesan (2009). Re-adapted from 1997 Version NIMH Socio Economic Status Scale. Secunderabad, National Institute for the Mentally Handicapped.

Vygotsky, L. S. (1962). *Thought and language.* Cambridge, MA: MIT Ress

Wartenburger, I., Heekeren, H.R., Abutalebi, J., Cappa, S.F., Villringer, A., Perani, D., 2003. Early setting of grammatical processing in the bilingual brain. Neuron 37, 159–170.

Appendix

Parent inventory/ Questionnaire

Date:

Informant: Father/Mother/Other (specify)

A. Child Information
a. Name:
b. Age:
c. Gender: M/F
d. Mother tongue:
e. Other languages:
f. Education: List the medium of instruction in different grades (beginning with preschool and continuing to the present)

Grade	Medium of instruction	Performance		
		Poor	Average	Good

g. Associated problems: Nil/Articulation/Language/HI/LD/MR/Others (specify)
h. Child resides with: Mother/Father/ Both /Other (specify)
i. Number of Siblings: Nil/1/2/3/>3

B. Parental Information
a. Age range in years:

Parent	20-30	30-40	40-50	50-60
Father				
Mother				

b. Education:

Relation	PG & Above (Post Graduate Diplomas, Doctorates, Professional Qualifications)	Graduates (Graduates with Diploma)	Under-Graduates (PUC, Intermediate, Plus Two Level Courses, etc)	Middle & High School (Passed or Failed Tenth Class, SSC, SSLC, etc)	Illiterate (Unread or cannot read or write)
Father					
Mother					

c. Occupation:

Professional (Doctors, Engineers, Chartered or Cost Accountants, IT Professional, Architects, Audiologists, Group A Jobs, Large Scale business with Turn over above INR 50 lac p.a.	Semi-Professional (Technicians, Skilled Workers, Business with turnover between INR 10-20 lacs per annum, Group B Jobs, etc	Technical (Technicians, Skilled Workers, Business with turn-over between INR 5-10 lacs per annum, Group C Jobs, etc	Semi-skilled (Assistants to Techies, Farmers, Field Workers, Group D Staff, auto)	Unskilled (Part time Jobbers, Manual Workers, House Maids, porters, etc)
Father				
Mother				

d. Family Income (p.a.):

Member	>= 75 lakhs	25-50 lakhs	10-20 lakhs	1-5 lakhs	<1 lakhs
Father					
Mother					
Others					

e. Property

>1 crore	50-100 lakhs	10-50 lakhs	<10 lakhs	Nil

f. Socio Economic Status (SES) **:** SES1/SES2/SES3

II. Brief family history
a. Family Status: Nuclear/Joint/Extended
b. Total number of persons in the family: <3/4-6/7-8/>8
c. Consanguinity: -ve /+ve (I degree/II degree/III degree)
d. Family history of associated problems: Yes/No

III. Language History:

a. Language predominantly spoken at home: Hindi/English/Both equally/Others

b. Languages used:

Languages	Understand	Speak	Read	Write
Child				
Father				
Mother				

c. Language exposure:

Languages	Home	School	Neighborhood
Hindi			
English			
Others (specify)			

d. Tick the appropriate one:

Languages	Proficiency/ Capacity	0-25%	25-50%	50-75%	75-100%
Hindi	Understand				
	Speak				
	Read				
	Write				
English	Understand				
	Speak				
	Read				
	Write				
Others (specify)	Understand				
	Speak				
	Read				
	Write				

e.   Age of acquisition:

Languages	Since birth	1-2 yrs	2-3 yrs	3-5 yrs	>5yrs
Hindi					
English					
Others (specify)					

f.   Language development

Languages	Absent	Delayed	Average	Above average
Hindi				
English				
Others (specify)				

g.   Language Growth:

Languages	First word	two-word phrases	complete sentences of four or more
Hindi			
English			
Others (specify)			

h.   Language preferences for communication:

Languages	Hindi	English	Both equally	Others (specify)
Child				
Parents				

i.   Decision of language for therapy taken by: Parents/Teacher/Speech Language Pathologists /Others (Specify)

Special services received by the child	Duration (in months)						Language Used			
	0	< 1	1-3	3-6	6-12	>12	Hindi	English	Both	Others (specify)
Speech Language Therapy										
Occupational Therapy										
Physiotherapy										
Special Education										
Behavior Therapy										
Others (Specify)										

LANGUAGE NON-SPECIFIC LEXICAL ACTIVATION IN BILINGUALS: EVIDENCE FROM THE PHONEME MONITORING TASK

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Abstract

The language-specific versus language non-specific views of bilingual lexical activation has been overwhelmingly debated in the contemporary bilingual research. In this context, the present study attempted to address this issue in a group of bilingual subjects. The study employing phoneme monitoring task in two orthographically dissimilar languages (Kannada & English) in a group of normal bilinguals. The subjects required more time to reject phonemes in the non-target language (translation) picture names. The findings of the study supported the language non-specific view of bilingual lexical activation. Further, the study also revealed the role of orthography in phoneme monitoring task especially when two orthographically dissimilar languages are considered.

Keywords : *Bilingualism, Orthography, Lexical activation, Phoneme monitoring task*

One of the most remarkable abilities of bilingual speakers is that of separating their two languages during the production of speech (Costa & Santesteban, 2004). Although the speech of highly proficient bilinguals in their second language (L2) often carries traces (e.g., accent, syntactic structures) of the first language (L1), it rarely exhibits lexical intrusions (Poulisse, 1999). That is, these bilinguals are competent enough at selecting and producing words from only one of their lexicons, both in L1 and L2 according to the communicative context. The contemporary investigations on the functioning of the bilingual mental lexicon focus to uncover this intricate mechanism. In the following section, we briefly review the architecture of the bilingual mental lexicon with emphasis on the points of disparities and proceed to the literature pertaining to the phoneme monitoring task in bilingual research.

Bilingualism has been gaining overwhelming interest in the contemporary literature owing to the rapid rise in the bilingual population across the world. This has further necessitated the research on the organizational principle of the bilingual mental lexicon. Literature on bilingualism reports various neurocognitive and neuroimaging studies relating to brain function investigating lexical representation and processes in bilinguals. Neuro imaging studies have been done using Positron emission tomography (PET) and Functional magnetic resonance imaging (FMRI), and also studies of Event related potentials (ERP) have helped us in understanding anatomical and physiological relationship during speech production in bilinguals.

Although significant advances have been made in the understanding of the organizational as well as the processing strategies of the bilingual mental lexicon, on certain fronts, such as the activation of the non-target language, a consensus is yet to emerge. One of the active areas of inquiries in bilingual research is the nature of lexical activation which focuses on the crucial issue of whether the activated semantic node spreads its activation only to the target lexical node (i.e. language-specific view) or both to the target and non-target lexical nodes (i.e. language non-specific view) in the bilingual mental lexicon. In the present study, we investigated this issue by employing a phoneme monitoring task in two orthographically different languages (Kannada – alphasyllabic and English – alphabetic, Vaid & Gupta, 2002). In the following section, we provide a brief overview of the nature of bilingual lexicon with special reference to the phoneme monitoring task employed in bilingual research.

The nature of lexical activation in the bilingual mental lexicon

Current lexical access models in bilingual speakers assume that the semantic system is shared by the two languages of a bilingual (De Bot, 1992; Costa, Miozzo & Caramazza, 1999; Green, 1986; 1998; Kroll and Stewart, 1994; Potter, So, von Eckhardt, & Feldman, 1984; Poulisse & Bongaerts, 1994) and It has now been agreed by a good majority of the researchers that there exists a conceptual/semantic store common to both languages in bilinguals. The contemporary research, therefore, focus on the crucial issue of whether the activated semantic node spreads its activation only to the target lexical node i.e. language-specific view or both to the target and non-target lexical nodes i.e. language non-specific view.

In the following section we briefly review the studies that have addressed the nature of lexical selection in bilinguals.

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The Language-specific view

Costa, Miozzo, and Caramazza (1999) investigated the nature of lexical selection (i.e. language specific or language non-specific) in Catalan-Spanish bilinguals using a picture-word interference paradigm. In their experiment, the distracter word was manipulated at two levels (with respect to the nature of relationship between the distracter and the target words (semantic, phonological, and identity conditions) and the language of the distracter (target and non-target language). Under the semantic conditions, an inhibition – that is, a slower naming when the subjects were presented with semantically related distracter words – was observed. Alternately, there was no difference between the magnitudes of inhibition when the distracter words were presented in either language. In addition, the authors also noticed a cross-language identity effect. That is, when the translation of the picture name was presented as the distracter, subjects named the pictures faster. This led Costa et al. (1999) to claim that the lexical selection took into account only the candidates within the target language, although both languages were activated. That is, according to these authors, the facilitation occurred as the target response was activated twice: once through the picture display and next through the translation equivalent of the distracter word in the non target language. To explain the cross-language semantic inhibition, these authors argued that in the semantic conditions, the distracter word activated its concept, which would spread its activation to the words in both lexicons, and competition would take place between the translation of the distracter and the name of the picture, both in the target language. Therefore, the target (picture name) and the semantically related distracter words (i.e. the translation equivalents in the target language) would compete for selection, thus delaying the lexical selection. Similar findings have been reported in other language pairs as well (e.g. Dutch-English; Hermans, Bongaerts, De Bot & Schreuder, 2000).

In yet another study, Costa and Caramazza (1999) tested whether there existed any competition between the two lexicons of bilinguals using two picture-word interference experiments. They performed the experiments on two groups of proficient bilinguals (English-Spanish and Spanish-English) while naming pictures either in their L2 (Spanish) for first group, or in their L1 (Spanish) for second group. Picture naming was facilitated when the name of the picture and the distracter word were the "same", regardless of the language in which the distracter was printed: same-language (e.g.,

mesa-*mesa* [*table* in Spanish]) or different-language pairs (e.g., *mesa-table*). The magnitude of this facilitatory effect was similar when naming in L1 and in L2. Costa and Caramazza (1999) also reported that naming latencies were slower when the distracter word was semantically related to the picture's name (e.g., *mesa-chair*), regardless of the language in which the distracter was presented. The results, therefore, suggested that there was no competition between the two lexicons of bilinguals during lexical selection for production, favoring the language-specific view of lexical selection in bilinguals.

Language non-specific view

There have been counter evidences to the language-specific nature of lexical selection in bilinguals. For example, Hermans et al. (1998) required a group of fluent Dutch-English bilinguals to name pictures in their L2 while ignoring the distracter words presented in L1 (experiment 1) and in L2 (Experiment 2). The authors varied the distracter word experimentally such that it was phonologically related to the target's translation (i.e. phono-translation condition). For example, while presenting a picture of a '*mountain*' to be named in English, the distracter word was '*berm*' ('verge') which was phonologically related to the target picture name's Dutch translation '*berg*'. The authors argued that the presentation of such a distracter would activate the targets' (mountain) Dutch translation ('berg'). In another way, target's Dutch translation would be highly activated when the target is presented with a phonologically related distracter compared to an unrelated one (e.g. '*kaars*' – candle) as in the former condition, there are two sources of activation. That is, the target lexicon receives activations from both the picture itself as well as from the translation of the distracter whereas in the latter – control – condition, the lexical node receives activation only from the picture's semantic representation. In this context, if lexical node of the non-target language (here, Dutch) is activated, it would compete for lexical selection which in turn, slower the naming latencies. This has been termed as phono-translation interference effect and Hermans et al.'s study supported such an interference effect. Therefore, these authors concluded that lexical nodes of both target and non-target languages compete for lexical selection, supporting the language non-specific selection models.

The support to this view can also be derived from few recent neuro imaging studies, Parker Jones et.al (2011) conducted a study using FMRI and found higher activation levels for bilinguals in five left hemispheric regions (dorsal precentral

gyrus, pars triangularis, pars opercularis, superior temporal gyrus & planum temporale) relative to monolinguals in a task involving picture naming in their native or non native language. This higher activation may be attributed to language non specific activation patterns along with other factors.

Event related potentials have also been useful in understanding processes involved in bilingual lexical activation. The first ERP evidence was obtained in a picture-naming priming task using Chinese-English bilinguals of languages with distinct scripts (Guo, Taomei, Peng, Danling, 2006). The results indicated that parallel activation of both languages supporting language non-specific hypothesis is a universal phenomenon in bilingual speech production. Furthermore, the study revealed that the temporal course and magnitude of activation of the non target language during target language production was modulated by the relative proficiency in the two languages.

Phonological activation in bilingual speech production

Yet another interesting question and perhaps a method to study the nature of language selection in bilinguals is the investigation into the phonological activations of the non-target lexical items. There are different views about spreading activation to corresponding lexical nodes from an activated conceptual representation. According to the cascaded view all the levels of representation (the semantic, lexical, and phonological levels) are activated. In the discrete stage models activation is restricted to the semantic and lexical levels, preventing phonological activation of non-selected lexical nodes. Considering the cascaded view of activation, which is widely accepted, studying the phonological activation of the target and non-target languages, might give us inferences on whether or not the non-target lexical nodes are considered for lexical selection. There have also been a few studies in the past addressing the activation of the phonological representation during bilingual speech production. In Hermans et al.'s (1998) study, the authors paired every picture stimulus with a semantically related word ('valley') and with phonologically similar term ('mouth') with the target 'mountain'. In addition, they presented the stimuli at different stimulus-onset-asynchronies (SOAs) of -300, -150, 0, and +150 ms. According to these authors, if the phonological (Phono-Dutch) interference occurred at the SOAs where semantic effects had previously been found, it could be said to occur at the lemma level. However, if the effects were observed when semantic interference was no longer

obtained, but phonological effects had been observed, it could be concluded that the effects of the Phono-Dutch condition were operating at the lexeme level. The results of Hermans et al. (1998) showed interference only in the lemma level where semantic effects had previously been found. This led the authors to conclude that even if the translation had been activated, it had not been phonologically encoded.

Costa, Caramazza, and Sebastián-Gallés (2000) investigated the phonological activation of the non-target language by requiring a group of Catalan-Spanish bilingual subjects to name pictures with cognate and noncognate words in Spanish. According these authors, cognates – having similarity at the phonological level – may be named faster compared to non-cognates since the latter share only their meaning, but not the morphology and phonology. The reason for this cognate facilitation effect, according to the authors, was twofold. First, common phonemes for the target word and its cognate translation would receive extra activation and therefore would be more easily retrieved. Second, the noncognates would have phonemes of their translation activated, and since these differ from those that the speaker produces, they would cause interference. Costa et al.'s result supported the cognate facilitation effect as such words were named faster compared to the non-cognate words. Thus, these authors argued that the non-target language's phonology is activated during bilingual speech production.

In the following year, Colomé (2001) investigated the phonological activation in the non-target language using the phoneme monitoring task. When employed in bilingualism, the phonemes are experimentally altered to fall under one among the three conditions: a) part of the response language (answer 'yes' – filler trial); b) part of the non-response language (answer 'no' – critical trial); part of neither language (answer 'no' – control trial). Colomé (2001) required the Catalan-Spanish subjects to monitor whether a certain phoneme was in the Catalan name or not. This study revealed that the participants took more time to reject the phoneme appearing in Spanish (non-target language) compared to the control phonemes that neither occurred in Catalan nor in Spanish. In addition, this result was also obtained at different stimulus-onset-asynchronies (-2000, +200, & +400 ms). From these observations, Colomé argued that both the target and non-target languages were activated which in turn activated their sublexical units, leading to the delayed rejection of the phonemes in the non-target language.

Role of orthography in phoneme monitoring task

Spoken words are made of combining speech sounds or phonemes and orthography of a language represent and convey these phonemes in a graphic form. Orthography has been found to play vital role in visual word recognition wherein it is claimed that access to the lexical representation is mainly phonologic. According to this view, orthographic information is typically recoded into phonologic information at a very early stage of print processing (Frost1989). Thus orthography is proposed to have a role in phoneme monitoring tasks as well (Dijkstra & Roleofs, 1995). These authors studied whether orthography in addition to the phonology plays a role in phoneme monitoring task. They required a group of Dutch speaking subjects to monitor the experimental phonemes that varied as a function of their primary and secondary spelling. They used three experimental phonemes (/k/: primary grapheme - /k/, secondary grapheme - /c/; /s/: primary grapheme - /s/, secondary grapheme - /c/; and /t/: primary grapheme - /t/, secondary grapheme - /d/). The assumption behind this study was that if orthographic codes become available during speech processing and are consulted in phoneme monitoring, secondary spelling may lead to interference effects because they are not congruent with the canonical spelling of the phonemes. And, in Dutch stimuli, whether a phoneme has primary or secondary phoneme in a word could only be determined on the basis of the identity of the word, requiring the lexical access. Their result showed that the phoneme monitoring times were slower when the phonemes had secondary spelling than when they had only primary spellings. Thus, Dijkstra and Roelofs (1995) concluded that orthographic information of the word is engaged in phoneme monitoring. Although these authors claimed that orthography had an effect on phoneme monitoring task, their evidences was from a monolingual task, examining only the congruency of the graphemes with respect to their phonemes. However, in a recent study on bilinguals, Hoshino and Kroll (2008) asked their Spanish-English (orthographically similar languages) as well as Japanese-English (orthographically dissimilar languages) subjects to name the cognate pictures. Their results showed evidences for the phonological activation irrespective of the differences in orthography.

To summarize the previous research findings, the debate on language-specific versus language non-specific views of lexical selection in bilinguals still continues, with greater evidences prevailing for the language non specific

hypotheses. However, before making specific conclusions about this issue, it is desirable to obtain evidences from bilingual subjects using structurally different languages. Additionally, in experimental paradigms employing the phoneme monitoring task, the orthography is expected to play a role, especially in the light of research findings from monolinguals. The present study aimed primarily at investigating the first issue – the nature of lexical selection in bilinguals – by employing the phoneme monitoring task in two orthographically different languages (Kannada – alphasyllabic; English – alphabetic, Vaid & Gupta, 2002). This provided us an opportunity to look into the role of orthography in phoneme monitoring task.

Method

Participants

Fifty right-handed adult bilingual (L1 – Kannada and L2 – English) subjects (males – 27 and females – 23) in the age range of 18 – 30 years (mean – 24 years; SD – 3) participated in the study. All had normal or corrected-to-normal vision and started learning their L2 at the age of 4-5 years with the commencement of schooling and had comparable proficiency in L2 (i.e., ratings of S4 in speaking and R4 in reading in English as per the Australian Second Language Proficiency Rating Scale (Ingram, 1985).

Stimuli

A set of 128 Black & White line drawings were selected from the Kannada adaptation (Ahmed, Krishnan, & Rajashekar, 2008) of Snordgrass and Vanderwart (1980) standardized set of pictures. The frequency, complexity, and imageability of these stimuli were matched. One hundred and twenty pictures were grouped into two blocks (60 items each) to be used for naming in Kannada (L1) and in English (L2). Remaining eight pictures were used as trial items, four in each language.

Design

The experiment was conducted in two different blocks, one for each language. In each block, the pictures were presented in three experimental conditions: *Related* (Condition 1 – Appendix A), *Unrelated* (Condition 2 – Appendix B), and *Control* (Condition 3 – Appendix C). In the *Related* condition, each picture was followed by the grapheme corresponding to the initial phoneme of the picture's translation in the non-response language. For example, while naming the picture of a *DOG* in English (L2) the grapheme corresponding to the phoneme /n/ - the initial phoneme of picture name in Kannada (*na:ji*) – was presented. This was designated as '*English related*' condition. Similarly naming in

Kannada (*na:ji*) followed by the presentation of the grapheme (e.g. /d/) of its English translation formed the '*Kannada related*' condition. In the *Unrelated* condition, each picture stimulus in both language blocks was followed by a grapheme which was neither a part of the picture's name in Kannada nor in English. For example, while naming the picture of *CAT* in English (L2), the grapheme corresponding to the phoneme /p/ - which was not the part of the picture name neither in Kannada (*bekku*) nor in English (*kæt*) – was presented. This formed '*English unrelated*' experimental condition and naming the picture in Kannada followed by the monitoring of an unrelated phoneme neither in L1 or L2 formed '*Kannada unrelated*' condition. In the *Control* condition, a grapheme that was the part of the target picture name in the response language was presented. For example, while naming the picture of a *BAG* in English (L2) the grapheme corresponding to the phoneme /b/ was presented. This formed '*English control*' experimental condition and naming in Kannada in this condition formed '*Kannada control*' condition.

In each language block, 15 pictures were presented under the '*Related*' and '*Unrelated*' conditions whereas 30 pictures were presented under the '*Control*' condition. This was necessary to balance the number of '*Yes*' and '*No*' responses in each language trail. In the *Related* and *Unrelated* conditions, the expected accurate responses were '*No*' whereas in the *Control* condition, the accurate response was '*Yes*'. Half of the subjects named the pictures in Kannada first followed by English and the remaining half named the pictures in English first followed by Kannada. Thus, each subject performed both Kannada as well as English tasks. The three conditions were randomized within each language block.

Procedure

The participants were tested individually in a quiet environment. The stimulus presentation and the response measurements were controlled using DMDX software program for Windows (Forster & Forster, 2003). The eyes-to-monitor distance was maintained at about 50 cm. The subjects were familiarized with the pictures and their names in both languages to eliminate the ambiguity of line drawings, if any. In addition, this familiarization task deemed important as the word length of the picture names were different

in English and Kannada. That is, most of the picture names were monosyllabic in English whereas they were bi- or tri-syllabic in Kannada (majorly due to the alphasyllabic nature of Kannada language). They were also provided with grapheme – phoneme conversion training before the commencement of the experimental trial. The grapheme- phoneme conversion training was given in order to rule out misjudging of phonemes with irregular orthographic representation (for eg. c for /s/ phoneme as in the word cigarette). Subsequent to this, they were instructed to press the 'm' key of the keyboard if the sound of the letter displayed immediately after the presentation of the picture was a part of the picture name they just saw. If it were not the part of the picture name, they were instructed to press the 'n' key of the keyboard. The subjects were required to make the responses using right hand. They were additionally asked to keep their palm on the palm rest of the keyboard and not to remove it after each response is made. This was to avoid the time lag in reaching the target keys on the subsequent trials. The entire testing session was completed in 30 minutes for each subject.

The experimental sequence

Following the above instructions, the subjects were familiarized with the procedure by presenting the trial items. This was followed by presentation of test items. Initially, a '+' sign was displayed at the centre of computer screen for 500ms. This was followed by the presentation of the picture to-be-named for 2000 ms. At the end of the picture presentation, the critical stimulus – a letter – was displayed for 2000 ms. The reaction time was calculated from the time of onset of the critical stimulus on the monitor until the subject pressed the button or the end of the 2000 ms period, whichever occurred earlier. A short break was provided at the end of the first block.

Results

The incorrect and out of time responses (i.e. before 400 ms or after 2000 ms) were removed from the statistical analysis of reaction time (RT). This constituted about 10% (601) of all the responses (6000; [15 related + 15 unrelated + 30 control] X 2 languages X 50 subjects). Table 1 provides the mean (SD) of the reaction times as well as the errors in each language across the experimental conditions.

Table 1: *Mean (SD) reaction time (ms) and error rates in Kannada and English across the experimental conditions*

	Experimental conditions					
	Related		Unrelated		Control	
	Mean RT (SD)	Mean Error (SD)	Mean RT (SD)	Mean Error (SD)	Mean RT (SD)	Mean Error (SD)
Kannada	1149 (*260*)	2.4 (2.17)	1048 (227)	0.96 (1.28)	1003 (247)	1.06 (1.42)
English	1010 (230)	2.92 (2.06)	958 (190)	1.72 (1.97)	837 (200)	2.64 (2.12)

After naming the pictures in the target language, to examine if the time required to reject a phoneme in the non-target language differed significantly from that of the phoneme which occurred neither in the target nor in the non-target language (i.e. under the related and unrelated conditions), we performed paired comparisons of the reaction times and errors for each language. In the Kannada Related condition, the subjects required 121 ms more than the Kannada unrelated condition and this difference was significant (t_{K-RT} (49) = 4.74, $p < 0.001$). The error pattern in these conditions also revealed similar finding (mean difference = 1.44) ($t_{K-error}$ (49) = 5.31, $p < 0.001$). As evident from Table 1, subjects exhibited more errors in the Related compared to the Unrelated condition. In English, the mean difference in RT between related and unrelated conditions was 52 ms and this difference was significant too (t_{E-RT} (49) = 2.75, $p < 0.05$). The error mean in English related and unrelated conditions also showed a statistically significant difference (mean difference = 1.2) ($t_{E-error}$ (49) = 3.87, $p < 0.001$). Like in Kannada, the English related condition showed more errors compared to English Unrelated condition (see Table 1).

