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A STUDY ON ACOUSTICAL ANALYSIS OF LAUGH IN CHILDREN, ADULT FEMALES AND ADULT MALES IN DIFFERENT CONTEXTS

Reshmi Mohanan, Swetha, G., Apala Gupta, & Jyotsana Singh

Abstract

Emotional key called laughter is expressions of happiness that may depend on conditions, situations and mood that are responsible for the different acoustic features, which vary because of glottal source and vocal tract. The study aimed to compare the variation of acoustic patterns of laugh between adult males, adult females and children in different contexts (tickle and humor). The study was carried out between 10 adult males (18-30 years), 10 adult females (18-30 years) and 10 children (3-12 years) with no voice problem and have normal intelligence quotient to understand the humor. Recordings done in a sound treated room without any environmental disturbances and special attention taken for appropriate space for sitting arrangement and placement of microphone and laptop. Stimulus used to elicit laugh were tickle and video clips (i.e., funny videos for adults and Tom and Jerry clips for children) for humor. Results of the study found that in adult males, only $f_2$ and $f_3$ were the parameters that had a high level of significance ($P<0.05$) to differentiate between tickle and humor, while other parameters like $f_0$, $f_1$, pitch max, pitch min and intensity did not get affected in tickle and humor. In adult females, only $f_0$ ($P<0.05$) varied in different laugh context (tickle and humor), but other parameters ($f_1$, $f_2$, $f_3$, pitch max, Pitch min, Intensity) had no level of significance. In children $f_0$, $f_1$, $f_3$, pitch max and intensity played a very important role to distinguish between tickle and humor and rest of the other parameters showed no difference. Children had highest mean formant frequencies secondary to adult females and were least in adult males for laughs elicited by tickle and humor. When tickle and humor were compared based on their mean values, tickle (1396) was higher than humor (1233). Thus various parameters extracted will help in forensic studies and can throw light on various emotional researches.

Keywords: Formant frequencies, Vocal fold length, Gender, Age

Introduction

Laughter is every day, human specific, affective and non verbal vocalization. Laughing is one of the elementary modes of phonic expressions that mostly resembles in all humans. It is considered as the stereotypical and distinctive aspect of positive emotional state of humans. According to Jerome Urbain, Huseyin Cakmak, and Thierry Dutoit (2012), laughter is a key signal in human communication, conveying information about our emotional state but also providing social feedback to the conversational partners. Laughter takes various shapes and depending upon the social interaction and communicative intent of the person involved with its environment. These various types of laughter accordingly affect the acoustics features of laughter. Laughter is characterized by maximally lowered larynx and greatly wide resonators (Luchsinger & Arnold, 1965). Study done on formant characteristics of human laughter by Diana, Darwin, Szameitat and Alter (2011), concludes that an extreme articulation during laughter production, such as wide jaw opening, suggests that laughter can have very high first formant frequencies and formant frequencies show typical gender effects with higher frequencies in female speakers when compared with normal speech production. Provine (1993) recorded laughs in public places like hotels, cinema theatres and drama theatres and has described 1500 different kinds of laughs. Typical laughter has typical /ha/ or /he/ and is of 75 millisecond duration. The time difference between two such sounds is about 210 msec.

Bickley and Hunnicut (1992) examined a small set of laughs and the results indicate that laugh could be described as the sequences of alternating voiced and unvoiced segments. In men and women both, laughter reaches surprisingly high frequencies. Frequency is measured by the rate at which the vocal cords vibrate. Sundaram and Narayanan (2007) remarked that the energy envelop of laughter waveforms oscillates like a physical mass-spring system.

The aim of the study is to compare how acoustic parameters of laugh vary between adult males, adult females and children in different contexts (tickle and humor).
Method

The study has been carried out by selecting and performing recordings on 30 normal subjects, 10 adult males (18-30years), 10 adult females (18-30years) and 10 children (3-12 years). Those subjects were chosen who fulfilled the criteria of no voice problem and have normal intelligence quotient to understand the humor. Each subject’s were requested to visit the clinics of Ali Yavar Jung National Institute of Hearing Handicapped, Northern Regional Centre where suitable recordings could be performed. Recordings were done in a sound treated room without any environmental disturbances, appropriate space for sitting arrangement and placement of microphone and laptop were taken into consideration. Stimuli used to elicit laughter were tickle and humor (video clips). For humor, we used funny videos for adults and cartoon clips for children. Laptop was used to present the video clips for humor, and laughter responses were recorded through digital recorder. Here, a relaxed atmosphere was provided, which could help subjects to elicit a natural laugh in response to the various stimuli. While analyzing in praat 5.3.17 only pure laugh of 3-4sec was taken with a sampling frequency of 44100Hz which was digitized, normalized and cut it into individual laughter sequences.

Following are the steps through which recording and analyzing of stimulus were done:

Step-1: Recordings were done in a sound treated room without any environmental disturbances. Special attention was taken for comfortable sitting arrangement, placement of microphone and laptop, proper lightening was also ensured. A chair with an arm rest, well cushioned was placed, each subject was asked to be seated comfortably for recordings.

Step-2: Proper instructions were given by the examiner to the subject about the task in a clear, concise and meaningful way. Subjects were 10 adult males, 10 adult females and 10 children (including both boys and girls). Recordings of laughter was done by two stimuli “tickle and humor”. In tickle stimulus, tickling was done by one examiner and recordings were done by another examiner. Digital recorder was used to record the pure laughter sequences of children, adult males and adult females.

Step-3: For humor, again same 30 subjects were taken for the recordings of laugh which was elicited by showing funny videos (funny video clips for adults and cartoon clips for children). The stimulus was given for 2-3 minutes and responses were recorded by the digital recorder.

Step-4: All over 60 recordings were done on 30 subjects by using different stimuli in different contexts. Only pure laugh of 3-4seconds was taken and all the words, sentences and other verbal utterances were deleted from the recording. The acoustic analysis of these laugh responses was done by speech acoustic software i.e.; praat 5.3.17 with a sampling frequency of 44100Hz. Acoustic parameters like f0 (fundamental frequency), f1 (first formant frequency), f2 (second formant frequency), f3 (third formant frequency), pitch maximum, pitch minimum and intensity were extracted and compared between these subjects.

Results and discussion

Statistical analysis has been carried out in order to find out the difference between tickle and humor for adult males, adult females and children. t-test was administered to find the difference. It was found that in males, only f2 and f3 were the parameters that had a high level of significance (P<0.05) to differentiate between tickle and humor, while other parameters like f0, f1, pitch maximum, pitch minimum and intensity did not get affected in tickle and humor. In females, only f0 (P<0.05) varied in different laugh context (tickle and humor), but other parameters (f1, f2, f3, pitch maximum, pitch minimum, intensity) had no level of significance. In children f0, f1, f3, pitch maximum and intensity played a very important role to distinguish between tickle and humor and rest of the other parameters showed no difference.

Based on the observations, the overall mean values were 1396, 1323, 779 (tickle) and 1286, 1200, 928 (humor) for children, females and males respectively. Children had highest mean formant frequencies [f0 (399), f1 (996), f2 (2169), and f3 (3339), pitch maximum (420), pitch minimum (230) and intensity (79)], followed by females [f0 (358), f1 (1004), f2 (2135), f3 (3276), pitch maximum (368), pitch minimum (220) and intensity (72)]. Males showed the least values for acoustic parameters [f0 (291), f1 (1616), f2 (1904), f3 (3081), pitch maximum (300), pitch minimum (180), intensity (73)] for laughs elicited by tickle and humor. When tickle and humor responses were compared based on their mean values, tickle (1396) responses were obtained higher than humor (1233) responses.

Statistical analysis tables of acoustic parameters along with the difference between tickle and humor for adult males, adult females and children are shown below.

In this table 1, standard deviation, standard mean
error and mean is taken out, by doing comparison between the tickle and humor stimuli in males.

**Table 1: Group statistics for males**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Aspect</th>
<th>N</th>
<th>Mean</th>
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<td>1616</td>
<td>2325</td>
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<tr>
<td>Pitch</td>
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<td>10</td>
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<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Minimum</td>
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<td>10</td>
<td>169</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Pitch</td>
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<td>480</td>
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<td>463</td>
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<td>85</td>
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In table 2, statistical analysis was done by comparing between the tickle and humor stimuli in males. The statistical analysis (p< 0.05) reveals that there is significant difference between Tickle and Humor. F2 and f3 were significant as compared to other acoustic parameters.

**Table 2: t-test for males**

<table>
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<th>Parameters</th>
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In table 3, standard deviation, standard mean error and mean are taken out, by doing comparison between tickle and humor stimuli in females.

In table 4, the statistical analysis for different acoustic parameters was done by applying T-test to find out the significant difference between the tickle and humor in female, reveals that f0 (p< 0.05) was significant as compared to other acoustic parameter.

**Table 3: Group statistics for females**

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**Table 4: t-tests for females**

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In table 5, standard deviation, standard mean error and mean are taken out, by doing comparison between tickle and humor stimuli in children.

**Table 5: Group statistics for children**

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<tr>
<td>Formant</td>
<td>Tickle</td>
<td>10</td>
<td>3081</td>
<td>100</td>
<td>31</td>
</tr>
<tr>
<td>Frequency f1</td>
<td>Humor</td>
<td>10</td>
<td>2520</td>
<td>357</td>
<td>113</td>
</tr>
</tbody>
</table>

In table 3, standard deviation, standard mean error and mean are taken out, by doing comparison between tickle and humor stimuli in females.
In table 5, standard deviation, standard mean error and mean is taken out, by doing comparison between the tickle and humor stimuli in children (both boys and girls).

**Table 6: t-test for children**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>t-test for equality of means</th>
<th>t</th>
<th>Df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formant Frequency f1</td>
<td></td>
<td>2</td>
<td>12.7</td>
<td>0.04</td>
</tr>
<tr>
<td>Formant Frequency f2</td>
<td></td>
<td>0.5</td>
<td>13.8</td>
<td>0.60</td>
</tr>
<tr>
<td>Formant Frequency f3</td>
<td></td>
<td>4</td>
<td>9</td>
<td>0.00</td>
</tr>
<tr>
<td>Pitch Mean f0</td>
<td></td>
<td>6</td>
<td>18</td>
<td>0.00</td>
</tr>
<tr>
<td>Pitch Minimum</td>
<td></td>
<td>-0.6</td>
<td>18</td>
<td>0.51</td>
</tr>
<tr>
<td>Pitch Maximum</td>
<td></td>
<td>4</td>
<td>9.8</td>
<td>0.001</td>
</tr>
<tr>
<td>Intensity Mean</td>
<td></td>
<td>1.5</td>
<td>18</td>
<td>0.14</td>
</tr>
<tr>
<td>Intensity Minimum</td>
<td></td>
<td>1.5</td>
<td>9.9</td>
<td>0.15</td>
</tr>
<tr>
<td>Intensity Maximum</td>
<td></td>
<td>2</td>
<td>11.9</td>
<td>0.04</td>
</tr>
</tbody>
</table>

In table 6, the statistical analysis for different acoustic parameters was done by applying T-test to find out the significant difference between the tickle and humor in children, reveals that $f_0$, $f_1$, $f_3$, Pitch maximum and Intensity were significant.

**Table 7: Comparison of means of acoustic parameters among children, males and females**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Aspects</th>
<th>Mean of children</th>
<th>Mean of males</th>
<th>Mean of females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formant Frequency F1</td>
<td>Tickle</td>
<td>996</td>
<td>1616</td>
<td>1004</td>
</tr>
<tr>
<td>Formant Frequency F1</td>
<td>Humor</td>
<td>886</td>
<td>788</td>
<td>925</td>
</tr>
<tr>
<td>Formant Frequency F2</td>
<td>Tickle</td>
<td>2074</td>
<td>1904</td>
<td>2135</td>
</tr>
<tr>
<td>Formant Frequency F2</td>
<td>Humor</td>
<td>1956</td>
<td>1324</td>
<td>1944</td>
</tr>
<tr>
<td>Formant Frequency F3</td>
<td>Tickle</td>
<td>3339</td>
<td>3081</td>
<td>3276</td>
</tr>
<tr>
<td>Formant Frequency F3</td>
<td>Humor</td>
<td>2735</td>
<td>2520</td>
<td>3212</td>
</tr>
<tr>
<td>Pitch mean $f_0$</td>
<td>Tickle</td>
<td>399</td>
<td>291</td>
<td>359</td>
</tr>
<tr>
<td>Pitch maximum</td>
<td>Humor</td>
<td>348</td>
<td>248</td>
<td>345</td>
</tr>
<tr>
<td>Pitch maximum</td>
<td>Tickle</td>
<td>174</td>
<td>183</td>
<td>262</td>
</tr>
<tr>
<td>Pitch minimum</td>
<td>Humor</td>
<td>195</td>
<td>169</td>
<td>252</td>
</tr>
<tr>
<td>Pitch minimum</td>
<td>Tickle</td>
<td>517</td>
<td>480</td>
<td>509</td>
</tr>
<tr>
<td>Intensity mean</td>
<td>Humor</td>
<td>449</td>
<td>463</td>
<td>500</td>
</tr>
<tr>
<td>Intensity mean</td>
<td>Tickle</td>
<td>79</td>
<td>73</td>
<td>72</td>
</tr>
<tr>
<td>Intensity maximum</td>
<td>Humor</td>
<td>75</td>
<td>73</td>
<td>74</td>
</tr>
<tr>
<td>Intensity maximum</td>
<td>Tickle</td>
<td>48</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Intensity minimum</td>
<td>Humor</td>
<td>44</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>Intensity minimum</td>
<td>Tickle</td>
<td>89</td>
<td>86</td>
<td>84</td>
</tr>
<tr>
<td>Intensity minimum</td>
<td>Humor</td>
<td>84</td>
<td>85</td>
<td>86</td>
</tr>
</tbody>
</table>

In our study, an overall increment in various spectral characteristics and more significant features seen in children followed by females and then in males for both tickle and humor except for $f_1$ and $f_3$, where males and females had higher values respectively. The reason could be the difference in size, vocal fold membranous length, elastic properties of tissue, and glottal shape among males, females and children (Titze 1989). Diana et al 2009 reported a similar result, where they found an increase in all the formant frequencies including fundamental frequencies in both females and males.

In another study done by Savitri (2000), males formant frequencies for laugh were higher than their habitual frequencies, but females had same habitual and formant frequencies for laugh. Similar findings were obtained in our study with tickle and humour, where females and children’s habitual and formant frequencies were same, but males had higher formant frequencies compared to their habitual frequency. The third observation was that all the acoustical parameters of tickle were higher as compared to humor among all the subjects. This could be because of the increased physical effort like forceful intake of large amount of air, which in turn can affect the laryngeal property of an individual and hence affecting the acoustical parameters.

Diana, Darwin (2011), study reveals that first formant of laughter vowels is characterized by...
exceptionally high frequencies which may be a result of a wide jaw opening or constricted pharynx usually found in "pressed voice". Some of the other researchers also supported the above findings, where he said that reliable depiction of both laryngeal levels is essential because of the likelihood of rapid fluctuations in the control of airflow through the larynx during incidents of laughter. It can also be because of the postural differences in laughter as compared to the normal speech.

**Conclusion**

Laughter is a research subject for many disciplines including emotional, psychological and forensic research of nonverbal speech. We have found that age and gender affects the acoustics of laugh because of difference in size, vocal fold membranous length, elastic properties of tissue, and glottal shape among different subjects according to Titze (1989). We concluded that acoustic parameters obtained by tickle and humor stimuli were higher in children than females and least in males, whereas the overall responses obtained for humor responses were lower as compared to tickle stimuli. It was found that in males ($f_2$ and $f_3$), females ($f_0$) and in children ($f_0$, $f_1$, $f_3$, pitch max and intensity) were the parameters that had a higher level of significance (P<0.05) and played a very important role to distinguish between tickle and humor. It was also observed from the above mean values that children and females had same habitual and formant frequencies, while male had higher formant frequencies compared to that of their habitual frequencies.

The various parameters extracted will help in forensic studies and can throw light on various emotional researches.

**References**


CLINICAL EVALUATION OF SWALLOWING AND DYSPHAGIA MANAGEMENT IN A PATIENT WITH TOTAL MANDIBULECTOMY AND PRIMARY RECONSTRUCTION

1Manju Mohan, P., 2Friji, M.T., 3Dinesh Kumar, S., & 4Deviprasad Mohapatra

Abstract

Dysphagia is an important postoperative problem in patients undergoing mandibulectomy. Mandibulectomy causes limitation of lip and jaw movements and subsequent slowing of oral stage of swallowing. Extensive resection of floor of mouth and bulky flap reconstructions also impair swallowing by reducing pharyngeal mobility and initiation of pharyngeal swallow. Radiotherapy (either pre- or post-op) may cause dryness of the mouth and fibrosis of the tissues which may further hinder swallowing and speech. Swallowing rehabilitation is a specialized area of speech pathology, but in the Indian scenario, practice in the realm of speech and swallowing management of head and neck cancer patients is limited. Efficient diagnosis and time bound goal directed therapy can improve the communication and swallowing problems in patients with total mandibulectomy and reconstruction. This article discusses the issues of swallowing in patients following total mandibulectomy and primary reconstruction that need to be addressed by SLP’s.

Key words: Speech Pathologists, Mendelshon Maneuver, Supersupraglottic Swallow

Introduction

Speech and swallowing deficits are very often seen following the surgical and radiation treatment of head and neck cancer patients due to the disruption of physiologically and anatomically important structures of swallowing. Mandible or lower jaw is important for speech, chewing and swallowing as it provides a platform for the soft tissues that control speech and swallowing.

The extent of surgical resection of the mandible (mandibulectomy) is based on the size, location and depth of mandibular invasion of cancers into the oral cavity as well as the benign characteristic of the lesions involving mandible. Different names for mandibulectomy are used depending on whether all or part of the mandible is removed. Marginal mandibulectomy involves the removal of a part of the mandible without losing the continuity of the bone. On the other hand, segmental mandibulectomy leads to discontinuity of the lower jaw. Total mandibulectomy is the removal of the entire jaw and hemi-mandibulectomy is the removal of one half of the jaw. In addition to mandibulectomy, floor of the mouth resections also become necessary in certain cases for adequate tumor clearance. This affects the mobility of the tongue and often leads to significant morbidity, both in respect of chewing and speech. Continuity of the mandible should be maintained after surgical resection to preserve the balance and symmetry of mandibular function and also for cosmetic integrity.

Case Report

A 66 year old male patient came with the complaint of non-healing ulcer on the lower jaw for the past 6 months. On examination, there was an ulcer-proliferative lesion involving the midline of lower jaw and right side of the floor of mouth with multiple neck nodes palpable. CT scan showed lesion involving the right side of the alveolus with extension to midline and invasion to floor of mouth on right side.

Histopathology report showed moderately differentiated squamous cell carcinoma. The patient initially received a course of radiation therapy of 63.8 Gy over a period of 2 months and...
later received 3 episodes of chemotherapy followed by surgical resection of the tumor.

The patient underwent wide local excision with total mandibulectomy (with preservation of both condyles) for tumor clearance. Reconstruction of the defect was done with free fibula osteocutaneous flap and Pectoralis major myocutaneous flap. After surgery, the patient was fed through naso-gastric (NG) tube during which time assessment for dysphagia and speech deficits was made.

A detailed subjective clinical swallowing examination was carried out along with a thorough oromotor examination. The oromotor examination revealed asymmetry of the lips at rest as well as during repeated movements. Lip closure was inadequate, and was affected more on left side. Difficulty was observed with the oromotor movements associated with cheek and lips. On retraction, the movement was restricted on right side. Patient had trismus with mouth opening of around 2 finger width and post-irradiation sequelae of dry mouth due to reduced salivary secretion. Patient was edentulous as dental extractions were done prior to radiation therapy. Tongue movements were normal. Laryngeal elevation and excursion were limited and volitional cough appeared weak. The bulk of the flap limited the adequate visual and digital inspection of the thyroid notch. After oromotor examination, swallowing was evaluated using different consistencies of food like thin liquids, thick liquids and solids. Patient was given half tea spoon water (thin liquid) which was administered using a spoon and fed by the clinician. There was loss of liquid through the lip corners and following the liquid intake the patient demonstrated spontaneous cough which threw light on the possibility of aspiration of the bolus. Patient failed to push the thick and solid food boluses, which were the other two food consistencies tried, at the oral preparatory stage itself due to severely restricted tongue movements. Thus the patient's poor ability for bolus propulsion, maintaining lip closure and reduced rate of mastication resulted in increased number of swallows per bolus. Overall, the clinical swallowing examination gave the impression of oropharyngeal dysphagia.

Therapy for dysphagia started with counseling the patient about the various techniques and the rationale behind using each of them. To improve swallowing, direct techniques (lingual control exercises, resistance and range of motion exercises for active articulators), compensatory techniques (postural adjustments, diet alterations, and food presentation strategies) and swallowing maneuvers were employed. Direct lingual control exercises, resistance and range of motion exercises for active articulators (lips, tongue and jaw) along with thermal and tactile stimulation were taught to the patient so as to address lip closure, tongue and jaw movement difficulties respectively, and to improve the post radiation/chemo therapy effects on oromotor physiology. Head back position reduces oral transit time and relies on gravity to clear the bolus from the oral cavity (Logemann, 1983). Thin liquid diet was advised as a compensatory technique under bolus control strategy as the patient could not push thicker bolus into the pharynx with his tongue. A head back position (compensatory positional strategy) was advised to facilitate bolus propulsion from oral to pharyngeal level since the spontaneous bolus movement was inadequate. As laryngeal elevation and excursion were restricted, the administration of thin liquids and a head back position was combined with supersupraglottic swallow. The patient was taught supersupraglottic swallow so as to bring the laryngeal inlet to a maximally closed position before swallowing (Logemann, Barbara, Alfred, & Laura, 1997). The patient was initially taught to hold the breath with the open mouth posture which was trained for two days. Next he was taught to bear down while holding the breath to help improve the closure effort and laryngeal excursion. Subsequently patient was trained on dry swallow attempts followed by immediate voluntary coughing which helps to clear the residue present, if any. The supersupraglottic strategy was taught in steps as the patient found it difficult to fully understand and follow the steps in the first sitting. Patient took 3 days to fully understand and use the technique completely.
Shaker exercises were not advised as the floor of the mouth muscles were involved in resection. Instead, Mendelsohn maneuver was recommended to improve the laryngeal elevation during swallow. The Mendelsohn maneuver is reported to improve the tongue base to pharyngeal contact, laryngeal elevation and subsequent opening of the cricopharyngeus muscle (Kahrilas, Logemann, Krugler, & Flanagan, 1991; Lazarus, Logemann, & Gibbons, 1993). Manual push up of the larynx was advised for the patient as he was finding it difficult to feel the laryngeal movements. Use of Mendelsohn Maneuver is also reported to improve the synchronization of pharyngeal swallowing mechanisms and airway closure. This technique can thus compensate for the structural and functional changes in oropharyngeal swallowing mechanism following reconstructive surgery for patients with head and neck cancer (Lazarus, Logemann, & Gibbons, 1993). Thus a combination of direct lingual control exercises, resistance and range of motion exercises for active articulators, thin liquid bolus control strategy, head back positional strategy, supersupraglottic swallow and Mendelshon maneuver were incorporated in dysphagia management for the patient. This highlights that combining various strategies is necessary in any dysphagia management programme. The regular practice of these techniques along with adequate motivation has helped our patient to learn the new swallowing method which enabled him to take oral feeds safely.

Swallowing rehabilitation was carried out for a period of 8 days (12 sessions of 30 minute duration). Following this, the patient could demonstrate safe swallow of thin liquids.

Discussion

Treatment for head and neck cancer usually involves surgery/ radiotherapy or combination of both. This usually results in speech and/or swallowing difficulties (Perry & Frowen, 2006). Although microsurgical reconstruction techniques have improved the quality of mandibular reconstruction and dental rehabilitation, effects on speech and swallowing function is less predictable. The extent of resection and the type of reconstruction are the major variables that would predict the functional outcomes after surgery (Perry & Frowen, 2006). Seikaly, Maharaj, Rieger and Harris (2005) have reported excellent functional outcomes like no significant swallowing difficulty and no instances of aspiration in cases of primary mandibular defects reconstruction with free fibula flap. However, in majority of post-mandibulectomy patients, limitations in the movements of the active articulators results in significant communication impairments and swallowing difficulties. Resection of the floor of mouth and removal of geniohyoid and mylohyoid muscles and bulky flap reconstruction significantly impair swallowing function due to tethering of tongue and increase the risk of aspiration due to reduced laryngeal elevation (Hirano, Kuroiwa, & Tanaka, 1992; Langton, 1992). Radiotherapy may further complicate the swallowing function due to xerostomia and post-radiation fibrosis.

Treatment options should be evaluated and selected based on the functional outcomes and quality of life. In this context, the need to include speech language pathologists to the medical team caring for head and neck cancer patients becomes necessary. In a head and neck cancer patient who has undergone surgery, the long term goals will be to improve the speech of the patient as well as to improve his/her swallowing capability. In addition, speech pathologists can also be consulted to recommend the optimal time for the removal of nasogastric tube and the subsequent initiation of oral feeds. But in our country there is lack of awareness as well as huge scarcity of manpower involved in swallowing therapy. Considering this we have attempted to detail out the subjective clinical evaluation of dysphagia along with its management. In the current patient, dysphagia management goals included were oromotor exercises, thin liquid bolus and head back position along with supersupraglottic swallowing maneuver and Mendelshon maneuver.

Conclusion

Mandibulectomy patients present with different types of dysphagia. Speech Language Pathologists should be sensitized towards the surgical procedure undergone by the patient along with the reconstructive procedures, which will help them in deciding the appropriate combination of strategies to be used for a particular patient. The current study discusses the possibility of pharyngeal dysphagia along with oral dysphagia in patients who have undergone resection of the whole mandible and floor of mouth. Also, the study highlights the necessity of combining swallowing maneuver with head back and thin liquid bolus strategy while advising dysphagia therapy for patients with total mandibulectomy and floor of the mouth resection.

References


COMPARISON OF VELOPHARYNGEAL CLOSURE AND PERCEPTUAL SPEECH CHARACTERISTICS IN INDIVIDUALS WITH SUBMUCOUS CLEFT PALATE

Gnanavel, K., Satish H.V., & Pushpavathi, M.

Abstract

The submucous cleft palate is a congenital condition which is characterized by an abnormal attachment of soft palate muscles to the hard palate. These individuals are at risk for abnormal speech characteristics such as hypernasal resonance, nasal air emission, and articulatory errors. Other symptoms may include persistent middle ear problems and swallowing difficulties. The present study is aimed to study the velar anatomy and function using Cineradiographic procedure and its association with perceptual speech characteristics of individuals with unoperated submucous cleft palate. 10 individuals with submucous cleft palate in the age range of 7 to 18 yrs (7 males and 3 females) were considered for the study. The speech samples consisted of vowels, high pressure words and standardized oral sentences. Right lateral cineradiographic videos were obtained for all the speech samples and were rated by three speech language pathologist for velar anatomy and function. For perceptual analysis of speech, the same samples were audio recorded in a quiet room and were presented to the same judges for perceptual rating. The results showed that all the subjects considered had inadequate velopharyngeal closure (56%). There was significant strong negative correlation for degree of velopharyngeal closure with hypernasality ($r_s=-0.68$) and nasal air emission ($r_s=-0.71$). No significant correlation for speech intelligibility and voice with velopharyngeal closure. Inter judge reliability had a higher internal consistency for all the perceptual speech parameters. The results indicated that both velar function and perceptual speech characteristics provide vital information that will be helpful in diagnosis and management of individuals with submucous cleft palate.

