Greeting from AIISH, Mysore! Wish you a very happy & fruitful 2011!!

The Journal of All India Institute of Speech and Hearing (JAIISH) which was resumed as an indexed journal with the ISSN No. 0973-662X in the year 2007 is publishing its annual volumes regularly. E-format of the Journal is also accessible in the portal http://aiish.ac.in directly or through the AIISH website www.aiishmysore.in.

There was overwhelming response in terms of the number of papers submitted for publication this year. In view of this, hereafter, each volume of Journal of AIISH will be brought out biannually as two numbers. Vol. 29, No.1 was released on 9th August 2010. I am happy to put before you No.2 of the 29th Volume of Journal of AIISH for the year 2010.

The present volume has certain special features. The authors/editors of three books consented for publication of the review of their book in JAIISH. Three book reviews have been included in this volume namely: Audiology in Developing Countries edited by Mc Pherson, B., Brouillette, R; Portage Guide to Early Childhood Education edited by Indumathi Rao, CBR Network (South Asia) and Clinical Audio-Vestibulometry for Otologists and Neurologists (IV Edition) by Anirban Biswas. These are published in the first number of this Volume. Our sincere thanks to them for consenting to offer their books for review. The book review section was started in the year 2009 with the intention of sharing information regarding the published books, particularly in India, for the benefit of the readers. The eminent reviewers of the books namely Dr. M. N. Nagaraja, Dr. S. Venkatesan, and Dr. Alok Thakar are sincerely acknowledged for providing their valuable opinion regarding the book. Vol. 29, No.1 also carried a write up by Dr. Prathibha Karanth titled “Women in Science”. This is the plenary address she delivered on the theme of “Speech Language Hearing Sciences and Disorder” at the Second National Women’s Science Congress hosted by the All India Institute of Speech and Hearing in November 2009.

The present Volume 29 (2) has 13 articles in the area of Speech and Language; 4 in the area of Hearing; one in the area of Special Education and one paper regarding the process evaluation of the much talked about DHLS program. The articles under the Speech Language section cover a wide range of topics. It has a couple of articles on much published topics under stuttering, speech rhythm and voice. It also has some interesting articles on acoustic patterns in honey bees; phonological similarity effect; vocabulary development and memory; swallowing disorders; TBI and high risk factors for Learning disability. These articles indicate the new domains of research our Speech Language Pathologists are exploring which is very encouraging. These are the proactive steps taken in to contributing to Speech Language Sciences not restricting themselves only to the areas of speech language disorders. The contribution to Speech Language Sciences will be even better if we start working with a multidisciplinary team.

The section on hearing has two articles on speech evoked ABR which is a potential area to understand the contribution of Auditory brain stem in speech processing and perception. With the medical fraternity depending on MRI for quite a few types diagnosis, the article on the side effects (of noise) of MRI is a welcome research. The steadily prospering India has made the life expectancy longer. In this context, a report on presbyacusis in India is useful. The lone article in the area of special education deals with the academic issues of children with hearing impairment.

The initiation of the quasi distance mode Diploma in Hearing Language and Speech (DHLS) with 12
study centers across the country in the year 2007-08 onwards has drawn a lot of attention and discussion amongst the speech and hearing fraternity in India. All of us are rightly concerned about the quality of education / training imparted through this novel strategy adopted for manpower development. We are also interested in knowing whether the program meets its objectives. The article on process evaluation of DHLS program reports the pilot data on this issue. I would request the readers to go through this article and give their feedback / suggestions to improve on this program. JAIISH is thus providing a professional platform to express opinion, criticism and give suggestions by all concerned. This endeavor, I believe, will show ways to promote ethical professional practices amongst us.

It is proposed to include a new section on "case reports" in the forthcoming volumes. It is proposed that a case report each in the area of Speech, Language, Hearing and one in the area of other related topics be chosen for publication. Students are encouraged to prepare the case reports based on their presentations, along with their guides, made at their in house clinical conferences conducted as a part of their training program. I look forward to your feedback and suggestions on this.

The 19 articles included in this volume were reviewed by 5 guest editorial members apart from the designated editorial members of the journal. Their contribution is sincerely acknowledged. Our appreciation to all the members of the Editorial Board for meeting our deadlines in reviewing the articles. Ms. K. Yeshoda, Lecturer in Speech Sciences who is the Coordinator for the journal has put in a lot of effort getting this publication through and this is sincerely appreciated and acknowledged.

I look forward to your continued support in contributing your valuable research publications in the Journal of All India Institute of Speech and Hearing. You may please email your suggestions regarding improving the standard of the journal to director@aiishmysore.in

Dr. Vijayalakshmi Basavaraj
Director & Chief Editor
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AGE AND GENDER DIFFERENCES IN PERSONS WITH STUTTERING

*Nisha Sudhi, **Merin John, ***Y.V Geetha

Abstract

Gender difference in stuttering is a much talked debated issue. A lot of studies have been done on this, mostly in the western countries. Stuttering is not only reported to be less common in females compared to males, with a 1:4 ratio, but its onset, development and recovery characteristics are more in favour of females. The present study is aimed to explore the similarities and differences in nature of disfluencies, if any, in male and female persons with stuttering, across the age groups in the Indian context. A retrospective analysis of 132 case files of all clients registered with the complaint of stuttering over a period of 6 months was made. The data was analyzed in terms of age of onset, nature and type of onset, associated problems and etiology of stuttering, across the gender and age groups. Across gender, significant differences have been obtained in most of the parameters under study and across the age and within gender too significant findings have been observed. The study confirms many of the earlier findings by other authors with regard to gender differences in stuttering. Female PWS are different in the onset, nature, development, severity characteristics of stuttering compared to male PWS.

Key words: Stuttering, nature of disfluencies, gender difference

Stuttering is a disorder of fluency, onset of which in majority of the individuals is in the preschool years. Despite decades of research it has evaded the researchers in understanding its onset, development, nature and management issues. Gender difference in stuttering has provoked the interests of many researchers but conflicts still exist regarding the differences in them. A look into the gender ratio in stuttering thoroughly documents an unequal sex distribution. Stuttering has been indicated as a male predominating disorder time and again in the literature. Early reports indicated that stuttering takes place more often in boys than girls (Blanton, 1916; Milisen & Johnson, 1936). Further research into this ratio was carried out. Yairi and Ambrose (1992) reported the male to female ratio to be 2:1:1. More recently, Van Borsel, Moeyart, Mostaert, Rossel, Loo and Renterghem (2006), in agreement with past studies reported stuttering prevalence to be higher in males than females. The tendency for stuttering prevalence to decrease with increasing age was confirmed too. The ratio is almost 4:1 in older children and adults as reported by many. This indicates that many female children recover while male children persist in stuttering. Many different aspects of the nature of disfluencies and the association with the gender reveal substantial information.

The onset of stuttering in males and females has been widely investigated and there are several contradictory evidences. Andrews, Craig, Feyer, Hoddinott, Howie and Neilson (1983) reported the age of onset to be same across gender and did not consider that males have an earlier age of onset of stuttering than females. However, more recent data indicate that girls begin to stutter a little earlier. Mansson (2000) in a study of incidence and development of stuttering reported that boys tended to have later onsets than girls (34 months for boys and 31 months for girls).

Research into the nature and development of stuttering in boys and girls reveals significant findings too. Historically, development of stuttering problems were typically reported to be a gradual process with easier more variable forms of stuttering followed by increasing fragmentation and tension. More recent reports (Yairi, Ambrose & Nierman, 1993) however,
suggest that a significant number of preschool children exhibit a sudden onset of moderate to severe stuttering. Buck, Lees and Cook (2002) found that 53 percent of their cases had onsets reported as sudden. Yairi, and Ambrose, (2003) reported that 41% of the preschool age children had sudden onset (1-3 days), 32% intermediate onset (1-2 weeks) and the remaining 27% of the children were reported to have a gradual onset of stuttering.

One consistent finding in the literature on stuttering is that a small but significant percentage of children who stutter exhibit concomitant speech/language disorders in addition to their stuttering. Children who stutter typically achieve lower scores than their peers on measures of receptive vocabulary, the age of speech and language onset, MLU and receptive and expressive syntax. Few studies have explored the difference in terms of gender also. Healey and Reid (2003) noted that an increasingly large number of children who stutter are being diagnosed with attention deficit hyperactivity disorder (ADHD). Also, boys are classified four times more emotionally disturbed than girls (Stout & Conoley, 1992).

The question of why there is a sex ratio in stuttering has been subject to almost as varied speculation as the cause of stuttering itself. In the past, the difference in incidence between males and females was explained in a number of different ways including cultural differences in child rearing practices, (Johnson 1955), different societal stress levels on boys and girls etc. Later theories tried to explain the disparity in sex ratio in stuttering based on biological and genetic differences between the sexes. Geschwind and Galaburda (1985) considered that sex ratio in stuttering is due to higher levels of testosterone in the male foetus than in the female. Testosterone retards the development of the left cerebral hemisphere, thus increasing the risk of speech and language disturbances including stuttering. Recent neuro-imaging studies have shown increased bilateral speech and language representation in females compared to males. The males are more likely to have a strong left hemisphere lateralization for speech and language (Shaywitz et al., 1995).

According to Kidd, Kidd and Records (1978) and Kidd (1983, 1984), stuttering genotypes are expressed as different susceptibilities based on sex. As the 'stuttering threshold' is hypothesized to be higher for females, it is assumed that more precipitating (genetic or environmental) factors that contribute to stuttering would have to be present for females to cross the threshold and manifest the disorder. Regarding the family history of stuttering, Andrews and Harris (1964) found that female probands have a higher frequency of affected relatives of both sexes than do the male probands. Kidd's (1984) study showed there was the highest risk for male relatives of females who stutter. However the data by Yairi and Ambrose (1996) indicated that the highest risk is for male relatives of males who stutter. More recently, Gupta (2001) reported that females had higher percentage of affected relatives than males. Anjana (2004) found that the first degree relatives have a higher percent of stuttering compared to second degree relatives.

Need for the study

There is a lot of debate about the onset, nature, development, type, associated problems and cause of stuttering in males and females with stuttering. Valuable opinion is available in scattered texts but these available information need to be compiled and a comprehensive comparison is necessary to give a better picture of the differences, if any, in the nature of disfluencies in them. This in turn may help in understanding their problems in a better way, finding out the prognosis and help in early intervention and serve better in treating the males and females persons with stuttering (PWS). The outlook towards the females with stuttering, their characteristics and needs can be understood better. In addition, most of the studies regarding gender and stuttering have been conducted in the Western countries and such intensive studies have not been conducted in India. Further investigation into the cause of the condition will also be possible.

Aims of the study

1. The present study aims at finding out the difference in nature of disfluencies if any in males and females with stuttering with regard to:
   - The age and nature of onset, development of stuttering
   - The severity of stuttering
   - The associated problems if any
   - The etiological factors if any in terms of family history/genetic factors, etc.
2. To compare the results obtained across age groups in each gender.

Method

Subjects

132 case files of PWS registered over a period of six months (from March to August 2009) at the All India Institute of Speech and Hearing were reviewed. 132 PWS were classified into four groups based on age and gender. Case files of 57 adult males, 46 male children, 10 adult females and 19 female children were considered for the study (see Table 1).

Procedure

The retrospective design was used in the present study. A total number of 132 case files of individuals who were registered with a complaint of stuttering were reviewed. They were evaluated by qualified professionals who consisted of speech language pathologists and psychologists. The case files with complete fluency evaluations were considered for the present study. Table 1 depicts the details of the subjects considered for the present study.

Parameters, namely the age and nature of onset, development of stuttering, severity, associated problems and the etiological factors were closely addressed, across age and gender.

Table 1: Details of the subjects selected for the study

<table>
<thead>
<tr>
<th>Age group</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (0-12 years)</td>
<td>46</td>
<td>19</td>
<td>65</td>
</tr>
<tr>
<td>Adults (12 years and above)</td>
<td>57</td>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
<td>29</td>
<td>132</td>
</tr>
</tbody>
</table>

Table 2: Age of onset and gender-wise distribution of individuals with stuttering

The data collected were grouped into 5 age groups, 3 years and below, 3.1 to 5, 5.1 to 10, and 10.1 to 20 and above 20 years for the analysis of age and onset, based on the information in the literature with regard to nature of onset. The results are shown in Table 2.

In terms of age of onset of stuttering, females were found to have an earlier age of onset (3.1-5 years) compared to males who had later onset of stuttering (5.1-10 years). This is in agreement with the literature which suggests early onset and recovery for females. Further, male to female ratio in the study is around 3:1 which is slightly higher probably because of inclusion of more children in the younger group.

(b) Nature and development of stuttering

The nature of onset was categorized into two types as sudden and gradual onset. Sudden onset included all responses that fell into one of three subcategories describing onset to occur within 1 day, 2-3 days and 1 week. Gradual onset included responses that fell into one of three subcategories describing onset to occur within 2 weeks, 3-4 weeks and more than 5 weeks. The current status of the condition was classified as progressive, static and regressive in nature. Graph 1 shows the nature of onset and Graph 2 depicts current status of the condition.

With regard to the nature and development of stuttering, females were found to have a sudden onset which was progressive in nature in most whereas in few of the females it was of a static nature. Males were found to have more gradual onset of stuttering which was progressive in 33%, static in 12% and regressive in very few (2%). Both male and female CWS were found to have a progressive nature of stuttering compared to adult male and female PWS.

Based on the data available, and as depicted in Table 3, associated problems were divided into persons having Learning Disability (LD), Mental Disability (MD) and one with no associated problems.
AF- adult female, AM-adult male, CF-child female, CM- child male

Graph 1: Nature of onset of stuttering across age and gender groups

AF- adult female, AM-adult male, CF-child female, CM- child male

Graph 2: Current status of the condition across age and gender groups

c) Associated problems

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>LD (0%)</th>
<th>MR (0%)</th>
<th>MA (0%)</th>
<th>Structural (0%)</th>
<th>DSL (0%)</th>
<th>Medical (0%)</th>
<th>Nil (0%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>F</td>
<td>3 (30%)</td>
<td>1 (10%)</td>
<td>0 (0%)</td>
<td>2 (20%)</td>
<td>1 (10%)</td>
<td>0 (0%)</td>
<td>3 (30%)</td>
<td>10</td>
</tr>
<tr>
<td>Child</td>
<td>F</td>
<td>0 (0%)</td>
<td>1 (5.26%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (5.26%)</td>
<td>1 (5.26%)</td>
<td>16 (84.2%)</td>
<td>19</td>
</tr>
<tr>
<td>Adult</td>
<td>M</td>
<td>2 (3.57%)</td>
<td>0 (0%)</td>
<td>2 (3.57%)</td>
<td>2 (3.57%)</td>
<td>2 (3.57%)</td>
<td>2 (3.57%)</td>
<td>47 (84.45%)</td>
<td>57</td>
</tr>
<tr>
<td>Child</td>
<td>M</td>
<td>5 (10.86%)</td>
<td>3 (6.52%)</td>
<td>5 (10.86%)</td>
<td>2 (4.34%)</td>
<td>5 (10.86%)</td>
<td>4 (8.69%)</td>
<td>22 (47.82%)</td>
<td>46</td>
</tr>
</tbody>
</table>

LD-Learning Disability; MR-Mental Retardation; MA-Misarticulation; DSL-Delayed Speech & Language

Table 3: Associated problems with stuttering across gender

problems like head injury, accidents etc. The occurrence of most of the associated problems with stuttering was found to be greater in females.

In females, adults had more history of learning disability, mental retardation, structural defects and delayed speech and language problems, whereas, in males, children had history of learning disability, mental retardation, misarticulation, structural deficits,
speech and language delay and medical problems. Therefore, the associated problems were reported more in adult females with stuttering whereas the opposite was observed in male children with stuttering.

(d) Severity of stuttering

Based on the scores and classification on Stuttering Severity Index (SSI), persons with stuttering have been grouped under the categories of very mild, mild, moderate, severe and very severe. The results are shown in Graph 3.

The graph clearly shows that in the category of severe and moderate stuttering, males outnumber females, whereas, in very mild, mild, very severe and Normal Nonfluency condition it is females who are more in number. Most of the female children with stuttering were found to be categorized under the mild degree of severity. Adult females with stuttering were categorized almost equally under all levels of severity.

In males most of the adults were categorized under moderate and severe stuttering, with one very severe adult case reported. 26% of both adults and children were categorized under mild category. There were six children who were diagnosed as NNF.

Majority of female CWS were categorized under mild severity of stuttering compared to adult females. Adult females with stuttering were categorized almost equally under all levels of severity. The severity of stuttering was found to be more in adult males compared to male children with stuttering.

(e) Causative factors

From the case history collected, the reported causes have been grouped into 3 main categories namely, family history/genetics, environmental and others as shown in Table 4. Family history has been further divided into maternal and paternal, and then again subdivided into first degree and second degree. Mother, father and siblings belong to first degree and other paternal and maternal relatives belong to second degree. The environmental causes include history of contact with another person with stuttering. The others category include stuttering caused due to fear, pressure at home, change in language, change in place etc.

Regarding the etiological factors, in both male and female PWS, family history of stuttering seem to rule over the other probable etiologies of stuttering, with females showing a stronger genetic basis of stuttering. From table 5, it may be seen that females had more maternal and paternal 1st degree relatives who stuttered compared to male PWS.

Results indicate that 90% of adult females presented with a family history/genetic etiolo-gy and 42% of female children with stuttering had reported to have genetic causes. Two female children had contact with PWS and 3 each in both adults and children group were reported to have other causes like change of place, fear etc. In males around 52% of children reported to have genetic cause. Six adults and four children had contact with stutterer.

Discussion

This study was an exploration into the age and gender differences in PWS. Male and female PWS were compared in terms of important parameters such as age of onset of stuttering, the nature and development of stuttering, the causal factors behind the condition, the severity levels and the associated problems with the condition. The results obtained are in support of earlier studies published in western literature.

Considering the age of onset of stuttering, Yairi & Ambrose (1992) had reported that the onset of stuttering in males is 40.56 months and in females it is 34.21 months. The present study too supports the findings that females had an earlier age of onset compared to males. This finding could be accounted to the fact that more females than males spontaneously recover. Geschwind and Galaburda (1985) have suggested that young male speakers may have greater difficulty in achieving or maintaining fluency. Boys may be less able to adapt to communicative stress than their female counterparts. The speech language development of girls is also earlier when compared with boys. It has been well established now that during the period of acquiring speech and language, the disfluencies tend to occur.

Exploring deeper into this area, there is a sex related genetic influence too that can account for this. Yairi and Ambrose (1999) in their study have found that young females who stutter are much less likely to persist in stuttering than young males. This phenomenon suggests that males are more likely to continue to stutter than females.
Moreover, etiological factors leading to the condition has received much attention. During the past few decades, the research conducted in this area has revealed a strong genetic component in PWS. Andrews and Harris (1964) found that female probands have a higher frequency of affected relatives of both sexes than do the male probands. The present study too supports these findings. The chance of getting stuttering is more for a female child with male relatives with stuttering. This is especially true in relatives of the first degree.

Stuttering has also been reported to be progressive or increasing in its development across age and gender. This progressive nature was more in children compared to adults wherein female CWS reporting this more than male CWS. Females reported more of a progressive development than males.

Significant differences across the gender have also been reported in terms of associated problems with stuttering. Blood, Ridenour, Qualls, and Hammer (2003), in their study found that children with learning disability made up to 15% of their large sample of children who stuttered. The present study too reports similar findings. Learning related problems are seen most associated with stuttering across age and gender, with females exhibiting a greater percentage of the same. The occurrence of most of the associated problems with stuttering, were found to be greater in females.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Genetics</th>
<th>Environmental</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>F</td>
<td>9 (90%)</td>
<td>0 (0%)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>Child</td>
<td>F</td>
<td>8 (42.10%)</td>
<td>2 (10.52%)</td>
<td>3 (15.7%)</td>
</tr>
<tr>
<td>Adult</td>
<td>M</td>
<td>15 (26.31%)</td>
<td>6 (10.52%)</td>
<td>5 (8.7%)</td>
</tr>
<tr>
<td>Child</td>
<td>M</td>
<td>24 (52.17%)</td>
<td>4 (8.69%)</td>
<td>4 (8.69%)</td>
</tr>
</tbody>
</table>

Table 4: Causative factors across age and gender groups

<table>
<thead>
<tr>
<th>Gender</th>
<th>Paternal</th>
<th>Maternal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st degree</td>
<td>2nd degree</td>
</tr>
<tr>
<td>Male</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>15.53%</td>
<td>18.40%</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>24.13%</td>
<td>13.79%</td>
</tr>
</tbody>
</table>

Table 5: Proximity of relationship in paternal and maternal sides under genetic factor
Summary and Conclusions

This study is aimed to explore the similarities and differences in nature of disfluencies, if any, in male and female persons with stuttering. It is also aimed to compare the nature of disfluencies across the age and gender groups. The review of the case files of 132 PWS, gender difference in stuttering was done. The study confirms many of the earlier findings by other authors with regard to gender differences in stuttering. Female PWS are different in the onset, nature, development, severity characteristics of stuttering compared to male PWS.

References


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ANALYSIS OF ACOUSTIC PATTERNS IN HONEY BEES- AN INVESTIGATION

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Abstract

‘Communication’ is believed to be the exchange of information between two partners. The broad field of animal communication encompasses most of the issues in ethology. Honey bee communication has been of special interest to ethologists. The purpose of this study is to determine the acoustic characteristics of the honey bees buzz in a species of Apis dorsata dorsata in natural and induced environmental conditions. The results revealed that change in the external conditions led to characteristic changes in the acoustic properties of the sounds produced by the honey bees. The mean fundamental frequency of bee buzz increased in the induced conditions compared to natural condition whereas amplitude variations were not consistent across conditions. These variations in communication patterns in honey bees across different conditions (pleasant or threatful situations) gives us good reason to call the communication pattern in honey bees as ‘language’.

Key words: Ethology, honey bee, communication

Every living being in this universe communicates as a quest for its survival. ‘Communication’ is believed to be the exchange of information between two partners. The Universal Communication Law as posited by Scudder (1980) rightly, states that, “All living entities, beings and creatures communicate”, i.e. all the living bodies in this universe communicate through sounds or movements, reactions to physical changes, verbal language or gestures, breath, etc. Thus, ‘communication’ proves as a means of survival.

Communication as of is not restricted to human beings only. All the information exchange between any living organism-i.e. transmission of signals involving a sender and receiver-can be considered a form of communication. There is the broad field of animal communication, which encompasses most of the issues in ethology. ‘Zoosemiotics’, the study of animal communication, has played an important part in the development of ethology, sociobiology, and the study of animal cognition. Further, the ‘biocommunication theory’ investigates communicative processes within and among non-humans such as bacteria, animals, fungi and plants i.e. intraspecies or interspecies communication. These various kinds of animal communication are intended for agonistic interactions, territorial invading/ ownership, alarm calls and/or for metacommunications. Ethologists and sociobiologists have discretely analyzed animal communication in terms of their automatic responses to stimuli, ignoring the fact whether the animals concerned, understand the meaning of the signals they emit and receive.

Honey bee communication has been of special interest to ethologists, in particular the apiologists.

A honeybee colony is a marvelously compact community of around 50,000 individuals, its members are highly social and cannot survive without constant inter communication, and the more one looks into their methods of conversation, the more remarkable they are found to be. Unlike human voice production, the bee does not have any structures as vocal cords to produce sound. In fact, there have been various postulations regarding the origin of the production of
sound in the honey bees. The fact that bees make sound by ejecting air through their spiracles is refuted by various experiments. The more pronounced possibility of the bee sound is the wing-vibration theory that is put forth which states that the vibration of the bees wings are responsible for the production and amplification. Both, sounds made by wing vibrations as well as the tail wagging, seem to be used to communicate distance and direction of feeding sites.

Bees communicate by performing dance patterns to direct their hivemates to a source of food. The dance pattern types performed by honey bees are the waggle dance and round dance. These vary based on the location (distance) of the food source, (Wenner, 1964). Further, it has been proved that they also transmit information by means of sound. The earliest work done on bee communication by Charles Butler (1609) has been registered in his book the “Feminine monarchy” where he describes two sound patterns produced by the bees. Huber (1972) named these sound patterns as the tooting (produced by the first/head queen bee) and the quacking (produced subsequently by the younger ones). Together these honeybee sounds are called as ‘queen piping’ (tooting and quacking) which are broadcast in the bee’s nest as vibrations of the combs. The temporal patterns and a frequency spectrum of these signals reveal that these are more or less pure tones at low frequencies equal to 400 Hertz. (Michelsen, Kirchner & Lindauer, 1986). These were produced by rapid contractions of the thoracic muscles, and transmitted directly to the substratum of the honey bee. Thus, the foraging bee’s communication to its fellows in the hive are made up of two elements: the dance patterns and the accompanying sounds.

An experiment by Wenner (1964) indicated a strong correlation between the rate of pulse production and the strength of the sugar concentration in a food source. It may turn out that the foraging bee’s entire message is carried by the sound signals. Broadbent (1962) in his article on “Attention and Perception of Speech” have compared the bee sound with that of human speech in terms of the varying emphasis and overlay of overtones in the sound produced by both. Nieh (1993) has even opined that human like stop sounds are also emitted by the tremble dances of honeybee which again forms a part of their communication system.

The review article by Kirchner (1993) traced the research works of different authors in the field of honey bee communication between 1774-1993. His work gives an account of communication patterns in honey bees, specifically among the members of the colony. It also explains the significance of sound signals in dance communication.

Various studies on bee buzz have revealed the fact that a bee’s buzz is not simply a noise rather it constitutes of modulations and variations. And the pattern varies based on the environmental conditions- when attacked by intruder, near a source of food, exposure to intoxicating fumes, inside the hive etc. When an individual bee is aroused to attack, its buzz rises in pitch and fluctuates in intensity. Even the sound produced by different species of bees has been noted to be different in its frequency and intensity. As well, the acoustic patterns of a queen honey bee will differ from that of younger bees or from that of a virgin queen bee (Wenner, 1964).

These very interesting information and facts motivated us to study the acoustic characteristics of the honey bees buzz in a species of Apis dorsata dorsata in natural and induced environmental conditions.

Aims of the study
1. To analyse the acoustic parameters of sounds produced by honey bees (Apis dorsata dorsata) in different conditions.
2. To compare the recordings of acoustic parameters obtained across different conditions (natural and experimental/ induced).

Method

Species of bees included for the study: Apis dorsata dorsata

The hive in one of the campus buildings which was closer to the lab in Speech Language Sciences department of the institute was chosen. The pictures of the hive with honey bees were sent to the Entomologist to ascertain the species of the bees.

Site: The audio recording of the honey bees was made in a quiet condition close to the hive.
**Timings:** Recordings were done twice in a single day. Trial 1: between 12 am to 12:30 am, Trial 2: between 4:30 am to 5 am.

**Procedure**

**Conditions**

**Condition 1:** Natural condition- swarm of bees hovering near a light source (tube light)

**Condition-2:** Induced-environmental conditions-
(a) Swarm of bees when presented with concentrated sugar syrup.
(b) Swarm of bees disturbed when exposed to fumes from incense sticks.

**Audio Recordings:** Instrument used: Sony mini IC recorder (Sony Corp, China) Model No. ICD-UX71F. The audio recordings were obtained in the following two conditions:

**Condition 1:** The audio recordings of the bee buzz were done when a group of about 100 honey bees were gathered around a tube light (natural condition). Three recordings of 5 minutes each were obtained.

**Condition 2a:** Food/Concentrated sugar syrup was placed in a bowl at a distance of 2 meters from the swarm of bees. Three recordings of 5 minutes each was done after the bees settled. The microphone was positioned at a distance of 5cms from the swarm.

**Condition 2b:** Incense sticks were lighted close to the swarm of bees settled on the bowl of sugar syrup. The buzz of the swarm was immediately recorded when the bees began moving away from the bowl.

**Data Analysis**

The recorded samples were transferred onto the computer memory. Cool edit pro version 2.0 software was used to convert the MP3 files to wave files for further analysis. Real Time Pitch analysis software of CSL Model 4500 was used for acoustic analysis. The recorded samples were line fed into the CSL module with a sampling rate of 44100 Hz (16 bit resolution). Eleven acoustic parameters were extracted and they were as follows:

*Pitch parameters*
1. Mean fundamental frequency (MF0-Hz)
2. Minimum Frequency (Min-Hz)
3. Maximum Frequency (Max-Hz)
4. Standard Deviation of F0 (S.D of F0)

5. Variation Fundamental frequency (vF0)
6. Relative Amplitude Perturbation (RAP)

*Energy Parameters*
1. Mean Amplitude (Mean dB)
2. Minimum Amplitude (Min dB)
3. Maximum Amplitude (Max dB)
4. Standard Deviation of Amplitude (S.D of Amplitude)
5. Shimmer (Shim %)

**Results and Discussion**

The acoustic data obtained from the honey bees across various conditions were analyzed and extracted using Real Time Pitch Analysis and CSL 4500. Table 1 gives results based on the conditions.

1. **Natural Condition**

The mean fundamental frequency in the natural condition when the swarm of bees started to hover around the light source was recorded to be 189 Hz with minimum and maximum varying from 125 to 334 Hz (SD of 92.69 Hz). The vF0 was found to be 0.41, and RAP 2.92. The mean energy of the buzz was 66.36 dB, with mean minimum and maximum mean varying from 62.95 to 70.77 (SD of 92.69 Hz). The mean shimmer value was 1.81dB.

2. **Induced Condition**

**2a) Concentrated sugar syrup condition:** The buzz of the swarm when near the concentrated syrup was found to be 268 Hz, range varying between 200 to 393 Hz (SD of 64.38). The vF0 and RAP were found to be 0.23 and 0.91 respectively. The mean energy of the buzz was 69.88 dB, with minimum and maximum mean varying from 66.89 to 72.30 (SD of 1.81 dB). The mean shimmer value was 1.60dB.

**2b) Incense stick fumes condition:** In this condition, the mean F0 was 336.32, ranging from a minimum mean 302.05 to a maximum of 397.30Hz (SD of 37.14). vF0 was 0.11, RAP 4.41. The mean energy was found to be 63.32 dB. Minimum energy was 61.91 dB, with the maximum energy being 65.67 dB (SD of 1.20 dB). The mean shimmer value was 2.10 dB.

**Comparison across conditions**

*Natural Vs concentrated sugar syrup*

When conditions 1 & 2a were compared, it was
observed that for the frequency parameters, there was an increase in mean F0, mean minimum and mean maximum F0, but SD of F0 reduced in the induced condition (2a) compared to natural condition. vF0 and RAP also decreased in induced condition (2a). Among the energy parameters, there was an increase of mean energy, mean minimum and mean maximum energy in 2a condition. However, the SD and shim% values reduced in 2a compared to natural condition. The characteristic ‘hum’ of a swarm of bees is of low frequency, estimated to be having a basic frequency of 250 Hz and is often associated with overtones (Kirchner, 1993; Wenner, 1964). But in the present study the Mean F0 was lower in natural condition, and then increased when food source was located.

The range of fundamental frequency was highest in the natural condition (209 Hz), followed by 2a (193 Hz) and 2b (95 Hz). Location of food resulted in an increase in the Mean F0 in 2a when compared to natural condition. Even in human voices, emotions like fear and anxiety may increase the habitual frequency of voice. The disturbance in honey bee has been manifested in the form of an increase in frequency and slight increase in loudness (from 66 to 69 dB), probably due to the enhanced wing vibrations by the bees. However, though these values are slightly more than the frequency produced in the natural condition, it is still comparable with the earlier estimations by Wenner (1964).

**Natural Vs Fumes from Incense sticks**

Mean F0, mean minimum and mean maximum F0, RAP was observed to be highest in 2b condition than natural condition. S.D of F0 and vF0 was however lesser in 2b condition. For energy parameters, mean energy, mean of minimum, maximum energy, SD was reduced in 2b condition. There was a subsequent increase in shimmer value in 2b condition compared to natural condition.

**Concentrated sugar syrup Vs Fumes of Incense stick**

In 2b condition, the mean F0, mean minimum and mean maximum F0, RAP was greater than 2a condition. SD of F0, and vF0 were lesser in 2b condition. There was a decrease in all energy parameters (mean, minimum, maximum intensity, SD), except shimmer which increased in 2b condition.

The present study revealed that, the buzz frequency of the honey bee increased maximally under conditions of threat, with variations in energy parameters. This observation is further strengthened by the findings of Wenner (1964) wherein the F0 of honey bees buzz varies depending on different environmental conditions (such as inside a hive, near a source of food, exposure to intoxicating fumes etc).

**Conclusion**

The present study is a preliminary attempt in documenting the acoustic characteristics of bees buzz (in a species of *Apis dorsata dorsata*) in different environmental conditions, some of which were induced artificially. The study documents that change in the external conditions led to characteristic changes in the acoustic properties of the sounds produced by the honey bees. The mean fundamental frequency of bee buzz was highest in the induced condition 2b (fumes from incense sticks) followed by induced condition 2a (concentrated sugar syrup).
and the natural condition (1). The relative amplitude perturbation also varied similarly. The above finding could be attributed to the very reason that animal behavior is likely to change depending on the environmental conditions. Reflecting while discussing in reference to the present context, it was noticed that when a bee was aroused to attack, or harmed, its buzz is likely to rise in pitch and fluctuate in energy unlike to that of a pleasant condition, where, the bee produces a comparatively lower pitch and intensity when a source of food is being introduced to it. These facts give us strong indication to call this communication system of the honeybee ‘a language’. The existence of a true language in honeybees in the form of a symbolic arbitrary one has also been proved by Gould & Gould (1988). Human communication is primarily verbal, whereas bee communication is acoustical in nature (at times chemical or pheromonal also). The use of verbal or acoustic mode for communication is immaterial of the fact that they are different, rather highlight on the importance of use of complex ways to ensure the exchange of information among organisms of the same group. Therefore, such a study is expected to throw some light in unraveling the mysteries of the communication patterns of these creatures. Further research would help understand various interesting facts regarding the complex yet fascinating communication system and strategies of such organisms in a variety of behavioral context.

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AWARENESS OF STUTTERING AMONG PROSPECTIVE TEACHERS OF MYSORE

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Abstract

The study is an attempt to explore the awareness and attitude of prospective teachers towards stuttering in Mysore city, conducted as a part of International Stuttering Awareness Day. As stuttering exists worldwide, among different cultures it is essential to pay considerable attention in identifying and comparing attitudes, knowledge and beliefs of different cultural groups. Attitudes of 64 educators toward stuttering were studied using the questionnaire developed with few statements adapted from POSHA (consisting of eight domains such as nature, concern, attitude, causes, treatment, awareness, characteristics and occurrence of stuttering). Results indicated that their awareness on stuttering is less on some domains but also reflected positive attitude on some domains. Some of the results of this study are similar to those of other comparable studies conducted in other countries and cultures including Belgium, Brazil, Shanghai and China suggesting that most of the community has poor knowledge on stuttering. Public ignorance may be one of the factors of the mental and emotional complexities of stuttering (Blood, 1999). The results of the present study indicate that there is a need for SLPs to provide teachers with more information about stuttering. Hence, this study also helps SLP to understand the environment of PWS which play a significant role in the onset and maintenance of stuttering.

Key words: Stuttering, prospective teachers

Stuttering is a communication disorder that disrupts the smooth, forward flow of speech but it also creates negative emotions and reactions by both the speaker and listener (Guitar, 2006). People who stutter (PWS) experience disruptions in their speech fluency as well as adverse affective, cognitive and behavioural reactions that stem from these disruptions (Bennett, 2006). The negative feelings that a person who stutters, experiences related to speaking are usually compounded by negative reactions expressed by listeners and the anticipation of negative reactions (Hult & Wirtz, 1994; Silverman, 1996; Yaruss & Quesal, 2004). Thus, "stuttering is apparently as much a disorder of communication as it is of speech; the receiver (listener) is at least as important as the sender (person who stutters) in the interchange" (Van Riper, 1982).

Listener reactions to stuttering have been considered important for many decades. Johnson (1934) surveyed PWS and found that stuttering in front of a close friend or family member was perceived as less embarrassing than stuttering in front of strangers. Johnson (1934) concluded that listener reactions influence PWS in a variety of ways and that listeners should make PWS feel as comfortable as possible by acting and speaking so that the stutterer will feel secure in one’s presence and will feel that he is being accepted as an individual, and will feel that he has nothing to lose by stuttering. Classroom teachers, speech clinicians, parents and society in general should apply this knowledge at every opportunity. This suggests that there are

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appropriate and beneficial communication strategies that listeners should employ in their interactions with PWS. Yet, awareness of stuttering among teachers is a topic that has received little attention in the speech pathology literature. The non-professionals' awareness, attitude towards stuttering has not been subjected to systematic investigation.

**Importance of teachers' attitudes**

Teachers carry a large share of the responsibility for the educational development of children. This responsibility is perhaps even greater when children with a disability are concerned. Teachers have an important part to play in the educational development of CWS (Children with stuttering) and their beliefs and attitudes can significantly affect the management of CWS in the classroom, as well as their progression (Lass et al., 1992; Stewart & Turnbull, 2007). In addition, the behaviour of teachers can influence the attitudes and actions of school children and in turn have impact on the self-image and peer relationships of children who stutter (Turner & Helms, 1995). It is, then, particularly worrying to find that the majority of teachers have negative perceptions of people who stutter (PWS) and typically associate negative personality traits with PWS (Lass et al., 1992; Dorsey & Guenther, 2000).

**Procedures for measuring attitudes, knowledge and beliefs about stuttering**

In the early years quite a number of surveys have also been used to elicit knowledge, attitudes and beliefs. These include the Parental Attitudes toward Stuttering Inventory (PATS; Crowe & Cooper, 1977), The Alabama Stuttering Knowledge Test (ASK; Crowe & Cooper, 1977) and the Clinicians Attitude toward Stuttering Inventory (CATS; Cooper, 1975). The scope of these surveys varies with topics ranging from studying parental attitudes and knowledge of stuttering, to sampling a variety of professional views regarding the nature of stuttering, its treatment and Speech Language Pathologists' (SLPs') competence and effectiveness in working with the disorder.

Emerick (1960) explored the relationship between elementary school teachers' ability to count or tally instances of stuttering and their attitudes toward stuttering. The Iowa Scale of Attitude toward Stuttering was administered to 21 male and 127 female teachers. A speech stimulus consisting of a 3.5 minute audiotaped recording of a male who stutters was made (the types and amount of disfluencies were not disclosed by the author). Participants were instructed to keep a count of the amount of stuttering they heard as the speech sample was played. The order in which participants completed the attitude scale or heard the speech sample varied. Participants who had a more tolerant attitude toward stuttering tend to observe more disfluencies. This trend applied most particularly to those teachers who had taken at least one course in speech pathology as compared to teachers with no formal training. Thus the author suggested that training in speech pathology might result in more tolerant attitudes toward stuttering while at the same time decreasing tolerance for speech nonfluencies (e.g., typically occurring disfluencies that are not generally considered to be core stuttering behaviors).

Crowe and Walton (1981) studied attitudes of 100 elementary school teachers toward stuttering using the Teachers Attitudes toward Stuttering Inventory and results indicated that significant positive correlations existed between teacher attitudes and knowledge of stuttering.

Yeakle and Cooper (1986) discussed attitudes of 521 teachers in the Tuscaloosa, Alabama City School (82% of the teacher population) toward stuttering were assessed using the Teachers' Perceptions of Stuttering Inventory (TPSI). Results indicated that a significant number of teachers hold unsubstantiated beliefs concerning the etiology of stuttering and the personality characteristics of stutterers. Teachers having experience with stutterers or having had course work in speech disorders indicated more realistic attitudes toward stutterers and expressed more demanding attitudes toward stutterers in the classroom situation.

A series of studies conducted by Lass, Ruscello, and colleagues (Lass et al., 1992, 1994; Ruscello, Lass, Schmitt, and Pannbaker, 1994) involved elementary and secondary school teachers, school administrators, and special education teachers were asked to provide adjectives that describe four hypothetical people who stutter, including a female child, male child, female adult and male adult.
Elementary and secondary school teachers provided a total of 287 adjectives to describe PWS of which 66.9% were negative in nature, 20.2% were positive and 12.9% were neutral (Lass et. al., 1992).

A replication of this study by Silverman and Marik (1993) found similar results. School administrators provided a total of 197 adjectives to describe PWS of which 72.6% were negative in nature, 19.8% were positive and 7.6% were neutral (Lass et. al., 1994). Special educators provided a total of 241 adjectives to describe PWS of which 67.2% were negative in nature, 17.4% were positive and 15.4% were neutral (Ruscello et. al., 1994). Thus, professionals involved in education are likely to provide adjectives that are primarily negative in tone, suggesting that educators, like SLPs, may be more tolerant of PWS (Lass et al., 1989). Thus, with few exceptions (e.g., Silverman & Paynter, 1990), it appears that educators and administrators in school and university settings hold negative attitudes toward PWS. Even when educators report knowing students who stutter (e.g., Crowe & Walton, 1981; Lass et al., 1992), the negative stereotype of PWS persists. It is not well understood how teachers’ perceptions of PWS influence their behavior toward students who stutter in the classroom. More research is needed that provides a more in-depth exploration of teachers’ attitudes toward PWS and correlates teachers’ attitudes with their behavior toward students who stutter in their classrooms.

Despite the availability of stuttering information through leaflets and websites it does not appear from the literature that teachers’ opinions have been sought regarding the precise information they would find helpful. In 1999, a Task Force consisting of research and policy-oriented SLPs, people who stutter and an epidemiologist (Ken St. Louis, Bobbie Lubker, Scott Yaruss, Jaan Pill, and Charles Diggs, respectively) convened to develop the first prototype of a questionnaire to measure attitudes toward stuttering known as the Public Opinion Survey of Human Attributes (POSHA-E). The Public Opinion Survey of Human Attributes (POSHA-E) by St. Louis (2005) is perhaps one of the most well developed scales which is designed to measure the attitudes, knowledge and beliefs toward stuttering among the general public in different cultural groups. The POSHA-E has been translated into and administered in several languages in various countries around the world (St. Louis, Andrade, Georgieva, & Troudt, 2005) and also considerable attention has been paid to the validity, reliability and standardization of the instrument. The inventory is unique in that it is designed to elicit attitudes toward stuttering and other human attribute and reduce response bias by not stating specifically that stuttering (or any of the other attributes) is the targeted attribute.

Since 1999, the POSHA-E has been revised three times. Like most other measures of attitudes, the POSHA-E samples a variety of beliefs, reactions, behaviors, and emotions that would identify societal ignorance, stigma, and/or discrimination (e.g., Blood et al., 2003; Gabel, Blood, Tellis & Althouse, 2004; Hulit & Wertz, 1994; Klein & Hood, 2004). These survey questions have been asked to more than 1,200 adult respondents in 27 nonprobability (nonrandom) pilot study samples in 11 countries (Brazil, Bulgaria, Cameroon, Canada, Denmark, Nepal, Nicaragua, Macedonia, South Africa, Turkey, and the U.S.). Respondents completed questionnaires in either English or one of six other languages (Bulgarian, Macedonian, Portuguese, Turkish, French, and Spanish).

The lack of awareness in teachers about PWS appears to be reflected in the findings by Crichton-Smith, Wright, and Stackhouse (2003). They reported that a large majority of SLPs in UK expressed the view that teachers do not have sufficient knowledge to manage CWS at school.

Studies have been attempted by (Abdalla & Saddah, 2009) to survey attitudes, knowledge and beliefs of Arab teachers in Kuwait and results revealed teachers in Kuwait require awareness and information about stuttering and how to deal with PWS. 60% of teachers responded that they feel uncomfortable when confronted with a PWS. Also, over 50% of the teachers responded that they would fill in words for the PWS.

The research focusing on the attitudes of the prospective teachers are limited. Therefore, to understand their attitudes, knowledge and beliefs about stuttering this study has been initiated involving prospective teachers in Mysore.
Purpose of the study

As stuttering exists worldwide, (Bloodstein & Ratner, 2008) among different cultures it is essential to pay considerable attention in identifying and comparing attitudes, knowledge and beliefs of different cultural groups. Blood, Blood, Tellis and Gabet (2003) reported that PWS live in an environment in which general public have negative attitude / stereotype attitude towards PWS or the disorder. Various studies have been conducted to assess the awareness of public towards PWS and the stuttering disorder. These studies have considered wide range of subjects which included store clerks (McDonald & Frick, 1954), college students (Silverman, 1982), public school teachers (Horsley & Fitzgibbon, 1987), vocational rehabilitation counsellor and employers (Hurst & Cooper 1983a), speech language pathologist (Lass et al., 1989) and general public. Even though the different groups were considered the findings are consistent related to the attitude towards PWS. Hence this study attempts to fill this void by exploring knowledge and beliefs about stuttering in teachers in the Indian scenario. This study explores the attitude of prospective teachers towards stuttering.

Objectives of the Study

- To estimate the awareness of teachers on domains such as nature, concern, attitude and cause of stuttering
- To estimate the awareness of teachers on domains, such as, occurrence, characteristics, knowledge and treatment of stuttering.

Method

Subjects

Subjects consisted of 64 participants (39 females and 25 males in the age range of 19 to 22 years) studying for diploma in education. The study was conducted as a part of orientation program on International Stuttering Awareness Day. The participants were fluent in Kannada and had the knowledge of reading and writing in Kannada.

Questionnaire

A questionnaire was developed by a qualified speech language pathologist having experience in assessment and management of fluency disorder. The questionnaire was developed in Kannada language. Few items were adapted from POSHA (St. Louis, 2005) and the same was translated to Kannada. The questionnaire consisted of eight domains such as nature, concern, attitude, cause, occurrence, characteristics, knowledge and treatment of stuttering. Each domain had ten statements. Each statement had three options (yes, no, I don’t know). Participants responded to each statement by marking any one option.

Data Collection

The participants were given questionnaire and were briefed about the marking for each statement. Participants were told to ask for clarification if any and to be filled by each participant. The data was collected prior to the orientation program on stuttering.

Statistical Analysis

The data from the questionnaire of the 64 participants were coded on the basis of the scale 0 to 3 and entered into an SPSS database. The responses were analysed separately for each domain. Data was analysed using SPSS (version 10 and 16). The response for each domain was analysed from percentage of subjects.

Results & Discussion

a) To estimate the awareness of teachers on domains such as nature, concern, attitude and causes of stuttering

Figures 1 and 2 depict the responses of subjects for domain on nature and concern of stuttering. Among the domain on nature of stuttering, 9.4% of participants believed that person with stuttering hide their speech problem, 23.4% responded that IQ is less in PWS, 89.1% of them felt that PWS usually have fear, 81.3% felt that they are shy in nature, 78.1% felt that they blame themselves for their problem, 71.9% felt that they can have friends and 60.9% responded that they can lead normal life. 51.6% felt that they have capacity to carry out all the activities while 67.2% felt that they have inferiority complex and 65.6% felt that they prefer to stay alone. The participants had a positive attitude on aspects like PWS do not hide their speech problem, have normal IQ and can lead normal life. But they also responded that PWS are shy, have inferiority complex...
and prefer to stay alone.

The second domain aimed to find the participants concern towards stuttering. In general, 60% to 82% of the participants responded that they have concern towards anyone affected with stuttering. These participants showed more concern to family members compared to neighbors and doctors. But, 20% of the participants responded that they are not concerned and 15% of the participants did not answer.

Figs. 3 and 4 depict the participants’ response towards attitude and causes of stuttering. The analysis of third domain indicated that the participants had positive attitude on PWS such as 60.9% of the participants responded that they behave normally with PWS, 93.8% of them responded that they help them by providing the word when they struggle 92.2% of them responded that they help them to speak slowly and 84.4% of them responded that they give them support and encourage them while speaking and 42.2% ignore the stuttering problem. However the negative attitude was very less as 10 to 15% responded on issues like they lose patience (10.9%), make fun of PWS (9.4%), avoid speaking to PWS (12.5%) and do not give them opportunity to speak (14.2%). 42.2% of them also expressed sympathy towards the problem.