To examine the performance across the experimental conditions and languages, we performed repeated measures one-way ANOVAs (3 experimental conditions x 2 languages) separately for RT and error data. The analysis of the RT showed a significant difference between the experimental conditions ($F1(2, 49) = 39.85$, $p < 0.001$, $\eta^2 = 0.449$, $MSe = 753623$). Post hoc LSD comparisons revealed that all three means were significantly different from each other. The mean RT in the related condition ($M = 1080$ ms) was significantly higher than the RTs in the unrelated ($M = 1003$ ms) and control conditions ($M = 920$ ms). Similarly, the two language also revealed a significant difference across the experimental conditions ($F2(1, 49) = 37.83$, $p < 0.001$, $\eta^2 = 0.436$, $MSe = 1301063$). However, the interaction between language and experimental conditions was not significant (see Figure 1).

Figure:1 *Mean Reaction Times (ms) as a function of languages and experimental conditions (1 – Related; 2 – Unrelated; and 3 – Control)*

The repeated measures one-way ANOVA of the error data showed a significant differences in the experimental conditions ($F1(2, 49) = 26.31$, $p < 0.001$, $\eta^2 = 0.35$, $MSe = 88.62$) as well as in languages ($F2(1, 49) = 16.48$, $p > 0.001$, $\eta^2 = 0.252$, $MSe = 68.16$). Post hoc LSD comparisons revealed that all three mean error rates were significantly different from each other in the three experimental conditions. The participants exhibited maximum errors in the related conditions ($M = 2.66$) compared to the control condition ($M = 1.85$), which in turn was significantly higher than the mean error in the unrelated condition ($M = 1.34$). However, the interaction between the language and experimental conditions was not significant (see Figure 2). Between the languages, subjects committed fewer errors in Kannada compared to English (Figure 2). Combining this observation with the RT data, that is, faster judgments in English compared to Kannada, it becomes apparent that there existed a speed-accuracy trade-off between the two languages.

The difference in RT between Kannada and English deemed worth exploring. For this, we performed paired comparisons of the RTs obtained from the two control conditions as they were devoid of any experimental variables.
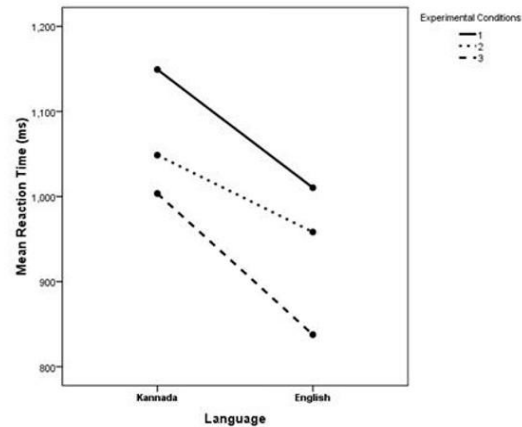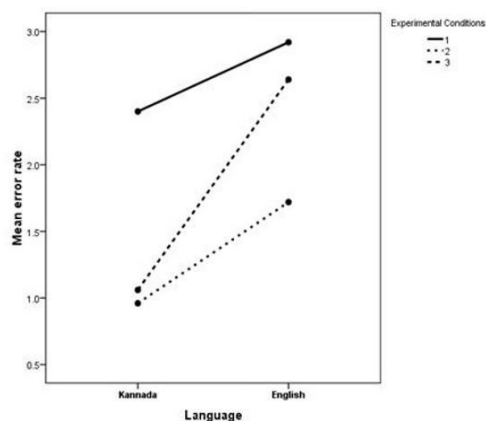
Figure 2: *Mean Error rates as a function of languages and experimental conditions (1 – Related; 2 – Unrelated; and 3 – Control)*

In addition, the *Control* condition required 'Yes' responses unlike the *Related* and *Unrelated* conditions. Therefore, the RT differences between *English* and *Kannada Control* conditions obtained may be attributed to the stimuli used in the current study. The results showed a significant difference in RT (Mean difference = 166 ms; $t_{KE-RT}(49) = 7.36$, $p < 0.001$; $SE = 22.54$) between the two languages.

Discussion

The primary aim of the current study was to investigate the phonological activation in a group of normal bilingual subjects who spoke two structurally different languages (Kannada and English) using a phoneme monitoring task. Secondarily, it aimed at exploring the influence of orthography in such a language pair employing phoneme monitoring task.

With respect to the primary objective, the results of the present study showed that in the *Related* condition, subjects required significantly more time to reject a phoneme which was present in the non-target language. This was the case both in Kannada as well as in English. The results, therefore, closely followed the findings of Colomé (2001) who employed a similar paradigm. In her study too, when two negative conditions (i.e. *Related* and *Unrelated* conditions as in the present study) were presented the subjects required more time to reject the phoneme that was present in the translation of the picture names they just monitored. As confirmatory evidence, Colomé did not find a significant difference in reaction time when the same task was performed by the monolingual subjects. However, in the present study, no monolinguals were employed. Yet, in the light of previous research findings, we confirm that bilingual subjects take more time to reject the phonemes in the non-target language. Therefore, it is apparent that the semantic nodes spread their

activations to the both lexicons in bilinguals, which in turn activate their sublexical nodes (phonemes). These activated phonemes are suppressed at the cost of extra effort (i.e. increased reaction time) in phoneme monitoring task. The results of error analysis too showed that the subjects committed more errors in the *Related* condition in both languages compared to the *Unrelated* conditions. The significantly more number of errors in the *Related* conditions may be indicative of the momentary failures to suppress the activated phonemes in the non-target language, leading to the subject responding '*Yes*'. It is also noteworthy that the subjects committed minimum number of errors in the *Unrelated* condition and this may be attributed to the lack of possibility for any momentary inhibitory failure while making the judgments. In essence, both the reaction time as well as the error data supported the activation of both lexicons (i.e. language non-specific view) in bilingual subjects, despite the orthographically different nature of the languages used in the current study.

The additional objective of the study was to explore the influence of the orthography in phoneme monitoring task, especially in two structurally different languages. The comparison of the reaction times in the control condition revealed a significant difference between Kannada and English. That is, the RT was shorter in the English language compared to Kannada. We attribute this difference to the possible role of orthography in phoneme monitoring task. The presence of this effect in the Control condition, where the task is evidently straightforward and eliciting a 'Yes' response, strengthens the role of orthography in phoneme monitoring task. Kannada and English are two orthographically dissimilar languages where the former is alphasyllabic and the latter is alphabetic (Vaid & Gupta, 2002). In the present study, the task employed was essentially a phoneme rather than grapheme monitoring task. All the subjects were trained on grapheme-phoneme conversion before the commencement of the experimental trials. Yet the advantage for English trials may be attributed to the experimental presentation of the English grapheme. That is, irrespective of the prior training and practice, when the subjects were presented with an English grapheme and required to monitor its sound in the picture's English name, their responses were faster, as this task was quite straightforward. In contrast to this, in the Kannada condition, the subjects were required to name the pictures in Kannada and then monitor the sound of an English grapheme as whether or not it is a part of the Kannada name may have produced some interference,

leading to the prolonged RT in this condition. In simple terms, the incongruence between the phoneme-to-be monitored and its physical (graphical) appearance may have resulted in the prolonged RT in Kannada trials. It may have been interesting to observe the RT when Kannada graphemes were presented. However, our paradigm was not equipped with the presentation of the Kannada graphemes, as the role of orthography was not the primary objective of the present study. In future, studies designed to investigate the phoneme monitoring task in orthographically distinct language shall take this variable into consideration.

Summary

The present study provided further evidences for the language non-specific view of bilingual lexical activation by extending the phoneme monitoring task into two orthographically different languages. In addition to this, the study also shed light into the possible role of orthography in phoneme monitoring task especially in orthographically distinct languages. The present study thus adds on to the understanding basic aspects of bilingual language processing and activation providing indirect implications in clinical practice. However further studies of similar nature in bilingual adult language disorders such as Aphasia, may provide greater insight about activation in impaired lexical systems. This might further help explaining clinical phenomenon of recovery in untrained language and may help in choosing the appropriate language for intervention.

Acknowledgment

Author roles:

Author GK conceptualized the idea, reviewed the relevant literature, designed the method, analyzed and interpreted the data, and prepared the manuscript. Author PS reviewed the literature, collected data, analyzed and interpreted the data and prepared the manuscript. BR coordinated the study.

References

Ahmed, W., Krishnan, G., & Rajashekar, B. (2008). *A set of 260 pictures standardized for name agreement, complexity, image agreement in Kannada*. Unpublished Masters Dissertation. Manipal University.

Altarriba, J., & Mathis, K. (1997). Conceptual and lexical development in second language acquisition. *Journal of Memory and Language, 36,* 550-568.

Chen, H., -C., & Ho, C. (1986). Development of Stroop interference in Chinese-English bilinguals. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 397-401.

Colomé, À. (2001). Lexical activation in bilinguals' speech production: Language-specific or language-independent? *Journal of Memory and Language, 45,* 721-736.

Costa, A., Caramazza, A., & Sebastián-Gallés, N. (2000). The cognate facilitation effect: Implications for the models of lexical access. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 1283-1296.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection *Journal of Memory and Language, 41*, 365-397.

De Bot, K. (1992) A Bilingual Processing Model: Levelt's 'Speaking Model Adapted. *Applied Linguistics, 13:* 1-24.

Dijkstra, T., Roelofs, A., & Fieuws, S. (1995). Orthographic effects on phoneme monitoring. *Canadian Journal of Experimental Psychology, 49,* 264-271.

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35*, 116-124.

Green, D. W. (1986). Control, activation and resource: A framework and a model for the control of speech in bilinguals. *Brain and Language, 27,* 210-223

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67-81

Hermans, D., Bongaerts, T., de Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent inferences from their first language. *Bilingualism: Language and Cognition, 1*, 213-229.

Hoshino, N., & Kroll, J. F. (2008). Cognate effects in picture naming: Does cross-language activation survive a change of script? *Cognition, 106,* 501-511.

Ingram, D. E. (1985*). Assessing proficiency: An overview on some aspects of testing.* In K. Hyltenstam & M. Pienemann (Eds.*), Modelling and assessing second language acquisition (pp. 215-276).* Clevedon, NJ: Multilingual Matters.

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.

Parker-Jones, O., Green, D.W., Grogan, A., Pliatsikas,C., Filippopolitis, K., Ali, N., Lee, H. L., Ramsden, S., Gazarian, K., Prejawa, S., Seghier, M.L., Price, C.J.(2011). Where, When and Why Brain Activation Differs for Bilinguals and Monolinguals during Picture Naming and Reading Aloud. *Cerebral Cortex*, 2011.

Potter, M. C., So, K. -F., von Eckhardt, B., & Feldman, L. B. (1984). Lexical and conceptual representation in beginning and more proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior, 23,* 23-38

Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied Linguistics, 15,* 36-57.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology,* 18, 646-662.

Vaid, J., & Gupta, A. (2002). Exploring word recognition in a semi-alphabetic script: The case of Devanagari. Brain and Language, 81, 679-690.

Appendix A

Related stimuli

Kannada		English	
Picture	Grapheme	Picture	Grapheme
/iruve/	/a/	Door	/b/
/karadi/	/b/	Donkey	/k/
/omte/	/k/	Fox	/n/
/alugɛdde/	/p/	Pig	/h/
/na:ji/	/d/	Wheel	/ʧ/
/ba:vuʈa/	/f/	Goat	/a/
/mane/	/h/	Swing	/u/
/navilu/	/p/	Violin	/p/
/kaθari/	/s/	Table	/m/
/mara/	/ʈ/	Corn	/ɟ/
/sara/	/n/	Button	/g/
/i:ruɭi/	/o/	Dress	/a/
/ka:lu/	/l/	Hat	/t/
/sarapaɭi/	/c/	Frog	/k/
/hebberaɭu/	/θ/	Lion	/s/

Appendix B

Unrelated stimuli

Kannada		English	
Picture	Grapheme	Picture	Grapheme
/ʧitte/	/m/	Cat	/p/
/mo:ɖa/	/r/	Finger	/k/
/mi:nu/	/b/	Window	/m/
/huli/	/n/	Pumpkin	/s/
/mola/	/k/	Orange	/u/
/uŋgura/	/t/	Owl	/r/
/bi:ga/	/d/	Needle	/t/
/θuʈi/	/a/	Knife	/b/
/kuðurɛ/	/ʧ/	Lemem	/g/
/kivi/	/p/	Deer	/ɭ/
/pusʈaka/	/v/	Candle	/v/
/hu:vu/	/g/	Apple	/g/
/noŋa/	/t/	Glass	/n/
/kai/	/l/	Spider	/m/
/buguri/	/m/	Spoon	/k/

Appendix C

Kannada		English	
Stimuli	Grapheme	Picture	Grapheme
/koɖli/	/k/	Arrow	/a/
/ɟɛ:nuhuɭa/	/ɟ/	Bag	/b/
/hʌkki/	/h/	Pineapple	/p/
/pa:ða/	/p/	Monkey	/m/
/ʧʌnðra/	/ʧ/	Toothbrush	/t/
/ili/	/i/	Sheep	/ʃ/
/gaɖija:ra/	/g/	Grapes	/g/
/ðo:ɳi/	/ð/	Hare	/h/
/basavanahuɭa/	/b/	Key	/k/
/nu:lu/	/n/	Pen	/p/
/su:rja/	/s/	Zebra	/z/
/gombe/	/g/	Vase	/v/
/rʌilu/	/r/	Heart	/h/
/θuθuri/	/θ/	Ladder	/l/
/nʌkʃʌʈra/	/n/	Fork	/f/
/ba:vi/	/b/	Gun	/g/
/a:me/	/a/	Helicopter	/h/
/hʌððu/	/h/	Pencil	/p/
/kiri:ʈa/	/k/	Guitar	/g/
/aɳʌbe/	/a/	Church	/ʧ/
/laʈʈaɳigɛ/	/l/	Cigarette	/s/
/mu:laŋgi/	/m/	Cake	/k/
/kambɭihuɭa/	/k/	Drum	/d/
/kaɳɳu/	/k/	Hanger	/h/
/bɛ:li/	/b/	Lamp	/l/
/kannadaka/	/k/	Kettle	/k/
/pʌrvaθa/	/p/	Gorilla	/g/
/mosaɭe/	/m/	Ostrich	/ɔ/
/ba:θuko:ɭi/	/b/	Paint brush	/p/
/koɭalu/	/k/	Shoe	/s/

Control condition

LEXICAL LEARNING OF NOVEL WORDS IN BI/MULTILINGUAL CHILDREN

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Abstract

Learning new linguistic forms in a bi/multilingual environment is an interesting phenomenon. Studies have reported that new vocabulary learning is more lexically mediated during the earlier stages of learning than in later stages (Kroll & Curley, 1988).While the literature provides some findings that pertain to lexical learning in monolinguals,comparable lexical learning studies involving bilinguals and trilinguals/multilinguals are unavailable. Indian context presents a unique scenario as individuals are routinely exposed to new words in a hitherto unknown language. It is thus imperative to attain some understanding of the strategies that come into play when they encounter these new words.Present study aimed to investigate novel word learning in Malayalam-English bilinguals (Group A) andTulu-Kannada-English multilinguals(Group B).Forty(40) bilingual/multilingualsin the age group of 15-16 years were selected as participants. Stimuli consisted of 32 novel words, 8 words in each language. Each participant was assessed for acquisition of novel words using two tasks namely referent identification task and picture naming task. Mean reaction time and error analysis was carried out for both groups.Bilingual children learned novel words faster in L1 (Malayalam) when compared to L2 (English) whereas multilingual children learned words faster in L3 (English) followed by L1 (Tulu) and L2 (Kannada).The results obtained in the present study are consistent with the view that novel word learning is not an idiosyncratic reflection of a subject's personal linguistic history, but that generalizations are possible involving such factors as language proficiency,degree of exposure and opportunities for frequent conversational use.

Keywords: Novel word learning, bi/multilingualism, second language learning

A multilingual person, in the broadest sense, is a person able to communicate in more than one language, actively (at the level of speaking and writing) or passively (at the level of listening and reading). In this study, we take bilinguals and multilingualsto be adolescents who learn a majority language from birth (L1) and use it as a mother tongue for primary functions in their society and who begin to learn a second language (L2) - and in multilingual case, a third language (L3) - from early childhood and use L2 (and, where applicable,L3) for formal functional language in their society. This definition is closely related to criteria used by Jia&Kohnert, 2006 to define multilinguals in their study on Spanish-English-Dutch trilinguals.

It is estimated that by the time a child graduates from high school he/she will have acquired an understanding of more than 60,000 words. To achieve the vocabulary of this size, the child must learn multiple words per day through out childhood (Bloom, 2000).Learning new linguistic forms in a multilingual environment is an even morechallenging task, and its analysis can in principle improve our understanding of how lexical representations are created and stored. Vocabulary is a cross-linguistically variable domain and the availability of vocabulary in the case of an individual speaker depends-in ways that are amenable to investigation-upon his/her experience and the

exposure to the language/s, his/her education, socio-economic status, native language/ dialect, IQ and sex (Mallikarjun, 2002).

The list of factors provided by Mallikarjundoes not include age as a crucial variable. However, there is some evidence that children approach to L2 vocabulary learning differently than adults.Approach to learning novel words seems to change as children age.Younger children learn new information by dedicating most of their focus to the stimulus being observed. As they mature, they begin to integrate previous knowledge to better interpret and commit new information to memory (Paris &Lindauer, 1982). Appel and colleagues (1972) found that older children may be using more conscious learning strategies when they are told to memorize lists of items. Learning L2 in early childhood and learning L2 later in life may utilize different learning strategies. When learning a new L2 word, children may simply associate the new word to a perceptual representation of whatever is being referred to. Potter et al, (1984) present data suggesting that conceptual representations mediate L2 vocabulary learning at both early and late stages of language learning.

Other studies have also supported the idea that new vocabulary learning is more lexically mediated during the earlier stages of learning than in later stages. Kroll and Curley (1988) found written translations to be faster than L2

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picture-naming in early L2 learners, but the naming and translation speeds did not differ for more proficient learners. Kroll &Dufour (1999) also found that less proficient Spanish speakers spent more time in making judgments when words were lexically similar, while the more proficient speakers met more interference judging the semantically similar words. This provides further evidence of the use of lexical mediation in the earlier stages of language. Chen and Leung (1989) evaluated the role of L1 lexical mediation and concept mediation during new vocabulary learning. They found that children used more concept mediation than the more experienced L2 learners.While the claim that age influences learning strategies seems consistent with a wide range of studies, the details of this effect are far from clear. Bronson, (2000) reviews a body of literature showing that as the ability for strategy use develops, approach to L2 vocabulary learning may also evolve.

Learning to add a new language vocabulary to an already existing language at a younger age, when a direct-mapping approach is more probable, results in using less L1 translations. Whereas learning to add a new language at a later age when lexical-mediation is more prevalent, results in the use of more L1 translations (Dijkstraet al, 2006). It was hypothesized that early L2 learners may learn a novel word faster and would also recall these words faster.This view stresses the possibility that learning an L2 in one's early childhood and learning it later in life may tend to be associated with different learning strategies. The suggestion is that young children, when learning a new L2 word, may simply connect the new word to a perceptual representation of the referent. This would indicate that the learning strategy that they are more prone to use, leads to more proficiency in vocabulary learning.

Although the studies cited above do not converge on anunambiguous account of the factors that determine the choice ofstrategy in novel word learning tasks, at least help identify directionsfor further inquiry in the case of monolinguals and bilinguals. It is noteasy, however, to use these results to arrive at norms (forclinical or other use) applicable to Indian speech communities, where bi- or multilingualism is quite frequent. A literature search shows thatnothing is known about the way age, language learning history andother factors interact in the responses of subjects from Indian speech communities to novel word learning.It is thus appropriate to perform at least preliminary analyses of novel word learning data from a speech community in which it ispossible to compare bilingual with trilingual subjects; hence the present study.

In the Southern Karnataka region, where this study was conducted,the most widely used languages are Tulu, Kannada and English.Kannada, with a national total of 40 million speakers, is the dominantlanguage of the state of Karnataka. Tulu, with 1.5 million speakers,though not a dominant language, is a robust feature of the linguisticlandscape of Southern Karnataka. Its speakers use Tulu with relativesand friends, Kannada as a spoken language in institutional settings, andEnglish to meet certain formal and educational needs. Also considering the linguistic scenario in Kerala, Malayalam is widely used as a spoken language and English is used for educational and formal functions.Thus, it isrelatively easy to find Tulu-Kannada-English trilingual subjects and Malayalam-English bilingual subjects who differ only in their languagelearning histories and are otherwise comparable. The linguistic similarities between Tulu, Kannada and Malayalam are close whereas English is phonetically, syntactically and morphologically different from these languages. Hence Tulu- Kannada – English trilinguals and Malayalam-English bilinguals presented as ideal target populations for the present study.

Need for the study

While the literature provides some findings that pertain to lexical learning in the context of monolingual and bilingual subjects, comparable lexical learning studies involving bilinguals and trilinguals are unavailable. In the Indian context, for clinical, pedagogic and other purposes, it is necessary to establish norms covering trilinguals as well. The absence of empirical material comparing bi- and trilinguals becomes a major problem. India is a country where ordinary natives are exposed to novel words in languages in which relatively they have no proficiency. It is thus imperative to attain some understanding of the strategies that come into play when they encounter these new words. This study is a first step towards such an understanding.

Aim

Present study aimed to investigate novel word learning abilities inMalayalam-English bilinguals andTulu-Kannada-English trilinguals using referent identification and naming task.

Methodology

The study was conducted on two different groups, Group A with Malayalam – English bilinguals and Group B with Tulu –Kannada-Englishmultilinguals.

Participants

Forty bi/multilingual school going children whose age ranged from 15-16 years were

selected as participants. These children were recruited from schools and their academic performance was above average as per the report obtained from class teacher. Group A consisted of 20 children whose mother tongue was Malayalam and second language was English. Similarly Group B consisted of 20 children whose mother tongue was Tulu, second language as Kannada and third language as English. The subjects were quantitatively assessed for their proficiency for all the languages using the International second language proficiency rating scale (ISLPR, Wylie & Ingram, 2006). The overall proficiency across languages in these participants varied from S: 3 – S: 4 level on ISLPR. None of the subjects presented with any history of auditory disorders, hearing loss, speech and language problem, neurological deficits or any other sensory, motor or cognitive problems.

Stimuli

The stimuli consisted of 32 novel words, 8 novel words in each language. These novel words were non words created with in Malayalam, Kannada, Tulu and English to obey the phonological composition of these languages and also to maintain naturalness of pronunciation. The novel words which were used in the current study were selected from this stimulus pool after being validated with the help of two linguists. Eight novel words in each language were made into 4 pairs and 32 pictures which are less familiar to these participants were selected.Each of these pictures was connected to one novel word. A total of 16 short stories were made, 4 stories in each language. Each pair of word was embedded in the story such that no two novel words occur within a single sentence.

To take a few examples, the English novel word *Penears* was associated with a picture of a synagogue –an image that the participants were unlikely to be familiar with. The novel words *Hugura* (Kannada) and *Jeppula* (Tulu) were associated with pictures of an avalanche and a submarine respectively.

Procedure

The participants were taken to a room which was devoid of distraction and a word learning task was carried out. The word learning task consisted of 5 sessions. In the initial phase these novel words were introduced by a live story narration along with a picture presentation. Each story episodes incorporated these novel words, provided maximum exposure to participants. The stories were repeatedly presented in each language for the next four sessions.Each participant was assessed for the acquisition of these novel words following the five phases of

story narration and this was tested in two different tasks.

A) Referent identification task

B) Picture naming task

In the referent identification task, a set of 3 picture choices were provided. The picture choices included the target referent and 2 distractors; a semantically related referent, and an unrelated referent. The target referent was then presented auditorily via a loudspeaker and the participant was instructed to point to the picture that corresponded to the auditory stimulus.

In the picture-naming task, the target referent was presented via a laptop computer and the participant was asked to name it. Responses were video recorded and phonetically transcribed for later analysis.

Analysis

The participant's responses were video recorded and phonetically transcribed for later analysis. Responses were evaluated for two different tasks.

1. Referent identification task

2. Picture naming task.

Reaction or latency time measurements were used to calculate the responses for both the tasks. Scoring for both the tasks was carried out based on the percentage of words correctly identified, correctly named and the percentage of repeated errors for the participants in both the groups was calculated using the following formula:

Number of correctly repeated/identified words

Total number of words   X

Word error analysis was done using Li and Williams (1990) checklist, extended version of error categorisation system by Kohn and Goodglass (1985). Reaction times taken for naming and referent identification was calculated separately and mean reaction time of each individual in all languages was found. In Group A the Reaction time between both languages was analysed using Paired T- test and in Group B one way ANOVA was used to calculate the reaction time of both the tasks.