Key words: Submucous cleft palate, Cineradiography, Velopharyngeal closure

Introduction

Submucous cleft palate (SMCP) is a congenital deformity of the soft palate. It is a defect of the muscles attached to soft palate with an undamaged oral and nasal mucosa (Shprintzen, McCall, Skolnick, & Lencoine, 1975). It was first described by Roux (1825) and the incidence was reported to be 1 in 10,000 to 1 in 20,000 of the population (Nasser, Fedorowicz, Newton, & Nouri, 2008). The cardinal symptoms of submucous cleft palate were a transparent region in the midline of the soft palate, a bifid uvula, and a triangular notch at posterior nasal spine (Calnan, 1954). However only 10% of the individuals are symptomatic and all the signs need not to be present for diagnosis of submucous cleft palate (Weatherly–White, Sakura, Brenner, Stewart, & Ott, 1972). Some individuals with SMCP are reported to have speech problems like hypernasal speech, articulation errors, and nasal air emission due to Velopharyngeal Dysfunction (VPD) (Weatherly-White, 1976).

Velopharyngeal dysfunction in SMCP occurs when there is an inadequate velopharyngeal (VP) closure caused due to structural and functional deficit of nasopharynx. The inadequate velopharyngeal closure results in escape of air through the nose during the production of oral pressure consonants which results in inappropriate nasal resonance. The assessment of speech in individuals with VPD is grouped under two major categories such as perceptual and instrumental assessment procedures. Perceptual assessment of speech is an important measure in the diagnosis of velopharyngeal dysfunction beside oral mechanism examination and case history (Trindade & Trindade Junior, 1996; Kummer, Briggs & Lee, 2003). Through perceptual evaluation of resonance in individuals with velopharyngeal dysfunction, assessment can be made for the occurrence of hypernasality, nasal air emission and compensatory articulation during speech production.

The instrumental assessment of velopharyngeal structures includes direct and indirect visualization procedures. The indirect procedures include nasoendoscopy and cineradiography / cinefluoroscopy (Golding–Krushner, Argamaso, & Cotton, et al.1990). Cineradiography is a non-invasive radiologic procedure envisioned to evaluate the ability of velopharyngeal closure. Video recording produces a continuous record of the velopharyngeal mechanism during speech. Cineradiography provides the most accurate measures of velar structure and function. The
measures related to velum that are utilized are pharyngeal depth, velar length, size of the opening, degree of contact during closure. A colloidal barium sulphate, radiopaque material is injected in to the nares to provide contrast in the cinefluoroscopic image. Different angles such as lateral, frontal and basal views can be used in isolation or in combination. The technique is used to evaluate various types of velopharyngeal insufficiency, including cleft palate. Cinefluoroscopy is often performed in addition to surgical preparation in individuals who do not respond to traditional treatment such as speech therapy.

The perceptual, structural, physiological characteristics of the velopharyngeal mechanism and speech characteristics were previously studied by many authors (Calnan, 1954; Dalston & Warren, 1985; Dalston & Seaver, 1990; Witt & D’Antonio, 1993; Baken & Orlikoff, 2000) and they have noted that the relationship between the perceived degree of hypernasal resonance and size of the velopharyngeal gap is nonlinear. The degree of nasality reflects the multifaceted interaction of a number of factors, including articulation; variations in oral, pharyngeal, and nasal cavity size; vocal pitch and intensity; respiratory effort; and the ratio of oral and nasal acoustic impedances (Baken & Orlikoff, 2000). Additional variables that may affect the perception of nasality include articulatory timing (Baken & Orlikoff, 2000); the extent of time the valve is open (Dalston & Seaver, 1990; Warren, Dalston, & Mayo, 1993), and the speaker’s articulatory compensations for the velopharyngeal opening (Watterson & Emanuel, 1981; Folkins, 1985).

Kummer, Curtis, Wiggs, Lee, and Strife (1992) conducted a study to investigate a relationship between velopharyngeal gap size and perceptual speech characteristics of individuals with Velopharyngeal dysfunction. The subjects included eight individuals with hypernasality only, 10 individuals with hypernasality and audible nasal emission devoid of any nasal rustle, and 10 individuals with nasal rustle only. The videofluoroscopic images were analyzed using nine parameters and was correlated with perceptual parameters. The results of the rating showed that velopharyngeal contact and lateral pharyngeal wall movement were significantly different between the two hypernasality groups and the nasal rustle group. These two variables were sensed to be related to velopharyngeal gap size. Based on the differences, it was concluded that individuals signifying hypernasality, with or without audible nasal emission or nasal rustle, had significantly larger velopharyngeal gaps than those with nasal rustle only. This finding suggested that velopharyngeal gap size may be predicted based on perceptual assessment.

Kummer et al. (2003) further studied the relationship of velopharyngeal gap size and characteristics of speech in individuals with velopharyngeal dysfunction secondary to cleft lip and palate. They studied 173 children retrospectively in the age range of 3 to 12yrs. Based on the perceptual rating scale the subjects were further divided into subsections such as subjects without nasal rustle (21), hypernasality with or without nasal air emission (27), hypernasality with nasal air emission (89), hypernasality with nasal rustle (27). The velopharyngeal closure was assessed by using videofluoroscopy and nasoendoscopy. The videos were rated by using rating scale for videofluoroscopic speech studies (Kummer & Neale, 1989). The results exhibited that moderate and severe hypernasality contributed considerably to the prediction of a large velopharyngeal gap size. The nasal rustle contributed significantly to prediction of a small gap size. Perceptual features of speech accurately predicted velopharyngeal gap size for 121 of the 173 individuals (70%). They concluded that if a subject had a moderate or severe hypernasality it helps in predicting greater velopharyngeal gap and the nasal rustle predicts lesser gap.

Dudas, Deleyannis, Ford, Jiang, and Losee (2006) studied the effectiveness of perceptual speech characteristics in predicting velopharyngeal closure. Twenty four children with VPD were included in a retrospective study where all the individuals underwent primary palatoplasty. All the subjects were evaluated for perceptual speech characteristics using the Pittsburgh Weighted Speech Scale (PWSS) and for velopharyngeal structure and function using lateral videofluoroscopy. The results showed that on lateral view the velopharyngeal closure correlated moderately with total scores of PWSS and the phonation scores of PWSS. They concluded that although perceptual speech characteristic provides some clues on prediction of velopharyngeal closure, the videofluoroscopy itself provides some valuable prediction of VPD.

The above studies mostly deal with the study of perceptual speech characteristics such as hypernasality, phonation and nasal air emission’s prediction on velopharyngeal anatomy and function. The subjects they considered were individuals with velopharyngeal dysfunction secondary to repaired cleft palate and further they grouped these subjects based on their speech characteristics. The present study is aimed to investigate the association between velar function and speech characteristics of individuals with submucous cleft palate only. SMCP is a structural
defect of the soft palate, mainly the musculus uvulae and levator veli palatini which attaches onto the palatine bone instead of creating an adequate muscular sling and palatine aponeurosis. The muscle alignment in individuals with SMCP is completely different from that of other types of cleft palate. Hence there is a need to explore the velar function and speech characteristics in individuals with SMCP.

**Aim of the study**

To study the relationship between velar structure and function based on cineradiographic videos with the perceptual speech characteristics of individuals with submucous cleft palate.

**Objectives**

1) To study the velar function and structure using cineradiography in individuals with submucous cleft palate.
2) To study the association between velopharyngeal closure and perceptual speech characteristics such as hypernasality, nasal air emission, voice and speech intelligibility in individuals with submucous cleft palate.

**Method**

**Participants:** Ten individuals with unoperated submucous cleft palate (SMCP) in the age range of 7 to 18 yrs (7 Males and 3 Females) were considered for the present study. The native language of all the subjects was Kannada, a Dravidian language. All the participants were evaluated by Craniofacial Team which included a plastic surgeon, speech language pathologist, psychologist and an orthodontist at Unit for Structural Orofacial Anomalies (U-SOFA), All India Institute of Speech and Hearing (AIISH). All the individuals considered for the study were diagnosed to have velopharyngeal dysfunction and did not have all the traid symptoms of submucous cleft palate. Informal language assessment revealed normal language ability in all the subjects. Individuals with congenital heart defects, syndromic features, hearing impairment and cognitive impairments were excluded from the study. The demographic details of the subjects are shown in Table 1.

**Instrumentation:** The instrument used for Cineradiographic/Cinefluoroscopic evaluation of participants was Siemens Axiom Artis U X-ray system, at Cath lab, Vikram Hospital. All investigations were made with the help of a remote-operated digital C-arm device with an image intensifier of 16-inches and focal spot range of 0.6 to 1.2 mm was considered for the present study.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Age (yrs)</th>
<th>Gender</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>M</td>
<td>SMCP</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>M</td>
<td>SMCP</td>
</tr>
<tr>
<td>C</td>
<td>14</td>
<td>M</td>
<td>SMCP</td>
</tr>
<tr>
<td>D</td>
<td>18</td>
<td>F</td>
<td>SMCP</td>
</tr>
<tr>
<td>E</td>
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</tr>
<tr>
<td>H</td>
<td>11</td>
<td>F</td>
<td>SMCP</td>
</tr>
<tr>
<td>I</td>
<td>17</td>
<td>F</td>
<td>SMCP</td>
</tr>
<tr>
<td>J</td>
<td>13</td>
<td>M</td>
<td>SMCP</td>
</tr>
<tr>
<td>Average</td>
<td>12.3 yrs</td>
<td></td>
<td>Submucous Cleft Palate</td>
</tr>
</tbody>
</table>

Cineradiographic images were obtained for the speech study with 30 images per second and were recorded using high-resolution CCD camera warranting an excellent image quality. A DDO function (Digital Density Optimization) spontaneously compensates for various densities. The program integrated for image post-processing optimizes as well as supports diagnosis and additional treatment steps.

**Procedure**

The speech samples consisted of isolated vowels (/a/, /i/, /u/), ten words loaded with high pressure consonants, standardized five oral sentences (Jayakumar & Pushpavathi, 2005). For cineradiographic evaluation, the subject was taken to cath lab and instructed to sit in upright and supine position in a seat placed at centre of the C-arm that is between fluoroscope and image intensifier of Siemens Axiom Artis X-ray system. Before starting this procedure a suspension of colloidal barium sulphate, a radiopaque substance is instilled in the nasopharynx for better visualization of the contrast. The subjects were asked to read the stimulus which was on a white sheet and the procedure was done with a help of radiologist. The obtained x-ray image was amplified by the electronic intensification, making it bright enough to be recorded in the video camera. The radiation exposure for each subject was approximately 2 roentgens. The obtained images were blinded and evaluated by three speech language pathologist (SLP) experienced in the field of craniofacial anomalies by using rating scale for videofluoroscopic speech studies (Kummer et al., 1989).

**Analysis**

Cineradiographic video: The rating scale for videofluoroscopic speech (Kummer et al., 1989) evaluates the structural and functional aspects of velopharyngeal mechanism. The rating scale...
includes subdivisions for velopharyngeal closure, velar length, velar thickness, height of the velum, tongue motion, passavant’s ridge and adenoids. The speech language pathologists were considered as judges. They were blindfolded about the details of the cineradiographic videos and they were asked to rate the video samples based on above mentioned parameters. They were informed to view the videos as many times before rating them.

Perceptual speech samples: For perceptual evaluation speech characteristics such as hypernasality, nasal air emission, voice and speech intelligibility were considered. The stimulus consisted of same high pressure words and sentences spoken by the subjects during cineradiographic evaluation which was recorded through digital audio recorder (Olympus digital recorder, 550M). The audio samples were blindfolded and judged by the same three speech language pathologists after a period of one week after rating the cineradiographic videos. The Henningsson, Kuehn, Sell, Sweeney, Trost-Cardamone, and Whitehill (2008) speech assessment rating scale (0-4) was used for rating the perceptual speech characteristics such as hypernasality, nasal air emission, voice and speech intelligibility.

Ethical consideration: This study was conducted with the written consent of the participants or their parents. Participants were provided with the information in the language he/she is capable of understanding and were explained about the aim, objectives, method of the research and approximate duration of testing.

Statistical Analysis: The mean scores for velar anatomy function and speech characteristics obtained from speech language pathologists were entered in Statistical Package for the Social Sciences software (IBM SPSS version 20) for statistical analysis. To find the association between velopharyngeal closure and perceptual speech characteristics Spearman’s rank correlation co-efficient ($r_s$) was calculated. Interjudge reliability was calculated to find the internal consistency between the judges on procedures used.

Results

The results of this study was explained in the following sections

a) Mean percentage scores of the rating for velar function and perceptual speech in SMCP.

The judges rated cineradiographic videos of different speech samples. The following Figure 1 depicts the few images of the velopharyngeal closure during production of vowels (/a/, /i/) and pressure consonants (/p/, /s/) in individuals with submucous cleft palate.

![Figure 1: Lateral Cineradiographic images of speech production in an individual with submucous cleft palate (a) vowel /a/ (b) vowel /i/ (c) pressure consonant /p/-in /psta/ (d) pressure consonant /s/-in /sadɡa/](image1)

The mean percentage scores of ratings done for cineradiographic videos by three speech pathologists are displayed in the below Figure 2.

![Figure 2: Mean perceptual rating of lateral cineradiographic speech samples in Individuals with SMCP](image2)

[VC = Velopharyngeal Closure, VL = Velar Length, VT = Velar thickness, VH = Velar height, TM = Tongue Motion]

The subdivisions included velopharyngeal closure (55.4%), velar length (37.5%), velar thickness (52.37%), velar height (51.62%) and tongue motion towards normal (56%). Among the subdivisions the velar length was rated as shortest with a lower percentage and tongue movement got the highest rating percentage. And none of the subjects considered for the study got 100% normal velopharyngeal closure as everyone was diagnosed with velopharyngeal dysfunction.

The mean ratings for perceptual speech characteristics such as hypernasality, nasal emission, voice and speech intelligibility of individuals with submucous cleft palate are represented in Figure 3. The rating scale used was
a 4-point rating scale [0=Normal, 1 = Mild,
2=Moderate and 3= severe] given by
Henningsson et al. (2008).

Figure 3: Mean perceptual rating of speech
characteristics in Individuals with SMCP

The subdivisions include hypernasality (2.1),
audible nasal emission (1.7), voice (1.5) and
speech intelligibility (1.6). Among the subsections
hypernasality was reported to have moderate
degree followed by nasal air emission and speech
intelligibility. The least rating was mild degree for
perceptual voice evaluation. And none of
the subjects had normal resonance and nasal air
emission was not present.

b) Relationship between velopharyngeal closure
and perceptual speech In SMCP

To find the association between velopharyngeal
closure and perceptual speech characteristics
Spearman’s rank correlation co-efficient ($r_s$) was
calculated for velopharyngeal closure and each
subdivision of perceptual characteristics such as
hypernasality, audible nasal air emission, voice
and speech intelligibility. The Spearman’s
correlation co-efficient for each subdivision was
tabulated in the Table 2.

Table 2: Relationship between velopharyngeal
closure and perceptual speech

<table>
<thead>
<tr>
<th>Speech</th>
<th>Nasality</th>
<th>Nasal Emission</th>
<th>Voice</th>
<th>Speech Intelligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>-0.687</td>
<td>-0.71*</td>
<td>-0.285</td>
<td>-0.285</td>
</tr>
<tr>
<td>co-efficient</td>
<td>0.289</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P Value</td>
<td>0.028</td>
<td>0.021</td>
<td>0.48</td>
<td>0.424</td>
</tr>
</tbody>
</table>

Correlation is significant at 0.05 levels
The results showed there was significant negative
relationship between degree of velopharyngeal closure
and hypernasality ($p = 0.02 < 0.05$).The association
between velopharyngeal closure and hypernasality was
strong moderate correlation ($r_s =0.68$) it was
represented in the Figure 4.
Figure 7: Relationship between VP closure and speech intelligibility

The significant negative relationship between nasal air emission and velopharyngeal closure at 0.05 levels was observed in Figure 5. When the degree of velopharyngeal closure increased there was a reduction in the degree of audible nasal air emission. But there was no significant difference for other two subsections such as voice (p = 0.48 > 0.05) and speech intelligibility (p = 0.42 > 0.05) in relation with degree of velopharyngeal closure. There was a weak negative correlation for the both subsections which was depicted in the above figures 6 and 7.

c) Inter judge reliability between the judges for perceptual rating scales

Inter judge reliability was calculated between the four judges for rating of velopharyngeal closure and perceptual speech characteristics. Cronbach’s alpha (α), co-efficient of reliability was calculated for each subsections and represented in the Table 3.

Table 3: Interjudge reliability between the judges for VP closure and perceptual speech

<table>
<thead>
<tr>
<th>VP Closure</th>
<th>Hypernasality</th>
<th>Nasal Emission</th>
<th>Voice</th>
<th>Speech Intelligibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach’s alpha (α)</td>
<td>0.860*</td>
<td>0.90***</td>
<td>0.82*</td>
<td>0.83*</td>
</tr>
</tbody>
</table>

*Excellent Internal consistency* *Good Internal consistency*

The results showed that there was higher internal consistency between the three judges for hypernasality and speech intelligibility. There was good inter judge reliability between the ratings of the judges for nasal air emission, voice and velopharyngeal closure.

Discussion

The present study aimed to study the velar structure and function using cineradiography in submucous cleft palate. It also further intended to study its relationship between perceptual speech characteristics such as hypernasality, nasal air emission, voice and speech intelligibility in individuals with submucous cleft palate (SMCP). The results showed that among the speech subsections that were perceptually evaluated the hypernasality and audible nasal air emission were the significant predictors of degree of velopharyngeal closure. And the reliability between the perceptual ratings of the judges had a higher internal consistency for both the perceptual rating scales.

The cineradiographic evaluation, an indirect visualization procedure was used in this study to evaluate the velar structure and function in individuals with submucous cleft palate. The assessment was done in relation to parameters like velopharyngeal closure, velar thickness, velar length, velar height and tongue motion. All the subjects in the present study were found to have reduced velopharyngeal closure because of the velopharyngeal dysfunction (VPD). This may be due to short soft palate which can be related with the previous literature that VPD in submucous cleft palate (Kaplan, 1975). The short soft palate resulted in the reduced velar length which was rated lower than other subsections. The poor velar elevation in SMCP is due to abnormal insertion of the soft palate muscles into the hard palate. This poor muscle orientation leads to VPD (Sommerlad, Fenn, Harland, Sell, Birch, Dave et al., 2004).

The relationship between degree of velopharyngeal closure and hypernasality showed a significant inverse association. The degree of velopharyngeal closure reduced as there was an increase in the hypernasality and this relation was nonlinear. The results of this study were highly in support by the previous studies (Dalston & Seaver, 1990; Witt & D’Antonio, 1993; Baken & Orlikoff, 2000; Kummer et al., 2003; Dudas et al., 2006). This may be relatively due to the relation between impedances of oral and nasal cavity which affects the perception of hypernasality. This association changes with effort, articulatory pattern, the size of the vocal tract, and timing of velopharyngeal closure in connected speech. (Zimmerman, Karnell, & Rettaliata, 1984; Stevens, 1998; Baken & Orlikoff, 2000; Kummer et al., 2003).

Then association between the velopharyngeal closure and audible nasal air emission was
significantly strong and non-linear. As velopharyngeal closure decreases the nasal air emission increases leading to hypernasality (Shprintzen & Golding-Kushner, 1989). This may be again related to the reduced velar length and inadequate oral and nasal coupling. Therefore nasal air emission is considered to be one of the major predictor of velopharyngeal closure in persons with velopharyngeal dysfunction. In contrast there was a weak or poor correlation between perceptual voice and speech intelligibility. But there was negative relationship between voice impairment and degree of VP closure. This may be due to the fact that velopharyngeal gap during speech requires the subjects to place grater phonatory effort for increasing their loudness. The factors that contribute to the weak correlation were as most of the subjects considered were children they are more prone to have enlarged adenoids and vocal nodules.

The weak correlation between speech intelligibility and velopharyngeal closure may be attributed to the type of speech sample used for perceptual rating of this subsection of the rating scale. These results of this subdivision are contradictory to the results obtained for other speech characteristics. The function of velopharyngeal mechanism in connected speech is very complex because of the length of the sample (Kummer et al., 2003). The relationship between velopharyngeal closure and speech intelligibility was nonlinear and difficult to predict its association. In connected speech, the perceptual speech characteristics provided some information in addition to visualization procedures such as videofluoroscopy and nasoendoscopy.

In the present study the results showed that hypernasality and audible nasal air emission were strong predictors of velopharyngeal closure. Although their association was high, there are other factors which influence the velopharyngeal closure. And influence of these factors was more when it is in connected speech. The variables other than VP closure which was discussed previously may influence the perceived quality of resonance and nasal air emission. So along with the examination of velopharyngeal anatomy and function using videofluoroscopy some perceptual cues from the perceptual assessment of speech characteristics would give additional information on the perceived speech quality.

Conclusions

The present study aimed studying the velar anatomy and function using cineradiography and its relationship with perceptual rating of speech characteristics (Henningsson et al., 2008). All the participants had velopharyngeal dysfunction and reduced velar length. The association between perceived speech parameters such hypernasality and nasal air emission had strong correlation with velopharyngeal closure. There was a weak correlation between velopharyngeal closure, voice and speech intelligibility. Thus evaluations of speech and velopharyngeal structure are important components in identification of an individual with VPD. The present study studied the predictors of velopharyngeal closure which further helps in the assessment and management of velopharyngeal dysfunction. The sample size considered for this study is very small and it cannot be generalized for the whole group of individuals with submucous cleft palate. So future research should focus on a larger sample size involving individuals with SMCP. In the present study for rating velar anatomy only right lateral videofluoroscopic images were used. For studying the velopharyngeal sphincter mechanism all the three views such as frontal, basal and lateral view images should be considered for rating.

Acknowledgement

The authors would like to thank Dr. S. R. Savithri, Director, All India Institute of Speech and Hearing, Mysore for permitting us to carry out this study. Also we would like to thank the subjects who participated in this study. This is a part of the ongoing doctoral study.

References


COMPARISON OF TONGUE CONTOURS IN CHILDREN AND ADULTS: A PRELIMINARY ULTRASOUND STUDY

Irfana, M., & Sreedevi, N.

Ultrasound is a safe and non-invasive articulatory technique which tracks the shape of the tongue contours during the production of lingual sounds. Though ultrasound based studies are abundant in European languages, there are dearth of such studies in Indian languages. Kochetov et al (2012) studied lingual stops using ultrasound in native Kannada speaking adults and the results showed distinct tongue shapes for retroflex, dentals, and velars. They also reported that the retroflex consonants were predominantly sub-apical but the tongue body retraction is not an obligatory property of retroflexion. In this perspective, the present study is planned to compare the tongue contours for lingual stops across native Kannada speaking children and adults using ultrasound imaging. A total number of 20 subjects with equal number of children (9-10 years) and adults (23-25 years) participated in the study. The test material were three meaningful Kannada words; /atta/, /aTTa/ and /akka/ incorporating the dental /t/, retroflex/ t/ and velar /k/. For recording the sample, the transducer probe of the Mindray ultrasound 6600 was placed beneath the participant’s chin. The software Articulate Assistant Advanced (AAA) ultrasound module (Version 2.14) was used for analysis. Smooth Spline Analysis of Variance (SS-ANOVA) was used to obtain the difference in the tongue contours. The results showed that tongue contours of children and adults are of similar patterns for the three places of articulation studied, but the overall height of the tongue contour is more in adults especially for the anterior tongue body region. The angle of retroflexion was not prominent in both groups which reveal that retroflex sound production is not always sub-apical. This study augments our understanding about the similarities and differences in tongue dynamics across children and adults and it paves the way to understand better tongue dynamics in communication disordered population.

Key words: Ultrasound, non-invasive, midsagittal tongue contour, Articulate Assistant Advanced, Smooth Spline Analysis of Variance.

Introduction

Ultrasound is one of the imaging techniques to study the tongue movements during speech production. The configuration of an internal articulator like the tongue influences the acoustic characteristics of the sounds produced during speech production. Ultrasound is a safe and non-invasive articulatory technique, and it provides information about the shape of the midsagittal tongue contour, including the root (Stone, 2005; Davidson, 2007; Zharkova, Hewlett & Hardcastle, 2009). It provides a direct representation of tongue movements in speech, and allows for viewing most of the tongue contours during dynamic speech production. Electropalatography (EPG) is also considered as one of the main articulatory techniques that has been used for decades in research and treatment (Gibbon & Lee, 2011), which records the location and size of tongue-palate contact but not the tongue shape. Ultrasound image gives information on tongue contour relatively easily compared to other imaging techniques. Several recent research publications have reported on visual feedback therapy using ultrasound (Bernhardt, Gick, Bacsfalvi, & Ashdown, 2003; Bernhardt, Gick, Bacsfalvi & Bock, 2005; Bacsfalvi, Bernhardt & Gick, 2007) and of qualitative ultrasound analysis of communication disordered population (Bressmann, Radovanovic, Kulkarni, Klaiman & Fisher, 2011).

Ultrasound studies have been conducted in English and in Indian languages like Tamil, Telugu, Kannada and Hindi. Švarný and Zvelebil (1955) studied Telugu and Urdu, where speakers showed a lesser degree of retroflexion for Telugu. Ramasubramanian and Thosar (1971), Balasubramanian (1972, 1982) and Thananjayarajasingham (1976) studied retroflex in Tamil by using complemented palatograms with linguograms and X-ray tracing; their results showed ‘more retroflexing’. Kochetov, Sreedevi, Manjula and Kasim (2012) studied Kannada retroflex, dental and velar sounds using ultrasound. As expected, the results showed distinct tongue shapes for retroflex, dentals, and velars. They also reported that retroflex consonants were predominantly sub-apical but the tongue body retraction is not an obligatory property of retroflexion. Further, overall displacement was greater for the vertical (raising) rather than horizontal (backing or fronting)
movement of the tongue, during the opening rather than closing movement. Bernhardt, Gick, Bacsfalvi and Bock (2005) studied adolescents and adults where they used ultrasound as a feedback method for producing the correct sound. Results showed more of sub-apical appearance of tongue during the production of a retroflex. Song, Demuth, Hufnagel, and Ménard (2013) used ultrasound to study coarticulation during cluster production. Their study revealed that overall, children showed adult-like patterns in tongue curvature but with changes in tongue height. Zharkova (2013) considered two quantitative measures including dorsum excursion index and tongue constraint position index to quantify the ultrasound image of tongue dorsum in cleft palate articulations before and after intervention, to assess the reduction in tongue shape variability after speech therapy. Scobbie, Punnoos and Khattab (in press) compared five liquids in Malayalam based on ultrasound images. They discussed the nature of the distinction between the tap and trill and between the alveolar and retroflex lateral and a fifth consonant /z/ which is a voiced sublamino palatal approximant. They opined that ultrasound is better than any other articulatory techniques and that ultrasound images revealed that rhotic /r, r/ and laterals /l, /l/ had relatively simple dynamic movement and liquid /z/, more complex blade motion.