Figure 4 depicts that a relatively high percentage of teachers believe that stuttering is caused by problem related to the tongue (82.8%) and a genetic inheritance (68.8%). Approximately 7-15% of the participants responded that they do attribute the causative factor to the influence of black magic/ghost or a curse by god. 56.3% of the participants felt that stuttering is caused due to accidents and pressure from the environment (40.6%). A few participants responded that they think that a virus/bacteria (37.5%) or lack of blood supply (62.5%) and due to imitation (53.1%) can cause stuttering while 5% of the subjects were not aware that if it’s caused by any causative agents listed in the questionnaire.

b) To estimate the awareness of teachers on domains, such as, occurrence, characteristics, treatment and knowledge of stuttering

Figure 5 and 6 depicts the response of the participants towards occurrence and characteristics of stuttering. The domain on occurrence of stuttering had statements related to the age of onset of stuttering and variation across gender. The participants responded that stuttering is seen during developmental period (60.9%), puberty (59.4%), only in adults (46.9%), only in children (43.8%) and 32.8% responded that it is seen only in geriatrics (32.8%). Among the differences across gender, 35.9% reported more in males while 18.8% felt more in females. 21.9% responded that it is seen in some specific races and 12.5% felt that it is a season specific. These results indicate that the majority of the participants were much aware of stuttering.

The domain on characteristics of stuttering also revealed interesting facts. 71.9% of participants felt that the PWS have stuttering in some situations, 65.6% felt that it is specific to individuals, 82.8% felt that they try to avoid the difficult words, 85.9% had secondaries, sweating, fast rate of speech (63.1%) and use synonyms (67.2%). But awareness was less on problems faced by PWS on difficulty with specific words (21.9%), less problem with family members and friends (29.7%). Participants also felt that PWS have fewer problems while reading (59.4%) and singing (43.8%).

The participants’ response on domains regarding the knowledge and treatment options is depicted in Figure 7 and 8. The domain on knowledge aimed at knowing the source of awareness of stuttering. 67.2% responded that their awareness of this problem comes from family members, friends, famous personality who stutter (67.8%), school (68.8%), doctors and nurse (62.5%), mass media (57.8%), cinema (51.6%), personal experience (53.1%) and news papers (45.3%).

The awareness regarding the treatment options were familiar to participants which are reflected in their response. 85.9% of the participants had felt that PWS are treated by doctors, speech language pathologists (84.4%), teachers (85.9%), psychologists (76.6%), spiritual leaders (57.8%), physiotherapists (50%) and family members of PWS (84.4%). 23.4% of them felt that stuttering cannot be cured and 57.6% of them felt that it is cured gradually.
Stuttering awareness among prospective teachers

Fig 1: Response for domain on nature of stuttering

Fig 2: Response for domain on concern of stuttering

Fig 3: Response for domain on attitude of stuttering

Fig 4: Response for domain on causes of stuttering

Fig 5: Response for domain on occurrence of stuttering

Fig 6: Response for domain on characteristics of stuttering

Fig 7: Response for domain on knowledge of stuttering

Fig 8: Response for domain on treatment of stuttering
Even though research and mass media has paid considerable attention towards educating public about stuttering and the extensive review which has proved that PWS are normal, reasonably well adjusted and has a normal capacity on all dimensions the stereotype behaviour of the public still persists. The present study is an attempt to explore the awareness and attitude of prospective teachers towards stuttering in Mysore city. This study is conducted as a part of International Stuttering Awareness Day highlighting the eight domains of stuttering. In general, the results indicated that their awareness on stuttering is less on some domains but also reflected positive attitude on some. The present study did not reveal only negative attitude on all domains.

Since the different studies conducted in this line have used different questionnaires, comparing the present study in each domain with other studies was not been attempted. But in general since few of the statements were similar an attempt is made to compare with the earlier studies. Some of the results of this study is similar to those of other comparable studies conducted in other countries and cultures including Belgium, Brazil, Shanghai and China (Bebout & Arthur, 1992; De Britto Perira et al., 2008; Mayo et al., 2004), as well as Bulgaria, Cameroon, Canada, Denmark, Nepal, South Africa, Turkey and US (St. Louis et al., 2005). These studies suggest that most of the community has poor knowledge on stuttering. Public ignorance may be one of the factors of the mental and emotional complexities of stuttering (Blood, 1999). Klompas and Ross (2004) suggested that there is a need for SLPs to provide teachers with more information about stuttering.

The literature also indicates that the clients families as well as the client's community towards the cause, effects and management of speech language disorders is important to the speech language pathologists work and vital to the therapeutic process (Bebout & Arthur, 1992). Therefore further studies looking into the validity, reliability, number quality, relevance and comprehensiveness of the attitude statements in some of these inventories are necessary. It is the responsibility of all the speech language pathologists to utilize all the opportunity to convey the information related to stuttering disorder and to help in building the positive attitude and acceptance of PWS and stuttering disorder. The positive attitude of the public helps PWS to combat their disorder and improve their quality of life.

Lass et al. (1992) recommended that teachers should receive training prior to practice and as part of their continuing professional education development (CPD) to increase their awareness of stuttering. In particular Lass et al., (1992) suggested teachers should learn to see CWS as whole people and not just in terms of their stuttering behaviour. A number of programs to train teachers specifically about stuttering and to encourage joint working between teachers and SLPs are suggested (Bennett, 2003; Gottwald & Hall, 2003; Stewart & Turnbull, 2007). There is a lack of evidence concerning feedback from teachers attending these training programs and no detail about the effectiveness of the training in terms of improving teachers' knowledge of stuttering and fostering links between the teacher and the clinician.

Conclusion
The result of the present study adds to the established results of the previous studies and explores the attitudes of prospective teachers of Mysore. This warrants the SLP to develop more systematic programs towards creating awareness on stuttering in various culture and communities. The programs should be conducted in all possible environments in which PWS spends most of their time (School, college, office, hospitals, public places like shop, bus stand). It is also important for speech language pathologists to have knowledge about teacher's awareness on stuttering, as teachers play an important role in identification and management of PWS. This study also helps SLP to understand the environment of PWS which play a significant role in the onset and maintenance of stuttering.

References


Stuttering awareness among prospective teachers
BILINGUAL VOCABULARY DEVELOPMENT AND MEMORY AS A FUNCTION OF AGE

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Abstract

Working memory like in first language acquisition plays a crucial role in learning the second language also. However the role of different memory measures in vocabulary development for bilinguals as a function of age is not known. In this context present study aimed at investigating and comparing the relation of different memory measures (phonological, verbal working and semantic) with vocabulary in younger and older Hindi-English sequential bilingual children. Sixty children in the younger bilingual group (5 to 7.11 yrs) and forty in the older bilingual group (8 to 10.11 yrs) participated in the study. Nonword repetition, digit span and word span tasks as memory measures and category generation as vocabulary measure were administered separately in the two languages (L1-Hindi, L2-English) of the participants. The results showed a similar pattern of performance on memory in relation to vocabulary development in the two languages across age. These findings thus maintain the view of interdependent development of the two languages in bilinguals. The association between the memory performance and vocabulary was found to be significant for the younger but not older bilingual group. Thus, the findings support the literature on memory role in early vocabulary development in bilingual children. Future research is needed to examine these memory aspects at different stages of bilingual development in typical as well as clinical population to better understand the interaction between the two.

Key words: Working memory, sequential bilingual, category generation

The development of language in children exposed to two or more languages has been a topic of growing interest in past few decades. Research data has demonstrated that bilingualism enhances the cognitive flexibility (Cummins, 1976; Diaz, 1983). Children as young as in the preschool stage learn contextual use of languages (Lanza, 1992). The two languages in bilingual children can be learned either simultaneously from infancy (simultaneous bilingualism) or sequentially, when a second language is introduced after the first language is well established (McLaughlin, Blanchard & Osanai, 1996; Watson, 1996).

Most bilingual children make unequal progress in acquiring the two languages. This depends on several factors as what language is being spoken to the child, how often it is being spoken and by whom, and on the opportunities the child has to use one language or the other (Goodz, 1994). Thus, bilingualism in children is complex and highly individual.

Vocabulary development in bilinguals

Studies examining lexical development in bilingual children report similar patterns and rate of vocabulary acquisition as that of monolingual children (Genesee, 2003; Patterson & Pearson, 2004). The relative vocabulary size in each language of a bilingual is dependent on the relative amount of time spent in each language (Pearson, Fernandez, Lewedag & Oller, 1997). The similarity in acquisition of the two languages in bilinguals could be explained in terms of the linguistic interdependence principle (Cummins, 1979, 2001).

This principle postulates that linguistic proficiency is common and interdependent across languages. As a result, cross-language transfer of these skills is expected. Peña, Bedore and Zlatic-Giunta (2002) investigated the lexical-semantic
organization in Spanish-English bilingual children of 4 to 7 yrs old using the category generation paradigm (Nelson & Nelson, 1990). Similar to monolingual peers, the bilingual children showed a shift in productivity from script-based (slot-filler) condition to a taxonomic condition. Moreover bilingual children generated a comparable number of category exemplars in each language (Spanish, English) under each condition (slot filler, taxonomic) and for each category (animal, food, and clothing), indicating similarity in rates of semantic development between the two languages.

Working memory (a temporary processing and storage of information) plays a crucial role in learning a second language. Research suggests that verbal working memory tasks may be useful to predict L2 acquisition (Service, 1992). For instance, the ability to repeat words in an unknown language has been observed to predict success in learning that language (Ardila, 2003). On the other hand, decreased digit span and inability to repeat pseudowords have been related to failure in L2 acquisition (Ganschow, Sparks, Javrosky, Pohlman & Bishop-Mabury, 1991). Further, word span and semantic span have also been implicated in learning the second language. However, these measures have seldom been studied in developing bilinguals.

Thus, present study aimed at examining the memory measures in relation to vocabulary (category generation task) in the two languages of Hindi-English bilingual children. This particular association between memory and vocabulary was measured as a function of age across younger and older bilingual children.

Method

Participants

A total of 100 children participated in the study. 60 children of age 5 to 7.11 yrs comprised the younger bilingual group and another 40 children of age 8 to 10.11 yrs comprised the older bilingual group. All children were early sequential bilinguals with Hindi as their mother tongue and English as the second language, with minimum age of exposure in L2 being 3-4 yrs. All children were recruited from schools with English as the medium of instruction. Participants obtained a score of 3 and higher for the two languages on a 5-point language proficiency rating scale given by Gutierrez-Clellen and Krieter (2003). All participants were screened for any complaints of hearing loss, cognitive deficits and/or history of speech and language problems.

Test measures

Memory measures such as phonological memory (non word repetition), verbal working memory (digit span test) and semantic memory (word span test) were studied in relation to vocabulary (using a category generation task) in the two languages of the participants.

Non word repetition: This test was used as a measure of Phonological Memory. A list of 9 non words were used in the study comprised of three 1 syllable, 2 syllable and 3 syllable words each. In English, the word list was adapted from non words developed by Hoff and McKay (2005). In Hindi, the word list was generated with the help of a linguist and fellow speech-language pathologists. A pronunciability check was done by three native Hindi speakers for the various non words in Hindi based on a 3-point rating scale from 0-2 and words rated as pronounceable by all three speech language pathologists were chosen for the study. These non words were audio recorded and presented to the children using the laptop computer using speakers. Participants were instructed to repeat the stimulus after every presentation. The syllables correctly repeated for every nonword by participants was given a score 1. The maximum score for the task was 18.

Digit span test: This test was used as a measure of Working Memory. This measure of randomized digit test used in the study is an adaptation from Binet-Kamath Test (Venkatesan, 2002). The children were presented with a recorded list of numbers. The length of the digits increased from 3 to 9 and the numbers ranged from 1-9. The digits were audio recorded and presented through laptop to the children. Participants were instructed to repeat the numbers in the same order after each presentation. The score given was the maximum span of digits which were correctly produced by the child in the correct order. The maximum score for this task was 9 and the minimum score was 3.

Word span test: This test was used as a measure of Semantic Memory. A list of semantically unrelated words was presented to the children and they were asked to repeat it in the respective order. English words were taken from Hoff and McKay (2005). Hindi word list was generated with the help of a linguist and fellow speech language pathologist. A familiarity check was done by three native Hindi speakers for
the various words in Hindi on the basis of a 3-point rating scale from 0-2. Words rated as familiar by three speech language pathologists were included in the list. The length of the words increased from 3 to 9 in the list. These words were also audio recorded and presented through laptop to the children. The children were instructed to repeat the words in the same order after each presentation. The score was the maximum span of words which was correctly produced by the child in correct order. The maximum score was 9 and the minimum score was 3.

**Category generation task**: This task was used as a measure of vocabulary in the two languages. In this task the children were instructed to give the names of as many items in one category as possible. Five different categories were used for this task namely animals, fruits, vegetables, common objects and vehicles. Every item produced in a category was given 1 point each. Individual points of each category were summed up to obtain the total score for category generation task.

**Procedure**

The testing was carried out in a quiet situation. The stimuli were presented through laptop computer using speakers. The responses obtained from the participants were recorded on paper and were scored according to each task.

**Results**

This study aimed at examining and comparing the relation between memory and vocabulary measures in younger and older Hindi-English sequential bilingual children. Table 1 provides the descriptive statistics for performance on memory measures and the vocabulary task across the two languages of the participants.

Figure: 1 depicts the performance trend of participants on memory and vocabulary measures in the two languages. The older bilinguals over performed the younger bilingual group in terms of memory measures. It was observed that performance on nonword repetition task reached the maximum level for the older bilingual group. Further performance on digit span and word span tasks also improved with age, though did not reach the maximum level. The performance on vocabulary measure (category generation) however did not show a significant improvement with increasing age.

Participants from younger bilingual group showed superior performance on various memory measures in English than in Hindi language. However, their performance on those memory measures was similar for the older bilingual group across the two languages. Further the association between performances on memory and vocabulary tasks in Hindi and English languages for the two groups of participants was tested using a Spearman correlation.

The results of correlation analysis between the memory measures (nonword repetition, digit span and word span) and vocabulary task (category generation) showed significant positive correlation in Hindi and English languages for the younger bilingual group. However no correlation was observed for the older bilingual group in either language (Table 2).

<table>
<thead>
<tr>
<th>Language</th>
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<th>Older bilinguals</th>
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<td>Inter-quartile range</td>
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<td>5</td>
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<td>Digit span test</td>
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<td>Word span test</td>
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<tr>
<td>Memory measures</td>
<td>Digit span test</td>
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<td>Vocabulary measure</td>
<td>Category generation</td>
<td>37</td>
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Table 1: Descriptive statistics of the performance on memory and vocabulary measures in the two languages
Adequate and appropriate development of language in children is one of the key features that accounts for their normal development. Many factors are responsible for language to develop adequately in a child. One such factor is cognition. In the field of bilingualism, researchers have proposed that the cognitive development in bilingual children is different from those of monolinguals, though the research has been limited in this regard. More elaborately, memory...
is one such cognitive feature which is responsible for language development in children (Baddeley, 2003). Literature indicates that various components of memory are important for second language development, like, phonological memory (Thorn & Gathercole, 2001; Service, 1992), working memory (Service, 1992) and semantic memory (Ardila, 1995).

The present study thus aimed at investigating the performance trend on different memory measures like phonological memory, working memory, semantic memory and vocabulary (category generation) in younger and older Hindi-English bilingual children and to find the association between different memory measures on vocabulary in these children. Non word repetition, Digit span test and Word span test were used as measures of phonological memory, working memory and semantic memory respectively. Category generation task was used as a measure of vocabulary. The performance on memory and vocabulary tasks was compared for younger and older bilingual children across the two languages. Results indicated that older bilingual participants outperformed younger bilingual participants on all memory measures as nonword repetition, digit span and the word span tasks. However, participants in both groups demonstrated comparable performance on memory measures across the two languages.

Our study findings showed a developmental trend in participants’ performance on phonological memory task across age. Durigonoglu, Naggy and Bhatt (1993) reported that phonological memory is dependent on phonological awareness ability. The better performance obtained by older bilinguals in our study thus indicate that their phonological awareness skills are more developed in comparison to younger bilinguals, who are still developing their phonological awareness skills. Also, participants’ performance being similar across the languages by both groups suggest that phonological awareness skill is a cognitive skill that develops simultaneously in children regardless of their monolingual or bilingual oral development (English, Leafstedt, Gerber & Villaruz, 2001). A similar trend was observed for participants’ performance on digit span task wherein older bilinguals performed better on digit span task indicating better working memory skills. The performance on working memory measures is mostly dependent on the demands placed on the central executive system (Baddeley & Hitch, 1974). Superior performance by older bilingual group thus suggests their central executive system works in a more developed manner as compared to younger bilinguals. Further, digit span performance in English (L2) being similar to that observed in Hindi (L1) language indicates that the processing of L2 might share the same executive system of working memory as the processing of L1 (Harrington & Sawyer, 1992). Children’s performance on semantic memory measure was also found to be parallel other memory measures. Older bilinguals performed better in comparison to younger group. These findings collectively suggest that semantic memory is more developed in older than younger bilinguals. The developmental trend reflected in participants’ performance suggests their ability on semantic memory was still developing. This finding is line with the available literature, wherein Cohen and Stewart (1982) also found that older children had improved ability to correctly recall presented words, as compared to younger children. These observations thus imply that bilingualism facilitates increased recall outputs, and that benefits are associated with age. Similar performance by the participants on semantic memory task in two languages further support parallel development in bilinguals’ first and second language lexical-semantic skills (Sheng, McGregor & Marian, 2006).

Participants from both group performed similarly on category generation task in the two languages. This is in accordance with findings of PenPa et al. (2002). It can be attributed to the fact that sequential bilingual children are at an advantage at learning second language. This finding could be explained by Cummins’ (1976) notion that a native language foundation can serve as a support for learning English as a second language and also helps in making the learning process easier and faster. According to Cummins (1979) the amount and quality of first language use in the home have been shown to be associated with student readiness for the academic demands of schooling and continued primary language development in the school. The findings that both the groups of participants had a low mean score of their total vocabulary skills may be accounted for the limited exposure to a rich and varied vocabulary (Epinosa, 2006). If the children speak one language in the home and are learning English at preschool, the child may also know some
words in one language and not the other.

Our study results also showed significant correlation of memory measures with vocabulary task for the younger bilingual group, though such a correlation was not observed for the older bilingual group. The role of phonological memory in vocabulary development is well established in the literature. The link between vocabulary knowledge and non word repetition is typically strongest during the early stages of acquiring a particular language (Gathercole, 2006). Vocabulary and non word repetition scores were found to be highly correlated with one another in 4-8 years old children (Gathercole & Baddeley, 1989; Gathercole, Willis, Emslie, & Baddeley, 1992). Non word repetition ability has been shown to be an excellent predictor of language learning ability in children learning English as a second language (Service, 1992; Service & Kohonen, 1995). Thus the positive correlation found between the nonword repetition and vocabulary task for the younger bilingual subjects in the two languages (Hindi and English) in our study could be explained on these grounds.

A similar performance trend was observed for digit span and word span in relation to vocabulary for the younger bilingual group. Considerable evidence is available indicating short term working memory plays a crucial role in supporting the long-term learning of the sound patterns of new words involved in the acquisition of both native and foreign languages (Baddeley, Gathercole & Papagno, 1998). Lanfranchi and Swanson (2005) showed that children with higher English and Spanish vocabulary had higher scores on English and Spanish working memory measures respectively, when compared to those with lower vocabulary. The authors justified their findings as a better working memory will result in better vocabulary development. Also, Harrington (1991) and Harrington and Sawyer (1992) in their study reported a moderate relationship between working memory performance in a second-language (English) reading span test and the second-language proficiency of Japanese children. The significant association observed between memory measures and the vocabulary task in our study thus support the fact that memory has a crucial role to play in vocabulary development (known in monolingual children) in both the languages of bilingual children. Furthermore, this association is prominent during the early years of the language development.

**Summary**

To summarize, findings of this study show that the performances on memory improved with age in bilingual children. Parallel trend observed in the development of memory and vocabulary skills in the two languages of Hindi-English early sequential bilingual children, thus support the interdependent development of two languages in bilinguals. Further, the association between memory measures and category generation was found to be significant in younger but not older bilingual children thus indicating the significance of memory in early vocabulary development.

**References**


Education.


CORRELATION OF VOICE HANDICAP INDEX SCORES WITH CLIENT PERCEPTIONS OF SEVERITY IN MALES V/S FEMALES WITH VOICE DISORDER

*Ms. Pallavi Sovani, **Mrs. Vinaya Keer, ***Mrs. Maya Sanghi

Abstract

Voice is the mirror of personality, and an indispensable ingredient for effective communication. A person with dysphonia would thus be affected functionally and emotionally. The Voice Handicap Index (VHI) measures these effects of a voice disorder. The present study aimed at making the VHI more usable in India, and finding the correlation of VHI scores with clients' self-perceived severity of the voice disorder. The VHI was translated to Hindi and Marathi languages. Back-translation of these versions and test-retest reliability was done before administering them to one of two groups (Hindi and Marathi) of 30 typical individuals. 11 males and 21 females with dysphonia were then given the VHI in their language of choice, and finally asked to rate the severity of their disorder. Spearman's rank correlation coefficient and t-test were used. Frequency of distribution of scores was also analyzed for the entire sample of 92 individuals. The mean VHI scores of the normative sample and pathological samples were significantly different. Test-retest reliability was >0.9 for both Indian versions. There was a moderate correlation between VHI scores and client perceptions of severity. It was moderate for males, poor for females, and poorest for working women. In cases with a discrepancy between VHI scores and self-perceived severity, at least one subscale score correlated well with the client's perception. The results suggest that Hindi and Marathi versions may regularly be used for assessment. Correlation analysis shows that persons with dysphonia give more priority to only one of the three aspects of the disorder (functional, physical, emotional). Males view their problem more holistically while females tend to underestimate their problem, perhaps a salient characteristic of the Indian woman. The study was a pilot attempt at validating the VHI in Indian languages, and gave valuable information for assessment and therapy planning.

Key words: Voice Handicap Index, Indian, perception

Voice is an attribute which is unique in every individual. It is one of the major characteristics which distinguish one individual from another. Naturally, it holds an important position in a person’s life, and in case it is disrupted in any way, it directly or indirectly affects the person functionally, socially and emotionally. This explains why persons with dysphonia report symptoms of psychosocial distress as a direct consequence of their dysphonia. These consequences of dysphonia are measured using quality-of-life measures.

Quality of life measures provide insight into what the person has experienced and recognize the centrality of his/her point of view. Typically, they have been in the form of questionnaires. An important contribution to these was the development of a standardized self-assessment ordinal scale, the Voice Handicap Index (VHI) by Jacobson et al. (1997). The VHI (Jacobson et al., 1997) is a question and answer tool to subjectively assess the amount of handicap a voice disorder is causing. It consists of 30 questions representing several different problems in speaking situations, and the person has to rate the frequency of the problem on a 5-point scale where: 0=never; 1=almost never; 2=sometimes; 3=Almost always; 4=always. Each question tests one of three aspects- functional, physical and emotional. The letters “F, P, E”
respectively precede each question number. There are thus three subscales and 10 questions belonging to each subscale.

Thus a VHI score form 0-30 represents a low score, and most likely there is a minimal amount of handicap associated with the voice disorder. A score of 31-60 represents moderate handicap, as is seen in people with vocal fold injuries, nodules, polyps or cysts. A score from 61-120 represents a serious amount of handicap due to a voice problem, and is often seen in patients with new onset vocal cord palsy, vocal cord scarring, etc. (Jacobson et al., 1997). The VHI has various uses ranging from assessing the impact of voice disorders, to measurement of functional outcomes and treatment efficacy (Rosen, Murr, Zin, Zullo & Sonbolian, 2000) in behavioral, medical and surgical treatments of voice disorders.

In Jacobson et al.’s (1997) study, an 85-item version of the VHI was administered to 65 consecutive patients seen at the Voice Clinic at Henry Ford hospital. The data was subjected to measures of internal consistency reliability and the 85-item version was reduced to a 30-item questionnaire, which had strong internal consistency reliability and test stability. Construct validity though was not fully evaluated here. Relationships between functional, emotional and physical subscales were moderately strong with Pearson product-moment correlation coefficients ranging from 0.70 to 0.79. In the same study, relationship between VHI score and voice disorder severity was studied. Results indicated a moderate relationship between the two self-assessment measures.

This was followed by studies comparing the VHI to other quality of life measures. Benninger, Ahuja, Gardener and Grywalski (1998) compared a general quality-of-life measure- Medical Outcomes Trust Short Form 36- Item (SF-36) and a voice-specific instrument, i.e., the VHI. They found that the two correlate with each other in the domains of social functioning, mental health and role function-emotional.

VHI scores have also been compared to other subjective voice-related measures like the Voice Symptom Scale (VoISS) by Wilson, Webb, Carding, Steen, MacKenzie and Deary (2006), and Voice Related Quality of Life measure (V-RQOL) by Portone, Hapner, McGregor, Otto and Johns (2006). Portone et al. (2006) concluded that the VHI and V-RQOL are highly correlated but not interchangeable measures. Murr, Medrado, Hogikyan and Jonathan (2004) had explored the relationship between trained listener ratings of voice quality and patients’ ratings of V-RQOL, and found that there is a moderate correlation, though each scale appears to provide unique information.

Krichke et al., (2005) tried to find if changes in Health Related Quality of Life (HRQL) depend on the kind of voice disorder, and the gender of the person, but concluded that they did not. Although it is perceived that women tend to perceive a disease in a different manner than do men, this study shows no significant difference in HRQL between men and women.

VHI results were also correlated by some researchers, with other tools like Voice Lab Measurements (Hsiung, Pai & Wang, 2002; Woisard, Bodin, Yardeni & Puech, 2006), and specific acoustic measures (Wheeler, Collins & Sapienza, 2006). These studies reveal poor correlation between VHI and objective/ acoustic parameters and conclude that they give independent information in practice.

The VHI has also been used to monitor treatment efficacy for voice disorders (Rosen et al., 2000). Roy et al., (2002) used the VHI as one of the measures to quantify benefit with voice amplification v/s vocal hygiene instruction for teachers with voice disorders. They also used the severity rating scale that has been used in the present study. In contrast to VHI results, data from the severity rating scale suggest the vocal hygiene group did not perform significantly better than the control group. The amplification group showed a decrease in mean VHI scores in contrast to the control group showing increases scores. Similar studies by other authors (Behrman, Rutledge, Hembree & Sheridan, 2008; Hall, 1995; Wolfe, Long, Youngblood, Henry & Olson, 2002) have used the VHI as one of the means to measure a dependent variable.

Certain specific populations have also been studied in detail using the VHI. Smith, Taylor, and Mendoza (1998) studied functional impact of nodules using the VHI, and found that the incidence of voice problems was more in females, and that females were affected more in areas like work and communication due to their voice disorder. A recent
A retrospective study along similar lines was by Bouwers and Dikkers (2009) who concluded that the VHI was a good reflection of the psychosocial impact of voice disorders. The VHI has extensively been used to study the population of singers (Murry, Zschommler & Prokop, 2009; Rosen & Murry, 2000). Wingate et al. (2005) studied the population of older patients with adductor spasmodic dysphonia with reference to the VHI. Other populations that have been studied using the VHI include laryngectomees (Kazi et al., 2007) and teachers (Kooijman, Thomas, Graamans & De Jong, 2007) and student-teachers (Thomas, Kooijman, Donders, Cremers and De Jong, 2007). However, there was no normative data available to describe expected VHI scores from adults with healthy voices. Hence Behrman et al. (2008) considered the upper limit of 11.5 as a cut off for a VHI score expected from a person without a voice disorder.

The VHI has been translated and validated in languages like Portuguese (Guimaeaes & Aberton, 2004) and Hebrew (Amir, Ashkenazi, Leibovitz, Michael, Tavor & Wolf, 2006). It has also undergone modifications, a recent one being the Pediatric Voice Handicap Index (pVHI) (Zur, Cotton, Kelchner, Baker, Weinrich & Lee, 2007). However, no study regarding the translation and validation to Indian languages has been published till date. The VHI would be much more useful clinically if translated and validated in Hindi and Marathi, especially Hindi being the national language of India. Thus there may be a large portion of the population of India that might not know English, but would be well-versed with these languages.

Hence the present study was aimed at making the VHI more usable in India and also measuring the correlation of VHI scores with clients’ perception of severity of the voice disorder. The extent of correlation has further been compared across males and females and also across males and working women in particular.

**Methods**

**Participants**

The sample for the study included:

- Two groups of 30 symptom-free (as regards voice problems) age matched adults (21-60 years) who were proficient in Hindi (Khariboli dialect) and Marathi languages respectively who consented to participate in the study;

- A purposive sample of 32 persons with dysphonia (11 males, 21 females) referred for voice therapy from the Otorhinolaryngology department of B.Y.L. Nair Hospital who were included in the study after viewing their Indirect Laryngoscopy findings and obtaining their informed consent. Only persons with hyper functional dysphonia and dysphonia due to neurological causes were included in the study. Subjects above 60 years and below 21 years of age were excluded, as voice anomalies in these age groups may be attributed to organic changes - hormonal, mucosal, or changes due to aging. The time period between age of onset of dysphonia and initiation of therapy was not held as a control variable for two reasons. Firstly, for two individuals with identical time elapsed between appearance of symptoms and therapy, their VHI scores may vary. Secondly, the study dealt with comparing correlation coefficients (and not absolute VHI scores) of males and females with dysphonia. However all the data was collected at the onset of therapy since therapy was a variable that could influence the correlation between VHI scores and client perceptions of severity.

**Tools and procedure**

The tools used were the Voice Handicap Index (VHI) (Jacobson et al., 1997) and its translated versions whose equivalency to the original English version was established as described below.

The VHI was first translated to Hindi (Khariboli dialect) and Marathi languages by native speakers of those languages who were also well versed with English. Back translations were then performed by a clinical psychologist and a social worker, both of whom were experienced translators. On back-translation, statements 11, 17 and 23 underwent minor grammatical changes. However, all the statements conveyed the same meaning as the original English version. Each of these two translated versions was administered to one of the two groups (Hindi and Marathi) of 30 symptom-free adults. To check the test-retest reliability, the VHI was administered twice to 7 randomly selected subjects each in Hindi and Marathi (5 symptom-free individuals and 2 persons with dysphonia).

Once the equivalency of the translated versions was thus established, all the three versions of the
VHI were then used for collection of data from persons with dysphonia.

The persons with dysphonia were given the VHI in a language which they were most comfortable with, out of English, Hindi and Marathi. They were given the following instructions:

“This questionnaire helps us to see the difficulties you face due to your voice problem. Answer the questions by marking the appropriate option, to let us know how frequently you encounter that situation. (An example was given using the first question.) Rate the frequency of the situation on a five-point scale where 0=never; 1=almost never; 2=sometimes; 3=Almost always; 4=always.”

<table>
<thead>
<tr>
<th>Overall test-retest reliability</th>
<th>Marathi</th>
<th>Hindi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional subscale</td>
<td>0.91</td>
<td>0.95</td>
</tr>
<tr>
<td>Physical subscale</td>
<td>0.87</td>
<td>0.84</td>
</tr>
<tr>
<td>Emotional subscale</td>
<td>0.94</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Table 1: Reliability coefficients

Every question was read aloud and the client’s response noted. The person was assured that there was no time limit. If the clinician had any doubt about the client having answered correctly, the client was asked whether he / she was sure they encountered that particular situation that frequently/rarely. After filling up the questionnaire, the person was asked to self-rate the severity of his/her voice disorder on a 4-point scale where: 0=normal; 1=mildly impaired; 2=moderately impaired; 3=severely impaired. The method of instruction was same as used in Jacobson et al., (1997).

The person was asked to rate, in his/her opinion, how severe the problem was, on this scale. No specific instruction was given regarding the meaning of “severity”.

Scoring and statistical analysis

The score obtained on VHI was put into one of the three categories- mild (0-30), moderate (31-60) and severe (61-120). These categories were then given ranks, such that: 1=mild, 2=moderate and 3=severe. The last question too yielded a rating of “mild”, ”moderate” or ”severe” for all the persons with dysphonia. Spearman’s rank correlation coefficient was computed for the entire sample (N=32) of persons with dysphonia. Separate correlation coefficients were also computed for males (N=11) and females (both working women and housewives, N=21), and compared. Further the correlation coefficient for only working women (N=14) was computed and was compared with that of males. The data was analyzed using the GraphPad Instat software.

Results

Indian versions of the VHI

As stated above, the back-translations yielded questions which conveyed the same meaning as the original English version. The test-retest reliability (using Pearson’s Product-Moment correlation coefficient) was good for both the Hindi and Marathi versions, for the total and subscale scores. The precise values are given in Table 1.

The mean VHI scores of the normative samples in Hindi and Marathi were compared to the mean VHI scores of the dysphonia samples in the respective languages that were obtained in the second part of the study. On applying the unpaired t-test, there appeared to be a significant difference between the means of the normal and pathological population. The means and SDs (standard deviations) are seen in Table 2.

Correlation of VHI scores and self-perception

When Spearman’s rank correlation coefficient was applied, the correlation between the clients’ perception of voice disorder severity and VHI scores appeared to be 0.41, implying moderate correlation. The correlation coefficient for males was 0.65 (moderate correlation) while that for females was 0.21 (poor correlation). When only working women were included for analysis, the correlation was found to be very poor, i.e. 0.018.

To investigate the nature of the relationship between VHI scores and self-perceived severity, the means of total VHI scores (ranks) and self-perception (ranks) were compared. The trend seen was that in males the mean rank of the VHI scores was approximately the same as that of self-perceived severity, but for females, whether it was women in general or working women, the mean rank of VHI scores was always higher.

On observing individual data, it was seen that in persons in whom there was a discrepancy between VHI scores and self-perceived severity, at least one of the three subscale scores was seen to correlate well with the client’s perception of severity. (For the
purpose of this comparison, the subscale scores too were categorized such that 0-10=mild, 11-20=moderate, 21-40=severe, in proportion with the categories of the total scores.

Finally, an analysis of the frequency of distribution of the scores was also done which revealed that

- Ratings of symptom-free individuals were frequently ‘0’ or ‘1’, while those in patients range from ‘0-5’.
- Most symptom-free individuals rated statement F-1 and F-3 (which pertained to the voice not being heard in general and in noise) as ‘1’.
- More than 50% of the persons with dysphonia answered “never” for questions E-9, E-25, P-26 and E-27 to E-30, most of which pertain to the extreme effects of voice problems, e.g.: "My voice 'gives out' on me" or "My voice makes me feel handicapped".
- Patients with vocal cord palsy gave most ratings in the range of 2-4, while those with dysphonia due to vocal abuse gave most ratings on the range of 1-3.

Discussion

The fact that the meaning of the statements was unchanged in the back-translations and that the test-retest reliability was good suggests that the Indian versions may be appropriate for use clinically.

Further a significant difference in the means of the normative and pathological samples for both the Indian versions of the VHI implies that the questionnaire even in its Indian version, is correctly measuring what it is intended to measure. The means of the normative sample are also well within the range of 0-11.5 suggested by Behrman et al. (2008). Thus, the study may later be replicated with a larger sample size to validate the VHI in Indian languages, following this preliminary attempt.

None of the persons with dysphonia selected the option of "normal" to describe their voices, suggesting that they all were aware of their voice problem. The clients' perception of severity of the voice problem correlates moderately with the VHI, a finding that agrees with those of Jacobson et al. (1997) but disagrees with Carding (2000) who stated that there is a good correlation between the two measures. One reason for the moderate correlation may be that the person might be giving a higher priority to one of the three factors- functional, physical or emotional, to judge his problem. Between the two measures, at least one subscale score correlates well with self-perception of severity. In this case, giving the client a holistic view of his problem could be one of the goals in therapy. Another reason could be that there are other factors at play which are not included in the VHI, e.g. personality, status within the family and society, etc. Both these possibilities should be carefully explored in therapy.

These factors which may influence a person's self-perception of severity of the voice problem may work both ways, i.e., may worsen his/ her impression of the problem or make it better than what it actually is. Some of these factors may be:

- Biases due to inadequate information obtained from the wrong sources
- Occupational demands, i.e., whether or not the voice needs to be used extensively at the workplace
- Social status and power: This refers to the importance or status given to the person within the family or within society. E.g.: An influential person may feel that his/ her voice problem is more severe as against a person perceived as insignificant by society.
- Personality traits like introversion or extroversion will determine the degree to which a voice problem will limit functioning. Further, an introvert may also want to keep back information while filling up the questionnaire.

<table>
<thead>
<tr>
<th>Marathi</th>
<th>Hindi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normative sample</td>
<td>Dysphonia sample</td>
</tr>
<tr>
<td>Mean</td>
<td>S.D</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>( t = 6.14 ) with ( 13 ) degrees of freedom</td>
<td>( t = 7.30 ) with ( 9 ) degrees of freedom</td>
</tr>
</tbody>
</table>

Table 2: Means and SDs of VHI Scores of normative and dysphonia samples
Significant other people’s opinion of the person’s problem may also influence his/ her self-perception.

Vulnerability of the person will determine the extent to which he/ she is influenced by other people’s opinions.

Perception of the voice problem in contrast to others: This means that if the person with a voice problem is surrounded by a lot of people with voice disorders or voices with a poor quality, his/ her self-perception of the problem will be different from what it would have been, had he/ she been surrounded by people with excellent voices.

Finally, the person’s literary skills and understanding may also lead to a poor correlation between the two measures, as the answers depend on what meaning is derived out of the question. Thus poor literary skills may lead to a wrong interpretation of the statement that is read.

The correlation coefficients show that males’ perception of the severity of the disorder may be slightly more holistic and rational than females in general and working women, in whom the correlation of VHI scores and self-perceived severity is poor. Also, means of ranks obtained from VHI scores were always higher than means of ranks given to self-perceived severity for both the groups of women (all women and working women). This finding suggests that most Indian women tend to underestimate their problem, and hence perceive the severity as less in spite of the large number of limitations in function that the VHI might actually show.

Finally the analysis of the frequency distribution of scores reveals that:

- Most symptom-free individuals too face difficulties with volumes of their voices.
- The rating of “never” for questions 9 and 25-30 may either mean that most persons with dysphonia do not face so severe a problem, that they have not come to terms with it, or that they do not wish to admit to strong statements like feeling “embarrassed, angry, incompetent, or ashamed” due to their voice problems.
- Persons with vocal cord palsy face more severe problems, and thus higher VHI scores than those with hyper functional dysphonia, a finding that supports those of Jacobson et al. (1997).

An interesting fact which was also noted in a study by Guimaeaes and Abberton (2004) was that responses to statements P-5 (calling people around the house) and P-6 (use of a phone) would differ not only due to the severity of the voice problem but also due to a person’s socioeconomic status. In fact, these are the only two questions where “because of my voice” is not stressed.

These findings on frequency distribution suggest that in future, the VHI may well be modified. Statements that elicit high ratings even in symptom-free individuals; or those that depend on socioeconomic status, etc. may be excluded. The VHI could also be made more sensitive to the factors other than the voice problem that exacerbate or reduce the limitations in function, in line with the recent International Classification of Functioning, Disability and Health (WHO, 2001).

**Conclusion**

The VHI is already an invaluable tool in the field of voice therapy and research. Its translation to Indian languages would make it even more applicable and useful to the vast Indian population. Its moderate correlation with client self-ratings of severity leads to many possible conclusions. Firstly, that the person is probably giving relatively greater priority to one of the areas affected by the problem, an important clue for the clinician for where to start therapy in order to have a well-motivated client. Secondly, that there might be areas the person is unaware of, or does not want to look at (i.e., underestimation, especially in case of women). In such a case it would help to counsel the client to come to terms with these areas and deal with the problems.

One might also want to explore and try to modify the factors discussed above (e.g. excessive vulnerability) which might influence self-perception of the problem. This, in other words, implies that the VHI has scope for expansion to include these “other relevant factors” that contribute to the problem.

The study also opens doors to future research with a larger sample size, or controlling for the factors like socioeconomic status, age, occupation, etc. which may yield information specific to certain subgroups of people. Validation of the VHI in other Indian languages may also be considered.
Finally, the study supports the fact that a subjective measure or a discrepancy in two findings does not complicate results, but gives us valuable new insights that can help us solve the problem more efficiently, ultimately leading to a better prognosis.

References


Thomas, G., Kooijman, P.G., Donders, A.R., Cremers,


CROSS LINGUISTIC STUDY ON PHONOLOGICAL SIMILARITY EFFECT

*Liveem Mariam Tharakan, **Aparna V.S., & ***K.S. Prema Rao

Abstract

The phonological similarity effect (PSE), poor retention of order for lists of similar-sounding items is a benchmark finding in the short-term memory literature. While the models of PSE have been investigated after extensive studies on monolinguals, the bilingual population would serve as a potential platform to examine PSE from cross linguistic perspective. The main aim of the study is to examine the PSE in Malayalam – English bilingual speakers and to find out a) The factors that facilitate serial recall b) Whether phonologically similar words have a detrimental effect on serial recall task c) Whether lexicality plays a role on PSE d) Whether the PSE on item recall is crucially affected by lexicality. Ten typical Malayalam -English bilinguals in the age range of 20 -25 years were selected for the study. Stimuli were categorized into five different lists, namely rhyming words list, alliterative words list, rhyming non- words, alliterative non words and simple non-word list in both English and Malayalam. The audio recorded stimuli were presented through the DMDX program. Subjects were instructed to recall maximum number of items in the serial order. The superior performance on rhyming words and alliterative words over simple non- words is in consonance with the lexicality effect reported in the literature. Consistent with the existing literature, our results also confirmed the categorical cueing effects which are responsible for better performance in recall of rhyme nonword over simple nonwords and alliterative nonwords over simple nonwords which in turn supports feature based model. Overall the results show similarities in PSE between Malayalam and English thus suggesting that the PSE construct employed to propose short term memory models for English language would also explain PSE in Malayalam though the two languages are from different families.

Key words: Rhyme, Alliteration, Feature Based Model, Lexicality Effect, Category Cueing Effect

A robust finding in working memory research is that to recall a set of phonologically similar words is much more difficult than to recall a set of phonologically dissimilar words, which is the well-known phonological-similarity effect (Conrad & Hull, 1964). This finding points out that the capacity of information retention in our working memory store more or less depends on the phonological nature of the to-be-memorized information. The more similar (phonologically) the to-be-memorized item, the more difficult it is to retain in the working memory store.

Watkins, Watkins & Crowder (1974) compared serial recall of phonologically similar and phonologically dissimilar lists. Performance was assessed using the strict serial recall measure and it was found that the performance was better for the phonologically distinct lists, demonstrating the classic Phonologic Similarity Effect (PSE). However, no difference in performance in item recall measure was found for the phonologically similar versus dissimilar lists. Similarly, Gathercole (1982) compared serial recall of phonologically similar and phonologically dissimilar lists. Using the strict serial recall measure, performance was better for the phonologically distinct lists; however, item recall was actually better for the phonologically similar lists than for the phonologically dissimilar lists. Besner and Davelaar (1982) demonstrated that the phonemically similar lists were less accurately recalled than lists of phonemically distinct items, irrespective of the word likeness of...
Poirier and Saint-Aubin operationally defined phonological similarity as lists of rhyming words while other studies have used lists of single syllable words with a common vowel and some overlap in the consonants (Coltheart, 1993). A study by Poirier and Saint-Aubin (1996) examined serial recall of lists of 2-syllable words. Strict serial recall was better for the phonologically distinct lists, but item recall was no different for the phonologically similar versus dissimilar lists. Some studies have obtained classic PSE that is PSE has been found in both item and serial recall. Drewnowski (1980) Coltheart (1993), found that recall was better for phonologically dissimilar than for phonologically similar lists in terms of both the strict serial recall and item recall measures.

Lian and Karlsen (2004) showed a significant interaction effect between lexicality and phonological similarity, indicating in their case that the phonological similarity factor affected words but not nonwords.

Roodenrys and Stokes (2004) found that there is a positive effect of word likeness on nonwords regardless of task. Non words of high word likeness appear subject to redintegration leading to errors in serial recall task or position accuracy (Fallon, Mak and Tehan, 2005).

Fallon, Groves, and Tehan (1999) reported that both the rhyming and the phonemically similar condition showed impaired order memory compared to a dissimilar condition, the recall of item information was actually enhanced in the rhyming condition albeit in the wrong order than in phonologically dissimilar condition. They suggested that the rhyming similarity can act as an effective category cue, and therefore facilitates item recall; but the phonological overlap without rhyme does not provide an effective category cue, and therefore does not facilitate item recall. However, the rhyming-non rhyming manipulation in their experiments was confounded with a difference in the degree of within-list phonological overlap. Each member of similar rhyming lists shared two phonemes, whereas each member of similar non rhyming lists such as shared on average only one phoneme. The difference in item recall for these two types of lists could therefore have been due to cueing by the degree of phonemic overlap rather than by rhyme category.

Theoretical account that has been proposed for the above observation is based on the feature model. The feature model of Nairne (1990) incorporates representations of this type. In this model, the effect of phonological similarity in serial memory arises from overlap of the feature vectors that represent the phonologically similar list items. Phonological similarity makes it difficult to recover an item's correct position within a list because there are overlapping features; however, common phonological features among list items can be used to discriminate the list as a whole from other lists, thus aiding item recall which is termed as category cue (Nairne & Kelley, 1999). The feature model would therefore predict that item recall for lists comprised of phonologically similar rhyming stimuli should be equivalent to that for lists comprised of phonologically similar non-rhyming stimuli such as alliterative lists, if the degree of phonological overlap is controlled which is referred to as feature account.

According to Baddeley’s phonological loop model which comprises of two components, the phonological short-term store and the sub-vocal rehearsal process, the source of PSE in immediate serial recall is the phonological store. It is argued that memory items that share a similar phonological structure will become more rapidly indiscriminable from one another due to decay than items with non-overlapping phonological structures (Baddeley, 1966).

Most of the studies regarding PSE have been carried out in English language. Cross-language investigations on PSE would be necessary to understand the influence of linguistic / structural differences in language processing. PSE on span of verbal short term memory in Persian language (Jahana, Baratzadeh & Nilipour, 2008) has been done using three different lists, namely rhyming words list, alliterative words list and dissimilar words list. The results showed significant difference between rhyming, allitative and dissimilar words. There was no difference between rhyming and allitative lists. They concluded that in rhyming and alliterative words, vowel, because of higher sonority (rather than the consonants) enhances the memory span as a cueing feature. Cross-language
differences, especially in phonemes sonority level may cause different phonological similarity effects among languages. Since verbal short term memory is sensitive to vowel in words, it seems that the verbal short term memory is linguistic in nature.

In English, rhyming words (similar final syllable) and alliterative words (similar initial consonant or syllable) have different significance since each syllable is stressed differently. Studies on PSE have not been conducted in Malayalam language, the language spoken in the state of Kerala. English is a phonemic or stressed language while Malayalam is considered as a syllabic language with equal stress. Therefore there would not be much difference with regard to position of stress. That is, both rhyming words and alliterative words will have the same effect provided the degree of overlap of the similar feature is constant.

Study of phonological similarity effect (PSE) in immediate serial recall (ISR) has produced a conflicting body of results. No studies have been able to distinguish both the influence of segmental as well as prosodic feature in PSE. Cross-language studies would help to understand the role of linguistic features in processing the phonological elements of language. No attempts have been made in Indian context to address this issue and to integrate linguistic research to short term memory models. This is also needed to verify if the short-term memory models developed in western context can be applied to Indian languages. The aim of this study is to examine PSE in cross-language context on span of verbal short term memory in Malayalam and English.

Aims of the study

The main objective of the study is to examine the PSE in Malayalam - English bilingual speakers. The study also aims to find out a) The factors that facilitate serial recall b) Whether phonologically similar words have a detrimental effect on serial recall task c) Whether lexicality plays a role on the order of detrimental PSE d) Whether the PSE on item recall is crucially affected by lexicality, a finding less well explained by the feature based model which is a prominent model of PSE.

Method

Participants: Ten typical Malayalam -English undergraduate students (females) in the age range of 20 -25 years with no history of neurological or psychological illness were selected for the study All the participants were early bilinguals studied in English medium school since preschool. All participants were self rated as highly proficient in both the languages based on their proficiency in reading, writing, and speaking in both the languages. No particular proficiency rating scale was used because of the nonavailability of standardized proficiency rating scale in the year of the study. The same group of subjects participated in all the experiments designed for the study.