Results

Group A (Malayalam- English bilinguals)

Reaction time: The results obtained in reaction time for Malayalam and English bilinguals were examined in following 2 conditions

A) Comparison of reaction time between L1 and L2

B) Comparison of reaction time within L1 and L2

Table 1: *Comparison of reaction time between Malayalam and English (Mean, standard deviation &t'value).*

Task	Language	Mean	SD	t' value
Referent Identifi-cation	L1	2.2024	0	0 NS
	L2	2.2024		
Naming	L1	2.9118	1.4140	4.2584 **
	L2	4.249		

(p<.05=* significant, P<.01=** highly significant, NS=Not significant)

Referent identification and naming tasks were evaluated in detail with respect to reaction time responses in all the languages. Highly significant differences were observed for naming task in L1 and L2. The time taken to name the novel words in L2 (English) was more when compared with L1 (Malayalam). This showsthat lexical retrieval was faster in L1 (Malayalam) than L2 (English). However no significant difference was obtained for referential identification task in neither of the languages.

Table 2: *Comparison of reaction time within Malayalam and English*

Language	Task	Mean	SD	T value
L1	Referent Identifi-cation	2.2024	1.3766	5.78 **
	Naming	2.9118		
L2	Referent identification	2.2024	1.7715	7.93 **
	Naming	4.249		

(p<.05=* significant, P<.01=** highly significant, NS=Not significant)

Comparison of reaction time with in L1 and L2 for referent identification and

naming revealed a highly significant difference. Referent identification scores were observed to be better for all the participants when compared with naming task.

Table 3: *Percentage of correctly repeated and identified for L1 and L2.*

Tasks	L1	L2
Referent Identification	100%	100%
Naming	82.5%	78.75%

The percentage of correctly identified words (100%) were similar in both the languages .The percentage of correctly repeated words were maximum in L1 (82.5%) followed by L2 (78.75%).

Table 4: *Analysis of word errors in L1 and L2*

Word Errors	L1(%)	L2(%)
Syllabic repetition	3.75	1.25
Syllabic substitution	3.75	1.25
Addition	1.87	0.62
Related word repetition	-	2.5
Part word repetition	0.62	1.87
Rejection error	0.62	0.62
Reduplication	1.25	
Final consonant deletion	-	3.12
Phonemic omission	-	6.25

A detailed analysis of word errors were carried out and percentage of each word error in both the languages were found out. The types of errors seen in L1 are syllabic repetition (3.75%), syllabic substitution (3.75%), addition (1.87%), part word repetition (.62%), rejection error (.62%) and reduplication (1.25%). Percentage of syllabic repetition and substitution were more in L1 with no final consonant deletion and omission errors.

Errors in L2 include syllabic repetition (1.25%), syllabic substitution (1.25%), addition (.62%), part word repetition (1.87%), rejection (.62%), final consonant deletion (3.12) and phonemic omission (6.25%). Final consonant deletion and omission error were more in L2 with no reduplication.

Results of Group B (Tulu, Kannada &English multilinguals)

To find out the significant difference in naming and referent identification for L1 (Tulu), L2 (Kannada) & L3 (English) one way ANOVA was carried out.

Table 5: *Mean and standard deviation of the reaction time for naming task in L1, L2 and L3.*

Languages	N	Mean	SD
L1	120	6.28	2.19
L2	120	6.82	1.88
L3	120	2.32	0.47

Mean reaction timefor naming task was almost similar in L1(Tulu) and L2(Kannada) with a minimal difference in standard deviation. L3(English) exhibited better naming scores i.e, less reaction time when compared with L1 and L2. Overall multilinguals named novel words faster in L3 compared to L1 and L2.

Table 6: *Comparison of reaction time for Naming task in L1,L2 & L3 using ANOVA.*

Sources of variation	F_{cal}	Significant difference
Between group Within group Total	252.035	.000*

Less reaction time were obtained forL3 followed by L1 and L2. L3(English) showed a high significant difference with L1(Tulu) and L2(Kannada) in both the conditions(i.e,within and between group). This shows lexical retrieval of novel words were faster in L3 (English) when compared to L1 and L2.

Table 7: *Mean and standard deviation of reaction time for referent identification in L1,L2 and L3.*

Languages	N	Mean	SD
L1	120	1.0417	0.2007
L2	120	1.0672	0.2515
L3	120	1.0000	0.000

From Table 7 it is clear that there was no markable difference in mean reaction time for referent identification task in L1,L2 and L3.However, there was a minimal difference in the mean and standard deviation scores for L3 (English) when compared with L1 and L2.This indicates L3 was slightly better followed by L1 and L2.

Table 8: *Between and within comparison of reaction time for referent identification in L1,L2and L3.*

Sources of variation	Degree of freedom	Mean square	Significant difference
Between group	2	.138	
Within group	356	3.442E-02	.019 NS

(NS=Not significant)

Comparison of reaction time between and within languages for referent identification revealed no significant difference in L1,L2 and L3 as shown in Table 8.

Table 9 : *Percentage scores of naming and referent identification*

Tasks	Tulu	Kannada	English
Referent identification	100%	100%	100%
Naming	77%	73%	88%

All the target referents were correctly identified by subjects in L1,L2 and L3.Maximum number of naming scores were obtained in L3 (88%) followed by L1(77%) and L2(73%).

Table 10 : *Analysis of word errors in L1, L2 and L3*

Word errors	L1 (%)	L2 (%)	L3 (%)
Syllabic repetition	4.75	3.75	1.55
Syllabic substitution	3.25	3.5	.82
Addition	1.55	1.85	.25
Related word error	__	__	2.5
Part word repetition	0.42	.25	1.87
Rejection error	1.25	2.25	0.62
Reduplication	.62	.425	__
Final consonant deletion	__	__	4.25
Phonemic omission	__	__	5.85

Word error analysis in each language showed maximum percentage of syllabic repetition (4.75% & 3.75%), syllabic substitution (3.25% & 3.5%) and addition errors (1.55% & 1.85%) in Tulu and Kannada.Part word repetion(.42% & .25%) and rejection errors(1.25% & 2.25%) were also seen in L1 and L2.

However, errors like final consonant deletion and phonemic omission were not seen in either Kannada or Tulu. Maximum percentage of omission (5.85%) and final consonant deletion (4.25%) errors were seen in English followed by part word repetition (1.87%).

Discussion

The present study attempted an in depth comparison of lexical learning skills in Malayalam-English bilinguals and Tulu-Kannada-English multilinguals. Naming and referent identification were used to study the lexical skills in these populations. The first finding we present is that bilingual children showed a very significant difference in word learning between L1 and L2. Naming scores for L1 were better when compared with L2.This shows that the lexical processing and the ability to learn a novel word was faster in L1 than L2. Paradis (1997) ventured that L1 may depend more on implicit, procedural memory because it has been acquired spontaneously, whereas L2 depends more on explicit, declarative memory if it has been acquired largely through school instruction. The reason for lower L2 scores could be attributed to the limited exposure of L2 which is only used for the academic purposes.

The Tulu-Kannada-English trilinguals showed a different pattern of results. Reaction time taken for naming in English was better followed by Tulu and Kannada. This shows that the lexical processing and the ability to learn a novel word were faster in L3 followed by L1 and L2. Unlike the subjects in Group A those in Group B were more frequently exposed to English and used

English more often for communication as reflected by their responses on ISLPR (S:4 level of proficiency).The higher scores obtained in L3 supports the view that as language proficiency increases, there may be a larger association between the lexical forms and semantics and eventually it becomes easier to retrieve the words faster (Kroll & Stewart 1994; Kroll & de Groot 1997). Interestingly, the referent identification scores across languages did not vary significantly across bilinguals and multilinguals. The children in both the groups received equal and repeated auditory presentation for all the novel words. Studies have suggested that repeated language comprehension training task would provide a faster lexical access (Fukkink et al, 2005). This may be the reason for similar identification scores across languages.

Additionally we also probed the error patterns for naming task in all the languages in these children. A detailed error analysis in all the languages revealed a similar pattern of errors in Malayalam, Kannada and Tulu. Maximum numbers of syllabic repetition, substitution and addition errors were found in these languages. English exhibited more of omission and final consonant deletion errors. This finding could be interpreted as a reflection of the structural differences between English and other languages. A similar error types in Malayalam, Kannada and Tulu may due to the close linguistic similarity between these languages. Phonemic deviation showed the highest score; such deviations occur more often in a second language. It is possible to suggest a weaker phonological mechanism in the subjects' knowledge of the second language. However, little is understood about error patterns during the learning of novel words in the case of Indian languages – or for any trilingual subjects – and it would be premature to do more than suggest the possibility that L2 phonological systems may in general be weaker than L1 systems. This study has major implications for almost all language impaired populations like those with hearing impairment, specific language impairment, and others, where learning a new word can be difficult.

Conclusions

The purpose of the current study was to compare the lexical learning skills in bilingual and multilinguals in two different language contexts. The results obtained in the present study are consistent with the view that novel word learning is not just an idiosyncratic reflection of a subject's personal linguistic history, but that generalizations are possible which may involve such factors as language proficiency, degree of exposure and opportunities for frequent conversational use.

The results also show that language dominance is a distinct factor; even if the two group of populations have English commonly in their repertory, it may be dominant in one population but not in the other, with sharply distinct consequences. As we work towards clinically useful norms in the multilingual societies of India, it becomes necessary to improve our understanding of different linguistic repertories and the consequences they have on a subject's word perception ability for each language in his or her repertory. The present study has major implications for language impaired populations affected by hearing impairment, specific language impairment, and other difficulties that affect the learning of new words. Studies that seek to replicate these results for other multilingual groups in India would be interesting. The results of such studies will be of great use in the context of setting specific treatment goals for language disabled individuals.

References

Apel, K., & Kamhi, A. (1987). Fast mapping skills of language impaired children: A muke is a muke. Paper presented at the Annual Convention of the American Speech-Language-Hearing Association, New Orleans, L.A.

Apel, K., & Dollaghan, C. (1985). Fast mapping skills in young children: Name that word. Paper presented at the annual convention of the American Speech-Language-Hearing Association, Washington, D.C.

Bloom, P. (2000). *How children learn the meaning of words*. Cambridge, MA: The MIT press.

Bronson, M. B. (2000). *Self-regulation in early childhood: Nature and Nurture*. New York: Guilford Press.

Carey, S., & Barlette. (1978). Acquiring a single new word. In papers and reports on child language development (Stanford University), 15, 17-29.

Chen, H-C., & Leung, Y-S. (1989). Patterns of lexical processing in a non-native language. *Journal of Experimental Psychology: Learning, Memory and Cognition, 15*, 316-325.

Carey, S. (1978). The child as word learner. In M.Halle, J.Bresnan, &G.miller (ed), Linguistic theory and psychological reality (pp.264-293). Cambridge, MA: MIT Press

Dollaghan, C. (1985). Child meets word: 'Fast mapping' in preschool children.*Journal of Speech Language and Hearing Research*, *28*, 449-454.

Dijkstra, A., & Van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition, 5*,175-197.

Dijkstra, T., & Brysbaert, M. (2006). Cited in Morais, J., & d'Ydewalle, G. (2006). *Bilingualism and second language acquisition*. Brussels: KVAB.

Fukkink, R. G., Hulstijn, J., & Simis, A. (2005). Does training in second language word recognition skills affect reading comprehension? An experimental study. *The Modern Language Journal, 89* (1), 54-75.

Heibeck, T., & Markman, E. (1987). Word learning in children: An examination of fast mapping. *Child Development*, *58*, 1021-1034.

Jia, G., Kohnert, K., & Collado, J. (2006). Action naming in Spanish and English by sequential bilingual children and adolescence. *Journal of Speech Language and Hearing Research. 49*, 588-602.

Kohn, S. E., & Goodglass, H. (1985). Picture naming in aphasia. *Brain and Language, 24,* 266-283.

Kroll, J.F., & Curley, J. (1988). Lexical memory in novice bilinguals: The role of concepts in retrieving second language words: In M. Grunenberg. P. Morris, & R. Skyes (Eds.), *Practical aspects of memory.* London: Wiley.

Kroll, J. F., & de Groot, A. M. B. (1997). Lexical and Conceptual Memory in the Bilingual: Mapping Form to Meaning in Two Languages. In de Groot, A. M. B. and Kroll, J. F. (Eds.), *Tutorials in Bilingualism: Psycholinguistic Perspectives.* (pp. 201-224). Mahwah, NJ: Lawrence Erlbaum Publishers.

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.

Li, C.T., & Williams, S. T. (1990). Repetition deficit in three aphasic syndromes. *Journal of communication disorders, 23*, 77-88.

Mallikarjun, B. (2002). Variables Relevant for Vocabulary Growth. *Language in India,2,122-129.*

Morais, J. & d'Ydewalle, G. (2006). *Bilingualism and Second LanguageAcquisition*. Brussels: KVAB.

Paradis, M. (1997). The cognitive neuropsychology of bilingualism. In de Groot, A. M. B. and Kroll, J. F. (Eds.), *Tutorials in Bilingualism: Psycholinguistic Perspectives.* (pp. 331-354). Mahwah, NJ: Lawrence Erlbaum Publishers.

Paris, S. G., & Lindauer, D. K. (1982). The development of cognitive skills during childhood. In B. Wolman (Ed.), *Handbook of Developmental Psychology.* Englewood Cliffs, N. J. Prentice Hall.

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.

Talamas, A., Kroll, J. F., & Dufour, R. (1999). From form to meaning: Stages in the acquisition of second language vocabulary. *Bilingualism: Language and cognition.2 (1),* 45-58.

Wylie, E. & Ingram, D. E. (2006). *International Second Language Proficiency Rating (ISLPR).*Nathan, Qld: Centre for Applied Linguistics and Languages. Mt Gravatt Campus Griffith University.

NONWORD REPETITION IN SIMULTANEOUS AND SEQUENTIAL BILINGUALS

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Abstract

Bilingualism is the process of knowing or using two languages with equal or nearly equal fluency. Research evidences have suggested that cognition is affected by the process of learning one or more languages. In this context the present study aimed at investigating the Phonological Working Memory (PWM), one of the language specific cognitive processing areas in different types of bilingual children. A Kannada based nonword repetition task (NWR) was administered to eight simultaneous and eight sequential Kannada-English bilingual children in the age range of seven to eight years. Their responses were audio recorded, transcribed, scored, and subjected to statistical analysis. The results indicated that the sequential bilingual children performed significantly better compared to the simultaneous bilinguals on 4-syllable, 5-syllable and on overall accuracy of nonword repetition task. Further error analysis indicated that the simultaneous bilingual children had more percentage of syllable substitutions and omission errors than sequential bilingual children. This suggested better phonological working memory skills in sequential bilinguals compared to simultaneous bilinguals which could be attributed to the age of acquisition effects of the second language and also on the amount of exposure and use of the first and second language. This study provides an insight into the phonological working memory skills in bilingual individuals who have acquired their languages in a different manner and the results could contribute to theories related to language processing in them.

Keywords: phonological working memory, sequential bilinguals, simultaneous bilinguals

Bilingualism is a language related phenomenon which is extremely prevalent in the present day scenario. The term *bilingual*, on the surface means knowledge of two languages. Individuals can acquire languages in a variety of ways at different points of time in their life and in a variety of circumstances and contexts. The extent of exposure to a particular language and its use also differs from person to person. Bilingualism therefore is not unitary or static phenomenon and is shaped by a variety of historical, cultural, political, economic, environmental, linguistic, psychological and other factors. Accordingly researchers are yet to arrive at a complete definition of bilingualism covering all the aspects. They have tried to classify bilinguals on the basis of age of acquisition of language, proficiency level of the languages and the context in which learning takes place. Consideration of the age of acquisition has given rise to several classifications from a developmental perspective. One such classification is simultaneous and successive bilingualism (Genesse, Hamers, Lambert, Mononen, Seitz, & Starck, 1978).

Simultaneous bilingualism occurs in early childhood, when a child learns two languages at the same time. They are considered to be learning a second language prior to the full grammatical development of the first, and therefore the two developing systems are said to interact more actively. It is also referred to as bilingual L1 acquisition (Meisel, 2001) because two languages develop together as first languages (two L1s). This could be as a result of dual language input from parents or caregivers. Simultaneous bilingual children acquire structure shared by both languages at approximately the same rate and in the same sequence (Kessler, 1971). In sequential bilingualism, on other hand, the first language (L1) and the second language (L2) are sequentially ordered, i.e., the acquisition of the second language happens after the child has acquired basic command and an established grammar in the first language, which for monolingual acquisition is typically taken to be roughly the age of 3-4 years (McLaughlin, 1978). They utilize this knowledge of the structures of the L1 as the foundation for the L2. The rate of mastery of each language depends on the amount of exposure each child gets in that language. Their literacy skills are still in the process of development, and thus schooling becomes an important mediating factor. Several such factors lead to differing levels of proficiency in the two languages.

Cognition is affected by the process of learning one or more languages. Working memory, an aspect of cognition, in particular, has been emphasized in studying language related cognitive functions in bilinguals. Bialystok (2009) showed that bilingual children exhibit an advantage in working memory. Working memory shows a clear-cut relationship with language acquisition on the basis of different sources of evidences (Vallar & Papagno, 2002).

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A component of working memory, called the phonological working memory (PWM) has been studied extensively by researchers. PWM refers to a process of receiving, analyzing and processing of sound elements in language. In Baddeley's model (Baddeley, Gathercole, & Papagno, 1998) PWM plays an important role in the learning of new words, whose unique phoneme sequences must be retained long enough to be assigned a semantic interpretation. In normal development, phonological memory skills correlates both with the existing vocabulary knowledge and the ease of learning new vocabulary either in native or foreign languages (Baddeley, 1998).

Different methods and stimuli have been used to study the PWM. One such method that has been recently researched upon is the use of nonword repetition (NWR) task. NWR task involves strings of letters or alphabets that are devoid of lexicality effects and that are not predictable as a word. Since repetition of nonwords calls for perception, storage and retrieval of its phonological constituents in a sequence, it is proposed as a potential task to identify the deficits related to phonological working memory in children. Gathercole and Baddeley (1990) suggested that nonword repetition allows a purer measure of short-term memory abilities than classic memory span tasks (i.e., digit span and word span). The ability to repeat words in an unknown language has been observed to predict success in learning that language. Conversely, inability to repeat pseudowords has been related with failure in L2 acquisition (Ardila, 2003).

A look into the literature revealed that NWR is influenced by the language knowledge and experience in the bilingual children. Thorn and Gathercole (1999) compared the nonword repetition abilities of English-French bilingual children. The children who were aged between 4 and 8 were classified as sequential (having acquired French after they partly or completely acquired English as their native language) and simultaneous (having acquired English and French at the same time) bilinguals. The simultaneous bilingual children obtained a raw score of 100 on both French and English vocabulary skill, but the sequential bilingual children's vocabulary score was 113 for English and 75 for French as found on questionnaire administered to parents. The investigators administered the French nonword repetition and English nonword repetition task on both the groups. The results indicated that wordlikeness effects were present only when the nonword stimuli were in the child's native language. The simultaneous bilinguals showed superior repetition of high than low word like nonwords

in both English and French. But the sequential bilinguals showed superior repetition of high than low word like nonwords only in English.

Gutierrez-Clellen and Simon-Cereijido (2010) evaluated the clinical utility of nonword repetition task with a sample of Spanish-English bilingual children and to determine the extent to which individual differences in relative language skills and language use had an effect on the clinical differentiation of these children by the measures. A total of 144 Latino children (95 children with typical language development and 49 children with language impairment) were tested using nonword lists developed for each language. The results showed that the clinical accuracy of nonword repetition tasks varied depending on the language(s) tested. Test performance appeared related to individual differences in language use and exposure.

Summers, Bohman, Gillam, Pena and Bedore (2010) investigated Spanish-English sequential bilinguals' recall of Spanish-like and English-like items on NWR tasks and also assessed the relationship between performance on NWR, semantics and morphology tasks. Sixty two Hispanic children who were exposed to English and Spanish were taken as subjects. The children completed NWR tasks and short tests of semantics and morphosyntax in both languages. The results revealed that the children produced the Spanish-like nonwords more accurately than the English-like nonwords. Further NWR performance was significantly correlated to cumulative language experience in both English and Spanish.

Further, there are a few studies reporting the influence of syllable length on the NWR task. Simkin and Conti-Ramsden (2001) conducted a study to provide normative guidelines for three language measures lacking standardization for children in their final year of primary education. They used the Children's Test of Nonword Repetition (Gathercole & Baddeley, 1996), the past tense task (Marchman, Wulfeck & Weismer, 1999) and the third-person singular task. Results revealed that there was a difference in the Children's Test of Nonword Repetition when the number of syllables was changed. The mean scores for nonword repetition at 2-syllable, 3-syllable, 4-syllable and 5-syllable are 9.84, 9.57, 8.97, and 8.98 respectively, i.e. the accuracy of the nonwords repeated decreased as the number of syllables increased. Few other studies reported the same findings (Gathercole, 2006).

Need for the study

A look into the literature revealed several studies conducted on the sequential bilingual children using the NWR task to study their PWM. These

studies were primarily carried out to assess the influence of language use and exposure on the PWM and they suggested that the bilingual children's language experience is divided across two languages. Since the sequential and simultaneous bilingual children differ in the context and manner of acquisition of languages, the usage and exposure of both L1 and L2, their performance on the NWR task could be different which needs to be investigated. Studying the performance on NWR in these types of bilingual children could enhance ones' understanding of the relationship between information processing and language learning. A few studies have focused on phonological working memory in different types of bilingual individuals using NWR tasks. However there are only limited studies comparing the two varieties of bilinguals such as the simultaneous and sequential on these aspects. Most of these have been carried out in the West. In the Indian context though there are studies using NWR tasks, most of them have been conducted in the monolingual population especially in children with communication disorders. There is a dearth of studies examining the performance of sequential and simultaneous bilinguals on nonword repetition. India being a multicultural and multilingual country provides a rich platform to conduct such studies. Hence the present study was carried out with the aim of comparing the performance of simultaneous and sequential Kannada-English bilinguals on a nonword repetition task and hence evaluating their phonological working memory. The specific objectives were to compare both the groups on the accuracy of nonwords and percentage of phonemes repeated and to analyze the type of errors exhibited during the nonword repetition.

Method

Participants

A total of 16 typically developing Kannada-English bilingual children in the age range of seven to eight years who were studying in second grade in different schools in Mysore were selected for the study. These bilingual children were classified into eight simultaneous bilinguals (6 males and 2 females) and eight sequential bilinguals (5 males and 3 females) based on the questionnaire (Harini & Shyamala, 2010). Children were classified as sequential when they acquired their mother tongue Kannada from birth and were exposed to English after they joined school at the age of 3.6years and simultaneous when they were exposed to both English and Kannada right from birth before they joined school. The WHO ten question disability checklist (Singhi, Kumar, Malhi, & Kumar, 2007) was administered to rule out any disability.

International Second Language Proficiency Rating scale (ISLPR, Wylie & Ingram, 1995, 1999) was administered to check their language proficiency in English. ISLPR describes language performance at eight points along the continuum from zero to native like proficiency in each of the four macro skills (speaking, listening, reading and writing). The simultaneous bilinguals obtained a score of 3 and the sequential bilinguals obtained a score of 2 on ISLPR. The parents and also teachers handling the children were also consulted while rating these children for their language proficiency. The semantics and syntax section of Linguistic Profile Test in Kannada (LPT, Karanth, Ahuja, Nagaraja, Pandit, & Shivashankar, 1991) was administered to evaluate the language abilities in Kannada of children in both the groups. The simultaneous bilingual children obtained a mean overall raw score of 153 and the sequential bilingual children obtained a mean overall raw score of 166.7. They were also tested for the semantic and syntactic skills in English by administering the English language test for Indian children (Bhuvaneshwari & Jayashree, 2010) wherein the simultaneous and sequential bilingual children obtained a mean overall raw score of 142.10 and 141.10 respectively. Both the groups had age appropriate language abilities in both Kannada and English. Subjects were administered with Kannada articulation test (Babu, Rathna, & Bettageri, 1972) to rule out the articulatory errors. The subjects were also matched for their socioeconomic status based on the NIMH Socioeconomic status scale (Venkatesan, 2009).

Stimuli

A list of nonwords (Shylaja & Swapna, 2010) was used as the stimulus. The nonwords were formed from meaningful Kannada words and differed in their syllable length. The list contained a total of 25 nonwords, with 20 nonwords as the test items (5 under each of the syllable lengths used) and 5 nonwords as the practice items. The list of nonwords were audio-recorded by a female native speaker of Kannada, using the "PRAAT" software (downloadable software for speech recording and analysis) loaded in the Compaq Presario C700 laptop system and then loaded into DMDX software to maintain a constant inter-stimulus interval of 4sec.

Procedure

The list of 20 nonwords which differed in their syllable length were presented along with five practice items through DMDX software using headphones at the comfortable listening level to the individual participants, in a quiet listening

environment. Each participant was given the recorded instructions in Kannada through headphones as following: "You are going to hear some funny made-up words. Your job is to say them back to me, exactly the way you hear them. Some of the words will be short, and others will be longer. Listen carefully, because the words will be said only once. Here comes the first word." The list of five practice items was presented first followed by the test items. No feedback was given on the test items, but encouragement was given as required. The responses were audio recorded directly into the DMDX software and then transcribed verbatim by the experimenter. These recorded responses were also transcribed and analysed by another experimenter who was also an experienced speech-language pathologist for 10% of the sample. The nonwords were analysed for overall accuracy, accuracy at different syllable lengths (2-, 3-, 4- and 5-syllable) and error analysis.