The present study aimed to investigate the dynamic aspects of the tongue during the production of retroflex, dental and velar stop contrasts in Kannada. Investigative studies are very few across different places of articulation in Indian languages and are mostly limited to selected contrasts produced by single speakers of languages such as Hindi, Tamil, Telugu and Malayalam. Though Kochetov et al (2012) compared tongue shapes of retroflex with dental and velar sounds; they considered only adults as subjects. In this perspective, the present study aimed at comparing the dynamic features of the tongue for dental, retroflex and velar stop contrasts across children and adults in Kannada using ultrasound imaging technique.

**Method**

**Participants:** A total number of 20 subjects with equal number of children and adults participated in the study. All the participants were native speakers of Kannada and were not known to have any diseases or disorders. Children were in the age band of 9-10 years and adults, between 23-25 years of age, with equal number of males and females. Participants were included for the study after oral mechanism examination.

**Material:** The test material consisted of three meaningful words including stops in three different places of articulation including dental /t/, retroflex /T/ and velar /k/. The words were /atta/, /aTTa/ and /akka/; the consonants occurred as geminates and were preceded and followed by vowel /a/. The low vowel /a/ context was chosen as it is considered to have the least possible coarticulatory effect on the consonant. Geminates were used to ensure that the ultrasound system could produce several frames of the consonant constriction duration. Geminates consonants in Kannada are described as twice as long as singletons, at least when occurring after short vowels (Schiffman, 1983).

**Instrumentation:** Mindray ultrasound 6600 connected with PC and installed with the software Articulate Assistant Advanced (AAA) ultrasound module Version 2.14 was used for the analysis with 60 frames per second. It is synchronized to the audio input with a sample rate of 22050 Hz. Hardware pulse generates a tone frequency of 1000 Hz with beep length of 50 milliseconds to accurate the synchronization. The transducer is a long-handled micro convex probe operating at 6.5 mHz placed beneath the chin of the participant. The sound wave travels upward through the tongue body until it reaches and reflects back downward from the upper tongue surface. The upper tongue surface interface is typically with the palate bone and airway, both of which have very different densities from the tongue and cause a strong echo. For analysis, the software AAA uses the technique ‘fan spline’ which has 42 axes or points. Splines are curves defined by a mathematical function that are constrained to pass through specified points.

**Data collection:** Participants were made to sit comfortably and the test procedure was described to them. They were asked to sip water before the recording to moisturize the oral cavity facilitating better ultrasound images. The transducer probe placed beneath the chin was smeared with ultrasound transmission gel (Aquasonic 100) for better tongue imaging. The probe was fastened by stabilization headset (Articulate Assistant Advanced) to reduce the artifacts because of head movement. For recording the speech sample, a headphone (iballi 333) was used. Previously prepared stimulus list was presented visually on the computer screen to the participant and three repetitions of each prompt were considered for further analysis. Thus, nine utterances were recorded from each participant including three repetitions of three target samples. A total of 90
utterances were collected from both groups including males and females and a total of 180 utterances were recorded for the study ((5+5= 10*9 = 90*2 = 180) including both children and adults. Figure 1 is an ultrasound image of a child’s tongue contour. The lower edge of the bright white curve is the surface of the tongue. The tongue tip is on the left and the black area below is caused by the bone of the chin.

**Analysis:** Fan spline setups were decided for each group and places of articulation, and used respectively since children’s tongue contour requires narrow fan setup and for adult’s it is wider. For dental and retroflex sounds, the fan was more towards the anterior region, and for velars, more towards the posterior region. Semiautomatic contour plotting was used in this study. The three frame images of each utterance were averaged in workspace to minimize the variation. 42 coordinal values of each contour were exported to text document to analyze the difference between two consecutive samples using Smooth Spline Analysis of Variance (SS-ANOVA). SS-ANOVA, a statistical method was used to compare two datasets to determine whether they are significantly different from each other. To describe the tongue contours, the tongue was divided in to three regions- the posterior tongue body, anterior tongue body and the tongue front, if it is visible (Davidson, 2006).

![Ultrasound image of a child's tongue contour](image1.png)

**Figure 1:** Ultrasound image at the consonant dental /t/ from the word /atta/ produced by a child speaker. Left side of the figure indicates the front of the oral cavity and right side shows back of the oral cavity.

The analysis was performed using assist package (Version 3.1.2) of R programming language (Version R 2.15.2; [www.r-project.org](http://www.r-project.org)). Overall, three SS-ANOVA were run for comparing places of articulation across children and adults.

**Results**

On examination of the ultrasound images of adults and children based on SS-ANOVA, the tongue contour, as expected was different for all the three places of articulation, /k/, /T/ and /t/. Tongue contour in children showed more variations compared to adults. Figure 3 shows tongue contours for velar place of articulation for children and adults separately in the word /akka/.

In both groups, contours are of similar pattern but the overall height of the adult’s tongue contour is more compared to children, especially for the anterior tongue body. Tongue front shows much proximity between children and adult tongue contours and posterior tongue body is more towards back for adults compared to children. In addition, a broad tongue contour was present in adults where as children showed narrower appearance.

![Schematic representation of tongue contour divisions](image2.png)

**Figure 2:** Schematic representation of divisions of tongue contour into three regions- the posterior tongue body, anterior tongue body and the tongue front. The vertical (Y) and horizontal (X) scale is in mm.

Figure 4 shows the comparison between children and adults tongue contour for the production of retroflex in the word /aTTa/. The pattern of tongue shape is similar for both groups but for the height of the tongue, which is more in adults. Tongue front is comparatively high in children, anterior and posterior body of tongue lowered compared to adult’s pattern. As seen in velar production, the broadness of tongue contour was more in adults than children. Tongue curling for retroflex sounds indicated as angle of retroflection was not very evident in both children and adults.
Discussion

Present study aimed at comparing the dynamic features of the tongue for different places of articulation such as dental, retroflex and velar stop contrasts in native Kannada speaking children and adults using ultrasound tongue imaging technique. The results showed different tongue contours for each place of articulation, which is in agreement with the findings of Kochetov et al (2012) who studied Kannada with the same test sample. This implied distinct place features of each sound.

As per the present study, children showed more variations in tongue contours compared to adults, which is in agreement with Zharkova (2013), who studied children with cleft palate. In the present study, the tongue height was more for adults than children which indicates larger size of the oral cavity and tongue in adults. The overall pattern similarity between children and adults across places of articulation indicates motor maturation of active articulators in children. These findings are in agreement with the study of Song et al (2013) who studied adolescent and adults coarticulation. However the present findings need to be confirmed with larger population of children in different languages.

The angle of retroflection was not prominent in the present study and is similar to the reports of Kochetov et al, 2012 in Kannada. Švarný and Zvelebil (1955) also reported that Telugu showed comparatively less retroflexion than Urdu. For Tamil, however, the findings were more of sub-apical palatal constriction for retroflex sounds (Ramasubramanian & Thosar, 1971; Balasubramanian, 1972, 1982; Thananjayarajasingham, 1976). Some of the studies (Bernhardt et al, 2005; Lawson et al, 2011) in English reported sub-apical retroflexion of the tongue. This indicates that the angle of retroflex varies across languages and that retroflexion is apical often rather than sub-apical which may depend on the language spoken.

Conclusions

The current study aimed to compare the dynamic features of the tongue for dental, retroflex and velar stop contrasts in native Kannada speaking children and adults using ultrasound imaging technique. The results showed similar patterns of tongue contours for both groups with the overall height of the adult’s tongue contour being more compared to children, especially for the anterior tongue body region. The angle of retroflexion was not prominent in both groups and indicated that retroflex sound production is not always sub-apical as it is presumed to be. This study augments our understanding about the tongue dynamics, which in due course can be related to the communication disordered population.
References


FREQUENCY OF OCCURRENCE OF PHONEMES IN CALICUT AND ERANAKULAM DIALECTS OF MALAYALAM

1Sreedevi, N., & 2Irfana, M.

Abstract

Malayalam is a Dravidian language primarily spoken in the southwest of India. The knowledge of the frequency of occurrence of phonemes in a language is essential to understand the language structure. This information is useful in the field of audiology and speech language pathology for preparation of assessment tools and treatment of communication disordered population. The present study aimed to compare the frequency of occurrence of various phonemes in Calicut and Eranakulam dialects of Malayalam using conversation samples. Participants were fluent native speakers of Calicut or Eranakulam dialects of Malayalam in the age range of 30 to 55 years. Fourteen conversation samples were recorded with seven groups from each dialect separately for 25-30 minutes. A minimum of 4 to 5 participants were present for each recording. The obtained samples were transcribed using both broad and narrow IPA transcription. Inter judge and intra judge reliability of phonetic transcription was calculated for 10% of the recorded samples. Recorded data was analyzed using the SALT software for obtaining frequency of phonemes. Mean and standard deviation of frequency of phonemes of all the fourteen samples were obtained. The analysis showed that /a/ was the most frequently occurring vowel and /k/ was the most frequently occurring consonant in both dialects. In Calicut dialect, the other most frequently occurring vowels were /a, i, u, a:/ and consonants were /n, t, l/. In Eranakulam dialect /a, i, o, a:/ were most frequently occurring vowels and consonants were /k, n, t, l, m/. The results obtained will help audiologists and speech language pathologists in developing and updating the existing test material for evaluating various communication disorders and also for selection of treatment targets in such population. The study also has implications in linguistics analysis, speech synthesis experiments and development of automatic speech recognition systems.

Key words: Dravidian languages, Malayalam, SALT software, Place of articulation, Manner of articulation

Introduction

In a language, a phoneme is the functional unit of speech that is used to distinguish meaning of a word. Different languages have different phonological systems and the same sound or the same groups of sounds do not necessarily have the same function in one language as in another. Although the dialects are the variations of a single language, they differ in terms of vocabulary, grammar, pragmatics and pronunciation (Siegel, 2010). The frequency of phonemes can vary from language to language and dialect to dialect.

There are about 600 consonants used in different languages around the world and some occur more frequently than others. The most common are the voiceless stops and about 98% of the world’s languages have the three voiceless stops /p/, /t/, /k/. As in consonants, an account of the number of vowels across the world may be difficult as one vowel glide into another easily. The well known forms of English have 14 vowels (Californian English) to 20 vowels (BBC English). Ladefoged (2000) reported /a/ to be the most common vowel followed by /e, i, o, a/ in English. Since 1930s, research has been ongoing on frequency of occurrence of phonemes. As the phonological organization changes across language use and dialects, several studies were carried out in different languages. The studies of phonemes were mostly on the written corpus since 1970s, where the studies mainly concentrated on the frequencies based on sources like newspapers, journals and scripts of plays. Mines, Hanson and Shoup (1978) studied in English based on spoken corpus of 1,03,887 phoneme. Vowel /a/ was the most frequently occurring phoneme followed by /n, t, i, s, r, l, d, e/. The three nasals /m, n, l/ and /ŋ/ accounted for 18.45% of all consonants produced in initial, medial and final positions. Liquids /l/ and /r/ had 6% occurrence in adult American English speech. Stops showed 29.21% of occurrence. Delattre (as cited in Edwards, 2003) included 2000 syllables for his study in English from narration and dramatization and found that the most frequent vowels were /a/, /i/, /u/ and the consonants were /t, n, r, l/.

Within the same language, there are observable differences in frequency of occurrence of
phonemes between written and spoken data. Sandoval, Toledano, de la Torre, Garrote and Guirao (2008) investigated the syllabic and phonemic frequency in spoken and written contexts in Castilian Spanish and reported that /s/ occurred for 8% in spoken and 7% in written contexts. Similarly an Indian study by Bhagwati (1961) calculated the phonemic and morphemic frequencies in Marathi. In Hindi, Ghatage and Madhav (1964) considered the phonemic and morphemic frequencies based on written source of materials and found that vowels were predominant than consonants in Hindi. Ghatage (1994) studied Malayalam phoneme and morpheme frequencies using 1,00,000 words from various written materials. The results showed that vowels /a/ and /I/ were the most frequent phonemes in their corpus. Among consonants, palatal nasal /ŋ/ was most frequent followed by /k/ and /m/ respectively. Based on reports of Kelkar (1994), in Oriya /a/ was the most frequent vowel followed by /a/ and /I/. Among consonants, /t/, /k/ and /n/ were the most frequently occurring phonemes.

In Kannada, the study by Ramakrishna (1962) was based on the written corpus. The results showed that long vowels and aspirated phonemes occurred less frequently. Vowel /a/ was the predominant vowel and consonants such as /t/, dentals /d/ and /t/ are the highly used consonants in conversational Kannada. Jayaram (1985) also studied phonemes in Kannada from news paper sources. Results revealed that /a, l, u, e/ were the frequently occurring vowels and /n, r, d, t, l/ were the frequently occurring consonants. Recently, Sreedevi, Smitha and Vikas (2012) found that in conversational or spoken Kannada, the most frequently occurring phoneme was vowel /a/ followed by /n/, /l/, /i/, /e/, /a/, /d/, /l/, /a/, /g/ and /k/. Phonemes /h/, /s/, /p/, /g/, /d/, /t/, /f/ occurred less frequently and vowels constituted 44.3% and consonants, 55.3% of the conversational data in Kannada.

In Telugu, Kalyani and Sunita (2009) found that consonants (51.21%) were predominant in spoken data than vowels (44.98%). Open vowels were higher in frequency and among consonants, alveolars showed significant occurrence followed by bilabials and velars. Kumar and Mohanty (2012) also found similar results and reported that aspirated stops were less in occurrence in Telugu spoken mode of communication.

There is a wide application for the statistics of phoneme occurrence in a language. These phoneme frequency data is of use in automatic generation of speech for reading machines for the blind. Frequency of phonemes in a language provides a database for phoneme identification process in an automatic speech recognition system.

The frequency of occurrence of phonemes plays important role in the development of linguistic theories in a number of areas including the semantic relations, phonotactics etc. Audiologists use several speech materials in the form of word lists, involving phonetically balanced phonemes in a language for hearing assessment and intervention. As these test materials are language specific, they require most frequently occurring phonemes in that particular language (Egan, 1948; Campbell, 1965). For speech language pathologists, these studies would provide a database for developing speech materials for assessment and selecting treatment goals for various communication disorders; knowledge about the most frequent phonemes help in targeting those phonemes in speech therapy for the hearing impaired which results in better intelligibility of their speech.

The phoneme statistics are also applicable to the fields of linguistics and speech, to teach the language as a foreign language. India is a country with diverse languages. And these languages have different phoneme system and there are different dialects under each language. A database of different dialects with its phoneme frequency will help us to know a language better. The present study investigates the frequency of occurrence of phonemes in Calicut and Eranakulam dialects of Malayalam.

The earlier study on phoneme frequency in Malayalam by Ghatage and Madhav (1994) was based on various written materials. Their findings possibly might have undergone changes as there are many new words, modified and loan words used in daily conversation with time. Sreedevi and Irfana (inpress) studied conversational sample of Calicut dialect of Malayalam and results showed /a/ as the most frequently occurring vowel and /k/ as the most frequently occurring consonant. Frequency of occurrence of phonemes in each dialect varies based on its phonological system. Therefore the present study is aimed to compare the frequency of occurrence of phonemes in conversational speech samples of Calicut dialect (D1) and Eranakulam dialect (D2) of Malayalam.

Method

Participants: Fluent adult native speakers of Ernakulam and Calicut dialects of Malayalam were identified from individual homes and offices and were randomly selected for the study. The participants were in the age range of 30 to 55
years with a minimum of 10 to 12 years of schooling in Malayalam medium of instruction. The participants were devoid of any diseases or disorders.

**Instrumentation:** For recording the conversation samples a digital recorder (Olympus WS 100) was used.

**Procedure:** The data was collected through conversations in controlled natural environments for about 25 to 30 minutes of duration. There were fourteen recordings with seven conversational groups from each dialect. A minimum of 4 to 5 participated in each recording. The digital recorder was kept at equidistance from all the speakers. Participants initiated the conversation without any specific topic being assigned to them. They were instructed to avoid words from other languages and to speak naturally only in Malayalam. They were not restricted from using commonly used loan English words (E.g.: Newspaper, table, school etc). Each of the seven recording sessions in both dialects involved different participants.

**Data Analysis:** The conversation samples were transcribed using International Phonetic Alphabet for Regional languages (Malayalam) by Asher & Kumari (1997) which is provided in Appendix 1. The transcribed data was analyzed using the software Systematic Analysis of Language Transcripts (SALT version 9) for the frequency count. A database of Malayalam phonemes was prepared and saved in the editable standard wordlists of SALT software. The SALT software compares the database and provides the phoneme count based on the loaded phoneme file.

**Inter judge and intra judge reliability:** 10% sample of each conversation recording was subjected to inter judge and intra judge reliability. Three graduate speech language pathologists served as judges for inter judge reliability measures. For intra judge reliability, the 10% of each conversational recording were transcribed and re-analyzed by one of the authors. Cronbach alpha test was applied and a reliability index (α) of 0.86 was obtained for inter judge and 0.91 was obtained for intra judge reliability.

**Results**

The aim of the present study was to compare the frequency of occurrence of phonemes in conversational speech in Eranakulam and Calicut dialects of Malayalam. Following the SALT analysis, it was found that more number of phonemes were recorded from Calicut dialect of Malayalam (83,561) and the number of phonemes recorded from Eranakulam dialect were 74,144. Each recording session elicited more than ten thousand phonemes except two conversational groups (G2 & G3) from the dialect of Eranakulam and the grand total was 1,57,705 phonemes from the fourteen recordings.

The transcribed data consisted a total of 1,57,705 phonemes including both consonants and vowels. Based on the descriptive statistical analysis the mean percentage of occurrence of consonants was more than vowels in both dialects. Mean occurrence of consonants was more in Calicut dialect and vowels were higher in Eranakulam dialect. Figure 1 shows the mean percentage of occurrence of consonants and vowels in both dialects. Occurrences of diphthongs were scanty in both dialects.

**Malayalam**

- Malayalam is a Dravidian language primarily spoken in the southwest of India. According to Summer (2009), it is the official language of Kerala state and Lakshadweep union territory. Within India alone there are over 35 million speakers of Malayalam, not including the other nearly 500,000 speakers outside India. Malayalam has 11 monophongs and 2 diphthongs and 52 consonant phonemes, encompassing 9 places of articulation which are bilabial, labiodentals, dental, alveolar, alveolo-palatal, retroflex, palatal, velar and glottal and 8 manners of articulation which include plosive, nasal, trill, tap/flap, fricative, affricate, central approximant and lateral approximant (Jian, 2010). Based on reports of Asher and Kumari (1997), places of articulations in Malayalam are labials, dentals, alveolars, retroflex, palatal, velars, glottal and manner of articulation include stops, nasals, fricatives, taps/trills, lateral and glides.

- Calicut is a northern district of Kerala where more of Muslim community is lodged. The dialect of Malayalam spoken by mappila Muslims shows deep influence of Arabic language. And the dialect is partially different from mainstream Malayalam.

- Eranakulam is a middle district of Kerala where more of middle class and upper middle class community is accommodated, which has more influence of English.

- SALT, the Systematic Analysis of Language Transcripts, is a freely downloadable computer program to analyze and interpret the language samples from one or more speakers during a conversation. It is providing options to analyze lexical, syntactic, semantic, pragmatic, rate, fluency, and error categories in different languages. It also gives information about the frequency of words, morphemes, phonemes, grammatical categories, etc.
The mean percentage of occurrence of each phoneme is depicted in Table 1. Overall, the mean percentage of occurrences of phonemes was similar in Calicut and Eranakulam dialect. Vowel /a/ occurred most frequently in all the recordings and it occurred for more than 10% in each of the fourteen conversational recordings. Some phonemes such as /d/, /h/, /ch/ showed highly reduced frequency of occurrence.

Table 1: Mean percentage and standard deviation of occurrence of vowels and consonants in Calicut and Eranakulam dialects of Malayalam.

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>Mean % (SD)-D1</th>
<th>Mean % (SD)-D2</th>
<th>Phoneme</th>
<th>Mean % (SD)-D1</th>
<th>Mean % (SD)-D2</th>
<th>Phoneme</th>
<th>Mean % (SD)-D1</th>
<th>Mean % (SD)-D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>/a/</td>
<td>13.83 (1.3)</td>
<td>13.22 (0.59)</td>
<td>/e/</td>
<td>1.59 (0.35)</td>
<td>1.85 (0.39)</td>
<td>/p/</td>
<td>0.78 (0.31)</td>
<td>1.18 (0.22)</td>
</tr>
<tr>
<td>/e/</td>
<td>4.31 (1.74)</td>
<td>5.01 (0.53)</td>
<td>/h/</td>
<td>0.002</td>
<td>-</td>
<td>/ø/</td>
<td>2.49 (0.2)</td>
<td>2.41 (0.49)</td>
</tr>
<tr>
<td>/i/</td>
<td>6.07 (0.24)</td>
<td>6.53 (0.42)</td>
<td>/i/</td>
<td>0.19 (0.11)</td>
<td>0.20 (0.12)</td>
<td>/u/</td>
<td>5.32 (1.07)</td>
<td>5.06 (0.70)</td>
</tr>
<tr>
<td>/u/</td>
<td>0.71 (0.17)</td>
<td>0.60 (0.18)</td>
<td>/u/</td>
<td>-</td>
<td>-</td>
<td>/j/</td>
<td>1.53 (0.7)</td>
<td>1.81 (0.74)</td>
</tr>
<tr>
<td>/a:/</td>
<td>3.46 (0.6)</td>
<td>2.81 (0.25)</td>
<td>/e:/</td>
<td>4.44 (0.5)</td>
<td>4.35 (1.79)</td>
<td>/m/</td>
<td>3.93 (0.5)</td>
<td>3.75 (0.22)</td>
</tr>
<tr>
<td>/e:/</td>
<td>0.64 (0.2)</td>
<td>0.64 (0.8)</td>
<td>/e:/</td>
<td>0.10 (0.10)</td>
<td>0.10 (0.05)</td>
<td>/f/</td>
<td>2.68 (0.31)</td>
<td>2.66 (0.23)</td>
</tr>
<tr>
<td>/e:/</td>
<td>3.75 (0.45)</td>
<td>4.40 (0.42)</td>
<td>/e/:</td>
<td>0.09 (0.06)</td>
<td>0.11 (0.07)</td>
<td>/g/</td>
<td>2.65 (0.34)</td>
<td>2.59 (0.33)</td>
</tr>
<tr>
<td>/a:/</td>
<td>0.88 (0.42)</td>
<td>1.18 (0.16)</td>
<td>/e:/</td>
<td>0.01</td>
<td>-</td>
<td>/l/</td>
<td>4.04 (0.39)</td>
<td>3.79 (0.32)</td>
</tr>
<tr>
<td>/a:/</td>
<td>0.15 (0.07)</td>
<td>0.09 (0.03)</td>
<td>/e:/</td>
<td>4.20 (0.44)</td>
<td>3.88 (0.44)</td>
<td>/l/</td>
<td>2.19 (0.14)</td>
<td>2.61 (0.32)</td>
</tr>
<tr>
<td>/o:/</td>
<td>1.23 (0.49)</td>
<td>1.52 (0.21)</td>
<td>/e:/</td>
<td>0.12 (0.06)</td>
<td>0.03 (0.03)</td>
<td>/v/</td>
<td>1.35 (0.21)</td>
<td>1.11 (0.13)</td>
</tr>
<tr>
<td>/o:/</td>
<td>1.67 (0.39)</td>
<td>1.76 (0.26)</td>
<td>/e:/</td>
<td>0.37 (0.20)</td>
<td>0.27 (0.12)</td>
<td>/g/</td>
<td>0.30 (0.06)</td>
<td>0.27 (0.05)</td>
</tr>
<tr>
<td>/au:/</td>
<td>0.03 (0.02)</td>
<td>0.04 (0.03)</td>
<td>/e:/</td>
<td>0.38 (0.18)</td>
<td>0.07 (0.04)</td>
<td>/l/</td>
<td>0.44 (0.14)</td>
<td>0.36 (0.08)</td>
</tr>
<tr>
<td>/u:/</td>
<td>5.58 (1.24)</td>
<td>5.88 (0.63)</td>
<td>/e:/</td>
<td>3.24 (0.39)</td>
<td>3.89 (0.40)</td>
<td>/j/</td>
<td>0.15 (0.05)</td>
<td>0.11 (0.04)</td>
</tr>
<tr>
<td>/k:/</td>
<td>7.06 (0.75)</td>
<td>5.40 (2.18)</td>
<td>/e:/</td>
<td>0.24 (0.01)</td>
<td>0.01 (0.03)</td>
<td>/l/</td>
<td>1.89 (0.24)</td>
<td>1.76 (0.26)</td>
</tr>
<tr>
<td>/h/</td>
<td>0.02 (0.02)</td>
<td>0.01 (0.01)</td>
<td>/e:/</td>
<td>0.46 (0.10)</td>
<td>0.36 (0.18)</td>
<td>/l/</td>
<td>0.24 (0.12)</td>
<td>0.42 (0.07)</td>
</tr>
<tr>
<td>/g:/</td>
<td>0.21 (0.08)</td>
<td>0.14 (0.06)</td>
<td>/e:/</td>
<td>0.17</td>
<td>0.11 (0.04)</td>
<td>/l/</td>
<td>0.035 (0.06)</td>
<td>0.07 (0.04)</td>
</tr>
<tr>
<td>/h/</td>
<td>0.01 (0.01)</td>
<td>0.01 (0.01)</td>
<td>/e:/</td>
<td>1.48 (0.32)</td>
<td>1.56 (0.38)</td>
<td>/l/</td>
<td>2.01 (0.20)</td>
<td>1.79 (0.12)</td>
</tr>
<tr>
<td>/g:/</td>
<td>0.01 (0.01)</td>
<td>0.01 (0.01)</td>
<td>/e:/</td>
<td>1.48 (0.32)</td>
<td>1.56 (0.38)</td>
<td>/l/</td>
<td>5.53 (0.53)</td>
<td>0.25 (0.11)</td>
</tr>
</tbody>
</table>

*D1-Calicut dialect and D2-Eranakulam dialect
In Calicut dialect, following /a/, the other most frequently occurring vowels were /I, ə, a, e/ and consonants were /ŋ, tʃ, t, l/. In Eranakulam dialect /a, ə, a, e/ were most frequently occurring vowels and consonants were /k, ɡ, t, p, t, l, m/. Occurrences of short vowels were considerably more than long vowels and open vowel /a/ was highly predominant than closed front vowels and back vowels in both dialects. Figure 2 shows the mean percentage of occurrence of long and short vowels.

**Figure 2: Mean percentage of occurrence of long and short vowels.**

Considering the consonants, voiceless velar stop /k/ showed highest percentage of occurrence and this was followed by alveolar nasal /n/ in both dialects. Glottal fricative /h/ occurred the least compared to all other consonants. Figure 3 depicts the mean percentage of occurrence of consonants based on places of articulation.

**Figure 3: Mean percentage of occurrence of consonants based on place of articulation in both dialects.**

Based on manner of articulation, stops showed predominant occurrence followed by nasals, glides, laterals and taps/trills in both groups. Fricatives were the lowest occurring manner of articulation. Occurrences of stops were more and nasals were less in D1 compared to D2. Figure 4 shows the mean percentage of occurrence of consonants based on manner of articulation.