Material and procedure: Stimuli were categorized into five different lists, namely rhyming words list (RW), alliterative words (AW), rhyming non-words (RNW), alliterative non words (ANW) and simple non-word (NW) list in both English (E) and Malayalam (M). Ten seven -item list were created for the five different categories of words. All to- be- recalled words were bisyllables. The stimuli were audio recorded in an adult female voice using PRAAT software sampling rate of 44.1 kHz on a Lenovo Y430 Idea pad computer. The audio recorded stimuli were presented through the DMDX2 program. DMDX software was used to maintain uniform presentation time and response time. The subjects were seated comfortably in a quiet room and were instructed to listen to the stimuli presented through a headphone. Prior instructions were given to the subjects to serially recall (serial recall) the presented stimuli once each seven item list is heard. They were also asked to recall the maximum number of items (item recall) possible. Each sequence of items in the list was followed by a signal to indicate the participant to respond with recall of wordlists. There was a 4 second interval between words in each sequence. Two practice items were given prior to the test stimuli. The responses were recorded onto the system and verbatim transcription was done. The accuracy of the serial recall and number of items accurately recalled were checked. The time taken for each participant to complete the testing is approximately 40 minutes. Counter balance design was used were among the 10 subject’s five subjects received stimuli in the order of Malayalam- English and 5 subjects in the order of English- Malayalam. Rhyme and nonwords were used to maintain the effect of prosodic feature and study the effect of semantics.
Non words were considered to family the effect of meaning in PSE. Alliterative words were used to study the effect of segmental feature. The degree of phonemic overlap was not consistent across the word list.

Results and Discussion

Statistical analysis was done for both item recall and serial recall tasks to examine the effects of wordlist across and within languages. One-way repeated measure ANOVA with wordlists as independent variable was carried out and the results revealed a significant main effect. Paired t-test was done to compare the performance for each wordlist within language. The results are discussed under three phases.

Phase I: This phase compares the performance on item and serial recall for rhyming words and alliterative words within languages. This is done in order to determine the feature responsible for PSE in both languages (Table 1).

<table>
<thead>
<tr>
<th>Language &amp; task</th>
<th>Word list</th>
<th>&quot;t&quot; value</th>
<th>Sig (2tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Recall (SRM)</td>
<td>RW-AW</td>
<td>1.590</td>
<td>.146</td>
</tr>
<tr>
<td>Serial recall (SRE)</td>
<td>RW-AW</td>
<td>.730</td>
<td>.484</td>
</tr>
<tr>
<td>Item recall (IRM)</td>
<td>RW-AW</td>
<td>.037</td>
<td>.971</td>
</tr>
</tbody>
</table>
| Item recall (IRE) | RW-AW | 6.263 | 0.000*

*significant at .05 level of significance

Table 1: T Values and Significance

In Malayalam language results of performance on serial recall and item recall for rhyming and alliterative words, shows no significant difference. This is attributable to the syllabic script of Malayalam in which rhyme and alliteration has the same effect.

In English serial recall of rhyme and alliterative words were not significantly different. This is probably because the category cueing effects of rhyming words were not strong to overcome the strict demands placed by the task. The rhyming words had consonantal overlap but the following vowel overlap was not present. This would have led to inadequate category cueing for serial recall also reported by Fallon, Groves and Tehan (1999). Results of item recall of rhyming and alliterative words in English show significant difference in accordance with the categorical cueing effect of the rhyme. This can also be in concordance with the findings of Poirier and Saint-Aubin (1996) where they found that there is no significant difference between phonologically similar versus dissimilar list in item recall.

Phase II: Phase two compared the performance of subjects in item recall and serial recall on rhyming words and alliterative words versus corresponding nonwords i.e. rhyming nonwords and alliterative nonwords, rhyming words versus nonwords and alliterative words versus nonwords within languages. In first two comparison features, which is rhyme and alliteration are kept constant and lexicality changes. In next two comparison both feature and lexicality changes. This was carried out to exclude the influence of word meaning (lexicality effect) and to study only the effect of features. If lexicality has a significant role in serial recall, rhyming and alliterative words must have larger scores compared to nonwords.

The results revealed significant difference between rhyme and simple nonword, alliteration and simple nonword, alliteration and alliteration nonword, rhyme nonword and alliteration nonword in both the languages for both item and serial recall task. The superior performance on rhyming words and alliterative words over simple non- words is in consonance with the lexicality effect consistent with the findings of Lian and Karlsen (2001) where they showed a significant interaction effect between lexicality and phonological similarity. Consistent with the existing literature, our results also confirmed the categorical cueing effects which are responsible for better performance in recall of rhyme nonword over simple nonwords and alliterative nonwords over simple nonwords. This shows that PSE is not only due to category cueing but also due to lexicality effect. The superior performance of rhyme words and alliterative words over simple nonwords in both the languages also in turn supports feature based model (Nairne, 1990). There was no significant difference between rhyme words and rhyme nonwords. This may be due to the word likeness of the rhyme nonwords and redintegration as supported by Roodenrys and Stokes (2004).

Phase III: Phase III compared the performance on item and serial recall for the entire lists across language (graph 1). This is done for a cross linguistic comparison of PSE. Performance across all the wordlists were compared and analyze.
Table 2: T Value and Significance between Rhyming and Alliterative Words and Non Words

<table>
<thead>
<tr>
<th>Language &amp; task</th>
<th>Word list</th>
<th>&quot;t&quot; value</th>
<th>Sig(2tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Recall (SRM)</td>
<td>RW-RNW</td>
<td>1.132</td>
<td>0.287</td>
</tr>
<tr>
<td></td>
<td>RW-NW</td>
<td>3.647</td>
<td>.005*</td>
</tr>
<tr>
<td></td>
<td>ALW-NW</td>
<td>3.679</td>
<td>.005*</td>
</tr>
<tr>
<td></td>
<td>ALW-ALNW</td>
<td>3.234</td>
<td>.010*</td>
</tr>
<tr>
<td>Serial recall (SRE)</td>
<td>RW-RNW</td>
<td>1.700</td>
<td>.123</td>
</tr>
<tr>
<td></td>
<td>RW-NW</td>
<td>.728</td>
<td>.485</td>
</tr>
<tr>
<td></td>
<td>ALW-NW</td>
<td>1.879</td>
<td>.095</td>
</tr>
<tr>
<td></td>
<td>ALW-ALNW</td>
<td>1.933</td>
<td>.085</td>
</tr>
<tr>
<td>Item recall (IRM)</td>
<td>RW-RNW</td>
<td>.158</td>
<td>.878</td>
</tr>
<tr>
<td></td>
<td>RW-NW</td>
<td>9.646</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>ALW-NW</td>
<td>8.94</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>ALW-ALNW</td>
<td>1.776</td>
<td>.109</td>
</tr>
<tr>
<td>Item recall (IRE)</td>
<td>RW-RNW</td>
<td>1.693</td>
<td>.125</td>
</tr>
<tr>
<td></td>
<td>RW-NW</td>
<td>5.416</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>ALW-NW</td>
<td>11.279</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>ALW-ALNW</td>
<td>10.036</td>
<td>.000*</td>
</tr>
</tbody>
</table>

"significant at .05 level of significance

Table 2: T Value and Significance between Rhyming and Alliterative Words and Non Words

Graph 1: Comparison of two languages in both SR and IR

Statistical analysis using one-way repeated measure ANOVA revealed that there was a significant main effect on all the type of tasks – item and serial across language (F (3, 36) = 7.354, p<0.001). Bonferroni multiple comparisons were done to find the word list that showed a significant difference.

The result showed a significant difference between non words (NW) (p<.05) across language. This can be explained by the word likeness of the words in the English non word list compared to Malayalam non words used in the study (Roodenrys & Stokes, 2004). Comparison of performance for rhyming words, alliterative words, rhyming nonwords and alliterative nonwords did not show a significant difference. This indicates that the PSE is similar in both the languages except in case of simple non-words. This can be attributed to the word likeness of the English nonwords when compared to those in Malayalam which is in consonance with the study by Roodenrys and Stokes (2004) where they found that there is a positive effect of word likeness on nonwords regardless of task. The similar results for PSE observed in both the languages for item and serial recall suggests close proximity of the two languages as though being on a continuum.

Conclusion

This study aimed to examine the phonological similarity effects between different word lists in
Malayalam-English bilinguals. From the first experiment it was found that performance for both item and serial recall tasks varied only for simple nonwords between the two languages. Performances on other wordlists were similar across both English and Malayalam. This shows the close proximity between these two languages. The superior performance on words over nonwords irrespective of the feature in both languages shows the effect of lexicality in both languages on both item recall and serial recall. The superior performance of rhyme words and alliterative words over simple nonwords in both the languages supports the premise that category cues for better recall which in turn supports feature based model (Nairne, 1990). Overall the results show similarities in PSE between Malayalam and English thus suggesting that the PSE construct employed to propose short term memory models for English language would also explain PSE in Malayalam though the two languages are from different families. This findings inturn suggest the need for incorporating the linguistic researches in short term memory models to verify the models as well as to consider the findings when adopting test materials from developed for western population. This should also be taken into account while developing test stimuli for assessing the short term memory as well as presenting stimuli during intervention.

References

Acknowledgements
The authors wish to express their gratitude to Dr. Vijayalakshmi Basavaraj, Director, AIISH for permitting to carry out this study. They also thank all the subjects for their cooperation for the study.
DEVELOPMENT OF SPEECH RHYTHM IN KANNADA SPEAKING CHILDREN

*Savithri S. R., **Sreedevi N., ***Jayakumar T., ***Kavya V.

Abstract

Rhythm in speech is the systematic organization of prominent and less prominent speech units in time, such as syllables and vocalic intervals. Language of the world has been organized under stress-timed, syllable-timed and mora-timed, depending on the type of syllables used in a language. The present study is initially output of large scale study which investigated the development of speech rhythm in typically developing Kannada speaking children by using the pair-wise Variability Index (PVI). Total of 15 boys, were divided in to three age groups (4-5, 8-9 and 11-12 years) with an equal number of participants. A five-minute of narrated speech sample of each child was elicited using cartoons or Panchatantra pictures. All the samples were audio-recorded using Olympus digital voice recorder at a sampling frequency of 16 kHz. Each speech samples were audio listened carefully removed the pauses manually. The Vocalic (V) and Intervocalic (IV) durations were measured in the samples using PRAAT software. The duration difference between successive vocalic and intervocalic segments was calculated and averaged to get the normalized Pair-wise Variability Index (nPVI) and raw Pair-wise Variability Index (rPVI), respectively. The result indicated that segmental timing showed a developmental trend in children and the boys begin to adult-like rhythm at around 11-12 years. Due to the high nPVI and low rPVI values the rhythmic pattern remains unclassified and cannot be placed in any of the rhythmic classes. The findings reveal that the syllabic structure used by children is different (prolonged vowel duration) from the adults.

Key words: Speech rhythm, Vocalic duration, Intervocalic duration, Pair wise Variability Index.

Rhythm, a prosodic feature, refers to an event repeated regularly over a period of time. Rhythm in speech is the systematic organization of prominent and less prominent speech units in time, such as syllables and vocalic intervals (Abercrombie, 1967). Rhythm varies with languages and depends on the types of syllables used in a language. Languages differ in characteristic rhythm, and with respect to adult speakers, they have been organized under stress-timed, syllable-timed and mora-timed, based on the Rhythm Class Hypothesis (Abercrombie, 1967). 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 (Ladefoged, 1975).

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 330ms. 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 and it is called a mora-timed language. When a language has complex syllabic structure, for e.g. V and CCCVCC, the difference between syllables can be very wide. In such a condition one has to use a slow stress-timed rhythm (Abercrombie, 1967).

The development of concept on rhythm measurement was started with the concept of isochrony- i.e. each syllable has equal duration or the occurrence of regular stress beats. The first attempt to test Rhythm Class Hypothesis (Grabe &
Low, 2002) by using the average syllable duration (ms), but was not found to be effective in classifying rhythm types. Roach (1982) used a different measure – inter-stress interval (ISI). However, ISI also does not seem to classify all languages on the basis of rhythm. Ramus, Nespor and Mehler (1999) measured and found that a combination (vector) of vocalic durations (%V) and SD of consonant intervals (\(\Delta C\)) provided the best acoustic correlate of rhythm classes. These measures reflected rhythmic differences as continuum, but not classes.

The Pair-wise Variability Index (PVI) was developed by Low (1998) for rhythmic analysis. This is a quantitative measure of acoustic correlates of speech rhythm and it calculates the patterning of successive vocalic and intervocalic (or consonantal) intervals, showing how one linguistic unit differs from its neighbor. The normalized Pairwise Variability Index (nPVI) and raw Pairwise Variability Index (rPVI) was developed by Low, Grabe and Nolan (2000). nPVI is used for rhythmic analysis of vocalic durations and rPVI is used for rhythmic analysis of intervocalic durations. Since it is a ratio it does not have any unit. Using the nPVI and rPVI value majority of the languages was classified successfully in comparison with other measures of rhythm. The classification of languages according to nPVI and rPVI is based on the following pattern shown in Table 1. Classifying the rPVI and nPVI value as high or low is in comparison with each other.

<table>
<thead>
<tr>
<th>Classification</th>
<th>rPVI</th>
<th>nPVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress-timed</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Syllable-timed</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Mora-timed</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 1: Classification of rhythm patterns based on the Vocalic and Intervocalic intervals.

In the Indian context, the research done so far is mostly on adults and much needs to be done on speech rhythm in children. Savithri, Sanjay Goswami and Kedarnath (2007) investigated rhythm in Kannada speaking adults and results showed that Kannada is a mora-timed language (low rPVI and nPVI). The rPVI values for the reading sample ranged between 35.90 and 52.10 with a mean of 46.18 and nPVI values ranged between 41.80 and 54.36, with a mean of 46.95.

With respect to children, few studies have been carried out recently. Subhadra, Das and Singh (2009) examined the rhythmic features of speech in 70 bilingual children speaking English and Hindi between 5 and 8 years. They found that at around 7 years of age, the durational variability for English became significantly larger than that of Hindi and suggested that children learning two languages exhibit characteristic speech rhythm around 7 years of age. A study by Savithri, Sreedevi and Kavya (2009) investigated the type of speech rhythm in typically developing 8-9 year old Kannada speaking children. The rPVI values for these children ranged between 44.97 to 78.17 with a mean of 65.90 and the nPVI values ranged between 80.10 to 122.75 with a mean of 96.06.

The results of above studies reported high nPVI and low rPVI values for adults as well as for children in Kannada language and therefore the rhythmic pattern remained unclassified. The results also showed that syllabic structure used by the children was simpler than adults. These reports give interest in investigating the trend of change in the rPVI and nPVI values across age groups. This intern will help to in known the syllabic structure changes in the spoken language across age groups which will help in assessment and management of children with arrhythmia. Hence there is a need to investigate the development of speech rhythm pattern in children. In this context the present study was undertaken. The present paper is a part of the DST project and investigated the development of speech rhythm in typically developing Kannada speaking children across the age and gender in large samples. The present study shows the result of three age groups of participants.

**Method**

**Participants:** A total of 15 boys participated in the study. Participants were divided into three groups according to their age. Group I consisted of 5 boys in the age range of 4-5 years; Group II consisted of 5 boys in the age range of 8-9 years and Group III consisted of 5 boys in the age range of 11-12 years. All the participants were screened by the speech-language pathologist for speech and hearing problem. Ling test was used for hearing screening and the standardized questioner developed by department of Prevention of communication disorder,
All India Institute of Speech and Hearing was used to screen the speech and language problem.

**Material:** Cartoons developed by Indu (1990) were used for children of Group I. Children in Group II and III described Panchatantra pictures developed by Rajendra Swamy (1992).

**Procedure:** Speech samples were collected in quiet room of schools in Mysore. A five-minute of narrated speech sample of each child was elicited using cartoons or Panchatantra pictures. From Group I children speech was elicited using prompts and repetitions. All the samples were audio-recorded using Olympus digital voice recorder at a sampling frequency of 16 kHz.

**Analyses:** Speech samples were displayed as waveform using the PRAAT software (Boersma & Weenink, 2004, version 5.0.34). They were heard carefully to identify pauses which were removed manually. This was done in order to get an appropriate measure of the vocalic and non-vocalic segments. The Vocalic (V) and Intervocalic (IV) durations were measured in the samples using PRAAT software. Vocalic measure refers to the duration of vowel/ semivowel/ diphthong that will be measured as the time duration from the onset of voicing to the offset of voicing for that vowel/ semivowel/ diphthong. Intervocalic measure refers to the duration between two vocalic segments. It was measured as the time duration between the offset of the first vocalic segment to the onset of the second vocalic segment. Figure 1 shows the illustration of vocalic and intervocalic measures in the sentence [ondu: ralli ondu ka:ge ittu].

The duration difference between successive vocalic and intervocalic segments was calculated and averaged to get the nPVI and rPVI, respectively. Pairwise Variability Index developed by Low, Grabe and Nolan (2000) was used as a measure of rhythm. The rPVI and nPVI were measured using the following formulae:

\[
\text{nPVI} = \frac{100}{m-1} \sum_{k=1}^{m-1} \frac{|d_k - d_{k-1}|}{(m-1) \left(\frac{d_k + d_{k-1}}{2}\right)}
\]

where, \( m \) is the number of intervals and \( d_k \) is the duration of the \( k^{th} \) interval.

\[
\text{rPVI} = \frac{100}{m-1} \sum_{k=1}^{m-1} \frac{|d_k - d_{k+1}|}{(m-1) \left(\frac{d_k + d_{k+1}}{2}\right)}
\]

where, \( m \) is the number of intervals and \( d_k \) is the duration of the \( k^{th} \) interval.

**Statistical analysis:** Microsoft Office Excel program was used to generate the formula and calculate the difference between successive vocalic and intervocalic segments and to obtain the nPVI and rPVI values. Mann Whitney-U test was used to obtain the significant differences between the groups.
Table 2: Mean rPVI and mean nPVI of the five male subjects across three age groups.

<table>
<thead>
<tr>
<th>Sub. No.</th>
<th>Group I (4-5 yrs)</th>
<th>Group II (8-9 yrs)</th>
<th>Group III (11-12 yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rPVI</td>
<td>nPVI</td>
<td>rPVI</td>
</tr>
<tr>
<td>1.</td>
<td>51.55</td>
<td>119.5</td>
<td>62.13</td>
</tr>
<tr>
<td>2.</td>
<td>49.75</td>
<td>96.07</td>
<td>48</td>
</tr>
<tr>
<td>3.</td>
<td>92.58</td>
<td>86.92</td>
<td>66.57</td>
</tr>
<tr>
<td>4.</td>
<td>74.34</td>
<td>92.46</td>
<td>63.21</td>
</tr>
<tr>
<td>5.</td>
<td>66.74</td>
<td>83.41</td>
<td>63.22</td>
</tr>
<tr>
<td>Median</td>
<td>66.74</td>
<td>92.46</td>
<td>63.21</td>
</tr>
<tr>
<td>(SD)</td>
<td>(17.63)</td>
<td>(14.18)</td>
<td>(7.25)</td>
</tr>
<tr>
<td>Confidence Interval (95%)</td>
<td>45.8-88.8</td>
<td>78-113.2</td>
<td>51.6-96.6</td>
</tr>
</tbody>
</table>

Results and Discussion

The mean rPVI of Group I ranged between 49.75 to 92.58 and the mean nPVI ranged between 83.41 to 119.5. The mean rPVI of Group II ranged between 48.0 to 66.57 and the mean nPVI ranged between 83.72 to 112.8. The mean rPVI of Group III ranged between 36.63 to 46.64 and the mean nPVI ranged between 67.52 to 78.8. The mean nPVI was found to be higher than the mean rPVI in all the three groups. Table 2 and the figure 2 shows the rPVI and nPVI values of all the subjects.

Results of Mann Whitney-U test indicated no significant difference between group I and II for rPVI \( |Z| = 0.94, p > 0.01 \) and nPVI \( |Z| = 0.52, p > 0.01 \). Significant differences between group II and III for rPVI \( |Z| = 2.61, p = 0.01 \) and nPVI \( |Z| = 2.61, p = 0.01 \) and between group I and III for rPVI \( |Z| = 2.61, p = 0.01 \) and nPVI \( |Z| = 2.61, p = 0.01 \) were found. The results revealed several points of interest. First, the results indicated that nPVI was higher than the rPVI values in all the three groups. This is in not consonance with the findings by Savithri, Sanjay Goswami and Kedarnath (2007) where they have used reading task for speech rhythm analysis in adults speaking Kannada. Current study showed high value of nPVI value which may be because of of longer durations of vocalic segments. This implies that children (boys) in the present study tend to prolong the vowel to a greater extent, which had effect on nPVI compared to adults. Another reason can be the difference in the task one being reading and another being narration. Narration of pictures requires more time (to form a sentence) which might have caused lengthening of vowels in children’s speech.

Second, the results of the present study revealed no significant difference between 4-5 years and 8-9 year old children. But there was a significant difference between 8-9 years and 11-12 year old children. The nPVI and rPVI were shorter in boys in the age range of 8-9 years compared to 11-12 year old boys. The nPVI value of boys in the age range of 11-12 years was closer to adults (Savithri, Sanjay Goswami & Kedarnath, 2007). This shows that the boys begin to acquire an adult-like rhythm at around 11-12 years. These findings support the results of several studies by Smith (1978), Lee, Potamianos and Narayanan (1999), Smith and Kenney (1999) which indicate that segmental timing shows a developmental trend in children and that the children start to develop speech rhythm as early as 15 months, which continues till the age of 12 years.

(Author data is from Savithri, Sanjay Goswami and Kedarnath, 2007)

Figure 2: Mean of nPVI and rPVI values for children of the three age groups vs. adults.
Third, the rhythm in boys in the present study showed high nPVI value and Low rPVI value which remains 'unclassified'. This is not in consonance with the results of the study in Kannada speaking adults by Savithri, Sanjay Goswami and Kedarnath (2007) which indicated that Kannada was a mora-timed language. This result generated doubts whether rhythm needs to be classified under the three types. Probably, there may be many more types of rhythm. Also, should the measurement of rhythm needs to be further investigated or whether the rhythm measurements should be based only on durations or should it be based on other acoustic correlates of prominence, namely increased F0, increased amplitude and changed vowel quality. Kohler, 2009 reported that rhythm is not a fixed typological prominence pattern for groups of language but is variable within each language. However it is also determined by the language in that the potential rhythmical patterns of F0, syllabic duration, energy and spectral patterning over time.

Fourth, it was observed that the PVI variability (SD) was larger in the younger age groups compared to the older age group and it decreased from 4-5 years to 11-12 years of age. Most of the time the variability was higher in nPVI compared to rPVI. These results support the findings of Lee, Potamianos and Narayan (1999), who reported that between the ages 9 and 12, both magnitude and variability of segmental durations decrease significantly and rapidly, converging to adult levels around age 12.

The study intends to investigate the development of speech rhythm in typically developing Kannada speaking children from 3 to 12 years of age. Hence, it is anticipated that a picture of emerging rhythm will appear when the study is complete.

Conclusions

Speech rhythm refers to the alternation of timing and the perceived regularity of prominent units in speech, and its acquisition provides valuable insights into how children learn their languages. The present study investigated the development of speech rhythm in typically developing Kannada speaking children by measuring the vocalic and intervocalic intervals. The results of the present study indicated that children appear to produce durational and other prosodic differences as early as 4-5 years, but their productions are characteristically variable until much later, stabilizing to more or less adult-like rhythmic patterns around 11-12 years of age. This study reveals that the syllabic structure used by children is different from the adults and there is a need to develop normative data to map the pattern in which they acquire adult-like speech rhythm.

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DISCOURSE IN TRAUMATIC BRAIN INJURY

*Hema N. & **Shyamala Chengappa

Abstract

Analysis of discourse production can be chosen as a means for testing cognitive-linguistic abilities of individuals with traumatic brain injury (TBI). The aim of the present study was to assess the cognitive-linguistic abilities in terms of discourse analysis in participants with traumatic brain injury and to compare them with discourse of neurologically intact individuals. The participants included 20 individuals with TBI (closed head injury) and 20 healthy talkers. The task involved use of a conversational topic, “family”. Conversation was audio recorded using computer software and speech sample was transcribed verbatim using IPA and analyzed for discourse parameters using a discourse analysis scale. The results of this study showed a significant difference between the participants with TBI and healthy talkers. Participants with TBI were deficient on certain parameters of discourse. The details are discussed.

Key words: Discourse analysis scale, traumatic brain injury, cognition, linguistic ability

Discourse can be defined broadly as language use “in the large”, or as extended activities that are carried out via language (Clark, 1994). It is a unit of language longer than a single sentence for verbal exchange and conversation. Discourse is a broad term used to describe four forms of connected speech (Rosenbek, LaPointe & Wertz, 1989): Procedural discourse deals with describing the procedures involved in performing an activity. Expository discourse deals in conveying information on a single topic by a single speaker. Conversational discourse is the one which conveys information between a speaker and listener or among speakers and listeners. And narrative discourse is a description of events. According to Brown and Yule (1983), discourse can be studied at comprehension level where it checks the ability to establish relationships within and between sentences by using context as the foundation for comprehension to form a coherent representation.

At expressive level, it can be transactional discourse which checks for the ability to express content and have interactional discourse which deals with the expression of personal attitudes and social relationships. Conversation is fundamental for socializing and strengthening interpersonal relationships through good comprehension ability and expressive skills. Individuals with TBI show poor conversational competence due to their verbosity, inappropriate responses to social communication, poor topic maintenance and reliance on additional conversational prompting. Thus, it is not surprising that their conversations have been described as less enjoyable, interesting or rewarding (Coelho, Youse & Le, 2002; Godfrey & Shum, 2000; Paterson & Stewart, 2002).

Discourse can be analyzed at microlinguistic and macrolinguistic levels (Ulatowska, North & Macaluso-Haynes, 1981; Ulatowska, Freedman-Stern, Doyle & Macaluso-Haynes, 1983; Glosser & Deser, 1990; Cannizzaro & Coelho, 2002): At microlinguistic level the processing of phonological, lexical-semantic and syntactic aspects of single words and sentences can be analyzed. Measures of syntactic complexity and production at the single word level are often used here. At macrolinguistic level, the ability to maintain conceptual, semantic and pragmatic organization at the suprasentential level can be analyzed.

Coherence and cohesion are often used as measures of macrolinguistic abilities (Halliday &
It relies on the interaction of both linguistic in terms of comprehension and expression and non-linguistic knowledge, especially the non-linguistic systems of executive control and working memory (Cannizzaro & Coelho, 2002). Competent speakers use a range of discourse levels in their daily communication to meet the demands of situations and partners (Bloom, 1994; Coelho, Liles & Duffy, 1994; Togher, 1998).

Finally, the discourse can be examined via a text, viewing it as a product or as a joint activity of discourse as a process. Because of its inherently dyadic nature, Clark (1994) suggested to view discourse as a joint and more meaningful activity, referring to interactional conversation as well as to stories told to others by single narrator.

Ehrlich (1988) has indicated that examination of communication skills of persons with TBI should always include assessment at the discourse level, particularly because these deficits on traditional linguistic tests are more subtle than what is observed for aphasia and/or other adult communication disorders. Discourse analysis has been widely used by psychologists, speech pathologists, and other professionals to analyze everyday language interactions (Stubbs, 1983). Discourse elicited from monologues and narrative tasks does not always represent interactional communication of everyday and therefore may not capture true communicative competence or incompetence of individuals with TBI (Snow, Douglas & Ponsford, 1995; Snow & Douglas, 2000). These tasks are used as controlled elicitation tasks mostly for research purposes.

Conversation and “social chat” have been recognized as important communication genres for individuals with TBI (Davidson, Worrall & Hickson, 2003; Larkins, Worrall & Hickson, 2004). It is well documented that individuals with TBI do not always produce proficient conversational discourse because they have difficulty in maintaining appropriate pragmatic and social skills. They may also have difficulty producing proficient discourse due to impaired attention, planning, organization, and self-regulation processes (Bond Chapman, Levin, Matejka, Harward & Kufera, 1995; Cherney, Shadden & Coelho, 1998). Previous research on conversational discourse of individuals with TBI has depicted their incompetence and communication difficulties. Conversations with individuals with TBI have been described as more effortful and less enjoyable because their partners are required to use “additional” prompting to maintain the topic and flow of conversation (Coelho, Youse & Le, 2002). Conversational interaction between friends, parents and siblings of individuals with TBI has been occasionally included in clinical studies, and it is difficult to identify if discourse performance of individuals with TBI may be improved in the presence of people who share meaningful (social) relationships with them. But this causes bias in choosing discourse partners and does not provide an accurate judgment of TBI individuals’ discourse ability. So, discourse studies in the TBI literature have focused on “conventional” genres such as monologues, narratives, procedural texts and structured conversations to make the task more controlled from a research point of view.

Many investigators have also made incidental comments on the salient impairments in conversation exhibited by participants with TBI. Coelho, Liles, Duffy and Clarkson (1993) examined conversations of five individuals with TBI, five individuals with aphasia, and five non-brain-injured controls using Blank and Franklin’s (1980) procedure for evaluating appropriateness within a conversation. Results indicated that the individuals with TBI had more turns, shorter utterances, decreased response adequacy, as well as difficulty initiating and sustaining topics. These findings suggested such analysis to be promising for delineating distinctions in conversational performance across groups. Functional communication requires language competence in a variety of settings ranging from informal social interactions to formal educational or work-related tasks (Snow, Douglas & Ponsford, 1997).

Recent investigations have demonstrated that individuals with TBI experience difficulty with communicative effectiveness across a number of discourse production genres. In various other studies (Allen & Brown, 1976; Milton, 1984; Mentis & Prutting, 1991), TBI patients were found to be lacking in many areas of conversational discourse like interactional/ non-propositional aspect and propositional aspect of conversation. The discourse abilities of adults who have suffered TBI have revealed that although these
individuals display “normal” or “near normal” language on traditional aphasia tests, they demonstrate varying levels of impairment in the coherence, cohesion, and informational content of their extended verbal production (Hagen, 1984; Ylsivaker & Szekeres, 1989, 1994; Hartley & Jensen, 1991; Coelho, Liles & Duffy, 1994).

The present study sought to validate a comprehensive discourse analysis using “Discourse Analysis Scale” (Hema & Shyamala, 2008) for conversation task in Kannada language. The scale consists of conversation parameters categorized under two headings. The propositional aspect deals with how discourse is organized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to maintain unity. And the non-propositional aspect deals with the important category of social communication behavior. These behaviors reflect the reciprocal nature of conversation and the joint co-operation required from the participants. This is a perceptual rating scale formed on the basis of standardized Damico’s Clinical Discourse Analysis scale (1985) and Grice’s (1975) Cooperative Principles for conversation, for differentiating discourse abilities between the groups of individuals with TBI and healthy talkers. A detailed description of all the parameters of discourse is shown in Appendix A.

Aim

The study aimed to assess, compare and differentiate the discourse abilities among the individuals with TBI and the healthy talkers.

Method

Participants: A total of 20 right handed individuals with TBI (Closed Head Injury) following road traffic accidents (male – 16, female – 6) in the age range of 20 to 40 were taken as TBI group. Although Kannada as mother tongue was the criteria, knowledge of other languages (English, Hindi, Tamil and Telugu) were noted. None of the patients included in the study had Aphasia as confirmed by Western Aphasia Battery test (Kertesz, 1982). They all belonged to a middle/high socioeconomic status confirmed from NIMH Socioeconomic Status Scale (NIMH, 1997). Participants were also selected according to the severity of the trauma. Participants who were identified as having moderate to severe injury on the basis of Glasgow Coma Scale (Jennette & Teasdale, 1981) were selected for the study. Participants with any other type of trauma like open head injury and mild insult were not selected for the study. All participants presented a history of post-traumatic amnesia and there was a gap of at least 1-5 months post accident.

The group of healthy talkers comprised of 20 normal individuals matched for age, sex and education with no history of traumatic brain injury or any other brain insult. They were also screened for any speech, language, cognitive-linguistic and hearing impairment using Western Aphasia Battery (Kertesz, 1982), Mini Mental Status Examination (MMSE) (Folstein, Folstein & McHugh, 1975) and routine pure tone audiometry. The detailed demographic data is tabulated in Table 1.

Procedure: The target task was free conversation between the participants and the investigator. A total of two sessions of conversation, each varying from 10 to 20 minutes, was carried out on various topics. The first session was aimed to improve interaction between the investigator and the participants to build rapport. During the second session the participants showed less inhibition in their conversation, since they became quite accustomed to the investigator. The succeeding single session was recorded. Only ten to fifteen minutes speech sample of this session was selected for the final analysis. The conversation 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 in between the recordings. Before recording, the participants were instructed to talk in a way similar to two friends talking to each other. They were also informed that they were free to ask any questions to the examiner during the conversation. Conversation sample was centered on particular topics like family and other few general topics like job, hobbies, hospital etc in order to keep the topic of conversation constant across all the participants.

From the recorded audio sample, transcription was done using broad International Phonetic Alphabet, (2007). Conversations between investigator (I) and participants (S) were transcribed. During transcription, initiation time, pause time, filled
<table>
<thead>
<tr>
<th>Pt No</th>
<th>Sex</th>
<th>Age at Injury (months)</th>
<th>DAA (months)</th>
<th>Type of Trauma</th>
<th>Severity</th>
<th>D H</th>
<th>GC S</th>
<th>PT A</th>
<th>LK</th>
<th>Lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>M</td>
<td>50</td>
<td>5</td>
<td>RTA</td>
<td>Severe</td>
<td>L</td>
<td>6/15</td>
<td>+ve</td>
<td>K, E, H</td>
<td>RTA with concussive head injury with fracture of left frontal bone with underlying fracture haematoma (small extra dural haematoma). Left frontal haemorrhagic contusion</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>40</td>
<td>3</td>
<td>RTA</td>
<td>Severe</td>
<td>L</td>
<td>8/15</td>
<td>+ve</td>
<td>K, E</td>
<td>RTA with concussive head injury with deep lacerated wound on left side of occipital scalp</td>
</tr>
<tr>
<td>3.</td>
<td>M</td>
<td>20</td>
<td>3</td>
<td>RTA</td>
<td>Severe</td>
<td>L</td>
<td>8/15</td>
<td>+ve</td>
<td>K, H, E</td>
<td>RTA with severe concussive head injury</td>
</tr>
<tr>
<td>4.</td>
<td>M</td>
<td>28</td>
<td>5</td>
<td>RTA</td>
<td>Severe</td>
<td>L</td>
<td>6/15</td>
<td>+ve</td>
<td>K, H, E</td>
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<tr>
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<td>40</td>
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<td>Severe</td>
<td>L</td>
<td>5/15</td>
<td>+ve</td>
<td>K, E</td>
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<td>Severe</td>
<td>L</td>
<td>8/15</td>
<td>+ve</td>
<td>K, E</td>
<td>RTA with severe head injury</td>
</tr>
<tr>
<td>7.</td>
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<td>RTA</td>
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<td>L</td>
<td>8/15</td>
<td>+ve</td>
<td>K, E, H, T</td>
<td>RTA with concussive head injury</td>
</tr>
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<td>40</td>
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<td>RTA</td>
<td>Severe</td>
<td>L</td>
<td>7/15</td>
<td>+ve</td>
<td>K, E</td>
<td>RTA with head injury with left emporomastoid bone fracture with left parietal bone fracture with underlying pneumozeaphalum</td>
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<td>Severe</td>
<td>L</td>
<td>7/15</td>
<td>+ve</td>
<td>K, E</td>
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<td>Severe</td>
<td>L</td>
<td>6/15</td>
<td>+ve</td>
<td>K, E, H</td>
<td>RTA with head injury with fracture post column left acetabulum with deep laceration of left frontal region</td>
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Table 1: TBI group case by case description
Table 1: TBI group case by case description

<table>
<thead>
<tr>
<th>Pt No</th>
<th>Sex</th>
<th>Age at injury (months)</th>
<th>DAA (months)</th>
<th>Type of trauma</th>
<th>Severity</th>
<th>D</th>
<th>H</th>
<th>GCS</th>
<th>PT</th>
<th>A</th>
<th>LK</th>
<th>Lesion</th>
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<td>11.</td>
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<td>26</td>
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<td>R</td>
<td></td>
<td>6/15</td>
<td>+ve</td>
<td></td>
<td>K, E, H, Ta</td>
<td>RTA with closed head injury with right temporal bone fracture with underlying moderate sized extra dural haemorrhage</td>
</tr>
<tr>
<td>12.</td>
<td>M</td>
<td>23</td>
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<td>Severe</td>
<td>R</td>
<td></td>
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<td></td>
<td>K, E, H, Ta, Te</td>
<td>RTA with severe head injury with right temporal bone fracture</td>
</tr>
<tr>
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<td>5</td>
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<td>R</td>
<td></td>
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<td>+ve</td>
<td></td>
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</tr>
<tr>
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<td>R</td>
<td></td>
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<td>+ve</td>
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<td>K, E, H</td>
<td>RTA with concussive head injury with right temporal bone fracture with mild cerebral edema</td>
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<td>R</td>
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<td>5/15</td>
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<td></td>
<td>K, E</td>
<td>RTA with severe head injury</td>
</tr>
<tr>
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<td>R</td>
<td></td>
<td>6/15</td>
<td>+ve</td>
<td></td>
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<td></td>
<td>8/15</td>
<td>+ve</td>
<td></td>
<td>K, E</td>
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<tr>
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<td>R</td>
<td></td>
<td>8/15</td>
<td>+ve</td>
<td></td>
<td>K, E</td>
<td>RTA with concussive head injury left temporal lobe small hyperdense area? contusion</td>
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<tr>
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<td>Severe</td>
<td>R</td>
<td></td>
<td>7/15</td>
<td>+ve</td>
<td></td>
<td>K, E, H</td>
<td>RTA with severe head injury with fracture of left sphenoid and zygomatic arch and gyriform hyperdensity right parietal lobe suggestive of subarachnoid haemorrhage with small pneumocephalus</td>
</tr>
</tbody>
</table>

pauses, unfilled pauses, false start etc. were carefully noted, for each episode. The time taken by the participants to respond to any question was noted from the same software.
The discourse was analyzed using “Discourse Analysis Scale” developed by Hema and Shyamala (2008) for the conversation and picture description task in Kannada. The scale consists of conversational parameters under two headings, the propositional aspect and the non-propositional aspect of conversational discourse (Hartley, 1995). Each parameter of this discourse scale is explained in detail in Appendix-A.

Scoring: Each parameter was rated and recorded on a specific criterion as shown in Appendix A. A five point perceptual rating scale (Appendix-A) was used to score two of the parameters, coherence and gaze inefficiency. A four point perceptual rating scale (Appendix-A) was used to score delay before responding. The other parameters were scored using a three point rating scale. The investigator repeated the process of transcription of discourse sample i.e., the conversation sample of two TBI and two healthy talkers were transcribed again after 10 days for verification of transcription, scoring, and reporting of the features. The findings were found to be correlating in the two instances.

Results
A comparison was made at the level of propositional and non-propositional aspects of discourse in communication tasks among the two groups using Mann-Whitney U test. Experimental group consisted of 10 TBI participants with LHD, 10 TBI participants with RHD and 20 healthy talkers as control group. As can be seen in Table 2, the healthy talkers showed very good performance in the discourse task when compared to TBI group.

It can be observed from Table 2 that the mean value for all the parameters in normal healthy talkers are higher compared to the TBI participants, except for information adequacy, inappropriate speech style and inappropriate intonation contour where it was found comparable.

Individual scores were calculated and Mann Whitney test applied for the sub-parameter of the discourse analysis procedure. The results are tabulated in Table 3. Among the TBI participants and healthy talkers, there was significant difference in their performance at both propositional and non-propositional aspects for conversation task. Except for information content and message inaccuracy, all the other parameters in discourse analysis showed significant difference at 0.05 level between the TBI and healthy talkers group for conversation task.

Discussion
An attempt is made in the present study to describe the features impaired in the discourse mode of conversation in TBI individuals comparing them with that of the healthy talkers. A comparison was made at the level of propositional and non-propositional aspects of discourse in communication tasks. Here, the healthy talkers showed very good percentage of performance when compared to TBI group. The significant difference in performance of TBI participants as compared to healthy talkers are discussed in detail under various sections.

The findings of this study have several implications pertaining to the characterization of conversational discourse performance following TBI and the use of discourse analysis procedure.

Propositional aspects of discourse
Failure to structure discourse
Between the TBI participants with LHD/RHD and healthy talkers, there was a significant difference for few parameters under discourse analysis. There are studies which support the results of the present study where the TBI groups lack forethought and organizational planning in their discourse structure. Study by Martin and McDonald (2003), describes a frontal lobe executive function account of pragmatic deficits resulting from traumatic brain injury. Pragmatic and discourse deficits resulting from RHD often mirror executive function deficits. Impulsivity, disorganization, poor planning, and poor judgment associated with executive function deficits are reflected in tangential, disorganized discourse, including responses that are not well thought out and may not be appropriate for a given situation according to Tompkins (1995). In summary, the TBI participants with LHD/RHD exhibit this particular feature of disorganized discourse and poor planning of discourse compared to normal control group.

Communication intent
Healthy talkers tended to greet others by themselves, but TBI participants did not make an effort to greet others by themselves. TBI groups were able to greet in response to other’s greeting. When compared to healthy talkers, these individuals were however, poor at initiating a conversation.
Table 2: Showing the mean, standard deviation of discourse analysis of conversation task for the TBI versus normal group

(* FSD-Failure to Structure Discourse, CI- Communication Intent, TM- Topic Management, IA- Information Adequacy, IC- Information Content, MI- Message Inaccuracy, COH- Coherence, NSV- use of Non-Specific Vocabulary, LNF- Linguistic Non-Fluency, ISS- Inappropriate Intonational Contour, GI- Gaze Insufficiency, TT- Turn Taking, CR- Conversation Repair, RB- Revision Behavior, NPT- Non-Propositional Total, PNPT- Propositional and Non-Propositional Total)

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<th>Std. Deviation</th>
<th>Normals</th>
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<th>Std. Deviation</th>
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<td></td>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td></td>
<td>Mean</td>
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<td>GI</td>
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Table 3: Results of Mann-Whitney test for the parameters of discourse analysis for conversation task

(†FSD-Failure to Structure Discourse, CI- Communication Intent, TM- Topic Management, IC- Information Content, MI- Message Inaccuracy, COH- Coherence, NSV- use of Non-Specific Vocabulary, LNF- Linguistic Non-Fluency, GI- Gaze Insufficiency, TT- Turn Taking, CR- Conversation Repair, RB- Revision Behavior, NPT- Non-Propositional Total, PNPT- Propositional and Non-Propositional Total)

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</table>

Table 3: Results of Mann-Whitney test for the parameters of discourse analysis for conversation task

(Note: ‘*’ indicate not significant difference)
**Topic management**

Lesser and Milroy (1993) define topic as “what is talked about through some series of turns at talk". Topic coherence can be defined as something that is constructed across turns by the collaboration of participant. It was noted that some of the TBI participants exhibited irrelevant introduction of topics which is an abnormal behavior. This result is in support with the study by Mentis and Prutting (1991) and Coelho, Liles and Duffy (1994) who found that TBI individuals produced unrelated topic changes.

There was a significant difference between TBI and healthy talkers for the parameter called rapid topic shift. It is reported in literature that some TBI participants change topics rapidly within few seconds. There was a mean difference between TBI participants and healthy talkers for this feature. This finding is in support of the study by Ehrlich and Barry (1989) where they report of rapid topic shift in TBI participants. The reason for this could be the deficit at executive functional level of the participants.

For non-coherent topic change there was significant difference between TBI participants and healthy talkers. Mentis and Prutting (1991) and Coelho, Liles and Duffy (1994) observed that TBI participants produced non-coherent topic changes compared to healthy talkers. Results of this study thus support, to some extent, that TBI participants, in general, exhibit this particular abnormal behavior in a conversation. This finds support with an Indian study done by Tanuja (2004) who found that TBI participants showed irrelevant and non-coherent topic changes when compared to normal speakers.

Perseveration in speech is reported in TBI participants. Here, an attempt was made to see if perseveration in terms of topic maintenance was observed even when the conversation partner changed the topic. TBI group showed some amount of perseveration behaviors. Most of the times, perseveration for topic was seen for a shorter time, which faded after two to three turns and very few times it persisted for a longer time. That is, TBI participants kept talking about the same topic for a long time.

Healthy talkers are seen to expand all the turns, unlike TBI participants who expand very few turns, according to study done by Tanuja (2004). This finding is in support of the earlier study done by Coelho, Liles and Duffy (1994) where they found that individuals with TBI contribute less elaboration to the topics, more often leaving it to the communication partner to develop and extend the topic.

Usually, healthy talkers give adequate elaboration to topics. They do not give more or less information. According to Hartley and Jensen (1991), some individuals with brain injury provide too many details and speak longer than required, while other individuals provide only short utterances and then give drastically reduced information. In the present study, the presence of this particular behavior was assessed and scored using three point perceptual rating scale (Appendix- A). There was a significant difference between the TBI participants and the healthy talkers.

Study done by Coelho, Liles and Duffy (1994) found that TBI participants provided shorter, less elaborations of a topic, more often leaving it to the communication partner to introduce and develop the topic. The results of the present study partially support this observation as minimal elaboration of topic was observed in the TBI groups. This could be because of individual’s linguistic and cognitive abilities. However, significant difference was found between the TBI participants and the healthy talkers.

In summary, it was seen that all the parameters under topic management showed significant difference between the TBI participants and the healthy talkers.

**Other propositional aspects of discourse**

**Information adequacy**

It was noted whether the information adequacy was at word level, sentence level or multiple sentence level. It was said to be adequate when it satisfied the question asked by the conversation partner. There was no significant difference between the TBI participants and the healthy talkers. These results are in contrast with the few studies, where the authors have revealed some pragmatic inappropriateness relative to difficulty in initiating and/or sustaining conversation with decreased response adequacy in individuals with TBI (Mentis & Prutting, 1991; Parsons, Lambier, Snow, Couch & Mooney, 1989; Snow, Douglas & Ponsford, 1997). Another supporting study by Hartley and Jensen (1991) reports that participants with closed head injury produce only one half or two-thirds the amount of accurate content produced by normal participants and have drastically reduced information. This was quoted with reference to the narrative discourse but
the same findings are not seen in the present study on conversational discourse, where both the groups performed equally well.

**Information content and message inaccuracy**

There was no significant difference between the TBI participants and healthy talkers for information content and message inaccuracy. Thus it is suggested that none of the participants showed any redundancy, incoherence and ambiguity in their speech. But studies have shown reduced informational content in TBI participants (Chapman et al., 1992; Ehrlich, 1988; Mentis & Prutting, 1991). In this study however, the difference was not seen.

**Coherence**

The present study reveals the same results as that of studies by Hough and Barrow (2003), Glosser (1993), Myers (1999a), Van Dijk and Kintsch (1983), where TBI participants demonstrate greater difficulty with global than local coherence showing more performance variability among participants in global as compared to local coherence.

**Use of non-specific vocabulary**

The speaker uses deictic terms such as “this”, “that”, “then”, “there”, pronouns, proper nouns and possessives when no antecedent or referent is available in the verbal or nonverbal context. Consequently, the listener has no way of knowing what is being referred to. Individuals displaying this difficulty also tend to overuse generic terms such as “thing” and “stuff” when more specific information is required. There are a few reports which say that individuals with TBI exhibit this behavior. Here TBI participants showed the presence of this particular behavior to a greater extent with a rating as ‘partially present’ when compared to healthy talkers. Statistical results showed significant difference at 0.05 level between the TBI participants and healthy talkers.

**Linguistic nonfluency**

Linguistic nonfluency can be defined as the speaker’s production disrupted by the presence of repetitions, unusual pauses, and hesitation phenomena. TBI groups have exhibited this particular behavior to a greater extent than healthy talkers, while there was a significant difference between the TBI participants and healthy talkers. In the present study among the many propositional aspects of discourse, linguistic nonfluency was present more in the TBI participants than among healthy talkers.

**Inappropriate Speech Style**

Inappropriate Speech Style means that the speaker does not change the structural, lexical, or prosodic form of his utterances according to the needs of the audience or the context. This may involve the occurrence of dialectal structural forms, code switching, style-shifting, language transfer, or interlanguage phenomena or idiosyncratic language codes. The TBI participants and healthy talkers did not show any difference in their mean and standard deviation as is shown in Table 1. Thus, between the two groups there was no significant difference.

**Inappropriate Intonational contour**

Both the groups did not show the presence of inappropriate intonational contour in terms of abnormal rising, falling and flat intonation contour with respect to a particular context. There was no difference in the mean and standard deviation, thus there was no significant difference between the two groups. But the study says the joint construction of discourse and the role of the conversational partner’s tone in the communicative exchange are additional factors to be considered in the analysis of discourse of adults with CHI (Togher, Hand & Code, 1997). These investigators studied information-seeking exchanges with five adults with CHI and with their non-brain injured matched controls. Their results suggest that not only did the participants with CHI differ from the controls in the way they “provided, requested, and negotiated information exchange”, but the communication partners interacted differently with the CHI population as well. For example, they found evidence of less information being given to the TBI population. Such features were not found in the present study.