Scoring

The accuracy of each of the individual's responses was calculated as the whole word correct or incorrect. The exact repetition of the nonwords was scored as "1". Any syllable substitutions, omissions and additions were considered as incorrect and scored as "0". The total number of the nonwords correct were calculated and tabulated.

The total number of vowels and consonants repeated correctly and the total number of different types of errors such as substitutions, additions, omissions was averaged across the different syllable lengths. The total percentage of vowels correct, the total percentage of consonants correct and the type and percentage of errors namely, substitution, omission, addition errors were calculated from the raw scores. The percentage of vowels/consonants correct was obtained by dividing the number of vowels/consonants correct by the total number of vowels/consonants multiplied by 100. The total percentage of different errors was also computed in a similar manner for each subject for the entire set of nonwords and also at each different syllable lengths.

These results were subjected to the statistical analysis in SPSS software (version 16). Descriptive statistics was used to compute the mean and standard deviation. Other statistical procedures like Mann- Whitney U test was carried out to answer the research questions. The inter-rater reliability was carried out and the cronbach's coefficient (α) ranged from 0.73-0.99 which suggested a good inter-rater reliability between the two judges.

Results

The results of the statistical analysis for both groups have been presented and discussed under the following sections:
I. Accuracy of responses
II. Error analysis

I.   Accuracy of responses

a.   Overall accuracy of responses

The accuracy of the responses was determined by calculating the total number of   nonwords repeated correctly. The mean and standard deviations were computed and the values for both the groups are depicted in Table 1. The overall mean score for the accuracy of nonword repetition task in the simultaneous bilinguals was 10.88 (SD= 3.83), which was lesser than 14.50 (SD=3.12) the mean obtained by the sequential bilinguals. This indicated that the simultaneous bilinguals had lower accuracy than the sequential bilinguals for the NWR task. This has been depicted graphically as shown in Figure 1.

To determine whether any significant difference existed between the performances of both the groups as a whole, Mann Whitney U test was administered and the results revealed that there was significant difference between sequential and simultaneous bilinguals. The /z/ values have been depicted in Table 1.

Table 1. *Mean, standard deviation (SD), and /z/ values for accuracy of responses in both the groups.*

Accuracy of Responses	Group	Mean	SD	/z/ values
A2s	Simultaneous	3.75	0.71	0.56
	Sequential	4.00	0.93	
A3s	Simultaneous	3.50	1.41	0.76
	Sequential	4.00	1.20	
A4s	Simultaneous	2.63	1.69	2.05*
	Sequential	4.25	0.89	
A5s	Simultaneous	1.00	0.76	2.00*
	Sequential	2.25	1.28	
Overall Accuracy	Simultaneous	10.88	3.83	2.01*
	Sequential	14.50	3.12	

Note: A2s- accuracy at 2-syllable length nonwords; A3s-accuracy at 3-syllable length nonwords; A4s- accuracy at 4-syllable length nonwords; A5s-accuracy at syllable length nonwords; *p<0.05.

On specific examination of the performance of the two groups across different syllable length, it was seen that there was a statistically significant difference in the performance on 4- and 5-syllable length nonwords and also in the overall accuracy of the nonwords (p<0.05) as revealed by Mann Whitney U test. Moreover there was a decrease in the accuracy of the nonword repetition responses in both the groups with the

increase in the syllable length. The sequential bilingual children had significant difficulty in repeating 5-syllable length nonwords, whereas the simultaneous bilingual children had difficulty in repeating both 4- and 5-syllable nonwords as revealed by the mean values shown in Table 1.
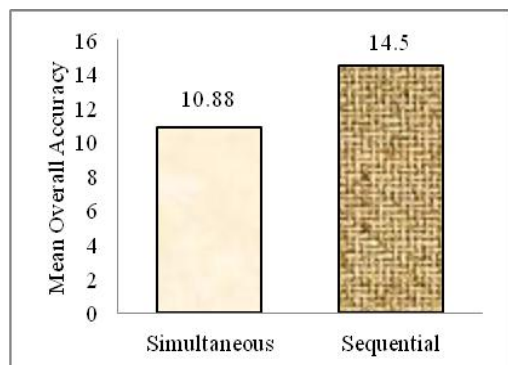

Figure 1. *Mean accuracy of responses on the NWR task in both the groups.*

b. Percentage of vowels and consonant correct across both the groups: The mean and standard deviation values for overall Percentage of Vowels Correct (PVC) and Percentage of consonants Correct (PCC) for the entire task and

at each syllable length for both the groups are shown in Table 2.

The overall mean scores of PVC for the sequential bilinguals was (mean= 96.07, SD= 2.38) was higher than that of simultaneous bilinguals group (mean= 92.14, SD= 5.12). The mean values at 3-syllable, 4-syllable and 5-syllable of the sequential bilinguals were also higher than the simultaneous bilinguals. The PVC also decreased from 2-syllable nonwords to 5-syllable nonwords, that is, the errors increased from shorter syllable length to the longer syllable length nonwords in both the groups. In a similar manner the mean scores of PCC at different syllable lengths and as a whole was higher for sequential (mean=92.68, SD= 8.10) than simultaneous bilinguals (mean= 83.93, SD=14.30). The same has been depicted in Figure 2. On the basis of mean scores, it can be stated that the sequential bilinguals repeated greater number of phonemes including vowels and consonants accurately. However, both the groups had higher percentage of vowels correct compared to the percentage of consonants. This suggests that both the groups had more difficulty in repeating consonants than vowels.

Table 2. *Mean, standard deviation (SD) and / z / values of PVC and PCC at different syllable lengths for both the groups.*

Syllable length	Group	PVC			PCC		
		Mean	SD	/z/ values	Mean	SD	/z/ values
2s	Simultaneous	98.75	3.54	0.62	87.50	7.07	0.66
	Sequential	97.50	4.63		90.00	11.95	
3s	Simultaneous	95.00	7.77	0.37	85.83	17.62	0.96
	Sequential	97.50	3.45		92.50	14.00	
4s	Simultaneous	90.00	11.95	0.86	86.25	14.58	1.66
	Sequential	98.13	2.59		96.88	4.58	
5s	Simultaneous	89.50	6.02	1.28	79.50	19.06	1.65
	Sequential	93.00	4.14		90.50	9.55	
Overall	Simultaneous	92.14	5.12	1.91	93.93	14.30	1.64

Note: PVC - percentage of vowels correct; PCC –percentage of consonant correct; 2s- 2-syllable nonwords, 3s- 3-syllable nonwords; 4s-4-syllable nonwords; 5s- 5-syllable nonwords
.

Mann Whitney U test was done to find whether there was significant difference between both the groups in the total PCC and total PVC for the overall nonword repetition task and also at different syllable length nonwords. The results of the test indicated that there was no significant group difference (p>0.05) in the total PVC and total PCC for the overall non word repetition task and also at different syllable lengths. These results are depicted in Table 2.

II. Error analysis in the nonword repetition task

Percentage of syllable substitution, addition and omission: The mean and standard deviation values for Percentage of Syllable Substitution

(PSS), Percentage of Syllable Addition (PSA) and Percentage of Syllable Omission (PSO) were calculated for nonwords at different syllable length and for the overall non word repetition task which are shown in Table 3. Both the groups had higher substitution errors, followed by omission errors and almost no addition errors. The same has been depicted in Figure 2. A specific examination of the PSS revealed that the simultaneous bilinguals had higher PSS than sequential bilinguals overall and at different syllable lengths. The values of PSA shown in the Table 3 also indicate that at 4- and 5-syllable length, only one child in simultaneous group had syllable addition error. All other children in both

the groups did not exhibit syllable addition errors. The simultaneous bilinguals also had higher PSO than sequential bilinguals group at 3- and 4-syllable lengths and at overall nonword repetition task. There was no syllable omission at 2-syllable length.

The results of Mann Whitney U test indicated that there was a significant difference between the two groups only in the PSS at 5-syllable length and the overall percentage of syllable substitution where in the simultaneous bilingual group had higher PSS indicating more errors than sequential bilingual group. The /z/ values are depicted in Table 3.
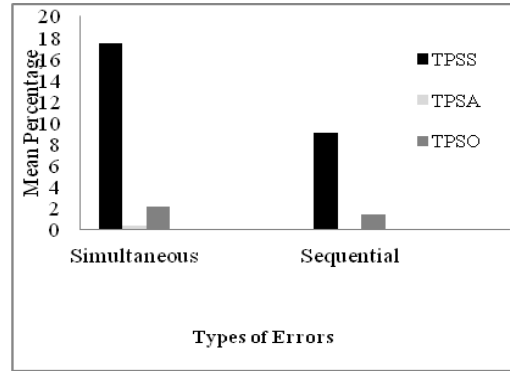
Figure 2. *Representation of the error types in both the groups.*

Table 3. *Mean, standard deviation (SD) and /z/ values of PSS, PSA and PSO across different syllable lengths for both the groups.*

Syllable length	Group	PSS			PSA			PSO		
		Mean	SD	/z/ values	Mean	SD	z/ values	Mean	SD	/z/ Values
2s	Simultaneous	13.75	7.44	0.22	0.00	0.00	0.00	0.00	0.00	0.00
	Sequential	12.50	11.65		0.00	0.00		0.00	0.00	
3s	Simultaneous	11.67	14.58	0.78	0.00	0.00	0.00	3.33	3.56	0.49
	Sequential	6.67	11.27		0.00	0.00		2.50	3.45	
4s	Simultaneous	15.63	14.25	1.94	0.63	1.77	1.00	2.50	7.07	1.00
	Sequential	5.00	6.55		0.00	0.00		0.00	0.00	
5s	Simultaneous	24.00	9.32	2.46*	0.50	1.41	1.00	1.50	2.98	0.51
	Sequential	12.50	6.57		0.00	0.00		2.50	4.24	
Overall	Simultaneous	17.50	9.06	2.22*	0.36	1.01	1.00	2.14	3.05	0.28
	Sequential	9.11	7.00		0.00	0.00		1.43	2.02	

Note: PSS - Percentage of Syllable Substitutions; PSA - Percentage of Syllable Additions; PSO - Percentage of Syllable Omission; 2s- 2-syllable length nonwords, 3s- 3-syllable length nonwords; 4s-4-syllable length nonwords; 5s- 5-syllable length nonwords, *p<0.05

Discussion

The present study aimed to compare the PWM in simultaneous and sequential Kannada-English bilinguals using NWR task. The results revealed that the performance of sequential bilinguals was better on nonword repetition task compared to the simultaneous bilinguals. The superior performance of the sequential bilingual children could be attributed to the age of acquisition effects of the second language, context of acquisition of the second language and also on the amount of exposure and use of the first and second language. The simultaneous bilingual children at least initially could have had lesser exposure to each language which might have led to the difficulty in forming representations of newly encountered sound sequences and hence poor nonword repetition scores. Similar conclusions have also been drawn by Hoff & McKay (2005). Gutierrez-Clellen & Simon-Cereijido (2010) also indicated the influence of language use and exposure on the performance of the bilingual children considered in their study.

There is evidence in literature to support the fact that the bilingual children and young adults have smaller vocabularies in each of their languages than monolinguals (Pearson, 1993; Pearson, Fernandez, Lewedeg, & Oller, 1997; Thorn & Gathercole, 1999; Hoff & Elledge; 2003). Sequential bilingual children are monolinguals up to a certain age after which they acquire their second language and hence could have had a larger lexicon. Further, Hoff & McKay (2005) suggested that young children, who live in an environment that requires them to learn two languages initially, build their vocabularies at a slower pace than children acquiring only one language. They also reported that the 23 month old monolinguals outperformed the bilinguals on the NWR task which indicated that monolinguals are better on phonological skills. These findings extend support to the present study.

In general, the children included in both the groups were not balanced bilinguals. Rather, the sequential bilingual children were more dominant in Kannada because they had acquired

Kannada first in their life and less dominant in English as revealed by the tests administered. Specifically, although both the groups of children had age appropriate language abilities in Kannada on the LPT (Karanth et al., 1991), a closer examination of the raw scores revealed higher semantic and syntactic abilities in the sequential bilingual children (overall mean raw score of 166.7) and hence their deeper and more abundant knowledge of Kannada language would have influenced the performance, since the nonwords were Kannada based. This is in accordance with the threshold hypothesis proposed by Cummins (1979, 1981, & 1984) and Toukomaa and Skutnabb-Kangas (1977) where in they stated that a higher proficiency in language reflect better cognitive abilities. Further studies do reveal a word likeness effect on repetition task (Summers et al., 2010). On the other hand, the simultaneous bilingual children were more proficient in English since their parents used English more frequently even during daily conversation at home. This was also revealed by the higher scores obtained in English on the ISLPR (Wylie & Ingram, 1995, 1999) administered, wherein the simultaneous bilinguals obtained a score of 3 and the sequential bilinguals obtained a score of 2. Further, it was observed that the simultaneous bilingual children were more fluent, proficient, confident and produced more grammatically complex sentences in English during an informal conversation compared to the sequential bilingual children. They also preferred to answer questions in English than in Kannada. The children obtained higher scores on the English language Test for Indian Children (overall mean raw score of 142.10) which was administered to assess their language abilities. This could be because of their exposure to English language since birth.

Further, several earlier studies have reported a positive correlation between language skill and nonword repetition performance (Ellis Wiesmer, Tomblin, Zhang, Buckwalter, Chynoweth & Jones, 2000; Montgomery, 2002; Roy & Chiat, 2004; Gutierrez-Clellen & Simon-Cereijido, 2010). A number of studies on groups of typically developing children ranging from 3 to 5 years of age have revealed correlation between nonword repetition and children's receptive and expressive vocabulary size. Associations have also been found between nonword repetition and indices of speech output including repertoire of vocabulary, utterance length, and grammatical

complexity (Adams & Gathercole, 1995, 2000; Summers et al., 2010). Adams & Gathercole (2000) found that children with typical language development who had better nonword repetition skills produced speech with a broader vocabulary, longer utterances, and a greater range of syntactic constructions than children with relatively poor nonword repetition skills. Hence the results of the present study where in the sequential bilingual children with better syntactic abilities in Kannada obtained better scores on Kannada based nonword repetition task is in agreement with the above mentioned studies. In addition there are evidences which suggest that the brain organization is different for individuals acquiring languages in a sequential manner compared to those acquiring languages simultaneously (De Houwer, 2005) which could have played a role in the superior performance seen in sequential bilinguals in this study.

The simultaneous bilinguals had a significant difficulty especially in repeating nonwords of 4 and 5 syllables, while sequential bilinguals had a significant difficulty only at the 5 syllable level. It was observed that as the syllable length increased, there was a concurrent increase in errors in the nonword repetition in both the groups. These results are in consensus with the earlier studies by Simkin & Conti-Ramsden, 2001; Gathercole, 2006) wherein they concluded that the accuracy of the nonwords decreased while the number of syllables increased in typically developing children. This could be a result of limited capacity nature of the phonological short-term memory.

The simultaneous bilinguals had a higher percentage of vowel and consonant errors compared to sequential bilinguals except at 2-syllable length. However, both the groups had higher percentage of vowels correct compared to the percentage of consonants. This suggests that both the groups had more difficulty in repeating consonants than vowels. The results of the present study are in consonance with the study done by Girbau and Schwartz (2008) who concluded that vowels are preferentially preserved in the phonological working memory task in typically developing children and in with children with SLI.

The results also indicated that the simultaneous bilinguals had significantly higher percentage of syllable substitution than sequential bilinguals overall and at different syllable lengths. In addition the percentage of syllable addition and omissions were also found to be higher in simultaneous bilinguals. The lesser errors in the sequential bilingual children compared to the simultaneous bilinguals could be due to their better syntactic abilities in Kannada language as

revealed through the language test administered (LPT, Karanth et al., 1991). However the syllable substitutions were found to be the most common error type in both the groups. These results are in consonance with the results of the earlier studies done by Marton and Schwartz (2003) and Girbau and Schwartz (2008) who found that consonant substitutions were the most frequent type of error found in both the children with typical language development and SLI.

Conclusions

It can be concluded from the present study that sequential bilinguals have better phonological memory than the simultaneous bilinguals since they performed better on the nonword repetition task. Further it can also be concluded that the language dominance and the amount of exposure to the two languages in the bilinguals plays an important role in determining their performance on different tasks. However, caution has to be exercised while generalizing the results since the number of subjects included was limited in this study. Hence multiple replications of the study are recommended. However, this study provides an insight into the phonological working memory skills in bilingual individuals who have acquired their languages in a different manner. In addition the findings of such research might contribute to theories related to language processing in bilinguals. Further research is warranted to examine the effects of bilingualism on both the languages the child is acquiring, longitudinal studies of the predictive relations between phonological skills, phonological memory and vocabulary growth, considering a large sample of subjects, in different languages, in different age groups and in different types of bilingual population.

References

Adams, A. M., & Gathercole, S.E. (1995). Phonological working memory and speech production in preschool children. *Journal of Speech and Hearing Research,* 38, 403-414.

Adams, A. M., & Gathercole, S. E. (2000). Limitations in working memory: Implications for language development. *International Journal of Language and Communication Disorders, 35* (1), 95-116.

Ardila, A. (2003). Language representation and working memory with bilinguals. *Journal of Communication Disorders*, 36(3), 233-240.

Babu, P. R. M., Ratna, N., & Bettagiri, R. (1972). Test of Articulation in Kannada. *The Journal of All India Institute of Speech and Hearing*, 111, 7-20.

Baddeley, A.D. (1998). Recent developments in working memory. *Current Opinion in Neurobiology*, 8, 234-238.

Baddeley, A., Gathercole, S, E., & Papagno, C. (1998). The phonological loop as a language learning device. *Psychological Review*, 105, 158–173.

Bialystok, E. (2009). Do bilingual children show an advantage in working memory? *Cognitive psychology Papers,* 1-41.

Bhuvaneshwari, N. M., & Jayashree, S. (2010).*English language test for Indian children.* Student research at AIISH Mysore (articles based on dissertation done at AIISH), Vol. VIII, Part B, 182-189.

Bain, B., & Yu, A. (1980). Cognitive consequences of raising children bilingually: one parent-one language. *Canadian Journal of Psychology*, 34, 304-313.

Carlson, M.S. & Meltzoff, N.A. (2008). Bilingual experience and executive functioning in young children**.** *Developmental Science,* 11(2), 282–298.

Cummins, J. (1979). Linguistic interdependence and educational development of bilingual children. *Review of Educational Research, 49, 222-251.*

Cummins, J. (1981). Bilingualism and minority language children. Toronto Ontario institute for studies in education.

Cummins, J. (1984). Bilingualism. Special edition issues in assessment and pedagogy, Clevedon England multilingual matters.

De Houwer, A. (2005). Early bilingual acquisition: Focus on morphosyntax and the Separate Development Hypothesis: In J. F. Kroll & A.M.B. DeGroot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches. New York: Oxford University Press.*

Ellis Wiesmer. S., Tomblin, J. B., Zhang, X., Buckwalter, P., Chynoweth, J. G., & Jones, M. (2000). Nonword repetition performance in school-age children with and without language impairment. *Journal of Speech, Language and Hearing Research*, 43, 865- 878.

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics*, 27(4), 530- 540.

Gathercole, S, E., & Baddeley, A. (1990). Phonological memory deficits in language impaired children: Is there a causal connection? *Journal of Memory and Language*, 29, 336- 360.

Gathercole, S., & Baddeley, A. (1996). *The Children's Test of Nonword Repetition.* London: The Psychological Corporation.

Genesse, F., Hamers, J., Lambert, W. E., Mononen, L., Seitz, M., & Starck, R. (1978). Language processing in bilinguals. *Brain and Language, 5, 1-12.*

Girbau, D., & Schwartz, R. G. (2008).Phonological Working Memory in Spanish-English Bilingual Children with and without Specific Language Impairment. *Journal of Communication Disorders*, 41(2), 124-145.

Gutiérrez-Clellen, V. F., & Simon-Cereijido, G. (2010). Using nonword repetition tasks for the identification of language impairment in Spanish-English-speaking children: Does the language of assessment matter? *Learning Disabilities Research & Practice*, 25: 48–58.

Harini, N.V., & Shyamala, K.C. (2010). Code mixing and code switching in simultaneous and

successive bilingual children. Student research at AIISH Mysore (articles based on dissertation done at AIISH), Vol. 6, Part B, 97-115.

Hoff, E., & McKay, J. (2005). Phonological memory skills in monolingual and bilingual 23-month-olds. Paper presented at the ISB4: Proceedings of the 4th international symposium on Bilingualism, Somerville, MA.

Hoff, E., & Elledge, C. (2003). Bilingualism as one of many environmental variables that affect language development. *Proceedings of the 4th International Symposium on Bilingualism.* April 30th – May 3rd, 2003. Tempe, Arizona.

Karanth, P., Ahuja, G.K., Nagaraja, D., Pandit, R., & Shivashankar, N. (1991). Language disorders in Indian Neurological patients-A study in Neurolinguistics in the Indian context. (Project No. 5/8/10(Oto)/84-NCD-IIRIS cell). New Delhi: (Indian Council of Medical Research 8403810).

Kessler, C. (1971). *Acquisition of syntax in bilingual children.* George town university press, Washington, DC.

Kharkhurin, V. A. (2008). The effect of linguistic proficiency, age of acquisition, and length of exposure to a new cultural environment on bilinguals' divergent thinking. *Bilingualism: Language and Cognition,* 11 (2) 225-243.

Marchman, V. A., Wulfeck, B., & Weismer, S. E. (1999). Morphological productivity in children with normal language and SLI: A study of the English past tense. *Journal of Speech, Language and Hearing Research*, 42(1), 206–219.

Marton, K., & Schwartz, G. R (2003).Working memory capacity and language processes in children with specific language impairment. *Journal of Speech, Language and Hearing Research*, 46, 1138-1153.

McLaughlin, B. (1978). *Second language acquisition in childhood.* New Jersey Laurence Erlbaum associates publishers.

Meisel, J.M. (2001). The simultaneous acquisition of two first languages: Early differentiation and subsequent development of grammars. In J. Cenoz & F. Genesee (Eds.), *Trends in bilingual acquisition* (pp. 11-42). Amsterdam: John Benjamins.

Montgomery, J. (2002). Understanding the language difficulties of children with specific language impairments: Does working memory matter? *American Journal of Speech-Language Pathology*, 11, 77–91.

Pearson, B. Z. (1993). Predictive validity of the scholastic aptitude test for Hispanic bilingual students. *Hispanic Journal of the Behavioral Sciences, 15,* 342-356.

Pearson, B. Z., Fernandez, S. C., Lewedeg, V., & Oller, D. K. (1997). The relation of input factors to lexical learning by bilingual infants. *Applied Psycholinguistics, 18,* 41-58.

Roy, P., & Chiat, S. (2004). A prosodically controlled word and nonword repetition task for 2- to 4-year-olds: Evidence from typically developing children. *Journal of Speech, Language, and Hearing Research*, 47, 223-234.

Shylaja, K., & Swapna, N. (2010). *Nonword repetition in children with language impairment: An exploratory study.* Student research at AIISH Mysore (articles based on dissertation done at AIISH), Vol.VIII, Part B, 263-272.

Simkin, Z., & Conti-Ramsden.G. (2001). Nonword repetition and grammatical morphology: normative data for children in their final year of primary school. *International Journal of Language Communication Disorders,* 36 (3), 395-404.

Singhi, P., Kumar, M., Malhi, P., & Kumar, R. (2007). Utility of the WHO ten questions screen for disability detection in rural community-The North Indian experience. *Journal of Tropical Pediatrics,* 53(6), 383-387.

Summers, C., Bohman, T. M., Gilliam, R.B., & Bedore, L.M. (2010).Bilingual performance on nonword repetition in Spanish and English. *International Journal of Language Communication Disorders,* 45 (4), 480-493.

Thorn, A. S. C., & Gathercole, S. E. (1999). Language-specific knowledge and short-term memory in bilingual and non-bilingual children. *Quarterly Journal of Experimental Psychology*, 52A, 303-324.

Toukomaa, P., & Skutnabb-Kangas, T. (1977). *The intensive teaching of the mother tongue to migrant children of preschool age.* (research reports 26). Tampere: University of Tampere, Dept of Sociology and social psychology.

Vallar, G., & Papagno, C. (2002). Neuropsychological impairments of verbal short-term memory. In A.D. Baddeley, M.D. Kopelman & B.A. Wilson (Eds.), *The Handbook of Memory Disorders*, 2nd edn (pp. 249–270). Chichester: Wiley.

Venkatesan (2009). Readapted from 1997 Version. NIMH Socioeconomic Status Scale, Secunderabad: National Institute for the Mentally Handicapped.