**Figure 4: Mean percentage of occurrence of consonants based on manner of articulation in both dialects.**

Among stops, unvoiced stops were significantly higher in occurrence compared to their voiced counterparts. Occurrence of unvoiced velar consonant /k/ was highest and constituted 7.06% and 5.40% of the total phonemes in D1 and D2 respectively. Occurrence of unvoiced retroflex stop /ɾ/ 4.44% was followed by unvoiced dental stop /ɾ/ in D1. But in D2, the occurrence of unvoiced retroflex stop /ɾ/ was 4.35% followed by unvoiced bilabial stop /p/. Unvoiced palatal affricate /ɾ/ was comparatively reduced in both dialects. Respective voiced counterparts of the above mentioned consonants were highly reduced in all the fourteen recordings. Occurrences of aspirated phonemes were also significantly reduced compared to their unaspirated counterparts. Unvoiced unaspirated stops accounted for 20.52% and 19.37% in D1 and D2 respectively and voiced unaspirated stops occurred for only 1.32% and 1.08% in the conversational corpus of D1 and D2. Voiced aspirated stops showed relatively higher occurrence than unvoiced aspirated stops in both groups. Figure 5 indicates the mean percentage of occurrence of stops in both dialects.

Among fricatives /s, ʃ, ʒ, h/, unvoiced alveolar fricative /s/ occurred predominantly for 1.35% and 1.11% in D1 and D2 data respectively. Glottal fricative /h/ was the least occurring among fricatives (0.15%) in D1 and /ɾ/ was the least in D2 corpus. All six nasal phonemes of Malayalam were present in the corpus with significant percentage of occurrence. Alveolar /n/ occurred significantly (5.32% and 5.06%) followed by bilabial /m/ with 3.75% and 3.75% of occurrence in both dialects. Palatal /ɾ/ occurred less
frequently than other nasal sounds in both Calicut and Eranakulam dialects.

**Mean percentage of occurrence of stops**

![Graph showing mean percentage of occurrence of stops](image)

In the present study among various manner of articulations, stops occurred the highest which is in concurrence with several previous studies in English (Mines et al, 1978) and Indian languages (Jayaram, 1985; Sreedevi et al, 2012; Kalyani & Sunitha, 2009; Kumar & Mahanty, 2012).

Comparing the present study with the earlier studies, nasal dental /n/ was higher in most of the previous studies (Mines et al, 1978 -English; Ghatage & Madhav, 1994 -Malayalam; Jayaram, 1985 & Sreedevi et al, 2012- Kannada). Also the present study observed significantly high occurrence of unvoiced stops compared to their voiced counterparts. There are no earlier reports on such high disparity between unvoiced and voiced stops. Ghatage and Madhav have not commented on the voiced/unvoiced distinctions in Malayalam. The aspirated sounds were minimally present, which is in agreement with all the other studies in Indian languages. This is possibly because; the aspiration feature is rarely used in colloquial conversations though it is phonemic.

**Discussion**

Within the vowel category, /a/ was highly predominant and is concomitant with several earlier studies (Ghatage & Madhav, 1964; in Malayalam; Ramakrishna, 1962; Jayaram, 1985 and Sreedevi et al, 2012 in Kannada, Mines et al, 1978; Sandoval et al, 2008 and Ladefoged, 2000 in English).

The frequency of occurrence of different phonemes in Calicut and Eranakulam dialects of Malayalam were determined using conversational samples collected from fourteen different recording sessions and the results showed that consonants constituted larger part of the total corpus than vowels. In Eranakulam dialect, /a, i, a:, e/ and consonants were /k, n, t, p, t, l/ and in Calicut dialect, the most frequently occurring vowels were /a, i, a, a:/ were most frequently occurring vowels and consonants were /k, n, t, p, t, l/.

**Conclusions**

This research aimed to obtain the frequency of occurrence of phonemes in Calicut and Eranakulam dialects of Malayalam. Results showed some salient findings. Based on descriptive statistical analysis, the mean frequency of occurrence of consonants were predominant than vowels in both dialects. Some of the studies in Kannada (Jayaram, 1985; Sreedevi et al, 2012) and Telugu (Kalyani & Sunitha, 2009) also showed similar findings.


Sreedevi, N., Smitha, N & Vikas, M. D. (2012). Frequency of occurrence of phonemes in Kannada. ARF project. AIISH.


Appendix I
CONSONANT SEGMENTS
International Phonetic Alphabet for Regional languages (Malayalam)
Asher & Kumari (1997)

<table>
<thead>
<tr>
<th>Manner of Articulation</th>
<th>Place of Articulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Labial</td>
</tr>
<tr>
<td><strong>Stops</strong></td>
<td></td>
</tr>
<tr>
<td>Voiceless</td>
<td>p</td>
</tr>
<tr>
<td>Voiceless Aspirated</td>
<td>pʰ</td>
</tr>
<tr>
<td>Voiced</td>
<td>b̪</td>
</tr>
<tr>
<td>Voiceless Aspirated</td>
<td>bʰ</td>
</tr>
<tr>
<td><strong>Fricatives</strong></td>
<td></td>
</tr>
<tr>
<td>Fricatives</td>
<td></td>
</tr>
<tr>
<td><strong>Nasal</strong></td>
<td>m</td>
</tr>
<tr>
<td><strong>Liquid</strong></td>
<td></td>
</tr>
<tr>
<td>Tap/Trill</td>
<td>r, ɾ</td>
</tr>
<tr>
<td>Lateral</td>
<td>l</td>
</tr>
<tr>
<td>Approximants</td>
<td></td>
</tr>
<tr>
<td>Glide</td>
<td>v</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
INVESTIGATION OF VOICE CHARACTERISTICS IN SPECIAL EDUCATORS USING DYSPHONIA SEVERITY INDEX (DSI)

Yeshoda, K., Rajasudhakar, R., Jayakumar, T., Amooya, G., & Deepthi Damodaran

Abstract

Special educators are those who educate children with special needs. They are involved in vocally demanding profession; especially those who deals children with Hearing Impairment and Mental retardation. It is likely that they are vulnerable to develop voice problems in due course. Not many studies have been done to investigate the voice characteristics of special educators working in preschool set up. The objective of the present study was to investigate the voice characteristics of special educators working in preschool, using objective vocal quality measurement (Dysphonia Severity Index, DSI). It is also focused on studying the effect of number of teaching years on DSI. Eighteen special educators who educate special children were included in the study. Among them, thirteen were females and five were males were included in the study. Female participants were further sub grouped based on number of years of teaching experience. Group 1 included teachers having less than 8 years of teaching experience and Group 2 included teachers having more than 8 years of teaching experience. lingWAVES version 2.5 (WEVOSYS German) was used to calculate DSI. The parameters extracted for the calculation of DSI were lowest intensity, highest frequency, maximum phonation time and jitter. Mann-Whitney U test was used to find the effect of gender and number of teaching years. The values of DSI parameters of special educators were within normal limits when compared with non professional voice users except for the highest frequency in female participants. There was no significant difference found between the DSI values of males and females. Years of teaching experience did not have any effect on the parameters of DSI. Teaching children with special needs did not have any effect on the most of the DSI parameters for the special educators in the present study. Further researches on larger sample would yield insight about the voice quality of preschool special educators.

Key words: lowest intensity, highest frequency, maximum phonation time, jitter.

Special educators are those who train children with disabilities (Ysseldyke & Algozzine, 2006). World Health Organizations, International classification of Impairment, Disabilities and Handicaps (1980) defined disability as any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner of within the range considered normal for a human being. A disability would result from a medical, social, or learning difficulty, which may interfere significantly with students’ normal growth and development. Indeed it hinders the ability to profit from schooling experiences or the ability to participate successfully in work activities. The special needs include learning difficulties, communication disorders, developmental disorders, physical disabilities, emotional and behavioral disorders. They may be having a genetic condition which is associated with different forms of brain damage, mental retardation, may have hearing or visual disabilities, or other disabilities. Dealing with these diverse needs, the challenges of special educators are more. Mainly they are engaged in teaching children with special needs. In other words, they form a group of professional voice users who are defined as those who depend on a consistent, special, or appealing voice quality, as a primary tool of trade and those who, if afflicted with dysphonia or aphonias, would generally be discouraged in their jobs and seek alternate employment (Titze, Lemke, & Montequin, 1997). Koufman (1999) suggests four categories of professional voice users. The Elite Vocal Performer, Level I, is an individual for whom even a small abnormality in voice may have dire consequences. Most actors and singers fall into this particular group. The Professional Voice User, Level II, is an individual for whom a moderate degree of voice problem may prevent adequate work performance. Teachers, clergy and lecturers are included in this group. The Non-Vocal Professional, Level III, is an individual for whom voice quality is not a condition for adequate work performance. This group includes laborers and clerks. Special educators can be included under level II of professional voice users for whom a moderate degree of voice problem may prevent adequate work performance.

1Yeshoda, K., Reader in Speech Sciences, All India Institute of Speech and Hearing (AIISH), Mysore, E-mail: k_yeshoda@hotmail.com, 2Rajasudhakar, R., E-mail: rajasudhakar82@gmail.com, 3Jayakumar, T., E-mail: jayakumar82@gmail.com, Lecturer in Speech Sciences, AIISH, Mysore-06, 4Amooya, G., JRF, AIISH, Mysore-06, E-mail: amooyaa021@gmail.com, & 5Deepthi Damodaran, Speech-Language Pathologist, E-mail: deepthidamodaran88@gmail.com
When it comes to preschool special educators, the challenges are still higher since they deal with younger children. Vocal abuse and misuse are considered as contributory factors for developing functional voice disorders like vocal nodules and vocal fatigue (Colton & Casper, 1996). Studies have shown that such diagnoses are common in preschool teachers, and the prevalence of voice problems in them vary from 32% to 72%, based on questionnaires (Axner & Behr, 1995; Sala, Laine, Simberg, Peniti, & Suonpaa, 2001). Fritzell (1996) found that such findings are reported to be more in female preschool teachers.

Sodersten, Granqvist, Ham marberg, and Szabo (2002) investigated preschool teacher's voice during work. In this study, ten normal female preschool teachers (mean age of 33 years) working in 10 Day Care Centers (DCCs) served as subjects. All subjects had different years of work experience and they also dealt with children in different age groups (1-3 years; 4-5 years; 6 years). Two microphones were positioned on either side of the subject's head. A portable Digital Audio Tape (DAT) recorder was attached to the subject's waist. The recordings were made at two instances: before work (baseline) where a standard reading passage was read and during work where spontaneous speech was recorded. Level of the background noise, and also the subjects’ mean fundamental frequency, voice sound pressure level (SPL), and total phonation time were measured. Results revealed that, mean background noise level was 76.1 dBA for the 10 Day Care Centers, which is more than 20 dB higher than what is recommended for speech communication (50–55 dBA). The subjects spoke with higher mean fundamental frequency of 247 Hz compared to the baseline mean fundamental frequency of 202 Hz and an average of 9.1 dB louder at work. Mean phonation time was found to be 17 %which was considered to be high. Thus, it was concluded from the study that preschool teachers have a vocally demanding profession.

Amita (2004) compared vocal demands in primary Vs secondary school teachers. In her study, she considered thirteen preschool and fourteen secondary school teachers in the age range of 20-50 years. A questionnaire was used to obtain self appraisal regarding their voice. Acoustic, aerodynamic characteristics were studied in both groups of teachers. Also, the background noise in class room was measured. The author reported that the secondary school teachers showed increased values for most of the voice parameters. The background noise levels in primary grade classrooms ranged from 78 dB SPL to 88 dB SPL and in secondary grades the existing noise range was 75 dB SPL to 82 dB SPL. Thus, the noise levels in primary grade classes were higher than the secondary grade classes, though significant difference was not found for the background noise levels.

Rajasudhakar and Savithri (2008) investigated working day effect on voice parameters like intensity, frequency, perturbation related and LTAS measures in a 37 year old normal male special school teacher of hearing impaired. Acoustic and aerodynamic measurements were collected at the beginning and at the end of the class. The result revealed an increase in fundamental frequency, jitter, shimmer and reduction in LTAS values at the end of the day. Voicing time (F0 time) was found to be reduced towards the end of the day, indicating the presence of vocal fatigue due to voice loading.

Many studies have reported that teachers are at risk for the development of voice problems and they are commonly reported with having vocal complaints (Russell, Oates & Greenwood, 1998; Roy, Merrill, Thibeault, Gray & Smith, 2004). Severe or frequent occurrence of such voice problems may thus lead to temporary or even permanent inability to teach (Roy, Merrill, Gray & Smith, 2005). Various studies are done in the past to investigate the voice characteristics in teachers using acoustic (Sodersten et. al, 2002; Lindstrom, Ohlsson, Sjoholm & Waye, 2010; Geneid, 2013), perceptual (Boominathan, Mahalingam, Samuel, Dinesh & Nallamuthu, 2012) and aerodynamic measurements (Rajasudhakar & Savithri, 2008).

Wuyts, De Bodt, Molenberghs, Remacle, Heylen, Millet, Van Lierde, Raes, and Heyning (2000) developed an objective multiparameter approach to measure voice quality using Dysphonia Severity Index (DSI). They developed it from multivariate analysis of 387 subjects including males and females. The DSI is based on the weighted combination of set of voice measurements: Maximum Phonation Time (MPT), lowest intensity (I-low), highest frequency (F-high), and jitter. A perceptually normal voice corresponds with a DSI score of +5 whereas a severe dysphonic voice corresponds with a DSI score of -5. Scores exceeding this range are also possible (>+5 or <-5).

Duffy and Hazlett (2004) investigated the vocal quality of 55 training teachers (age range of 21-39 years) using DSI. They were divided into three groups: 23 subjects were in the control group, 20 were in the indirect group and 12 were in the direct group. The vocal performance of the three groups of training teachers were measured at two instances during the one year course: first before the training began, and for a second time after the
first teaching practice. They reported a DSI score of +4.0 (80%), which indicates good vocal quality in 55 student teachers.

Hakkesteegt, Brocaar, Wieringa & Feenstra (2006) investigated age and gender effect on the DSI. The DSI of 118 non smoking adults (69 females, 49 males within the age range of 20-70 years) without voice complaint was measured. They concluded that age has an effect on the DSI value and on its parameters highest frequency and lowest intensity only in females. Whereas they found that gender has no effect on the DSI. It has a significant effect on the parameters highest frequency and maximum phonation time.

Van Lierde, Claeys, Dhaseeleer, Deley, Derde, Herregods, Strybol and Wuyts (2010) used DSI to examine the voice quality of 143 female student teachers (mean age of 20.8 years). The result of the study revealed DSI score of +2.6, indicating a perceptually normal voice for the subjects.

Jayakumar and Savithri (2012) measured DSI parameters in Indian population. One hundred and twenty participants (60 females and 60 males with age range of 18-25) volunteered for the study. The DSI measures were compared with the studies by Wuyts et al (2000) and Hakkesteeg et al (2006). Results of the study showed significant difference between Indian and European population on highest frequency, MPT and DSI values. DSI score was higher in female subjects when compared with male subjects which is contradicting with the findings by western population.

Though studies have been done to investigate voice measures in teachers (Van Lierde et al, 2010; Grillo & Fugowski, 2011) and special educators (Rajasudhakar and Savithri, 2008); but not many studies are done to investigate the objective vocal quality in preschool special educators using DSI. Since special educators are in a profession that places high vocal load, it is hypothesized that they are more prone to develop voice problems eventually. The present study was thus aimed at examining the voice characteristics of preschool special educators using objective multiparameter approach.

Objectives of the study:

- To investigate the voice characteristics in preschool special educators using Dysphonia Severity Index (DSI).
- To investigate effect of gender and number of teaching years.

### Method

**Participants**: Eighteen special educators who educate special children, included for the present study 13 females (age range: 26 to 46 years with a mean age of 33 years) and 5 males (ranging in age from 26 to 37 years with a mean age of 30.2 years) who were working at All India Institute of Speech and Hearing, Mysore. All participants had a minimum of one year of teaching experience. They used their voice for minimum of hours in a day for 5 days in a week. They teach children with hearing impairment, mental retardation, autism, and multiple disabilities. All the teachers were proficient in English. None of the participants in the study had any history of hearing related complaints, neurological, or velopharyngeal problems. None of them complained of having any ear infection at the time of recording. One teacher had undergone Tympanoplasty in early childhood. Among the participants, two females and one male reported of strain in voice when they used their voice for a long period of time.

Female participants were further sub grouped based on years of teaching experience as group 1 (<8 years of teaching experience) and group 2 (>8 years of teaching experience). This was done to study the effect of years of teaching experience on DSI. Details of the participants in the study are given in table 1.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Age/Gender</th>
<th>Years of teaching experience</th>
<th>Mother Tongue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28 years/Female</td>
<td>6</td>
<td>Malayalam</td>
</tr>
<tr>
<td>2</td>
<td>44 years/Female</td>
<td>22</td>
<td>Malayalam</td>
</tr>
<tr>
<td>3</td>
<td>27 years/Female</td>
<td>5</td>
<td>Gujarati</td>
</tr>
<tr>
<td>4</td>
<td>26 years/Female</td>
<td>4</td>
<td>Urdu</td>
</tr>
<tr>
<td>5</td>
<td>35 years/Female</td>
<td>15</td>
<td>Tamil</td>
</tr>
<tr>
<td>6</td>
<td>46 years/Female</td>
<td>20</td>
<td>Kannada</td>
</tr>
<tr>
<td>7</td>
<td>33 years/Female</td>
<td>7</td>
<td>Kannada</td>
</tr>
<tr>
<td>8</td>
<td>35 years/Female</td>
<td>8</td>
<td>Telugu</td>
</tr>
<tr>
<td>9</td>
<td>35 years/Female</td>
<td>7</td>
<td>Telugu</td>
</tr>
<tr>
<td>10</td>
<td>36 years/Female</td>
<td>3</td>
<td>Kannada</td>
</tr>
<tr>
<td>11</td>
<td>27 years/Female</td>
<td>6</td>
<td>Malayalam</td>
</tr>
<tr>
<td>12</td>
<td>32 years/Female</td>
<td>9</td>
<td>Kannada</td>
</tr>
<tr>
<td>13</td>
<td>33 years/Female</td>
<td>8</td>
<td>Kannada</td>
</tr>
<tr>
<td>14</td>
<td>26 years/Male</td>
<td>2</td>
<td>Kannada</td>
</tr>
<tr>
<td>15</td>
<td>30 years/Male</td>
<td>3</td>
<td>Kannada</td>
</tr>
<tr>
<td>16</td>
<td>29 years/Male</td>
<td>10</td>
<td>Kannada</td>
</tr>
<tr>
<td>17</td>
<td>29 years/Male</td>
<td>1</td>
<td>Kannada</td>
</tr>
<tr>
<td>18</td>
<td>37 years/Male</td>
<td>13</td>
<td>Malayalam</td>
</tr>
</tbody>
</table>

**Procedure**: Ling WAVES version 2.5 (WEVOSYS, Germany) was used to calculate DSI. Initially, the subjects were instructed to phonate vowel /a/ at a comfortable pitch and loudness. Then they were instructed to phonate vowel /a/, starting at a comfortable pitch and then
gliding up to the highest pitch possible. Similarly they were instructed to phonate starting from the comfortable loudness to the lowest possible loudness. MPD was calculated based on the sustained phonation task of vowel /a/ at habitual pitch and loudness after deep inhalation. From the above tasks, the following acoustic measures were extracted: jitter (%), minimum intensity (I-low, dB (A)), maximum phonation time (MPT, sec) and Maximum frequency (F0-high, Hz). The lingWAVES software calculated the DSI score automatically.

**Statistical analysis:** SPSS Version 16 (SPSS, Norusis, 1992, Chicago, IL) was used to perform the statistical analysis of the data. Mann-Whitney U test was used to find out the statistical differences between the groups and the effects of gender and number of years of experience.

**Result and Discussion**

Mean, standard deviation (SD), and p values for the DSI measures are tabulated. Results are discussed under three sub-headings:

(i) **DSI in special educators:** Table 2 shows mean, standard deviation, and p value for the DSI parameters: Jitter, Minimum intensity, Maximum Phonation Duration, Maximum F0 for male and female subjects.

From Table 2, it can be seen that the DSI score for male and female subject were 4.36 and 3.83 respectively which indicated normal vocal function (Wuyts et al., 2000).

**Table 2: Mean, SD and p values for the DSI measures in male and female participants**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Male</th>
<th>Female</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Jitter (%)</td>
<td>0.14 (0.07)</td>
<td>0.47 (0.80)</td>
<td>0.428</td>
</tr>
<tr>
<td>Minimum Intensity (dB)</td>
<td>50.3 (5.77)</td>
<td>46.96 (5.03)</td>
<td>0.349</td>
</tr>
<tr>
<td>MPT (sec)</td>
<td>18.67 (6.85)</td>
<td>12.97 (3.56)</td>
<td>0.054*</td>
</tr>
<tr>
<td>Maximum F0 (Hz)</td>
<td>524.60 (161.16)</td>
<td>472.68 (180.05)</td>
<td>0.767</td>
</tr>
<tr>
<td>DSI</td>
<td>4.36 (0.67)</td>
<td>3.83 (2.18)</td>
<td>0.430</td>
</tr>
</tbody>
</table>

*p ≤ 0.05

Mean Jitter for male participants were found to be 0.14% and 0.47% for female participants. Similar result was found in the study by Hakkesteeg et al (2006) in normal subjects. Mean minimum intensity for the two groups was 50.3 dB and 46.96 dB respectively which indicated normal findings, according to the study done by Hakkesteeg et al (2006) and Jayakumar and Savithri (2012). MPT ranged from 11.82 sec to 25.52 sec in male special educators whereas for female special educators the MPT ranged from 9.41 sec to 16.53 sec. This is in concordance with the findings in normal subjects by Jayakumar and Savithri (2012), indicating normal MPT range for both male and female special educators. Mean of maximum F0 was found to be 524.60 Hz for male participants. This was in accordance with the findings by Hakkesteeg et al (2006) and Jayakumar and Savithri (2012). Whereas the mean maximum F0 was found to be 472.68 Hz for female participants, which is not in consonance with the findings of previous studies on normal non professional voice users. In other words, mean maximum F0 was found to be reduced for female special educators, from the norm. Seven of the female participants in the present study were not able to perform the task to their higher capacity. This could be the possible reason for the deviancy.

(ii) **Gender difference in DSI:** The result of Mann Whitney-U test revealed that there is no significant difference in DSI score between male and female preschool special educators. This result is consistent with the findings of Jayakumar and Savithri (2012). In their study they had found no gender effect on DSI score for a group of normal subjects. According to Wuyts et al. (2000) only one version of the DSI can be used for both males and females because the gender effect is canceled out due of the opposite behavior of the MPT and Maximum F0 for female and male subjects. No counteracting balance between F0 high and MPT was observed in the present study. Rather maximum F0 was found to be higher in male subjects compared to females. Seven of the female participants in the present study were not able to perform the task to their higher capacity. Whereas all the male participants attempted the task achieving falsetto voice. This could be the possible reason for the males having high F0 compared to females. Another reason can be attributed to the unequal number of subjects in each group. Table 2 shows that mean MPT was lower for female participants than male participants which has significant difference (p=0.054). In most of the studies, it is found that the mean MPT in males are higher than in females (Wuyts et al., 2000; Hakkesteeg et al., 2008; Jayakumar and Savithri, 2012). Arnold (1955) reported that MPT demonstrates the general status of the patient’s respiratory system. Since males have higher lung volume than females, researches support that higher lung volume and also better airflow rate will facilitate in getting voice for longer duration (Hirano, Koike & Von Leden, 1968). Jitter percentage was found to be 0.14%
and 0.47% for male and female participants respectively. Although the results revealed that there was no significant difference for Jitter between male and female participants, the mean jitter was found to be more for female participants than the male participants. This is in concordance with the result of study reported by Wuyts et al. (2000) and Jayakumar and Savithri (2012). The gender effect was not evident in the present study for minimum intensity. Hakkesteegt et al. (2006) reported in their study that minimum intensity did not differ between the genders. Similar result was found in the study by Jayakumar and Savithri (2012).

(iii) Comparison across females special educators based on years of teaching experience: DSI parameters like Jitter, Minimum intensity, MPT, maximum frequency were compared for the two groups of female special educators. Table 3 shows the mean, standard deviation and p value for the two groups of subjects.

The result of the statistical analysis revealed no significant difference for the DSI parameters between the two groups. The result indicated that there is no influence of years of teaching experience on vocal quality in female special educators. Although not significant, DSI score was found to be better for the group with more teaching experience or older participants.

Table 3: Mean, SD and p values for the DSI measures in females special educators based on years of teaching experience.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Less than 8 years experience (SD)</th>
<th>More than 8 years experience (SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter (%)</td>
<td>0.76 (1.11)</td>
<td>0.23 (0.34)</td>
<td>0.062</td>
</tr>
<tr>
<td>Minimum Intensity (dB)</td>
<td>49.26 (4.78)</td>
<td>45 (4.68)</td>
<td>0.116</td>
</tr>
<tr>
<td>MPT (sec)</td>
<td>13.53 (4.67)</td>
<td>12.5 (2.57)</td>
<td>0.721</td>
</tr>
<tr>
<td>Maximum F0 (Hz)</td>
<td>523.37 (180.92)</td>
<td>429.22 (181.06)</td>
<td>0.283</td>
</tr>
<tr>
<td>DSI</td>
<td>3.23 (2.41)</td>
<td>4.34 (2.01)</td>
<td>0.317</td>
</tr>
</tbody>
</table>

The obtained finding is in concordance with the findings of the study done by Goy, David, Fuller, and Lieshout (2013). When we compare the individual measures of DSI for any age effect, there was no significant difference for jitter between the two groups. Hakkesteegt et. al. (2006) reported that the DSI measures in normal male and female subjects, (age range of 20-79 years), they found no effect of advancing age on the MPT and jitter for female subjects. Hollien, Dew and Philips (1971) found no effect on the highest frequency with advancing age in their group of subjects (male and female) in the age range of 18 to 38 years. Both the studies support the findings of the present study on MPT, jitter and highest frequency. In the study by Hakkesteegt et al. (2008), the lowest intensity became significantly higher with advancing age in female subjects. The above study is contradicting with the findings of the present study. Minimum intensity in group II is relatively low than group I, but it was not statistically significant. Experienced female special educators were able to phonate in the lowest possible intensity compared to that of less experienced female special educators. It can be speculated that, experienced female special educators had better control of their voice since they are more experienced in their voice usage. This needs to be investigated further on larger sample for its replicability.

Conclusions

The present study investigated the voice characteristics in special educators who educated children with special needs, using quantitative vocal measure using DSI. Results have shown that the DSI scores of both male and female special educators were normal like non educators and there was no gender effect on the measures for male and female preschool special educators. It was also found that there was no effect of number of years of teaching experience on DSI. The results of the present study should be generalized with caution, since number of participants considered in the present study was small. This is a preliminary attempt to investigate voice characteristics in preschool special educators dealing with children with hearing impairment, mental retardation, autism and multiple disabilities. Further researches on larger sample and different set up would yield better insight about the voice quality of preschool special educators.

References


ONE THIRD OCTAVE ANALYSIS: A DIAGNOSTIC TOOL TO MEASURE NASALITY IN CONJUNCTION WITH NASALANCE IN CHILDREN WITH REPAIRED CLEFT LIP AND PALATE

1Navya, A., & 2Pushpavathi, M.