**Gaze insufficiency**

The percentage score for gaze insufficiency was considered and the result of non-parametric test showed significant difference at 0.05 level between the TBI participants and healthy talkers.

**Delay before responding**

Time taken by the TBI participants in responding to any questions asked by investigator was noted using a four point rating scale (Appendix- A). The participants in TBI group with LHD and RHD showed a delay of 4-6secs respectively in responding to any question. There was a significant difference between the TBI participants and healthy talkers.
Non-Propositional aspects of discourse

Turn taking

Between the TBI participants with LHD/RHD and healthy talkers, there was significant difference for all the parameters under non-propositional aspects of discourse. Normal participants are seen to initiate many turns in a conversation. In contrast, TBI participants are reported to take less initiation of turns. They initiate very few turns in conversation. This result is in support with the findings of Milton, Prutting and Binder (1984). TBI group were very reluctant to initiate the turns. Only few participants were able to initiate the turns.

Wave Surfer 1.5.7, computer software was used to note down the time (in terms of seconds) taken to start a turn. From the individual scores it was noticed that all the TBI participants showed the presence of this particular feature. Participants took little time to start the turn. However, there was significant difference between the TBI participants and healthy talkers.

According to Schegloff (1987), normal individuals are reported to take contingent turns in conversation. Results suggest that there was a significant difference between the two groups. This is supported by literature where, according to Milton, Prutting and Binder (1984), three out of five adults in their study presented problem in taking contingent turns. The non-contingent turns can be attributed to lack of perception of flow of conversation. It seemed like they could not perceive the meaning of the preceding turn because of lack of concentration, subsequent to which they concentrated on one particular word and started speaking in relation to that word in a non-coherent way.

Many studies have implicated the right hemisphere in the production and comprehension of prosody, specifically emotional prosody (Baum & Dwivedi, 2003; Pell, 2006; Ross, 1981; Walker, Daigle, & Buzzard, 2002). In general, prosodic cues are necessary in conversation to take over the turn from the other partner. A normal speaker is able to understand the prosodic cues in a sentence to take over the turn. However, the TBI groups failed to take prosodic cues from the conversation partner in order to take over the turn. Results from Table 1 show that there was significant difference between the TBI group with LHD/RHD and healthy talkers. This observation supports the proposition by Milton (1984) and Hartley (1995) who reported that TBI participants had problem in understanding prosodic cues to take over the turn. It is seen that individuals with very severe TBI shift their mode of communication to nonverbal because of the impairment in verbal mode. In the present study, the TBI participants exhibited this particular behavior and there was significant difference between the TBI and healthy talkers.

In normal conversation, it is expected that only when one communication partner stops, the other partner initiate the turn. Results showed that there was significant difference between the TBI participants and healthy talkers. But all participants in the TBI groups showed the presence of a behavior called ‘persistent to listener’s or speaker’s mode’ in their conversation. These participants started speaking abruptly without letting the other person finish his turn and used to stay either in listener’s mode or speaker’s mode. This result is in support of a study by Mc Tear (1985), where the TBI population persists longer in either speaking or listening mode. This conversation behavior can be attributed to their lack of the ability to appropriately monitor and shift attention in TBI individuals.

Conversation repair

Conversation repair is a necessary strategy present in the conversation to convey a message in an effective manner. Results suggested significant difference between TBI participants and healthy talkers. But the individual scores in TBI group indicated that except for four participants all the other participants used too much of self repair through repetition in their conversation. This result is in support with the study by Tanuja (2004), who found that in TBI group, participants showed more of self repair strategy. The possible reasons for use of too much self repetition could be due to variability in terms of participants’ features. Many participants showed disfluencies, because of which there were many self corrections observed. The TBI participants used too much of revisions through clarification in their conversation when compared to healthy talkers. This result contradicts the one found by Marsh and Knight (1991) where the TBI individuals do not ask for clarification even if they do not understand the conversation. The reason for observation of more revisions in the speech of experimental group in the present study can be explained on the basis of their
inability to add on further information in speech in terms of giving clarification. Few participants made an effort to use clarifications given by the investigator and tried using the same as revisions.

Too much of other initiated repair behavior was seen when participants failed to convey the message and the partner asked for more clarification. The reason for use of too much of other initiated repair strategy is because of lack of perception of their own speech due to which they do not try to self-initiate the repair. Other reasons could be increased redundancy, incoherence, dysfluency, reduced information, fast rate of speech and unintelligibility in their speech leading to inability of the conversation partner to understand the message conveyed by the participants. This was observed more in TBI participants than healthy talkers.

**Revision behavior**

Revision behavior was observed and assessed based on the presence or absence of false starts and self-interruptions (Appendix-A). The results show significant difference between the TBI participants and healthy talkers. From the individual scores it was seen that in the TBI group, all the participants showed the presence of revision behavior except four participants.

**Inter-rater reliability**

To check for inter-rater reliability, ten percent of the data from the TBI participants and healthy talkers was considered. The alpha co-efficient was found to be 98% indicating good inter-rater reliability.

**Conclusion**

Everyday use of language underlies a complex system of cognitive and linguistic process. Language can be viewed and analyzed on many levels, one of which is “language in use” or discourse. Compared to production of sounds, words, or sentences in isolation, discourse production as an integrative and context-driven construct is thought to be representative of the complex communication needed for daily life activities. Therefore, cognitive and linguistic analysis at the level of discourse should be more sensitive to characterizing the types of communication deficits that various clinical populations may exhibit in the context of daily living.

An effort was made to combine all parameters taken from many discourse analysis tests and use as a “Discourse Analysis Scale” (Appendix-A). This will help the clinicians to tap the totality of discourse impairment in conversation. Thus, discourse analysis procedure was used to assess the discourse ability in individuals with TBI and healthy talkers. All the parameters of discourse were significantly different between the TBI participants and healthy talkers except information content and message inaccuracy of propositional aspects of discourse.

It is concluded that TBI participants have impairment in discourse when compared to healthy talkers because of injury effects. In summary, there was significant difference between the TBI participants and healthy talkers on a few parameters. In general, the healthy talkers performed better compared to TBI group in all the aspects of discourse. Both the groups showed a better performance on propositional aspects of discourse compared to non-propositional aspects of discourse. The clinical implications are many and they would further help in assessment, formulation of prognosis and development of appropriate treatment strategies for such population. The study could be extended to include not only a larger sample but also different post morbid durations as well as comparison of unstructured verses semistructured conversational tasks of discourse in the traumatically brain injured.

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**Acknowledgement**

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Appendix- A  
Discourse Analysis Scale  
By Hema and Shyamala, 2008

Points to be considered while using Discourse Analysis Scale:

The parameters of propositional and non-propositional aspects of conversation were quantified with few general instructions to the evaluator as:

1. Scoring procedure involves the use of rating scale.
2. Should read the keys provided in each sub headings which explains the exact meaning of the parameters to be scored.
3. Each appropriate behavior (normal) is given a higher score and the inappropriate behavior (abnormal) is scored as lowest value.
4. Finally if needed, one can find discourse quotient, using the total score on propositional and non-propositional aspects of communication which should be divided by total scores of all the features of propositional and non-propositional aspects of communication. This may be multiplied with hundred to get the score in percentage.

Propositional aspects of communication.

1) Failure to Structure Discourse (DS) [Score: 0-Frequently present, 1-Seldom present, 2-Absent]
   Key: The discourse is confusing even if it’s organized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to maintain unity.
   a) Lacks for thoughts               ( )
   b) Lacks organizational planning    ( )

2) Communication intent (CI) [Score: 0-Absent, 1-Seldom present, 2-Frequently present, except for (e)]
   Key: Presence or absence
   a) Greets others:
      - By themselves               ( )
      - In response to other’s greeting ( )
   b) Introduces self              ( )
   c) Starts a conversation         ( )
   d) Asks for information          ( )
   e) Asks for assistance in understanding conversation ( )
      [Score: 0-Frequently present, 1-Seldom present, 2-Absent]
   f) Criticizes the conversation by agreeing or disagreeing to a part in the conversation ( )
   g) Fabricates/ imagines events    ( )
   h) Understands advancers and blockers in the conversation ( )

3) Topic management (TM) [Score: 0-Frequently present, 1-Seldom present, 2-Absent, except for (e)]
   Key: Presence or absence
   a) Irrelevantly introducing topics ( )
   b) Rapid topic shift                  ( )
   c) Non coherent topic changes/Inappropriate topic changes ( )
   d) Perseveration in the topics       ( )
e) Responses which expand topics → ( )
   [Score: 0-Absent, 1-Seldom present, 2-Frequently present]

f) Minimal responses (Giving only Yes/No responses) → ( )

g) Extra elaboration of topics → ( )

h) Minimal elaboration → ( )

4) Information adequacy (IA)
   Key: Answer to any question during conversation at word level/ single sentence level/multipl sentence level. Underline the level at which the patient is positioned.
   ● Word level/ Single Sentence level/ Multiple sentence level → ( )
   [Score: 0-Absent, 1-Seldom present, 2-Frequently present]

5) Information content (IC)
   Key: Meaningful and adequate information to any of the question in terms of initiating and/or sustaining conversation or if you know what the person is talking about...even if the information doesn’t appear to be available then give higher score.
   ● Non-meaningful and inadequate information → ( )
   [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

6) Message Inaccuracy (MI)
   Key: An attempted communication involving inaccurate/misinformation.
   ● Incorrect answers to the question/confabulation within the same question frame → ( ) [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

7) Coherence (COH)
   ● Global coherence → ( )
   Key: Presence of relationship between the meaning and content of verbalization with respect to the general topic of conversation.
   [Score: 0-Absent, 1- Seldom presents 2- Frequently present, 3-Very frequently present, 4-Always present]

   ● Local coherence → ( )
   Key: Presence of relationship between the meaning and context of verbalization with that of the immediately preceding utterance produced either by interviewer or participant. [Score: 0-Absent, 1-Seldom presents 2- Frequently present, 3-Very frequently present, 4-Always present]

8) Use of Nonspecific Vocabulary (NSV) → ( )
   Key: Overuse of generic terms such as “thing” and “stuff” when more specific information is required.
   [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

9) Linguistic Nonfluency (LNF) → ( )
   Key: Presence of repetition, unusual pauses, hesitations [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

10) Inappropriate Speech Style (ISS) → ( )
    Key: Presence of dialectal structural forms, code switching, style-shifting. [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

11) Inappropriate Intonational Contour (IIC) → ( )
    Key: Presence of abnormal rising, falling, flat intonation contour with respect to a particular context. [Score: 0-Frequently present, 1-Seldom present, 2-Absent]
12) **Gaze Inefficiency (GI)** \(\rightarrow\) ( \\
- Consistently no appropriate eye gaze with another person (Score- 0)
- Severe restricted eye gaze (appropriate eye gaze less than 50% of time?) (Score- 1)
- Appropriate eye gaze 50% of the time (Score- 2)
- Appropriate eye gaze 75% of the time (Score- 3)
- Consistent use of appropriate eye gaze (Score- 4)

13) **Delays before responding (DR)** \(\rightarrow\) ( \\
Key: Time taken to respond to any questions during the conversation which should be measured in terms of seconds.
- 7-8sec (Score-0)
- 5-6sec (Score-1)
- 2-4sec (Score- 2)
- 0.5-1sec (Score- 3)

**Non propositional or Interactional aspects of communication**

This is one of the important categories of social communication behavior. These behaviors reflect the reciprocal nature of conversation and the joint co-operation required of the participant.

The following subcategories are considered:

1) **Turn taking (TT)** [Score: 0-Frequently present, 1-Seldom present, 2-Absent, except for (a)]

   Key: Presence or absence
   a) Initiation of turn \(\rightarrow\) ( ) [Score: 0-Absent, 1-Seldom present, 2-Frequently present]
   b) Taking (some amount of) time to start a turn \(\rightarrow\) ( )
   c) Non contingent turn \(\rightarrow\) ( )

   Key: Does not fulfill the semantic or informational expectation of the previous turn, but shares the same topic. This also includes “don’t know,” “yes,” and “no” responses when used to avoid maintaining a topic, and echolalia.
   d) Unable to take prosodic cues \(\rightarrow\) ( )
   e) Rapid shift in the mode \(\rightarrow\) ( )
   f) Persistent in listeners or speakers mode \(\rightarrow\) ( )

2) **Conversation repair (CR)** [Score: 0-Frequently present, 1-Seldom present, 2-Absent]

   Key: Presence or absence
   a) Too much of self repair through repetition \(\rightarrow\) ( )
   b) Too much of revisions through clarification \(\rightarrow\) ( )
   c) Too much of other initiated repair ( )

3) **Revision behaviors (RB)** \(\rightarrow\) ( )

   Key: Presence of false starts and self-interruptions.
   [Score: 0-Frequently present, 1-Seldom present, 2-Absent]
EFFECTS OF TEACHING AND VOICE REST ON ACOUSTIC VOICE CHARACTERISTICS OF FEMALE PRIMARY SCHOOL TEACHERS

*Rajasudhakar R. & **Savithri S. R.

Abstract

Voice problems are known to be the most common among voice professionals worldwide. Teachers form a large group of voice professionals where females are a majority in that profession and are known to have more voice problems than males. The present study investigated the short-term effects of teaching (vocal loading) on acoustic parameters like mean fundamental frequency of phonation (pF0), standard deviation of fundamental frequency of phonation (SD pF0), speaking/reading fundamental frequency (sF0), frequency and amplitude perturbation (jitter and shimmer) and harmonic-to-noise ratio (HNR). Also, the study examined the effect of vocal rest following a workday teaching performance on these parameters. Twelve female primary school teachers in the age range of 23 to 42 years participated in the study whose average professional teaching experience was 8.6 years. The teachers were instructed to phonate vowel /a/ for 8-10 seconds at their comfortable pitch and loudness and read a standard reading passage in Kannada. These recordings were made at three different time intervals - i.e., (a) Monday morning (5-10 minutes prior to starting of teaching) - condition 1, (b) Monday evening (5-10 minutes after the school hours) - condition 2, and (c) Tuesday morning (after 17-18 hours of voice rest) - condition 3. The light-weight, portable digital audio tape (DAT) recorder was used to collect the voice and speech sample. The pF0, SD pF0, perturbation measures like jitter and shimmer and HNR were extracted from phonation of vowel /a/ and sF0 was measured from the reading sample by using PRAAT software. Results revealed that the difference between the acoustic values between condition 1 and 2 were, 14 Hz (pF0), 0.4 Hz (SD pF0), 7 Hz (sF0), 0.2% (jitter), 2.36% (shimmer) and 0.12 dB (HNR). Except HNR, all other vocal parameters increased after teaching performance (condition 2) and recovered back to baseline after 17-18 hours of voice rest (condition 3). The results indicated that these acoustic parameters (except HNR) were sensitive enough to document the extent to which the voice changes occurred due to vocal loading. Also, these altered vocal parameters were transient which recovered back to baseline after adequate voice rest.

Key words: Vocal fatigue, vocal usage, voice disorders, voice changes

Persons whose occupation places them at a high demand on vocalization are often considered to be at risk for the development of voice disorders. According to many questionnaire studies, 50% to 80% of teachers experienced voice problems (Pekkarinen, Himberg & Pentti, 1992; Gotaas & Starr, 1993) and teaching constitutes one of the 10 occupations who often require medical help for voice difficulties (Fritzell, 1996). A survey study conducted by Boominathan, Rajendran, Nagarajan, Seethapathy & Gnanasekar (2008) found 49% of high- and higher secondary Indian school teachers experienced voice problems. Voice use in teaching profession is highly demanding, and the hazardous factors are teaching often at high voice output level due to the presence of background noise, poor classroom acoustics, and poor working posture, long speaking distance, poor quality of air/ventilation,
stress, non-availability or poor-quality aids, inadequate treatment of early symptoms, especially laryngeal infections. Contributing co-factors are gender, living habits, individual endurance, vocal skills/experiences etc. Majority numbers of primary school teachers are women and Smith, Kirchner, Taylor, Hoffman, and Lemke (1998) reported that the majority of all phoniatric voice patients were women.

One of the sources of variability in the voice loading studies was experimental conditions some being conducted in laboratory and others in field conditions. Duration of loading might be considered as the second variability. Studies used the shortest loading times, being 15-20 minutes (Stone & Sharf, 1973; Linville, 1995) and the longest from 45 minutes-2 hours (Neils & Yairi, 1987; Gelfer, Andrews & Schmidt, 1996). The third difference may be the loading tasks, mostly being reading task (Neils & Yairi, 1987) or naming vowels (Verstraete, Forrez, Mertens & Debruyne, 1993). On the other hand, the loading in field condition has been habitual speaking during work such as acting in a theatre play (Novak, Dlouha, Capkova & Vohradnik, 1991), or teaching at school (Gotaas & Starr, 1993).

Very few studies were reported on voice changes induced by vocal loading. Fundamental frequency, sound pressure level, perturbation measures and long-time average spectrum have been used for documenting voice changes. These studies reported contradictory results and revealed individual differences. However, the most common result is that fundamental frequency (F0) rises after loading (Gelfer, Andrews & Schmidt, 1991; Stemple, Stanly & Lee, 1995). It has been found that the fundamental frequency depend on the circumstances i.e. lower in reading samples in laboratory condition than in teaching speech in a classroom condition (Rantala, Limdhoba & Vilkman, 1998). The problem in laboratory condition is the difficulty of simulating the real-life situation. It is feasible to manipulate one or more vocal parameters under laboratory condition that cannot adequately simulate live performance. The sound pressure level and shimmer increased after loading (Vilkman, Lauri, Alku, Sala & Sihvo, 1999). Laukkanen, Iломаки, Leppanen and Vilkman (2006) reported that the fundamental frequency of text-reading after a vocally loading workday registered a higher value compared to baseline in a group of primary school teachers. Interestingly, studies have shown that the jitter value increased (Gelfer, Andrews & Schmidt, 1991), or decreased (Stemple, Stanley & Lee, 1995) and/or showed no essential changes (Verstraete, Forrez, Mertens & Debruyne, 1993) due to vocal loading.

A very few empirical data are available on voice problems and the changes induced by vocal loading on voice parameters in Indian school teachers. Rajasudhakar and Savithri (2009a) reported increased fundamental frequency of phonation, standard deviation of fundamental frequency of phonation and jitter after one-day workload (teaching performance) in a primary school teacher. In a field study conducted by Rajasudhakar and Savithri (2009b) in five primary school teachers, reported after 6 hours of teaching, fundamental frequency of phonation, standard deviation of fundamental frequency of phonation, jitter and speaking fundamental frequency were increased compared to the pre-teaching (baseline) condition.

To the best of the knowledge, there have been very few empirical study on the teaching performance on voice in Indian school teachers in the natural-field situations. Also, the effect of voice rest after continuous, prolonged loud teaching is however not well understood. In this context, the present study documented and measured the short-term effect of changes in voice after teaching, and investigated the effect of voice rest on vocal parameters.

Method

Participants: Twelve female primary school teachers in the age range of 23-42 years (average age: 32.2 years) volunteered to participate in the experiment. Their teaching experience ranged from 5-20 years (average teaching experience: 8.6 years). They taught Science, Mathematics, Kannada, Social science and English to third and/or fourth grade students. The average number of students in each grade was about 30 to 35. The number of classes taken by the teachers per day was around five and the duration of each class was 45 minutes. The school timing was between 10 am to 4 pm including lunch time of 40 minute in afternoon. None of the participants were involved in private coaching/extra teaching after school hours. The participants were free from hypertension, diabetes, allergies, asthma and gastro-esophageal reflux disorder and did not
report of any speech, language, hearing or voice problems at the time of the study.

**Instruments used:** A portable, light-weight digital audio tape (DAT) recorder (Olympus digital voice recorder WS-100, Japan) was used. The recorder had in-built condenser microphone (ME 15) and the weight of the device was about 54 grams (including battery). The overall frequency response of the microphone was 100 Hz to 5000 Hz and size of the DAT recorder was about 94(L) x 40(W) x 15.1(T) mm. The sampling frequency was 12 kHz and the maximum power consumption of the DAT recorder was 100mWatts. PRAAT (Boersma & Weenink, 2009) software was used to extract some acoustic parameters of voice.

**Recording procedures:** The recording of voice samples was done on two regular workdays (Monday and Tuesday) after a relaxed weekend. The teachers were instructed not to overuse the voice on Sunday and spend the day with more voice rest and adequate sleep. Also, the same was to follow after school hours on Monday. The DAT recorder was worn around the neck of the subject. The distance between microphone and mouth was kept 10-12 cm constantly for all the participants. The subjects were instructed to phonate the vowel /a/ for 8-10 seconds at their comfortable (habitual) pitch and loudness at three different time intervals - (1) Monday morning (5-10 min prior to the starting of school i.e. condition 1, (b) Monday evening (5-10 min after the school hours i.e. condition 2, and (3) After 16-18 hours of voice rest (Tuesday morning) i.e. condition 3. Also, the subjects were instructed to read a standardized Kannada passage (‘Bengaluru namma’ - 42 words) after the phonation of vowel /a/. Figure 1 shows the subject wearing the digital audio tape recorder.

**Acoustic analyses:** PRAAT software was used to extract the acoustic parameters of voice like mean fundamental frequency of phonation (pF0), standard deviation of fundamental frequency of phonation (SD pF0), fundamental frequency of speech/reading (sF0), jitter, shimmer, and harmonic to noise ratio (HNR). The measures like pF0, SD pF0, jitter and shimmer were measured from phonation of vowel /a/. The initial and final (2 seconds) portion of the vowel phonation was truncated and the middle (4-5 seconds) steady state portion was considered for acoustic analyses. The sF0 was measured from the Kannada reading passage.

**Statistical analysis:** The mean and standard deviation of pF0, SD pF0, sF0, jitter, shimmer, and HNR were calculated from twelve teachers at three conditions. Repeated measures of ANOVA was administered to check the differences across conditions and Bonferroni's multiple comparison was done to test the pair-wise differences.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pF0 (Hz)</td>
<td>194</td>
<td>208</td>
<td>193</td>
</tr>
<tr>
<td>2</td>
<td>SD pF0 (Hz)</td>
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<td>2.07</td>
<td>1.87</td>
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<td>3</td>
<td>sF0 (Hz)</td>
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<td>210</td>
<td>202</td>
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<td>4</td>
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<td>0.43</td>
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<tr>
<td>5</td>
<td>Jitter (%)</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>6</td>
<td>sF0 (dB)</td>
<td>14.36</td>
<td>14.46</td>
<td>13.32</td>
</tr>
</tbody>
</table>

Table 1: Mean (M) and standard deviation (SD) of frequency, perturbation and HNR measures of teachers.

**Figure 1:** Subject wearing the digital audio tape recorder.

**Results**

The mean fundamental frequency of phonation (pF0) of vowel /a/ in condition 1 was 194 Hz. The pF0 value rose to 208 Hz at the end of the day (condition 2). After 18 hrs of voice rest, pF0 was dropped to 193 Hz. The mean and standard deviation of acoustics measures across three conditions were tabulated in table1.

Results of repeated measures of ANOVA revealed significant difference across the conditions at 0.001 levels on pF0 [F(2,22)=11.134, p<0.001]. Results of Bonferroni’s multiple comparison revealed that there was significant difference between condition 1 and 2, and between condition 2 and 3. But, no significant difference was noticed between condition 1 and 3. The standard deviation of fundamental frequency of phonation (SD pF0) was 1.61 Hz in condition 1. The SD pF0 increased to 2.01 Hz in condition 2 and dropped to 1.52 Hz in condition 3. Results of repeated measures of ANOVA revealed significant difference across conditions at 0.001.
levels on SD pF0 [F(2,22)=15.237, p<0.001]. Results of Bonferroni’s multiple comparison revealed significant differences between condition 1 and 2, and condition 2 and 3. But, no significant difference was noticed between condition 1 and 3.

The mean fundamental frequency of speaking/reading (sF0) in condition 1 was 203 Hz. The sF0 rose to 210 Hz at the end of the day (condition 2). After 18 hrs of voice rest, sF0 dropped to 202 Hz. Results of repeated measures of ANOVA revealed significant differences across the conditions at 0.001 levels on sF0 [F(2,22)=11.412, p<0.001]. Results of Bonferroni’s multiple comparison revealed significant differences between condition 1 and 2, and between condition 2 and 3. But, no significant difference was noticed between condition 1 and 3.

Jitter, in condition 1 was 0.53% which increased to 0.73% after 5 to 6 hours of teaching (condition 2). After 17/18 hours of voice rest, jitter dropped to 0.47%. Results of repeated measures of ANOVA revealed significant differences across the conditions at 0.001 levels on jitter [F (2,22)=9.217, p<0.001]. Results of Bonferroni’s multiple comparison revealed significant differences between condition 2 and 3 only.

In condition 1, shimmer was 10.41% and it increased to 12.77% after teaching performance (condition 2). In condition 3, (after voice rest) the shimmer value decreased to 10.01%. Results of repeated measures of ANOVA revealed significant differences across the conditions at 0.001 levels on shimmer [F(2,22)=6.040, p<0.001]. Results of Bonferroni’s multiple comparison revealed significant differences between condition 2 and 3 only. Before the starting of the teaching day, the mean HNR was 14.36 dB (condition 1) and it was 14.48 dB at the end of the teaching day (condition 2). After voice rest, i.e., on the next morning, it was 13.02 dB in condition 3. Results of repeated measures of ANOVA revealed no significant difference across the conditions on HNR measure.

Discussion

The results showed that the frequency related measures like pF0, SD pF0 and sF0 were significantly higher in condition 2 compared to condition 1. The results indicated that the frequency related parameters were increased from condition 1 to 2 by 14 Hz for pF0, 0.33 Hz for SD pF0, and 7 Hz for sF0. Compared to any other profession, teachers often speak loudly for longer duration in presence of high level background noise and not in a conducive environment. Due to this, most of the teachers suffer from vocal fatigue at the end of the workday. The accompanying feature along with vocal fatigue would be an increase in the level of muscular and structural tension of the vocal folds as reported by Welham and Maclagan (2003), thus leading to a higher F0 value. The obtained results are in agreement with the findings of Ranta, Vilkman and Bloigu (2002) who reported that the F0 increased by 9.7 Hz between the first and last lesson and also SD pF0 after loading. Rajasudhakar and Savithri (2009a) who reported that the F0 increased about 7.24 Hz between the first class recording and last class recording in a workday.

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

The pF0, SD pF0, and sF0 dropped significantly from condition 2 to condition 3. After 17 to 18 hours of voice rest, the measured acoustical parameters were the same as in condition 1. The present results supported the findings of Jayaram and Kalaiselvi (2006) who reported that there was reduction in frequency measures after 12 hours of complete voice rest following vocal loading (yakshagana performance).

The perturbation measures like jitter and shimmer also increased significantly from condition 1 to condition 2 by 0.23% and 2.63%, respectively.
Gelfer, Andrews and Schmidt (1991) and Rantala, Vilkman and Bloigu (2002) reported similar findings that jitter value increased after vocal loading. Also, shimmer increased after loading (Vilkman, Lauri, Alku, Sala & Sihvo, 1999; Rantala & Vilkman, 1999). The jitter and shimmer values which increased from condition 1 to 2, reduced significantly from condition 2 to 3. This reduction would be attributed to 17-18 hours of vocal rest wherein, the vocal folds and the surrounding laryngeal regions regained blood supply. Also, the resting of vocal apparatus brought about a reduction in structural and muscular tension of vocal folds, thereby controlling the variations in the vibration of vocal folds.

Harmonic to noise ratio (HNR), is one of the noise related measure. Interestingly, it did not show any significant changes across conditions. The results of the present study is in consonance with the findings of Verstraete et al., (1993) who found no significant changes in HNR value following 60 minutes reading task in untrained voice users. But, the present findings did not support the findings of Jayaram and Kalaiselvi (2006) who reported increased HNR after Yakshagana performance (vocal loading). This needs to be studied in a larger group of teachers to make any conclusions.

Summary and conclusions

The study measured the effects of teaching performance and voice rest on acoustic voice parameters in primary school teachers. The analysis of speech and voice samples of 12 primary school teachers’ revealed that the frequency related measures like, pF0, SD pF0 and sF0 along with perturbation measures like jitter and shimmer increased after 6 hours of voice use (classroom teaching). After 17-18 hours of voice rest, following the vocal loading, the increased voice parameters dropped and it reached to pre-teaching (baseline) condition. HNR did not show any characteristic ‘trend’changes after performance and after voice rest. It can be concluded that the acoustic voice parameters (except HNR) are sensitive enough to document the short-term effect of teaching on voice. The importance of voice rest and its concomitant effect on voice features was positive i.e., it recovered to the baseline value. So the changes induced by short vocal loading are transient and it can be brought back to normal (baseline) after adequate voice rest. The results of the present study may augment the knowledge for speech-language pathologists in counseling the professional voice users on voice usage, voice changes consequent to vocal loading and its short- and long-term effect on voice etc, in general and particular in teachers.

Future directions: The study can be administered on large number of teachers and can include male teachers to examine gender differences. Also, the same method can be employed to study differences between trained and untrained voice users. The study can be done by manipulating the rest period at different intervals of time. Acoustic analyses of voice can be coupled with aerodynamic, or electro-myographic measures to document the changes due to vocal loading.

References


**Acknowledgements**

This study is a part of an outcome of the doctoral research of the first author. The authors would like to thank Dr. Vijayalakshmi Basavaraj, Director, All India Institute of Speech & Hearing, Mysore for granting permission to carry out this study. Also, authors extend their thanks to the subjects who participated in the study.
PHONOLOGICAL AWARENESS SKILLS AND READING IN CHILDREN WHO ARE AT RISK FOR LEARNING DISABILITY: ROLE IN THE INDIAN CONTEXT?

*Jayashree C. Shanbal, **Goswami S.P., ***Chaitra S., ****Prathima S.

Abstract

Phonological awareness in young school going children has always been the emphasis on children learning to read and write English, especially in the western context. Its importance and relevance to children learning English in the Indian context has just begun. Whether phonological awareness skills are equally crucial for literacy skills in young Indian children is still been explored. Yet another challenge is to study these skills in children who are at risk for learning disability. Hence, the present study necessitates to research phonological awareness skills in typically developing children and in children who are at risk for learning disability. The aim was to study phonological awareness skills and reading in typically developing children and children who are at risk for learning disability. Two groups of subjects in the age range of 3-6 years participated in the present study. The control group consisted of sixty typically developing children (N = 60) and the clinical group consisted of twelve children (N=12) who are at risk for learning disability. All the children studied in schools with English as the medium of instruction. The results of this study indicated that in phonological awareness, the older children (5-6 years) fulfilled 60% criteria on phoneme blending, phoneme identification and phoneme substitution tasks. Other skills were still in the process of development. Children who are at risk for LD did not score on any of the sub-skills of phonological awareness. Typically developing children scored better for reading words than reading non words. Children at risk for LD, performed poorer on both reading words and non words when compared to typically developing children. Overall, performance on reading task was better than phonological awareness tasks. This study has implications on early identification and remediation for children at risk for learning disability.

Key words: phonological awareness, reading, assessment, early identification, at risk for learning disability.

To develop reading skills, children must learn the code used by their culture for representing speech as a series of visual symbols. Learning to read is thus fundamentally a process of matching distinctive visual symbols to units of sound referred to as phonology. Mastery of this system allows children to access thousands of words already present in their spoken lexicons. Phonological awareness, also referred to as phonological sensitivity, comprises the ability to recognize, identify, or manipulate any phonological unit within a word, be it phoneme, rime or syllable (Goswami & Bryant, 1990). Over the decades researchers have investigated phonological awareness and its association with reading skills. A large number of studies have shown that good phonological awareness skills characterize good readers, whereas poor phonological awareness skills characterize poor readers (Adams, 1990; Brady & Shankweiler, 1991; Scarborough, 1998; Wagner & Torgesen, 1987).

Research has widely focussed to study the links between different levels of phonological awareness and literacy development which are carried out on preschool and young school-aged children.

While, there may be links between awareness of syllables and progress in literacy, there are
stronger indications that awareness of phonemes and intrasyllabic units may play a greater role in the successful development of literacy (Bradley & Bryant, 1983). It also seems likely that during the early stages of literacy learning there is a reciprocal relationship between certain aspects of phonological awareness, such as the awareness of sounds, and literacy development (Cataldo & Ellis, 1988).

Most work on phonological awareness and literacy development are on monolingual English-speaking children. However, there are few studies, Durgunoglu, Nagy and Hancin-Bhatt (1993, Spanish/English: Spanish); Campell and Sais (1995, Italian/English: English); Bruck and Genesee (1995, French/English: English); Holm and Dodd (1996), Jackson (1996) (Chinese/English: English), that have considered phonological processing and literacy in bilingual children concentrating on only one of the children’s languages in the Indian context.

Phonological awareness is proved to be a primary factor underlying early reading development in children (Ehri, Nunes, Willows, Schuster Yaghoub-Zadeh & Shanahan, 2001). Wagner, Torgesen, Rashotte, Hecht, Barker, Burgess, Danahue and Garon (1997) experimented the amount of information that a measure of phonological awareness could add to the prediction of reading, once a measure of current word reading and vocabulary was considered. The results revealed that the phonological awareness was more predictive to reading in the younger age and less efficient in prediction of reading as the child gets older. These differences have also been found among the sub-level skills of phonological awareness like word level, syllable level, onset-rime level and phoneme level skills. Goswami and Bryant (1990) studied development of phonological awareness skills in English language. The results revealed that preschoolers demonstrated good phonological awareness of syllables, onsets, and rimes in most languages. Syllable awareness was usually present by about age 3 to 4, and onset–rime awareness was usually present by about age 4 to 5 years. Phoneme awareness only develops once children are taught to read and write, irrespective of the age at which reading and writing is taught. A longitudinal study by Bradley and Bryant (1983) and Blachman (1984) observed that performances on tasks of phonological awareness skills in nursery or grade 1 is a powerful predictor of reading achievement.

There are a few Indian studies available to date on metalinguistic skills and reading development in Indian children. Prema (1997) studied meta-phonological skills such as rhyming, syllable and phoneme related skills in Kannada speaking children. The reports revealed the importance of metalinguistic skills for reading acquisition in Indian children. However, contradicting to this was a study reported by Sunitha (1995) and Rekha (1996) who reported that meta-phonological skills are not essential for learning to read a non-alphabetic script (Kannada), rather they reported that the knowledge of orthographic principles seem to be more significant. Samasthitha (2009) studied meta-phonological and reading skills in monolingual (Kannada) and bilingual (Kannada and English) children, in the age range of 8-9 years. Results revealed that, there is a developmental trend in the acquisition of meta-phonological skills. Rhyme and syllable awareness appears to be the earliest skills to be developed followed by phoneme awareness. Results also showed that bilingual group performed better than the monolingual group on the meta-phonological and reading tests.

According to Read, Zhang, Nie and Ding (1986) some aspects of phonological awareness are not natural result of maturation but may be a consequence of learning an alphabetic orthography. They also reported that without this instruction, individuals may gain only minimal overt knowledge or awareness of phonemic units.

Loizou and Stuart (2003) examined levels of phonological awareness in monolingual and bilingual English and Greek five-year-old children. The participants were divided in four groups: two bilingual (English-Greek, Greek-English) and two monolingual (English, Greek). A set of six phonological tasks were compared. Bilingual children were tested in both English and Greek versions of the tasks; monolingual children were tested for the phonological tasks in their mother tongue only. The results showed that the bilingual English-Greek children significantly outperformed the monolingual English children, but this pattern was not replicated in the bilingual Greek-English/monolingual Greek comparisons. This difference is discussed in terms of the bilingual
enhancement effect. Results also showed that English-Greek bilingual children performed significantly better than Greek-English bilinguals, especially on tasks requiring phoneme awareness. They concluded that learning to read in an alphabetic language promotes the level of phonological awareness.

Liberman, Shankweiler, Fischer and Carter (1974) used a tapping task to measure the development of phonological awareness at the syllable and phoneme levels in normally developing American children. Results revealed that no 4-year-olds and only 17% of 5-year-olds could manage the phoneme version of the task, whereas 70% of 6-year-olds reached a criterion of six consecutive correct responses. Cossu, Shankweiler, Liberman, Katz and Tola (1988) tested phonological awareness in Italian children and the results showed that the majority of preschoolers (ages 4 and 5 years) could not manage the phoneme task (20% reached criterion), whereas older children already at school (7- and 8-year-olds) were very proficient (97% reached criterion). Criterion at the syllable level was reached by 67% of the 4-year-olds, 80% of the 5-year-olds, and 100% of the school-age sample.

Reading acquisition should be more rapid in orthographies in which letter–sound relationships are highly consistent. Indeed, a number of monolingual studies carried out in relatively consistent writing systems have reported high accuracy scores for recoding words and nonwords toward the end of Grade 1. For example, Greek children read on average 90% of real words correctly compared with 89% for nonwords (Porpodas, Pantelis & Hantziou, 1990). Italian children read on average 94% of real words correctly compared with 82% for nonwords (Cossu, Gugliotta & Marshall, 1995). French children read about 87% of words and 80% of nonwords correctly (Sprunder-Charolles et al., 1998). Even in a Semitic language, such as Hebrew, decoding accuracy was found to be around 80% at the end of Grade 1 (Share & Levin, 1999). Note that Hebrew children learn to read pointed Hebrew, which has almost perfect grapheme-phoneme correspondences. These quite high accuracy scores for phonological decoding stand in sharp contrast to the performance of English children a year later, at the end of Grade 2 (Share & Levin, 1999). English has very inconsistent grapheme–phoneme relations, and in a representative study, children learning to read English scored no more than 70% correct in word reading and 45% correct in nonword reading (Frith, Wimmer & Landerl, 1998).

Blaiklock (2004) conducted a longitudinal study examining the relationship between phonological awareness and reading for a group of children during their first two years at school. Children showed rhyme awareness before they began to read but were unable to perform a phoneme deletion task until after they had developed word-reading skills. Prakash (1993) investigated the development of reading proficiency in relation to meta-linguistic awareness and reported that the acquisition of literacy in children reading a non-alphabetic script follows two successive stages, firstly the syllable decoding and secondly the syllable decoding + comprehension stages. He accounted these stages to a probable interaction between the nature of orthography and instructional process rather than meta-phonological skills per se.

Need for the study

In western context extensive research are conducted to study the development of phonological awareness and reading skills. To study the development of phonological awareness and reading skills extensive researches are carried out in the western context. It is not possible to directly generalize such studies to the Indian context because children in India are generally exposed to varied culture and language. Though there is dearth of studies in the Indian context, these studies are conducted for the older group of children. Therefore, it is essential to develop a screening tool, which assesses phonological awareness and reading skills especially in the younger age group. This in turn would aid in the early identification of children who are at risk for learning disability. Hence, there is need to study the developmental pattern of phonological awareness and reading skills in younger group of children through a tool, which will further help in the identification of children who may be at risk for learning disability.

Aims of the study

The aim of the study was to examine the relationship between phonological awareness and
reading in children.

Following were the objectives considered for the study:

- To study the relationship between phonological awareness and reading skills in typically developing children (TDC).
- To examine the difference in pattern of development amongst children who are at risk for developing learning disability (ARLD).

This study was carried out as part of an ongoing research project funded by AIISH research fund titled “Development of Early Literacy Screening Tool”.

**Method**

**Subjects:** Two groups of children participated in the study. All children studied in schools with English as the medium of instruction. The control group consisted of sixty typically developing children (N=60) in the age range of 3-6 years who were selected randomly from schools in different localities of Mysore city. They were sub divided into three groups with an inter age interval of one year (3-4 years, 4-5 years and 5-6 years). Each sub group comprised of 20 subjects including 10 boys and 10 girls. So a total of 60 subjects were considered in the first group. The clinical group consisted of twelve children (N=12) in the age range of 3-6 years with poor academic skills as reported by the teachers.

The subjects were selected based on the following criteria:

- Native speakers of Kannada, being reared in an urban ambient environment of Kannada.
- Belonging to middle socio economic status.
- Exposed to English language in their school set up.
- Attended schools which followed similar teaching methods.
- Those who passed the WHO Ten-Question Disability Screening checklist (cited in Singhi, Kumar, Prabhjot & Kumar, 2007) which screens for any speech, language and hearing deficits.

**Test material:** Initially test items for the tasks of phonological awareness and reading were developed by reviewing journals, books, internet and age appropriate academic books. The compiled material was rated by five Speech Language Pathologists. They were expected to rate the test items on a five point rating scale for the 14 parameters listed. E.g.: Simplicity of the test material, familiarity of the test stimuli etc. Using this material, a pilot study was conducted on a group of 20 children in the age range of 3-6 years. After analysing the piloted data, the test items which were most relevant was chosen to form the test materials for the final administration of the test.

**Procedure:** Participants were withdrawn from the class and worked with the examiner in a quiet room in the school. Phonological awareness tasks and reading tasks were administered to all children. Phonological awareness section consisted of 6 subsections: phoneme counting, phoneme blending, phoneme identification, phoneme substitution, phoneme deletion and phoneme oddity. Each subsection consisted of two practice items and one test item.

Reading task consisted of reading three words and three non words. Words were selected from their curriculum books which were appropriate to their age and the non words were formed based on the premise that they followed the phonotactic rules of the English language. (See Appendix-I for the test material)

**Scoring and analysis:** For both the tasks a gross score of ‘1’ and ‘0’ was given for correct and incorrect responses respectively. Scoring was immediately noted by the examiner on a scoring sheet. The scores were coded and then subjected to statistical analysis. From the scores obtained, mean, standard deviation were calculated for each age group. Passing criteria of 60% was set for all the skills considering that minimum of 60% of the subjects had to perform each of the tasks correctly.

**Results**

The objectives considered for the study were:

- To study the relationship between phonological awareness and reading skills in typically developing children (TDC).
- To examine the difference in pattern of development amongst children who are at risk for developing learning disability (ARLD).

The results presented in the following sections are those of the main cohort of 60 children, who were identified as developing literacy (in English) without difficulties and 12 children who were identified as at risk for learning disability. Since the focus of this paper is the development of task, we give here only descriptive statistics, by which we mean the
aggregate means and standard deviations of the children’s scores. For ease of comparison across the age ranges and between the two groups the task results are given as proportions and displayed in a series of graphs.

Table 1 shows the overall mean and SD for phonological awareness skills and reading skills across three groups of typically developing children (3-4 years, 4-5 years and 5-6 years). From the Table 1 and Figure 1 and 2 it is evident that, in both the groups of children a developmental trend was observed for phonological awareness and reading skills across the age range. There was a drastic improvement observed from 4-5 years to 5-6 years for both the skills. Children at risk for LD scored lesser than the typically developing children in both the skills. Another salient feature observed was that, reading scores were better than phonological awareness skills in both typically developing and children who are at risk for LD.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Typically developing Children</th>
<th>Children At Risk for LD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-4 Years</td>
<td>4-5 Years</td>
</tr>
<tr>
<td>Phonological Awareness</td>
<td>Mean 0</td>
<td>.65</td>
</tr>
<tr>
<td></td>
<td>SD 0</td>
<td>1.5</td>
</tr>
<tr>
<td>Reading Skills</td>
<td>Mean 0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>SD 0</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Table 1: Mean and SD for Phonological awareness and reading skills of TDC and ARLD across age. (Maximum score= 6.00 each for Phonological awareness and reading skills)

Figure 1: Mean scores of Phonological awareness and reading skills of TDC and ARLD across age.

Figure 2: Mean percentile scores of Phonological awareness and reading skills of TDC and ARLD across age.
Table 2: Mean percentile scores for sub-skills of Phonological awareness in TDC and ARLD across age.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Typically developing Children</th>
<th>Children at risk for LD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-4 Years</td>
<td>4-5 Years</td>
</tr>
<tr>
<td>PC</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>PB</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>PI</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>PD</td>
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<td>10</td>
</tr>
<tr>
<td>PS</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>PO</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Further descriptive statistics was conducted separately for all the sub-skills of phonological awareness and reading.

**Performance of children on Phonological Awareness Skills**

In the present study, phonological awareness tasks included were phoneme counting (PC), phoneme blending (PB), phoneme identification (PI), phoneme substitution (PS), phoneme deletion (PD) and phoneme oddity (PO).

The results of the present study on phonological awareness skills revealed that, overall a developmental trend was seen across most of the sub-skills (see Table 2 & Figure 3). In sub-skills of phonological awareness, the older children (5-6 years) in typically developing group fulfilled 60% criteria on phoneme blending, phoneme identification and phoneme substitution tasks. Other sub-skills like phoneme counting (50%), phoneme deletion (35%) and phoneme oddity (20%) were still in the process of development. Even the older children (5-6 years) who are at risk for LD did not score in any of the sub-skills of phonological awareness.

**Performance of children on reading words and non words**

Reading task included reading a list of three words (RW) and three non-words (RNW) in English by two groups of children (TDC and ARLD) in the age range of 3-6 years. The performance of children in reading words and non words is explained below.

From Table 3 and Figure 4, it is evident that, performance of reading skills is improving from younger children to older children. Typically developing children scored better for reading words (91.6%) than reading non words (53.3%). A similar comparison could not be observed in children at risk for LD, as reading non words emerged only in the older group (5-6 years) and the performance was equal to that of reading words. However, in both reading words and non words children at risk for LD could not meet the criteria of 60%. Also, to note that children of 3-4 years in both groups (TDC & ARLD) did not score in reading section.

Figure 3: Mean percentile scores for sub-skills of Phonological awareness in TDC and ARLD across age.
Discussion

The present study aimed to examine the difference in pattern of development in typically developing children and children at risk for learning disability. The study also aimed to investigate the relationship between phonological awareness and reading skills in the two groups.

Analysis of results for phonological awareness skills revealed a developmental trend in typically developing children from younger to older children. The older typically developing children (5-6 years) fulfilled 60% criteria on phoneme blending, phoneme identification and phoneme substitution tasks (see Table 2). Other sub-skills like phoneme counting, phoneme deletion and phoneme oddity were still in the process of development. This supports study by Cossu, Shankweiler, Liberman, Katz and Tola (1988) on phonological awareness in Italian children. Their results also revealed that majority of preschoolers (ages 4 and 5 years) could not manage the phoneme tasks (20% reached criterion), whereas older children already at school (7- and 8-year-olds) were very proficient (97% reached criterion). On the other hand in the present study even older children at risk for LD could not perform on any of the sub-skills of phonological awareness. This may be because children at risk for LD have not attained mastery of at least a few phonological awareness skills which are achieved by the typically developing children.

Analysis of results on reading skills revealed that, typically developing children in the age range of 4-6 years scored better than children who are at risk for LD (see Table 3). In typically developing children, reading words was better than reading non-words. It is an accepted phenomenon that reading words in English involves the direct route and non-words involves the indirect route. Indirect which is more dependent on the phoneme-grapheme or grapheme-phoneme correspondence generally takes longer time to be decoded especially in an irregular language like English. Hence, children take longer time to read non-words than words. This difference may be significantly seen in the younger children as children would not have mastered all the skills required to decode a non-word through the indirect route. This finding supports Frith, Wimmer and Landerl (1998) in English language. Their results revealed that since English has very inconsistent grapheme–phoneme relations, children learning to read English scored better for word reading (70%) than nonword reading (45%). Children in the younger group of 3-4 years in both groups (TDC & ARLD) did not score in reading section. This can be attributed to the fact that, the children in this age range were exposed only to reading alphabets and not reading words and non words and these children were still in the process of combining letter or phoneme strings to form words for reading.

The study also revealed that performance on

<table>
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<th>Tasks</th>
<th>Typically developing Children</th>
<th>At Risk for LD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RW</td>
<td>3-4 Years: 0, 4-5 Years: 43.3, 5-6 Years: 91.6</td>
<td>3-4 Years: 0, 4-5 Years: 8.3, 5-6 Years: 16.6</td>
</tr>
<tr>
<td>RNW</td>
<td>3-4 Years: 0, 4-5 Years: 6.6, 5-6 Years: 53.3</td>
<td>3-4 Years: 0, 4-5 Years: 0, 5-6 Years: 16.6</td>
</tr>
</tbody>
</table>

Table 3: Mean percentile scores for sub-tasks of Reading skills in TDC and ARLD across age.