Wylie, E., & Ingram, D. E. (1995) (revised 1999). International Second Language Proficiency Ratings (ISLPR): General proficiency version for English, Brisbane: Centre for Applied Linguistics and Languages, Griffith University.

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SENSITIVITY EVALUATION OF "CAPP-M" IN CHILDREN WITH HEARING IMPAIRMENT

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Abstract

The present study aimed to investigate the sensitivity of 'Computerized assessment of Phonological Processes in Malayalam' (CAPP-M- Merin, 2010) in children with hearing impairment. CAPP-M is a user friendly software developed using Malayalam Articulation Test (MAT; Maya, 1990), which was administered on Malayalam speaking children, in the age range of 3-3.6 years. A total of 20 picture stimuli are included in this tool. While assessing a particular child, the clinician has to listen to the child's production of the 20 target words one by one and choose any of the four options for each target word provided on the computer screen. At the end of 20 responses, CAPP-M provides a list of processes ranked in descending order i.e., from the most occurring to the least occurring process in a single child's utterances. This tool assesses eight frequently occurring phonological processes in normal children. A mean correlation of 65% was obtained for the subject's productions and the possible productions listed in the software, for six out of eight children. For the remaining two children, the mean correlation score was 45%. The results revealed that for the children with hearing impairment considered in the study, overall 60% of their productions matched with those of the templates in CAPP-M. The phonological processes identified in children with hearing impairment from the most occurring to the least occurring were cluster reduction, idiosyncratic productions, affrication, stopping, palatalization, and metathesis.

Key words: *Computerized assessment, CAPP-M, Phonological processes.*

A child new to the world learns to speak the language of the world through experimentation and imitation of the adult forms heard. Little does the child know that its speaking apparatus is incapable, rather immature of producing exactly what is heard. In light of this incapability, the child gets armed with a strategy of his own, wherein the adult's productions are simplified making it resemble the adult's production, though not identical to it. In this way, the child is able to speak like an adult eventually by acquiring the correct forms. This process of simplification of adult speech by a child is basically described as phonological processes. Lowe (1996) defined phonological process as "systematic sound change that affects classes of sounds or sound sequences and results in a simplification of productions." In other words, the child simplifies the complex adult model by substituting sounds that are within his or her phonetic repertoire for those sounds that he or she has not yet achieved. These phonological processes are not haphazard but follow a specific developmental sequence (Stampe 1969; Compton 1970; Smith 1973). That is most children develop the ability to articulate gradually, and before perfecting an adult production they reduce the complexity of words in characteristic ways. By investigating the phonological processes, one comes near to unraveling the development of the phonological system of a child, being able to discover the

intricacies of a child's development of speech. Moreover, such information is of substantial use in cases of children with communication disorders as it shows where the child lies in the process of phonological development and how deviant the child's productions are when compared to a typically developing child.

Phonological process analysis is carried out by gathering a speech sample, transcribing it in the International Phonetic Alphabet, and identifying the patterns of error (processes) in the data. However, by following such procedures some of the major difficulties one encounters are keeping track of the data on a host of different worksheets, tallying up percentages and frequency counts, and cross checking a variety of relationships found in different portions of the client's transcript. This is time consuming and laborious. Researchers therefore began investigating the applicability of computers to this task. Hence, began the era of computerized phonological assessment procedures. In English, several such computer based analysis are in use. The computerized Articulation and Phonology Evaluation System (CAPES) (Masterson and Bernhardt, 2002) is a good example of such a system that was developed to elicit and analyze phonological productions. Some other Computerized phonological analysis programs are Computer Analysis of Phonological Processes (CAPP) version 1.0 (Hodson,1985), Computer Profiling (CP) (Long & Fey,1988),

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Logical International Phonetic Programs Version 1.03 (LIPP) (Oller & Delgado,1990), and Programs to Examine Phonetic and Phonologic Evaluation Records Version 4.0 (PEPPER) (Shriberg,1986).

In India, Ramadevi (2006) developed a computerized assessment tool for profiling the phonological production of children with hearing impairment. However, only the presentation of the stimuli was computerized, with the major other tasks left solely to the hands of the clinician. Merin (2010) developed another computerized assessment tool 'Computer based Assessment of Phonological Processes in Malayalam (CAPP-M*).* This is a user friendly software program developed to assess the phonological processes in Malayalam speaking children, in the age range 3-3.6 years. The framework of this tool was developed using the Malayalam articulation test (MAT; Maya 1990). MAT was administered on 30 (15 boys; 15 girls) typically developing Malayalam speaking children. The tool tests 20 words which outnumbered the other erroneous production of the children from MAT. For these 20 words, three most frequently occurring production of each target word is included (Appendix 1). To accommodate any novel or idiosyncratic productions as well, an option named 'any other' was also provided. Therefore, a page of the software contained a picture of the target word, IPA transcriptions of the correct production, three most occurring productions, and the option 'any other' having a total of five options/ templates. The clinician's task is to present the stimuli, listen to the child's production and click on the pattern produced by the child (Appendix 2). Automatically, a count of the phonological

processes is registered by the tool. After completing the administration of the 20 test words, on clicking an option 'Report', a list of the phonological processes produced by the child is presented in a descending rank order. The tool provides a quick assessment of the various phonological processes present in the child tested. This newly developed tool can be used as a quick screening tool in children.

Children with hearing impairment comprise a major population with many articulatory problems. In a busy diagnostic setting, detailed phonological assessment of the child may not be possible, despite its relevance. This is because the task is tedious, laborious and time consuming. Use of a computer to replace the manual effort will therefore be significantly appreciated. Though such a tool has been developed for Malayalam speaking children, its sensitivity in evaluating the disordered population has not been explored. Only after its validity is established in the disordered population, will it serve as a clinical tool. The present study aimed to investigate the sensitivity of 'Computer based assessment of Phonological Processes in Malayalam' (CAPP-M., Merin, 2010) in children with hearing impairment.

Method

Participants: 12 native Malayalam speaking children diagnosed as delayed speech and language with hearing impairment, in the age range 3.5-5.3 years were considered for the study. Demographic data of the children are depicted in Table 1. These children were devoid of any other psychological or neurological illness.

Table 1: *Demographic data of participants*

Sl. No.	Participants	Duration of speech and language therapy attended	Chronological age	Degree of hearing loss
1	Participant 1	8 months	3.5	B/L Severe
2	Participant 2	1.2 years	5.3	B/L Moderately severe
3	Participant 3	1.5 years	4.9	R- Moderate L- Moderately severe
4	Participant 4	2.1 years	4.8	R-Severe L- Moderately severe
5	Participant 5	1.9 years	5.0	B/L Moderately severe
6	Participant 6	11 months	4.3	R-Severe L- Moderately severe
7	Participant 7	2.2 years	4.5	B/L Severe
8	Participant 8	1.3 years	4.7	B/L Moderately severe

Inclusion criteria for participant selection: Children who obtained a language age of 3-4 years, on Computerized Linguistic Protocol for screening (CLIPS, Anitha; 2004) was included as

the participants of the study. Eight among the 12 children passed these criteria.

Materials: Computerized Linguistic Protocol for Screening, -CLIPS, developed by Anitha, 2004

(which gives an estimate of the receptive and expressive language age), Computer based Assessment of Phonological Processes in Malayalam -CAPP-M; Merin, 2010 (assess the phonological processes in Malayalam speaking children) were administered.

Procedure: Administration of CLIPS: CLIPS was initially administered on 12 children considered for the study. After the children were comfortably seated, each child was shown a PowerPoint Presentation of the picture stimuli. The receptive and expressive language age was obtained. Eight children, who surpassed the test by procuring a language score of 3-4 years, were the participants for administration of CAPP-M.

Administration of CAPP-M: CAPP-M was administered on the eight children who obtained a language age of 3-4 years. On completion of the test items, a list of phonological processes produced by the child were then obtained in a descending rank order. In order to test the sensitivity of the tool for children with hearing impairment, the clinician made a manual calculation of the percentage of child's productions that matched the four options (excluding 'any other') and obtained a mean percentage score.

Results

The present study intended to test the sensitivity of the newly developed tool (CAPP-M; Merin, 2010) in eight children with hearing impairment, that is, to what extent the child's production matched the patterns in the display of the software. This was done by calculating the percentage of the child's production that matched the templates in the tool. (as shown in Table 2). Table 2 indicates that mean percentage score for all the participants considered was 60%. Only Subjects 1 and 6 showed a correlation of < 50%. (Mean percentage=45%). The remaining six participants obtained a correlation of > 50% (Mean percentage= 65%).

Table 2: *Percentage of correlation between the child's production and the template*

Sl. No.	Subjects	Number of templates matched	Percentage of Templates matched
1	Subject 1	9	45
2	Subject 2	13	65
3	Subject 3	1	55
4	Subject 4	14	70
5	Subject 5	15	75
6	Subject 6	9	45
7	Subject 7	13	65
8	Subject 8	12	60

The phonological processes identified for the eight children with hearing impairment, in a descending rank order are: Cluster reduction, idiosyncratic productions, affrication, stopping, palatalization, and metathesis.

Discussion

This study aimed to evaluate the sensitivity of CAPP-M (Merin, 2010) in children with hearing impairment. Participants for the study were 8 Malayalam speaking children with hearing impairment in the age range of 3.5-5.3 years, with a language age between 3-4 years. CAPP-M was administered on all the participants selected. The phonological processes produced by each child were automatically estimated. The mean percentage score of the child's productions that matched with those of the templates in the software developed were then calculated. The results indicate that for 6 out of 8 children, a better correlation was obtained between the child's production and the templates listed in the tool. Two children were found to exhibit a poor correlation. This could be attributed to three major factors- the severity of hearing loss, duration of speech and language therapy attended and the chronological age of the child. The six subjects with better correlation had a lesser degree of hearing loss, had attended speech and language therapy for a longer duration and were also older than the two subjects who acquired poorer correlation. This study is in consonance with the findings of Gordon-Brannan, Weiss (2007) who reported a direct correlation between hearing loss and articulatory skills of the hearing impaired. Serious attention is driven to the fact that an adequate language age alone (here, as indicated by CLIPS), does not result in normal articulatory skills in children with hearing impairment.

Conclusion

CAPP-M serves as a quick, easy and automatic tool for assessment of phonological processes. However, with inclusion of sufficient database of productions of children with hearing impairment and other communication disorders, it will serve as a promising screening tool for assessment of phonological processes in Malayalam speaking children.

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References

Anitha, (2004). Computerized Linguistic Protocol for Screening. Student Research done at AIISH, Vol II, pp 110-120.

Compton, A. (1970). Generative Studies of children's phonological disorders. *Journal of Speech and Hearing Disorders, 35*, 315-339.

Gordon-Brannan, M. E., & Weiss, C. E. (2007). Clinical Management of Articulatory and Phonologic Disorders (3rd eds.). Baltomore: Lippincott Williams and Wilkins.

Hodson, B. W. (1985). Computerized Assessment of Phonological Processes: Version 1.0 (Apple II series Computer Program). Danville III, Interstate.

Hodson, B. W. (2003). Computerized analysis of Phonological Patterns (HCAPP). Wichita, KS: Phonomp Software.

Long, S., & Fey. M. (1988). Computerized Profiling (Apple II Series Computer Program). Department of Speech Pathology and Audiology, Ithara College, Ithara, New York.

Lowe, R. J. (1996). Workbook for the Identification of Phonological Processes (2nd ed.). Austin, TX: PRO-ED.

Masterson, J., & Bernhardt, B. (2002). Computerized Articulation and Phonology Evaluations System. San Antonio. TX: The Psychological Corporation.

Maya, S. (1990): 'An articulation test battery in Malayalam'. Research at A.I.I.S.H, II, 179-180.

Merin, J. (2010). Computer Based Assessment of Phonological Processes in Malayalam (CAPP-M): A Preliminary Attempt. Unpublished Masters Dissertation, Submitted to University of Mysore.

Oller, K., & Delgado. R. (1990). Logical International Phonetic Programs: Version 1.03 (MS-DOS Computer Program). Miami, Intelligent Hearing System.

Ramadevi, S. (2006). Phonological Profile in Kannada, A study on Hearing Impaired. Ph D Thesis submitted to the University of Mysore.

Shriberg, L. (1988). Programs to examine Phonetic and Phonologic Evaluation Records. ASHA, 57-58.

Shriberg, L. (1997). Cited in Gordon- Brannan, M.E., & Weiss, C.E. (2007). Clinical management of Articulatory and Phonologic Disorders. Baltimore: Lippincott Williams & Wilkins.

Shriberg, L., Friel- Patti, S., Flipsen Jr, P., & Brown, R. L. (2000). Otitis media, fluctuant hearing loss and speech- language delay: A preliminary structural equation model. Journal of Speech, Language and Hearing Research, 43, 100-120.

Smith, N. (1973). The Acquisition of Phonology. Cambridge, UK: Cambridge University Press.

Stampe, D. (1969). 'A Dissertation on Natural Phonolgy'. Unpublished Dissertation, University of Chicago.

Appendix 1

The list of target words and their variable productions considered in the software
(CAPP-M; Merin, 2010)

SL. No	Correct Production	1	2	3
1	dōktəR	dōtəR	dōkt̪əR	dōt̪əR
2	nəḳṣət̪Rəm	nəʃət̪əRəm	nəktʃət̪əRʈ	nətʃət̪əRəm
3	sImhəm	sImgəm	tʃIməm	tʃImgəm
4	bRəʂə	bət̪ʃə	bRəʃə	bəʃə
5	pust̪əkəm	put̪əkəm	puʃt̪əkəm	putʃəkəm
6	bIskətə	bIkətə	bIʃkətə	
7	vəst̪Rəm	vəst̪əRəm	vət̪Rəm	vət̪əRəm
8	ṣəRtə	tʃəRtə	ʃəRtə	t̪əRtə
9	pat̪Rəm	pat̪əRəm	pat̪əm	-
10	tʃ ə̃əd̪ɾən	tʃ ə̃d̪ɾ ərən	tʃəd̪ən	-
11	skutəR	kutəR	tʃutəR	-
12	pRāvə	pāvə	paRvə	-
13	tʃəkRəm	tʃəkəRəm	tʃəkəm	kəkəRəm
14	bəsə	bəʃə	bət̪ʃə	bət̪ə
15	kəsɛra	kəʃɛra	kət̪ʃɛra	kət̪ra
16	sə̃dʒi	t̪ə̃dʒi	t̪ə̃di	-
17	ʃə̃gʰə	tʃə̃gʰə	t̪ə̃gʰə	-
18	mɛʃa	mɛtʃa	mɛt̪a	-
19	surjen	ʃurjen	t̪urjen	tʃurjen
20	ɛʃu	ɛtʃu	ɛt̪u	-

Appendix 2

A sample from the tool

CLEAR AND CONVERSATION SPEECH PERCEPTION IN SIMULATED COCHLEAR IMPLANT AND SIMULATED ELECTRO ACOUSTIC STIMULATION

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Abstract

Perception of speech is an important goal for persons with Cochlear Implant (CI) and Electro Acoustic Stimulation (EAS). It has been argued that naturally produced clear speech is more intelligible to such persons than conversational speech. The factors responsible for clear speech advantage are increased voice intensity slower rate, frequent pauses, greater vowel duration and dynamic formant movements. The relative advantage of clear speech in CI and EAS are not yet well understood. The present study used 20 native Hindi Speaking (age range 20-30 years) participants on a listening task. The stimuli were 90 previously selected Hindi sentences processed with a noise band vocoder implemented in Matlab. The sentences were spoken by a native Hindi speaker which was recorded in both Clear and Conversational speaking styles & mixed with four talker babble at -4 dB SNR. CI processing simulated using 8-channel noise-band vocoder. The sentences were filtered to 8 bands and the envelopes were extracted from each band. The carrier noise bands were modulated by the envelopes and resynthesized to produce the processed speech. Simulation of EAS was achieved with low pass stimulus (630Hz) and upper five channels of the eight-channel vocoder. Verbatim responses of the subjects were recorded and scored for accuracy. The overall results indicated better understanding in clear speaking style than in conversational style, in simulated CI condition as well as simulated EAS condition. The data was consistent with previous studies. Clear speech had an advantage in improving speech perception whenever there werefewer cues for speech perception due to noise in CI and EAS. The details of comparison of CI and EAS conditions will be discussed.

The style in which we communicate everyday is referred to as 'conversational speech'. However, a talker may naturally adopt a distinct intelligibility enhancing style of speech production called 'clear speech' when they are aware of a speech perception difficulty that will occur when communicating in the presence of background noise, with a person with hearing impairment or in a different native language. Various perceptual studies on clear speech have shown significant improvements in intelligibility over ordinary conversational speech (Picheny, Durlach, & Braida, 1985; Gagné, Masterson, Munhall, Bilida & Querengesser, 1994; Helfer, 1998; Bradlow & Bent, 2002; Krause & Braida, 2002; Bradlow, Kraus & Hayes, 2003). Previous studies have justified clear speech advantage to be 15-20 percentage points in terms of intelligibility when compared to the conversational speaking style for various listener populations, speech materials and listening conditions (Picheny et al., 1985; Gagne et al., 1994; Helfer, 1998; Bradlow & Bent, 2002; Krause & Braida, 2002; Bradlow et al., 2003). Also Picheny, Durlach, & Braida (1986) reported vocal intensity to be 5 to 8 dB greater in clear speech along with a higher and more variable fundamental frequency relative to the conversational style.

Moreover, production of clear speech includes various articulatory/acoustic adjustments. These include decreased speaking rate comprising of longer and frequent pauses as well as longer segments, greater sound pressure level, increased intensity of fricatives, increased intensity in the 1000 Hz to 3000 Hz range and an expanded vowel range (Picheny et al., 1986, 1989; Krause & Braida, 2004; Bradlow et al., 2003; Liu, Rio, Bradlow, & Zeng, 2004; Moon & Lindblom, 1994; Ferguson & Kewley-Port, 2002; Johnson, Flemming, & Wright, 1993). Bradlow et al. (2003) also revealed less frequent alveolar "flapping" in clear speech.

Additionally, Picheny et al. (1986), Ferguson & Kewley-Port (2002), Moon & Lindblom (1994) have showed an increase in vowel duration and enlarged acoustic vowel spaces (Bradlow et al., 2003). Also vowels have greater dynamic formant movement when spoken clearly. Ferguson et al. (2002) stated a significance of formant movement over vowel nucleus for clear speech.

Clear Speech Advantage in Cochlear implant Users

Apart from clear speech advantage in normal hearing individuals, the cochlear implants (CI), users also demonstrate this advantage. The current generation 'standard-electrode', often used, are capable of providing very high levels of speech understanding (in quiet) to many patients. However, they have tremendous

difficulty in understanding speech in noise (Friesen, Shannon, Baskent & Wang, 2001; Nelson, Jin, Carney & Nelson, 2003) Normal-hearing listeners show an advantage for speech understanding in competing noise, by utilizing various auditory cues (pitch, timing and localization cues) to separate the multiple sound sources and thereby focus the target speech (Duquesnoy, 1983). CI listeners, on the other hand, are presumably unable to perceive some of these cues, making the competing talker situations particularly difficult for them to segregate the various talkers. In addition, the fluctuating and irregular nature of the competing talker background allows normal-hearing listeners to potentially listen to the target speech in the temporal and spectral 'dips' of the background. However, implant users with temporal acuity deficits reveal poor frequency resolution which worsens their ability to listen in spectral 'dips'.

Nelson et al. (2003) and Qin & Oxenham (2003) demonstrated reduced frequency resolution, in fluctuating backgrounds, to produce diminished speech recognition in normal-hearing listeners similar to cochlear implant users. Thus, the primary deficit of CI listeners in resisting the effects of competing background signals, when listening to speech, appears to be related to poor frequency resolution. Frequency resolution of normal-hearing, hearing-impaired and CI listeners was compared by Henry, Turner & Behrens (2005) in a task requiring discrimination of spectral peaks in a broadband stimulus. It was observed that Normal-hearing listeners had the best frequency resolution, which were followed by individuals with sensori-neural hearing loss, and the poorest resolution was observed in CI users.

Iverson & Bradlow (2002) reported a small clear speech advantage (5%), in quiet, for CI users and normal subjects listening to simulations. However for both the groups, a larger clear speech advantage (15%) was seen when speech was presented in Noise. This difference was seen as the clear speech, primarily, enhances the broadband amplitude modulation and not the spectral differences.

A similar study by Liu et al. (2004) compared a clear speech perceptual benefit in normal hearing adults and adults with CI. Both the groups derived a significant clear speech advantage, although listeners using CI needed somewhat better signal-to noise ratios in order to perform at the same level as normal hearing adults. Also, a high degree of individual variability was demonstrated in clear speech perception for the CI users.

Electro-Acoustic Simulations

Cochlear implantation, which was earlier recommended to only severe to profound hearing loss individuals, though recently it has become an option even for comparatively less severe (mild to moderate) hearing losses, especially with a residual hearing at the low frequencies. The implant manufacturers integrate in one device (E.g. Med-El DUET) the bimodal stimulation, which processes low frequencies of the message using an acoustic unit (classical BTE hearing aid), while high frequencies are processed by another unit which sends an electrical message (implanted electrodes).

Residual hearings, in low frequencies, provide a significant advantage for understanding speech in background noise (Turner, Gantz, Vidal, Behrens & Henry, 2004). Electro-Acoustic simulations, thus, combine the functions of CI for processing the high frequencies and hearing aid unit to amplify the low frequencies (250 to 1500 Hz). Seldran, Truy, Gallego, Berger-Vachon, Collet & Thai-Van (2008) evaluated the number of electrical channels necessary to restore the lack of speech intelligibility of a hearing impaired patient implanted with EAS. It was reported that the speech understanding was restored (>90%) with 1 channel for residual hearing till 1400Hz, 2 channel for residual hearing till 100 Hz, 3 channels for residual hearing till 700 Hz and 4 channels with residual hearing until 500 Hz. The scores of monosyllabic word recognition enhance up to 50-75% with EAS when compared to the conventional CI (Von Ilberg, Kiefer, Tillein, Pfenningdorff, Hartmann & Sturzebeche, 1999; Keifer, Pok, Adunka, Sturzebecher, Baumgartner & Schmidt et al., 2005).

The literature reveals a substantial body of research works on acoustical and perceptual characteristics of clear speech, in individuals with CI users. In Indian context, clear speech has been focused for assessing the production and perception, along with similar clear speech advantages for languages like Kannada and Indian accented English (Kumar & Kumar, 2008; Prabhu, 2009). However, insufficient data is available on perceptual characteristics of clear speech and its advantage over conversational style, in EAS condition. So the present study, thus, compares the differences in speech perception scores in clear and conversational speaking styles among Normal hearing individuals using acoustic simulations of CI and EAS. The aims of the at measuring the speech perception scores in clear and conversational speaking styles in normal hearing individuals using acoustic simulations of CI and EAS.

Method

Participants

Twenty native Hindi speakers in the age range of 20 to 30 years (mean 23 years), who had learnt this language from primary school level, participated in the study. The participants reported of no history of speech, language, or neurological problems. All the participants had their pure tone hearing thresholds ≤ 15 dB HL at octave frequencies in 250 Hz to 8000 Hz range.

Stimuli

The stimuli consisted of 90 standardized Hindi sentences, selected from the speech perception in noise test for children and adults (Kumar, 2008). The selected sentences were recorded by a 23 year old female audiologist who was a native speaker of Hindi and had an extensive experience of communicating with individuals with hearing impairment. In the first recording session, she was instructed to read the sentence list using her normal, conversational speaking style. At a second recording session on the following day, she was instructed to read the same sentences, as though talking to a hearing-impaired, pronouncing each word clearly and carefully. The talker rehearsed each style prior to recording and the experimenter monitored her productions for errors during recording. The stimuli were recorded in a sound treated room using a digital sound stereo headphone (SSD-HP-202) microphone using the Praat software (Boersma & Weenink, 2008) at a sampling rate of 44100 Hz.

Signal Processing

The recorded sentences were mixed with four-talker babble at -4 dB SNR. For the CI stimulations, the recorded speech stimuli were processed using a Noise Vocoder Signal processing was performed using MATLAB (Math works, Natick, MA). The electric stimulation was simulated with an 8-band Vocoder simulation (Shannon et al., 1995). The number of processing bands was selected based on the observation that 8-band Vocoder produces performance levels most similar to that of CI users (Friesen et al., 2001). The entire spectral range of the Vocoder processing was limited to 80 to 6000 Hz (Figure 1). The cut-off frequencies of the individual spectral bands were determined by first converting the lower and higher spectral limits in Hz into corresponding cochlear distances in mm, using the Greenwood mapping function (Greenwood, 1990), then dividing the entire cochlear length into equal distances, and finally converting the ranges in mm back to corresponding frequencies in Hz. These cutoff frequencies were determined separately for the analysis and synthesis filters. The envelopes were extracted from the output of the analysis

filters by half-wave rectification followed by a low-pass Butterworth filter (-18 dB/oct) with a cut-off frequency of 160 Hz. Filtering white noise with the synthesis filters produced the carrier noise bands. The noise carrier in each synthesis band was modulated with the envelope extracted from the corresponding analysis band. The processed speech was the sum of the modulated noise bands from all Vocoder bands.