Abstract

Hypernasality is the most predominant feature perceived in speech of individuals with cleft lip and palate. Instrumental assessment of speech can provide additional information along with the perceptual evaluation of speech for accuracy in diagnosis in individuals with cleft lip and palate (CLP). The widely used objective assessment of nasality is measuring nasalance using Nasometer. However, the spectral analysis of nasality in speech can provide complementary information along with nasalance measures. Hence, the present study is aimed to measure nasalance values and one third octave spectral peaks and their ability to differentiate children with repaired cleft lip and palate (RCLP) from control group. The study included eight children with RCLP age ranging from six to ten years. The control group included sixteen typically developing age and gender matched children. Vowel /a/ and /i/ was selected as stimuli. Nasalance was measured using Nasometer and 1/3rd octave spectral analysis was measured using a specially designed MATLAB programme. Statistical analysis was performed using SPSS 17 software. To differentiate the groups with the cutoff values, sensitivity and specificity of the variables was derived using receiver operating curves (ROC). The results showed high sensitivity and specificity of the nasalance values with the cutoff of 8.8% for /a/ and 31.6% for /i/. The frequency region between 998Hz and 2663 Hz provided high sensitivity and specificity for differentiating groups using 1/3rd octave spectra analysis. Further studies are required to generalize the results of one third octave spectra analysis.

Keywords: Nasalance, 1/3rd octave analysis, Repaired cleft lip and palate.

Hypernasality and nasal emission are the evident perceptual characteristics of the individuals with cleft lip and palate due to unoperated cleft/fistula. (Mc Williams, 1958; Morris, 1962, 1968). This is due to velopharyngeal inadequacy leading to nasal escape of air through nasal cavity. Perceptual rating scales were used to distinguish speech of individuals with CLP (Weinberg & Shanks, 1971). The reliability of perceptual judgments in population with cleft is becoming more confronting due to versatile nature of the voice. The perception of speech depends on alterations in pitch, loudness and resonance. There are different perceptual rating scales available for assessing the speech of cleft lip and palate. The various centers use different rating scales and this is leading to difficulty in comparing the speech outcomes across the centers (Vogel, Ibrahim, Reilly, & Kilpatrick, 2009). This led to the need of developing a protocol to measure the outcome which can be used across centers. (Henningsson, Kuehn, Sell, Sweeney, Trost-Cardamone, & Whitehill, 2007). But, due to the differences in linguistic structure of the language, the adaptability of this tool was limited (Hutters & Henningsson, 2004).

The perceptual evaluation is considered as the gold standard method for evaluating nasality. The development of a comprehensive assessment tool can improve the accuracy of an investigation in clinical population along with perceptual measures. The data obtained using these instrumental measures can allow the clinicians to right away use the formerly obtained data without any apprehension for reduced test-retest reliability. This has led to the development of several quantitative measures of nasality. The most commonly used quantitative measure of perceptual nasality is nasalance derived using Nasometer (Kay PENTAX, Lincoln Park, NJ). The nasalance score is the ratio of acoustic output of the oral and nasal cavities that are measured using Nasometer (Dalston, Warren, & Dalston, 1991). Nasometer is provided with a headset having a baffle plate separating the nasal and oral cavities. This plate aids in improving the accuracy of the data analysis by limiting the integration of signals from the oral and nasal cavities. The previous studies have shown good correlation of the perception of nasality with the Nasometer scores (Sweeney & Sell, 2008; Hardin, Van Demark, Morris, & Payne, 1992). Along with the nasalance measures using Nasometer, several other methods based on the speech physiology have developed together with the Horii Oral-Nasal Coupling Index, ratio of oral breath pressure (Vogel, Ibrahim, Reilly, & Kilpatrick, 2009), sonography (Dillenschneider, Zaleski, & Greiner, 1973). Each one of these measures is supplement to the perceptual measures for the
accurate measures. However, the use of these objective measures is often limited due to lack of published data on the sensitivity and specificity of these research designs. Along with the recognition for imaging studies (nasendoscopy & videofluroscopy) that provides information on the structure and function of velopharyngeal value (Vogel et al., 2009) the user friendly commercially available instruments like the Nasometer reduces the need of other objective measures.

The analysis of spectral peak amplitudes of the speech signal provides information on the perceived nasality in speech of individuals exhibiting velopharyngeal dysfunction (Forner, 1983; Philips & Kent, 1984; Ericsson, 1987). However, some limitations of these measures need to be recognized before implementing the technique. Extensive user expertise and laborious analysis regimes are required in most of the acoustic techniques. The rigorous evaluation is not done to find the appropriateness of the selected stimulus (Watterson, Lewis & Foley-Homan, 1999; Vogel, Ibrahim, Reilly, & Kilpatrick).

The literature has shown reduced amplitudes of the first formant frequencies (F1) in assessing speech of individuals with cleft palate and five children without cleft palate included in the study and vowel /i/ was considered to obtain one-third octave spectrum. All these 37 speech samples were rated severity of hypernasality by four experienced listeners using a six-point equal–appearing interval scale. On comparing the groups, increased spectral amplitudes between F1 and F2 and decreased spectral amplitudes in the region of F2 indicated characteristics of hypernasality for cleft group. High correlation (r=0.84) between the amplitudes of 1/3rd octave bands (1k, 1.6k, & 2.5 kHz) and the perceptual ratings was revealed using multiple regression analysis. The study concluded that the appropriate measure for quantification of hypernasality can be done by measuring the amplitude of the three 1/3-octave bands using the isolated vowel /i/.

The nasality in speech of children with CLP is evaluated predominantly using perceptual judgments. However, the easy-to-use objective techniques can contribute significantly for the effective empirical and clinical practice. One such tool is 1/3rd octave spectra analysis. Another
objective measure which is extensively used is nasalance using Nasometer. Any diagnostic tool need to have high sensitivity and specificity while using for differential diagnosis. Hence the goal of the present study is to measure the mean nasalance values and variations in the one third octave spectral peaks (energy concentration) in the spectrum of speech in children with repaired cleft lip and palate (RCLP) and control subjects.

Objectives of the study: The objectives of the present study are as follows.
1. To evaluate the following acoustic parameters in children with RCLP with age and gender matched typically developing children (Control group).
   a. Nasalance value for vowels - /a/ and /i/
   b. Spectral amplitude (energy concentration) at 1/3rd octave spectrum for vowels /a/ and /i/.
2. To investigate the sensitivity and specificity of nasalance and 1/3rd octave spectral analysis for vowels /a/ and /i/ to differentiate between children with RCLP with age and gender matched typically developing children (Control group).

Method

The present study considered twenty four children between six to ten years. The eight children with RCLP (experimental group) are attending diagnostic and therapeutic services at All India Institute of Speech and Hearing. Sixteen age and gender matched typically developing Kannada speaking children passing the WHO checklist to screen for disability detection (Singhi, Kumar, Malhi, & Kumar, 2007) with no history of diseases related to ear, nose and throat were included as control group. All the children were subjected to hearing screening before including in to the study. All the care takers/ parents of the participants provided the informed consent. The following inclusion and exclusion criteria were considered for selecting the children in to the Group I.

Inclusion criteria for Group I (Children with repaired cleft lip and palate):  
1. The children with repaired cleft palate, cleft lip and palate, and repaired soft palate in the age range of 6 to 10 years with normal cognitive abilities and neuromotor dysfunction  
2. Children with no residual hard or soft palate fistulae and non-syndromic clefts.  
3. Children with hearing thresholds below 20 dB in the poorer ear

Exclusion Criteria:
2. Children with neuromotor dysfunction, cognitive deficiency, and history of ear, throat and nose pathologies.  
3. Children with associated problems like cerebral palsy, dysarthria and apraxia.

Instrumentation: Nasalance Measures were derived using Nasometer (Model 6400 II, Kay Pentax, New Jersey). The one third octave spectra analysis was extracted using MATLAB.7 version software.

Procedure
Nasalance measure for vowel /a/ and /i/: Nasalance values were obtained using Nasometer (Model 6400 II, Kay Pentax). The children were instructed to sit comfortably in upright position and the headgear of nasometer is placed and adjusted. The children were demonstrated to repeat/ phonate at comfortable pitch and loudness level.

Calibration of the Nasometer II was done every day prior to the data collection as per the instructions provided by the manufacturer. Before the recording session the phonation of the stimulus was demonstrated. To make up the child more comfortable with the recording procedure the phonation for the first time was considered as practice trail. The phonation of the consecutive speech samples were recorded with an interval of 1-2 minutes. Every recording was saved for further analysis. The selection of the stimulus for analysis was performed by dragging the cursors from onset to the offset of the part of the selected stimulus. Each stimulus was recorded separately and mean nasalance values were obtained. The average of mean nasalance values of three trails of the phonated stimulus was calculated.

One-third (1/3rd) octave spectra analysis for vowel /a/ and /i/: One-third octave spectra analysis of the selected stimulus was performed using MATLAB.7 version software in the computer. The mean of the amplitudes (dB) were calculated for every 1/3rd of an octave frequency bands (100–16,000 Hz) for the stimulus /a/ and /i/. The speech sample was analyzed over 23 one-third octave bands (over a frequency range of
100–16,000 Hz) to match the ANSI standard (ANSI S1.11-1986) using a digital filter. A 10th order Butterworth band pass filter with attenuation of 60 dB/Octave was used. By adding and considering mean of components over 1/3rd octave intervals with center frequencies ranging from 100 Hz to 16,000Hz average long-term RMS value were obtained. The procedure involved writing the MATLAB® version software and analyzing the mean amplitudes of one third octave filters between 100 Hz to 16,000Hz. Each stimulus was recorded and analyzed separately.

Statistical Analysis: SPSS 18 was used for statistical analysis and at \( p < .05 \) was considered as significant levels. For vowels /a/ and /i/ eventhough the 1/3rd octave spectra mean amplitudes (dB) were measured between 100 Hz to 16,000Hz statistical analysis was limited to frequency bands (476 Hz and 3089 Hz). These are the frequency bands that had high sensitivity to hypernasality as mentioned in the literature (Kataoka et. al, 2001; Lee, Yang, & Kuo, 2003). Further, the chance of Type II error can be reduced by limiting the analysis to those frequency bands proved to be more sensitive. The normality check was performed for all the data included in the study using Kolmogorov-Smirnov Test. The histograms were plotted across each stimulus and group prior conducting the statistical analysis. Normality was observed on majority of the data sets considered. As the diagnostic measures should have high sensitivity and specificity (i.e., low false negative and false positive rates) to widely use across the clinical population ROC curves were estimated. In order to arrive at optimum values, Receiver-Operating Characteristics (ROC) curves (Swets & Pickett, 1982; Begg, 1987) were used for the variables (nasalance & 1/3rd octave spectral analysis). The cutoffs values were derived from these ROC curves and used to differentiate between the groups of children with RCLP and control subjects with optimum sensitivity and specificity.

Results and Discussion

The present study is aimed to analyze the nasality interms of nasalance scores and one third octave spectra analysis in children with RCLP and control group.

a) Nasalance Values: Means of nasalance values were calculated for the stimuli (/a/ and /i/) out of three trials. The mean values for the stimuli and standard deviations for the groups are reported in Table 1 and Figure 1. In general, the increased nasalance value was observed in children with RCLP and vowel /i/ had higher nasalance values compared to /a/ in both groups. Statistically significance difference (\( p<0.05 \)) was observed between the groups. The results supports the finding of the are previous studies (Watterson et al., 1996; Sweeney & Sell, 2008) who reported high nasalance values in individuals with cleft lip and palate when the correlation was investigated.

<table>
<thead>
<tr>
<th></th>
<th>Normals(%) Mean (SD)</th>
<th>RCLP(%) Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasalance - /a/</td>
<td>5.00 (1.70)</td>
<td>22.00 (9.33)</td>
</tr>
<tr>
<td>Nasalance - /i/</td>
<td>22.56 (5.88)</td>
<td>65.38 (19.53)</td>
</tr>
</tbody>
</table>

The correlation coefficient was reported from 0.70 to 0.82 (Dalston et al. 1991), and 0.69 to 0.74 (Sweeney & Sell, 2008). The increased nasalance scores reported in subjects with RCLP in the present study and across the studies may be due to incomplete closure of velopharyngeal port leading to the flow of air through the nasal cavity reducing the oral airflow. Another finding of the present study is increased nasalance for vowel /i/ than /a/ which is an expected finding based on the literature (Lewis, Watterson, & Quint, 2000; Gopi Sankar & Pushpavathi, 2008). This finding can be related to the articulatory dynamics while producing the vowels. The open vowel (/a/) demonstrates less resistance to airflow out of the mouth results in maximum transmission through the oral cavity. In case of high vowels (/i/ & /u/) relatively more resistance to airflow is imposed resulting in reduced airflow through oral cavity.

The physiological point of view the production of high vowels (/i/ & /u/) requires greater degree of velopharyngeal closure than the production of low vowel (/a/) in normals (Moll, 1960).

Table 2 represents the maximum area of the variable under the reference curve. The area covered under the reference curve provides the
ability of the variable to differentiate the RCLP and control groups. If the variable covers greater area under the reference (ROC) line the ability to differentiate the groups with high sensitivity and specificity will be more. The nasalance scores for both the vowels are under the curve, even though the difference between the vowels is negligible the area covered by /i/ (1.00) is more than /a/ (0.98). This represents the nasalance scores of both the vowels are valid measures for discriminating the groups. Figure 2 depicts the groups difference using nasalance values of /a/ with a sensitivity of 0.87 specificity of 0.93 and cutoff point was 8.8% and for /i/ sensitivity was 1.00 specificity was 0.93 and cutoff point was 31.6%. On the basis of the cutoffs identified using ROC curves, the nasalance measures of the vowels /a/ and /i/ differentiated across groups. The results showed significant difference in the nasalance values across the groups. The above results are in accordance with earlier study by Sweeney and Sell (2008) found sensitivity ranged from 0.83 to 0.88 and specificity ranged from 0.78 to 0.95.

Table 2: Area under the ROC curve based on nasalance scores across stimuli and groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Area under the ROC curve for /a/</th>
<th>Area</th>
<th>Std. Error</th>
<th>Asymp Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>/a/ MN</td>
<td>0.984</td>
<td>0.020</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>/i/ MN</td>
<td>1.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Mean and standard deviations of energy concentration across groups.

<table>
<thead>
<tr>
<th>Frequency(Hz)</th>
<th>500</th>
<th>666</th>
<th>832</th>
<th>998</th>
<th>1331</th>
<th>1664</th>
<th>1997</th>
<th>2663</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCLP-/a/</td>
<td>52.89(10.12)</td>
<td>57.79 (8.36)</td>
<td>59.00 (8.54)</td>
<td>62.89 (5.96)</td>
<td>66.65 (8.03)</td>
<td>65.58 (7.07)</td>
<td>57.43 (9.84)</td>
<td>46.87 (6.79)</td>
</tr>
<tr>
<td>Control-/a/</td>
<td>48.44 (12.17)</td>
<td>52.29 (8.04)</td>
<td>53.08 (9.81)</td>
<td>57.02 (9.43)</td>
<td>54.86 (9.33)</td>
<td>56.01 (9.81)</td>
<td>45.99 (11.4)</td>
<td>39.28 (8.21)</td>
</tr>
<tr>
<td>RCLP-/i/</td>
<td>47.93 (12.70)</td>
<td>57.20 (6.01)</td>
<td>47.31 (8.77)</td>
<td>44.62 (4.58)</td>
<td>42.16 (5.31)</td>
<td>42.37 (5.39)</td>
<td>40.47 (4.99)</td>
<td>42.06 (3.55)</td>
</tr>
<tr>
<td>Control-/i/</td>
<td>49.88 (12.89)</td>
<td>48.42 (8.39)</td>
<td>43.10 (7.91)</td>
<td>36.96 (6.40)</td>
<td>34.49 (6.25)</td>
<td>33.93 (5.99)</td>
<td>34.66 (6.51)</td>
<td>41.23 (8.54)</td>
</tr>
</tbody>
</table>

Figure 2: Sensitivity and specificity of mean nasalance scores across stimuli and groups.

b) 1/3rd octave spectra analysis: A summary of 1/3rd octave spectra mean amplitudes (dB) and standard deviations of children with RCLP and control subjects for stimuli (/a/ & /i/) are in Table 3 and Figure 3 and 4. According to data derived from one-third octave spectra analysis, significant differences in mean scores across the groups are evident in the Figure 3. In the present study energy concentration over the one third octave spectrum for vowel /a/ and /i/ were more in RCLP than normal. These findings strengthen the results of the study by Kataoka (2001) who stated that different spectral profiles were demonstrated by speakers with hypernasality than compared with controls.

Figure 3: Mean of energy concentration across the frequencies and groups.

Figure 4: Mean and SD of energy concentration across frequencies and groups (RCLP-c & Control-n).
Table 4 depicts significant differences in energy concentration of vowel /a/ in 1331Hz, 1664 Hz, 1997 Hz, and 2663 Hz frequencies, where as for /i/ in 998 Hz, 1331Hz, 1664 Hz and 1997 Hz frequencies between the groups as shown in Table 5. However, significant differences in spectral peaks were observed in the mid frequencies between 1331 Hz to 2663 Hz for vowel /a/ and between the 997 Hz to 1997 Hz For /i/.

Another finding of the present study is significant differences in spectral peak amplitudes for /a/ and /i/ were observed above 1331 Hz and 998Hz respectively. This indicates the change in the spectral amplitudes below 1331Hz for vowel /a/ were not significant. However, for vowel /i/ the increase in amplitude was noticed at the frequencies below 1 KHz itself exhibiting significant differences between the groups. This could be due to coupling of the nasal tract to the main vocal tract introduces pole-zero pairs in the transfer function. Whereas low vowel /a/ is nasalized, the amplitude of F1 decreased because the first nasal zero appears in the frequency region of F1. When high vowels such as /i/ and /u/ are nasalized, however, the first nasal zero appears in a higher frequency region than F1. Therefore, the amplitude of F1 is not attenuated. (Kataoka, et al., 2001). The findings of Kataoka et al (2001) reported similar results indicating highest spectral peak amplitudes at 1, 1.6, and 2 KHz for vowel /a/ in the moderate to severe hypernasal group than the normal resonance group. For vowel /i/ characterized by increased amplitude level at F1 and between F1 and F2, decreased amplitude in the levels of F2 and F3 region in children with cleft lip and palate (House & Stevens, 1956; Fant, 1970).

Table 4: Significance values of the frequencies differentiating the groups across the vowels

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Sig. value (P&lt;0.05)-a</th>
<th>Sig. value (P&lt;0.05)-i</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>.384</td>
<td>.729</td>
</tr>
<tr>
<td>666</td>
<td>.133</td>
<td>.015</td>
</tr>
<tr>
<td>832</td>
<td>.158</td>
<td>.248</td>
</tr>
<tr>
<td>998</td>
<td>.186</td>
<td>.007</td>
</tr>
<tr>
<td>1331</td>
<td>.007</td>
<td>.011</td>
</tr>
<tr>
<td>1664</td>
<td>.023</td>
<td>.003</td>
</tr>
<tr>
<td>1997</td>
<td>.024</td>
<td>.038</td>
</tr>
<tr>
<td>2663</td>
<td>.035</td>
<td>.798</td>
</tr>
</tbody>
</table>

As mentioned earlier the area covered by the variable indicates the ability to differentiate the groups. Table 5 represents the maximum area covered by the target frequencies are 1331 Hz, followed by 1664Hz, 1997Hz and 2663Hz for /a/. Figure 5 represents the cutoffs frequencies differentiating the groups with high sensitivity 0.87 to 0.75 and 0.75 to 0.56 specificity with cut off 61.58dB at 1331Hz and 43.75dB at 2663Hz are identified using ROC curves.

Table 5: Area under the ROC curve based on energy concentration distributed across frequencies for vowel /a/.

<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>Area</th>
<th>Std. Error</th>
<th>Asym Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>.574</td>
<td>.122</td>
<td>.561</td>
</tr>
<tr>
<td>666</td>
<td>.680</td>
<td>.117</td>
<td>.159</td>
</tr>
<tr>
<td>832</td>
<td>.656</td>
<td>.117</td>
<td>.221</td>
</tr>
<tr>
<td>998</td>
<td>.629</td>
<td>.121</td>
<td>.312</td>
</tr>
<tr>
<td>1331</td>
<td>.836</td>
<td>.084</td>
<td>.008</td>
</tr>
<tr>
<td>1664</td>
<td>.785</td>
<td>.094</td>
<td>.025</td>
</tr>
<tr>
<td>1997</td>
<td>.773</td>
<td>.105</td>
<td>.032</td>
</tr>
<tr>
<td>2663</td>
<td>.754</td>
<td>.105</td>
<td>.047</td>
</tr>
</tbody>
</table>

To strengthen the objective evaluation of nasality along with the nasalance measures, spectral analysis of speech was carried out by the earlier researchers. In the present study, energy concentration over the one third octave spectrum for vowel /a/ and /i/ were more in CLP than normals. In case of vowel /a/ various acoustic studies have shown similar pattern of additional spectral peaks.
Table 6: Area under the ROC curve based on energy concentration distribution for various frequencies for vowel /i/.

<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>Area under the ROC curve for /i/</th>
<th>Area</th>
<th>Std. Error</th>
<th>Asymp Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>.465</td>
<td>.129</td>
<td>.129</td>
<td>.783</td>
</tr>
<tr>
<td>666</td>
<td>.813</td>
<td>.088</td>
<td>.088</td>
<td>.014</td>
</tr>
<tr>
<td>832</td>
<td>.613</td>
<td>.129</td>
<td>.129</td>
<td>.375</td>
</tr>
<tr>
<td>998</td>
<td>.816</td>
<td>.089</td>
<td>.089</td>
<td>.013</td>
</tr>
<tr>
<td>1331</td>
<td>.891</td>
<td>.066</td>
<td>.066</td>
<td>.002</td>
</tr>
<tr>
<td>1664</td>
<td>.910</td>
<td>.061</td>
<td>.061</td>
<td>.001</td>
</tr>
<tr>
<td>1997</td>
<td>.754</td>
<td>.107</td>
<td>.107</td>
<td>.047</td>
</tr>
<tr>
<td>2663</td>
<td>.523</td>
<td>.117</td>
<td>.117</td>
<td>.854</td>
</tr>
</tbody>
</table>

Figure 6: Sensitivity and specificity of frequencies (500Hz to 2663Hz) for /i/ across groups

However, reduced amplitude between F2 and F3 is also reported in majority of the studies (Yoshida et al., 2000; Vogel, Ibrahim, Reilly, & Kilpatrick, 2009). Kataoka et al (2001) reported difference in amplitude of isolated vowels across experiment and control groups. The spectral change over the duration of the vowel was considered as the coexisting speech characteristics that influenced the percentage of hypernasality perceived. Miller (1989) reported that the influence of spectral changes such as logarithmic shifts in frequency and intensity on perception is insufficient. However, shifts in the relative position of spectral peaks have a significant influence on vowel perception. Strange (1989) stated that dynamic properties of vowels could be represented by the spectra at three different points of time at one glide (the initial), off glide, and the nucleus, which contain formant values most closely approximating the steady state part of vowels. Bakkum et al (1995) applied whole spectrum analysis to represent these dynamic properties of vowels (1/3rd octave) using the averaged 1/3rd octave spectrum over a time window.

According to Miller’s (1989) the change in atleast one of the formant frequency (F0, F1, F2, & Fn) i.e., a spectral peak between F1 and F2 results in changing the relative level of F0 to each formant. This change apparently results in a different perceived severity of hypernasality during vowel production. Hypernasal vowels in general, have broad peaks and flattened spectra when the spectral peaks are not prominent. The shape of the entire region of the spectral envelope is important for vowel perception rather than the frequency and amplitude of the spectral peaks (Beddor & Hawkins, 1990). Therefore, 1/3rd octave spectral analysis evaluates overall spectral envelope may have a theoretical advantage in analyzing hypernasal vowels. Furthermore, the static properties of the vowel spectra have been examined by formant analysis, where as 1/3rd octave analysis can utilize both static and dynamic approaches. This is the initial study focused on exploring the application of ROC curves in differentiating the RCLP from the control groups based on one third octave analyses. Hence to generalize the results related to the specificity and sensitivity of 1/3rd octave analysis to differentiate the groups, further research needs to be carried out.

Acknowledgment

The authors wish to thank Dr. S. R. Savithri, Director of AIISH for permitting us to carry out the study; Ms. M. S. Vasanthakshmi and Mr. Santhosth C. D., Lecturers in Biostatistics, for the help in statistical analysis. Our sincere thanks to all the participants of the study. The present study is a part of ongoing doctoral thesis.

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PERTURBATION AND NOISE MEASURES IN TYPICALLY DEVELOPING CHILDREN IN THE AGE RANGE OF 6-12 YEARS

1Arsha Shaji, & 2Pebbili Gopi Kishore

Abstract

Perturbation and noise measures of voice have been reported to be the ones that tap subtle and early changes in voice. Although attempts have been made to document these measures in Western context, considering the geographical and ethnic variations, the same values might not be applicable in Indian context. In this context, the present study was taken up to document noise and perturbation measures in voice of typically developing children in the age range of 6-12 years and comparing them across the western norms in children and the Indian norms in adults. Participants included in the study were typically developing children with normal voice in the age range of 6-12 years. The Multi-dimensional voice profile (MDVP), advanced version (Model 5150) module with Computerized Speech Lab hardware system was used for the analysis of voice sample to obtain the perturbation measures jitter %, RAP, PPQ, sPPQ, shimmer %, APQ, sAPQ and noise measures NHR, VTI and SPI. The participants were instructed to phonate vowel /a/ at their comfortable pitch and loudness. A three second steady segment of the voice sample was used to obtain perturbation and noise measures. The obtained measures were tabulated and subjected to statistical analysis to compute mean, standard deviation and range. One way MANOVA indicated no significant effect of gender on any of the measured parameters (p>0.05). One sample t-test revealed that most of the measured parameters are significantly different from western norms in children and also from adult Indian norms. Considering these variations, it may be concluded that the database established in any population cannot be used universally and indigenous norms are essential. The results of the present study may be used as preliminary norms for children in the age range of 6-12 years.

Introduction

Comprehensive evaluation of voice involves measurements under perceptual, acoustic, aerodynamic, physiological, and self-perceptual domains. Although perceptual analysis is considered as the gold standard, it is known to be influenced by the factors such as experience of the clinician. Among the objective measures of voice, acoustic analysis is considered as a non-invasive, easily applicable and low cost measurement of voice that complements other laryngeal diagnostic methods. Measurement of frequency and amplitude perturbations and noise related measures are commonly used as a part of the comprehensive objective voice evaluation. They provide information regarding periodic and aperiodic components of the voice production. Perfect periodicity is absent even in normal voices. From one voice pulse to the other there are minimal changes in the fundamental frequency. This is an indication of a neuromuscular physiological process where twitches of the slow rate single motor unit occur in the vocal folds (Baer, 1980). Studies related to speech synthesis have shown that human voice is inherent with such arbitrary variation. The minor disturbances in the frequency and the amplitude of the voice signal, called perturbations are unavoidably present even during the production of a steady sound (Titze, 1994). The normal voice production and normal physiology of the human body is inherent of such minor irregularities in the sound wave output (Orloff & Baken, 1989). It was found that when vocal folds vibrate asymetrically it yields sub-harmonic structures in the spectrum and thus produces a rough or creaky voice (Ishiki & Ishizaka, 1976). Stiffness, nodules or other histological pathology causes these perturbations to become worse and result in more severe deviation from the normal pattern of voice. This is perceptually defined as dysphonia and the quality is described as breathy, hoarse and rough (McAllister, Sederholm, Ternstorm, & Sundberg, 1996).