![Figure 4: Mean percentile scores for sub-tasks of Reading skills in TDC and ARLD across age.](image)
reading skills were better than phonological awareness skills. This is indicative of the fact that phonological awareness is probably an underlying skill to development of reading skills in children. This finding supports Read, Zhang, Nie and Ding (1986), phonological awareness does not appear to be a natural result of maturation but seems to be a consequence of learning an alphabetic orthography. They also reported that without this instruction, individuals may gain only minimal overt knowledge or awareness of phonemic units. Loizou and Stuart (2003) concluded that learning to read in an alphabetic language promotes the level of phonological awareness. According to Goswami and Bryant (1990) phoneme awareness only develops once children are taught to read and write, irrespective of the age at which reading and writing is taught.

Conclusions

Overall the results of this study indicated a developmental progression in both phonological awareness and reading skills. The performance of children improved from younger age to older age group. However, a slope was observed for typically developing children in the age range of 4-5 years to 5-6 years (see Figure 1 & Figure 2) and these children showed significant improvement in both phonological awareness and reading skills. This progression was not evidently noted in children who are at risk for LD. Overall, performance on reading task was better than phonological awareness tasks.

Implications

This study has implications on early identification and remediation for children at risk for learning disability. The study would have an impact in the Indian context, since the availability of the appropriate test material in assessing phonological awareness skills and reading are sparse.

Limitations of the study

This study included a small sample of 20 typically developing children in each age range. Administration of it on a large sample would help in standardization of the tool. Only 12 children who are risk for learning disability were considered in the study. Including larger number of subjects in this group would provide a better insight into the results.

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**Acknowledgements**

The authors wish to thank Dr. Vijayalakshmi Basavaraj, Director, AIISH, for permitting to present part of project as paper for publication and all the support provided to conduct this study. The authors also wish to thank all the subjects who participated in this study and teachers for their co-operation.
Appendix-I

Phonological Awareness Skills

Maximum score: 06

a. Phoneme counting

Instructions: I am going to say a word and I want you to say how many sounds you hear in that word.
Example: When I say cat, I hear three sounds, /k/, /a/, /t/. When I say go, I hear two sounds, /g/, /o/. Now you try.

- Van

b. Phoneme Blending

Instructions: I am going to say some words, spreading out the sounds. Guess the word I am saying.
Example: If I say ‘f-at’, you say ‘fat’. If I say ‘m-ug’, you say ‘mug’.

- m-at

c. Phoneme Identification

Instructions: I want you to listen to just one sound in a word. Tell me the sound you hear at the beginning of each word I say.
Example: If I say ‘car’, the first sound in the car is /k/. In Nest, the first sound is /n/.

- Time- /t/

d. Phoneme Deletion

Instructions: Now I will say a word, you will have to take off the first sound and make a whole new word.
Example: If I say ‘cat’, you say ‘at’. If I say ‘eat’, you say ‘at’.

- Meat /m/ eat

e. Phoneme Substitution:

Instructions: Now let us play another game. I will give you a word. Listen to it carefully and change one phoneme to another as indicated by me and tell the whole new word.
Example: If I Say the word ‘goat’ by changing the /g/ to /b/ it becomes ‘boat’.

- Hat-mat (change /h/ to /m/)

f. Phoneme Oddity

Instructions: Now I will tell four words, you have to listen to it carefully and pick the odd one out
Example: bat, cat, mat, elephant

- Sun, gun, rat, fun

Reading skills

Maximum score: 06

Task: Ask the subject to read the words.

Note: Check for G-P-C skills for scoring.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Words</th>
<th>Non-Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ant</td>
<td>Gog</td>
</tr>
<tr>
<td>2</td>
<td>Cap</td>
<td>Dar</td>
</tr>
<tr>
<td>3</td>
<td>Bag</td>
<td>Nat</td>
</tr>
</tbody>
</table>
TIMED TEST OF SWALLOWING IN SIX MONTH POST STROKE INDIVIDUALS

* Radish Kumar. B., **Rishita, U., & ***Jayashree S. Bhat

Abstract

The swallowing problems after acute stroke are often temporary but sometimes lead to various complications such as aspiration pneumonia, dehydration and death. Though these individuals recover from swallowing disorder as assessed subjectively and objectively, it is not known if they have recovered completely. Hence the present study was attempted at identifying any swallowing problems in six month post stroke individuals, using timed test of swallowing. The study followed the Prospective case control design. All the participants in both the clinical and the control group were asked to drink 150 ml of water from a plastic beaker ‘as quickly as possible’. The number of swallows performed by the participants was counted by observing the movement of the thyroid notch. A stopwatch was started when the water first touched the lower lip, and stopped when the larynx came to rest, ensuring the last swallow. Timed test of swallow includes quantitative elements i.e., the volume swallowed, the number of swallows used and the time taken, which yields three quantitative indices, which are average volume per swallow (ml), average time per swallow (s) and swallowing capacity (volume swallowed in ml/s) in both the group of participants. The results revealed a significant difference between the means for both the group of participants, at p <0.05 for all the three indices of timed test of swallowing, suggesting that the clinical group exhibited lower volume per swallow, increased time per swallow and a lower swallowing capacity in each swallow than control group. The obtained results were discussed with respect to the stroke and its effect on swallowing. Hence, the timed test of swallow can be used as a clinical tool for identifying swallowing problems in post stroke individuals.

Key words: Post stroke individuals, timed test, swallowing capacity

The swallowing problems after acute stroke are often temporary but sometimes lead to various complications such as aspiration pneumonia, dehydration and death (Gordon, Hewer & Wade, 1987; Holas, Depippo & Reding, 1994; Johnson, McKenzie & Seivers, 1993; Warnecke et al., 2008; Smith Hammond et al., 2009). Though these individuals do not complain of swallowing disorder six months post stroke, it is not known if the recovery is complete as assessed subjectively and objectively. Previous studies of individuals with dysphagia, used quantitative measurements like amplitude of EMG muscle activity during swallow, time duration for which the activity is present, swallowing apnea duration, etc. in the assessment of individuals with swallowing disorders (Vaima, Eviatar & Segal, 2004).

Simple timed test of swallowing was proposed in addition to the routine assessment of individuals with neurological impairment along with reliability and validity (Nathadwarawala, Nicklin & Wiles, 1992; Hughes & Wiles, 1996). Timed test of swallow includes quantitative elements i.e., the volume swallowed, the number of swallows used and the time taken, which yields three quantitative indices, which are average volume per swallow (ml), average time per swallow (s) and swallowing capacity (volume swallowed in ml/s). These indices might be useful in screening those at risk for dysphagia or its complications (Koji et al., 1999). We consider that these measures are the indicators of complete...
recovery as it assesses the finer aspects of swallowing behavior i.e., volume per swallow, time per swallow and the swallowing capacity. We considered that the individuals obtaining age appropriate scores are believed to have recovered completely from their abnormal swallowing behavior and the individuals failing from this test are considered to have persisting swallowing problems which warrants further instrumental evaluation to evaluate the swallowing physiology in them.

Hinds and Wiles (1998) have reported abnormal findings of timed test of swallowing in acute stroke individuals and concluded that a timed water swallowing test can be a useful test of swallowing and may be used to screen patients for referral to a speech language therapist after a acute stroke. Swallowing speed was significantly slower in individuals who reported swallowing problem or those who had abnormal symptoms or signs compared to those who did not, providing further evidence for the validity of timed test of swallowing (Nathadwarawala, McGroary & Wiles, 1994). This study also provided evidence of a significant incidence of disordered swallowing in individuals who had not reported any swallowing problems but, who had symptoms potentially relevant to swallowing (Nathadwarawala, McGroary & Wiles, 1994). Hence this particular measure was chosen in the present study to identify swallowing problems if any in six months post stroke individuals. Six months after the stroke, though these individuals do not complain of swallowing disorder, it is not known if they have recovered completely as assessed subjectively and objectively. Hence the present study was an attempt in this direction with the aim of identifying swallowing problems if any in six month post stroke individuals using timed test of swallowing.

**Method**

**Patients:** Participants were divided into two groups. Group 1 comprised of forty male individuals with a history of dysphagia in their acute period of stroke six months ago. All these participants were in the age range of 40 to 60 years. Group 2 consisted of forty male healthy age matched volunteers.

The study protocol followed the case control design.

**Assessments**

All the participants in both the groups were subjected to clinical assessment of swallowing.

**Clinical Assessment of Swallowing:** All the participants were submitted to a detailed clinical assessment of swallowing by a speech pathologist, which included patient identification, questioning about different aspects of swallowing, and structural and functional clinical assessment. For the functional assessment, two 5-ml boluses of liquid (water) and 5 ml of thick consistency, obtained by the dilution of commercially available rice flakes were offered through a graduated syringe. The following parameters were assessed: presence of swallowing complaints on specific questioning; posture during the assessment; cervical auscultation before, during, and after bolus swallowing; vocal quality before and after swallowing; labial closure; use of compensatory maneuvers when swallowing; bolus stasis after swallowing; pneumonia, choking; cough; weight loss and dyspnea. The presence of abnormal findings in any of the assessed parameters, independent of the presence of complaints after specific questioning, classified the participants as having abnormal swallowing function during clinical assessment. All the participants in both the groups were classified as having normal swallowing function as they successfully completed the clinical assessment of swallowing.

All the participants were well oriented and were able to follow the instructions given during the study. All the participants in the group 1 had history of dysphagia with aspiration, as their primary symptom during their acute period of stroke for around ten days following which they returned to oral feeding as ascertained from the medical records. All these participants were on nonoral feeding for around ten days during their acute stroke period and they did not undergo any swallowing therapy due to the orientation and auditory comprehension problem. Presently all these participants were on oral feeding consuming all types of food. The exclusionary criteria considered for both the groups were those who exhibited difficulty in swallowing 10ml of water, those with a past medical history of major surgery on or above the neck, thyroid disease, and individuals who had consumed alcohol in the previous 9 hours. All patients and control volunteers were fully informed about the objectives and methods of the study and gave written informed consent before participation. This study was approved by the local Human
Research Ethics Committee. **Timed test of swallowing:** The participants were seated comfortably on a chair in an upright position. The timed test of swallowing was then administered on those who followed the norms of the study. These participants were asked to drink a 150 ml of water from a plastic beaker ‘as quickly as possible’. The number of swallows performed by the participants was counted by observing the movement of the thyroid notch. All the participants were able to hold the beaker of water to their mouth and drink. A stopwatch was started when the water first touched the lower lip, and stopped when the larynx came to rest, subsequent to the last swallow. Participants were instructed not to spill the water through the mouth while performing the test. This was repeated when the spillage through the mouth was observed. Hence the number of swallows performed by the participants and the time taken to complete the 150ml of water was noted by the two independent judges. Using these information, following timed test parameters were calculated by both the judges.

1. **Volume per swallow** is defined as the volume of the water consumed during single swallow i.e., 150 ml/ average no of swallows performed by the participants.

2. **Time per swallow** is defined as the time taken to consume a single bolus of water i.e., average time taken to complete the 150ml of water / average no of swallows performed by the participants.

3. **Swallowing capacity** is defined as volume of the water consumed per second i.e., 150ml/ average time taken to consume the 150 ml of water

Inter judge reliability was calculated in fifteen of the participants to ensure that the measurement made by the judges were same. Independent t-test was used to compare the significant difference between the means of both the groups.

**Results**

The present study investigated swallowing problems if any in six month post stroke individuals using timed test of swallowing. The results of independent t-test revealed that there is a significant difference between the means of both the groups, at p<0.05 for all the three indices of timed test of swallowing which is shown in the table 1. Inter judge reliability was found to be 96% and hence the measurement made by both the judges were considered as reliable.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control group</th>
<th>Clinical group</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Average volume per swallow (ml)</td>
<td>25.01</td>
<td>25</td>
</tr>
<tr>
<td>Average time per swallow (s)</td>
<td>1.027</td>
<td>8</td>
</tr>
<tr>
<td>Swallowing capacity (ml/s)</td>
<td>25.32</td>
<td>7</td>
</tr>
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</table>

Table 1: Mean and SD of the timed test indices in six months post stroke individuals.

From the table, it is clear that the clinical group exhibited lower swallowing capacity and volume per swallow and increased time per swallow as compared to the control group. Also 11 participants from the clinical group (28%) obtained age appropriate scores and the remaining participants (72%) obtained reduced bolus volume per swallow, increased time per swallow and lowered swallowing capacity suggesting persisting subtle swallowing abnormality though they do not complain of swallowing problem. This indicates that few of the post stroke individuals did have subtle swallowing abnormality which needs to be evaluated using other instrumental evaluation. This further suggests the need for screening of swallowing behavior in the post stroke individuals using the timed test of swallowing.

**Discussion**

Most of the previous studies with dysphagia and stroke have aimed at detecting aspiration through bedside examination and video fluoroscopy. Previous bedside assessments of swallowing function have included oral sensory and motor examinations, 3oz water swallow test and simply observing the patient during eating. But, these findings are unlikely to provide information on the subtle swallowing problems, if any, in six months post stroke individuals especially because these individuals do not complain of swallowing disorder. Also, it is not known if they have recovered completely from the initial swallowing problems with no overt complaints. Hence, timed test of swallowing was assessed to identify the dysphagia risk in these individuals. The results revealed a
significant difference between the means for both the groups, at p < 0.05 for all the three indices of timed test of swallowing.

A reduction in swallowing capacity can be due to a reduction in average bolus volume, or a prolongation of average time per swallow, or a combination of both. Temporary cessation of breath will lead to prolongation of the average time per swallow and a reduced swallowing capacity; volume per swallow is less affected by respiratory function and in this regard is a better measure of swallowing function alone (Hughes & Wiles, 1996). Changes in average time per swallow and average bolus volume per swallow contribute to the significant reduction in swallowing capacity seen in stroke individuals with a swallowing problem; 'taking smaller sips' and spending longer on each swallow are obvious ways of reducing the risk of overt decompensation occurring (Hughes & Wiles, 1996). Hence, the reduction in the swallowing capacity due to the reduction in volume per swallow or increased time per swallow in the clinical group may be expected as a compensatory mechanism for an abnormal swallowing behavior mechanism (Hughes & Wiles, 1996). But it is interesting to note that these individuals did not attend any swallowing rehabilitation during their acute periods of stroke. However, they learnt the compensatory mechanism without the guidance from the speech language therapist which is evident in the present study. This may pose the individual at risk for developing swallowing problems at the later course of the life span. Therefore, this measurement of swallowing is a likely indicator of abnormal swallowing behaviour.

There are specific patient signs that correlate with presence of dysphagia and aspiration, such as, cough or inability to produce a cough; voice quality change; dysarthria to name a few. These clinical signs are predictors of dysphagia from a screening examination. But these were not evident in six month post stroke individuals at the start of the study but the "timed test of swallowing" revealed increased time per swallow and lowered swallowing capacity in these individuals. This suggests that the recovery is not complete in the clinical group. The failure of the individuals from this test further recommends the use of other instrumental evaluation to delineate the physiological underpinnings of increased time per swallow and lowered swallowing capacity which would guide the clinician to initiate the rehabilitation process in these individuals.

Though sex is the major determinants of swallowing function (Alves, Cassiani, Santos & Dantas, 2007), it was not controlled in the present study. Also the events such as double swallow could not be accounted for using this procedure which adds further limitations to the present study.

**Conclusion**

The present study assessed the swallowing in six months post stroke individuals using timed test of swallowing and the results revealed that there is a significant difference between the means for the clinical and control group at p < 0.05 for all the three indices of timed test of swallowing suggesting lower volume per swallow, increased time per swallow and a lower swallowing capacity in each swallow of six month post stroke individuals than control groups. Hence the timed test of swallow can be used as a tool for identifying swallowing problems in post stroke individuals who do not complain about swallowing.

**References**


Koji, T., Risa, U., Yoshizumi, Y., Yukari, Y., Atsushi,


Abstract

The study aimed to measure the effects of vocal loading on voice characteristics in Indian adult males, to document complaints associated with vocal fatigue and to monitor recovery patterns of voice after the vocal loading task. Twenty adult males between the ages of 18 and 30 years participated in this study. The subjects were instructed to read a book at 75-80 dB SPL up to an hour or until they reported themselves as fatigued. Pre and post experiment voice assessments were carried out using GRBAS scale and MDVP analysis. The duration of prolonged reading and signs of vocal fatigue were documented. Voice recovery was tracked at 5, 10, 15, 20 minutes and 24 hours following the immediate post experiment. Paired t test and repeated measure of analysis of variance (ANOVA) were used for statistical analysis. Overall quality of voice change (Grade) was more pronounced after vocal loading. Significant reduction (around 6 seconds) in maximum phonation time and a significant increase in S/Z ratio were found. MDVP analysis revealed significant decrease in lowest fundamental frequency and increase in phonatory fundamental frequency range, short and long term frequency and amplitude measurements, noise and voice irregularity related measures after vocal loading. Initial signs of fatigue such as throat pain, throat tightness and running out of breath were noticed as early as 15 minutes and subjects were able to sustain the task for not more than 30 minutes. Short and long term frequency and amplitude measures and noise to harmonics ratio revealed a significant recovery pattern. Complaints of vocal fatigue, voice symptoms, and vocal recovery after vocal loading can be tracked and monitored using perceptual and acoustic measures. These findings can be applied to understand vocal endurance, susceptibility to vocal fatigue and physiological changes due to vocal loading.

Key words: vocal loading task, GRBAS, MDVP, vocal endurance and susceptibility

Terms ‘vocal abuse’ and ‘vocal misuse’ occur frequently in discussion of voice disorders related to vocal hyperfunction. Phonation under these conditions results in tissue changes in larynx which alters the mass, elasticity and tension of the vocal folds. The tissue changes and mechanical alterations of the vocal folds together result in abnormal production of voice and vocal fatigue.

Many individuals report symptoms of vocal fatigue after extended voice use. Vocal fatigue is a frequent complaint among individuals who depend on their voice for their profession and those who have disordered voice. The mechanical basis of vocal fatigue is not well known. Titze, 1983 (as cited in Callaghan, 2000) postulated that vocal fatigue is linked to inefficient use of mechanism and dehydration. Vocal fatigue may result from both the fatiguing of the respiratory and laryngeal muscles and from bio-mechanical challenges in non muscular tissues that cause the vocal folds to vibrate less efficiently. Symptoms of vocal fatigue include complaints of increased effort to talk, not able to talk continuously and a tired, weak voice (Smith, Kirchner, Taylor, Hoffman & Lemke, 1998). One common scenario of excessive voice use is a condition in classrooms which involves teaching for long hours, which is usually referred to as vocal loading. Kelchner, Toner and Lee (2006) defined vocal loading...
as “Prolonged loud voice use and has four distinct phases: warm up (adapting to the voicing task), performance (continuation of the voicing task), vocal fatigue (perceived increase of physical effort associated with voicing; physical challenges to the larynx), and rest or recovery”. Prolonged loud reading is one of the vocal loading task that is most often used to mimic excessive usage of voice (Stemple, Stanley & Lee, 1995; Kelchner, Lee & Stemple, 2003; Kelchner et al., 2006). These prolonged loud reading protocols vary with reference to procedural variations, loudness levels and total time spent on reading. Most reported outcome data involving vocal loading task include comparisons of pre and post perceptual, acoustic, stroboscopic and aerodynamic measures (Stemple, et al., 1995; Kelchner et al., 2003; Kelchner et al., 2006).

Voice use can also be documented by using voice accumulators (Ohlsson, Brink & Lofqvist, 1989) and portable DAT recorders (Sodersten, Granqvist, Hammarberg & Szabo, 2002; Rajasudhakar & Savithri, 2009). Other methods include vocal loading measurements in experimental conditions (Stemple et al., 1995; Kelchner et al., 2003; Kelchner et al., 2006) and work environments or real life situations (Rajasudhakar & Savithri, 2009). The experimental methods used a procedure which was similar to classroom and other vocal loading conditions (singing, acting) thereby measuring the effects of it on voice production. Several methods have been developed over the years to document the amount of voice use in professional voice users especially teachers during work and other experimental conditions. Krishna and Nataraja (1995) developed criteria for susceptibility to vocal fatigue in 5 teachers and 5 non-teachers based on MDVP parameters before and after an hour of loud reading. Teachers as a group showed significant changes in the acoustic parameters like average fundamental frequency ($F_{0}$), average pitch period ($T_{p}$), standard deviation of $F_{0}$ (STD), highest fundamental frequency ($F_{h}$) and lowest fundamental frequency ($F_{l}$) after reading. However, this study was limited to describing acoustic changes after vocal loading without mentioning recovery patterns across time and effects of observing vocal hygiene and conservative voice use post vocal loading task. Other studies have examined various factors related to vocal loading such as environment (Sodersten et al., 2002), health (Roy, Merrill, Thibeault, Parsa, Gray & Smith, 2004) and stress related (Smith et al., 1998).

There are numerous social and educational situations an adult may engage in using loud voice. These events can often result in voice change and complaints of vocal strain and fatigue. People who use their voice excessively are at risk for voice disorders. Boominathan, Rajendran, Nagarajan, Muthukumaran and Jayashree (2008) studied regarding vocal abuse and vocal hygiene practices among different levels of professional voice users (teachers, singers, vendors & politicians) in India. The results indicated alarming levels of vocally abusive behaviors and poor vocal hygiene practices among the groups studied.

These increased occurrences of vocally abusive behaviors in professional voice users could possibly be applied to general population as well. Vocally abusive behaviors lead to vocal hyperfunction and is generally believed that vocal hyperfunction is an underlying component in majority of voice disorders (Boone, 1983, as cited in Hillman, Holmberg, Perkell, Walsh & Vaughan, 1989).

Apart from information regarding vocal abuse and hygiene practices, understanding the vocal health status of normal adults becomes important. Data on vocal health may facilitate prevention and management of voice problems in adults. Further, understanding of the effects of vocal loading, fatigue and endurance may be the first step to define vocal health Physiologically. In this connection, the present study aims to add information on the effects of controlled prolonged loud voice use and resulting complaint of vocal fatigue or voice change and recovery pattern of voice in the healthy adult Indian males.

**Method**

**Subjects**

Twenty normal adult Indian males between the ages of 18 and 30 years participated in this study. The subjects were recruited based on the exclusion and inclusion criteria given below.

**Exclusion criteria:**

1. History of smoking, laryngeal pathology, intubation, neurologic disorder, respiratory disorder, systemic illness, and surgery/ accident/
2. Sustained (prolonged use) medications for any medical condition,

Inclusion criteria:
1. Perceptually normal voice in terms of pitch, loudness and quality,
2. Loudness dynamic range of 40 - 80 dBSPL.

Procedure
I. Pre-experiment phase

Directions to subjects prior to participation in the experiment: Every subject was asked to refrain from excessive voice use (yelling, prolonged singing / talking, whispering and throat clearing), to avoid caffeine, and was instructed to drink adequate water (6-8 glasses) for 24 hours preceding their appointment to participate in the experiment.

Pre experimental recording for obtaining baseline measures: To obtain baseline measures, the subjects were asked to phonate /a/, /i/, /u/ and sustain /s/, /z/ as long as possible and speak (1 minute) at their comfortable pitch and loudness before performing the experimental task. The subjects were seated in a comfortable upright posture and the recording was done with a microphone (SM 48) distance of 10 cm from the mouth, at an off angle position of 45°. The signal was recorded using KAY Computer Speech Lab model 4300 (Kay Elemetrics Corp., NJ, USA), at 44,100 Hz sampling rate.

Pre experiment analysis for baseline measures:

a) Perceptual analysis: Phonation and conversation samples were judged for the perceptual correlates of voice by a qualified Speech Language Pathologist for parameters of pitch, loudness and quality. The judge performed the perceptual evaluation in one session with two pauses, and there was no limit as to how many times the judge was allowed to listen to each of the voice samples. For intra-judge reliability the samples were reanalyzed entirely with a minimum gap of 1 day. Maximum Phonation Time (MPT) and S/Z ratio were also analyzed and noted. The GRBAS scale (Hirano, 1981) was used for the perceptual analysis of voice in conversation tasks.

b) Acoustic analysis (PrT): The recorded phonation sample was analyzed using Multi Dimensional Voice Profile (model 5105, Kay Elemetrics Corp., NJ, USA). The first portion of the phonated sample /a/ (0.25 s) was cut off, and measurements were performed during the subsequent 3.0 seconds, thus minimizing variability caused by sampling errors. The remaining portions of the sample were discarded, which ensured that the initial and final parts of voicing did not influence the final result. The recorded phonation samples were analyzed for frequency related (F0), amplitude related (I0), voice break, noise related, sub-harmonic component, voice irregularity and voice tremor related measures.

II. Experimental phase

Prolonged loud reading task: A calibrated (acoustic calibrator 4231) Sound Level Meter (SLM) (Bruel & Kjaer sound analyzer 2260) with a pre-polarized free field ¼ inch condenser microphone (Model 4189) was mounted on a stand and kept at a distance of 18 inch from the subject's mouth. Using the SLM as a guide for intensity, the subjects were instructed to read a book or reading material of their interest at 75-80 dB SPL in standing posture upto an hour or until they reported themselves as fatigued.

The experimenter cued the subject to maintain comfortable pitch and loud intensity level as needed, and monitored I0 for every 30 seconds for the entire duration of prolonged loud reading task. The experimenter monitored and noted the time of initial sign of vocal fatigue from the beginning of the reading. The number of times the experimenter asked the subject to increase his loudness after the initial sign of vocal fatigue was also recorded. The frequency of reminder was taken as a subjective indicator of vocal fatigue.

In case, a subject was unable to read at that intensity level for 1 hour, the reading was terminated and the duration of prolonged reading was noted. In addition, the experimenter observed for any physical or vocal signs of discomfort (e.g. coughing, throat clearing, and voice quality change). These signs were meticulously noted by the experimenter.

III. Post experiment phase

Directions to subjects after the participation in the experiment: Subjects were asked to remain...
silent between the termination of the prolonged loud reading task and the immediate post-test assessment. The subjects were asked to follow strict vocal hygiene guidelines: 1) no extreme voice use (yelling, prolonged singing, talking, whispering & throat clearing), 2) avoid caffeine, 3) avoid smoking, 4) coughing, 5) throat clearing, and 6) drink adequate amounts of water for 24 hours after the experimental task. The subjects were refrained from throat clearing until the post evaluation procedures were completed.

**Post experiment recording and analysis:** Following the prolonged loud reading task, the phonation and conversation samples were recorded again as mentioned in baseline measurements and MDVP parameters were analyzed. MPT and S/Z ratio were also analyzed. The data obtained immediately after vocal loading task served as immediate post-test measurements, which was named as $P_{oT_0}$.

Voice recovery was tracked at 5, 10, 15 and 20 minutes and 24 hours following the immediate post test, which were named as $P_{oT_5}$, $P_{oT_{10}}$, $P_{oT_{15}}$, $P_{oT_{20}}$, and $P_{oT_{24hr}}$ respectively.

Paired $t$ test was used to measure the pre and post test voice measures. A repeated measure of analysis of variance (ANOVA) was performed on $P_{oT_5}$, $P_{oT_{10}}$, $P_{oT_{15}}$, $P_{oT_{20}}$, and $P_{oT_{24hr}}$ to measure the recovery of vocal function.

**Results & Discussions**

I. Pre and immediate post-experiment comparisons

**Perceptual analysis of phonation and conversation:** The pre-experiment (PrT) analysis for phonation and conversation sample was judged to be normal with respect to pitch, loudness and quality. Immediate post vocal loading task ($P_{oT_0}$) analysis of phonation samples revealed pitch deviancies (low pitched phonation), loudness deviancies (soft phonation) and quality deviancies (hoarse & breathy voice) in phonation. The results are tabulated in Table 1. This change was observed in 100% of the subjects on the immediate post vocal loading task. Acoustic analysis (discussed later) ascertains the perceptual findings. These changes are attributed as effects of vocal loading. However, contrary to these findings, Kelchner et al. (2003) assessed quality in phonation after the vocal loading task and reported no significant difference in the voice quality.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Severity</th>
<th>PrT</th>
<th>$P_{oT_0}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Normal</td>
<td>100 %</td>
<td>50 %</td>
</tr>
<tr>
<td></td>
<td>Mild</td>
<td>0 %</td>
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<td></td>
<td>Moderate</td>
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<td></td>
<td>Severe</td>
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<tr>
<td>Roughness</td>
<td>Normal</td>
<td>100 %</td>
<td>50 %</td>
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<td></td>
<td>Mild</td>
<td>0 %</td>
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<tr>
<td></td>
<td>Moderate</td>
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<td></td>
<td>Severe</td>
<td>0 %</td>
<td>0 %</td>
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<tr>
<td>Breathiness</td>
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<tr>
<td>Strain</td>
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<td>Severe</td>
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Table 1: Perceptual evaluation of conversation samples using GRBAS scale obtained from Pre (PrT) and immediate post experiment ($P_{oT_0}$) recordings.

The pre-experiment analysis for conversation samples was judged to be normal with respect to grade, roughness, breathiness, asthenia and strain. The post experiment revealed 0 % strain. This may be due to the difficulty in identifying strain. Both grade and roughness showed 50 % mild deviancies. Breathiness (12.5 %) and asthenia (7.5 %) were less commonly observed in the conversation samples.

To check intra-judge reliability for phonation and conversation samples, Spearman coefficient of correlation was done. Statistically significant correlation was obtained between the repeated ratings made by the judge at two different times (phonation- $+0.37$; conversation- $+0.25$). Hence the perceptual evaluation by the judge was considered reliable.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Severity</th>
<th>PrT</th>
<th>$P_{oT_0}$</th>
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<tbody>
<tr>
<td>MPT and S/Z ratio:</td>
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<tr>
<td>The maximum phonation time (MPT) for /a/, /i/, /o/ and S/Z ratio was measured pre and post experiment (PrT &amp; $P_{oT_0}$) to obtain status of laryngeal function and coordination with breathing mechanism after the vocal loading task. The results are given below in Table 2.</td>
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Table 2 revealed a significant reduction in MPT after the vocal loading task. The reduction in MPT ranged from 4 – 8 seconds. On contrary, Kelchner et al. (2006) found no significant difference in MPT in pre-pubescent males after the vocal loading task. The S/Z ratio also revealed a significant increase in post-test. Higher S/Z ratio indicates poor laryngeal control rather than poor expiratory forces. Eckel and Boone, 1981 (as cited in Prater & Swift, 1984) found that 95 % of their patients with laryngeal pathologies had S/Z ratios that were greater than 1.40. For better identification of laryngeal pathologies, it has been recommended that S/Z ratio greater than or equal to 1.20 to be used as the cutoff value. The significant differences in MPT and S/Z ratio could be taken as an effect of vocal loading on the coordination of respiratory and the laryngeal mechanism.

**a) Acoustic analysis:** Mean, standard deviation and p - values for the acoustic measures are tabulated based on the different parameters specified in MDVP. A series of two tailed paired t tests for correlated samples was run for each of the acoustic measures to determine statistical difference between the pre (PrT) and post experiment (PoT) data.

**i) Frequency related parameters:** Mean, standard deviation and p - values for the frequency related parameters are tabulated in Table 3.

Table 3 indicated no significant differences for most of the frequency related measures, except for phonatory fundamental frequency range (PFR) and lowest fundamental frequency (Flo). The PFR showed an increase in values and Flo revealed a decrease in the values. The slight decrease in Flo, Flo and increase in PFR was in strong agreement with the perceptual findings reported in this study. Similarly, Neils and Yairi, 1987 (as cited in Rantala & Vilkman, 1999) reported no significant changes in Fo in vocally untrained women following 45 minutes of reading in background noise (50 – 70 dB A).

However, Krishna and Nataraja (1995) found significant differences in average fundamental frequency (Fo), average pitch period (t0), standard deviation of Fo (STD), highest fundamental frequency (Fhi) and lowest fundamental frequency (Flo) after a 30 minutes reading task. In a similar study, Stemple et al. (1995), Gefler and Andrews, 1991 (as cited in Stemple et al., 1995) and Vilkman, Lauri, Alku, Sala and Sihvo (1999) documented increase in habitual Fo following prolonged voice use. This discrepancy may be due to variations in duration of vocal loading tasks and gender differences across the studies.

**ii) Short and long term frequency measurements:** Table 4 showed mean and standard deviation of frequency perturbation measures. Measures such as jitter in % (Jitt), relative average perturbation (RAP), pitch period perturbation quotient (PPQ), smoothed pitch perturbation quotient (sPPQ) and absolute jitter (Jita) showed significant difference and vFo did not show any significant difference in pre and immediate post experiment. All these parameters measure the short and long term variations of the pitch period within the analyzed sample. The increase in the short and long term frequency measurements may be due to irregular vibration of the vocal folds. This altered mode of vibration could have lead to an increase in frequency perturbation measures. These changes are attributed as effects of vocal loading.
Table 4: Mean, standard deviation and \( p \) - values for short and long term frequency related measures.

The finding in the present study also stands in support of the results from Gelfer et al., 1991 (as cited in Stemple et al., 1995) that found a significant change between pre- and post test Jitter ratio for the vowel /i/ in trained singers after vocal loading task. In contrast to this findings, Verstaete, Forrez, Mertens and Debruyne, 1993 (as cited in Welham & Maclagan, 2004) found no significant changes in jitter values in untrained voice users.

iii) Short and long term amplitude measurements: The amplitude perturbation measures in Table 5 indicated a significant increase in all the measures such as shimmer (Sh dB), shimmer percent (shim), amplitude perturbation quotient (APQ), smoothed amplitude perturbation quotient (sAPQ), and peak amplitude variation (vAm).

All these parameters measure the period-to-period variability of peak to peak amplitude within analyzed sample. The higher values in amplitude measures can be explained as the inability of the subjects to maintain a constant intensity in phonation after the vocal loading task. However, Verstaete et al., 1993 (as cited in Welham & Maclagan, 2004) found no significant differences in shimmer values in untrained voice users.

Table 5: Mean, standard deviation and \( p \) - values for short and long term amplitude related measures.

Table 6: Mean, standard deviation and \( p \) - values for noise related measures.

iv) Noise related parameters: The mean, standard deviation and significance of noise related measures such as soft phonation index (SPI), voice turbulence index (VTI) and noise to harmonics ratio (NHR) is showed in Table 6. The results showed a significant increase in NHR and SPI. Higher NHR values indicated that there is considerable increase in noise component in voice after vocal loading task and this may be due to increase in glottal gap during phonation. The other noise related VTI did not show a significant difference. On the contrary to these findings, Krishna and Nataraja (1995) found no significant difference in noise related measures.

v) Voice break related parameters: Table 7 showed no significant variations in the pre- and post experiment values for voice break related measures such as degree voice breaks (DVB) and number of voice breaks (NVB). Therefore, indicating no effect of vocal loading task on voice break related measures. Krishna and Nataraja (1995) also found
no significant differences in voice break measures.

Table 7: Mean, standard deviation and $P$-values for voice break related measures.

<table>
<thead>
<tr>
<th>Parameters (unit)</th>
<th>$PrT$ Mean (SD)</th>
<th>$PsT_o$ Mean (SD)</th>
<th>$P$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVB (%)</td>
<td>0.00 (0.00)</td>
<td>0.18 (0.59)</td>
<td>0.186</td>
<td>-</td>
</tr>
<tr>
<td>NVB</td>
<td>0.00 (0.00)</td>
<td>0.10 (0.30)</td>
<td>0.163</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 7: Mean, standard deviation and $P$-values for voice break related measures.

vi) Sub-harmonic component measures: The results in Table 8 show no significant variations in the pre- and post test values such as degree of sub harmonic segments (DSSH) and number of sub harmonic segments (NSH). Therefore, indicating vocal loading task is not affecting sub-harmonic components in the current study. Krishna and Nataraja (1995) also found no significant differences in sub-harmonic component measures.

Table 8: Mean, standard deviation and $P$-values for sub-harmonic component related measures

<table>
<thead>
<tr>
<th>Parameters (unit)</th>
<th>$PrT$ Mean (SD)</th>
<th>$PsT_o$ Mean (SD)</th>
<th>$P$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSSH (%)</td>
<td>0.03 (0.09)</td>
<td>0.35 (0.93)</td>
<td>0.132</td>
<td>-</td>
</tr>
<tr>
<td>NSH</td>
<td>0.10 (0.30)</td>
<td>1.1 (2.8)</td>
<td>0.116</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 8: Mean, standard deviation and $P$-values for sub-harmonic component related measures

vii) Voice irregularity related measurements: The results in Table 9 showed significant variations in the pre- and post test values for voice irregularity parameters such as degree of unvoiced segments (DUV) and number of unvoiced segments (NUV). This irregularity in voicing was due to the effect of vocal loading on vocal mechanism. However, Krishna and Nataraja (1995) found no significant differences in voice irregularity measures.

Table 9: Mean, standard deviation and $P$-values for voice irregularity related measures

<table>
<thead>
<tr>
<th>Parameters (unit)</th>
<th>$PrT$ Mean (SD)</th>
<th>$PsT_o$ Mean (SD)</th>
<th>$P$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUV (%)</td>
<td>0.08 (0.03)</td>
<td>1.2 (5.8)</td>
<td>0.06</td>
<td>+</td>
</tr>
<tr>
<td>NUV</td>
<td>0.25 (0.83)</td>
<td>2.9 (6.8)</td>
<td>0.05</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 9: Mean, standard deviation and $P$-values for voice irregularity related measures.

viii) Voice tremor related measurements: The mean, standard deviation and significance of voice tremor related measures such as $F_{tremor}$ frequency ($F_{ftr}$), amplitude tremor frequency ($F_{atr}$), frequency tremor intensity index ($F_{TRI}$) and amplitude tremor intensity index ($A_{TRI}$). Table 10 showed significant increase for $F_{TRI}$ and $F_{ftr}$ measures. This may be explained due to the tremor component in the voices of the subjects after the vocal loading task. There were no significant differences noticed for the other voice tremor related measures.

Table 10: Mean, standard deviation and $P$-values for voice tremor related measures

<table>
<thead>
<tr>
<th>Parameters (unit)</th>
<th>$PrT$ Mean (SD)</th>
<th>$PsT_o$ Mean (SD)</th>
<th>$P$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{ftr}$</td>
<td>1.8 (1.9)</td>
<td>4.1 (3.3)</td>
<td>0.024</td>
<td>+</td>
</tr>
<tr>
<td>$F_{atr}$</td>
<td>1.6 (1.8)</td>
<td>2.1 (2.1)</td>
<td>0.446</td>
<td>-</td>
</tr>
<tr>
<td>$F_{TRI}$</td>
<td>0.1 (0.1)</td>
<td>0.4 (0.3)</td>
<td>0.005</td>
<td>+</td>
</tr>
<tr>
<td>$A_{TRI}$</td>
<td>1.3 (1.4)</td>
<td>2.6 (2.9)</td>
<td>0.107</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 10: Mean, standard deviation and $P$-values for voice tremor related measures.

ix) Prolonged reading task - duration as an indicator of vocal fatigue: The overall mean and standard deviation for duration of total loud reading time and notice of initial fatigue are described in Table 11.

Table 11: Minimum, Maximum, Mean and standard deviation for duration of prolonged reading and symptoms of initial fatigue

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total reading time (minutes)</td>
<td>30</td>
<td>45</td>
<td>35 (4.34)</td>
</tr>
<tr>
<td>Initial fatigue noticed (minutes)</td>
<td>10</td>
<td>23</td>
<td>15 (3.36)</td>
</tr>
<tr>
<td>Frequency of reminder (number)</td>
<td>13</td>
<td>21</td>
<td>16 (2.28)</td>
</tr>
</tbody>
</table>

Table 11: Minimum, Maximum, Mean and standard deviation for duration of prolonged reading and symptoms of initial fatigue.

In the current study, the length of time an individual could maintain loud reading task was subjectively interpreted as a partial indicator of vocal fatigue or endurance. Krishna and Nataraja (1995) suggested 30 minutes of reading was sufficient to induce fatigue. In the present study duration of reading ranged from 30 - 45 minutes. The mean duration of prolonged reading for subjects was 35
minutes with a standard deviation of 4.34. It was found that prolonged loud reading for 35 minutes itself was sufficient to induce vocal fatigue which was indicated by changes in the acoustic measures.

None of these subjects were able to complete the prolonged loud reading task for an hour. The time of initial fatigue revealed that all of the subjects reported fatigue before 25 minutes of the loud reading task. The mean duration of initial fatigue reported by the subjects was 15 minutes with a standard deviation of 3.36.

Majority of the subjects reported throat pain as a primary complaint along with throat tightness and running out of breath during prolonged loud reading task. These complaints correlate with some of the primary symptoms of vocal fatigue listed by Kostyk and Roche, 1998 (as cited in Welham & Maclagan, 2003).

II. Immediate post comparisons with PoT5, PoT10, PoT15, PoT20, and PoT24hr Voice recovery pattern: The MDVP parameters were recorded before, immediately after and at each additional 5 minutes increment till 20 minutes and 24 hours following the experimental task. The subjects were asked to follow strict vocal hygiene guidelines for 24 hours after the experimental task. Repeated measures of ANOVA was used in which time was modeled as a within subject effect. Test results demonstrated a significant difference in the group for immediate post-test and post-tests till 20 minutes for some of the voice measures. Graphical representation of the recovery patterns of different voice measures are given below.

**Frequency related measurements:**

The frequency related measurements such as Fo, Flo, Fhi, STD and PFR did not show a significant recovery pattern through comparisons from the pretest to the post-tests till 20 minutes. However, Kelchner et al. (2006) documented significant recovery pattern for Fo in prepubescent males. This variation may be due to the duration and intensity of reading employed in the study (Figure 1).
**Short and long term frequency measurements:**
The parameters such as Jitt, RAP, PPQ, sPPQ and jita showed significant difference from the immediate post-test to the post-test done at 20 minutes. Whereas, vFo did not reveal a significant recovery pattern. There was a significant increase in the values of the measures observed after the experimental task. And there was a subsequent recovery pattern noticed which was indicated by the returning of the values to near pre-test level within 20 minutes from the vocal loading task. The measures reached the pre-test levels at post-test done at 24 hours. This indicated that the voice parameters recovered completely after the acute physiologic change due to the vocal loading task 24 hours later (Figure 2).
Figure 2: Voice recovery pattern of Jitt, RAP, PPQ, sPPQ, vFo, and Jita.
Noise related measures: In the noise related measures, NHR showed a significant difference from the immediate post-test to the post-test done at 20 minutes. Whereas other parameters such as SPI and VTI did not reveal a significant difference in the recovery patterns. There was significant increase in the values and there was a subsequent recovery pattern noticed which was indicated by the returning of the values to near pre-test level within 20 minutes. The values reached the pre-test levels at 24 hours post-test (Figure 4).

Conclusions

The results revealed several interesting facts:

1. **Effects of vocal loading:**
   a) Changes in pitch, loudness and quality were noted after the vocal loading task. Overall voice quality change was more pronounced. Vocal loading lead to a more rough voice quality. Strain was difficult to measure.
   b) The maximum phonation time showed a significant reduction (around 6 seconds) after the vocal loading task for all the three vowels (/a/, /i/, /u/) measured. The S/Z ratio also revealed a significant increase after the vocal loading task.
   c) The acoustic analysis measured using MDVP revealed significant difference for some of the parameters. The parameters such as fundamental frequency, PFR, short and long term frequency measurements, short and long term amplitude measurements, noise and voice irregularity related measures showed significant difference after the vocal loading task.

2. **Fatigability time:** None of the subjects could sustain (75 - 80 dB SPL) loud reading task for an hour. Initial signs of fatigue were seen as early as 15 minutes. So it was concluded that normal healthy adult males could possibly sustain voice at such loudness levels not more than 30 minutes. It would be interesting to note if this sustained time would vary in women, children and with altered intensity levels.

3. **Associated vocal fatigue symptoms:** Majority of the subjects reported throat pain as a primary complaint along with throat tightness and running out of breath while talking.

4. **Voice recovery pattern:** Various acoustic parameters such as short and long term frequency measures, short and long term amplitude measures and NHR in noise related measures revealed a significant recovery pattern. This recovery was characterized by the returning of values to pre-test levels 24 hours after the vocal loading task.

The information obtained in this study ascertains that prolonged voice use can result in vocal symptoms. Complaints of vocal fatigue, voice
symptoms, and voice recovery can be tracked and monitored using perceptual and acoustic measures. These findings can be applied to understand vocal endurance, susceptibility to vocal fatigue and physiological changes due to vocal loading.

References


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AUDITORY BRAINSTEM RESPONSES TO FORWARD AND REVERSED SPEECH IN NORMAL HEARING INDIVIDUALS

*Sujeet Kumar Sinha, **Vijayalakshmi Basavaraj

Abstract

Differences in the coding of forward and reversed speech has indicated that the human auditory system is sensitive to different types of speech sounds. Infants as well as adults are reported to respond differently to forward and reversed speech. Functional magnetic resonance imaging (FMRI) have revealed that listening to forward speech activates large regions of the temporal lobe, whereas reverse speech evokes significantly diminished and nonlocalised brain responses. The objective of the present study was to assess the differences, if any, in the brainstem responses to forward and reversed speech stimuli. 50 normal hearing adults participated for the study. A synthesized 40msec short stimulus /da/ syllable was used as the stimulus for both forward and reversed conditions. The syllable was reversed with the help of Adobe Audition software. Auditory brainstem responses were recorded for the forward and reversed /da/ stimulus. Results revealed that the amplitude of wave V was larger for reversed speech as compared to the forward speech. On the other hand, the amplitude of the frequency following responses, fundamental frequency and the formant frequency were smaller in the reversed speech condition as compared to the forward speech condition. The findings of the present study suggest that differential processing of forward and reversed speech occurs at the brainstem level as well even for a short duration stimulus. The better response to forward speech could be due to the universal temporal and phonological properties of human speech which is familiar to the brainstem and hence is processed efficiently. These findings suggest that Speech evoked ABR may throw light to understand the encoding of complex acoustic stimulus at the brainstem level.

Key words: Brainstem, Speech Evoked ABR, Forward Speech, Reversed Speech,
top-down mechanisms (Banai & Kraus, 2008).

Given the information that the brainstem does contribute to processing of speech, it will be interesting to study the nature of processing of the different aspects of speech by the subcortical structures.

Reversed speech is considered as a good stimulus to investigate in this area since reversed speech has the unique characteristics to maintain the physical characteristics of speech such as the distribution of frequency of sounds, their global amplitude and, to some extent, their temporal and rhythmic characteristics. The main difference between forward speech and reversed speech lies in the coarticulations which are totally distorted in the reversed signal. If speech stimuli are played backwards it sounds like unfamiliar and often bizarre sounding language even though phoneme duration and the fundamental voicing frequency are preserved (Binder et al., 2000; Dehane, Dehane & Hertz-Pannier, 2002). This is because reverse stimulation violates phonological properties universally observed in human speech (Binder et al., 2000; Dehane et al., 2002).

There are reports which suggest differences in the coding and processing of forward and reverse speech stimulus. Adults as well as infants are sensitive to these stimulus differences. It has been reported that 4 days old neonates and 2 months old infants can discriminate native and foreign languages but not when those sounds are played backwards (Mehler, Jusczyk, Lambertz, Halsted, Bertoncini & Amiel-Tison, 1988). Functional magnetic resonance imaging (FMRI) have indicated that the left angular gyrus, right dorsolateral prefrontal cortex and the left mesial parietal lobe (precuneus) get significantly more activated by forward speech than by backward speech. (Mehler et al., 1988). FMRI studies have also shown that listening to forward speech activates large regions of the temporal lobe, but backward speech evokes significantly diminished and non-localised brain responses (Binder et al., 2000). The direct contrasts Words-Pseudowords and Words-Reversed have no areas of significant activation difference in either direction in neither hemisphere, nor a direct contrast between Pseudowords and Reversed conditions (Binder et al., 2000).

The segmental and suprasegmental features of speech may condition and modify brainstem neurons to process familiar sounds more selectively and preferentially. It is also possible that the type of signal processing may affect the subsequent cortical development and language lateralization. Galbraith et al. (2004), where they have obtained the brainstem responses to forward and reversed speech (using an 880 msec 4 syllable phrase. Both horizontal and vertical electrode montages were used to record the responses on a small sample of 11 subjects. There is a need to ascertain the findings of Galbraith et al. (2004) on a larger sample. Also, there is a need to explore the auditory brainstem processing using different types and duration of speech stimuli, with and without background noise and with different methods of presentation. The information documented by such studies especially using a larger sample than that used by Galbraith et al (2004) would throw light on the similarities and differences between the subcortical and cortical processing of speech, the interaction between the two levels and implication of these interactions or the lack of it. Since, Galbraith et al (2004) did only FFT analysis of the brainstem responses, it will be interesting to measure the amplitude of each peak to substantiate the differences between the forward and reversed speech. Therefore there is a need to study the amplitude of each peak and FFT analysis on a larger sample. Thus, the objective of the present study was to assess the possible differences in brainstem responses to forward and reversed speech stimuli.