In speech processing of Electro-Acoustic simulation strategy, the Vocoder processing and Low Pass Filter (LPF) speech was combined. In EAS map the LPF speech replaced the lower synthesis filters of the Vocoder (with the cut-offs of 630Hz). The remaining synthesis filters (5 bands) represented the limited stimulation range of electric hearing.
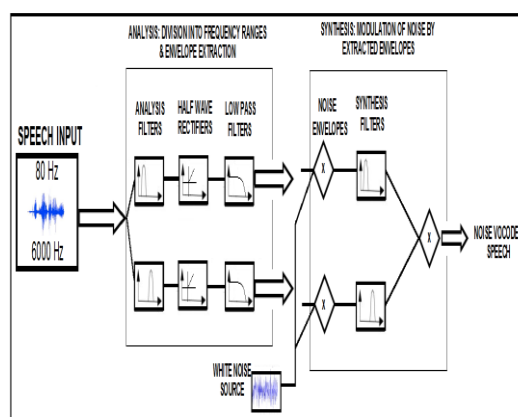

Figure 1: *Representation of the signal processing of the stimuli*

Procedure

A total of 80 sentences (40 in CI and 40 in EAS condition) and 10 practice trials (5 in each condition) were presented to the participants, in a sound treated room. The processed stimuli in both clear and conversational styles were mixed and presented in each simulated conditions. After presentation in each condition, the participants were released for an interval of 2 hours, in order to avoid subject bias due to fatigue. The stimulus presentation and response acquisition was controlled via 'DMDX' software, using high fidelity Tech-Com Digital Sound stereo headphones (SSD-HP 202) at the level of 50-70 dB SPL. A personal computer, HP Pavilion dv6000 was used for the same. The participants were required to repeat each word verbatim. These responses were recorded and analyzed, in each condition, for the number of correctly repeated key words. A score of '1' was given for correct repetition of each word and '0' for the incorrect response. To obtain the speech recognition scores, the total number of correctly repeated key words was summed.

Results

The comparison of speech recognition scores across clear and conversational speaking styles for the simulated CI and EAS condition has shown in figure 2 and table 1. The Clear speech advantage is clearly indicated in both the conditions relative to the conversational style. Also, the speech recognition scores suggest a better understanding in noise for simulated EAS condition compared to the simulated CI condition
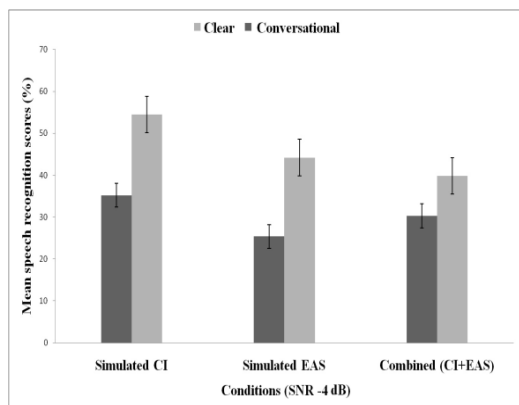

Figure 2: *Speech recognition scores for Clear and Conversational speaking styles in each of the simulated conditions, namely Conventional CI and EAS.*

Table 1: *Speech recognition scores for Clear and Conversational speaking styles in each of the simulated conditions*

Conditions	Speaking style	Mean speech recognition scores (%)	Std. Deviation
Simulated CI	Clear	35.20	4.29
	Conversational	25.39	3.78
	Total	30.29	6.37
Simulated EAS	Clear	54.46	2.41
	Conversational	44.21	2.94
	Total	39.81	11.34

Within group comparison

Simulated CI condition

The speech recognition scores for sentences presented in simulated CI condition obtained a mean percentage of 25.3% in conversational style and 35.2% in clear speaking style. Thereby, indicating better scores for clear speech relative to the conversational speech.

Simulated EAS condition

Similar to the above results, speech recognition scores for sentences presented in EAS condition attained mean percentage scores of 44.21% in conversational style and 54.46% in clear speaking style. The scores yet again indicate better speech recognition for clear speech.

Across group comparison

As evident from the figure 2, the speech recognition scores obtained in the simulated EAS condition are much higher relative to the simulated CI condition. However, both the groups showed clear speech advantage over the conversational speaking style. The statistical analyses, a two way ANOVA [$F_{(1, 76)} = 612.86$, $p < .001$] showed a significant main effect on speech recognition scores across simulated CI and EAS conditions. This indicates a significantly better speech perception for sentences presented in simulated EAS condition. Moreover, similar main effect was seen for clear and conversational styles irrespective of processing conditions [$F_{(1, 76)} = 170.05$, $p < 0.001$] which reveals clear speech advantage Furthermore, Paired Sample t-test conducted between clear and conversation styles in each condition revealed significant difference between the mean values ($t = 7.65$, $p < 0.001$) for simulated CI and ($t = 12.03$, $p < 0.001$) EAS conditions.

Thereby, the overall results indicate that listeners recognized words more accurately in clear speaking style than in conversational speech, not only in simulated CI condition but also in simulated EAS condition.

Discussion

Various studies in the literature confirm the presence of clear speech advantage over conversational speaking style in normal hearing individuals (Krause & Braida, 2002; Bradlow et al., 2003, Ferguson et al., 2002). Also similar advantage in clear speech is observed in Cochlear Implant condition as well (Iverson & Bradlow, 2002, Liu et al., 2004). The present study compared speech recognition scores for stimuli presented under degraded condition across clear and conversational styles in simulated CI and simulated EAS conditions. The speech recognition scores were obtained for native speakers of the language. The present study reports clear speech advantage over the conversational style in both simulated CI condition and EAS conditions.

Moreover, the CI users show a small clear speech advantage (5%) in quiet and a greater advantage (15%) in degraded conditions (Iverson & Bradlow, 2002; Liu et al., 2004). One of the reasons for better Clear speech perception are expansion of the Vowel space which could also be associated with an intelligibility advantage (Bradlow, 2002; Ferguson & Kewley-Port, 2002; Prabhu, 2009) and slower speaking rate and larger temporal modulation (Liu et al., 2004). Following the same trend the results of the

present study suggest that naturally produced clear speech is an effective way of enhancing speech perception under adverse speaking conditions.

Sufficient amount of research work recommends EAS as an improved and more natural form of auditory rehabilitation when compared to the traditional CI, pertaining to preserve the residual hearing and further amplifying the frequencies which are at loss (Seldran et al., 2008, Gstoettner et al., 2006). Owing to the same reasons, the across group comparison of the present study confirms EAS as a better stimulation strategy compared to the traditional CI strategies, primarily in adverse listening conditions. The clear advantage in EAS mainly due to the availability of low frequency information and fine structure cues that will be available with other cues like expansion of vowel space, slow speaking rate, lager temporal modification as in CI.

Cochlear implants reduce spectral resolution while mostly leaving broadband amplitude modulation intact. Adding noise reduces amplitude modulation within the frequency bands of cochlear implant processors. The recognition of clear speech seems to be less affected by this reduction in amplitude modulation ((Iverson & Bradlow, 2002). Furthermore Mathew, Kumar & Alexander (2010) indicate clear speech to facilitate a better and faster learning of foreign language words. Therefore, the clear speaking style is beneficial for training young children to learn a new language and also rehabilitation of individuals with communication disorders. The present study further extends this view towards the rehabilitation of individuals with hearing impairment which could be improved with the help of clear speech usage not only for children using CI but also with EAS users. As there are numerous differences between acoustic and electric hearing, one should be very careful about applying the results from simulations with normal-hearing listeners to actual implant users.

Conclusions

The present study aimed at comparison of speech perception scores across clear and conversational speaking situations in individuals with Normal hearing, simulated with CI and EAS. The study concludes a clear speech advantage in improving speech perception whenever there are fewer cues available for speech recognition due to noise, in both CI and EAS strategies. In addition, it plays an important role in learning of a new language, especially in pediatric Cochlear Implant group. Moreover, a critical contribution of the clear speech advantage was reported in the presence of reduced spectral cues in noise. Recommendations for the future research include generalization of the present results into to the clinical population.

References

Boersma, P., & Weenink, D. (2008). Praat: Doing Phonetics by computer (Version5.0.17) [Computer Program]. Retrieved from http://www.praat.org/

Bradlow, A. R., & Bent, T. (2002). The clear speech effect for non-native listeners. *Journal of the Acoustical Society of America, 112,* 272-284. Doi: 10.1121/1.1487837

Bradlow, A. R., Kraus, N., & Hayes, E. (2003). Speaking clearly for learning-impaired children: Sentence perception in noise. *Journal of Speech, Language and Hearing Research, 46*, 80–97. Doi: 10.1044/1092-4388(2003/007)

Duquesnoy, A.J., (1983). Effect of a single interfering noise or speech source upon the binaural sentence intelligibility of aged persons. *Journal of the Acoustical Society of America*, *74,* 739–743. Doi: 10.1121/1.389859

Ferguson, S. H., & Kewley-Port, D. (2002). Vowel intelligibility in clear and conversational speech for normal-hearing and hearing impaired listeners. *Journal of the Acoustical Society of America, 112*, 259–271. Doi:10.1121/1.1482078

Friesen, L.M., Shannon, R.V., Baskent, D., & Wang, X. (2001). Speech recognition in noise as a function of the number of spectral channels: Comparison of acoustic hearing and cochlear implants. *Journal of the Acoustical Society of America, 110,* 1150–1163. Doi:10.1121/1.1381538

Gagné, J.-P., Masterson, V. M., Munhall, K. G., Bilida, N., & Querengesser, C. (1994). Across talker variability in auditory, visual, and audiovisual speech intelligibility for conversational and clear speech. *Journal of the Academy of Rehabilitative Audiology, 27,* 135–158.

Helfer, K. S. (1998). Auditory and auditory-visual recognition of clear and conversational speech by older adults. *Journal of the American Academy of Audiology, 9*, 234–242.

Henry, B.A., Turner, C.W., & Behrens, A. (2005). Spectral peak resolution and speech recognition in quiet: Normal hearing, hearing impaired and cochlear implant listeners. *The Journal of the Acoustical Society of America, 118,* 1111–1121. Doi: 10.1121/1.1944567

Iverson, P., & Bradlow, A. (2002). The recognition of clear speech by adult cochlear implant users. In S. Hawkins & N. Nguyen (Eds.), Temporal Integration in the Perception of Speech (p. 78). Cambridge, UK: Centre for Research in the Arts, Social Sciences, and Humanities.

Johnson, K., Flemming, E., & Wright, R. (1993). The hyperspace effect: Phonetic targets are hyper articulated. Language, 69, 505–528.

Kiefer, J., Pok, M., Adunka, O., Sturzebecher, E., Baumgartner, W., Schmidt, M., et al. (2005). Combined electric and acoustic stimulation (EAS) of the auditory system: Results of a clinical study. *Audiology and Neurotology*, *10*(3), 134-44. *Doi: 10.1159/000084023*

Krause, J. C., & Braida, L. D. (2002). Investigating alternative forms of clear speech: The effects of speaking rate and speaking mode on intelligibility. *The Journal of the Acoustical Society of America, 112,* 2165–2172. Doi: 10.1121/1.1509432.

Kumar P. (2008). *Comparing Acoustic Parameters of Conversational and Clear Speech in Kannada*. Unpublished Master Dissertation, Mangalore University, Mangalore, India.

Liu, S., Del Rio, E., Bradlow, A.R., & Zeng, F.G. (2004). Clear speech perception in acoustic and electric hearing. *Journal of the Acoustical Society of America, 116,* 2374–2383. DOI: 10.1121/1.1787528

Liu, C., & Kewley-Port, D. (2004). Vowel formant discrimination for high-fidelity speech. *The Journal of the Acoustical Society of America, 116,* 1224–1233. Doi: 10.1121/1.1768958.

Mathew, K., Alexander, S.A., & Kumar, A.U. (2010). *Foreign Word Learning: Effect of Training in Clear & Conversational Speaking Styles*. Poster presented at NYSSLHA's 50th annual convention. New York

Moon, S. J., & Lindblom, B. (1994). Interaction between duration, context, and speaking style in English stressed vowels. *Journal of the Acoustical Society of America, 96*, 40–55. DOI: 10.1121/1.410492

Nelson, P., Jin, S-H., Carney, A., & Nelson, D. (2003). Understanding speech in modulated interference: Cochlear implant users and normal-hearing listeners. *Journal of the Acoustical Society of America, 113,* 961–968. Doi: 10.1121/1.1531983

Picheny, M. A., Durlach, N. I., & Braida, L. D. (1985). Speaking clearly for the hard of hearing I:

Intelligibility differences between clear and conversational speech. *Journal of speech and hearing research, 28*, 96-103.

Picheny, M. A., Durlach, N. I., & Braida, L. D. (1986). Speaking clearly for the hard of hearing. II: Acoustic characteristics of clear and conversational speech. *Journal of Speech and Hearing Research, 29,* 434–446.

Picheny, M. A., Durlach, N. I., & Braida, L. D. (1989). Speaking clearly for the hard of hearing. III: An attempt to determine the contribution of speaking rate to difference in intelligibility between clear and conversational speech. *Journal of Speech and Hearing Research, 32*, 600–603.

Prabhu, S. (2009). *Acoustic characteristics of vowels in clear & conversational speaking style in Kannada*. Unpublished Master Dissertation, Mangalore University, Mangalore, India.

Qin, M. K., & Oxenham, A. J. (2003). Effects of simulated cochlear-implant processing on speech reception in fluctuating maskers. *Journal of the Acoustical Society of America, 114*, 446-454. Doi: 10.1121/1.1579009

Seldran F, Truy E, Gallego S, Berger-Vachon C, Collet L, Thai-Van H (2008): Simulation of an electro-acoustic implant (EAS) with a hybrid vocoder. Retrieved from http://www.Acoustics o8-paris.org/

Turner, C. W., Gantz, B. J., Vidal, C., Behrens, A., & Henry, B. A. (2004). Speech recognition in noise for cochlear implant listeners: Benefits of residual acoustic hearing. *Journal of the Acoustical Society of America, 115,* 1729–1735. Doi: 10.1121/1.1687425

Von Ilberg, C., Kiefer, J., Tillein, J., Pfenningdorff, T., Hartmann, R., Sturzebecher, E., et al. (1999). Electric-acoustic stimulation of the auditory system: New technology for severe hearing loss. *ORL-Journal for Oto-Rhyno-Laryngology and its Related Specialties, 61*, 334–340.

COMPARISON OF CLICK AND TONE BURST INDUCED ELECTROCOCHLEOGRAPHY IN INDIVIDUALS WITH NORMAL HEARING

[1]Prawin Kumar, & [2]Pallavi

Abstract

Electrocochleography (ECochG) is a tool to record the receptor potentials of the cochlea and the whole nerve action potential in individuals with normal hearing and in different clinical population. The present study aimed to see the difference in performance between click and 1000 Hz tone burst stimuli in individuals with normal hearing. There were ten ears with normal hearing individuals in the age range of 18 to 25 years. The results of the study revealed a significant difference for latency measurements of summating potential and action potential between click and 1000 Hz tone burst stimuli at p < 0.01 level. However, there were no statistically significant difference for amplitude measurements of summating potential and action potential between click and 1000 Hz tone burst stimuli at p > 0.05 level. Furthermore, SP/AP amplitude ratio revealed no statistically significant difference between click and 1000 Hz tone burst stimuli in individuals with normal hearing at p > 0.05 level. These finding can be utilized for clinical population in differential diagnosis. However, further studies needs to be carried out on large population in clinical group.

Key words: *summating potentials, action potentials, extratympanic, transtympanic*

Electrocochleography (ECochG) is a measurement of stimulus related electrical potentials, which includes the cochlear microphonics (CM), summating potentials (SP) and compound action potentials (AP) of the auditory nerve. ECochG is an ideal test for the diagnosis of Meniere's disease. It is thought to reflect changes in the anatomic position of the hair cells. This bias in the position of the hair cell is what is expected to occur in active Meniere's disease (Levin, Margolis & Daly, 1998). Thus, ECochG have focused on amplitude measure of SP alone or on the amplitude ratio of SP and AP. The purpose of measuring ECochG include monitoring of cochlear and auditory nerve function during surgery, which could result in compromising of these function, and improving the ease with which wave I is identified during ABR testing. Another area of clinical interest and application of the ECochG response is in differential diagnosis of Meniere's disease.

Several investigators have routinely used transtympanic (TT) recording methods (Eggermont, Odenthal, Schmidt, & Spoor, 1974; Gibson, Prasher, & Kilkenny, 1983; Yoshie, 1976). Others have preferred extratympanic (ET) methods by recording from ear canal wall as it is non-invasive techniques (Coats, 1974; Coats & Martin, 1977; Elberling, 1974) or, recently from the tympanic membrane (TM) (Lilly & Black, 1989; Ruth & Lambert, 1989). Current extratympanic studies focus almost exclusively on the amplitude of the summating potential (SP), either absolute or relative to that of the action potential (AP), as elicited by high-level click stimuli (Coats, 1981; Mori, Asai, Doi, & Matsunaga, 1987). In addition, tone burst stimulation as an extension to clicks is far more often applied in TT than in ET studies (Eggermont, 1976). However, TT technique is invasive technique in nature and tedious to perform. Tone burst stimuli have been used to extend the analysis of SP and SP/AP amplitude ratios (Dauman & Aran, 1991).

ECochG can be elicited with tone burst signals (Campbell, Faloon, & Rybak, 1993; Ge, & Shea, 2002). ECochG measurements with tone burst signals are often applied in the diagnosis of Meniere's disease (Campbell, Harker, & abbas, 1992; Orchik, shea, & Ge, 1993). There is some evidence that the diagnostic value of ECochG is relatively higher for 1000 Hz tone burst frequency (Sass, 1998; Conlon, & Gibson, 2000).

Schoonhoven, Fabius, and Grote (1995) aimed to explore the applicability of ET and TT methods of electrocochleography. They used both clicks and tone burst stimuli to record electrocochleography at different intensity levels. The tone burst stimuli were octave frequencies from 500 Hz to 8000 Hz. The tone burst had a trapezoidal envelope with a 4 msec plateau duration, and with rise/fall time times of two periods of the carrier frequency. They were tried to find out threshold levels by reducing the intensity levels in 10 dB steps started from 90 dB HL. The results revealed that ET responses were reduced in amplitude in comparison to TT responses by a factor of 0.43. However, the latencies were similar for ET and TT recording. It was also found that ET responses to tone burst in normal individuals showed the same response characteristics as found in TT Electrocochleography.

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Ghosh, Gupta and Mann (2002) evaluated and compared the results of ET and TT ECochG in individuals with normal hearing and different clinical population. There were 20 individuals with Meniere's disease served as clinical group and 20 age-and gender-matched control (10 of which were those with chronic suppurative otitis media) group in the age ranged from 20 to 61 years. They used clicks as stimuli presented at two different intensity levels (80 dB SPL and 100 dB SPL) for both TT and ET recording. The various parameters compared were summating potential, action potential in terms of latency and amplitude, and ratio of SP/AP amplitude. The results revealed that there were significant difference between control and clinical groups by both methods. They observed the sensitivity of 100% and specificity of 90% for TT method, whereas the ET method showed corresponding values of 90% and 80% respectively. They conclude ET method is less invasive compared to TT method and can be easily performed on clinical population.

Need for the study

There is an ambiguity in terms of selecting type of stimuli and recording methods to be adopted for ECochG. Study done by Ghosh, Gupta and Mann (2002) used only click as stimuli at two different intensity levels and recorded with both TT and ET methods. However, Schoonhoven, Fabius, and Grote (1995) used clicks as well as different octave frequencies tone burst stimuli from 500 Hz to 8000 Hz to obtain input-output graph for TT and ET recording. In addition to that, later study did recording at different intensity levels starting from 90 dB HL reducing in 10 dB steps till threshold level. Further, they have not specified the stimuli which yielded the best response. Hence, present study was taken up to check the more useful stimuli for recording ECochG in individuals with normal hearing.

Aim of the study

The aim of the present study to check the difference between click and 1000 Hz tone burst stimuli while recording ECochG. This includes recording of latency and amplitude of summating potential (SP), action potential (AP), and SP/AP amplitude ratios in individuals with normal hearing.

Method

The present study was conducted with the aim of studying the difference between click and 1000 Hz tone burst stimuli while recording ECochG in individuals with normal hearing.

Participants

Total number of ten ears from six normal hearing individuals (1 female & 5 male) was selected.

The age range of the participants varied from 17 to 25 years. Participants with any history of otologic or neurologic history were excluded from the study. All the participants were randomly selected from 380 undergraduate / postgraduate programs being conducted in the city of Mysore. Oral consent was obtained from all the participants.

Participant selection Criteria:

Individuals having hearing sensitivity less than 15 dB HL at octave frequencies between 250 Hz to 8000 Hz for air conduction and from 250 Hz to 4000 Hz for bone conduction were selected. They had normal middle ear functioning as indicated by Immittance evaluation. Participants having speech identification scores greater than 90% and having no history of any otologic, neurologic problems were included for this study.

Instrumentation:

To carry out the pure tone audiometry and speech audiometry, a calibrated two channels Orbiter-922 diagnostic audiometer with TDH-39 headphone with MX-14/AR ear cushion, and Radio ear B-71 bone vibrator were used. A calibrated immittance meter, GSI-Tympstar was used to assess middle ear functioning. Bio-logic system (version, 7.0) with impedance matched ER-3A insert earphone was used to record and analyse the ECochG.

Test Environment:

All the measurement was carried out in an acoustically treated double room situation. The ambient noise level was within the permissible level according to ANSI (1991).

Test Procedure:

Pure tone thresholds were obtained with head phones for octave frequencies between 250Hz to 8000Hz for air conduction using modified Hughson-Westlake procedure (Carhart & Jerger, 1959). The tympanometry and acoustic reflex were carried to rule out any middle ear pathology.

Extratympanic ECochG recording: Participants were made to sit comfortably in order to ensure a relaxed posture and minimum rejection rate. ECochG was recorded from one channel. Silver chloride (AgCl) electrodes were placed after cleaning the electrode sites with skin preparing gel. TIPTRODE electrode was used for recording ECochG. Conduction paste was used to improve the conductivity of the signal. For ECochG, the non-inverting electrode was placed in the ear canal, ground electrode was placed on the nasion and the inverting electrode was placed on the opposite ear mastoid. The electrodes were secured in place using plasters. The electrode

impedance value was kept less than 5 kΩ and the inter electrode difference was less than 3 kΩ.

The click stimuli duration was 100 μsec with no rise and fall time. The tone burst stimuli of 1000 Hz had 2 msec rise time and 2 msec fall time with 0 msec plateau. Blackman ramp was used for tone burst stimuli. The test protocol is mentioned in the table 1.

Table 1: *Test protocol for Electrocochleography*

Parameters	Click stimuli	1000 Hz tone burst stimuli
Analysis window	10 msec	10 msec
Gain	50,000	50,000
Filter setting	10 Hz -1500 Hz	10 Hz- 1500 Hz
Type of stimulus	Click	1000 Hz
Polarity of stimulus	alternating	alternating
Repetition rate	7.1/s	7.1/s
No. Of stimuli	1000	1000
Intensity of the Stimulus	90 dB nHL	90 dB nHL

Latency of summating potential, and action potential was measured. Peak to peak amplitude values of summating potential and action potential was measured. The SP/AP amplitude ratio was also calculated for individuals with normal hearing. Two audiologists independently analyzed the waveform.

Results

The latency and amplitude of the summating potentials, action potentials and amplitude ratio (SP/AP) were recorded for click and 1000 Hz tone burst stimuli (Figure 1). Mean and standard deviation (SD) was calculated separately for latency and amplitude for click and 1000 Hz tone burst stimuli. Wilcoxon signed ranks test was administered to check if there is a statistically significant difference between the measures obtained with click and 1000 Hz tone burst stimuli. SPSS software (version 17) was used to carry out the statistical analysis.
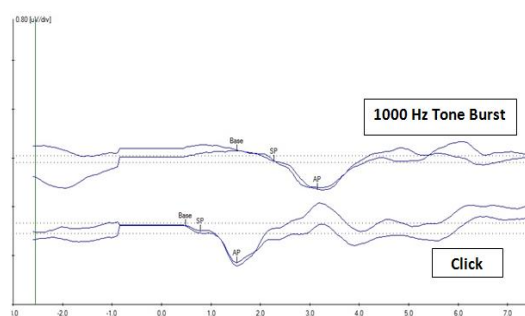

Figure 1: *Sample waveform of click and 1000 Hz Tone Burst stimuli recording*

Latency measurements for click and 1000 Hz tone burst stimuli

The mean latency for click stimuli was less than 1000 Hz tone burst stimuli for summating potentials and action potentials. Furthermore, standard deviation was also less for click stimuli than 1000 Hz tone burst stimuli. It indicates that the variability is more for tone burst stimuli than click stimuli (Table 2 & Figure 2).