Voice perturbations such as jitter and shimmer correlate with the perceived “roughness” and “breathiness” (Dejonckere, Remacle, Fresnel-Elbaz, Woisard, Crevier –Buchmann, and Milet,1996). Voice perturbations increases with increase in the laryngeal pathology (Schoentgen, 1982; Murry and Doherty, 1980) and is also helpful in partially discriminating different functional voice disorder types (Gelzinis, Verikas, & Bacauskiene, 2008; Ortega, Cassinello, & Dorcatto, 2009). Studies have also reported that perturbation measures can identify the subtle changes in voice which are not evident by other methods like auditory or visual (Hanson, 1997 and Stojadinovic, Shaha, Orlikoff, et al., 2002). Despite the significance of perturbations measures in voice evaluation, they were found to be influenced by several factors.

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Stimulus related variable such as pitch, loudness, and vowel (Orlikoff & Kahane, 1991; Dejonckere, 1998; and Brockmann, Storck, Carding, & Drinnan, 2008), instrumental variables such as sampling rate, smoothing factor (Jafari, Till, & Law-Till, 1992), microphone characteristics, algorithm used for analysis, and participant related variables such as ethnicity, age, and gender of the participant (Steinsapir, Forner, & Stemple, 1988 and Jafari et al., 1992) have been reported to influence perturbation measures.

Jitter and shimmer value change across the voice range and thus they vary across the pitch and loudness. In the study by Orlikoff and Baken (1990) it was seen that the jitter and shimmer were similar in women and men at comfortable pitch. It was also observed that the change in jitter with change in F0 was more evident in men. Orlikoff and Kahane (1991) described a reciprocal linear relation of the perturbation measures to SPL. Also Pabon (1991) reported that the jitter and shimmer values were higher at low frequencies and SPLs. Dejonckere (1998) reported that there was a significant reduction in the perturbation measures when the loudness was increased. In one of the recent studies by Brockmann et al., (2008) the authors concluded that both jitter and shimmer values increased drastically as SPL decreased. This increase was most evident when the loudness dropped from “medium” to “soft” loudness. It was also reported that there were large changes in jitter and shimmer even when there were small changes in SPL below 80 dB. The authors also explain this finding as at lower intensities and frequencies, the muscle tension of the inherent vocal fold muscle is low, resulting in better mucosal cover variability and thus higher perturbation of voice at lower SPLs (Hodge, Colton & Kelley, 2001).

Perturbations are also affected by the stimuli used i.e. vowel and running speech. Sederholm (1996) reported that listeners found instability in voice was almost absent in running speech but seen in sustained vowels. This could be because sustaining a vowel may be a rather unfamiliar vocal task. Influence of type of vowel phonated during the measurement of jitter and shimmer has been explored by a number of authors (Kane & Wellen, 1985; Steinsapir et al., 1986; and Glaze, Bless, Milenkovic & Susser, 1988). Highest jitter values have been reported in vowels /u/, /i/ or /a/ and lowest shimmer in /i/ or /u/. In a recent study by Brockmann, Drinnan, Storck, and Carding (2011) it was seen that there was a significant influence of vowel on shimmer whereas the jitter was not influenced by the vowel type.

Studies also reported higher jitter values for children compared to adult (Steinsapir et al., 1986). In a study by Cappellari and Cielo (2008) the authors found higher jitter values in children who are 4 years old compared to 7 years suggesting that the control of airflow was steadier with increase in age i.e. the aperiodicity in the vibrations of the vocal folds decreased with neurological maturation. Authors also suggested that frequency perturbations have a reciprocal relationship to the development of motor control.

Noise related measures

Voice signal consists of periodic and aperiodic energy. Periodic component of the signal results from vibration of the vocal folds. The additive noise/aperiodic component in the voice signal results from perturbations in the voice and turbulence at the level of glottis during voice production. Perturbations in frequency and sound pressure level results in the noise of low frequency and turbulence due to poor glottic closure leads to additive noise in the high frequency region. The noise thus produced increases the inter-harmonic energy and reduces the energy at harmonics. Therefore, parameters which measure the overall noise energy level and relative energy levels of noise and harmonics in the given signal can reflect the information of voice quality.

Harmonic to noise ratio (HNR) is an acoustic measure that is sensitive indicator of the laryngeal function. HNR quantifies the comparative amount of noise that gets added in the voice signal (Awan & Frenkel, 1994). The ratio is an indication of how abundant the harmonics in the voice are over the noise. The harmonics represent the periodicity and the noise represents aperiodicity in the voice and this ratio of HNR is quantified in terms of dB. Perceptually HNR reflects the quality of voice, because the quality of voice is influenced by the amount of noise in the spectrum (De Krom, 1993). Martin, Fitch, & Wolfe (1995) reported that HNR is a significant predictor of perceptually rough voice.

Carole (1996) compared the efficacy of HNR and jitter in identifying additive noise in the voice signal. Results indicated that, when the voice signal had additive noise, jitter showed very minimal or no change while HNR showed significant variation. From this the authors concluded that amount of noise added in the signal is better reflected by HNR than jitter. The
authors also suggested that acoustic measures of jitter were poorly correlated with the stroboscopic patterns. Soft phonation Index (SPI) is another acoustic measure that reflects the poverty in the harmonic components at the high frequencies which may be suggestive of poor adduction of the vocal folds during phonation. It reflects the average ratio of low to high harmonic energies. The low frequency energy ranges from 70-1600Hz while the high frequency harmonic energy ranges from 1600-4500Hz.

Cappellari and Cielo (2008) reported that the SPI values decreased as the mean APQ values increased. The study also reports that APQ, PPQ, and HNR highly correlated with each other. This may be because all of them are affected by common factors of poor control of the neuromusculature and by transglottic airflow. In order to resist the pressure of the airflow good neural control of the musculature of the vocal folds is essential. Adequate neuromuscular control is essential for maintaining firmness and stability of the vocal folds in order to withstand the resistance of the airflow. SPI and the VTI correlated negatively with each other.

Thus the perturbation and noise measures yield valuable information that can aid in understanding the functioning of phonatory system. However these objectives measures may be influenced by age, gender, ethnicity etc. In a study Hema, Sangeetha and Pushpavathi (2009) attempted to develop a normative data for adults in the Indian context and compare it with the western norms. The authors reported difference in perturbation measures when compared with the western norms. Further, there has been dearth of such attempts in this regard for children especially in the Indian scenario. This is essential as the production of voice in children is different from that of adults primarily because of variations in the anatomy and the physiology of the paediatric larynx. The paediatric larynx differs from the adult larynx in terms of its size, orientation, consistency and shape. The laryngeal cartilaginous structures are not ossified in the paediatric larynx with the exception of the hyoid bone. Also the paediatric larynx is positioned at a higher level at C2-C3 level (Hudgins, Siegel, Jacobs & Abramowsky, 1997). Stathopoulos and Sapienza (1997) reports of differences in anatomy of the upper and lower respiratory tracts with increasing age, which inturn affect the acoustic output. Muller and Brown (1980) also report of differences in the layers of vocal folds and stability of the thyroarytenoid muscle to improve as the children get older.

Need for the study
In voice clinics and voice research, acoustic analysis of voice is considered as a non-invasive, easily applicable and low cost measurement of voice that complements other laryngeal diagnostic methods. Measurement of frequency and amplitude perturbations and noise related measures are commonly used as part of the comprehensive objective voice evaluation. They supplement the information obtained through visual laryngeal examination as well as perceptual evaluation. These measures are useful in describing pathological as well as normal voices. However, the lack of normative data in Indian context requires them to be interpreted in comparison with the western norms, thus reducing the sensitivity and specificity of them. This assumption was further strengthened by the reported significant differences in acoustic measures among adult Indians to that of Western. Further these measures are also known to be influenced by the age and sex of the participants. Therefore, it is essential to have a database for Indian children for appropriate interpretation of the data and to verify thus obtained data with western norms and adult Indian norms. In this context, the present study was an attempt to document noise and perturbation measures in voice of typically developing children in the age range of 6-12 years and to compare them across the western norms in children and the adult Indian norms.

Objectives of the Study
1. To document perturbation and noise measures of voice in typically developing children in the age range of 6-12 years.
2. To compare the data thus obtained with the Western norms.
3. To compare the data obtained with the adult Indian norms.
4. To verify the effect of gender on these parameters.

Method
Participants: The sample population included a total of 60 children (28 male and 32 female) aged between 6-12 years. The children had no history of any voice problem and had perceptually normal voice at the time of recording. Children with no complaints/reports of upper respiratory tract infection, reduced hearing acuity, and previous history of neurological problems were considered for the study. The subjects had not
been part of any singing activity either as solo or choir. During the data collection, some of the participants achieved extreme scores, influencing the mean value. In order to eliminate this, box plots were drawn using the statistical software SPSS 18.0 for the nine acoustic parameters. The box plots indicated the extreme scorers and thus they were removed manually from the main data. Statistical analysis was performed further on a total of the remaining 50 participants (24 males and 26 females).

**Instrumentation:** The Multi-dimensional voice profile (MDVP), advanced version (Model 5150) module with Computerized Speech Lab hardware system (Kay PENTAX Corp, Lincoln Park, NJ) was operated on a compatible desktop computer. The window length of 6 seconds was used for recording and the signal was sampled at the rate of 50 KHz.

**Procedure:** The children were instructed to phonate the vowel /a/ at their comfortable pitch and loudness. The mouth to microphone distance was maintained at 15 cm. Three trials were given and the best trial was selected for further analysis. A three second steady portion of the phonated vowel was taken and was subjected to analysis. The MDVP analysis was performed to obtain the acoustic parameters of voice. MDVP provides a total of 33 parameters which can be classified under frequency measures, perturbation measures, noise measures, tremor measures, voice irregularity (voice break and sub-harmonic) measures. From the obtained parameters, the perturbation measures jitter%, RAP, PPQ, sPPQ, APQ, sAPQ, and noise measures NHR, VTI and SPI were noted down for further analysis. The absolute jitter (μsec) and absolute shimmer (dB) values were not included in the present study as these were reported to be influenced by major variations in average pitch period and amplitude during phonation (Titze, 1994).

**Table 1: Perturbation and noise measures analysed in the study**

<table>
<thead>
<tr>
<th>Acoustic Parameter</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter %</td>
<td>Jitt</td>
</tr>
<tr>
<td>Pitch period perturbation quotient</td>
<td>PPQ</td>
</tr>
<tr>
<td>Relative average perturbation</td>
<td>RAP</td>
</tr>
<tr>
<td>Smoothened pitch period perturbation quotient</td>
<td>sPPQ</td>
</tr>
<tr>
<td>Amplitude perturbation quotient</td>
<td>APQ</td>
</tr>
<tr>
<td>Smoothened amplitude perturbation quotient</td>
<td>sAPQ</td>
</tr>
<tr>
<td>Noise to harmonic ratio</td>
<td>NHR</td>
</tr>
<tr>
<td>Voice turbulence index</td>
<td>VTI</td>
</tr>
<tr>
<td>Soft phonation index</td>
<td>SPI</td>
</tr>
</tbody>
</table>

**Statistical analysis:** The data was analysed using the software Statistical Package for Social sciences (SPSS) version 18. Measurement of mean, standard deviation and range for all the parameters across the gender included the descriptive statistics. Two way multivariate analysis of variance (MANOVA) was performed to determine the effect of independent variables on the dependent variables. The independent variable was gender, and the 9 acoustic parameters measured (Jitter%, RAP, PPQ, sPPQ, APQ, sAPQ, NHR, VTI and SPI) were the dependent variables. One sample t – test was performed to check if there was a significant difference in the acoustic parameters between the results obtained in the present study with that of the adults and the Western norms.

**Results and Discussion**

Acoustic analysis of voice is an easy, non-invasive, and economical way of objectively measuring an individual’s voice. Thus obtained measures can be used in differentiating normal from abnormal voices, screening individuals who are at-risk for developing voice disorders, and for documenting therapeutic and surgical treatment outcomes. In this context, the present study was an attempt to document perturbation and noise measures of voice in typically developing children in the age range of 6-12 years, and to compare them with western children and adult Indian norms. It further attempted to verify the influence of gender on the perturbation and noise measures of voice. The results of the study are presented and discussed under the following subheadings.

- Perturbation and noise measures in typically developing children in the age range of 6-12 years.
- Comparison of perturbation and noise measures with Western norms.
- Comparison of perturbation and noise measures with the adult Indian norms.
- Effect of gender on perturbation and noise measures.

**Perturbation and noise measures in typically developing children in the age range of 6-12 years:** Mean, standard deviation and range across perturbation and noise measures were computed. Table 2 shows the mean and standard deviation values for perturbation and noise measures in these children. Overall the frequency perturbation measures were found to have less deviated from their average values compared to the amplitude perturbation measures (figure 1). sPPQ under the frequency perturbation measures
and VTI under the noise measures revealed larger variations with standard deviation higher than their mean values.

Table 2: Mean, standard deviation, and range of the perturbation and noise measures in children.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range Minimum</th>
<th>Range Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter%</td>
<td>1.13</td>
<td>0.68</td>
<td>0.19</td>
<td>3.01</td>
</tr>
<tr>
<td>RAP</td>
<td>0.68</td>
<td>0.41</td>
<td>0.117</td>
<td>1.81</td>
</tr>
<tr>
<td>PPQ</td>
<td>0.67</td>
<td>0.42</td>
<td>0.11</td>
<td>1.81</td>
</tr>
<tr>
<td>sPPQ</td>
<td>0.93</td>
<td>0.96</td>
<td>0.08</td>
<td>5.62</td>
</tr>
<tr>
<td>Shimmer%</td>
<td>5.12</td>
<td>1.96</td>
<td>1.37</td>
<td>9.55</td>
</tr>
<tr>
<td>APQ</td>
<td>3.76</td>
<td>1.62</td>
<td>1.00</td>
<td>8.17</td>
</tr>
<tr>
<td>sAPQ</td>
<td>5.23</td>
<td>1.79</td>
<td>2.38</td>
<td>11.33</td>
</tr>
<tr>
<td>NHR</td>
<td>0.14</td>
<td>0.04</td>
<td>0.10</td>
<td>0.33</td>
</tr>
<tr>
<td>VTI</td>
<td>0.05</td>
<td>0.17</td>
<td>0.17</td>
<td>0.05</td>
</tr>
<tr>
<td>SPI</td>
<td>5.94</td>
<td>4.55</td>
<td>1.06</td>
<td>18.52</td>
</tr>
</tbody>
</table>

The wider range of perturbation can be attributed to the type of task used to elicit the voice sample. Sustaining a vowel is a rather unfamiliar task and causes instability of voice causing a wider range in the perturbation measures (Sederholm, 1996). Further, the study included children of 6 years as well as 12 years of age. The anatomical and physiological changes may improve the vocal functioning in children as they grow older. Therefore, the group might have been heterogeneous with children at different levels of anatomical and physiological maturation.

The findings of laryngeal and respiratory anatomical and physiological variations in developing children have been reported by earlier studies (Muller and Brown, 1980; Stathopoulos and Sapienza, 1997; and Karike and Kishore, 2012). Muller and Brown (1980) reported of differences in the layers of vocal folds and stability of the thyroartenoid muscle to improve as the children get older. Stathopoulos and Sapienza (1997) also reported of differences in anatomy of the upper and lower respiratory tracts with increasing age, which in turn affect the acoustic output.

Karike and Kishore (2012) reported increase in estimated subglottic pressure (ESGP) value in males increased till 10-11 years of age then declined in the age group of 11-12 years. Even in females the ESGP value increased till 8-10 years and declined afterwards. Thus, indicating that the development variations in the laryngeal system will have a significant effect on the acoustic measures of voice. The results of the present study indicate that the children in the developmental age will be heterogeneous with respect to their voice characteristics. Therefore, considering the preliminary status of the present study, the findings have to be verified on larger population with more number of children under each age group.

Comparison of perturbation and noise measures in present study with Western norms: The results of the present study were compared with the Western norms that are provided in the MDVP database. The results of one sample t-test indicated that compared to Western norms the values in Indian children differ significantly for all frequency perturbation measures, APQ and NHR (table 3). The frequency perturbations are higher in general in the Western children compared to the Indian children. The APQ and NHR values are higher in Indian children compared to Western children (table 2). This may be due to the factors that generally influence perturbation and noise measures such as differences in the vocal tract length, intensity, type of phonatory initiation and termination, F0 level (Koike 1973, Hollien, Michel & Doherty, 1973).

Table 3: Mean and p values of the perturbation and noise measures across Indian and Western population

<table>
<thead>
<tr>
<th>Indian</th>
<th>Western</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter%</td>
<td>1.13</td>
<td>1.69</td>
</tr>
<tr>
<td>RAP</td>
<td>0.68</td>
<td>1.03</td>
</tr>
<tr>
<td>PPQ</td>
<td>0.67</td>
<td>0.98</td>
</tr>
<tr>
<td>sPPQ</td>
<td>0.93</td>
<td>3.8</td>
</tr>
<tr>
<td>Shimmer%</td>
<td>5.12</td>
<td>4.25</td>
</tr>
<tr>
<td>APQ</td>
<td>3.76</td>
<td>2.81</td>
</tr>
<tr>
<td>sAPQ</td>
<td>5.23</td>
<td>3.8</td>
</tr>
<tr>
<td>NHR</td>
<td>0.14</td>
<td>0.12</td>
</tr>
<tr>
<td>VTI</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>SPI</td>
<td>5.94</td>
<td>10.2</td>
</tr>
</tbody>
</table>

*parameters found to be significant at p<0.05
The present study used the mouth-to-microphone distance of 15cm, and the recordings are made in a quiet room rather sound treated room, possibly contributing to increase in amplitude perturbations. However, it is not clear to what extent this difference is due to the methodological differences as these details are not provided in the MDVP manual or in the official website. Nevertheless, according to the manual, the database was based on a small group of participants, and suggests having indigenous normative database.

Comparison of perturbation and noise measures with the adult Indian norms: The results of the present study are compared with the study in Indian adults by Hema, Sangeetha, and Pushpavathi (2009). The results of one sample t-test indicated that compared to adults the values in Indian children differ significantly for all perturbation measures. Noise measures are comparable to adults and showed no statistically significant difference (table 4). However, the SPI value was found to be lower in children compared to the adults. The lower SPI value may be due to use of loud voice by children both habitually and due to performance related enthusiasm. As louder voice demands a firm glottic closure, which allows lower air turbulence and subsequently lower high-frequency noise than usual phonation, hence decreasing the SPI value.

The perturbation measures especially the amplitude perturbation measures are higher in children when compared to that of adults (figure 3). This finding is consistent with the study by Cappellari and Cielo (2008) who reported jitter values to be higher in younger children when compared to older ones. The authors reason the finding that as the maturation increases the perturbations decrease as there was a gradual higher control of emission as the age increased. The higher values of jitter % in children was also in agreement with the study by Steinsapir et al., (1986) who also reported higher jitter values for children compared to adults.

Table 4: Mean and p values of the perturbation and noise measures across Indian children and adults.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Children (Mean)</th>
<th>Adults (Mean)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter%</td>
<td>1.13</td>
<td>0.99</td>
<td>0.00*</td>
</tr>
<tr>
<td>RAP</td>
<td>0.68</td>
<td>0.58</td>
<td>0.00*</td>
</tr>
<tr>
<td>PPQ</td>
<td>0.67</td>
<td>0.56</td>
<td>0.00*</td>
</tr>
<tr>
<td>sPPQ</td>
<td>0.93</td>
<td>0.6</td>
<td>0.00*</td>
</tr>
<tr>
<td>Shimmer%</td>
<td>5.12</td>
<td>3.14</td>
<td>0.00*</td>
</tr>
<tr>
<td>APQ</td>
<td>3.76</td>
<td>2.19</td>
<td>0.00*</td>
</tr>
<tr>
<td>sAPQ</td>
<td>5.23</td>
<td>2.91</td>
<td>0.00*</td>
</tr>
<tr>
<td>NHR</td>
<td>0.14</td>
<td>0.12</td>
<td>0.00*</td>
</tr>
<tr>
<td>VTI</td>
<td>0.05</td>
<td>0.04</td>
<td>0.3</td>
</tr>
<tr>
<td>SPI</td>
<td>5.94</td>
<td>14.47</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*parameters found to be significant at p<0.05
children during pre-pubertal age. They opined that as the development and physiological functioning of the phonatory system remains similar pre pubertally in children and the gender differences are more evident during and post-pubertally.

Further, the relative measures of perturbation such as Jitter %, RAP, APQ etc. are less influenced by the level of average fundamental frequency or average amplitude (Horri, 1979). Therefore, the absence of gender effect in the present study may be due to the fact that only relative measures of frequency and amplitude perturbations were considered. Hema et al., (2009) also reported no significant influence of gender on the noise measures NHR, VTI and SPI; and on majority of the perturbation measures. It may be possible that both males and females are using similar physiological patterns in terms of glottic closure and cycle-to-cycle variations, despite the presence of structural differences in vocal tract and vocal folds. This indicates that both males and females compensate for variations in their vocal tracts in order to reach the goal of voice production without majorly perturbing the system.

Table 5: Effect of gender on the perturbation and noise measures.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>p value (Between Gender)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jitter%</td>
<td>0.31</td>
</tr>
<tr>
<td>RAP</td>
<td>0.33</td>
</tr>
<tr>
<td>PPQ</td>
<td>0.22</td>
</tr>
<tr>
<td>sPPQ</td>
<td>0.06</td>
</tr>
<tr>
<td>Shimmer%</td>
<td>0.67</td>
</tr>
<tr>
<td>APQ</td>
<td>0.87</td>
</tr>
<tr>
<td>sAPQ</td>
<td>0.90</td>
</tr>
<tr>
<td>NHR</td>
<td>0.07</td>
</tr>
<tr>
<td>VTI</td>
<td>0.12</td>
</tr>
<tr>
<td>SPI</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Conclusion

Perceptual assessment remains the gold standard for voice evaluation. However evaluation of voice perceptually is affected by factors such as experience of the examiner and expertise in the field. Thus the perceptual evaluation requires to be validated by an objective method for better reliability. MDVP is one such objective method of evaluation which gives an insight into a wide arena of parameters that tap different parameters of vocal physiology non-invasively. However the lack of normative data of children in the Indian scenario might limit the effective use of this module. This study is a preliminary effort at documenting the perturbation and noise measures in children between 6-12 years. The results of the study indicated no effect of gender on the perturbation and noise measures. The study also revealed a significant difference of the mean values of the perturbation measures when compared with those of the adults. The study may be replicated in a larger population with larger sample size under each age group and by better controlling the factors that affect perturbation and noise measures for better validation of the results.

References


PHONOLOGICAL MEAN LENGTH OF UTTERANCE (PMLU) IN TYPICALLY DEVELOPING TELUGU SPEAKING CHILDREN: A DEVELOPMENTAL PERSPECTIVE

Kalyani, B., Lakshmi Prasanna Swamini, Vani Rupela, & Lakshmi Venkatesh

Abstract

Phonological MLU or pMLU is a measure of whole word complexity that gives an indicator of phonological development. The objective of the current study was to study phonological skills of Telugu speaking typically developing children using pMLU as a measure. Cross-sectional data were collected from fifty typically developing Telugu-speaking children. Children were divided into five age groups from 2;6 to 5;0 years of age. As age increased, the pMLU also increased and the five age groups were significantly different from each other. Overall, the pMLUs were larger than those of English- and Hindi- speaking children and similar to those of Kannada-speaking children. Further, pMLUs of five mental age matched children with Down syndrome are presented in comparison to those obtained from typically developing children. Children with Down syndrome demonstrated pMLUs which were significantly lower than those of the typically developing children. Results are discussed from a cross-linguistic perspective highlighting the limitations and usefulness of pMLU in the Indian context.

Keywords: pMLU, phonology, Telugu, Down syndrome

Early studies on phonological acquisition have emphasized analysis of individual segments in within a word or utterance in general and specifically the accuracy of consonants. Quantification of errors has had some focus as well. One popularly used metric is Percentage of Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982; Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997) and many variants have also been described in the literature considered to be useful for varied clinical or research purposes. However, types of errors and whole-word errors are not taken into account. Recent studies have focused on measures of whole word complexity (Masterson & Kamhi, 1992, Ingram, 2002). One such whole word measure targeting phonological proficiency is the Index of Phonetic Complexity (IPC; Jakielski, 1998) designed to capture the nature of child’s speech independent of the target in terms of features (dorsals, liquids, affricates), word characteristics in terms of place of articulation and word shapes (final consonants and clusters). This has the advantage of analyzing the strengths and weaknesses of the child’s phonological system rather than simply comparing the child’s phonological system with a target. However, not much psychometric data is available for this measure and three is a need for further studies on establishing validity and reliability for the IPC measure.

Another measure, the Weighted Speech Sound Accuracy (WSSA; Preston, Ramsdell, Oller, Edwards, & Tobin, 2011) on the other hand uses a relational analysis (i.e. comparing the child’s form with the adult target). Child’s production is compared with the target form in terms of the number of segments (global structural agreement) and in terms of features of the segments that are represented (featural agreement) to result in a single score for a given utterance, segment or sample (Preston, et al., 2011). Weightage is given according to the kinds of errors recorded. Major changes in substitution as judged in English are weighted more heavily than minor changes. Initial validity and reliability data do point to usefulness of this measure in separating typical and disordered speech production. More research will prove valuable in establishing a quantification system for phonetic accuracy.

Another measure is the Phonological Mean Length of Utterance (pMLU) (Ingram & Ingram, 2001; Ingram, 2002) which has gained popularity despite its limitations in not giving weightage to types of errors which have been overcome by measures such as IPC and WSSA. pMLU is calculated as the total number of consonants and vowels produced regardless of whether they are accurate or inaccurate plus the number of correct consonants, divided by the number of words produced (Ingram, 2002). The value of pMLU has been demonstrated in tracking phonological development in monolinguals, bilinguals, across languages, and in comparison with children having disordered phonologies. It must be noted that the pMLU measure may be influenced by the...
phonological structure of words and child’s vocabulary (Preston, et al., 2011). This measure has had a lot of attention in India as well with studies being published in Kannada, and Hindi in typically developing as well as disordered population.