**Method**

**Research design:** "A Within Subject" research design was used where in the responses of each subject to forward and reversed speech stimuli were compared.

**Hypothesis:** The null hypothesis that there is no difference between the ABR responses for forward and reversed speech in subjects with normal hearing sensitivity was adopted.

**Participants:**

Fifty young adult students (30 males and 20 females) in the age range 17 to 23 years, with a mean age of 19 years consented to participate in the study. All the subjects had normal hearing thresholds as defined by puretone thresholds of <20 dBHL from 250 Hz to 8000 Hz with normal middle ear functions as revealed by A type of tympanograms and presence
of acoustic reflexes present at 500 Hz, 1000 Hz, 2000 Hz & 4000 Hz for both ipsi and contralateral stimulation.

**Test Stimulus:**

Synthesized /da/ syllable of 40 msec length was used as the test stimulus, synthesized with a Klatt synthesizer (Klatt, 1980). The stimulus was prepared to include an onset burst frication at F3, F4, and F5 during the first 10 msec and a fundamental frequency range of 105-121 Hz, followed by 30-msec F1 and F2 transitions ceasing immediately before the steady-state portion of the vowel. Although the stimulus does not contain a steady-state portion, it is psychophysically perceived as a consonant-vowel speech syllable. Such a stimulus was first developed at Northwestern University by King et al (2002) and the same has been used for research at Northwestern University.

Figure- 1 shows the /da/ stimulus of 40 msec whereas the figure 2 shows the reversed waveform of the same stimulus. Stimulus in the figure-2 is the mirror image of the stimulus in figure-1. Adobe audition version-2 software was used to reverse the stimulus.

![Figure 1. Waveform of the forward /da/ stimulus.](image1)

![Figure 2. Waveform of the temporally reversed /da/ stimulus.](image2)

**Instrumentation:**

- A calibrated (ANSI S3.6-1996), two channel clinical audiometer Madsen OB922 with TDH-39 headphones housed in Mx-41/AR ear cushions were used for Pure tone audiometry. Radioear B-71 bone vibrator was used for measuring bone conduction thresholds.
- A calibrated middle ear analyzer, (GSI Tympstar) using 226 Hz probe tone was used for tympanometry and reflexometry.
- Intelligent Hearing (Smart EP windows USB version 3.91) evoked potential system with insert ear ER-3A receiver was used for recording auditory brainstem responses.

**Procedure**

All the subjects underwent puretone audiometry and
tymanometry to ensure that they had normal hearing sensitivity and normal middle ear functions. The speech evoked auditory brainstem responses were recorded for all the subjects for both the forward and the reversed /da/ stimulus in the EP system of Intelligent Hearing systems version 3.91. The details of the protocol for recording the speech evoked ABR are given in table-1.

### Analysis:

Speech evoked ABR consists of six peaks. These peaks are labeled as (V, C, D, E, F, & O. (Russo et al., 2004; Russo et al., 2005, Johnson et al., 2005). The amplitude of waves V, D, E and F were measured for the forward as well as reversed conditions. Wave C and wave O were not taken into consideration for analysis as they were not present in all the subjects. Two audiologists who have the knowledge of the Speech evoked ABR analyzed the waveforms independently. The inter audiologist reliability was ensured by doing a correlational analysis for all the peaks. All the peaks showed a high positive correlation for the peaks marked by the two audiologists.

### Measurement of Fundamental frequency (F0) and First Formant frequency (F1):

FFR consists of energy at fundamental frequency of the stimulus and its harmonics. The period between response peaks D, E, and F in the recorded waveform corresponds to the wavelength of the F0 of the utterance (Johnson et al., 2005). Moreover, Fourier analysis of this portion of the response confirms a spectral peak at the frequency of F0. Additionally, the spacing of the small, higher-frequency fluctuations between waves D, E, and F correspond in frequency to the F1 of the stimulus (Russo et al., 2004; Russo et al., 2005, Johnson et al., 2005). Fast Fourier analysis was performed on the recorded waveform. Activity occurring in the frequency range corresponding to the fundamental frequency (F0) of the speech stimulus (103-121Hz) and activity corresponding to the first formant frequency (F1) of the stimulus (220 Hz -729 Hz) were measured. 2 ms on-2 ms off Hanning ramp was applied to the waveform. Zero-padding was employed to increase the number of frequency points where spectral estimates were obtained. A subject's response was required to be above the noise floor in order to include in the analysis. This calculation was performed by comparing the spectral magnitude of pre stimulus period to that of the response and if the quotient of the magnitude of the F0 or F1 frequency component was greater than or equals to one the response was considered to be present. The analysis of F0 and F1 was done with the MATLAB software.

### Results

A long term average speech spectrum of both the forward and reversed speech was performed to see whether the spectrums of the two sounds are different. On analysis it was found that the spectrum of the forward and reversed stimuli remained the same. Figure 3 shows the long term average spectrum of the forward and reversed speech stimuli. Since there was a perfect overlap of the two spectra it was difficult to differentiate one from the other. Hence, the SPL of the reverse speech (shown in continuous line) was deliberately reduced to differentiate it from the forward speech spectrum (shown in dotted line).

Wave V was identified for the forward and the reversed speech similar to the way it is identified for click stimulus. Since wave V is the result of an onset response, this is similar to both the click and the speech evoked ABR. Johnson et al., (2005) have reported and illustrated that the visual analysis of /da/ stimulus waveform and its corresponding brainstem response has several similarities. They

<table>
<thead>
<tr>
<th>Stimulus parameter</th>
<th>Stimulus</th>
<th>Forward /da/ and reversed /da/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>40 msec</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>80 dB nHL</td>
<td></td>
</tr>
<tr>
<td>Polarity</td>
<td>Alternating</td>
<td></td>
</tr>
<tr>
<td>Repetition rate</td>
<td>9.1/sec</td>
<td></td>
</tr>
<tr>
<td>Total no. of stimulus</td>
<td>2000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acquisition parameter</th>
<th>Analysis time</th>
<th>Filter setting</th>
<th>Electrode Montage</th>
<th>Transducer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 msec</td>
<td>30 to 3000 Hz</td>
<td>Noninverting(+ve):Vertex, Inverting(–ve):Test ear mastoid, Ground: Non test ear mastoid</td>
<td>Insert receiver-ER-3A</td>
</tr>
</tbody>
</table>

Table 1: Recording parameters for the speech evoked auditory brainstem responses for the forward /da/ and the reversed /da/ stimulus
have recommended to shift the stimulus waveform by approximately 7 msec to account for neural conduction time to identify the speech ABR peaks which correlate with the peaks in the stimulus, namely peak D, E and F. In the present study the speech ABR peaks corresponding to the peaks D, E and F in the stimulus were identified using the same procedure for both the forward and reversed speech keeping the burst of the stimulus as reference. The burst for the forward stimulus appears in the beginning of the stimulus and for the reversed speech it appears in the last of the stimulus and hence, the peaks D, E, and F occurs in the reversed order for the reversed speech and thus it can be seen from figure 4b that wave F follows wave V against wave D.

Figure- 3. Long term average speech spectrum of forward and reversed speech

Figure 4a. Sample of Speech evoked ABR for the forward Speech and its correlation with the stimulus peaks

Figure 4b. Sample of Speech evoked ABR for the reversed Speech and its correlation with the stimulus peaks
Descriptive statistics:
SPSS software version 15 was used for statistical analysis. Mean and standard deviations for the amplitude alone of waves V, D, E and wave F were determined for all the subjects for the forward and reverse speech. Latency parameter was not subject to analysis as this is determined by the stimulus parameters. The mean and Standard deviation (SD) of amplitude of the different waves for the forward & reversed speech are presented in table 2.

From the table 2 it can be noticed from that the mean amplitude for wave V is larger for the reversed speech as compared to that for the forward speech condition. The amplitude of others peak (waves D, E & F) are larger for forward speech condition as compared to that for the reversed speech condition. This can be seen in figure 5 as well.

<table>
<thead>
<tr>
<th>Wave</th>
<th>Forward Speech Amplitude (µv)</th>
<th>Reversed Speech Amplitude (µv)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Wave V</td>
<td>0.18</td>
<td>0.10</td>
</tr>
<tr>
<td>Wave D</td>
<td>0.33</td>
<td>0.25</td>
</tr>
<tr>
<td>Wave E</td>
<td>0.35</td>
<td>0.16</td>
</tr>
<tr>
<td>Wave F</td>
<td>0.28</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Table 2: Mean and standard deviations (SD) for amplitude (µv) of different peaks for the forward & reversed speech

To know the significance of difference between the amplitude of different peaks the dependent 't' test was done. The results of dependent 't' test revealed a significant difference between the amplitude of wave V [t (49) = 6.54, p...
Also an analysis of fundamental frequency and first formant frequency was done. This was done using "Matlab Software". A sample figure of how the fundamental frequency and the first formant frequency were measured is given in the figure 6 above.

F0 and F1 analysis:

Analysis of Fundamental frequency and first formant frequency revealed that the mean amplitude of fundamental frequency for forward speech was 15.72µv and of the reversed speech was 9.23 µv. The amplitude of first formant frequency for forward speech was 12.86 µv and that of reversed speech was 7.83 µv. A dependent’t’ test was applied to compare the amplitude of fundamental frequency and the first formant frequency of forward speech and reversed speech. This revealed a significant difference for the F0 [t (49) = 2.34, p<0.05] and for the F1 [t (49) =2.22, p<0.05].

Thus the null hypothesis that there is no significant difference between the brainstem responses to forward and reversed speech conditions was rejected. To summarize the results, amplitude of all the peaks for forward speech except for "wave V" was more as compared to that of the reversed speech. Also, the amplitude of fundamental frequency and first formant frequency was more for forward speech as compared to the reversed speech.

Discussion

Auditory brainstem is the site of extensive synaptic complexity and acoustic signal processing in the auditory pathway (Eggermont, 2001). The regularities in the acoustic biotope, consisting of individual vocalizations and background sounds that are part of the natural habitat are likely to be manifested in the response properties of auditory neurons (Aertsen, Smolders, & Johannesma, 1979; Nelken, Rotman, & Yosef, 1999; Smolders, Aertsen, Johannesma, 1979).

In the present study the frequency following responses to forward and reversed speech were recorded in a vertical montage. The vertical frequency following responses measure responses originating in the rostral brainstem (Galbraith, 1994; Gardi, Merzenich & Mckean, 1997). The principal finding of the present study is that there is a significant difference between the forward and the reversed speech coding even for a short duration stimulus of 40 msec at the brainstem level. The amplitude of the frequency following responses to reversed speech stimulus were reduced as compared to that for the forward speech. Further, the results also indicate that the amplitude of fundamental frequency and the first formant frequency were also reduced in the individuals for the reversed speech condition. The reduced amplitude of FFR, fundamental frequency and the first formant frequency suggests that the brainstem processes the forward speech differently than the reversed speech. Galbraith et al (2004) have also reported a reduced FFT response to reversed speech compared to the forward speech. The present study supports their findings and further illustrates that the differential processing is seen even for a short duration CV stimulus like /da/. However, responses obtained for short duration stimuli using horizontal montage needs to be explored as present study used only vertical montage.

It is possible that the reduced amplitude of the frequency following responses (i.e. the amplitude of the wave D, E and F) may simply be due to the coarticulation effect in forward and reversed speech. The coarticulations are reported to be totally distorted in the reversed signal (Binder et al., 2000; Dehane, et al., 2002). One may argue that the reduced responses in the brainstem may be due to the distortion of the coarticulations in the reversed speech rather to the differences in the processing at brainstem level. However in the present study, the FFT analysis of the FFR shows reduced amplitude of F0 and F1. It is difficult to explain the reduced responses of F0 to the coarticulation effect because in the reversed speech some of the parameters such as distribution of frequency of sounds, their global amplitude, phoneme duration and the fundamental voicing frequency are preserved (Binder et al.2000; Dehane, et al. 2002), as shown in figure 3 also. Therefore, the findings in the present study may not be due to the distortion of the coarticulation effect alone. It appears to be because of the differential processing of forward and reversed speech at the brainstem level. Thus, the results of the present study suggest that the brainstem structures processing is also different for familiar and non familiar stimuli similar to the cortical processing.
It appears that the synaptic processing at the level of rostral brainstem is more effective for speech stimuli characterized by highly familiar prosodic and phonemic structures as illustrated by better ABR responses for the forward speech condition. This could be due to the conditioned exposure to native speech patterns that may modify the microanatomy and processing capabilities of the auditory system (Querleu & Renard, 1981). Indeed there are studies which suggest that there is plasticity even at the level of brainstem (Russo et al., 2005). The notion that neural activity in the rostral brainstem is sensitive to language experience, (i.e., language-dependent) is also reported (Krishnan et al. 2005). At this point, a question arises as to whether these observed FFR effects are stable for all types of stimuli. Further studies with a longer duration stimuli, a tonal stimulus, words and sentences will strengthen the present area of research.

**Conclusion**

The present study highlights the differential processing of forward and the reversed speech at the brainstem level similar to that at the cortex. Differences in the processing at the cortical level for forward and reversed speech has been reported (Binder et al., 2000). Findings of the present study suggest that the differential processing occurs at the brainstem level as well. The differences in the processing of forward (familiar) and reversed (non familiar) speech could be due to the previous exposure to the forward speech making the universal temporal and phonological properties of speech familiar to the auditory system. Findings of the present study also suggest that speech evoked ABR provides information to understand the encoding of complex acoustic stimulus at the brainstem level. Further research on normal and abnormal speech evoked ABR may throw light on some of the factors contributing to the poor speech perception. Although speech perception involves various cognitive processes that go beyond a single neural code and the brainstem encoding of speech sounds alone may not account for the speech perception, it is possible that abnormal neural response patterns at the brainstem may be one of the many factors which contributes to the poor speech perception.

**References**


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- All the students who participated in the study
EFFECT OF SENSORINEURAL HEARING LOSS ON SPEECH EVOKED AIDED AUDITORY LATE LATENCY RESPONSE

*Kumari Apeksha, **Ms. N. Devi

Abstract

The aim of present study was to compare the auditory late latency response (ALLR) waveform obtained for naturally produced speech tokens, such as /ba/, /da/, and /ga/ in unaided and aided conditions. It also aimed to evaluate the usefulness of ALLR in selection of amplification device using naturally produced speech tokens. Two groups of participants were taken, including 10 individuals with normal hearing and hearing impairment (9 ears) in the age range of 20 to 50 yrs. Speech evoked ALLR was done both in unaided and aided conditions. Aided ALLR was done with two pre-selected digital hearing aids with first fit. The results revealed that there was significant difference between unaided and aided responses ($x^2 = 197.04$, df = 26, $p < 0.001$). However, only /ba/ and /ga/ for P1 and /ba/ for N1 showed significant difference at 0.05 significance level. The latency was shorter and amplitude was higher for the group with normal hearing than hearing impaired group. There was difference in terms of latency for the speech sounds taken for the study. /ga/ stimulus was found to have shorter latency and /da/ had longer latency out of three stimuli. Similar pattern was also observed for absolute amplitude. Finding from the present study also revealed that there was significant difference between performances of individuals with sloping sensorineural hearing loss with different hearing aids in aided ALLR. Aided ALLR can help in selection of hearing aids as it mimics the hearing aid processing. It can be suggested to use aided ALLR to select hearing aids as it is objective test and can assessed in shorter duration.

Key words: Auditory Late Latency Response, Hearing loss, Hearing aids, Speech stimuli

Cortical potentials reflect the functional integrity of the auditory pathway involved in the processing of complex speech stimuli. It can be used to understand the neurophysiologic basis of speech perception, which would give information of the speech processing abilities of the individuals. It is one of the ideal objective tools for aided hearing instrument evaluation because it is reliably present in young infants and adults, it correlates well with perception, it can be evoked by a range of speech stimuli, and it seems to be sensitive to differences between speech stimuli (Tremblay, Friesen, Martin & Wright, 2003).

The long latency auditory evoked potentials are characterized by components comprising time domain of 50 to 500 msec (McPherson & Starr, 1993) and are labelled according to their latency and polarity at the vertex (Picton, Woods, & Proulx, 1978). The major component of Auditory Late Latency Response (ALLR) are characterized by an initial positive peak between 60-80 msec (P60/P1), having an amplitude of about 7 $\mu$V and a width of about 15 msec. The second peak occurs between 90-100 msec (N100/N1) and is a negative peak with amplitude of 10 $\mu$V and width of 40-50 msec. The third peak is a positive occurring at about 100-160 msec (P160/P2) and has amplitude of 6 $\mu$V and a width of 40-50 msec.

The forth peak occur at 180-200 msec (N200/N2) is a negative peak and has amplitude of 6 $\mu$V and width of 70 msec. The major applicability of cortical auditory evoked potentials comes from the fact that it can be recorded from premature and full term newborns, and from older children. Contrary to...
maturation effect seen in early childhood, there is an increase in latency and decrease in amplitude with the advancing age (Cranford & Martin, 1991).

Yetkin, Ronald, Chriestensen and Purdy (2004) suggested the physiological reasons for difference in the ALLR responses for the low and the high frequency stimuli. They reported that the cortical area responding to low frequency auditory stimuli are located more superficially than the deep layer of the cortical regions for high frequency. Hence low frequency stimuli produce smaller latency of ALLR than high frequency speech sounds.

Some of the reports indicate that ALLR may be used to assess the capacity of the auditory cortex to detect changes within the speech stimuli (Martin & Boothroyd, 1999). An investigation by Hinduja, Kusari and Vanaja (2005) revealed that ALLR of individuals with a hearing aid showed larger amplitude and shorter latency when the aided thresholds were within speech spectrum than compared to the hearing aid in which aided thresholds were outside the speech spectrum. These pre-attentive cortical potentials have also been used to reflect on the auditory training induced changes.

Tremblay, Billings, Friesen and Souza (2006) recorded ALLR for amplified speech sounds /Si/ and /?i/ in 7 adults with mild to severe sensorineural hearing loss and in 7 normal hearing individuals. The results revealed that the speech evoked ALLR can be used reliably both in aided and unaided conditions. Similar results are reported by Korczak, Kurtzberg and Stapells (2005) in individuals with severe to profound hearing loss.

Most of the subjects with hearing loss showed increase amplitude, decreased latencies and improved waveform morphology in the aided conditions. Furthermore, most subjects with hearing loss tested by Korczak, Kurtzberg and Stapells (2005) showed longer peak latencies and reduced amplitudes than the normal hearing group. The amount of response change is quiet variable across individuals as reported by Tremblay et al. (2006).

ALLR was recorded in both aided and unaided condition using /i/, /m/ and /s/ in 10 hearing impaired children in the age range of 5-7 years (Shruthi, 2007). The response obtained from the three stimuli resulted in distinct responses indicating that the stimuli are coded differently in the auditory system. Stimuli /i/ resulted in better morphology, shorter latency, and higher amplitude than /m/ and /s/ stimuli, indicating that vowels are better coded than the consonants.

ALLR was recorded using three speech stimuli, /ba/, /da/ and /ga/ from cochlear hearing loss subjects (Sumitha, 2008). It was observed that the P1-N1-P2 latency was shorter for /ga/ stimuli, and longer for /da/ stimuli. Amplitude did not show significant difference across the three sounds in both normal hearing individuals as well as individual with hearing loss.

Need for the study

It is important for any listener to listen to all the speech sounds, which encompasses the speech spectrum. It is not sufficient to study only the processing of single frequency stimuli. Hence, there is a need to study the ALLR, which is evoked by speech stimuli which largely encompasses the speech spectrum. Hence, the three different speech stimuli /ba/ which has spectral energy concentration in low frequency, /ga/ syllable dominated by mid frequency spectral energy and /da/ syllable dominated by high frequency spectral energy will be taken up for the study.

Aim of the study

The aim of present study was to compare the ALLR waveform obtained for naturally produced speech tokens, such as /ba/, /da/ and /ga/ in unaided and aided condition with that of normal hearing individual. And also to evaluate the usefulness of ALLR for naturally produced speech tokens, such as /ba/, /da/, and /ga/, in validation of appropriate hearing aid.

Method

Participants:

Two groups of participants were included in the study. Group I included 10 individuals with normal hearing in the age range of 20 to 50 years and Group II included 9 ears with hearing impairment in the age range of 20 to 50 years having moderate to moderately-severe sloping sensorineural hearing loss.

Participant selection Criteria:

Group I included 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. They
had normal middle ear functioning as indicated by immittance evaluation. Auditory brainstem response (ABR) and transient evoked otoacoustic emission (TEOAE) were done to rule out auditory dys-synchrony. Participants having speech identification scores greater than 90% and having no history of any otologic, neurologic problems were included for this study.

Group II included individuals having pure tone thresholds greater than 41 dB HL and less than 70 dB HL with air bone gap of less than 10 dB. They had normal middle ear functioning as revealed by immittance evaluation. ABR and TEOAE were done to rule out auditory dys-synchrony. Participants having speech identification scores proportionate to their pure tone average and having no history of any otologic and neurologic problems were considered 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, Radio ear B-71 bone vibrator, and loudspeaker were used. A calibrated immittance meter, GSI-Tympstar was used to assess middle ear functioning. ILO (version, VI) OAE Analyser was used to check for the hair cell functioning. Bio-logic system (version, 7.0) with matched loudspeaker was used to record and analyse the speech evoked auditory late latency responses (ALLR) and ABR. NOAH HI-PRO software (version, 3.12) was used to program the hearing aids.

**Materials:**

Stimuli for recording ALLR were /ba/, /da/, and /ga/. Those syllables were spoken by an adult speaker having clear articulation, into a unidirectional microphone connected to the computer. The recording was done using Adobe Audition software (version 2) with a sampling rate 48000Hz and 16 bit resolution. The stimuli duration was kept less than 250 msec across all the speech sounds. The wave file was loaded for ALLR recording.

**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). For presentation of stimuli for recording ALLR, the speaker was calibrated with the help of sound level meter. The presentation level of the speaker was adjusted such that the output of the speaker at 1 m distance was 65 dB SPL as measured in sound level meter. The same output level was maintained throughout the study.

**Test Procedure for Group I:**

Pure tone thresholds were obtained in the sound field 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. ALLR recording was done for the participants who meet the selection criteria.

ALLR recording: Participants were made to sit comfortably in order to ensure a relaxed posture and minimum rejection rate. Speaker was placed at a distance of one meter and at a 0° azimuth to the test ear. Silver chloride electrodes were placed after cleaning the electrode sites with skin preparing gel. Conduction paste was used to improve the conductivity of the signal. The electrodes were secured in place using plasters, conventional electrode montage with non-inverting electrode on Fz, inverting electrode on the mastoid of the test ear and common electrode on the mastoid of the non-test ear. The electrode impedance value was kept less than 5 kΩ and the inter electrode difference was less than 3 kΩ.

**Test procedure for Group II:**

Similar to the procedure used in group I, pure tone thresholds, Tympanometry and acoustic reflexes were done for participants of group II. Two digital hearing aids having similar features (2 channels, 3 programmable memories, suitable till moderately severe degree of hearing loss) were selected and programmed based on the audiological findings and first fit option was selected. Aided ALLR was used to rate the hearing aids regarding their suitability.

ALLR Recording:

ALLR was recorded separately for the three stimuli /ba/, /da/, /ga/ without the hearing aid as well as with the preselected hearing aids. The procedure selected for the ALLR was same as that used for group I.
**Analysis**

The waveform was analysed by two audiologists who were unaware of the test conditions identified the P1-N1-P2 peaks. Latency and amplitude of the identified peaks were noted.

**ALLR test protocol:**

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>/ba/, /da/, and /ga/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulus Level</td>
<td>65 dB SPL</td>
</tr>
<tr>
<td>Transducer</td>
<td>Loudspeaker at 0° azimuth</td>
</tr>
<tr>
<td>Rate</td>
<td>1.1/sec</td>
</tr>
<tr>
<td>Polarity</td>
<td>Alternating</td>
</tr>
<tr>
<td>Filters</td>
<td>1-30 Hz</td>
</tr>
<tr>
<td>Notch Filters</td>
<td>On</td>
</tr>
<tr>
<td>Number of channels</td>
<td>Single channel</td>
</tr>
<tr>
<td>Recording time window</td>
<td>500 msec</td>
</tr>
<tr>
<td>Amplification</td>
<td>50,000</td>
</tr>
<tr>
<td>Sweeps</td>
<td>200</td>
</tr>
<tr>
<td>Number of Repetition</td>
<td>2</td>
</tr>
</tbody>
</table>

**Results**

The aim of the present study was to investigate the effects of spectrally different speech syllables on the auditory long latency responses in individuals with normal hearing and sloping sensorineural hearing loss. The latencies and amplitudes of P1, N1, and P2 peaks were measured. The Mean and standard deviation (SD) were calculated for 2 groups for 3 syllables for latencies and amplitudes of P1, N1 and P2.

From table 1 and graph 1, it can be inferred that the unaided mean and SD latencies of clinical group was higher than the control group for /ba/, /da/ and /ga/. Further, it was seen that latencies for aided was shorter than unaided clinical group for P1, N1, and P2.

Similarly from table 2 and graph 2, it can be inferred that the unaided mean and SD amplitudes of clinical group was lesser than the control group for /ba/, /da/ and /ga/. Further, it was seen that amplitudes for aided was higher than unaided clinical group for P1, N1, and P2.

Further, Friedman test was carried out to find out the difference between unaided and aided condition. Results revealed that overall there was significant difference between unaided and aided responses ($\chi^2 = 197.04$, df = 26, $p < 0.001$). However, when it was done separately, only /ba/ and /ga/ for P1 and /ba/ for N1 showed significant difference at 0.05 level of significance.

Wilcoxon signed rank test was done to compare the hearing aid 1 and hearing aid 2 findings. Results revealed that there were differences in performance with two different hearing aids for /ba/ stimuli for P1, N1 and P2. Further, for /da/ stimuli only P2 showed significant difference between two hearing aids performance. However, for /ga/ there was no significant difference noticed at all the peaks (Table 3).
Graph 1: Mean for P1, N1, and P2 latencies elicited by /ba/, /da/ and /ga/ syllables in control and clinical group (unaided and aided).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Syllables</th>
<th>Control group</th>
<th>Clinical group (Unaided)</th>
<th>Clinical group (HA1)</th>
<th>Clinical group (HA2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>P1</td>
<td>/ba/</td>
<td>1.10</td>
<td>0.71</td>
<td>0.39</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>/da/</td>
<td>1.29</td>
<td>0.66</td>
<td>0.28</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>/ga/</td>
<td>0.96</td>
<td>0.38</td>
<td>0.61</td>
<td>0.53</td>
</tr>
<tr>
<td>N1</td>
<td>/ba/</td>
<td>3.40</td>
<td>1.08</td>
<td>1.77</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td>/da/</td>
<td>3.60</td>
<td>1.57</td>
<td>1.15</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>/ga/</td>
<td>3.73</td>
<td>1.23</td>
<td>1.82</td>
<td>1.27</td>
</tr>
<tr>
<td>P2</td>
<td>/ba/</td>
<td>3.38</td>
<td>1.44</td>
<td>1.28</td>
<td>1.09</td>
</tr>
<tr>
<td></td>
<td>/da/</td>
<td>3.44</td>
<td>1.38</td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>/ga/</td>
<td>2.34</td>
<td>0.80</td>
<td>0.49</td>
<td>1.31</td>
</tr>
</tbody>
</table>

Graph 2: Mean for P1, N1, and P2 amplitudes elicited by /ba/, /da/ and /ga/ syllables in control and clinical group (unaided and aided).

Table 2: Mean and SD for P1, N1, and P2 amplitudes elicited by /ba/, /da/ and /ga/ syllables in control and clinical group (unaided and aided).

<table>
<thead>
<tr>
<th>Peaks</th>
<th>Group (HA1 &amp; HA2)</th>
<th>Z-value</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>/ba/2 - /ba/1</td>
<td>-2.07</td>
<td>0.03*</td>
</tr>
<tr>
<td></td>
<td>/da/2 - /da/1</td>
<td>-0.53</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>/ga/2 - /ga/1</td>
<td>0.23</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>/ba/2 - /ba/1</td>
<td>-2.19</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>/da/2 - /da/1</td>
<td>-1.26</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>/ga/2 - /ga/1</td>
<td>-0.89</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>/ba/2 - /ba/1</td>
<td>-2.31</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>/da/2 - /da/1</td>
<td>-2.31</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>/ga/2 - /ga/1</td>
<td>-0.17</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Table 3: Wilcoxon signed rank test for comparison of hearing aid 1 and 2 (*p < 0.05).
Discussion

The speech stimulus in the present study was selected in such a way that it covered the low frequency, mid frequency and high frequency region. The stimuli varied only in the spectral content. All the stimuli selected for the study was voiced CV syllable, the vowel /a/ was kept constant. Sound /ba/, which has a spectral energy concentration majorly in low frequency, was selected as low frequency stimuli; /ga/ was selected as mid frequency stimuli and /da/ as high frequency stimuli.

It has been noticed in present study that the latency of /da/ stimuli was longer than /ba/ and /ga/ for both clinical group as well as control group. The speech stimuli /ga/ elicited a shorter latency for both control and clinical group (Table 1 & graph 1). Further, absolute amplitude of all the stimuli also showed similar patterns (Table 2 & graph 2). Study by Sumitha (2008) also revealed a similar finding in subjects with normal hearing and cochlear hearing loss.

Agung, Purdy, McMohon and Newall (2006) used the speech stimuli /a/, /u/, /i/, /s/, /sh/, /m/ and /ë/ which covered a broad range of frequencies across the speech spectrum. They found that latencies of speech stimuli with high frequency content had significantly prolonged latencies than the other stimuli. In individuals with normal hearing as well as in individual with hearing loss, low frequency speech stimuli represents better responses than mid or high frequency speech stimuli. The present findings are in agreement with the finding of other studies (Agung et al., 2006; Shruthi, 2007; Sumitha, 2008).

The physiological reasons for difference in ALLR responses for low and high frequency stimuli was investigated using fMRI studies by Yetkin, Ronald, Chriestensen and Purdy, (2004). These investigators reported that the cortical areas that respond to the low frequency auditory information are located more superficially (i.e. closer to the surface of the scalp) than the deep layer of the cortical regions for high frequency. Hence, the low frequency stimuli may activate more superficial cortical areas and produce smaller latency of ALLR component than the high frequency speech sounds, when surface scalp electrodes are used.

Finding from the present study also revealed that there was significant difference between performances of individuals with sloping sensorineural hearing loss with different hearing aids in aided ALLR. However, the difference was not noticed for all the individuals in clinical group. It may be because of individual variation. Tremblay et al. (2006) also noticed that even though most of the subjects with hearing loss showed increased amplitude, decreased latency and improved waveform morphology in the aided conditions the amount of responses change was quite variable across individuals. This variability may be related to the fact that the hearing aid alters the acoustics of a signal, which in turn affect the evoked response pattern. It was also noticed that /ga/ stimuli was not showing any changes between two hearing aids performance. Similar finding was also observed by Shruthi (2007).

Conclusion

It can be concluded that the aided ALLR recorded by spectrally different speech sounds were different in individuals with normal hearing and sloping sensorineural hearing loss. This suggests that neurophysiological processes are different for different speech sounds. Longer latency for /da/ suggests that latency of the processing at the cortical center was also different depending on the frequency composition of the signal. Further, it also concludes that aided ALLR can help in selection of hearing aids as it mimics the hearing aid processing. But, it was difficult to say whether it can be sensitive with different configuration of hearing loss. However, one must noticed that there was difference in performance in sloping hearing loss individuals. It can be suggested to use aided ALLR to select hearing aids as it is objective test and can be assessed in shorter duration.

Implication of the study

- It will help us to decide objectively the most appropriate hearing aid for a client.
- To assess the speech perception ability of the cortical structures objectively.
- It helps in selecting hearing aids for difficult to test clients.

References


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EXAMINATION OF AUDITORY EFFECTS OF NOISE EXPOSURE DURING MAGNETIC RESONANCE IMAGING

* Snithin Sasheendran, ** Mritunjay Kumar, *** Krishna Y., & **** B. Rajashekar

Abstract

The purpose of this study was to determine if there is any noise induced Threshold Shift resulting from the noise exposure for the various Magnetic Resonance Imaging examinations. A total of 17 adult patients (34 ears) were scheduled for MRI studies anticipated to require at least 20 mins of imaging time were included in this study. Screening OAE test was done & baseline pure tone air & bone conduction thresholds were determined employing a step size of 2dB for each ear. The MRI instrument under the present study is a General Electrical Sigma Contour 0.5 Tesla device. The post MR imaging audiometric threshold estimation was done as soon as possible after the completion of MRI study. Statistical analysis using the paired 't' test shows that there was a significant increase (p < 0.001) in the air conduction thresholds at 4 kHz and at 8kHz (p < 0.001) after. This shows that there is a noise induced Threshold Shift in the normal hearing subjects after the MRI which suggests that the noise exposure during the MRI has damaging effects on the auditory system. The parents study shows that the noise exposure during an MRI scan has an effect on the human auditory system and has been found to cause significant noise induced threshold shift at 4 kHz and 8 kHz. Noise and its auditory and non-auditory effects are proven in the literature. Since the present study revealed significant noise induced Threshold Shift, there is a need for effective Ear Protective Devices usage during MRI procedures to reduce long-term auditory effects.

Key words: MRI, noise induced threshold shift, pure tone audiometry

The introduction of Magnetic Resonance Imaging (MRI) has resulted in a tremendous advance in the technology of medical diagnosis. However with all positive advances there are normally some negative aspects. One of the potentially adverse aspects of MRI is that the equipment is extremely noisy. Many patients complain of noise, which is so loud that some children are frightened by it; some tinnitus suffers claim that it makes their tinnitus more, such loud sounds are not only an annoyance to the patients undergoing MRI, but they have the potential of adversely affecting the patients hearing. It is a well-known fact that loud sounds can induce a hearing loss. The hearing loss can be permanent if the sound is sufficiently intense and the exposure sufficiently long. Less intense sounds or shorter periods of exposure will result in a reversible hearing loss. Since the first Magnetic Resonance Imaging (MRI) concept was devised, gradient coils and gradient pulsing has been the basic imaging book for decades. This basic gradient pulsing in conjunction with the magnetic field in MRI produces what is called acoustic noise.

Ever since the appearance of clinical MRI scanners, it has been one of the most disturbing obstacles for MRI patients scanning, especially for psychiatric patients and small children (Quirk, Letendre, Ciottone, & Lingley, 1989; Brummett, Talbot, & Charuhas, 1988; Hurwitz, 1989).

There have been some attempts to reduce the noise by using the antiphase noise cancellation technique (Goldman, Grossman, & Friedlander,
1989) and the Lorentz force cancellation technique (Mansfield, Chapman, Botwell, Glover, Coxon, & Harvey, 1995). Most of these techniques have not been very successful and significant sound noise still remains. A simpler and perhaps more ideally used technique is the use of ear plugs but this method seems to protect only against sound transmitted by the auditory canal to the ear and does not protect against the sound transmission through bone conduction mode. In fact, patients still experience loud sound noise even after wearing ear plugs since ear plugs suppress only the high-frequency sound noise within audible frequency band (Mansfield et al., 1995).

Although studies have been reported on noise during MRI procedures and its effects, it is felt that a more quantitative physical analysis of sound noise produced by recently variable MRI systems would be an important asset for future research on this important problem, especially in connection with the newly developing functional MRI and other cognitive science research.

**Review**

Acoustic noise levels during Echo Planar Imaging (EPI) have been reported to increase significantly pure tone hearing thresholds in the optimal frequency hearing range between 0.1 to 8 kHz. These effects vary across the frequency range. The threshold changes according to the characteristics of the sequence-generated acoustic noise. Notably, if may be possible to take into account the MR system-induced auditory activation by using a control series of scans in task paradigms. Experimental results have been reported for mapping auditory activation induced by MR system-related acoustic noise.

The ear is highly sensitive wide-band receiver. The human ear does not tend to judge sound powers in absolute terms but assesses how much greater one power is than another. Combined with the very wide range of powers involved, the logarithmic decibel scale, dB, is used when dealing with sound power.

Since the ear is not equally sensitive to all frequencies, data may be weighted using the dB (A) measurement scale, which biases the meter to respond similarly to the human ear. The quality or efficiency of hearing is defined by the audible threshold, that is, the SPL at which one can just begin to detect a sound.

Noise is defined in terms of frequency spectrum (in Hz), intensity (in dB), and duration (in minutes). Noise may be steady state, intermittent, impulsive, or explosive. Transient hearing loss may occur following loud noise, resulting in a Temporary Threshold Shift (TTS) (shift in audible threshold). Brummett, Talbot, & Charuhas, (1988) have reported temporary shifts in hearing thresholds in 43% patients scanned without ear protection and also in those with improperly fitted protection. Recovery from the effects of noise should be exponential and occur quickly. However, if the noise insult is severe, full recovery can take up to several weeks. If the noise is sufficiently injurious, this may result in a Permanent Threshold Shift (PTS) (i.e., permanent hearing loss) at specific frequencies.

**MRI-related acoustic noise:**

The gradient magnetic field is the primary source of acoustic noise associated with MR procedures (Goldman, Grossman, & Friedlander, 1989; Hurwitz, Lane, Bell & Brant-Zawadzki, 1989). This noise occurs during the rapid alternations of currents within the gradient coils. These currents, in the presence of a strong static magnetic field of MR system, produce significant (Lorentz) forces that act upon the gradient coils. Acoustic noise, manifested as loud tapping, knocking, or chirping sounds, is produced when the forces cause motion or vibration of the gradient coils as they impact against their mountings which, in turn, also flex and vibrate.

Alteration of the gradient output (rise time or amplitude) caused by modifying the MR imaging parameters will cause the level of gradient-induced acoustic noise to vary. This noise is enhanced by decreases in section thickness, field of view, repetition time, and echo time. The physical features of the MR system, especially whether or not it has special sound insulation, and the material and construction of coils and support structures also affect the transmission of the acoustic noise and its subsequent perception by the patient and MR system operator.

Gradient magnetic field-induced noise levels have been measured during a variety of pulse sequences for clinical MR systems with static magnetic field strengths ranging from 0.35 to 1.5 T
Peak hearing sensitivity occurs in the region of 4 kHz; and is also the region where the potential maximum hearing loss will occur which change spreading into neighbouring frequencies. Recovering from the effects of noise exposure during an MRI should be exponential and quick (Brummet et al., 1988). However if the noise insult is severe, full recovery can take up to several weeks.

Gradient magnetic field –induced noise leads have been measured during a variety of pulse sequences for clinical MR systems with static magnetic field strengths ranging from 0.35Tesla to 1.5Tesla. Hurwitz et. al. (1989) reported that the sound levels varied from 82 to 93 dB (A) and from 84 to 103 dB on a linear scale.

Aim of the study
The purpose of this study was to determine if there is any noise induced Threshold Shift resulting from the noise exposure for the various MR imaging examinations.

Method
1. Instruments used:
   - MAICO MA 53 audiometer with Telephonics TDH 49
   - P headphones & Radio ear B-71 bone vibrator
   - MAICO ERO SCAN OAE Test system
   - General Electric Sigma Contour 0.5 Tesla MRI device

2. Participants:
A total of 17 adult patients (34 ears) who were scheduled for MRI studies anticipated to require at least 20 mins of imaging time were included in this study. Informed consent was obtained from all patients after the nature of the procedure was fully explained.

3. Procedure:
   - All the subjects with positive history of ear pathology, medical history for otological damage, noise exposure or the use of any ototoxic drugs were excluded from this study.
   - An otoscopic examination was performed on the each patient to check the status of the external auditory meatus & the tympanic membrane.
   - Then, a screening OAE test was done using

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Table 1: Permissible Exposure Levels to Acoustic Noise

<table>
<thead>
<tr>
<th>Noise duration / day (hours)</th>
<th>Sound level (dB A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>1.5</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>102</td>
</tr>
<tr>
<td>0.5</td>
<td>105</td>
</tr>
<tr>
<td>0.25</td>
<td>115</td>
</tr>
</tbody>
</table>

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JAIISH, Vol.29(2), 2010
ERO SCAN, Etymotic Research, MAICO OAE Screening instrument to check the status of the outer hair cells of the cochlea.

- All the evaluations were carried out in a quiet room with ambient noise within permissible limits as per ANSI (1977) using biological calibration.

- Then the baseline pure tone air & bone conduction thresholds were determined employing a step size of 2dB for each ear using the MAICO MA-53 audiometer with TDH 49P headphones & Radio ear B-71 bone vibrator. The bone conduction thresholds were also found out to rule out any middle ear condition noticed through the Air Bone Gap (ABG). The test frequencies were 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz & 8 kHz. All the subjects had normal hearing air conduction thresholds (20 dBHL or below across frequencies 250 Hz to 8 kHz).

- The MRI instrument under the present study is a General Electric Sigma Contour 0.5 Tesla device. The average of noise exposure ranged from 30 mins to 1 hour 30 mins depending on the type of scan (determines the number and type of sequences for it) & patient's status; the time taken for the MRI of pelvis is found to be approximately 80 mins for 8 sequences, for knee is 40 to 60 mins for 6 sequences, for spine is 30 to 45 mins for 5 sequences, for shoulder is 60 to 90 mins & for brain is 30 to 45 mins for 5 sequences.

Out of the 17 subjects 5 had pelvis scan, 2 had knee scan, 6 had spine scan, 3 had shoulder scan & 1 had brain scan.

- The post MR imaging audiometric threshold estimation was done as soon as possible after the completion of MRI study. The average time taken to initiate the test after the termination of the MRI was approximately 5-10 mins.

- Mean, Standard Deviation (S.D.) of the pre, post and between different MRI procedures were calculated. Further to estimate if the mean difference is significant, paired ‘t’ test was used using SPSS version 5.

Results and Discussion

The literature reveals that various studies have found that the noise levels during the MRI procedure causes Temporary Threshold Shift. Noise levels in the scanning room were done using Brüel & Kjaer Sound Level Meter revealed that average Leq levels were 129 dBSPL for 20 mins. The hearing thresholds obtained pre and post MRI procedure are presented and discussed below.

The mean and Standard Deviation (S.D.) for baseline AC thresholds of the 34 ears are as shown in Table 2.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>250 Hz</th>
<th>500 Hz</th>
<th>1 kHz</th>
<th>2 kHz</th>
<th>4 kHz</th>
<th>8 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (dBHL)</td>
<td>14.53</td>
<td>14.18</td>
<td>14.53</td>
<td>14.18</td>
<td>14.06</td>
<td>14.47</td>
</tr>
<tr>
<td>SD</td>
<td>3.98</td>
<td>3.69</td>
<td>4.96</td>
<td>3.83</td>
<td>4.76</td>
<td>6.88</td>
</tr>
</tbody>
</table>

Table 2: Mean and S.D. for Pre MRI AC thresholds

<table>
<thead>
<tr>
<th>Frequency</th>
<th>250 Hz</th>
<th>500 kHz</th>
<th>1 kHz</th>
<th>2 kHz</th>
<th>4 kHz</th>
<th>8 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (dBHL)</td>
<td>15.94</td>
<td>15.27</td>
<td>14.09</td>
<td>15.00</td>
<td>22.65</td>
<td>20.47</td>
</tr>
<tr>
<td>SD</td>
<td>4.94</td>
<td>4.19</td>
<td>5.18</td>
<td>5.00</td>
<td>5.90</td>
<td>7.25</td>
</tr>
</tbody>
</table>

Table 3: Mean and S.D. for Post MRI AC thresholds

<table>
<thead>
<tr>
<th>Scan</th>
<th>Duration</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spine</td>
<td>45 min</td>
<td>1.5</td>
<td>3.09</td>
<td>0.67</td>
<td>4.03</td>
<td>2.28</td>
<td>3.34</td>
<td>7.80</td>
<td>3.11</td>
<td>2.4</td>
<td>4.41</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Pelvis</td>
<td>80 min</td>
<td>-1.6</td>
<td>3.10</td>
<td>0.4</td>
<td>4.20</td>
<td>-0.6</td>
<td>3.41</td>
<td>0.8</td>
<td>7.08</td>
<td>3.11</td>
<td>2.4</td>
<td>4.41</td>
<td>2.4</td>
</tr>
<tr>
<td>Knee</td>
<td>60 min</td>
<td>3.03</td>
<td>5.03</td>
<td>1.5</td>
<td>4.43</td>
<td>2.25</td>
<td>2.63</td>
<td>3</td>
<td>6.22</td>
<td>9</td>
<td>5.77</td>
<td>7.5</td>
<td>2.52</td>
</tr>
<tr>
<td>Brain</td>
<td>45 min</td>
<td>1.41</td>
<td>0</td>
<td>5.66</td>
<td>-1</td>
<td>1.41</td>
<td>-2</td>
<td>0</td>
<td>10</td>
<td>5.66</td>
<td>7</td>
<td>7.07</td>
<td>7</td>
</tr>
<tr>
<td>Shoulder</td>
<td>90 min</td>
<td>5.33</td>
<td>5.16</td>
<td>2.83</td>
<td>5.67</td>
<td>1</td>
<td>7.13</td>
<td>-1</td>
<td>4.85</td>
<td>9.67</td>
<td>5.57</td>
<td>6</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Table 4: Mean & S.D. of difference in thresholds (dBHL) between pre & post MRI for the different scan procedures.
The Mean and S.D. of difference in thresholds between the pre and post MRI thresholds are tabulated above for the different scan procedures (Table 3).

The Mean and S.D. of difference in thresholds between the pre and post MRI thresholds are tabulated above for the different scan procedures (Table 4).

The mean values between the pre and post MRI thresholds shows a difference at 4 kHz and 8 kHz, and to check if there is a statistical significant difference, paired ’t’ test was performed and it was observed there was a significant increase (P < 0.001) in the air conduction thresholds at 4 kHz and at 8 kHz (P < 0.001) after MRI. The frequencies from 250 Hz to 2 kHz did not show any statistically significant difference after exposure to acoustic noise of MRI. This that there is a noise induced Threshold Shift in the normal hearing subjects after the MRI which suggests that the noise exposure during the MRI has damaging effects on the auditory system shows.

These findings can be correlated to the finding of Brummett et al., (1998) where in a total of 14 adult patients were subjected to MRI study of 0.35- Tesla equipment, wherein significant threshold shifts of 15 dB or above were found in frequencies 560 Hz, 4 KHz, 6 KHz and 8 KHz in 43% of patients. Ear plugs, when properly used can abate noise by 10-30dB, which is usually an adequate amount of sound attenuation for the MR environment. The use of disposable ear plugs has been shown to provide a sufficient decrease in acoustic noise that in turn would be capable of presenting the potential temporary hearing loss associated with MR procedures (Bandettini, Wong, Hinks, Tikofsky, & Hyde, 1992). Passive noise control techniques of using Ear Protective Devices (EPD) provide poor attenuation of noise transmitted to the patient through bone conduction.

**Conclusion**

The present study shows that the noise exposure during an MRI scan has an effect on the human auditory system and has been found to cause significant noise induced threshold shift at 4 kHz and 8 kHz. Noise and its auditory and non-auditory effects are proven in the literature. Since the present study revealed significant noise induced Threshold Shift, there is a need for effective Ear Protective Devices usage during MRI procedures to reduce long-term auditory effects.

**References**


HEARING LOSS IN ELDERLY: AN INDIAN PERSPECTIVE

*Nachiketa Rout, ** Bijoyaa Mohapatra, *** Sushmit Mishra

Abstract

The article aims to analyze audiological findings of 151 geriatric individuals with hearing loss who complained of a progressive reduction in hearing since 10 years. The degree of hearing loss corresponded to moderately severe sensory-neural hearing loss (52%). Cardiovascular diseases including high blood pressure (42%) and diabetes (17%) were the most frequently associated condition while 34% reported no known etiologies of hearing loss. Most common symptoms included difficulties in understanding conversational speech (54%) followed by tinnitus (49%), vertigo (25%) and intolerance to loud sounds (15%). The prevalent audiogram contour corresponded to a steep sloping pattern (45%). Males mostly (52%) had steep sloping high frequency hearing loss as compared to females (60%) who predominantly had a flat audiogram or gradually sloping audiogram (10%). There was a poor follow-up of 14%, most of who came with a complaint of poor benefit from the hearing aid especially in noisy situations.