Table 2: *Mean and SD of Latency for click and 1 kHz tone burst stimuli (N = 10)*

Types of stimuli	Different parameters of ECochG	Mean (msec)	Standard deviation (SD)
Click	SP	0.75	0.12
	AP	1.50	0.07
1000 Hz	SP	2.16	0.38
	AP	3.02	0.35

The latency range varied for summating potential from 0.57 msec to 0.99 msec for click and from 1.78 msec to 3.11 msec for 1000 Hz tone burst in individuals with normal hearing. In addition, Wilcoxon signed rank test revealed that there is statistically significant difference between click and 1000 Hz tone burst stimuli for summating potential ($Z = 2.80$, $p < 0.01$) and action potential ($Z = 2.80$, $p < 0.01$).

The present finding is in consonance with the finding by different researchers (Schoonhoven, Fabius, & Grote, 1996; Ghosh, Gupta, & Mann, 2002). As per Ghosh et al. (2002), the mean latency for summating potential in individuals with normal hearing using clicks with extratympanic techniques was 0.53 msec at 100 dB SPL and 1.06 msec at 80 dB SPL. Similarly mean latency for action potential was 0.90 msec at 100 dB SPL and 1.55 msec at 80 dB SPL.
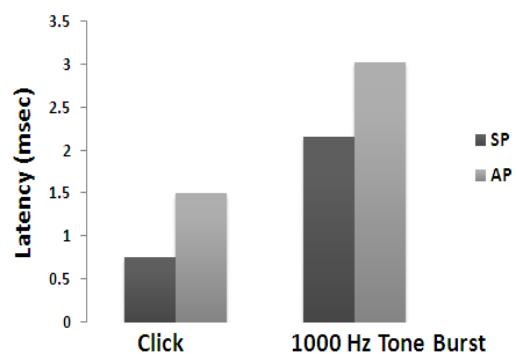

Figure 2: *Latency measurements for summating and action potential*

Amplitude measurements for click and 1000 Hz tone burst stimuli

For amplitude measure, the trend was not similar as it was for latency measurements. The mean amplitude for summating potentials and action potential was more for click stimuli than 1000

Hz tone burst stimuli. In addition, SD for click stimuli was more than 1000 Hz tone burst stimuli for summating potential which indicates variability was more for click stimuli than 1000 Hz tone burst stimuli. However, in case of action potential SD was lesser for click than 1000 Hz tone burst stimuli (Table 3 & Figure 3).

Table 3: *Mean and SD of amplitude for click and 1 kHz tone burst stimuli (N = 10)*

Types of stimuli	Different parameters of ECochG	Mean (msec)	Standard deviation (SD)
Click	SP	0.10	0.28
	AP	0.57	0.27
1000 Hz	SP	0.05	0.14
	AP	0.30	0.41

The range of amplitude for summating potentials varied between 0.01 µV to 0.57 µV for click and 0.01 µV to 0.23 µV for 1000 Hz tone burst in individuals with normal hearing. Furthermore, Wilcoxon signed ranks test revealed that there is no statistically significant difference between click and 1000 Hz tone burst stimuli for summating potentials (Z = 0.53, p > 0.05) and action potentials (Z = 1.47, p > 0.05). In a similar line, Ghosh et al. (2002) reported that the mean amplitude for summating potential in individuals with normal hearing using clicks as stimuli was 1.19 µV at 100 dB SPL and 0.59 µV at 80 dB SPL. Similarly, the mean amplitude of action potential was 7.88 µV at 100 dB SPL and 3.22 µV at 80 dB SPL.
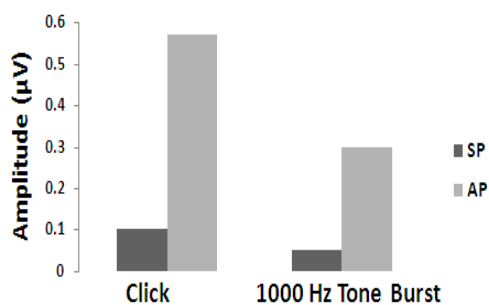

Figure 3: *Amplitude measurements for summating and action potential*

Amplitude ratio (SP/AP) for click and 1000 Hz tone burst stimuli

The mean amplitude ratio (SP/AP) was in the range of 0.10 to 0.50 for click and 0.12 to 0.46 for 1000 Hz tone burst stimuli. The mean was almost same for both click and 1000 Hz tone burst stimuli for individuals with normal hearing. The SD was little higher for click than tone burst which indicates variability was more for clicks than tone burst (Table 4). The Wilcoxon signed rank test was performed to check if there is any

difference in amplitude ratio (SP/AP) between click and 1000 Hz tone burst stimuli. The results indicated no statistically significant difference between click and 1000 Hz tone burst stimuli (Z = 0.15, p > 0.05).

Table 4: *Amplitude ratio (SP/AP) for click and 1000 Hz tone burst stimuli*

	Mean	SD	Minimum	Maximum
Click	0.26	0.13	0.10	0.50
1000 Hz	0.26	0.11	0.12	0.46

The present finding is in agreement with the results from different researchers (Ghosh, Gupta, & Mann, 2002). In individuals with normal hearing the amplitude ratio (SP/AP) with extratympanic recording techniques using clicks as stimuli was 0.16 at 100 dB SPL and 0.18 at 80 dB SPL (Ghosh, Gupta, & Mann, 2002).

Discussion

The objective of our study was to explore the type of stimuli to be used while recording ECochG in extratympanic mode. It is non-invasive mode of recording and less time consuming. It also helps us to understand the physiology behind changes occurring with the use of different stimuli.

In present study, click and 1000 Hz tone burst stimuli were used for recording ET ECochG. As per present finding, click showed better responses in terms of amplitude measure for both summating potential and action potential. However, in terms of latency, 1000 Hz tone burst show better responses than click stimuli. The reported literature suggests that latency is more stable parameter than amplitude measure. Hence, authors suggest use of click stimuli for ECochG recording until frequency specific information is required.

According to Schoonhoven et al. (1995), for any given tone burst intensity, action potential latency increases with decreasing stimulus frequency. The action potential latency for the click is in the same range as the latencies for the 4000 Hz to 8000 Hz tone bursts. In the present study, the latency for 1000 Hz (low frequency) tone burst stimuli was more (prolong) than click (high frequency) stimuli, could be reflection of the tonotopic organization of the cochlea.

In present study, data showed higher amplitude for clicks stimuli than 1000 Hz tone burst stimuli. It could be due to the basal shift of the cochlear activation pattern (Rose, Hind, Anderson & Brugge, 1972). Schoonhoven et al. (1996) also showed that the action potential amplitude increases gradually and latency decreases with increase in stimulus intensity.

In clinical population, amplitude ratio (SP/AP) was assessed using click and tone burst stimuli by Arenberg, Kobayashi, Obert, and Gibson (1993). They reported that when click was used, the amplitude ratio (SP/AP) change was more significant than the change observed measuring the absolute SP amplitude portion of the ratio alone. It was also concluded that the tone burst stimulation gives more frequency specific information, making tone burst more useful in detecting early or different focal types of endolymphatic hydrops. Hence, these authors suggested the use of tone bursts at different frequencies along with clicks could be useful in assessing endolymphatic hydrops.

Conclusions

It can be concluded from the present study that the different parameters of the ECochG can be assessed using either click or tone burst stimuli through extratympanic recording technique. The parameters which can be assessed are summating potential, action potential and amplitude ratio (SP/AP). These parameters are very helpful in the diagnosis of different pathology of inner ear. The recorded data can be used for reference when administering same test on clinical population. The results of the present study revealed that the latency of summating and action potential for clicks were less than 1000 Hz tone burst. However, the amplitude of the summating and action potential were higher for clicks than 1000 Hz tone burst stimuli with extratympanic recording. The above finding could be because of the tonotopic organization of the cochlea. The amplitude ratio (SP/AP) revealed no significant difference between click and 1000 Hz tone burst stimuli in individuals with normal hearing. However, amplitude ratio (SP/AP) is very important diagnostic tool for clinical population. Hence, further research can be done on clinical population to validate the importance of present finding.

References

American National Standard Institute (1991). Maximum permissible ambient noise for audiometric test rooms. ANSI S3.1-1991. New York.

Arenberg, I. K., Kobayashi, H., Obert, A. D., & Gibson, W. P. R. (1993). Intraoperative electrococheleography of endolymphatic hydrops surgery using clicks and tone bursts. *Acta Otolaryngologica (suppl.), 504,* 58-67.

Campbell, K. C., Harker, L. A., & Abbas, P. J. (1992). Interpretation of electrococheleography in Meniere's disease and normal subjects. *Annals of Oto-Rhino-Laryngology. 101,* 496-500.

Campbell, K. C., Faloon, K. M., & Rybak, L. P. (1993). Non-invasive electrodes for electrocochleography in the chinchilla. *Archive of*

otolaryngology- Head, Neck and Surgery, 119*, 767-771.

Carhart, R., & Jerger, J. (1959). Preferred methods for clinical determination of pure tone thresholds. *Journal of Speech and Hearing Disorders, 16*, 340-345.

Coats, A. C. (1974). On electrochocleographic electrode design. *Journal of the acoustical society of America, 56,* 708-711.

Coats, A. C. (1981). The summating potential in Meneiere's disease. I. Summating potential amplitude in Meniere's and non-Meneire's ears. *Archives of Oto-Rhino-Laryngology 107*, 199-208.

Coats, A. C., & Martin, J. L. (1977). Human auditory nerve action potentials and brain stem responses. *Archives of Oto-Rhino-Laryngology, 103,* 605-622.

Conlon, B. J. & Gibson, W. P. R. (2000). Electrocochleography in diagnosis of Meniere's disease. *Acta Otolaryngology, 120,* 480-483.

Dauman, R., & Aran, J. M. (1991). Electrochocleography and the diagnosis of endolymphatic hudrops: clicks and tone bursts. In I. K. Arenberg (Ed.), surgery of the inner ear (pp. 123-133). Amsterdam: kugler Publications.

Eggarmont, J. J. (1976). Analysis of compound action potential responses to tone bursts in human and guinea pig cochleas. *Journal of Acoustical Society of America, 60,* 1132-1139.

Eggermont, J. J., Odenthal, D. W., Schmidt, P. H., & Spoor, A. (1974). Electrocochleography: basic principles and clinical application. *Acta Oto-Laryngologica, supplement (Stockhom), 310,* 1-84.

Elberling, C. (1974). Action potentials along the cochlear partition recorded from the ear canal in man. *Scandinavian audiology, 3,* 13-19.

Ge, X., & Shea, J. J. (2002). Tranastympanic electrocochleography: a 10-year experience. *Otology & Neurotology, 23,* 799-805.

Ghosh, S., Gupta, A. K., & Mann, S. S. (2002). Can electrocochleography in Meniere's disease be noninvasive?, *The Journal of Otolaryngology, 31,* 371-375.

Gibson, W. P. R., Prasher, D. K., & Kilkenny, G. P. G. (1983). Diagnostic significance of transtympanic electrococheleography in Meniere's disease. *Annals of Otology, Rhinology, and Laryngology, 92,* 155-159.

Levin, S., Margolis, R. H. & Daly, K. A. (1998). Use of Electrochleography in the diagnosis of Meniere's Disease. *Laryngoscope, 108,* 993-1000.

Lilly, D. J., & Black, F. O. (1989). Electro cochelography in the diagnosis of Meniere's disease. In J. B. Nadol (Ed.), meniere's disease (pp. 369-374). Amsterdam: Kugler & Ghedini.

Mori, N., Asai, H., Doi, K., & Matsunaga, T. (1987). Diagnostic value of extratympanic electrocochleography in meniere's disease. *Audiology, 26,* 103-110.

Orchik, D. J., Shea, J. J., & Ge, X. (1993). Tranastympanic electrocochleography in Meneire's disease using clicks and tone bursts. *American Journal of Otology. 14*, 290-294.

Rose, J. E., Hind, J. E., Anderson, D. J., & Brugge, J. F. (1972). Some effects of stimulus intensity on response of auditory nerve fibres in the squirrel monkey. *Journal of Neurophysiology, 29,* 288-314.

Ruben, R. J., Bordley, J. E., Lieberman, A. T. (1961). Cochlear potentials in man. *Laryngoscope. 71,* 1141-1164.

Ruben, R. J., Knickerbocker, G. G., Sekula, J., et al. (1959). Cochlear microphonics in man. A preliminary report. *Laryngoscope. 69,* 665-671.

Ruth, R. A., & Lambert, P. R. (1989). Comparison of tympanic memebrane to promontory electrode recording of electrocochleographic responses in patients with Meneire's disease. *Otolayngology-Head and Neck surgery, 100,* 546-552.

Sass, K. (1998). Sensitivity and specificity of transtympanic ECochG in Meneire's disease. *Acta Otolaryngologica. 118,* 150-156.

Schoonhoven, R., Fabius, M. A. W., & Grote, J. J. (1995). Input/output curves to tone bursts and clicks in extratympanic and transtympanic electrocochleography. *Ear and Hearing. 16,* 6119-630.

Yoshie, N. (1976). Electrocochleographic classification of sensorineural defects: Patholoical pattern of the cochlear compound nerve action potential in man. In R. J. Ruben, C. Elberling, & G. Salomon (Eds.), Electrocochleography (pp. 353-386). Baltimore: university Park Press.

Acknowledgement

EFFECT OF DIFFERENT COMPRESSION PROCEDURES ON AIDED SPEECH IDENTIFICATION SCORES IN INDIVIDUALS WITH VARYING DEGREES OF HEARING LOSS

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Abstract

The aim of the present study was to determine the effect of different types of compression on aided speech identification scores (ASIS) in a group of individuals with hearing impairment of varying degrees. The ASIS were determined at two presentation levels (40 and 70 dB HL) in a quiet environment, for three types of compression (i.e., Dual compression only, Syllabic compression only and a combination of both Dual and Syllabic compression across the frequency channels). Ten ears in each degree of hearing loss (Moderate, Moderately Severe, and Severe), a total of 30 ears, were taken in the present study. ASIS were determined by using phonemically balanced word list developed by Yathiraj and Vijayalakshmi (2005). The results of the present study indicated that there was a significant improvement in ASIS for the compression procedure in which a combination of the two procedures was used. However, there was no significant difference when any one of the compression procedures was used individually in all the frequency channels across various degrees of hearing loss. This indicates that the consonant to vowel ratio is more enhanced in the combined compression procedure than when only one of the compression procedures is used. There was also a significant improvement for a higher presentation level when compared to a lower presentation level irrespective of the compression procedure used. This could be attributed to the better audibility of the speech.

Key words: Aided Speech Identification Scores, Syllabic compression, Dual compression, Consonant to vowel ratio.

Hearing loss is a form of sensory impairment that affects many individuals across the world. Sensorineural hearing loss is most common form, which is usually irreversible and results in decreased audibility, decreased dynamic range, decreased frequency resolution, and decreased temporal resolution (Dillon, 2001). This form of hearing impairment can be usually fitted with amplification devices such as hearing aids and/or cochlear implants. With the advancement in the hearing aid technologies there are now many options available in the same hearing aid to improve the perception of speech in individuals with hearing impairment.

The audibility of a signal can be compensated by just providing amplification to the incoming signals. However, it is observed that, most of the individuals with hearing impairment are not satisfied with their hearing aids, moderate to intense sounds cause discomfort though soft sounds are audible, which were not audible before. This is often referred to as 'reduced dynamic range'. This reduction in their dynamic range may be due to loss of cochlear compression. This would be due to acoustic trauma or cochlear injury (Ruggero, 1996; Robles & Ruggero, 2001). Thus, reduction in dynamic range associated with loudness recruitment or softness imperceptions cannot be compensated with fixed gain linear amplification hearing aids due to inconvenience in selection of desired gain (Chaudhari, 2002).

Also, linear hearing aids amplify all the sounds present in the environment equally, which leads to increase in background noise and thus, decreases the speech perception abilities. In the past, this issue was controlled by peak clipping strategies, where the output of the hearing aids was not over-amplified. However, this in turn distorted louder sounds. Later, hearing aids used dynamic range compression, which addressed the issue of full-range amplification by providing amplification based on the level of the input signal (Amlani, 2008).

With advent of technology, digital hearing aids at present, has the facility to be programmed, and thus allows the user to adjust the equalization of their hearing aids to meet their particular needs. Some of these hearing aids also featured noise reduction and feedback suppression; however, the limitations of analog signal processing meant that these devices were quite crude. The most advanced hearing aids featured multi-band processing schemes that incorporated wide dynamic range compression and adaptive time constants for the compression to further improve sound quality (Amlani, 2008). These hearing aids also has ability to divide the signal into many components based on frequency, intensity or time and apply different processing techniques to

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manipulate the signal, resulting in precise tuning of the signal to benefit the individuals with hearing impairment.

Compression amplification is most beneficial to the hearing aid users, but there is no consensus as to which form of compression is most beneficial. Single-channel compression is substantially better than those without compression. However, there is only a modest improvement of two-channel compression systems over single-channel compression (Young & Buckles, 1995), and ambiguous results with respect to the use of many compression channels.

Wide dynamic range circuits provide relatively more gain for low input sound levels and less gain for high input sound levels. Phonemic, syllabic and slow-acting compressions are sub-categories of WDRC. The goal of phonemic and syllabic compression is to reduce the amplitude differences between individual phonemes or syllables of speech, respectively (Moore, Johnson, Clark, & Pluvinage, 1992; Mare, Dreschler, & Verschuure, 1992; Hickson, 1994; Dillon, 2001). This would result in improved audibility of low-intensity speech sounds, such as most consonants, without over amplification of the high intensity speech sounds, such as most vowels. Phonemic and syllabic compressors must act quickly in order to adapt to the varying input levels of different speech segments. Attack times are often less than 5 ms, and release times may range from 50 ms to 200 ms. Attack and release times are not faster than this because the sum of the attack and release times should be at least 5 times longer than the period of the lowest frequency of the input signal in order to avoid waveform distortion (Moore & Glasberg, 1986).

On the other hand, dual compression has both syllabic and Automatic volume control algorithm. In this algorithm, short and long attack and release times are used depending on the level and time course of the input signal, exploiting the advantages of both compression procedures (syllabic and AVC). Gain reduction with short time constants reacts quickly to sudden, loud sounds and quickly turns to the original level after the loud sound is over. Thus the desired soft signal occurring after the loud sound is not affected. In contrast, if the criterion sound level is presented for a longer time, the long time constants are activated. The gain of the hearing instrument is adjusted only to slow changes to the average input level and the natural loudness variations in speech levels are preserved (Moore, Glasberg & Stone, 1991).

Several researchers have studied various perceptual benefits of various attack and release times which showed varied results. When the perceptual rating was measured, many preferred slow-acting release times in presence of certain background noises, but not for other noise background (Neuman, Bakke, Mackersie, Hellman & Levitt, 1995). Bentler and Nelson (1997) reported that there is no effect of various combinations of phonemic, syllabic and slow-acting compressors on nonsense syllable identifications in noise, perceived intelligibility, or hearing aid usage time. Jenstad and Souza (2005) studied the acoustic effects of release time on vowel-consonant nonsense syllables. They reported that faster release times were associated with a larger difference between the WDRC processed and unprocessed signals. Also, shorter release times were associated with a larger difference in level between the consonant and vowel segments. Both of these results indicate that faster release times led to more effective compression for nonsense speech syllables.

Comparison of the dual and syllabic compression was made by many researchers to determine which one would be more appropriate to improve the speech identification ability of individuals with hearing impairment. Geetha (2005) compared the effect of syllabic and dual compression on speech identification scores among individuals with mild to moderately severe sensorineural hearing loss. The results of this study reported that there was no significant difference in speech identification scores with either types of compression but the subjective preference was towards dual compression. Similar findings were also obtained with different degrees of hearing loss (Sarathy, 2010).

Need for the Study

Various research studies have revealed that, there is not much difference observed among the two compression procedures though the dual compression is meant to improve the speech perception ability than the syllabic compression. Research studies have indicated that the syllabic compression or dual compression alone has not brought changes in speech perception abilities. Investigators have evaluated the efficiency of two compression procedures either using either of the procedure alone or a comparison of the two. This lack of consensus among the compression procedures, would leave a question whether, any further modifications or different combination of these compression procedures would improve the speech perception abilities. Hence, the current study was taken up to determine the speech identification abilities with the combination of these two procedures where in dual compression for the low frequency bands and syllabic compression for the high frequency bands were incorporated.

Objectives

The objective of the present study is twofold, the first is to study the effect of compression procedures on speech perception in individuals with different degree of hearing loss and to compare the speech identification scores obtained using different compression procedures at different presentation levels in individuals with different degree of hearing loss.

Method

Participants

The participants with sensori-neural hearing loss were divided into three groups namely moderate, moderately-severe and severe based on the degree of hearing loss having taken ten ears in each group. The age range of participants was from 31 to 57 with mean age of 44 years. The participants in the moderate group had hearing thresholds of 41 to 55 dB HL, moderately-severe group had thresholds of 56 to 70 dB HL and severe group had thresholds of 71 to 90 dB HL. The mother tongue of all the participants was Kannada. All the participants were naive hearing aid users.

Stimulus

Phonemically balanced word lists developed by Yathiraj and Vijayalakshmi (2005) were used for the study. The word list consists of four lists with 25 words in each list. The words were randomized using random tables to obtain eight lists which were used in this study.

Instrumentation

A non-linear digital behind-the-ear hearing aid with the following features was selected in the present study. The hearing aid had four compression channels with the facility to select dual or syllabic compression in each of the channels. The hearing aid also had an option to program for individuals with hearing impairment of various degrees. The hearing aid could accommodate three programs in which different compression procedures could be stored by keeping all other parameters constant.

A Pentium IV Computer along with Hi-Pro device and programming cables was used for connecting the hearing aid to the computer and to program. NOAH-2 and Connexx (V5.0a) softwares were used to program the hearing aid. The stimulus was presented through Adobe Audition V3.0 connected to an audiometer from the computer through an auxiliary cable. The stimulus was presented through loudspeakers at 45 degree azimuth and speech identification scores for different compressing conditions were determined.

Procedure

The pure tone thresholds (from 250 Hz to 8 KHz for air conduction and from 250 Hz to 4 KHz for bone conduction) of the test ear were fed into the NOAH fitting software. The subject was fitted with the digital hearing aid on the test ear using a custom ear mold. The hearing aid was connected to the HI-PRO that was in turn connected to a computer with the programming software. The hearing aid was detected by the Connexx software after switching the hearing aid "on" and both the volume control and the acclimatization level was set at two. The default prescriptive formula used was NAL-NL1.

The hearing aid was programmed for the first fit condition and the compression option was first set to the dual compression in the low frequency channels and the syllabic compression in the high frequency channels and this first program was named as P1. In the 2nd program (P2), compression method was set to dual compression in all the frequency channels and in 3rd program (P3), it was set to syllabic compression in all the frequency channels. The compression threshold and the compression ratio values set by the software, i.e. default settings were unchanged.

The aided speech identification scores were determined at two presentation levels (40 dB HL and 70 dB HL) using the word lists developed by Yathiraj and Vijayalakshmi (2005) in all the three programs. The order of administration of P1, P2, and P3 were randomized across all the 3 groups. The subject was instructed to provide a verbal response for all the stimuli presented and the correct responses were scored. The speech identification scores were tabulated and subjected to statistical analysis.

Results and Discussion

The speech identification scores for three programming conditions (P1, P2, & P3) at two presentation levels were noted for all the three groups. The data obtained from the thirty ears with different degrees of hearing loss was tabulated and analyzed using Statistical Package for Social Sciences, (SPSS, V17) to determine the effect of different compression procedures on speech identification scores across different degrees of hearing loss and also to determine the effect of different compression procedures on speech identification scores at different presentation levels. Thus mean and standard deviation of speech identification scores of all the three groups were obtained, which is shown in Table 1 and these results were compared across the groups.

Table 1: *Mean and Standard deviation of aided speech identification scores at different compression procedures used in the three groups at presentation levels of 40 and 70 dB HL.*

S.No	Degree of Hearing Impairment	Compression Procedure	Presentation Level (dB HL)	Mean (SIS)	Standard deviation
1.	Moderate	P1	40	88.4	2.27
			70	91.2	1.69
		P2	40	68.8	4.13
			70	75.60	2.95
		P3	40	68.0	3.77
			70	76.0	3.71
2.	Moderately Severe	P1	40	85.6	5.4
			70	90	4.71
		P2	40	66.6	5.51
			70	73.8	5.85
		P3	40	70.8	4.64
			70	74	6.11
3.	Severe	P1	40	66.4	6.59
			70	72.4	4.69
		P2	40	50.8	5.01
			70	56.8	5.59
		P3	40	50.4	6.02
			70	57.6	7.82

Repeated measures of ANOVA was done for the tabulated speech identification scores, the results revealed that there was no significant difference with regard to the speech perception abilities in P2 and P3 programs, i.e., there was no significant difference in speech identification scores between the dual compression only and the syllabic compression only condition across the frequency channels. There was also no significant difference in speech identification scores across different degrees of hearing loss over these two compression procedures. These results are in support of that reported by Geetha (2004) and the results across different degrees of hearing loss were also consistent with the study reported earlier by Sarathy (2010). These results are also supported by the findings of the study done by Bentler and Nelson (1997), who also reported no effect of various combinations of phonemic, syllabic and slow-acting compressors on nonsense syllable identification in both quiet and noise. Sarathy (2010) also reported similar findings. In contrary, to these findings, Moore et al. (1991) reported that the speech identification scores were better for dual time constant compression compared to adaptive compression. However, these authors fail to explain the reason for their results.