Two studies have been done in Kannada-speaking children. Balasubramanium and Bhat (2009) investigated pMLU in 400 Kannada-speaking children between 3-7 years of age. pMLU from spontaneous speech samples increased with increase in age of children indicating a developmental trend in pMLU acquisition. No significant gender differences were observed. Archana, John, Veena, Mohite and Rajashekar (2011) studied Kannada speaking children with Down syndrome between 6 to 15 years and language-age matched typically developing children (3-4 year olds’). Children with Down syndrome (DS) had significantly lower pMLU scores when compared with typically developing children. All of the typically developing children belonged to stage V and above of pMLU as described by Ingram (2002). On the other hand, 57% of the children with DS were in group V, around 3% were in group III, 34% were in group IV, and 6% belonged above group V. A comparison of the two studies in Kannada was not possible because of unavailability of raw scores. Findings were only reported to be slightly different because of variations in method in the two studies including nature or speech sample, sample size and listener bias. pMLU and related measures (Percentage of Words Correct-PWC and Proportion of Whole Word Proximity-PWP) were studied in Hindi among 12 typically developing children in the age range of 2-3 years divided into two groups of six-month age intervals (Jaisinghani, Akshay, & Sreedevi, 2012). The study utilized 30 ‘most familiar’ words from the Hindi articulation test to obtain the speech samples. While there was a significant increase in scores of pMLU and PWP in the older children, PWC scores in the younger and older groups were not significantly different from each other. Authors report that their results were ‘similar’ to those found by Balasubramanium and Bhat (2009). Since the age ranges of the Hindi study (2-3 years) were different from the Balasubramanium and Bhat study (3-6 years), we presume the authors mean similarity in terms of age effect i.e. pMLU values increase with age. Also, there were methodological differences between the two studies and therefore no direct comparisons can be made. While Balasubramanium and Bhat (2009) used spontaneous speech samples, the other two Indian studies (Archana et al., 2011; Jaisinghani et al., 2012) used imitation tasks involving repetition of words from articulation tests. In another study, Balasubramanium, Bhat, and Prasad (2011) studied 16 individuals with phonological disorders between 3 and 6 years of age in comparison with 30 chronological age matched typically developing children. They found that pMLU of children with phonological disorders were significantly lower than those of typically developing children.

Ingram (2002) studied children acquiring Cantonese and Spanish in a cross-linguistic study. It was found that while the Cantonese child had relatively low pMLU, the Spanish children, had higher pMLU values by the age of two years. Ingram (2008) made a cross-linguistic comparison of Spanish, English, French and Dutch. While the Spanish speaking children had relatively low pMLU values, English, French and Dutch-speaking children had relatively low pMLU values suggesting that the phonologies of these languages are harder to acquire (Ingram, 2008). pMLU was therefore found useful in discerning cross-linguistic differences and also helped in understanding the course of phonological acquisition in varied language environments.

Utility of pMLU also lies in studying children with communication disorders. Gerrits and Bree (2009) studied PCC (Percentages of Consonants Correct) and pMLU in Dutch children with a family history and therefore risk of dyslexia and compared the results with children with Specific Language Impairment (SLI) and typically developing children. Lowest scores were obtained by children with SLI, followed by children at risk of dyslexia, and typically developing children. pMLU values and PCC scores were examined in Spanish-English bilingual children with speech sound disorders and age-matched monolingual peers (Burrows & Goldstein, 2010). Results revealed that differences between the bilingual children with speech sound disorders and monolingual children were not statistically significant. In a study of Finnish children with developmental verbal dyspraxia, Martikainen and Korpihalhi (2011) examined the efficacy of Touch-Cue Method and Melodic Intonation Therapy, using the pMLU measure among other measures. They found that the child’s progression during the period examined was meaningfully reflected in the pMLU values. There exist very few studies on phonological development in children speaking Indian languages which have examined the pMLU measure. This measure seems to have had some popularity in India in the recent past and we decided to study its usefulness in the data in Telugu speaking children. The current study

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aimed to determine the pMLU in utterances of typically developing Telugu speaking children between 2 years 6 months and 5 years of age. A group of five children with Down syndrome were also included in a comparison group to evaluate the clinical utility of this measure.

**Method**

**Participants**

*Standard group:* Fifty typically developing children in the age range of 2; 6 to 5; 0 years participated in the study. Children were enrolled from play schools, pre-primary and primary schools in Hyderabad, Andhra Pradesh. They were divided cross-sectionally into five groups of six-month age intervals (group-1: 2;6-3;0 & group-5: 4;6-5;0 years). Each group had an equal number of male and female participants. All children were from primarily Telugu speaking families and they had limited exposure to Dakhini and English in their respective schools and neighborhoods. Inclusionary criteria for enrollment of children into the study included typical development of speech and language as reported by parents and age appropriate performance on Receptive and Expressive Emergent Language Scale (REELS; Bzoch& League, 1971) and the extended Receptive and Expressive Emergent Language Scale (compiled by All India Institute of Speech & Hearing), no prior enrollment in speech or language intervention and learning difficulties as per teacher’s reports, normal hearing status as per informal hearing screening, and without developmental, psychological or neurological deficits. The structure and function of oral articulators was found to be within normal limits as assessed informally.

*Comparison group:* Five children with Down syndrome with a mental age of 3 to 5 years and chronological age between 5-8 years were also included in the study. Of the five children, four were females and one child was male. All children were reported to have Trisomy 21 by their caregivers. They had all been receiving speech and language therapy for an average of 2 years. Details of receptive and expressive language ages are given in Table 2. Their recordings were conducted in relatively quiet surroundings using a digital recorder.

**Stimuli:** In order to assess the pMLU, spontaneous speech samples were elicited from each child for duration of 20 to 30 minutes. Samples comprised a minimum of 50 utterances.

**Procedure**

The experimenter served as a conversational partner and elicited a spontaneous speech sample from children using age appropriate pictures and toys. A sample of continuous speech is reported as the most valid means of determining the frequency of occurrence of specific syllable structure in a language (Morrison & Shriberg, 1992). Conversational speech is also considered to reflect the child’s habitual speech in actual communicative settings (Craighead, Newman & Secord, 1989). The samples were obtained informally and audio recordings were done using a portable digital recorder in a relatively quiet environment. The children’s productions were transcribed using broad IPA transcription method and pMLU was calculated for each child as per the guidelines given by Ingram (2002). For each word, the number of consonants and vowels as produced by the child were counted and summed with the number of correct consonants in the word. This sum calculated for each word was further summed across all the words produced by a child and divided by total number of words to obtain the pMLU scores.

In the pMLU count, the child’s target words were first assigned points for all segments (one point for each consonant and vowel segment) and an additional point was given for all consonants (one point per consonant). A Telugu word such as /ka:lu/, meaning ‘leg’, would receive a score of six (four plus two), while a word such as /padava/, meaning ‘boat’, would receive a score of nine (six plus three). Therefore, in an analysis of 50 words, all 50 target word pMLU scores were added and the sum was divided by 50 to gain an average pMLU score for a child.

**Statistical Analysis:** One-way Analysis of Variance (ANOVA) was used to assess differences in pMLU across the five age groups among typically developing children. Paired comparisons between age groups were made using Bonferroni post-hoc analysis. Five children with Down syndrome were also included in a comparison group. However, no group comparisons between typically developing children and children with Down syndrome were made because of the small number of children in the comparison group. It was found more useful to compare the individual findings of this group because of the variability in speech of children with Down syndrome (Stoel-Gammon, 1980).
Results

pMLU in typically developing children: Table 1 shows the descriptive statistics for pMLU calculated for conversational speech samples of typically developing children in the five age groups. The same is shown in Figure 1. Groups 1 through 5 represent the younger to older children. Statistical analysis was done using One-way ANOVA that revealed significant differences in pMLU of children across the five age groups (F (4, 45) = 412.53, p<0.001, η²_p = 0.973) suggesting a developmental trend in the pMLU scores of Telugu-speaking children from 2; 6 years to 5 years of age. Post hoc analysis of age effect using Bonferroni method corrected for multiple comparisons revealed significant differences across all the five age groups (p<0.001). Therefore, pMLU scores increased across all the five age groups of children. If we were to divide the groups in terms of stages as described by Ingram (2002), we would find that while group 1 and 2 were in stage V, the other three groups were above stage V. Therefore, even though the group means were increasing with age, the progression of ‘stages’ did not occur the same way.

Table 1: Descriptive statistics for pMLU among the five age groups of typically developing children

<table>
<thead>
<tr>
<th>Age Groups (years; months)</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2; 6 - 3; 0</td>
<td>7.06</td>
<td>0.10</td>
<td>7.10</td>
<td>6.87</td>
<td>7.17</td>
</tr>
<tr>
<td>3; 1 - 3; 5</td>
<td>7.48</td>
<td>0.17</td>
<td>7.48</td>
<td>7.21</td>
<td>7.69</td>
</tr>
<tr>
<td>3; 6 - 4; 0</td>
<td>7.95</td>
<td>0.11</td>
<td>7.98</td>
<td>7.75</td>
<td>8.07</td>
</tr>
<tr>
<td>4; 1 - 4; 5</td>
<td>8.36</td>
<td>0.07</td>
<td>8.37</td>
<td>8.26</td>
<td>8.46</td>
</tr>
<tr>
<td>4; 6 - 5; 0</td>
<td>8.99</td>
<td>0.12</td>
<td>8.95</td>
<td>8.82</td>
<td>9.18</td>
</tr>
<tr>
<td>Total</td>
<td>7.97</td>
<td>0.69</td>
<td>7.98</td>
<td>6.87</td>
<td>9.18</td>
</tr>
</tbody>
</table>

Comparison of pMLU by gender showed that there was no statistically significant difference between the means of pMLU scores of female and male participants across the different age groups.

pMLU in children with Down syndrome: Five children with Down syndrome (DS) with a mental age between 3-5 years were also included in the study in order to investigate the clinical utility of the pMLU measure. The chronological age of children ranged from 5-to-8 years. Table 2 shows the pMLU obtained from conversational speech samples of children with Down syndrome.

Table 2: pMLU in children with Down syndrome

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Chronological Age (years; months)</th>
<th>Sex</th>
<th>Receptive Language Age (years; months)</th>
<th>Expressive Language Age (years; months)</th>
<th>pMLU</th>
<th>Stage of pMLU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5;0</td>
<td>F</td>
<td>3;6 - 4;0</td>
<td>3;0 - 3;6</td>
<td>7.61</td>
<td>Above V</td>
</tr>
<tr>
<td>2</td>
<td>5;5</td>
<td>F</td>
<td>2;9 - 3;0 scattered to 3;0 - 3;6</td>
<td>2;6 - 2;9 scattered to 2;9 - 3;0</td>
<td>6.16</td>
<td>IV</td>
</tr>
<tr>
<td>3</td>
<td>5;7</td>
<td>F</td>
<td>2;6 - 2;9 scattered to 2;9 - 3;0</td>
<td>2;6 - 2;9 scattered to 2;9 - 3;0</td>
<td>5.77</td>
<td>IV</td>
</tr>
<tr>
<td>4</td>
<td>8;0</td>
<td>F</td>
<td>3;0 - 3;6 scattered to 4;0 - 4;6</td>
<td>3;0 - 3;6</td>
<td>7.67</td>
<td>Above V</td>
</tr>
<tr>
<td>5</td>
<td>7;0</td>
<td>M</td>
<td>3;0 - 3;6</td>
<td>3;6 - 4;0</td>
<td>7.58</td>
<td>Above V</td>
</tr>
</tbody>
</table>

The pMLU scores of children with Down syndrome ranged from 5.77 to 7.67. While two children were in stage IV, the other three were above Stage V. Since there were only five children in the comparison group, we found it more useful to compare their individual means to the typically developing children’s group means rather than the stages they were in. pMLUs that were lower than those seen in typically developing children below 3 years 6 months of age. Indeed, the language age of children with Down’s syndrome was lower than age matched typically developing children.

Discussion and Conclusions

The current study attempted to investigate pMLU in typically developing Telugu speaking children of 2;6-5;0 years of age. Clinical utility of calculation of pMLU scores was also investigated on children with Down syndrome. Results revealed that among typically developing children, pMLU scores increased with age and the differences were significant across the multiple comparisons. pMLU seems to be a fairly good indicator of phonological maturity with age.
among typically developing children. When we compared 5-8 year old children with Down syndrome, we found that their scores were lower than those seen in typically developing children below 3;6 years of age. The results suggest that phonological patterns used by children with Down syndrome have characteristics of those used by typically developing younger than 3;6 years.

In general, the pMLU scores were higher in comparison to those of English speaking children as reported by Ingram (2002) and largely similar to those observed by earlier studies of Kannada speaking typically developing children (Balasubramanium & Bhat, 2009; Archana et al., 2011). Kannada and Telugu are both Dravidian languages that are phonologically similar to each other. On the other hand, English has a different morphosyntactic and phonotactic structure when compared to Dravidian languages. The stages described by Ingram (2002) could not be suitably applied in the current context. In typically developing children, while the means increased with age, the stages did not and therefore, it was not useful in the present study to compare the stages in and of themselves. In fact, in children with Down syndrome, the children above stage V were only around 0.08 to 0.11 points above the cutoff point for being in Stage V. It is therefore clear, that the same cut-off points for pMLU in English-speaking children cannot be applied for children speaking Dravidian languages such as Kannada or Telugu. However, pMLU was useful in both deriving a developmental trend in phonology among typically developing children and also in its clinical value for the assessment of phonological skills of children with Down syndrome. Significant differences in pMLU were observed across the groups of typically developing children in the current study. These preliminary findings among children with Down syndrome suggest that pMLU has potential to serve as indicator of phonological complexity of a child’s speech. It is also clear that chronological age of children with Down syndrome was not an indicator of pMLU.

In conclusion, most of these numerical measures of phonology such as PCC (Shriberg & Kwiatkowski, 1982; Shriberg et al., 1997) and all its variations, pMLU, IPC (Jakielski, 1998), WSSA (Preston et al., 2011) and other such measures of phonological complexity may be appropriate as objective measures especially for research purposes. Their value in the clinical setting for deriving phonological goals for intervention however needs careful consideration. Nevertheless, such measures require rigorous psychometric data in order to be applicable to the Indian context. A beginning was the study using 400 spontaneous speech samples by Balasubramanium and Bhat (2009). However, the validity and reliability of the measure could not be established and unavailability of raw scores made the task of cross-linguistic comparisons difficult. Various limitations of pMLU need to be evaluated before such a large scale study is implemented. The findings of the current study in Telugu are preliminary. Future studies using large samples and rigorous psychometric data would go a long way in rendering usefulness of a measure such as pMLU in the Indian setting.

Acknowledgment

Authors thank the children and their families for participation in the study. Authors also thank the school authorities for help with recruitment of children and Dr. P. Hanumantha Rao, Founder-Chairman, Sweekaar Rehabilitation Institute for Handicapped, Secunderabad, for granting permission to conduct the study. This work was carried out when the authors were at Sweekaar Rehabilitation Institute for Handicapped, Secunderabad.

References


PLEOMORPHIC ADENOMA – SOFT PALATE: A CASE REPORT

Rajeshwari, G., & Sundara Raju, H.

Abstract

Pleomorphic Adenoma is the most common benign tumor of the salivary gland. It predominantly occurs within the parotid gland, less than 3% of salivary gland tumors have been reported of pleomorphic adenoma of minor salivary gland. A case of a 47 year old woman presenting with Pleomorphic Adenoma of minor salivary gland is reported. Though Malignancies are very common in the minor salivary glands occasionally benign tumors like Pleomorphic Adenoma can also occur. Fine needle aspiration cytology study has to be established before planning surgery. The incidence of recurrences is low when a wide excision is planned.

Key words: minor salivary gland tumor, benign salivary gland tumor, oro pharyngeal tumor

Introduction

Pleomorphic adenoma is the most common benign salivary gland tumor. It is characterized by the proliferation of epithelial and myoepithelial cells of the ducts and increase in stromal component. The stroma is made up of myxoid, chondroid, fibroid, or osteoid tissue. It presents as a slow growing swelling, if the tumor is in oral cavity change in voice quality, a muffled or hot potato voice, is observed, patient can also complain of difficulty in swallowing. Elsevier health science - 2007 survey for salivary gland tumors show 60% of minor salivary gland tumors are malignant (Table 1).

Table 1: Distribution of Benign and Malignant Neoplasms of the salivary gland in various salivary gland

<table>
<thead>
<tr>
<th>Salivary Gland</th>
<th>Malignant (%)</th>
<th>Benign (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parotid</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Submandibular</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Minor salivary glands</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>

Investigations like Fine Needle Aspiration Cytology, Hematological Investigation, Radiological Investigation, Speech evaluation is required for appropriate diagnosis.

The british salivary gland tumour panel reviewed 2519 salivary gland tumour, of these the principal site of tumour was parotid followed by minor oropharyngeal gland. Pleomorphic adenoma formed the largest group of tumour in most sites and more common in parotid.

Pleomorphic Adenoma occurring in unusual anatomic sites includes the hard palate the soft palate para pharyngeal space. Pleomorphic adenoma can arise in the deep lobe of the parotid gland or, a minor salivary gland in the oropharynx.

Treatment is complete excision; the tumor has a false capsule. It is usually nodular and bosselated in appearance. Small projection of the tumor may penetrate the capsule causing recurrence. If the excision is incomplete it is followed by radio therapy. It accounts for about 65% of salivary gland neoplasm. Inadequate excision causes recurrence; malignant transformation can occur in 2.10 % of these tumors and is called carcinoma expleomorphic adenoma.

Case Report

A 45 year old female presented with a swelling of the soft palate and uvula of 6 months duration. It started as a small swelling in the area of the soft palate and uvula and gradually progressed to attain a size of 2 cm x .5 cm. It was a well circumscribed firm non tender mass with a smooth surface (Fig 1). The swelling was embedded in the mucosa of the soft palate; there was no extension to nasopharynx, hypo pharynx, tonsil, hard palate or any other part of oral cavity. Endoscopic evaluation reveals a normal larynx. Initially the patient was asymptomatic, except for the appearance of the mass, later she observed a change in voice, and then it was followed by difficulty in swallowing solid food. Apparently there were no other complaints, or systemic problems.

Patient underwent Fine Needle Aspiration Cytology. (FNAC) smears showed scantily cellular and few scattered and clustered epithelial cells with round to oval nuclei and moderate eosinophilic cytoplasm and basal nuclei. Features are suggestive of pleomorphic adenoma of minor salivary gland.surgery was planned under general anesthesia.

1Rajeshwari, G., E-mail: rajeshwarigovindaswamy18@gmail.com, & Sundara Raju, H., E-mail: drhsr_04@yahoo.co.in, Professors of ENT, All India Institute of Speech & Hearing (AIISH), Mysore- 06.
Figure 1: Pre operative picture

Under General Anesthesia with Nasotracheal intubation patients was placed in tonsillectomy position, a Doyens mouth gag was applied.

A horizontal incision was placed over the swelling. The capsule was dissected from the embedding mucosal surface with blunt dissection with a tonsil dissector and was excised completely. The redundant mucosa was excised and the palate was sutured with 3-0 chromic catgut after ensuring haemostasis. Patient was followed up for a period of 6 months and there was no recurrence (Fig 2).

Figure 2: Post operative picture

The excised mass was sent for histopathological examination. Cut section showed grey white tissue, section showed a polypoidal structure lined by stratified squamous epithelium, lying in the sub epithelium is a well circumscribed lesion separated by a grey zone from the overlying epithelium. Lesion show tumor tissue with a biphasic cell population consisting of myoepithelial cells and epithelial cells arranged in nests, cords and trabeculae in a fibro myxoid stroma no atypia is seen (Fig 3) Histopathology of the excision specimen confirmed the diagnosis of pleomorphic adenoma.

Discussion

Majority of salivary gland tumors are benign or low grade malignant. In long standing neoplasm genetic alteration such as p53 mutation and c-erb B2 amplification occurs. This results in malignant transformation, stromal invasion, high grade progression, over growth and dedifferentiation. Pleomorphic adenoma is a benign neoplasm consisting of cells with epithelial (luminal) and myoepithelial (abluminal) differentiation with various amount of stroma (Fig 4). Pleomorphic adenoma is a pure epithelial tumor with divergent differentiation.

Figure 3: Histopathology FNAC smears show scantily cellular and few scattered and clustered epithelial cells with round to oval nucleus and moderate eosinophilic cytoplasm and basal nuclei are seen.

Figure 4: Tubules lined by inner layer of ductal cells and outer layer or modified of myoepithelial cells

The monoclonal origin of both the epithelial and mesenchymal elements has been supported by molecular analysis. It occurs more frequently in women. It is prevalent from fourth to sixth decade. It can occurs in various mucosal sites such as nasal cavity, bronchus, skin, breast tissue and soft tissue.

Treatment of choice is complete surgical excision. Recurrence rate is 3-6 % respectively. Enucleation spillage or rupture of tumour, presence of protuberances, abundance of...
chondromyxoid stroma, young age are associated with higher recurrence rate.

Macroscopic appearance: The tumour varies from a few millimeters to several centimeters. It is thinly encapsulated and solitary. The cut surface may be rubbery fleshy mucoid or glistening depending on the stroma of the tumor. On microscopic the protuberances may protrude through the fibrous capsule. Histological appearance consists of tubular structures enveloped by myoepithelial mantles submerging in a chondromyxoid stroma.

The luminal cell components are columnar cuboidal or flat forming anastomosing tubules, cysts or ribbons. The duct lumen contains cosinophilic colloid like material. Myoepithelial cells appear as cuboidal, spindle, stellat, plasmacytoid hyaline, nondescript epitheloid and hydrophilic clear cells.

The stroma is mostly composed of acidic mucosubstances produced by the modified myoepithelial cells, and is positive for alcaline blue but variably positive for PAS. The stroma is a mixture of myxoid, chondro, chondromyxoid, hyaline tissue.

Immunohistochemistry is to demonstrate the coexistence of glandular and myoepithelial components. When the diagnosis is uncertain pleomorphic adenoma shows a low Ki – 67 proliferative index, rare immuno reactivity for P53 protein and week BCL2 staining.

Cytogenetic studies – shows translocation of genes PLAG 1 or HMGA2. These translocation can be identified by reverse transcriptase polymerase Chain reaction or fluorescence insitu hybridization which may aid in classifying tumour type.

Conclusion

Pleomorphic adenoma though a common partoid tumour, and tumours of minor saliving gland are mostly malignant. Pleomorphic adenoma can occur in minor salivary gland. A Fine Needle Aspiration Cytology before surgery helps to plan surgery. Wide excision inclusive of surrounding normal tissue would ensure low recurrence rate.

Reference


A COMPARATIVE STUDY ON THE IMPACT OF MEDIA VIEWING ON EARLY CHILDHOOD OF TYPICALLY DEVELOPING CHILDREN AND CHILDREN WITH AUTISM

1Anubhooti Nagar, 2Madhumita James, & 3Sah, V. P.

Abstract

With few literature reviews available in India over the effects of media exposure on children, a study was required to appraise the effects of media and timing of its exposure. A standard & validated questionnaire (adapted from the study of Rideout V.J. et al, 2003) was used in the survey to collect information from the parents (fluent in English) of 30 typically developing children and 25 autistic children between 3-6 years of age. In the first phase of data collection adaptation of the questionnaire to our cultural context and life-style was done. Second phase included collection of primary data through non probability sampling. A detailed history of the child with language assessment (REELS, Bzoeh & League, 1971) was taken. Additional CARS (Schopler et al, 1966) was administered on children with autism. On SPSS (V-12), a significant difference (p≤ 0.05) was found between the autistics and typically developing children in terms of receptive (t=9.033) and expressive (t=10.230) language age. Results revealed on an average child with autism were exposed to electronic media for 15.7 hours and typically developing children for 17.4 hours per week. Longer duration with unhealthy quality of viewing was seen in children (30.9%) belonging to low socioeconomic status and less educated parents. 64% parents of autistic and 56% parents of typically developing children stated that exposure to educational television shows mostly helps the children in intellectual development. According to parents either a positive or a negative behavioral modification was observed in children of both groups after being exposed to the electronic media. In conclusion, this paper highlights the need to assess the unfathomable intrusion of technology and its prospective effect in the life of children these days. The effects are detrimental and exposure to electronic media should be taken into consideration when assessing children with delayed or deviant language or any other behavioral problems. Better understanding of the amount and type of exposure will have scientific implications in terms of how the early environment of a child should be structured.

Key words: Language delay, Media exposure, Learning, Behavior, Autism

Introduction

While discovering the pleasures of life we have entered an age where we seem to have find solace in technology to do all our chores. For children the youngest recipients, technology seems to be the most amusing thing on planet! Incidently technology has turned out to be both a boon and a bane. Media viewing especially television viewing began in late 1990’s which has now become an increasingly common occurrence and in the current scenario television has turned out to play a central role in most of the families (Mittal, 2011; Christakis, 2009). With the explosion in the media channels and the ideology which says that there should be something for everyone to watch all the time, the young brigade seems to be the most fascinated one. Consequence of which is that on an average an Indian kid is spending nearly 18-20 hours per week, viewing television (Mittal, 2009). But how this great deal of viewing affects its youngest audience which includes both, the typically developing children and the children with autism, is the question which compels us to find an answer. There are illustrious studies and certain perceptual notions of people which profoundly celebrate the downbeat effects of media viewing like obesity & inadequate dietary intake (Robinson, 1999) in typically developing children. It is observed these days that television has changed a typically developing child- an irresistible force to an immovable object. But sad enough media viewing in children with autism is not a celebrated domain. Besides the constitutional effects, the others areas which are said to have been affected by media viewing are language, cognition, attention, vocabulary and reading & writing skills. Literature avers that viewing violent images can cause restlessness in children (Hemamalini, Aram & Rajan, 2010); television viewing for more than 2hrs/day by children aged 12 months or less leads to language delay (Chonchaiya & Pruksananonda, 2008; Tanimura, Okuma & Kyoshima, 2007; Zimmerman, Christakis & Meltzoff, 2007). Early media exposure is also found to have influenced...
long term cognitive processes (Zimmerman & Christakis, 2005, Christakis, 2009). The timing of media exposure is also found to be a critical mediator in behavioral problems (Christakis, 2004; Christakis 2009; ) and early academic skills (Wright, Huston, Murphy, Peters & Kotler, 2001). Children with autism literature advocates their predilection for electronic screen media and resulting verbal and physical imitation (Shane & Albert, 2008). When compared to typically developing children, children with autism showed tendency of earlier onset and higher frequency of media viewing (Chonchaiya, Nuntnarumit & Pruksanananonda, 2011) but the resulting impact of media viewing, whether it is positive or negative in that group is not much documented.

Need for the study

With an alarming increase in the number of cases with delayed language and behavioral problems and few literature reviews available in India over the effects of media exposure on children, a study in India was the need of an hour to appraise the effects of media and timing of its exposure, which has become an integral part of today’s children’s life. This paper is bringing forth the results of a survey which is a part of an ongoing project, which will give us a clear picture of the effect of nature and the type of media exposure among typically developing and children with autism in India.

Aim of the study

To compare the differences and similarities between the two groups of children with autism and those that are typically developing in terms of:

1. The type of electronic media options they are exposed to
2. The duration of electronic media exposure per week
3. The preference of electronic media option by them
4. Parental preference for choice of electronic media options
5. The preferred television shows by children
6. Any variation in quantity and quality of media exposure in terms of educational status of parents
7. Any variation in quantity and quality of media exposure in terms of socioeconomic status of the family
8. Parental perspective about the impact of electronic media on children
9. Any change in behavior due to an impact of electronic media (as reported by parents).