The causes of hearing loss observed in these individuals are among the well known causes that are responsible for old age hearing loss. Even the audiograms obtained correspond to those of Schuknecht's audiograms. It is found that there is quite much an acceptance to hearing loss in the Indian population and intervention is sought until and unless it is found to reach a degree where it interferes with one’s day to day communication.

Key words: Audiogram, speech recognition thresholds, cochlea.

Despite major advances in the ability to prolong life, there have been fewer concomitant advances designed to reduce the illnesses and disabilities attendant upon increased age. Ranking highest among age-related disabilities are those involving communication (Jacobs-Condit, 1984). Hearing loss (HL) which essentially affects oral communication is the third most common chronic condition reported by geriatric population (Lethbridge-Cejku, Schiller & Bernadel, 2002). The geriatric population is defined as population aged 60 years and above (Elango, 1998). HL that is significant enough to interfere with social function affects 25% of persons aged 65 to 74 years and 50% of those age 75 years and older (Marcincuk & Roland, 2002). In spite of the high prevalence and only about 20% of the elderly individuals in America with significant hearing impairment obtain hearing aids; as many as 30% of the hearing aid owners are dissatisfied (Kochkin & Marke Trak, 2003) and 16% of them never used the aids after obtaining them (Kochkin & Marke Trak 2000). Hearing loss in this population needs to be addressed because of its isolating effects and the increasing geriatric age group. Population projections indicate that individuals over 65 years of age will increase to approximately 22% by the year 2050; by this time 59% of the individuals over 65 years of age will have hearing impairments (Fein, 1983). The geriatric population in India which was 6.3% in 1991 has increased to 7.5% (Census, 2001), 3.4% of this population has both speech and hearing disabilities (National Sample Survey Organization.,-2003).

Studies pertaining to HL in the elderly population of India are very few and hardly conclusive. Articles concerning health problem of the geriatric often ignore HL, probably because of its invisibility, non
acute nature and unawareness amongst both the participants and researchers. The social and medical dynamics of India is rapidly changing. The social problems have been caused by the break-up of the joint family system, housing shortages in urban areas and the increasing participation of women in the workforce. The health care of the pediatric and the especially the geriatric group which were taken care by the family is of concern. Further it's observed that age old traditional of medical systems of India like Ayurveda is losing its effect and the western mode of medication, Allopath is being preferred. Common life styles to maintain hearing prescribed by Ayurveda like putting mustard oil in the ears daily to maintain healthy hearing is strictly being prohibited by the new age doctors. Thus health issues concerned with hearing which was taken care by the traditional wisdom of the family and the traditional healers are slowly becoming the concern of the state. In this regard there is a need to understand the hearing loss and its effects which would facilitate data to address the issues and allocate resources towards them. The present study is an effort in the same direction.

This article aims to answer questions pertaining to HL in the elderly. The issues addressed include, type and degree of HL in this group, the most common symptoms, the pattern of HL, the probable etiological factors which might have precipitated the HL and the amplification device which suited most of them.

Pathophysiology A few eminent researchers including Gacek & Schuknecht (1969) have identified four sites of aging in the cochlea and divided presbycusis into four types based upon these sites. They are Sensory (cochlear) Presbycusis, Neural Presbycusis, Strial Presbycusis, and Inner ear Conductive (Mechanical, cochlear-conductive) Presbycusis (Figure 1). The histological changes are correlated with symptoms and auditory test results.

Sensory presbycusis: Type 1. Sensory presbycusis refers to the epithelial atrophy with the loss of sensory hair cells and supporting cells in the organ of Corti. This process originates in the basal turn of the cochlea and slowly progresses towards the apex. These changes are correlated with the precipitous drop in the high frequency thresholds, which begins from the middle age. The speech discrimination often is persevered. The process is slow progressive over the time.

Neural presbycusis: Type 2. It refers to atrophy of nerve cells in the cochlea and central neural pathways. Gacek & Schuknecht (1969) estimates that 2100 neurons are lost every decade (of 35,000 in total). This loss begins early in the life and may be genetically predetermined. Effects are not noticeable until old age, because pure tone average is not affected until 90% of the neurons are gone. Atrophy occurs throughout the cochlea. Therefore no precipitous drop in high frequency threshold on audiogram is observed. A disproportionately severe decrease in speech discrimination in clinical testing correlate to neural presbycusis and may be observed because HL is noted as fewer neurons are required to maintain speech threshold than speech discrimination.

Metabolic (strial presbycusis): Type 3. It results from the atrophy of the Stria Vascularis. The Stria Vascularis normally maintains the chemical and bioelectric balance and the metabolic health of the cochlea. Atrophy of the Stria Vascularis results in HL represented by flat hearing curve because the entire cochlea is affected. Speech discrimination is preserved. This process tends to occur in people aged 30 – 60 years. It progresses slowly and may be familial.

Mechanical (cochlear conductive): Type 4. This type of presbycusis results from thickening and secondary stiffening of the basilar membrane of the cochlea. This thickening is more severe in the basal turn of the cochlea where the basilar membrane is narrow. This correlates with a gradually sloping high frequency sensorineural HL that is slow progressive in nature. Speech discrimination correlates with pure tone average.

Presbycusis, referred to as hearing loss due to aging may be the most common cause of diminished hearing in the older population, but it should not be diagnosed until other potential causes of hearing loss have been ruled out (Marcincuk & Roland, 2002). Conditions that may contribute to presbycusis include atherosclerosis, chronic noise exposure, chemical exposure, diet and metabolism, and genetics (Velazuez-Villasensor et al, 2000).
Method

Participant details

The participants of the study included 151 clients, 101 males and 50 females in the age range of 60-83 years (mean 70 ± SD: 7.2 years). All approached Ali Yavar Jung National Institute for the Hearing Handicapped (AYJNIHH, ERC), an aural rehabilitation centre in eastern India with a complained of progressive reduction in hearing sensitivity and could not attribute any cause to it. Individuals having any type of external and middle ear diseases were not included in the study. They availed aural rehabilitation as hearing loss had become severe enough to be noticed by family and interfered a lot with day today activities. Some did not know where to go (33.11%) or (11.25%) did not have facilities to come to AYJNIHH, ERC. A few (7.28%) of the participants reported no specific reason for the delay. Twelve (7.94%) of the participants consulted otolaryngeologists for the HL. The physician attributed HL to aging and recommended hearing aid to seven while others were prescribed neuro-vitamins.

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![Figure 1: Audiogram Type](image)

The participants belonged to poor socio-economic strata with a monthly income below Rupees 6,500/- The Government of India categorizes this income group as considerably poor, and provides them with free of cost hearing aids. All the participants resided in and around Kolkata, one of the metro cities of India. The symptoms of HL were noticed by the participants 10 years prior to coming to the clinic. When inquired about the reason for the delay, they frequently (48.36%) attributed it to the procrastination.

Procedure

The participants came to AYJNIHH with a complaint of hearing loss. After a detailed case history the clients were referred for an ENT and audiological evaluation. A detailed audiological evaluation protocol included pure tone audiometry along with immittance measures. Most comfortable level (MCL) and Uncomfortable level (UCL) were done for participants who complained of intolerance to loud sounds. The hearing trial followed where ever a
hearing aid was opted and recommended. Audiological evaluations and hearing aid trial was done in acoustically treated rooms with a noise level below 27dBA. The hearing aid prescription followed a counselling session in a one to one setup. The MAICO MA52 audiometer and the GSI 38 Auto-lymp immittance meter were used for the evaluations.

The clinical data, symptoms and auditory test results and were correlated and classified under four types of presbycusis as mentioned by Gacek & Schuknecht (1964). Statistitical Package for Social Sciences (SPSS) for Windows (version 10) was used for descriptive statistical analysis.

Results
During otological evaluation 28% of the participants (28 males and 15 females) had impacted wax in their ear canal which was cleared by syringing the ears before commencement of the audiological evaluations. On immittance audiometry, 92.05% of the participants had ‘A’ type tympanogram indicative of an apparently mobile and intact middle ear. Seal could not be obtained in three of them and six had ‘As’ type indicative of a relatively stiff middle ear mechanism. Only three participants had ‘B’ type tympanogram which is usually suggestive of a minimally mobile middle ear and may be indicative of pathology, though visual otological evaluation did not suggest the presence of any abnormality in them.

All the participants were diagnosed to be having bilateral sensory neural hearing loss mostly (52%) of moderately severe degree. The audiogram patterns of the participants were classified into four types (Type 1-4). Nine audiogram contours did not fit into any category. Majority, 45% of the audiograms corresponded to Type 1 followed by Type 3 (24.5%) and Type 4 (13.2%) had type 2 audiograms. Males mostly (52%) had Type 1 audiogram corresponding to a steep sloping high frequency hearing loss as compared to females (60%) who predominantly had a flat audiogram.

Many (47%) participants did not have any medical records with them. The associated conditions as reported and noted from medical records include, unknown etiology in 34% of the participants, high blood pressure was as frequent as in 42%. History of exposure to noise was reported both males (25%) and females (26%) and 17% of the participants had diabetes. These factors were in present isolation as well as in combination (figure 2). The symptoms which were more frequently reported by the participants included difficulty in understanding speech (54%) followed by tinnitus (49%), vertigo (25%) and intolerance to loud sounds (15%) etc. As reported in 13.2% of the cases, tinnitus was the primary symptoms with HL and in 36% of the cases tinnitus was associated with other symptoms (figure 3).

Most Comfortable Level (MCL) and Uncomfortable Level (UCL) were obtained using Bengali sentences for 15% clients who reported of intolerance to loud sounds. Out of the fifteen eight participants had a narrow dynamic range of 10 dB HL and less. Hearing aid trial for the eight candidates was done at different tone control positions in noisy (70 dB Broad band Noise) and in a relatively quiet room in clinic. All the eight did not complaint of intolerance to conversational speech at ‘H’ settings of the tone control in a quiet room. All of them preferred using the hearing aid.

A moderate class hearing aid was preferred and fitted to most (79%) of the participants. After a counseling session the participants were asked to pay a follow up visit in 3 months for re-evaluation of their hearing and the hearing aids. Only 14% participants paid a follow up visit in 1-3 months. Most of them came with a complaint of malfunction in the hearing aid or distorted output from the aid. On examination of the hearing aid by the electronic technician, 5 of them were found to be having minor problems like damaged cords or defective switches, 16 of them reported to have minimal benefit from the aid especially in noisy situation like market place or where they were in conversation with more than 2-3 persons at a time.

Discussion
With age the entire physiology of the body changes and so does the auditory system. The outer ear loses its elasticity and strength with increased activity of cerumenous glands rising the likelihood of cerumen impaction (Weinstein, 2002), as in 28% of the participants in the present study. Cerumen can accumulate significantly without any accompanying hearing loss, an occlusion of 95% and more results in significant conductive hearing loss (Roland, Marple & Meyerhoff, 1997). Middle ear was found to be considerably healthy and mobile in majority of the
participants never the less eight percent of the participants had an abnormal tympanogram of ‘As’ type or ‘B’ type. With age arthritic changes occur in the middle ear and the tympanic membrane becomes stiff (Roland et al., 1997). Degeneration and stiffening of the middle ear muscles and ossicular ligaments may be reflected as an ‘As’ type tympanogram although structural changes in middle ear mechanism due to aging have minimal effect on impedance test of hearing loss and greater hearing loss severity (Agrawal, Platz & Niparko, 2008). The implication is that income and education influence access to healthcare and adequate nutrition, as well as increased exposure to adverse environmental and social conditions, which in turn impact hearing.

In the present study majority of the participants noticed hearing loss at the age of 60 years; approximately 10 years prior to coming to the clinic.

The participants in the study belonged to the lower socio economic strata and had a lower educational level. Prior studies have related low income and educational levels to a higher prevalence (Weinstein, 2002) of hearing loss and greater hearing loss severity (Agrawal, Platz & Niparko, 2008). The implication is that income and education influence access to healthcare and adequate nutrition, as well as increased exposure to adverse environmental and social conditions, which in turn impact hearing.

During case history when it was asked “What do you mean by noticeable HL?” 83% replied, when they could not effortlessly participate in regular conversation. It seemed others mumbled and friends and family members started complaining about he/
she not being able to understand verbal commands especially when spoken from behind and name called from the other room. Most of the participants with mild to moderate degree of hearing loss presented complaint of tinnitus or vertigo rather than hearing loss. Some (3%) with mild degree of hearing loss in one ear and moderate to moderately severe degree of hearing loss in the other reported of hearing loss only in the poorer ear and perceived the better ear to be normal. The Articulation Index theory predicts the intensity of average conversational speech to be 60 dB sound pressure level (SPL) (American National Standards Institute, 1969). The low frequency vowels and diphthongs, which have an intensity of 65-70 dB SPL (Fletcher, 1953) contributes importantly to performance on sentence material. Vital audiometric frequency region for correctly identifying sentence material is around 750 Hz and a person with high frequency hearing loss will typically experience little problems with sentence identification tasks (Hall & Mueiler, 1997). The performance of individual in social communication and linguistic skills improve with age and hence older adults tend to fill in the missing linguistic input better (Pichora-Fuller and Singh, 2006). Thus till the hearing loss progresses up to 60-65 decibels (moderately severe degree) the person does not considerably appreciate the hearing loss which is in progress since a few years. Further elderly people usually do not experience problems understanding speech in ideal listening conditions that include quiet environments and familiar talkers, as long as the speech level permits audibility of high frequency information (Dubno, Dirks & Morgan, 1984). A few, 9% of the participants had history of ear discharge in childhood but no middle ear disease was detected by the otologist. Eastern India especially the coastal belt is a hot and humid, many people living in villages still take bath in ponds. This makes them prone to middle ear infections especially during childhood.

In addition to age related degeneration, excessive exposure to occupational or recreational noise, genetic factors, eighth nerve tumor, trauma, metabolic diseases, vascular diseases, infection, ingestion of ototoxic agents (aminoglycosides, ethaerynic acid salicylates) and cardiovascular diseases (CVD) contribute to hearing loss (Weinstein, 2002). CVD has been identified as a risk factor for hearing loss in older adults (Brant et al., 1996; Susmano & Rosenbush, 1988). CVD-related potential risk factors include heart disease, hypertension, diabetes mellitus, smoking history and white blood cell count. Majority of the participants (69%) in the study had either diabetes or high blood pressure along with HL. Conversely, many researchers have not found an association between hearing loss and CVD risk factors or combinations of risk factors (Bunch, 1931, Karamitsos et al., 1996). In a recent study (Pratt & Geriatric Research Education and Clinical Center, 2009) contrary to expectations; CVD histories did not appear to influence hearing thresholds in this group of elders, suggesting that characteristics intrinsic or strongly tied to the groups in this study disposed them or made them resistant to hearing loss.

The fact that persons with diabetes have hearing impairment is a relatively recent discovery especially after diabetes induced animal studies of micro vascular changes in the inner ear including in circulation flow, narrowing capillaries and loss of outer hair cells that amplify sound energy entering the cochlea, an overall atrophy of the ganglion cells are also seen in persons with diabetes (Salvinelli et al, 2004). There is no recent research that has directly evaluated the association between CVD and cochlear function in older adults (Torre III., Cruickshanks, Barbara, Ronald & David, 2005). To date, researchers have used animal models to investigate the restriction of cochlear blood flow and its effect on DPOAEs (Distortion product otoacoustic emission) (Mom, Telischi, Martin & Lonsbury-Martin, 1999). Once the blood flow was restored, DPOAE levels returned to pre compromise levels.

In this study hearing loss in 34.34% of the participants could not be attributed to any known etiology. Brant et al, (1996) found a relationship between a large sample of older adults who were free of noise induced HL and other etiologies causing hearing related disorders. There are many physiological factors which trigger hearing loss. Conclusions of a study by Frisina (2002) signify the reduced levels of aldosterone, with age contributed to the hearing loss. Aldosterone is a hormone which is important for regulation of sodium and potassium ions in the inner ear and has protective functions. Auditory efferent feedback system starts declining in middle age in both humans and mice.
The effect of noise on hearing occurs primarily in the high frequencies above 1000 Hz. The effect of noise and hearing are difficult to separate from presbycusis since noise also causes hair cell damage and has a similar audiometric configuration (Stach, 1990). For whatsoever reason, beyond a certain age no differentiation can be made between the two. As a result, the problem of hazardous noise exposure becomes less and less important and maintenance of reasonable hygiene of the ear becomes more and more routine (Davis & Silverman, 1970).

The extent to which an individual recognizes this disability may influence his or her motivation to seek assistance through amplification or aural rehabilitation. Age related differences are observed on measures of perceived hearing disability. In a study with adults and elderly Americans with mild to moderate HL, elderly adults (65-76 years) report less social and emotional impact of hearing impairment in their daily life (Gordon-Salant, Labtz, Fitzgibbons, 1994). In a large scale study of 2150 adults in Japan, there were significant age differences in self perceived hearing problems. Elderly subjects (60-79 years) reported less hearing disability than middle aged subjects (40-59 years) (Uchida, Nakashima, Ando, Niino & Shimokata, 2003). These analogous studies conducted in United States and Japan has similar findings and underscores the universality of the phenomenon. In the present study during the case history interview process when the patients were inquired about their problem, some of them replied there was no problem per se; it’s just that they had reduced hearing sensitivity which is usually associated with old age. Seven participants remarked (in Hindi) “ye to prakritik den hae” which means it’s “by the grace of nature”. This reflects a laid-back attitude of the elderly towards their HL and an accepted deterioration of sensory function in old age. A few of the elderly in the study reported hearing loss to be advantageous especially in some situations which they want to avoid.

The symptoms which was most frequently reported was difficulty in understanding speech (54.30%), Van Rooij, Plomp and Orlebeke, 1989 report the proportion of persons with problems in perceiving speech doubles per decade, from 16% at age 60 to 32% at age 70, to 64% at age 80. However, there are large individual differences in understanding speech in individuals over 60 years of age (Weinstein, 2002). Investigators have attempted to isolate several factors that contribute to this variability. Several hypotheses have been posited to explain the mechanism underlying speech understanding problems experienced by the older adults including the peripheral hypothesis, the central auditory hypothesis, and the cognitive hypothesis (Humes, 1996).

Vertigo and tinnitus were frequently reported symptoms. The sense of balance is largely regulated by the inner ear structures called the vestibular system. American Speech-Language-Hearing Association (1999) reports that the elderly between ages 65 and 75 who do not present any major health problem or acute balance disorder, at least 25–35% complained a significant fall annually. As many as 25% of the participants reported of vertigo and were prescribed medications for the same. Most of them recover by symptomatic treatment (Igarashi, 1984).

The principal treatment of age related HL at present is with suitable amplification (Gordon-Slant, 1994). Despite the documented benefit of amplification for elderly hearing impaired individuals (Stark and Hickson, 2004), market trend as reported by some private practitioners in West Bengal show that only 20-25% of the population who come for hearing evaluation purchase hearing aids. Factors reported by elderly people who do not adhere to recommendations to purchase a hearing aid are cost and relatively low value placed on effective communication (Garstecki & Erler, 1999). Some who do not wear aids report the main reasons for not wearing hearing aid to be poor benefit, particularly in noise, restaurants and large group (Kochkin, 2000). The hearing aids provided by the government of India are conventional body level aids. Conventional hearing aids have relatively few options (e.g., gain, output, frequency response) and few controls (e.g., on/off, volume, tone) that could be adjusted by the user according to his or her situation-specific listening preferences.

In this study although all had opted for hearing aids, most of them did not follow up for re-evaluation in spite of the recommendations. Follow up is expected after a period of 3-4 months as the mostly stops functioning due to damage of cords. The drop out of patients may be attributed to various factors.
like lack of use of hearing aids, lack of facilities to follow up at AYJNIHH due to distance as well as the cost of travel or on health grounds.

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INTELLIGENCE, CREATIVE THINKING ABILITIES AND ACADEMIC ACHIEVEMENT OF CHILDREN WITH HEARING IMPAIRMENT - A CORRELATION STUDY

*Vijetha, P. & **Jangaiah, C.

Abstract

The present study investigated the relationship between intelligence and creative thinking abilities, intelligence and academic achievement and also academic achievement and creative thinking abilities of 11 to 13 years old children with hearing impairment studying in Residential special schools in Mysore. For testing Intelligence, Standard Progressive Matrices by J. C. Raven and for testing creative thinking abilities, Non-Verbal test of Creative Thinking Abilities by Baqer Mehdi tools were used for the study. These tools were administered on 50 (24 boys and 26 girls) 11 to 13 years old children with hearing impairment. Participants were instructed and the data was scored as per the manual. For testing the Academic achievement both the present and past class exam marks were collected from school records. The results indicated that there exists no significant relationship between intelligence and creative thinking abilities, academic achievement and creative thinking abilities. But there exists significant relationship between intelligence and academic achievement. The study also revealed that children scoring Intelligence Grade V indicating “intellectually impaired” outperformed in creative thinking abilities compared to those children scoring Grade III indicating “intellectually average” and Grade IV indicating “below average in intellectual capacity”. The results of the current study can be used to plan special programs based on the abilities and talents of children with hearing impairment rather than intelligence and school exam marks in order to foster their creative thinking abilities and thereby prepare them for appropriate and productive vocations.

Key words: Special programs, abilities, productive vocations

Education is the fundamental right of every child. Children with disability have a right to education that promotes them to their fullest potential. In India, there are billion persons and Census of India (2001) revealed that over 21 million people in India are suffering from one or the other kind of disability which is equivalent to 2.1% of the population. Among them (7.5%) and (5.8%) of population has some kind of speech or hearing disability respectively.

Early identification and early intervention of children with hearing impairment has its own benefits and rewards. But at the same time in the society there are children with hearing impairment, who are late identified, who come from poor-social economic backgrounds, those who are born in rural areas or less advantaged and they are quite sizeable in society. So, it is imperative to develop services to cater to these children with hearing impairment in order to actualize their potential.

At present there are approximately 700 special schools for children with hearing impairment in India. Most of these schools tend to focus their educational objectives and goals on remediation related to different aspects of their disability rather than focusing on identifying and fostering special abilities and talents hidden in children with hearing impairment. Due to which they are often gone unrecognized and undeveloped. Consequently these lacunae lead to many ill effects. And one of the major ill effects is their underemployment and unemployment. Large numbers of deaf people seem to be employed in jobs that are far beneath their ability (Schein & Delk, 1974). Therefore it is very important to recognize and develop special abilities and talents. Shanker (1968)

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points out that the study of exceptional types of children with a view to finding ways and means of their proper location, care, rehabilitation, education and guidance is essential both from the individual and the social points of view. In order to support these thoughts strong evidence based research is required. Buch (1991) also suggested that there is a need to devise programs and methods, which would promote creativity and divergent thinking.

In addition to the above, a review of related literature emphasized that very few studies worked on creative thinking abilities of children with hearing impairment especially compared to typically developing children. Further hardly any study found to have correlated Intelligence and Academic Achievement to Creative thinking abilities of children with hearing impairment. This is the major research gap. Thus, keeping this in view the present study is taken up to find out whether any significant relationship exists between Intelligence, Creative Thinking Abilities and Academic Achievement of children with hearing impairment.

In this context, the present study on “Intelligence, Creative Thinking Abilities and Academic Achievement of children with hearing impairment - A correlation study” is mainly aimed at studying the relationship between the three variables - Intelligence, Creative thinking Abilities and Academic Achievement of Children with Hearing Impairment.

Objectives of the Study
1. To study the relationship between Intelligence and Creative thinking abilities of children with hearing impairment.
2. To study the relationship between Intelligence and Academic Achievement of children with hearing impairment.
3. To study the relationship between Creative thinking abilities and Academic Achievement of children with hearing impairment.
4. To study the Gender differences for Intelligence.
5. To study the Gender differences for Academic Achievement.
6. To study the Gender differences for Creative thinking abilities.

Operational Definitions
A number of terms and concepts have been used in the study. To convey the specific meaning an attempt has been made to explain in what sense these terms and concepts have been used in the present study.

Children with Hearing Impairment
Children with hearing impairment are those who have problems in hearing the various sounds. In the present study, children with hearing impairment refers to those who have hearing loss of 60dB or above in the better ear in the conversational range of frequencies.

Creative Thinking Abilities
Creative thinking abilities refer to the ability of an individual to think creatively. In the present study, it refers to the ability of an individual in the three non-verbal sub-tests namely Picture construction, Picture completion, and Triangles and Ellipses. The creative thinking abilities are measured by using Baqer Mehdi’s Non-verbal test of creativity.

Academic Achievement
It refers to the marks obtained by children with hearing impairment in Annual Examination of present class and previous class in the school.

Intelligence
In the present study, it refers to the score and grade obtained using Standard Progressive Matrices by J.C. Raven.

Method
Sample: The sample consisted of fifty children with hearing impairment. They were studying in Residential special schools for children with hearing impairment in Mysore. The participants included 24 boys and 26 girls in the age range of 11 to 13 years. The method of teaching in these special schools is Total communication. The sample for the study is selected by means of convenience sampling which included the following criteria: (i) Severe to Profound hearing loss, (ii) Age range between 11 to 13 years and (iii) No additional impairment.

Tools used for the Study: For testing Intelligence, Raven, J. C. Court, J.H. & Raven, J. (1998) “Manual for Raven’s Progressive Matrices Vocabulary Scale”, Standard Progressive Matrices was used. It is made up of five sets of diagrammatic puzzles. Each puzzle has a part, which the person taking the test has to find among the options. The standard test consist of 60 problems divided into five sets (A, B, C, D and E), each made up of 12 problems. These five sets provide five opportunities to grasp
the method of thought required to solve the problems and five progressive assessment of a person’s capacity for intellectual activity. After completing the test the raw scores were computed and converted into the scaled scores, which are then totaled, and the grade of intellectual capacity was obtained from the Manual.

For testing Creative thinking abilities, Mehdi, B. (1989) Manual for Non-verbal Tests of Creative Thinking was used. It is intended to measure the individual's ability to deal with figural content in a creative manner. Three types of activities are used for this purpose, viz., picture construction, picture completion, and triangles and ellipses. Scoring is done for elaboration and originality dimensions. Elaboration is represented by a person’s ability to add more ideas to the minimum and primary response to the stimulus figure. The minimum and the primary response to the stimulus figure is that the response, which gives essential meaning to the picture. It is important to see the primary and minimum response is meaningful and relevant to the stimulus. Originality is represented by uncommonness of a given response.

**Procedure:** Standard Progressive Matrices was administered on each child with hearing impairment individually at school in a quiet classroom. Every attempt was made to ensure a good testing environment. The child was instructed carefully to closely observe the pictures and to note the responses in the score sheet. Each child required approximately 35 to 40 minutes for completing the test. The investigator computed the raw scores and converted them into scaled scores as per the manual. The degree of intelligence against this scaled score was established from the manual. Non-verbal test of Creative thinking abilities was administered in a group of approximately ten children with hearing impairment. It was administered in a good classroom environment away from unnecessary noise and distractions. Children were instructed to think and carefully draw the pictures with the given figure. Any clarifications required by the children were given individually. Each child required approximately 40 to 45 minutes to complete the test. After completing the test, raw scores were computed as per the guidelines given in the manual in terms of two dimensions elaboration and originality. For testing the Academic achievement, previous and present class exam marks of children were obtained personally from the school records with the permission of the School Principal.

**Results and discussion**

**Statistical Techniques Employed:** Descriptive statistics are given for Intelligence, creative thinking abilities and Academic achievement. Independent t-test was done to study the gender differences. Spearman's correlation coefficient was used to see the correlation between the parameters under study.

The above Table 1 shows the mean and standard deviation of intelligence, creative thinking abilities and academic achievement in males and females. And by observing the scores in the present study, it can be inferred that in Creative thinking abilities, Academic achievement and in Intelligence, females scored higher than males but it is not statistically significant. The following Table 2 shows results of independent t-test. Independent t-test was administered to study the differences between males and females in intelligence, creative thinking abilities and academic achievement. It revealed no significant differences between males and females.

This is supported by Pandey & Pandey (1984) reporting that there were no consistent gender differences in respect of various factors of creativity.

The following Table 3 shows the mean and standard deviation of Academic Achievement and creative thinking abilities in relation to Intelligence. Figure 1 shows the relationship between Intelligence, Creative thinking abilities and Academic Achievement.

The results of the present study revealed interesting findings and discussions. First, it reveals that the calculated correlation coefficient between intelligence and elaboration dimension of creative thinking ability is $r = -0.123$ and intelligence and originality dimension of creative thinking ability is $r = -0.161$. These values are not significant at 0.05 level. Hence there is no significant relationship between Intelligence and Creative thinking abilities (elaboration and originality).

This finding is in consonance with the study done by Kaltsounis (1970) where he compared the creative thinking abilities of deaf students and hearing students by using Torrance Tests of Creative Thinking – Figural. He founded that deaf subjects surpassed
hearing age-mates on measures of non-verbal fluency and originality, whereas hearing subjects were superior in non-verbal flexibility. Kitano & Kirby (1986) state “an individual can be extremely bright but uncreative or highly creative but not necessarily intellectually gifted”.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
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<td>9.62</td>
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<td></td>
<td>Female</td>
<td>26</td>
<td>35.04</td>
<td>6.57</td>
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<td>Group</td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>Male</td>
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<td>69.75</td>
<td>18.52</td>
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<td></td>
<td>Female</td>
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<td>11.55</td>
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<td>Previous class exam marks</td>
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<td>24</td>
<td>71.93</td>
<td>16.54</td>
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<tr>
<td></td>
<td>Female</td>
<td>26</td>
<td>70.88</td>
<td>14.95</td>
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<tr>
<td>Present class exam marks</td>
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<td>24</td>
<td>33.54</td>
<td>11.16</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>26</td>
<td>35.62</td>
<td>8.88</td>
</tr>
<tr>
<td>Creative thinking abilities</td>
<td>Group</td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>Male</td>
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<td>78.25</td>
<td>21.87</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>26</td>
<td>75.19</td>
<td>28.59</td>
</tr>
</tbody>
</table>

Table 1: The mean and standard deviation of Intelligence, Creative thinking abilities and Academic Achievement in males and females.

<table>
<thead>
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<th>Parameters</th>
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<tbody>
<tr>
<td>Intelligence</td>
<td>0.197</td>
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<tr>
<td>Creative thinking abilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaboration</td>
<td>0.730</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Originality</td>
<td>0.422</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Academic achievement</td>
<td>0.622</td>
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<tr>
<td>Previous class exam marks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present class exam marks</td>
<td>0.189</td>
<td>&gt;0.05</td>
</tr>
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</table>

Table 2: The results of t-test for Intelligence, Creative thinking abilities and Academic Achievement in males and females.

<table>
<thead>
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<th>Mean</th>
<th>Std. Deviation</th>
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<tr>
<td>III</td>
<td>% of previous class exam marks</td>
<td>41</td>
<td>75.41</td>
<td>12.66</td>
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<td></td>
<td>% of present class exam marks</td>
<td>41</td>
<td>73.42</td>
<td>15.08</td>
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<tr>
<td></td>
<td>elaboration</td>
<td>41</td>
<td>66.93</td>
<td>19.22</td>
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<tr>
<td></td>
<td>originality</td>
<td>41</td>
<td>58.95</td>
<td>20.32</td>
</tr>
<tr>
<td>IV</td>
<td>% of previous class exam marks</td>
<td>7</td>
<td>54.90</td>
<td>8.16</td>
</tr>
<tr>
<td></td>
<td>% of present class exam marks</td>
<td>7</td>
<td>66.49</td>
<td>14.15</td>
</tr>
<tr>
<td></td>
<td>elaboration</td>
<td>7</td>
<td>61.26</td>
<td>20.52</td>
</tr>
<tr>
<td></td>
<td>originality</td>
<td>7</td>
<td>55.27</td>
<td>16.64</td>
</tr>
<tr>
<td>V</td>
<td>% of previous class exam marks</td>
<td>2</td>
<td>40.60</td>
<td>6.50</td>
</tr>
<tr>
<td></td>
<td>% of present class exam marks</td>
<td>2</td>
<td>49.60</td>
<td>17.57</td>
</tr>
<tr>
<td></td>
<td>elaboration</td>
<td>2</td>
<td>77.88</td>
<td>17.68</td>
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<tr>
<td></td>
<td>originality</td>
<td>2</td>
<td>72.30</td>
<td>6.53</td>
</tr>
<tr>
<td>Total</td>
<td>% of previous class exam marks</td>
<td>50</td>
<td>71.15</td>
<td>15.19</td>
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<tr>
<td></td>
<td>% of present class exam marks</td>
<td>50</td>
<td>71.50</td>
<td>15.58</td>
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<tr>
<td></td>
<td>elaboration</td>
<td>50</td>
<td>66.58</td>
<td>19.21</td>
</tr>
<tr>
<td></td>
<td>originality</td>
<td>50</td>
<td>58.97</td>
<td>19.52</td>
</tr>
</tbody>
</table>

Table 3: The mean and standard deviation of Academic Achievement and creative thinking abilities in relation to Intelligence
Second, the calculated correlation coefficient between intelligence and previous class exam marks is $r = 0.711$ and intelligence and present class exam marks is $r = 0.413$. These values are significant at 0.001 level. Hence there is significant relationship between Intelligence and Academic achievement (previous class exam marks and present class exam marks). This finding is supported by Alam (2001) stating that there is a positive and significant correlation between academic achievement and intelligence. This finding is also supported by Meadow (1980), McCall (1977) revealing that intelligence tests predict academic achievement.

Third, the calculated correlation coefficient between elaboration dimension of creativity and previous class exam marks is $r = -0.028$ and elaboration dimension of creativity and present class exam marks is $r = -0.043$. These values are not significant at 0.05 level. It means that there is no significant relationship between elaboration dimension of creativity and previous and present class exam marks. It also revealed that the calculated correlation coefficient between originality dimension of creativity and previous class exam marks is $r = -0.159$ and originality dimension of creativity and present class exam marks is $r = -0.062$. These values are also not significant at 0.05 level. It means that there is no significant relationship between originality dimension and previous and present class exam marks. Hence there is no significant relationship between Creative thinking abilities (elaboration and originality) and Academic achievement (previous class exam marks and present class exam marks) and it is supported by Marschark (2003) stating deaf children frequently have different experiences; different language backgrounds and different cognitive skills and do not mean that deaf students are in any way deficient.

Another major finding depicted in Figure 2 above revealed that children scoring Intelligence Grade V indicating “intellectually impaired” outperformed in creative thinking abilities compared to children scoring Grade III “intellectually average” and Grade IV “below average in intellectual capacity” respectively. In this study, Creative thinking of children with hearing impairment became apparent even though their academic performance and Intelligence scores are found below average. But this has to be supported by more concrete evidence based research. As reported by Whitmore & Maker (1985) deaf children have been less likely than their hearing peers to be screened, identified and served by special programs to assess and develop their creativity.

Therefore it is important to take up some special programs based on the abilities of children with hearing impairment to nurture their hidden talents rather than concentrating on what they are lacking. The fact that they are “differently able” must be accepted positively. As rightly pointed out by Johnson, Karnes & Carr (1977), failure to identify and serve deaf children with creative thinking abilities is an indictment against the society and a problem that should not be tolerated.

As there are no gender differences in Intelligence, Creative thinking abilities and Academic achievement, all the boys and girls can be trained for special programs for fostering creative thinking abilities.
Figure 2: Graph showing children scoring intelligence Grade V outperformed in creative thinking abilities compared to children scoring Grade III and Grade IV.

Limitations

There were few limitations that should be considered due to paucity of time, limited availability of resources and several other aspects that could not be covered in this present study due to practical constraints.

1. The study was limited only to fifty children with hearing impairment and they were selected on the basis of convenience sampling.
2. The study was confined to selected three Residential special schools in Mysore for children with hearing impairment.
3. For Academic achievement, no test was administered but previous and present class exam marks of children were obtained from the school records.

Summary

The present study summarized that there exists no significant relationship among Intelligence and creative thinking abilities, Academic achievement and creative thinking abilities of children with hearing impairment. It also highlighted the need for planning of special programs to foster creative thinking abilities of children with hearing impairment based on abilities and talents rather than Intelligence and school exam marks. Future research can be carried out such as a comparative study in creative thinking abilities of children with hearing impairment and children with hearing. A study to find out the relative effectiveness of Baqer Mehdi’s verbal and Non-verbal tests of creativity may be taken up with reference to children with hearing impairment studying in regular schools.

More specifically, a special curriculum for children with hearing impairment may be designed to foster their creative thinking abilities and thereby prepare them for appropriate and productive vocations. Thus, the present study contributed significant educational implications on its findings.

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2. Dr. C. Jangaiah, Associate Professor, English and Foreign Languages University, Hyderabad.
INTONATION IN THE WH AND Y-N QUESTIONS OF MOTHERS OF HEARING IMPAIRED: INFLUENCE OF TYPE OF PARTNER IN COMMUNICATION

*Amulya, P. Rao , **Sushma Manjunath, ***R. Manjula & ****Priyashri Sridhar

Abstract

‘Intonation’ a prosodic feature of speech is characterized by the variation of fundamental frequency over time. The study attempted to analyze the variations in the use of intonation patterns of WH and Y-N questions in mothers following two approaches; Woodford Oral technique and non-specific technique, when they speak (a) to their children with hearing impairment and compare the same with their use of the same questions when it is addressed to (b) normal adults and (c) normal children. 30 mothers of children with hearing impairment served as participants and they were divided into 2 groups – one group followed Woodford Oral Technique and the other group followed non-specific technique. The participants were instructed to ask as many questions as possible to 3 different communication partners on a selected picture stimuli. A total of 14 WH and 5 Y-N questions spoken with a similar syntactic structure were analyzed for the intonation features that were expressed by majority of the mothers of the two groups. The intonation contours for each question across WH and Y-N questions, three conditions and two groups of mothers were extracted and plotted. Temporal measures included duration of the intonation contours and frequency measures included the analysis of onset and terminal F0 of the intonation contour, F0 range in the intonation contour, terminal contour of the intonation curve and declination gradient in the intonation contour. The results revealed a significant difference in the pattern of intonation contours especially in the frequency related parameters across the two groups of participants, across the conditions. Also, significant difference in the intonation contours were observed across the conditions for mothers following Non-Specific Technique suggesting that more natural intonation curves were used by mothers in Non-Specific Technique than the Woodford Oral Technique.

Key words: Hearing impaired, Intonation contours, Woodford Oral technique, Non specific technique

Supra-segmental features or ‘Prosody’ are considered as one of the most important but highly evasive properties of spoken language (Price, Ostendorf, Shattuck-Hufmagel and Fong, 1991). According to Lehiste (1970) and Crystal (1986), prosody represents the linguistic use of vocal aspects of speech, such as variations in fundamental frequency (perceived as pitch), intensity (perceived as loudness) and duration (perceived as length) without consideration of the segmental aspects (speech sounds or phonemes). ‘Intonation’ is a prosodic feature of speech characterized by the variation of fundamental frequency over time (Collier, 1991), and it has many communicative roles: conveys attitudes (Crystal, 1986); old or new information, social status; grammatical functions; and information about discourse and speakers attitude (Brazil, Coulthard & Johns, 1980).

There are limited studies addressing the intonation features in Indian languages. Manjula (1979) and Nataraj (1981) found that in Kannada language, sentences are expressed with a final fall except for those with emotions like fear and anger, wherein a final-rise is noticed. Manjula (1997) studied the features of intonation and stress in question words (WH) and Yes – No (Y-N) interrogatives in standard dialect of Kannada and found that there is a general rise in the fundamental frequency (F0) for

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Y-N and fall in $F_0$ for WH questions, and there are different patterns of declination and inclination in $F_0$ observed for Y-N and WH questions.

Early communication in typically developing infants is extremely melodic in nature. Infants express using various intonation patterns which reflect their physiological and emotional needs (Lewis, 1951; Lennenberg, 1967). Amongst the suprasegmental features, the role of intonation in the acquisition of language has received relatively less attention. Crystal (1973) suggested that infants respond to supra-segmentals at an early age, possibly at the expense of other linguistic features. Infants master voice patterns that vary in pitch well before words are learned and this in turn facilitates acquisition of both speech perception and production skills (Smith and Goodenough, 1971).

Prosodic variations, including boundary phenomena, are especially prominent in the speech of adults directed to children or otherwise popularly known as “motherese” (Fernald & Simon, 1984; Albin & Echols, 1996). Child-directed speech or infant-directed talk, also referred to as baby talk or caretaker speech (and informally as “motherese”, “parentese”, or “mommy talk”), is a nonstandard form of speech used by adults while talking to toddlers and infants. It is usually delivered with a “cooing” pattern of intonation which is different from that of normal adult speech: high in pitch, with many glissando variations that are more pronounced than those of normal speech. Motherese is also characterized by the use of short and simple words. Swanson, Leonard & Gandour (1992) examined the vowel duration in mothers’ speech with their typically developing children as compared to adult directed speech. They reported that the content words in the speech of mothers were often highlighted due to the lengthening of vowels in the content words rather than on function words. Ratner (1996) compared the child directed and adult directed speech of mothers in preverbal, holophrastic and combinatorial expressions and reported that vowels of content words were longer in phrase-final position in child directed speech when compared to adult directed speech.

Most of the specialists including the speech language pathologists recognize that mothers of hearing impaired children speak with their hearing impaired children in a very different prosodic form when compared to the mothers of typically developing children. The differences stand out in terms of exaggerated suprasegmental patterns in their speech which they probably do to facilitate increased auditory input to the child or slow down the rate of speech or improvise speech reading skills of the child and many other reasons. At times, a shift in the suprasegmental patterns of the mothers of hearing impaired children are seen with respect to the situation that they are placed in (For example, formal and informal contexts), persons that they are speaking to (For example, elders in the family, addressing a normal child etc), situation/context of the speech (For example, teaching the child versus holding small talk with the child etc). Overall, a noticeable change in the prosody of speech is observed in mothers of hearing impaired children when compared to mothers of children diagnosed as presenting other types of communication disorders such as mental retardation or cerebral palsy or learning disability etc. Although this impression is gained by most of the listeners who communicate with mothers of hearing impaired children, there is very little documented evidence available in the form of studies to understand this issue.

The role of intonation in the acquisition of language has received relatively less attention. The same is true for children with hearing impairment. A review of existing literature reveals a dearth of research regarding the nature of motherese in general and intonation patterns in specific, in mothers of children with hearing impairment. There are scanty reports that address this issue in western context and hardly any in the Indian context. One of the studies conducted in the western context by Szagun (1997) suggests that there is exaggerated intonation pattern used by mothers of hearing impaired.

Use of appropriate intonation patterns has a great impact on child’s development of communication skills. Mothers of children with hearing impairment use different techniques to communicate with their children and to teach them how to communicate. This is often different from the natural or typical manner of speaking. For example, few mothers of hearing impaired children who follow ‘Woodford oral technique’ (used extensively as a teaching method at Balavidyalaya, Chennai, India,
which is a school for hearing impaired children that promotes aural verbal approach) give the impression of use of exaggerated prosody, especially in terms of intonation use. It is of scientific interest to verify how different the intonation pattern of this group of mothers is, and if it is different, what is the extent to which it is affected and are there any observable differences in the use of intonation patterns of these mothers as used with different groups of communication partners. Another point of interest that is well acknowledged is that the prosodic characteristics in general and intonation contours in particular, of different speakers is also influenced by the type of utterance. For example, a question would show an intonation contour that varies from that of a statement. Similarly, within questions, the category of questions [WH versus Yes-No (Y-N)] would also play an important role in deciding the intonation contour. Another influential parameter would be the communication pattern. Considering that the mothers of children with hearing impairment follow different methods of communication, it becomes extremely necessary to find answers to questions such as “Do mothers use the same intonation with children and adults who have hearing within normal limits?” Fetching answers to such questions will not only help us understand the extent to which their speech is same or different across different contexts, but also serves as benchmarks that help us evaluate the extent to which a method is influential.

Although one can find a decent review of literature on segmental features in children with hearing impairment, the same cannot be said of supra segmental features. Despite the widespread occurrence of prosodic problems in some communicatively impaired individuals, relatively few studies have examined the nature of prosodic impairment and how best to remediate prosodic problems (Shriberg & Kwisatkowski, 1985; Shriberg et al., 1986). An understanding of the mothers’ prosody will enable us to understand the prosodic deficits seen in children with hearing impairment, because, mothers serve as models of communicative behaviour right from infancy through childhood to adulthood; their model of speech goes a long way in determining the type of deficits seen in communication of children. Knowing the deficits along with the cause will equip us to tackle them more effectively and establish appropriate patterns of communication.

This study is proposed to understand the differences in WH and Y-N questions of selected mothers of hearing impaired children, as spoken to their hearing impaired child, a normal child without hearing impairment and an adult, in a simulated experimental design. Comparison of stylistic use of intonation in these contexts by mothers of hearing impaired children will throw light on the flexibility of the intonation mechanism that a mother of hearing impaired uses across the said context. If the differences are evident, it will provide scope to introspect the reasons behind such shifts in intonation styles adopted by mothers of hearing impaired children.

Aims of the study

The study aims to compare the intonation patterns (in terms of F0 range, initial and terminal F0 range and terminal intonation contours) for selected ‘WH’ and ‘Yes-No (Y-N)’ questions in Kannada language of mothers of children with hearing impairment as used with the following groups (three conditions):

- Hearing impaired children
- Normal adult
- Normal children

Method

Participants: For the experimental study, thirty Kannada speaking mothers of children with hearing impairment were included. All the mothers were in the age range of twenty five - forty years. The duration for which they were training their children ranged from one month to four years. The group included those mothers who were following the ‘Woodford oral technique’ (fifteen number) exclusively and those who did not follow any specific method of teaching (fifteen number).

Material: The stimulus material used to elicit utterances from the mothers in the three conditions of the experiment consisted of a non-emotional picture of kitchen items (enclosed as Appendix 1). This stimulus was selected on the basis of a pilot study that was carried out by the investigators prior to the experiment.

Pilot study: A pilot study was conducted in the first
phase of the experiment to ensure that the stimuli material used in the study could generate questions with similar syntactic structure across the speakers. Ten adult participants (mothers of typically developing children) in the age range of twenty five – forty years, who were not part of the actual experiment, were randomly assigned to two groups of five each to administer two tasks.

The task of one group of mothers was to rate for the familiarity and ambiguity of the pictures on a three point rating scale. Three pictures which provided scope for use of non emotional utterances were considered as stimuli for the pilot study. The three pictures depicted a city, a study room and items used in the kitchen. On the rating scale, a score of ‘2’ indicated that the items/actions are familiar and non-ambiguous, ‘1’ indicated that the items/actions are less familiar and somewhat ambiguous and ‘0’ indicated that the items/actions are unfamiliar and ambiguous. If the ratings were ‘0’ or ‘1’ they were asked to explain the actual reason for the rating. Based on the pilot study, the picture of kitchen items which elicited a 5/5 response was selected for the experiment.

The task of another group of mothers was to look into the possibilities of eliciting question sentences of WH and Y-N with similar syntactic structure using the pictures. This was required since the intention of the study was to compare the intonation contours of groups of mothers keeping the syntactic structure similar. Each mother was instructed to construct as many WH and Y-N questions as possible for each picture. The picture depicting kitchen items elicited the greatest number of similar questions. Thus, the picture depicting the kitchen items was considered as the final stimulus for the study.

Procedure: For the experiment, the speech samples of thirty mothers of hearing impaired children (fifteen mothers who followed Woodford oral technique and fifteen who followed non specific teaching methods) were collected individually in a sound treated room. The mothers were instructed to ask as many WH and Y-N questions under each of the three conditions. The three conditions included asking questions about the stimuli picture to:

(1) Their child with hearing impairment
(2) A normal child
(3) A normal adult.

The stimuli picture was placed in between the mother and the participant in such a way that the card was visible to both of them at a time. Looking at the picture, the mothers asked as many questions as possible to the participant. The mothers and their communicating partners were kept blind to the purpose of the study. They were not even sensitized as to the type of questions to be asked. The stimuli of kitchen picture was so constructed that it provided opportunities for the mother in framing WH and Y-N questions in a natural manner, more than any other type of questions. In order to maintain a true representation of the simulated condition of the experiment, the speech of communication partner was also recorded on a portable tape recorder, although the speech of the partner was not analyzed or included in the study design. When the mother asked the questions, she was instructed to do so as naturally as possible. The speech samples were recorded using a professional digital tape recorder with external microphone and the data was directly stored on a computer using line feed procedure. The speech recordings of mothers across the three conditions were randomized to counterbalance and to control order effect if any. The syntactic structure of WH question forms ‘where’ & ‘what’ were not the same across the mothers & hence these were not included in the final analysis.