However, there was a significant difference in speech identification scores for the combined compression procedure when compared with that of either dual only or syllabic only condition [F $(2,27) = 419.04$, $p<0.01$]. The same was found to be true at two presentation levels. There was a significant difference in speech identification scores between P1 & P2 and between P1 & P3 at 40dB and at 70 dB HL. Fig. 1 shows that

participants in all the three groups performed better when combined compression was used than when single compression was utilized at 40 dB HL.
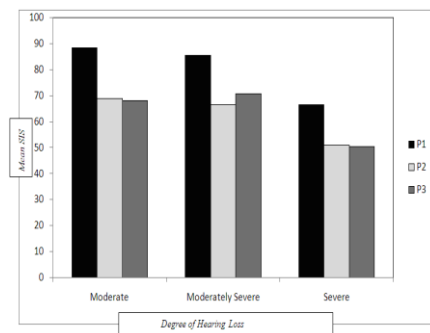

Figure 1: *Mean speech identification scores of individuals with hearing impairment with various degrees of hearing loss at 40 dB HL presentation level using three compression procedures*

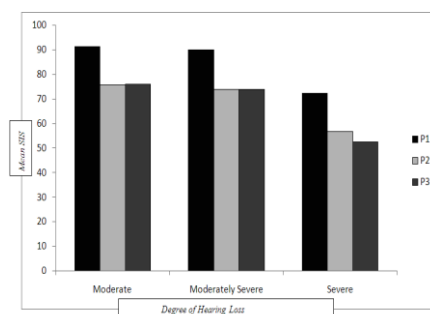Similar results were obtained at 70 dB HL as illustrated by Fig 2.

Figure 2: *Mean speech identification scores of individuals with hearing impairment with various degrees of hearing loss at 70 dB HL presentation level using three compression procedures*

Boneferroni multiple comparison tests at a significance level of 5% was also done to determine which of the two groups differ significantly. The results of Bonferroni multiple comparison tests revealed that there was a significant difference in speech identification scores between the combined compression method with that of the single compression method across the frequency channels. Duncan post hoc analysis revealed that the three groups (moderate, moderately-severe, and severe) differed significantly from each other in the combined compression method.

The results of the present study also revealed that individuals belonging to all the three groups performed better at 70 dB HL when compared to 40 dB HL irrespective of the compression procedure used. This could be related to better audibility of the sounds that made perceive speech better at high intensity levels. There was also a significant difference in speech identification scores across different degrees of hearing loss which could be related to the more audibility at high presentation level. This finding is in contrary to the study done by Moore et al. (1991), who reported that there is no significant difference in speech identification scores at high presentation levels (70dB HL) compared to low stimulus presentation levels (40 dB HL).

The results of the present study has revealed that the speech identification scores for the combined compression method (Dual compression at low-frequency channels and Syllabic compression at high-frequency channels) is significantly higher than that of the either of the two other compression procedures presented alone across all the frequency channels. With this type of combined compression procedure the short duration portion of the speech signals (i.e., consonantal part) will be enhanced (in both the channels), whereas the vowel part (which is longer in duration than consonants) will not be enhanced to the same extent as that of the consonantal part. The reasons that the vowels are more concentrated in lower frequencies and are longer in duration. Thus, the vowel part will not be amplified to the same extent as that of the consonant. This in turn increase the consonant-to-vowel (CV) ratio with the combination of the both the compression procedures, and thus, increase the speech identification abilities. Hickson, Thyer and Bates (1999) reported that CV ratio will be generally increased with compression, compared to linear amplification, and that the effects will be greatest for amplification with compression in the high-frequency channel. This finding is in contrary to study by Souza (2002) who states that acoustically, the amplitude contrast between the

C and V is significantly altered by WDRC. The WDRC reduces the vowel level and increases the consonant level relative to the original speech token. The difference in results could be due the difference in types of compression used.

This is also true at different presentation levels (i.e., both at 40 dB HL and 70 dB HL). The results can be better explained at 70 dB HL, as the compression would have worked above the compression knee point. Hearing aid used in the present study had knee point around 62 to 66 dB HL, so the high presentation level (70 dB HL) was above the knee point and the low presentation level was below the knee point. Unexpectedly, there was a significant improvement in speech identification scores of individuals with cochlear hearing loss.

Conclusions

The present study made an attempt to find out the effect of different combination of compression procedures on speech perception across varying degrees of hearing impairment. The results showed that the speech identification scores for the combined compression method (Dual compression at low-frequency channels and Syllabic compression at high-frequency channels) is significantly higher than that of the either of the two other compression procedures (Dual compression and Syllabic compression) utilized alone across all the frequency channels in individuals with moderate, moderately-severe and severe hearing loss. Also, in individuals with moderate, moderately-severe and severe hearing loss, similar performance is obtained in speech identification scores when only dual compression and only syllabic compression was used across the frequency channels. In addition, it was found that individuals belonging to all the three groups performed better at 70 dB HL when compared to 40 dB HL in speech identification task.

Implications of the study

As the combined compression in digital hearing aids improves speech perception in individuals with hearing impairment, the combined compression is to be used clinically. As the performance in this condition is much better, there will be more acceptance and better adoptability with the amplification. This results in optimum use of hearing aids. Thus, helping Audiologists to achieve the main goal of rehabilitation.

References

Amlani, A. M. (2008). Multichannel Compression Hearing Aids: Perceptual Considerations. *The ASHA Leader.* Retrieved on December, 15, 2010, from http://www.asha.org/Publications/leader/2008/080304/f080304b.htm

Bentler, R. A., & Nelson, J. A. (1997). Assessing release-time options in a two-channel AGC hearing aid. *American Journal of Audiology, 6*, 43–51.

Chaudhiri, S. (2002). Hearing aids: Speech processing techniques. *Hearing Aid Journal, 16(4)*, 72-76.

Dillon*, H*. (2001). Hearing Aids. *Forlaget Thieme.* Boomerang Press, Sydney.

Geetha, C. (2005). *Effect of syllabic and dual compression on speech identification scores*. Unpublished Masters Dissertation, University of Mysore.

Robles, L., & Ruggero, M.A.(2001). Mechanics of the mammalian cochlea. *Physiological. Review, 81*, 1305–1352.

Ruggero, M. A. (1996). The effects of acoustic trauma, other cochlear injury, and death on basilarmembrane responses to sound. *Scientific Basis of Noised-Induced Hearing, 23*–35.

Moore, B. C. J., Glasberg, B., & Stone, M. (1991). Optimization of slow acting automatic gain control system for use in hearing aids. *British journal of audiology, 25 (3)*, 171-182.

Moore, B. C. J., Johnson, J. S., Clark, T. M., & Pluvinage, V. (1992). Evaluation of a dual-channel full dynamic range compression system for people with sensorineural hearing loss, *Ear and Hearing, 13*, 349–370.

Mare, M. J., Dreschler,W. A., & Verschuure, J. (1992). The effects of input-output configuration in syllabic compression on speech perception, *Journal of Speech and Hearing Research, 35*, 675–685.

Hickson, L. M. H. (1994). Compression amplification in hearing aids, *American Journal of Audiology, 3*, 51–65.

Hickson, L., Thyer, N., & Bates, D. (1999). Acoustic analysis of speech through a hearing aid: consonant-vowel ratio effects with two-channel compression amplification, *Journal of American Academy of Audiology, 10(10),* 549-556.

Moore, B. C. J., & Glasberg, B. R. (1986). A comparison of two-channel and single-channel compression hearing aids, *Audiology, 25,* 210–226.

Neuman, A. C., Bakke, M. H., Mackersie, C., Hellman, S., & Levitt, H. (1995). Effect of release time in compression hearing aids: Paired-comparison judgments of quality, *The Journal of the Acoustical Society of America, 98,* 1471–1478

Sarathy, K. (2010). Effect of Syllabic and Dual Compression on Speech Identification Scores Across Different Degrees of Hearing Loss, Unpublished Masters Dissertation, University of Mysore.

Souza, P.E. (2002). Effects of compression on speech acoustics, intelligibility and sound quality. *Trends in Amplification, 6 (4),* 131- 165.

Jenstad, L. M., & Souza, P. E. (2005). Quantifying the effect of compression hearing aid release time on speech acoustics and intelligibility, *Journal of Speech, Language, and Hearing Research, 48,* 651–667.

Yathiraj, A., & Vijayalakshmi, C. S. (2005). Phonemically Balanced Word List in Kannada. Developed in Department of Audiology, All India Institute of Speech and Hearing, Mysore.

Yund, E. W, & Buckles, K. M. (1995). Enhanced speech perception at low signal-to-noise ratios with multichannel compression hearing aids. *Journal of the Acoustical Society of America, 97,* 1224-1240.

TEST RETEST RELIABILITY OF OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIALS

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Abstract

Occular Vestibular Evoked Myogenic Potentials (oVEMP) responses have been consistently obtained in healthy individuals. Reports in literature have been suggestive of their utility in evaluating patients with vestibular disorders (Iwasaki et al., 2008 & 2009). Compared to Cervical VEMPs (cVEMPS), oVEMPs are less strenuous for the subjects to perform, and symmetrical responses can be easily obtained without monitoring background activation. As the oVEMP test gains popularity and worldwide recognition as a valid and reliable test of otolith function, it is likely to supplement cVEMP in the assessment of end organ function and act as a complementary technique when assessing central vestibular disorders. However, the clinical use of any test requires the establishment of reliability of the test and little is known about the test-retest reliability of oVEMPs (Isaradisaikul, Strong, Moushey, et al., 2008; Eleftheriadou, Deftereos, Zarikas, et al., 2008). Nguyen et al., (2010) reported about the test-retest reliability of oVEMP , however, smaller number of participants, larger gap between test and retest sessions and absence of fixed reference point for upward gaze may have played spoilsport and a better control at these variables may bring about a different result. So, the present study aimed at examining the test-retest reliability of the sound-induced oVEMP parameters. Monaural contralateral oVEMPS were recorded from 30 healthy individuals with normal audio-vestibular system and the test was repeated after a minimum gap of 1 week, keeping the other parameters constant. The obtained data was analyzed using Cronbach's alpha test. The results revealed excellent test-retest reliability for the amplitude parameters barring the asymmetry ratio, which showed fair-to-moderate reliability. The latencies also demonstrated fair-to-moderate test-retest reliability. These reliability values for oVEMP are better than those reported for cVEMP and could be attributed to a number of factors including smaller area of electrode placement making it less error prone, oVEMP being excitatory potential as opposed to cVEMP being inhibitory, and lesser fatigability of extra-occular muscles contrary to higher fatigability of the SCM muscle. The test-retest reliability values, thus, prove that the test is quite reliable and can be used clinically with confidence.

Key Words: Otolith functions, SCM muscle, cVEMP

Nearly a decade after the clinical use of the cervical Vestibular evoked myogenic potentials (cVEMP), Rosengren et al. (2005) and Iwasaki et al. (2007) reported about the incidence of extra-ocular potentials of vestibular origin in response to the bone-conducted skull vibrations. This laid the foundation stone for the discovery of the ocular VEMP (oVEMP). The subsequent literature (Todd, Rosengren, Aw, & Colebatch, 2007; Wang, Jaw, & Young, 2009) has brought out the possibility of obtaining oVEMP in response to the same auditory stimuli that have been used for evoking cVEMPs. The normal individuals have been shown to produce highly replicable waveforms in comparison to absence of any reproducible deflections in the electromyogram in the persons with vestibular abnormailities (Iwasaki, Smulders, Burgess, et al., 2008).

The oVEMP represents excitation of the extraocular muscles via the crossed vestibulo-ocular pathways. It is optimally recorded with maximum upward gaze with surface electrodes placed inferior to the eyes on the cheeks. The waveform, thus obtained, consists of a negativity occurring at approximately 10 ms, which has

been popularly referred to as the n10 potential, followed by a positivity occurring at approximately 16 ms, which has been named as the p16 potential (Iwasaki et al., 2007). Of these waves, only the n10 response has been found to be both absent in patients with vestibular loss and present in patients with hearing loss but intact vestibular function. This may indicate towards non-vestibular origin or contribution to these later waveforms (Iwasaki et al., 2007).

oVEMP responses have been consistently obtained in healthy individuals. Reports in literature have been brimming with the positivity with regards to their usefulness in evaluation of cases with vestibular disorders (Iwasaki et al., 2008 & 2009). Moreover, oVEMPs have been found to be less strenuous for the subjects to perform in addition to being largely symmetrical even without monitoring the muscle activation. As the oVEMP test gains popularity and the world gets ready to embrace it as a valid and reliable test of otolith function, it is likely to supplement cVEMP in the assessment of end organ function and complement the assessment of central vestibular disorders.

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Although the normal cVEMP parameters and test-retest reliability in response to sound stimuli has been the subject of several investigations, sparce knowledge is available in the contemporary literature about the test-retest reliability of oVEMPs (Isaradisaikul, Strong, Moushey, et al., 2008; Eleftheriadou, Deftereos, Zarikas, et al., 2008). Nguyen, Welgampola and Carey (2010) reported excellent test-retest reliability for all peak-to-peak amplitudes and asymmetry ratio for clicks and fair to good reliability for the parameters of tone-burst. However, they included only 12 subjects for evaluating test-retest reliability which is a small number and use of a larger number of subjects may reveal a more real picture. In addition, by they used a wide gap between the test and retest sessions, which may be capable of inducing many other variables that could adulterate the results of retest sessionsand deflect the results in favour of inducing larger variabilty. Moreover, the authors demanded their participants to maintain maximum upward gaze. An absence of a fixed reference point may be a culprit in them obtaining slightly lower values for some of the oVEMP parameters.

Aim of the study

The main aim of the present study was to find out the test-retest reliability of the sound-induced oVEMP parameters.

Method

Thirty healthy individuals (12 male and 18 female) with a mean age of 35 years (range of 18 to 50 years) with normal audio-vestibular system, ensured by administering a detailed case history that included questions specific to balance disorders, served as the participants of the study. The retest was done on all the participants with a minimum gap of 1 week and maximum gap of 3 weeks between the evaluations. The participants were queried briefly about any untoward incident that may have resulted in audio-vestibular problems during the test retest interval. All subjects gave informed consent before undergoing the evaluations.

A Nicolet Viking Quest (version 8.1) evoked potential system with TDH 39 supra-aural earphones was used for acquiring VEMP. The subjects were seated comfortably in an upright position in a well illuminated acoustically treated test room with the ambient noise levels within the ANSI specifications (ANSI S3.1-1999). They were instructed to maintain maximum upward gaze by concentrating at a particular point placed on the ceiling during the recording. A break was given after each recording to avoid fatigue adulterating the results. The electrode montage consisted of a non-inverting electrode placed on the cheek approximately 3 mm below the eye and centred beneath the pupil, an inverting electrode placed 2 cm below the non-inverting electrode and a ground electrode placed on the forehead. The skin overlying the cheeks and the forehead was cleansed using Nuprep skin preparing gel. The silver-chloride electrodes with wiring lengths of 1.5 meters each were placed using the 10-20 conduction gel. The recording was contralateral alone as reports in literature (Marnane & Akin, 2009) have shown that contralateral oVEMPs are more replicable and higher in amplitude than ipsilateral their counterpart. The stimulus and acquisition parameters of oVEMP have been given in table 1.

Table 1.*Protocol for recording oVEMP.*

Stimulus	Acquisition
Type: 500 Hz tone burst	**Epoch time:** 100 ms
Ramping: Default (as in tone-burst ABR)	**Filter settings:** 1–1,000Hz
Duration: Default (as in tone-burst ABR)	**Amplification:** 30,000X **Sweeps:** 150
Intensity: 95 dB nHL	
Polarity: Rarefaction	
Rate: 5.1 Hz	

The statistical analysis of the obtained data was done using Cronbach's alpha test to obtain the test retest reliability of the oVEMP parameters. The α-values of greater than 0.7 were considered to have excellent reliability, those with lesser than 0.4 were considered to have poor reliability and the intermediate values were considered to have fair/moderate reliability. This scale of categorization is based on the scale used by Versino, Colnaghi and Callieco (2001), who used this for establishing the test retest reliability of cVEMP.

Results and Discussion

The resultant waveforms were analysed to identify the oVEMP peaks. Figure 1 shows a sample waveform acquired from one of the participants of the study.
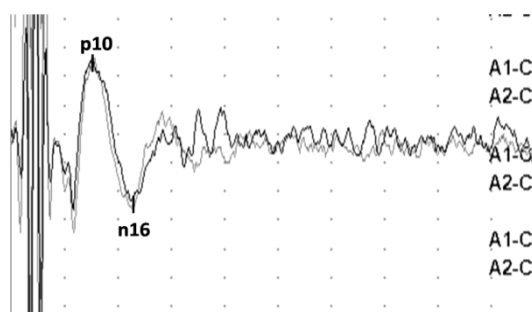

Figure 1: *Sample waveform acquired from one of the participants of the study.*

The n10 potential was identified as the first distinctive peak in the wave form, occurring approximately 10 to 13 ms after stimulus onset, and the p16 potential was identified as the first distinctive trough in the wave form, occurring approximately 14 to 18 ms after stimulus onset. The peak-to-peak amplitude was calculated as the sum of the n10 and p16 absolute amplitudes. The asymmetry ratio (AR) was calculated, in terms of percentage, by dividing the difference in peak-to-peak amplitudes of the two ears by the sum of the peak-to-peak amplitudes of the two ears.

Descriptive statistics

The mean and standard deviation values of the oVEMP parameters (p10 latency, n16 latency, p10 amplitude, n16 amplitude, peak-to-peak amplitude, threshold, and asymmetry ratio) for the first and second testing sessions are shown in Tables 2.

Table 2. *Mean and standard deviation values of different oVEMP parameters.*

	p10 latency [Mean (S.D.)in ms]	p10 amplitude [Mean (S.D.) in µV]	n16 latency [Mean (S.D.)in ms]	n16 amplitude [Mean (S.D.) in µV]	Peak-to-peak amplitude [Mean (S.D.) in µV]	oVEMP threshold [Mean (S.D.)in dB nHL]	Assymetry ratio [Mean (S.D.) in %]
Test session	11.21 (1.17)	4.55 (1.52)	15.43 (1.45)	3.72 (0.98)	7.38 (1.31)	84.40 (3.5)	21.67 (3.72)
Retest session	10.91 (1.04)	4.78 (1.43)	14.98 (1.51)	4.02 (1.06)	7.66 (1.27)	83.50 (4.5)	24.73 (5.16)

Test-Retest Reliability

Table 3 shows the Cronbach's α-values for oVEMP test-retest reliability. The amplitude parameters (p10, n16, and Peak-to-peak amplitudes) were found to have excellent reliability in response to tone-bursts of 500 Hz. Nguyen et al. (2010) also reported similar test-retest reliability. The excellent reliability of these oVEMP parameters is in contrast to several reports in literature about the cVEMPSs, which report the reliability to range from poor to moderate for most of the parameters (Isaradisaikul, Strong, Moushey, Gabbard, Ackley & Jenkins, 2008; Maes, Vinck, De Vel, D'haenes, Bockstael, Keppler, Phillips, Swinnen & Dhooge, 2009) This may be due to several basic differences that underlie the origin, electrode placement and task required by the participants to perform during the recording of the two sound induced vestibular potentials. First of all, the surface area of the cheek is smaller than that of the SCM muscle which makes the electrode placement less prone to error in terms of optimum placement. In addition, upward gaze may produce less fatigue in the muscle than does flexing or turning the neck, which may also lead to less inter-session variations (Fuchs & Binder, 1983). Also, there may be less variability in and soft tissue depth on the cheek than on the neck. Lastly, the oVEMP response is an excitatory potential measured in the midst of relatively small background noise of extraocular muscle activation. In contrast, the cVEMP response is a small modulation of a relatively noisy background of SCM contraction (Rauch, 2008). The former might be expected to be a more repeatable measure than the latter. The results of the present study tend to support the above mentioned arguments. The current study also found that the latencies of p10 and n16, peak-to-peak amplitude asymmetry ratios and threshold of oVEMP demonstrated fair-to-moderate reliability for tone-bursts and the above mentioned reasons appear to suffice explanation.

Table 3. *Test retest reliability (Croncbach's α) values of oVEMP parameters.*

	p10 latency	p10 amplitude	n16 latency	n16 amplitude	Peak-to-peak amplitude	oVEMP threshold	Assymetry ratio
á-values	0.42	0.82	0.46	0.85	0.84	0.66	0.61

Conclusions

Ocular VEMPs may test a combination of utricular or saccular function, and the combination may depend on the stimulus being used. Although the exact otolith function being tested with oVEMPs is still a matter that awaits confirmation with more research, it appears that oVEMPs would plug several loopholes that their more conventional counterpart, the cVEMP, still has. These include greater overall reliability, less patient fatigue, and no need for correction for underlying muscle activity. As further research clears the clouds over the contributions from the utricular and saccular end organs to oVEMPs under specific testing conditions, the reliability

and other advantages of oVEMPs should catapult the its usage in the years to come and make them a useful addition to the vestibular test battery.

References

Eleftheriadou, A., Deftereos, S. N., Zarikas, V., et al. (2008). Vestibular evoked myogenic potential eliciting in normal subjects: comparison of four different methods. *Journal of Otolaryngology and Head & Neck Surgery*; 37: 704-711.

Fuchs, A. F., Binder, M. D. (1983). Fatigue resistance of human extraocular muscles. *Journal of Neurophysiology*; 49:28-34.

Iwasaki, S., Chihara, Y., Smulders, Y. E., et al. (2009). The role of the superior vestibular nerve in generating ocular vestibular-evoked myogenic potentials to bone conducted vibration at Fz. *Clinical Neurophysiology*; 120:588-593.

Iwasaki, S., McGarvie, L. A., Halmagyi, G. M., et al. (2007). Head taps evoke a crossed vestibulo-ocular reflex. *Neurology*; 68:1227-1229.

Iwasaki, S., Smulders, Y. E., Burgess, A. M., et al. (2008). Ocular vestibular evoked myogenic potentials in response to bone-conducted vibration of the midline forehead at Fz. A new indicator of unilateral otolithic loss. *Audiology & Neurotology*; 13:396-404.

Iwasaki, S., Smulders, Y. E., Burgess, A. M., et al. (2008). Ocular vestibular evoked myogenic potentials to bone conducted vibration of the midline forehead at Fz in healthy subjects. *Clinical Neurophysiology*; 119:2135-2147.

Isaradisaikul, S., Strong, D. A., Moushey, J. M., Gabbard, S. A., Ackley, S. R., & Jenkins, H. A.

(2008). Reliability of vestibular evoked myogenic potentials in healthy subjects. *Otology & Neurotology*; 29:542-544.

Nguyen, K. D., Welgampola, M. S. & Carey, J. P. (2010). Test-retest reliability and age-related characteristics of the ocular and cervical vestibular evoked myogenic potential tests. *Otology & Neurotology*, 31(5):793-802.

Maes, L., Vinck, B. M., De Vel, E., D'haenes, W., Bockstael, A., Keppler, H., Phillips, B., Swinnen, F., & Dhooge, I. (2009). The vestibular evoked myogenic potential: a test-retest reliability study. *Clinical Neurophysiology,* 120(3), 594-600.

Murnane, O. D. & Akin, F. W. (2009). Vestibular-Evoked Myogenic Potentials. *Seminars in Hearing*, 30 (4), 267-280.

Rauch, S. D. (2006). Vestibular evoked myogenic potentials. *Current Opinions on Otolaryngology and Head & Neck Surgery*; 14:299-304.

Rosengren, S. M, Todd, N. P., Colebatch, J. G. (2005). Vestibular evoked extraocular potentials produced by stimulation with boneconducted sound. *Clinical Neurophysiology*; 116:1938-1948.

Todd, N. P., Rosengren, S. M., Aw, S. T., et al. (2007). Ocular vestibular evoked myogenic potentials (OVEMPs) produced by air- and bone-conducted sound. *Clinical Neurophysiology*; 118:381-390.

Wang, S. J., Jaw, F. S., & Young, Y. H. (2009). Ocular vestibular-evoked myogenic potentials elicited from monaural versus binaural acoustic stimulation. *Clinical Neurophysiology*; 120: 420-423.