Analysis: From the recorded samples, questions which were framed using similar syntactic structure across the thirty mothers & across all the three conditions in both WH and Y-N question categories were selected. This process yielded a total of nineteen questions (fourteen WH and five Y-N questions) (see Appendix 2). These questions were transferred through line feed to PRAAT software (Boersma & Weenink, 2001) to analyze the intonation contours of WH and Y-N questions, using ‘F0 analysis’ module in the Speech analysis section of the software. The speech signal was digitized at a sampling rate of 16000 Hz. The basic unit of analysis included the WH or Y-N question, within which the temporal and F0 measurements were carried out. For the purpose of pitch analysis, F0 range was set between 100 to 350 Hz and the window frame length of analysis was 25 ms. The pitch contours were
extracted using pitch extracting algorithm of PRAAT software. The F0 contours of WH and Y-N questions analyzed were stored as separate files. In order to obtain accurate duration measurements and facilitate discernible boundaries of syllables and intonation units, the utterances were displayed on a wide-band spectrogram. The spectrographic display was obtained between 0-80% Nyquist frequency and was analyzed in Blackman window weighting. The pre-emphasis level was set at 0.80. The acoustic measurements were carried out by the investigators of the study. To check for reliability of measurements of temporal and F0 parameters, approximately 10% of the speech sample was measured independently by another investigator, and these were found to be reliable as the contour to contour agreement was greater than 90%.

The acoustic measurements of duration and F0 were obtained for the following parameters:

**Temporal measures:**
- Duration of the intonation contour for question as a whole

**Fundamental frequency (F0) measures:**
- Onset and terminal F0 of the intonation contour
- F0 range in the intonation contour
- Terminal contour of the intonation curve, with respect to rise, fall, level and the combinations of these.
- Declination gradient in the intonation contour.

**Graphic representation of intonation contours:** To facilitate comparison of the WH and Y-N intonation contours of the mothers, the intonation contours of each question as expressed by mothers were superimposed on each other for graphic representation and further analysis. This was carried out by copying the contours extracted through PRAAT analysis on to Microsoft PowerPoint office and placing them on the temporal and F0 scale using Microsoft paint office. The contour of each mother’s utterance was represented in specific colour as codes to facilitate identification of the mother and for further analysis and comparison. The contours for each question asked by mothers across three conditions were thus depicted graphically.

**Results & discussion**

The selected features of intonation contours were analyzed for WH and Y-N questions of mothers for the three conditions separately. The results are presented in two sections for Y-N and WH questions respectively.

The phonetic transcription to represent questions is based on Schiffman (1979) for Kannada language (Appendix 3). Graph 1 and 2 presented in Appendix 4 shows an example of the superimposed intonation contours for one out of five Y-N questions and one out of fourteen WH questions.

Table 1a shows the duration of the intonation contours for the yes-no questions. The duration of the Y-N questions along with mean and SD for the two groups of mothers namely, the group that followed Woodford Oral technique (Group 2) for the three conditions – adults (C1), typically developing child (C2) and their hearing impaired child (C3) was lesser compared to the group that followed non-specific technique. In general, the mean duration was higher in mothers who followed non-specific technique than that of mothers who followed Woodford Oral Technique. This was probably because of lesser number of syntactically similar questions in mothers following Woodford Oral Technique compared to mothers who used non-specific technique. The mean non-specific technique was higher for C1, C2 conditions and C3 was greater in Woodford Oral Technique group. Thus, the two groups of mothers revealed differences in the duration of whole sentence across conditions. However, the differences must be examined in the light of absence of syntactically similar questions in quite a few cases in Group 2 which may have resulted in lesser values. Although the data is limited to five, it can probably be inferred that there was a difference in terms of duration of intonation contours between the Woodford Oral Technique and non specific technique group.

The duration of the WH questions along with mean and SD for the two groups of mothers namely, the group that followed Woodford Oral Technique (Group 2) for the three conditions – adult with hearing sensitivity within normal limits (C1), typically developing child (C2) and their hearing impaired child (C3) are shown in Table 1b. In general, the mean duration was almost similar in mothers who followed
1. Duration of the intonation contour for Y-N and WH questions in three conditions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mothers: Non-specific approach</th>
<th>Mothers: Woodford technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Q1</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Q2</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Q3</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Q4</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Q5</td>
<td>1.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>7.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Mean</td>
<td>1.46</td>
<td>1.7</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.24</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table 1a: Duration of the intonation contour for Yes-No questions in sec (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Mothers: Non-specific approach</th>
<th>Mothers: Woodford technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Q1</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Q2</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Q3</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Q4</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Q5</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Q6</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Q7</td>
<td>1.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Q8</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Q9</td>
<td>-</td>
<td>1.5</td>
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<tr>
<td>Q10</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Q11</td>
<td>1.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Q12</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Q13</td>
<td>1.6</td>
<td>2</td>
</tr>
<tr>
<td>Q14</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>16.3</td>
<td>21.5</td>
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<tr>
<td>Mean</td>
<td>1.35</td>
<td>1.53</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.25</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Table 1b: Duration of the intonation contours in sec for the WH questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)

non-specific technique and mothers who followed Woodford Oral Technique, with very minor differences across the conditions in both the groups. Thus the two groups of mothers revealed no differences in the duration of the whole sentence across conditions. This is reflected in the changes seen in the intonation contour. One can see that there are almost similar modulations in the intonation contour in both the conditions.

Table 2a shows the difference in range of onset and terminal F0 in Hz for yes-no questions for both groups of mothers. Table 2b shows the difference in range of onset and terminal F0 in Hz for WH-questions for both groups of mothers. The difference was calculated as the value of the final /end point of the contour minus the initial /onset of the contour. A positive value indicates an upward inclination in the contour and a negative value indicates a downward declination in the contour. In Y-N and WH questions, mothers who followed Woodford Oral Technique showed lesser standard deviations in all three conditions as compared to those mothers who followed a non specific technique, who showed greater variability in onset and terminal F0 range. In WH questions, the greatest variability in terms of the range was found for C2 condition in both groups. The least variability was found for the C3 condition in both groups.

The groups showed similar inter-condition changes within their respective groups. The results point to the possible explanation that the type of communication partner did not have a significant effect on the onset and terminal F0 in mothers who follow Woodford Oral Technique. It seems like the mothers who follow Woodford Oral Technique tend to generalize the method across communication
partners and tend to show more of flat pitch than mothers who follow the non-specific method. Table 3a shows the F0 range of Y-N intonation contours of both the groups of mothers for yes-no questions along with the total, mean and standard deviation. Table 3b shows the F0 range of WH intonation contours of both the groups of mothers for WH questions along with the total, mean and standard deviation. For both the question types, mothers who followed the non specific technique exhibited wider range of F0 with a higher mean F0.

They demonstrated significant intra-group variability and hence a higher standard deviation was noticed. Also, across conditions, they demonstrated

2. Difference between onset and terminal F0 of the Y-N and WH intonation contours

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Mothers: Non-specific approach</th>
<th>Mothers: Woodford technique</th>
</tr>
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<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Q1</td>
<td>110</td>
<td>140</td>
</tr>
<tr>
<td>Q2</td>
<td>-50</td>
<td>210</td>
</tr>
<tr>
<td>Q3</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>Q4</td>
<td>-20</td>
<td>-30</td>
</tr>
<tr>
<td>Q5</td>
<td>-50</td>
<td>-50</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>320</td>
</tr>
<tr>
<td>Mean</td>
<td>12</td>
<td>64</td>
</tr>
<tr>
<td>S.D.</td>
<td>98</td>
<td>146</td>
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Table 2a: Difference between onset and terminal F0 (in Hertz) of the intonation contour (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Mothers: Non-specific approach</th>
<th>Mothers: Woodford technique</th>
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</thead>
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<tr>
<td></td>
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<tr>
<td>Q1</td>
<td>-10</td>
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<td>Q2</td>
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<td>Q3</td>
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<td>Q4</td>
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<tr>
<td>Mean</td>
<td>2.72</td>
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<td>S.D.</td>
<td>97.27</td>
<td>155.71</td>
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Table 2b: Onset and terminal F0 in Hertz of the intonation contour for WH questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)

3. F0 range in the Y-N and WH intonation contours

<table>
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<th>Mothers: Woodford technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Q1</td>
<td>110</td>
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<td>Q2</td>
<td>50</td>
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<tr>
<td>Q3</td>
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<td>Q4</td>
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<td>Q5</td>
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<td>Total</td>
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<td>440</td>
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<tr>
<td>Mean</td>
<td>82</td>
<td>88</td>
</tr>
<tr>
<td>S.D.</td>
<td>38</td>
<td>72</td>
</tr>
</tbody>
</table>

Table 3a: F0 range in Hertz in the intonation contour for yes-no questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)
Table 3b: F0 range in Hz in the intonation contour for WH questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison).

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Mothers: Non-specific approach</th>
<th>Mothers: Woodford technique</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
<td>C2</td>
</tr>
<tr>
<td>Q1</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Q2</td>
<td>-10</td>
<td>160</td>
</tr>
<tr>
<td>Q3</td>
<td>-20</td>
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<td>Q4</td>
<td>-10</td>
<td>10</td>
</tr>
<tr>
<td>Q5</td>
<td>-</td>
<td>-20</td>
</tr>
<tr>
<td>Q6</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Q7</td>
<td>-30</td>
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<tr>
<td>Q8</td>
<td>20</td>
<td>30</td>
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<tr>
<td>Q9</td>
<td>-</td>
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</tr>
<tr>
<td>Q10</td>
<td>-10</td>
<td>-100</td>
</tr>
<tr>
<td>Q11</td>
<td>0</td>
<td>-100</td>
</tr>
<tr>
<td>Q12</td>
<td>-10</td>
<td>-100</td>
</tr>
<tr>
<td>Q13</td>
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<td>-30</td>
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<td>Q14</td>
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<td>Total</td>
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<td>-60</td>
</tr>
<tr>
<td>Mean</td>
<td>2.72</td>
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</tr>
<tr>
<td>S.D.</td>
<td>97.27</td>
<td>155.71</td>
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</table>

Table 3b shows variability in their F0. Highest values of F0 were obtained for C2 followed by C1 and C3. This implies that F0 variations were highest with typically developing children and adults as against children with hearing impairment. On the other hand, the total F0 range of mothers who followed Woodford Oral Technique was significantly lesser than the F0 range of mothers who followed the non specific technique and also showed lesser intra-group variability. All the F0 values obtained under each condition were the same.

This shows that mothers who follow Woodford Oral Technique use lesser variations in F0 and show little intra-group variability as compared to the other group. The F0 range was higher for C1 than C2 indicating that the mothers who follow Woodford Oral Technique use a higher range of F0 with adults than typically developing children. However, no syntactically similar questions were obtained for C3 and hence the condition was not analyzed.

The terminal contours of the Y-N and WH intonation contour were examined and were categorized as rise, fall, level and combinations of these. The result of the general pattern that emerged for Y-N questions is shown in table 4a and that of WH questions is shown in table 4b. The number of syntactically similar questions elicited for mothers who follow the Woodford Oral Technique was lesser and hence the pattern of the terminal contour of mothers who followed Woodford Oral Technique was found to be mixed consisting of both rise and fall. In both the question types, the pattern of terminal contours of mothers who followed non specific technique was mainly of falling types with not much inter-condition variability within the group. Thus, more consistency in terms of the terminal contour pattern was found in mothers who followed the non specific approach. The pattern of the terminal contour of

4. Terminal contour of the Y-N and WH intonation curve, with respect to rise, fall, level and the combinations of these.

Table 4a: Terminal contour of the Y-N intonation curve, with respect to rise, fall, level and the combinations of these for yes-no questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison).
mothers who followed Woodford Oral technique was found to be mixed consisting of both rise and fall with majority of them showing rise pattern.

The intonation contours were analyzed in terms of inclination or declination pattern. The declination and inclination gradients are tabulated in Table 5a and 5b and compared across the two groups of mothers for yes–no and WH questions respectively. For both the question types, in mothers who follow the non specific technique method, significant inter and intra-group variability was found across the three conditions with C1 and C2 showing declination for few questions and inclination for few. However, there was not much variability in C3 with most of the mothers showing a declination pattern. In mothers who follow the Woodford Oral Technique, no fixed pattern was noticed.

In Y-N questions, the number of syntactically similar questions elicited was very less for C2 and C3. Hence a declination gradient could not be calculated. The two groups of mothers demonstrated significant difference in the declination gradient. In WH questions, not much of inter-condition variability emerged and a careful analysis reveals similar patterns across the three communication partners for each question. This indicates that the mothers who follow the Woodford Oral Technique tend to generalize the intonation pattern across different communication partners.

The present study is the first of its kind to be carried out in the Indian context. Despite the widespread occurrence of prosodic problems in some communicatively impaired individuals, relatively few studies have examined the nature of prosodic impairment and how best to remediate prosodic problems (Shriberg & Kwisatkowski, 1985; Shriberg et al., 1986). One of the studies in the western context conducted by Szagun (1997) suggests that there is exaggerated intonation pattern in mothers of hearing impaired. However, the exact nature of prosody in mothers of children with hearing impairment and how it is influenced by the method followed is not highlighted.

This study highlights the difference in WH and

|---------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|

Table 4b: Terminal contour of the intonation curve, with respect to rise, fall, level and the combinations of these for WH- questions (C1 = Adult, C2 = N Child and C3 = HI child, '-' indicates that syntactically similar questions were not available for comparison)

Table 5a: Declination/ Inclination gradient in the intonation contour for yes-no questions. (C1 = Adult, C2 = N Child and C3 = HI child)
Y-N intonation contours across two groups of mothers following two different techniques across different communication partners namely typical adult, typically developing child and child with hearing impairment. The results indicate that there is not much of inter-condition variability in mothers who follow the Woodford Oral Technique as compared to mothers who follow the non specific technique. This suggests that mothers who follow Woodford Oral Technique exhibited similar exaggerated intonation and stereotypic patterns irrespective of the age and diagnosis of the communication partner. On the other hand, mothers who follow the non specific technique showed more variability across the conditions suggesting a more natural way of communication and that which is similar to the typical communication patterns.

The differences in the intonation contours for WH and Y-N questions within the groups across participants are not very different. This suggests that a similar pattern is maintained for the type of questions by subjects using one method. There are however, significant differences across the two groups (Woodford Oral Technique and non specific technique) especially in terms of the F0 range, terminal contours, declination gradient and range of F0 onset and termination values. The durational measures are however, not significantly different across the two groups suggesting that temporal parameters are not greatly affected by the method adopted whereas frequency measures, which are core features of intonation are highly dependent on the method followed for both the Y-N and WH questions.

Conclusion

The present study was conducted to compare the intonation contours of Y-N and WH questions across the two groups who follow the Woodford oral technique and the Non specific technique. Comparisons were also made across three conditions (with communication partners including typically developing children, normal adults and children with hearing impairment) in which the mothers uttered the Y-N and WH questions in simulated experimental conditions. The results reveal a significant difference in the pattern of intonation contours especially in the frequency related parameters across the two groups of participants, across the conditions. Also, significant difference in the intonation contours were observed across the conditions for mothers following non specific technique suggesting that more natural intonation curves were used by mothers in non specific technique than the Woodford Oral Technique.

Implications

The study compared the intonation patterns of WH and Y-N questions of two groups of mothers who used two different teaching methods to teach and stimulate their children with hearing impairment. Results suggest that the mothers of the Woodford Oral Technique go on to generalize the same with
other communication partners irrespective of their age and hearing status. This gives rise to unnatural use of intonation by such mothers. It also implies that they are less flexible and rather rigid in the stylistic use of intonation in different communication contexts.

On the other hand, mothers who follow the non specific technique who do not actually abide by any specific technique of teaching intonation seem to be more flexible in terms of their intonation use especially so as reflected in the use of WH and Y-N questions. Extrapolating this finding to the modeling of language by adult to child, one can attribute the prosodic deficits seen in the children to the method adopted by the mother. That is, the parameters of ‘motherese’ is reflected not only in terms of segmental variations but also in terms of intonation variations and this may in turn have an effect on the production of intonation in children’s speech.

References
Appendix 1 – Picture stimuli
Appendix 2
Questions of participants with common syntactic patterns which were analyzed for intonation contours
[Notations used from Schiffman (1979)]

<table>
<thead>
<tr>
<th>WH Questions</th>
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<tbody>
<tr>
<td>1. bindige yaake beeku?</td>
</tr>
<tr>
<td>2. gyaas stov yaake beeku?</td>
</tr>
<tr>
<td>3. bakeT yaake beeku?</td>
</tr>
<tr>
<td>4. baaNaLe yaake beeku?</td>
</tr>
<tr>
<td>5. mora yaake beeku?</td>
</tr>
<tr>
<td>6. paip yaake beeku?</td>
</tr>
<tr>
<td>7. sink yaake beeku?</td>
</tr>
<tr>
<td>8. chaaku yaake beeku?</td>
</tr>
<tr>
<td>9. porke yaake beeku?</td>
</tr>
<tr>
<td>10. Tuut braS yaake beeku?</td>
</tr>
<tr>
<td>11. iliLigemaNe yaake beeku?</td>
</tr>
<tr>
<td>12. miksi yaake beeku?</td>
</tr>
<tr>
<td>13. haalinkaanu yaake beeku?</td>
</tr>
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<td>14. friDj yaake beeku?</td>
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<table>
<thead>
<tr>
<th>Y-N Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. aDige maaDa bahuda?</td>
</tr>
<tr>
<td>2. anna maaDa bahuda?</td>
</tr>
<tr>
<td>3. hallu ujjabahuda?</td>
</tr>
<tr>
<td>4. kasa guDisabahuda?</td>
</tr>
<tr>
<td>5. snaana maaDa bahuda?</td>
</tr>
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Appendix 3
Transcription of sounds in Kannada language using Schiffman’s (1979) transcription procedure

Vowel Sounds

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<th>Short</th>
<th>Central</th>
<th>Back</th>
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</thead>
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<td>i</td>
<td>u</td>
<td></td>
</tr>
<tr>
<td>Long</td>
<td>ii</td>
<td>uu</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Mid</th>
<th>Short</th>
<th>Long</th>
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</thead>
<tbody>
<tr>
<td>Short</td>
<td>e</td>
<td>ee*(ae)</td>
</tr>
<tr>
<td>Long</td>
<td>oo</td>
<td>oo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low</th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>a</td>
<td>aa</td>
</tr>
</tbody>
</table>

Diphthongs
“ai” and “au”

Consonant Sounds

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<tr>
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<th>Unaspirated</th>
<th>Aspirated</th>
<th>Nasals</th>
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<tr>
<td>Velar</td>
<td>k</td>
<td>gh</td>
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<td>Palatal</td>
<td>c</td>
<td>ch j</td>
<td>jh</td>
<td></td>
</tr>
<tr>
<td>Retroflex</td>
<td>T</td>
<td>Th D</td>
<td>Dh N</td>
<td></td>
</tr>
<tr>
<td>Dental</td>
<td>t</td>
<td>th d</td>
<td>dh n</td>
<td></td>
</tr>
<tr>
<td>Lateral</td>
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<td>ph b</td>
<td>bh m</td>
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</table>

<table>
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<th>Fricatives</th>
<th>Laterals</th>
<th>Continuant</th>
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<tbody>
<tr>
<td>V</td>
<td>UV</td>
<td>V</td>
<td>UV</td>
<td>V</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retroflex</td>
<td>S</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apicopalatal</td>
<td>Y sh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alveolar</td>
<td>s</td>
<td>z</td>
<td>l</td>
<td></td>
</tr>
<tr>
<td>Labiodental</td>
<td>V f</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

V= voiced and UV= unvoiced or voiceless
Appendix 4:

Graph 1: A sample of superimposed Yes – No (Y-N) intonation contours of mothers in the two groups (G1= Mothers using non specific approach and G2 = Mothers using Woodford’s technique)

Graph 2: Intonation contour of a WH question of mothers in the two groups (G1= Mothers using non specific approach and G2 = Mothers using Woodford’s technique) across 2 groups and 3 conditions
**PILOT STUDY ON PROCESS EVALUATION OF DHLS PROGRAM\footnote{Process Evaluation of DHLS program}**  
CONDUCTED THROUGH REAL VIS-À-VIS VIRTUAL MODES: 2007-08\footnote{Distance Learning (DL) is a system and process for providing instruction from a distance (Bates, 1995). It occurs when a teacher and student are physically separated by real time or space. It reduces, sometimes eliminates, the constraint of space, time and individual differences. There are numerous formats for this instruction. They include courses on audio/video tape; two-way live interactive question answer formats on hotlines, telephones and television, print as well as on World Wide Web. Further, there can be teleconference courses, audio/video conference, correspondence courses, computer based online or web based courses (real time or delayed) respectively. Contrast this with web based learning or online education where in interactions occur between faculty and students via emails, virtual class rooms, electronic forums, chat rooms, bulletin boards, instant messaging, internet, world wide web, and other forms of computer based communication. A fine line exists between online programs and distance learning courses since it is difficult to call all distance-learning courses as online courses. The technology in both the mode may be different in some cases (Holmberg, 1989). In practice, each of these formats often include multitude of subsidiary formats (such as, fax, mail or telephone, printed material, student group meetings, etc.) In some cases the computer based learning or online education is delivered in various forms such as video conferencing, chat rooms, bulletin boards, etc., with or without access to the faculty. It depends on the communication medium} 

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**Abstract**

Distance Learning (DL) is a system and process for providing instruction from a distance. This is distinguished from real or traditional instruction, in which all students are on campus face-to-face with the instructor. There are several misconceptions and misapprehensions regarding DL—especially regarding its newer formats by use of two way live and interactive teleconference modes, use of virtual classrooms and/or such other technology enabled services for teaching and education. The DHLS (Diploma in Hearing, Language and Speech) program initiated at AIISH, Mysore (2007-08) through terrestrial linked two way video-conference mode in 11 centers across the country offers a splendid occasion and opportunity to undertake a comparative process evaluation through real vis-à-vis virtual modes of instruction. By combining the use of a cross sectional multi-group comparison design along with a component of survey and tool development embedded within it, the present study seeks to evaluate interpersonal perceptions between teacher-pupil, their views on the technology enabled methods of instruction as well as their impact in terms of comparative performance and results in the end annual examination of the students by using appropriate and standardized questionnaires, rating scales and self reporting schedules. Results indicate highly satisfactory mutual ratings both by teacher/supervisors as well as students across real and virtual centers. In terms of the findings on evaluation of the video-conferencing, teachers experience greater problems or glitches related to the use of this technology than the recipient students. Finally, there appears to be no differences in the eventual outcome of results in final examinations between the two modes of distance learning in the field of communication disorders. The implications of the study along with future potential and possibilities for research along these lines are presented and discussed.

**Key words: Open Distance Learning – Process Evaluation – Virtual Learning – DHLS Program**
telephone) to support teacher-student exchanges of information. Across these formats, DL is a powerful and versatile tool for assisting student learning. It holds unprecedented opportunities for expanding the academic community. It includes distance teaching. The three components of DL are: teacher’s role in the process—distance learning, and the student’s role in the process and the desired outcome—distance education (Verduin & Clark, 1991; Lane, 1992; Willis, 1993).

DL is distinguished from (a) real or traditional instruction, in which all students are on campus face-to-face with the instructor, (b) teach-yourself programs, in which students engage exclusively in independent private study, and (c) other uses of technology in education, such as independent computer-assisted instruction (Keegan, 1986). DL refers to the whole process or system of education (Lane, 1992; Willis, 1993). It refers to the teacher’s role in the process of providing instruction at a distance (Lane, 1992; Willis, 1993; Schlosser and Anderson, 1994).

DL models are based on entirely different footing than the brands of traditional education. It is learner centered. The students have to actively discover, create meanings and construct knowledge. They have to be proactive during the learning process. They develop their own thinking. They manage their own learning at their own pace. The teacher is mere facilitator who provides instructional supports. Contrast all this with the traditional system which is teacher centered. The teacher presents knowledge. The student is receptive and reactive during the teaching process. They run according to the pace of the teaching or teacher. The teacher dominates the entire proceedings during the teaching or learning process (Venkatesan, 2007).

DL is an upcoming, untapped and unrecognized agenda in contemporary educational practice. Programs under this mode range from high end options leading to award of doctoral degrees, masters, bachelors and/or graduate, post graduate diplomas or the more modest low end certificate/bridge courses across various disciplines and subjects. It is currently plagued with several startup problems, misconceptions and misapprehensions and misconceptions. A few important mistaken beliefs are given below (Clarke, 1993; Imel, 1998; Inman and Kerwin, 1999):

- It is not real teaching
- It represents weaker learning
- Effective instruction can/must be live and face-to-face
- Student-faculty interaction is minimized in DL
- Certain subject matter can be taught only in live traditional classrooms.
- Some DL formats eliminate the need for faculty.
- Academic dishonesty among DL students is frequent and uncontrollable.
- DL courses will decrease on-campus enrollments (Barron, 1987; Carl, 1991; Dillon & Walsh, 1992; Moore, 1995).

These misgiving are more a result of functional fixedness in the attitudes of its perpetuators and protagonists. When it comes to the issue of analyzing or understanding issues and problems related to DL, there is need for attitudinal shift in educational planners, policy makers and program implementers. There is mistaken notion on “change the individual, rather than the system” orientation in many people (Evans, 1982). This “system-centered” tendency obviously is directly opposed to “student-centered” approach, a characteristic feature of these programs (Phelps, 1991).

The DHLS Program

The DHLS (Diploma in Hearing, Language and Speech) program is aimed at training lower level functionaries in the field of speech and hearing. After the completion of this 10-month course, they are eligible to work as speech and hearing assistants. Their job functions generally include activities like carrying routine screening, assessment and therapeutic management of clients with communication disorders. The location of their work can include Child Guidance Centers, District General Hospitals, Primary Health Centers, Special Schools for Deaf, Inclusion Schools and/or under the ongoing National Program on Prevention and Control of Deafness. They are designated as “Speech and Hearing Assistants”. The completion of this course also allows these candidates to gain lateral entry into the graduate level BASLP program.

The entry requirements for this Diploma Program are 10+2 level courses with majors in science
subjects in the age above 17 years. The medium of instruction is English/Hindi or other regional languages. The prescribed course content covering six subjects extends over 400 hours. As recommended by Rehabilitation Council of India (RCI), it contains 40% of total number of working hours on theory and 60% of the time on practical and clinical work. There are prescribed rules and regulations on the designation and teaching experience of the staff, minimum space requirements and equipments or materials required to start or run this program.

For example, it is mandated that the mode of teaching must be in the form of classroom lectures/demonstrations, virtual classes through distance mode supplemented by handouts, manuals, brochures, checklists, proforma, audio-visual tools with supervised clinical practice. There are minimum requirements to be guaranteed by every centre with regard to appointment of at least two lecturers in audiology/speech language pathology with graduate/post graduate level educational qualifications apart from visiting staff as one each clinical/rehabilitation psychologist and, special education teacher. There are minimum requirements of space with specified dimensions for at least one class room, audiometric room, staff/office room, group therapy room, earmould lab/cum hearing aid workshop, library and two individual therapy rooms respectively. The minimum requirement of equipment/materials include an audiometer, hearing aids of all makes and models, speech trainer, hearing aid repair kit, group hearing aids, sound recorders with CDs and cassettes, therapeutic toys, auditory trainers, models of the ear and larynx, etc. A summary table on prescribed vis-à-vis availability matching of staff, materials, equipments, infrastructure and human resources across sample centers during the period of this study (2007-08) as verified by on site/field inspection by one of the investigators is given under table one.

The DHLS Program is currently being run at 30 centers across the country including the host center (AIISH, Mysore) in the year 2007-08.

With the commencement of DHLS Program through virtual mode at AIISH, Mysore; it becomes pertinent to initiate a simultaneous process evaluation of its efficacy and equivalence with the traditional modes of instruction. Such an evaluation is likely to throw light on the relative merits and demerits of both these modes of instruction as also they may offer useful suggestions for any needed improvisation in the ongoing program. It was the aim of this study to undertake a process evaluation of DHLS program conducted through real vis-à-vis virtual modes of instruction at various centers across the country.

Method

The present study combines the use of a cross sectional multi-group comparison design along with a component of survey & tool development embedded within it.

Sample:

FOUR centers across various zones in the country that run the DHLS Program under the recognition of RCI along with the FOUR study centers under the virtual mode from AIISH, Mysore, were chosen as the target institutions for this multi-centered study. The host center (AIISH, Mysore) may be viewed as a unique entity blending both the features of real and virtual centers since the students are located in front of the teacher as also they can interact and are affected by the under-camera factors that influence participants from the other virtual centers.

Tools & Materials:

Evaluation is recognized as a dynamic scheme for assessing the strengths and weaknesses of programs, policies, personnel, products and organizations to improve their effectiveness (American Evaluation Association, 2002). Process evaluation describes and assesses program materials and activities. Outcome evaluation studies the immediate or direct effects of the program on participants. Impact evaluations look beyond the immediate results of policies, instruction or services to identify long term as well unintended program effects. Regardless of the kind of evaluation, all of them use qualitative as well as quantitative data collected in a systematic manner. In the context of
the aims and objectives of this study, it covered three inter-related but distinct components:

(a) Teacher-Pupil Evaluation,
(b) Technology Evaluation, and
(c) Outcome Evaluation

All these components were covered through development of appropriate measurement tools and materials. The following measuring instruments were developed as part of this endeavor:

(a) **Institution & Infrastructure Profile**

This format contained questions to elicit information on or about the participating institution. Some of the included questions related to title of the institution, whether government or private, date of

<table>
<thead>
<tr>
<th>Sl. No</th>
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<th>PRESCRIBED PER CENTER</th>
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<td></td>
<td>Speech Therapist/Audiologist</td>
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<td></td>
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<td>-</td>
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<td></td>
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<td>C</td>
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<tr>
<td></td>
<td>Staff/Office Room</td>
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<tr>
<td></td>
<td>Group Therapy Room</td>
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<tr>
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<td>Ear Mould Lab/Hearing Aid Workshop</td>
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<td>TEACHING PRACTICES</td>
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<td>Lectures/Supervisor</td>
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<td>OHP/PP Presentations</td>
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<td>Checklists/Scales</td>
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<td>Yes</td>
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<td></td>
<td>Supervised Clinical Practice</td>
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<td></td>
<td>Study Manuals</td>
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<td>Yes</td>
</tr>
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</table>

Table 1: Prescribed vis-à-vis Availability Matching for Staff, Materials, Equipments, Infrastructure & Human Resource across Centers (2007-08)
establishment, objectives and activities, funding, manpower development courses being run, staff strength and patterns in terms of administrative, technical, professional and part-time, date of commencement of DHLS course, student strength, earlier history of pass-outs, space available, infrastructure, costs, etc.

(b) Teacher-Pupil Evaluation Profiles

This format had questions related to individual teacher-student characteristics in the context of traditional classroom and DL teaching procedures. Depending on the background of the given sample, individual teachers and students were administered this Likert type rating scales for responses on individual items. Part A of this questionnaire related to characteristics of the individual teachers (to be blind rated by sub-sample of students), such as, extent or depth of their knowledge, competency in expressive language, approachability through the medium of their instruction (either real or virtual), clarifications or explanations to be able to seek or receive, maintenance of class controls, supervisions possible or otherwise, etc. Part B of this questionnaire comprised of items related to pupil features (to be blind rated by a sub-sample of teachers/supervisors), such as, their classroom participation, ability to ask or answer questions, complete assignments, supervision by distant/remote or near, communicability, responsiveness of pupils, spontaneity, classroom milieu, feeling of familiarity-unfamiliarity, approachability, visibility, convenience for monitoring, etc. In in-house 2-week test retest reliability exercise revealed a correlation coefficient of 0.87 and another inter-rater reliability coefficient between two investigators as 0.91 respectively. Face validity for the instrument was established by circulation between the authors and was found to be high.

(c) Technology Evaluation

The sample of teachers-pupils exposed to virtual format of instruction alone was subjected to this evaluation by means of a rating scale and covering on the technological aspects of the program. Queries covered details on the ease or difficulties in operating the electronic gadgets, need or availability of technical assistance at hand, trouble shooting, etc. A 2-week test retest reliability exercise revealed a correlation coefficient of 0.71 and concurrent validity between two groups of respondent sub-sample was found to be 0.79.

(d) Outcome Evaluation

This evaluation was carried out in terms of the comparative final examination results of the students across all the centers after completion of their training program. Outcome or summative evaluation in terms of job placements of the successful candidates at the end of this program across all training centers, although initially planned could not be taken before the end of this pilot study. Likewise, cost benefit evaluation in terms of monetizing input-output benefits from this program is another ongoing exercise which will be reported as part of another related study.

Procedure:

Data collection involved visiting or securing filled in questionnaires of respective respondents from four virtual centers (Mumbai, Manipur, Puducherry and Delhi) as well as five regular centers (Pune, Bhopal, Puducherry, Kolkata and Mysore) across the country. This was carried out after ascertaining that the students as well as teachers have familiarized with each other at least over a period of three months from the startup date of their DHLS program.

Results & Discussion

The results of the study are presented under the following discrete but related headings:

(a) Pupil Evaluation of Teachers / Supervisors

(b) Teacher/Supervisor Evaluation of Pupils

(c) Pupil Evaluation of Technology

(d) Teacher/Supervisor Evaluation of Technology

(e) Outcome Evaluation of Results in Final Examinations

(a) Pupil Evaluation of Teachers/ Supervisors

The results on pupil evaluation of teachers/supervisors (Table 2) shows mean total score of 85.49 (SD: 13.6) for staff from virtual centers as compared to a slightly higher score of 94.33 (SD: 7.94) given by students for teachers/supervisors of actual/regular centers. The differences were compared using Mann-Whitney U Test revealed no statistically significant differences for the teachers/
supervisors across both categories of training centers (p: >0.05).

An analysis of individual ratings by students from different centers shows that the highest scores are given by students from Delhi virtual center (Mean: 99.02; SD: 3.06) followed by Pune (regular center) (Mean: 98.97; SD: 0.91), Bhopal (regular center) (93.40; SD: 5.97) and so on. The lowest score ratings are given by students at Manipur virtual center (Mean: 78.64; SD: 6.74) for their teachers and supervisors.

The specific items on which teachers/supervisors were rated ‘highly satisfactory’ by pupils included their ‘extent or depth of knowledge in the subject’, ‘competency in expressive language’, ‘updates or recent information on the subject’, ‘clarifications/explanations for doubts or queries’, ‘lecture presentations’ and ‘use of audio visual aids’, ‘summarizing or paraphrasing’, ‘dressing and general present ability’, ‘interest and involvement in class’, etc. The items on which was rated as ‘not satisfactory’ were related to ‘approachability or accessibility as a person’, ‘maintenance of class discipline/controls’, ‘intelligibility of teacher’s voice’, etc.

(b) Teacher/Supervisor Evaluation of Pupils:

Conversely, the results of teacher/supervisor evaluation of students (Table 3) shows mean total score of 73.56 (SD 11.85) for pupils from virtual centers as compared to a slightly higher score of 76.00 (SD: 14.92) given by teachers/supervisors of actual/regular centers with no statistically significant differences (p: >0.05).

An analysis of individual ratings by teachers from different centers shows that the highest scores are given by six teachers for students from Pune (regular center) (Mean: 98.96; SD: 0.94) followed by the virtual center in Puducherry (Mean: 80.63; SD: 12.57), virtual center in Mumbai (75.21; SD: 14.06) and so on. The lowest score ratings are given by teacher/supervisors at the regular center in Kolkata (Mean: 61.00; SD: 8.38) for their students in the DHLS program. However, for this sub section, it must be noted that six teachers from virtual centers are the same as compared to different teachers/supervisors for students in the actual/regular centers. Therefore, comparison of teachers/supervisors across all centers may not be tenable as it cannot be done in case of students from these different centers.

The specific items on which students were rated as ‘highly satisfactory’ by teachers included their interest and involvement in class, class discipline, attendance, punctuality and regularity, attitude to seek guidance, notes taking, etc. The items on which was rated as ‘needs improvement’ were responsiveness of the students, flexibility, adaptability or ability to change to presentation, openess or free from Inhibition, seeking clarifications/explanations for doubts or queries, interactions between and within students, communicability, asking or answering questions, spontaneity, etc. There were individual differences between the actual content on these ratings about students from different centers. For

<table>
<thead>
<tr>
<th>Type of Center</th>
<th>Location</th>
<th>N</th>
<th>NS</th>
<th>NI</th>
<th>S</th>
<th>HS</th>
<th>Mean Score*</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual</td>
<td>Mumbai</td>
<td>18</td>
<td>0</td>
<td>3.6</td>
<td>47.6</td>
<td>48.9</td>
<td>86.33</td>
<td>10.18</td>
</tr>
<tr>
<td>Virtual</td>
<td>Manipur</td>
<td>108</td>
<td>0</td>
<td>11.2</td>
<td>63.0</td>
<td>25.8</td>
<td>78.64</td>
<td>6.74</td>
</tr>
<tr>
<td>Virtual</td>
<td>Puducherry</td>
<td>103</td>
<td>5.4</td>
<td>14.6</td>
<td>35.0</td>
<td>45.0</td>
<td>79.92</td>
<td>16.15</td>
</tr>
<tr>
<td>Real</td>
<td>Delhi</td>
<td>96</td>
<td>0</td>
<td>0.2</td>
<td>3.6</td>
<td>96.3</td>
<td>99.02</td>
<td>3.06</td>
</tr>
<tr>
<td>Real</td>
<td>Pune</td>
<td>150</td>
<td>0</td>
<td>0</td>
<td>4.1</td>
<td>95.9</td>
<td>98.97</td>
<td>0.91</td>
</tr>
<tr>
<td>Real</td>
<td>Bhopal</td>
<td>42</td>
<td>0.1</td>
<td>2.8</td>
<td>20.6</td>
<td>76.6</td>
<td>93.40</td>
<td>5.97</td>
</tr>
<tr>
<td>Real</td>
<td>Pondicherry</td>
<td>50</td>
<td>0.3</td>
<td>4.9</td>
<td>60.3</td>
<td>34.5</td>
<td>82.24</td>
<td>10.89</td>
</tr>
<tr>
<td>Real</td>
<td>Kolkata</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>15.8</td>
<td>84.2</td>
<td>96.06</td>
<td>2.90</td>
</tr>
<tr>
<td>Real</td>
<td>Mysore-Host</td>
<td>144</td>
<td>0.1</td>
<td>1.1</td>
<td>22.5</td>
<td>76.3</td>
<td>93.75</td>
<td>7.07</td>
</tr>
</tbody>
</table>

(Mann Whitney U Test: Z: 0.98; p: >0.05; NS); KEY: NS: Not Satisfactory, NI: Needs Improvement, S: Satisfactory, HS: Highly Satisfactory; * Calculated by the total of all 25 ratings out of 100 and converted to percentage)
example, if ‘openness’ an ‘free from inhibition’ and ‘communicability’ was rated ‘not satisfactory’ for students from one center, it was ‘poor notes taking behavior’ and ‘asking or answering questions’ which was rated on the same lines at another center. The students at the host center (AIISH) attended classes in the video conference room. They were a part of the whole group of students in the other virtual centers. The overall results on student evaluation of the video-conferencing technology (Table 4) across all four centers (N: 66; Mean: 80.20; SD: 13.49) as compared to similar evaluation from the participating students at the host center (N: 16; Mean: 91.15; SD: 9.73) alone shows a favorable overall mean score against similar ratings from virtual centers at Delhi (N: 16; Mean: 88.85; SD: 10.46), followed by Mumbai (N: 3; Mean: 76.11; SD: 3.47), Puducherry (N: 13; Mean: 73.72; SD: 11.39) and least ratings by students from Manipur (N: 18; Mean: 68.15; SD: 7.11) respectively.

This implies that Manipur located farthest in the north-east reported greatest dissatisfaction and glitches with video conferencing technology compared to all the other centers across the country. A Kruskal Wallis H test run through these findings showed significant differences between the evaluation by students from different virtual centers on or about the technology (p: <0.001). Further, to study pair wise differences, Mann Whitney U Test was administered between each pair. As a result, significant differences were observed between AIISH hosting center and all other virtual centers except Delhi (p:<0.05). This implies that pupil rating of their experience with video conferencing technology is high and similar for Delhi and the AIISH hosting center, while the mean scores of other virtual centers at Mumbai, Manipur and Puducherry are relatively lower and cluster together (p: <0.001). It must be reiterated that the host center (AIISH-Mysore) (N: 16; Mean: 91.15; SD: 9.73) with the highest score must be viewed as an odd one out because its

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>N</th>
<th>Teachers Responses towards Pupils</th>
<th>Mean Score*</th>
<th>Standard Deviation</th>
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</thead>
<tbody>
<tr>
<td>Virtual</td>
<td>Mumbai</td>
<td>6</td>
<td>NS: 0, NI: 19.2, S: 60.8, HS: 20.0</td>
<td>75.21</td>
<td>14.06</td>
</tr>
<tr>
<td></td>
<td>Manipur</td>
<td>6</td>
<td>NS: 0, NI: 34.2, S: 61.7, HS: 4.2</td>
<td>67.50</td>
<td>8.22</td>
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<td></td>
<td>Puducherry</td>
<td>8</td>
<td>NS: 0, NI: 12.5, S: 52.5, HS: 35.0</td>
<td>80.63</td>
<td>12.57</td>
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<tr>
<td></td>
<td>Delhi</td>
<td>6</td>
<td>NS: 0, NI: 30.8, S: 64.2, HS: 5.0</td>
<td>68.54</td>
<td>7.64</td>
</tr>
<tr>
<td></td>
<td>Pune</td>
<td>6</td>
<td>NS: 0, NI: 0, S: 4.2, HS: 95.8</td>
<td>98.96</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Bhopal</td>
<td>5</td>
<td>NS: 0, NI: 24.0, S: 50.0, HS: 22.0</td>
<td>72.75</td>
<td>10.31</td>
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<tr>
<td>Real</td>
<td>Pondicherry</td>
<td>5</td>
<td>NS: 5.0, NI: 20.0, S: 54.0, HS: 21.0</td>
<td>72.75</td>
<td>14.64</td>
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<tr>
<td></td>
<td>Kolkotta</td>
<td>5</td>
<td>NS: 6.0, NI: 45.0, S: 48.0, HS: 1.0</td>
<td>61.00</td>
<td>5.26</td>
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<tr>
<td></td>
<td>Mysore-Host</td>
<td>9</td>
<td>NS: 1.7, NI: 13.9, S: 73.9, HS: 10.6</td>
<td>72.78</td>
<td>8.38</td>
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</table>

(Mann Whitney U Test: Z: 0.576; p: >0.05; NS); KEY: NS: Not Satisfactory, NI: Needs Improvement, S: Satisfactory, HS: Highly Satisfactory; *Calculated by the total of all 15 ratings out of 60 and converted to percentage)

Table 3: Teacher/Supervisor Evaluation of Pupils

(a) Pupil Evaluation of Technology

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>N</th>
<th>Response of Pupils towards Technology</th>
<th>Mean Score*</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
<td>Virtual</td>
<td>Mumbai</td>
<td>3</td>
<td>NS: 0, NI: 4.4, S: 86.7, HS: 8.9</td>
<td>76.11</td>
<td>3.47</td>
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<tr>
<td></td>
<td>Manipur</td>
<td>18</td>
<td>NS: 1.5, NI: 34.8, S: 53.3, HS: 10.4</td>
<td>68.15</td>
<td>7.11</td>
</tr>
<tr>
<td></td>
<td>Puducherry</td>
<td>13</td>
<td>NS: 6.7, NI: 25.1, S: 34.9, HS: 33.3</td>
<td>73.72</td>
<td>11.39</td>
</tr>
<tr>
<td></td>
<td>Delhi</td>
<td>16</td>
<td>NS: 2.5, NI: 5.8, S: 25.4, HS: 66.3</td>
<td>88.85</td>
<td>10.46</td>
</tr>
<tr>
<td>Actual</td>
<td>Mysore-Host</td>
<td>16</td>
<td>NS: 1.3, NI: 2.9, S: 25.8, HS: 70.0</td>
<td>91.15</td>
<td>9.73</td>
</tr>
</tbody>
</table>

(Kruskal Wallis H Test: X²: (4): 36.192; p: <0.001; VHS); KEY: NS: Not Satisfactory, NI: Needs Improvement, S: Satisfactory, HS: Highly Satisfactory; *Calculated by the total of all 15 ratings out of 60 and converted to percentage)

Table 4: Student Evaluation of Technology
students share the characteristics of, both, real as well as virtual centers.

The specific kind of problems reported by students as ‘needs improvement’ are related to ‘operation of video conference equipments’, ‘electricity and availability of power’, ‘frequency of mechanical breakdown’, ‘intelligibility of teachers voice’, ‘clarity of teachers image or power point presentations’, ‘access to recorded versions’, ‘overall audio/video quality’, ‘visibility of writing on electronic board’, ‘spontaneity and naturalness of classroom situation’, etc.

(d) Teacher/Supervisor Evaluation of Technology

The overall results on teacher/supervisor evaluation of the video-conferencing technology (Table 5) across all five centers (N: 35; Mean: 73.76; SD: 10.43) is lower than student evaluation of the same (N: 66; Mean: 80.20; SD: 13.49). This implies that, on an average, teachers experience greater problems or glitches related to the use of this technology than the recipient students. The specific kind of problems reported by teachers/supervisors are related to ‘operation of video conference equipments’, ‘electricity and availability of power’, ‘frequency of mechanical breakdown’, ‘intelligibility of students voice’, ‘clarity of their images’, ‘comfort level of video conference’, ‘spontaneity and naturalness of classroom situation’, etc.

A Kruskal Wallis H test run through these findings on technology evaluation by the same teacher/supervisors for different virtual centers reveals statistically significant differences (p: <0.001). Further, pair wise differences were studied on Mann Whitney U Test to once again find significant differences between hosting center and all other virtual centers except Delhi (p: <0.05). This implies that teacher ratings of their experience with video conferencing technology is high and similar for Delhi and hosting center, while the mean scores of other virtual centers at Mumbai, Manipur and Puducherry are relatively lower and cluster together (p: <0.001).

(e) Outcome Evaluation of Results in Final Examinations

Outcome evaluation was carried out in this study only in terms of the comparative final examination results of the students across all the centers following the completion of the training program through virtual mode as against those students for the DHLS program on actual/regular mode (Table 6). An analysis of the findings reveal that while the number of students who took the final DHLS examinations (2007-08) were close to identical for actual/regular centers (N:51) and virtual centers (N:54), there are greater number of ‘distinctions’ (N:3; 6%) as well as ‘failures’ (N:20; 37%) from the latter centers as compared to the former. There are more students passing in first and/or second division from actual/regular centers than their counterparts from virtual centers respectively. On the whole, however, there appears to be no differences in the eventual outcome of results in final examinations between the two modes of distance learning in the field of communication disorders ($X^2$:2.235; df:3.84; p:>0.05; NS with Yates correction)

Summary & Implications

In sum, it may be inferred from the results of this investigation that, on an average, pupil evaluation of their teachers/supervisors is on the higher side for both actual/regular centers as well as virtual centers.
respectively. This is reciprocated by similar high ratings by teachers/supervisors for their students from both the types of centers although there appears to be slightly lesser scores given by teachers/supervisors for their students than vice versa. In terms of the findings on evaluation of the video-conferencing, teachers experience greater problems or glitches related to the use of this technology than the recipient students. Finally, there appears to be no differences in the eventual outcome of results in final examinations between the two modes of distance learning in the field of communication disorders. It is possible to consider outcome or summative evaluation in terms of job placements apart from only being based on successful performance in final examinations as done in the present study. Likewise, cost benefit evaluation in terms of monetizing input-output benefits is another possible exercise that can be taken as part of another related study. These findings suggest a need to continue a closer and continual monitoring of the scope, functionality, problems, issues and challenges between the traditional and virtual modes of instruction for the DHLS program. It holds promise for expanding this modes of instruction even for higher end programs in the field of communication disorders.

References


communication. *American Journal of Distance Education, 5* (3), 7-19.