A standard & validated questionnaire (adapted from the study of Rideout, Vandewater & Wartella, 2003) was used in the survey to collect information from the parents of 30 typically developing children and 25 children with autism between 3-6 years (mean age of typically developing children- 4.6yrs & children with autism- 4.5yrs, Standard Deviation (SD) - 1.16 & 1.15 respectively) from a Non Governmental Organization (NGO) and a preschool in New Delhi. Data was collected in two phases. First phase included adaptation of the questionnaire to our cultural context and life-style. Item analysis was done by a group of 10 speech and language pathologists with a minimum of 5 years of experience. Subsequently, the questionnaire was fabricated by deleting and modifying the questions as per scores.

Second phase included collection of primary data through non probability sampling. Parents were made to fill questionnaire in informal structured environment. A detailed history of all the children along with language assessment with REELS (Receptive and Expressive Speech Emergent Language Scale, Bzoch & League, 1971) was done. Childhood Autism Rating Scale (CARS), Schopler, (1966) was administered on children with autism. As the parents included in the study were fluent in English, responses were collected in the English version of the questionnaire. Inter-rater and intra-rater reliability of the items was also checked.

Results and discussion

Descriptive statistics and t-test values were obtained at 0.05 significance level (SPSS version 12.0). The mean age for children with autism included in the study was 4.6yrs and that for typically developing children was 4.5yrs. The mean scores were lower in children with autism compared with typically developing children in terms of receptive language age at 48.6 and 80.1 respectively and expressive language age at 45.1 and 80.2 respectively. Children with autism were exposed to electronic media at a mean of 15.7hours per week whereas typically developing children were exposed for 17.4 hours per week. However differences on impact of media on children of both groups did not vary much based upon the socio-economic status between the two groups.

The mean receptive language age as shown in children with autism and typically developing children was 48.6 and 80.1 respectively. The mean expressive language age in children with
autism was 45.1 and whereas in typically developing children it was 80.2 (table 1).

A significant difference (p≤ 0.05) was found between the children with autism and typically developing children in terms of the receptive (t=9.0) and expressive (t=10.2) language age, current educational placement (t=6.1), preferred electronic media by parents (t=-2.9) and the preferred television shows by the child (t=5.4) (table 2).

Table 1: Mean scores of children with autism and typically developing children among different categories.

<table>
<thead>
<tr>
<th>GRP</th>
<th>N</th>
<th>MEAN</th>
<th>SD</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>1</td>
<td>30</td>
<td>4.5</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>4.6</td>
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</tr>
<tr>
<td>SEX</td>
<td>1</td>
<td>30</td>
<td>1.4</td>
<td>.498</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.7</td>
<td>.436</td>
</tr>
<tr>
<td>RLA</td>
<td>1</td>
<td>30</td>
<td>80.1</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>48.6</td>
<td>13.8</td>
</tr>
<tr>
<td>ELA</td>
<td>1</td>
<td>30</td>
<td>80.2</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>45.1</td>
<td>13.4</td>
</tr>
<tr>
<td>Current educational placement</td>
<td>1</td>
<td>30</td>
<td>2.4</td>
<td>.56</td>
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<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.4</td>
<td>.58</td>
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<tr>
<td>Duration</td>
<td>1</td>
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<td>17.4</td>
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<td></td>
<td>2</td>
<td>25</td>
<td>15.7</td>
<td>7.3</td>
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<td></td>
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<td>25</td>
<td>2.2</td>
<td>.6</td>
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<td>30</td>
<td>1.2</td>
<td>.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.7</td>
<td>.6</td>
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<tr>
<td>Preferred electronic media by parents</td>
<td>1</td>
<td>30</td>
<td>1.6</td>
<td>.9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.2</td>
<td>.5</td>
</tr>
<tr>
<td>Preferred electronic media by child</td>
<td>1</td>
<td>30</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>3.9</td>
<td>1.7</td>
</tr>
<tr>
<td>TV. shows</td>
<td>1</td>
<td>30</td>
<td>1.8</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.6</td>
<td>0.94</td>
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<td>30</td>
<td>1.23</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1.20</td>
<td>0.40</td>
</tr>
</tbody>
</table>

SD- standard deviation, SEM- standard error of measurement
RLA- receptive language age
ELA- expressive language age, TV- television

Both children with autism and the typically developing children were more exposed to television as compared to any other electronic media. While there was a difference in duration of exposure to electronic media, the typically developing children were exposed for more duration (number of hours per week) i.e.17.4 hours than children with autism (15.7 hours) (figure 1).

Figure 1: Comparison of mean scores of both groups.

Figure 2: Percentage distributions of electronic media preferred by both the groups

80% of the children with autism and 70% typically developing children prefer to watch television shows as compared to any other electronic media. 56% of children with autism loved to watch music shows (figure 2) while 60% of the typically developing children preferred cartoons. 5.4% girls prefer watching soaps and serials while 23.6% boys love action oriented shows (figure 3).
Table 2: Comparative score of different categories in both groups

<table>
<thead>
<tr>
<th></th>
<th>Levene’s Test for Equality of Variances</th>
<th>T-test for Equality of Means</th>
<th>T-test for Equality of Means</th>
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<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
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<tr>
<td>Age</td>
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<td>.003</td>
<td>.9</td>
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<tr>
<td></td>
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<td>.212</td>
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<td>Sex</td>
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<td>6.3</td>
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<td>0.09</td>
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<td>48.0</td>
</tr>
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<td>Equal variances assumed</td>
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<td>0.1</td>
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<td></td>
<td>Equal variances not assumed</td>
<td>10.1</td>
<td>48.7</td>
</tr>
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<td>0.7</td>
</tr>
<tr>
<td></td>
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<td>6.17</td>
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</tr>
<tr>
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<td>0.4</td>
<td>0.5</td>
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<tr>
<td></td>
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<td>52.7</td>
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<td></td>
<td>Equal variances not assumed</td>
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</tr>
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<td>Preferred educational media by child</td>
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<td>.000</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
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<td>46.9</td>
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<tr>
<td>Favorite/ preferred type of TV Shows</td>
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<td>.010</td>
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<td></td>
<td>Equal variances not assumed</td>
<td>5.2</td>
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<td>0.558</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td>.294</td>
<td>52.0</td>
</tr>
</tbody>
</table>

RLA- receptive language age, ELA- expressive language age, TV- television

80% parents of typically developing children preferred educational television shows for their children while 52% of those having children with autism favored educational DVD’s of rhymes and stories as those children respond better to music (figure 4).

Children of low socio economic status and less educated parents were exposed to television for long durations with unhealthy quality of shows (30.9%) whereas those of highly educated parents with better socio-economic status were exposed to all kinds of electronic media and learned through Hi- Tech gadgets (table 3).
Figure 4: Comparison of preferred electronic media by parents of both groups.

About 64% parents of children with autism and 56% of typically developing children state that exposure to educational television programs mostly helps children in their intellectual development (figure 5).

Table 3: Frequency distribution of subjects in educational status versus economic status category

<table>
<thead>
<tr>
<th>Economic status</th>
<th>Educational Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High school</td>
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<tr>
<td>&lt;10,000</td>
<td>6</td>
</tr>
<tr>
<td>10,000-50,000</td>
<td>6</td>
</tr>
<tr>
<td>&gt;50,000</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
</tr>
</tbody>
</table>

N.B. Typical ⇒ Typical children; Autistic ⇒ Children with Autism

Figure 5: Comparison of percentage scores of parental perspective about effect of television viewing among both groups.

A change in behavior (positive or negative) of children after being exposed to the electronic media was reported by the parents in both the groups. Typically developing children were reported to emulate aggressive behavior while the ones with autism were accounted for benefit from media exposure (figure 6).

Among children with autism, majority (56%) of the subjects belonged to middle income group, most children go to either special school or NGO (60%) suggesting that the need of special intervention and care and a dreamy scenario of inclusive education for these kids. Television (80%) was the most preferred choice of electronic media by the children among which music channels were favored most. Parents preferred educational DVD’s of musical rhymes and stories, revealing that these children enjoy music a lot and melodic intonation therapy is beneficial and worth for this group. 64% of the parents had a perspective that educational television shows can have beneficial impact on their child’s intellectual development as they respond to the television shows mostly in a positive manner and it enhances their memory and cognition skills. 80% of the parents reported a change in behavior of their child due to electronic media.

In typically developing children, majority of subjects were pre-scholars (63.3%) and belonged to high income group (46.7%), television was the most preferred electronic media among 80% of the parents and 70% of the children. Even the perspective of this group was that television shows mostly help their children (56.7%) and 76.6% noticed a change in behavior of their child. Aggression, throwing tantrums, destructiveness, restlessness and distraction were some the negative behavior’s which were informally reported whereas some of the parents reported that their children learn social and self management skills, better ways of communication and adapted loving, caring and respectful nature.
Limitations of the study

The first and the foremost limitation of this paper is the small group of 30 typically developing children and 25 children with autism. Secondly, this is not a longitudinal study which would compare the effects of media viewing in children and would explore the concrete effects of media viewing in children in terms of language development, behavioral outcomes and cognition in Indian context.

Areas of future research

With the manifold advancement in technology, the exposure to media in young children is inevitable and so, is the broad area of research in the effects of media viewing in young children in India. With the rising number of children turning up with delayed or deviant language in hospitals and clinics these days, media exposure is definitely one field which needs to be explored and primary prevention approaches to excessive or inappropriate viewing should be formulated rather than media reduction strategies. Better understanding of the amount and type of exposure will have scientific implications in terms of how the early environment of a child should be structured.

Conclusion

This paper highlights the need to assess the unfathomable intrusion of technology and its prospective effect in the life of children these days. As evident considerable work in the area of young children and media is needed as media’s presence in lives of young children is large and growing. As stated above, the effects are detrimental and thus, the exposure to electronic media should be taken into consideration when assessing children with delayed or deviant language, or other behavioral problems. Hence, parents should be counseled regarding fruitful media viewing or its usage approaches for where there is a will, wisdom finds its way.

References


ASSESSMENT OF LANGUAGE PROFICIENCY IN BILINGUALS: RELEVANCE FOR BILINGUAL EDUCATION

1Prema K. S., & 2Mekhala, V. G.

Abstract

Consequent to globalization, proficiency in language has become an integral part in the domain of education. With the prevailing bilingualism in the educational set-up, there is a need to explore if we are geared to meet the challenges of bilingual education. Two studies were conducted in this direction. The first study focused on development of language proficiency assessment tool for Kannada-English bilinguals with primed Lexical Decision Task (LDT) paradigm (online task) validated with self rating questionnaire, LEAP-Q (offline task). The reaction time obtained on LDT was compared with the scores on LEAP-Q. The results indicated positive correlation between translation equivalent pairs of LDT and LEAP-Q suggesting that primed LDT could serve as a test for bilingual proficiency. In the second study, fifteen teachers who are non-native speakers of Kannada and English were tested for language proficiency using the online task. The results indicated that the teachers, although residing in Kannada speaking areas for long years, were less proficient in Kannada (mother tongue of children) compared to English (the medium of instruction). The outcome of the study has implications for educational policy makers and teacher educators in countries where bilingualism and multilingualism in education has been a challenge.

Keywords: Bilingual education, Proficiency assessment, Lexical decision task

Bilingualism refers to knowledge and use of two languages and an ability to make a meaningful utterance in another language (Harding and Riley, 1986). It is a sociolinguistic phenomenon that has received much scholarly attention. Bilinguals may have varying degrees of proficiency over their two languages. Hence, assessment of language proficiency is a complex task that continues to stir much debate among language researchers, test developers as well as educators. Major differences of opinion concern the exact nature of bilingualism, language proficiency and how best to do its assessment. MacNamara (1967) grouped the kinds of tests used to measure bilingual ability into rating scales, fluency tests, flexibility tests and dominance tests. Rating scales and Questionnaires are the commonly used tools in the assessment of language proficiency and they are subjective in nature, prone to bias as the subject himself/herself rates his/her proficiency. Besides these, administration of such tests is generally time-intensive for both the examiner and the examinee. To overcome this limitation, online tools have been used in the recent years.

Among the online tasks, primed lexical decision tasks and lexical naming tasks (Meyer and Schvaneveldt, 1971) have been frequently used to study bilingual lexical organization. There are very few studies documented in the Indian context investigating priming effects as an indicator of language proficiency. Bilingualism in India is different from that prevalent in other countries. The heterogeneity in India suggests that the language framework cannot be defined by fixed categories given by a few bilingual theorists (Pattanayak, 2011). The International Meet held with the National Multilingual Education Resource Consortium (NMRC) and many other organizations in September, 2011 in Mysore discussed issues of Mother tongue based Multilingual Education (MLE) policy adopted by many states in India. One of the major issues was ‘capacity building’ for a large number of teachers since the number of teachers available from within a given language community is disproportionate to the number of children.

While majority of discussion by theorists and educational policy makers focus on bi/multilingual status of children, very few have explored its significance in bi/multilingual teachers imparting education to children who are ‘native speakers’ of ‘non-native language’ of teachers. Therefore, a need for development of an online tool for the assessment of language proficiency in teachers was strongly felt and was designed in two phases as Study 1 and Study 2 as detailed below.

Study No. 1: Development of online test for language proficiency: The study was undertaken with the aim of developing a computer based test for quick, online assessment of language proficiency in Kannada-English bilinguals that serves a wide range of purposes for professionals such as speech language pathologists, researchers, educational administrators involved in assessing the proficiency of languages in teachers, diplomat from different countries or the second language learners.

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Method

Thirty adults in the age range of 18-30 years, with Kannada as their native language L1 that is acquired first and English as their L2 that is acquired later, with a minimum educational qualification of 10 years in L2 served as participants for the study. All the participants self-rated their language proficiency on LEAP-Q (Language Experience and Proficiency questionnaire, Ramya & Goswami, 2009) as well as performed on a Lexical Decision Task (LDT). Informed consent was obtained from all the participants and ethical guidelines stipulated by the organization are followed for the conduct of the study.

Procedure: A total number of stimuli used for the LDT were six hundred target items and ten trial items. Out of six hundred items, three hundred each were selected from Kannada and English language. Three different types of primes were prepared for selected target words: semantically related primes, translation equivalents primes and semantically unrelated primes. The sets were formed based on the relation of prime with that of target word, the three sets being semantically related (SR), translation equivalents (TE) and semantically unrelated (SUR) conditions. For each language 99 non words were selected in order to achieve word to non word ratio of 0.3. The stimulus presentation for the lexical decision and the response recording were controlled using DMDX, a computer based software. Mean reaction time was computed in each of the prime categories. The mean reaction time measures were compared and correlated with proficiency levels on LEAP—Q.

Results

The performance of participants in the LDT was compared for Kannada and English languages. The mean and standard deviation values of R.T. for the three types of stimuli (translation equivalents, semantically related and semantically unrelated) between the two languages of the bilinguals (Kannada and English) are shown in Table 1 and Figure 1. Results revealed that the performance was better in Kannada (L1) in comparison to English (L2). Short R.T. was observed on TE stimuli compared to the other two prime types (SR and SUR) in both L1-L2 and L2-L1 conditions.

As shown in Table 1 and Figure 1, for translation equivalent stimuli type in Kannada, the mean and standard deviation values were 1468.36 milliseconds and 405.97 milliseconds respectively. Paired samples T-test to test for statistical differences in the R.T. between Translation Equivalent (TE) stimuli types in Kannada and English language indicated significant difference (p<0.004).

Table 1: Mean R.T. and SD values of LDT for Kannada and English languages

<table>
<thead>
<tr>
<th>Type of stimuli</th>
<th>Mean scores (Range: 200-4000ms)</th>
<th>N</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>KMTE</td>
<td>1468.36</td>
<td>30</td>
<td>405.97</td>
</tr>
<tr>
<td>EMTE</td>
<td>1780.45</td>
<td>30</td>
<td>508.99</td>
</tr>
<tr>
<td>KMSR</td>
<td>1757.95</td>
<td>30</td>
<td>361.50</td>
</tr>
<tr>
<td>EMSR</td>
<td>2028.67</td>
<td>30</td>
<td>439.61</td>
</tr>
<tr>
<td>KMSU</td>
<td>2024.51</td>
<td>30</td>
<td>454.54</td>
</tr>
<tr>
<td>EMSU</td>
<td>2396.40</td>
<td>30</td>
<td>356.51</td>
</tr>
</tbody>
</table>

(KM-Kannada mean; EM- English mean; TE-Translation Equivalent; SR-Semantically Related; SUR-Semantically Unrelated)

Figure 1: Mean R.T. for Kannada and English languages

Comparison of LDT scores for TE with the four domains of LEAP-Q (speaking, understanding, reading and writing) also indicated positive correlation offering support to our premise that LDT can serve as a test for bilingual proficiency. The results showed relatively better correlation between Understanding and Speaking domain in comparison to Reading and Writing domains. The significant negative correlation of TE with Understanding and Reading domains (Table 2) indicates that with the increase in the R.T. for the LDT, there was a decrease in the self ratings for these two domains.

The results suggest that the online test developed for language proficiency assessment could be
employed to determine proficiency in bilinguals. Alternatively, it may be said that the primed LDT can be used as an objective tool for assessing proficiency in performance as against proficiency in competence determined through self rating questionnaires (Prema, 2011).

Table 2: Correlation coefficients for TE stimuli (Kannada) language with LEAP-Q

<table>
<thead>
<tr>
<th></th>
<th>TE</th>
<th>KU</th>
<th>KS</th>
<th>KR</th>
<th>KW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation coefficient</td>
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<td>-0.89</td>
<td>-0.48</td>
<td>-0.16</td>
<td></td>
</tr>
<tr>
<td>Significance level</td>
<td>0.001</td>
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<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

TE- Translation Equivalent stimuli; KU- Kannada Understanding; KS- Kannada Speaking; KR- Kannada Reading; KW- Kannada Writing

Study No. II: Assessment of language proficiency in school teachers: The objective of the Study 2 was to examine the language proficiency in teachers employed in schools of Mysore city.

Participants: A purposive sample of 15 primary school teachers who are not native speakers of Kannada or English but reside in the state of Karnataka (with regional language being Kannada) and serve as teachers in the schools of Mysore city, India were selected. One of the criteria adapted for selection was that the teachers should not be a native speaker of Kannada or English language, the languages that are offered as medium of instruction in schools of Mysore city. Informed consent was obtained from all the participants and ethical guidelines stipulated by the organization are followed for the conduct of the study.

Procedure: Encouraged by the results of the study 1, the online test for language proficiency was administered on the 15 teachers. The results of language proficiency assessment on teachers were analyzed using SPSS (version 17) to examine if there is a difference in their language proficiency when compared to those participants selected in Study No.1 i.e., bilingual participants who are native speakers of Kannada (L1) and second language learners of English (L2).

Results: The R.T. to perform on LDT for Kannada and English in both Study 1 and study 2 was compared. Mixed ANOVA was carried out and the results are as shown in Table 3 and Table 4.

Table 3: R.T. on Kannada-English LDT

<table>
<thead>
<tr>
<th></th>
<th>Study</th>
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<th>Std. Deviation</th>
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</tr>
</thead>
<tbody>
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<td>English</td>
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<td>1780.46</td>
<td>508.99</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>980.52</td>
<td>217.26</td>
<td>15</td>
</tr>
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<td>Total</td>
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<tr>
<td>Kannada</td>
<td>1.00</td>
<td>1468.36</td>
<td>405.97</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>1100.91</td>
<td>400.72</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1345.88</td>
<td>436.36</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 4: Tests of Within-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>language</td>
<td>1</td>
<td>2.05</td>
<td>.159</td>
</tr>
<tr>
<td>language * study</td>
<td>1</td>
<td>10.43</td>
<td>.002</td>
</tr>
<tr>
<td>Error (language)</td>
<td>43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P.S.: Sphericity Assumed

Table 4 shows that there is no statistically significant difference in the RT between the two languages in both Study 1 and Study 2 (p<0.159). However, interaction effect was observed between languages and Study I and II (p< 0.002). R.T. for the two languages was compared between Study 1 and Study 2 and found to be significant (p< 0.000). Analysis of results by employing MANOVA further supported the earlier findings that there was a significant difference in scores on LDT for Kannada (p<0.006) and English (p<0.000) languages between Study 1 and study 2. Details are shown in Table 5.

Table 5: Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>study</td>
<td>English</td>
<td>1</td>
<td>33.662</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Kannada</td>
<td>1</td>
<td>8.262</td>
<td>.006</td>
</tr>
<tr>
<td>Error</td>
<td>English</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kannada</td>
<td>43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Paired sample t-test was conducted to tease out the combined effect derived from collating data from study 1 and study 2. The results showed that there is a statistically significant difference in the RT between the two languages in Study 1 but no significant difference in the RT between the two languages in Study 2 as shown in Table 6.

Table 6: Paired sample t-test

<table>
<thead>
<tr>
<th>Study</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair I</td>
<td>English - Kannada</td>
<td>3.690</td>
<td>29</td>
</tr>
<tr>
<td>Study 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair I</td>
<td>English - Kannada</td>
<td>-1.432</td>
<td>14</td>
</tr>
</tbody>
</table>

The results indicate that teachers who are non-native speakers of Kannada and English did not
show differential proficiency in Kannada and English languages whereas there is a difference in the language proficiency in the two languages under study in native speakers who are not teachers (Study 1). The likelihood of absence of significant difference in mean scores for RT of participants in Study 2 is speculated to be due to the lower mean scores compared to that of participants in Study 1. Therefore, confidence intervals were explored at 95% level for mean scores to fix the lower and upper limits of performance for both Study 1 and Study 2. Table 7 shows the lower bound and the upper bound values of the RT obtained using 95% confidence interval. The lower and the upper bound for Kannada in Study 1 were 1468.36 & 316.77 and 1100.91 & 878.99 in Study 2 respectively. Similarly, the lower and the upper bound for English in Study 1 were 1590.39 & 1970.51 and 860.21 & 1100.84 in Study 2 respectively. The confidence interval limits indicated that the teachers’ performance on LDT (Study 2) was superior compared to the native speakers of Kannada (Study 1) as shown in Table 7 & Figure 2.

**Table 7: 95% Confidence Interval for mean scores**

<table>
<thead>
<tr>
<th>Lang.</th>
<th>Study</th>
<th>Mean &amp; SD</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng</td>
<td>1.0</td>
<td>1780.46 (508.99)</td>
<td>1590.39</td>
<td>1970.52</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>980.52 (217.26)</td>
<td>860.21</td>
<td>1100.84</td>
</tr>
<tr>
<td>Kan</td>
<td>1.0</td>
<td>1468.36 (405.97)</td>
<td>1316.77</td>
<td>1619.96</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1100.91 (400.72)</td>
<td>879.00</td>
<td>1322.82</td>
</tr>
</tbody>
</table>

**Figure 2: Mean R.T on LDT for Kannada & English in Study I and Study II**

**Discussion**

Assessment of bilingual proficiency in primary school teachers using online task with LDT paradigm suggested that the teachers were less proficient in Kannada (mother tongue of children) compared to English (the medium of instruction). As per the Third All India Education Survey (Sharma, 2001), 58 languages find a place in the school curricula and 47 are used in public administration at various levels. India is a multilingual and multicultural nation and therefore, there is coexistence of more than two or three languages in almost all the states of India. The National Policy on Education (wwwDepartmentsIndia.org) by the Government of India proposed several policies among which, the Three Language Formula (TLF) is an important proposition to the multilingual context of India. As a consequence of this national policy for education, there are many challenges in the educational sector, specifically development of measures for language proficiency in teachers who are non-native speakers of the language(s) of children.

Survey conducted by Shanbal & Prema (2007), Khurana and Prema (2009) indicated that when the native language is not the language of instruction, the use of the non-native language gets restricted to school environment with the predominance of the native/local language for other communicative purposes. In school set-up, the language teaching practices is so designed that the students learn languages through subjects rather than learning subjects through languages. Consequently, students fair poorly both in subjects as well as language. The challenges of bilingual education can be successfully met provided suitable measures are taken-up to empower teachers to meet the demands of bilingual education. The survey conducted on a random sample of fifteen teachers using the online assessment tool for language proficiency indicated large differences in the teachers’ language proficiency in their non-native language (Kannada and English) that are the school language of the State where the study was conducted. While it is widely accepted that teachers’ language proficiency is so essential to either communicate or impart educational concept for bilingual children in the school set-up, there is an immense need for the system of education in India to gear-up to meet the requirements of bilingual and multilingual children.

Agnihotri (2011) commenting on the classical paradigm of a classroom comprising of a ‘teacher’, a ‘classroom’, a ‘textbook’ and a ‘language’ emphasized the need to re-examine and re-work the concepts of MLE (Multilingual Education). He reiterates that in a multilingual classroom, space be given to all languages. And that, giving spaces to all languages does not require the teacher to know all the languages that the children in a classroom use. However, the teacher should emulate how children, despite having varied linguistic resources, interacted with
each other while playing. Teacher should learn to ‘play with children’ and use language as a tool for empowerment. In the present study, the teachers’ proficiency in the languages of children (Native language, Kannada and school language, English) does not permit this to happen in the classroom context.

In view of the above findings, empowerment of in-service teachers should be taken up by offering additional requisite skills to manage MLE system. Specially designed courses through correspondence mode (conventional distance education and learning or through virtual classrooms) appears to be the best option in view of the availability of technology. It is possible to rope-in a large number of teachers if this mode of skill delivery is made viable thus speeding up teacher empowerment. Reorienting education to improve quality outcomes requires education system that is geared to meet the challenges posed by linguistically diverse population of India. The discrepancy in the demand vs. supply of quality educators in bilingual medium is an important issue to be seriously viewed and pursued if India has to meet the vision and mission of ‘Education for All’.

**Reference**


BILINGUAL LEXICAL DECISION: EFFECT OF LANGUAGE PROFICIENCY AND PRIMES

1Prema, K. S., 2Prarthana, S., & 3Abhishek, B. P.

Abstract

Bilinguals may have varying degrees of proficiency over their two languages. Assessment of bilingual proficiency by employing tools developed for non-Indian population is not suitable to the bilingual population in India. Tools developed indigenously for quick and objective assessment of language proficiency is warranted. Therefore, the present study assessed performance of 30 Kannada-English bilinguals in primed lexical decision task (LDT) with three different prime types—translation equivalent, semantically related and semantically unrelated primes along with self-rating questionnaire, LEAP-Q. Good correlation of scores on questionnaires and reaction time for LDT suggest that primed LDT serves as a test for bilingual proficiency. Among the prime types, the translation equivalent prime indicated proficiency better than the semantically related and semantically unrelated stimuli. Results of the study suggest that primed lexical decision task can be used as a tool for assessing proficiency based on the performance of individuals as against only competence assessed through questionnaires.

Key words: Bilingual proficiency. Lexical Decision Task, Prime type

Bilingualism refers to knowledge and use of two languages and an ability to make a meaningful utterance in another language (Harding, Ruth and Riley, 1986). It is a sociolinguistic phenomenon that has received much scholarly attention. India being a multilingual and multicultural nation, presents a linguistic landscape of coexistence of more than one and often more than two or three languages almost throughout the country. Hence bilingualism/multilingualism is a common phenomenon prevalent throughout the country which poses innumerable challenges to speech and hearing specialists and educators in terms of language assessment, management and teaching.

The nature of bilingual lexical organization and type of bilingualism in individuals has raised number of questions to be addressed by researchers. Commonly asked question among those is whether the bilinguals store their two languages in discrete or common memory systems. Studies have also focused on understanding the bilingual organization by proposing numerous models to explain the same. These models have been proposed to support or refute either of two hypotheses i.e., language specific (Costa, Miozzo, & Caramazza, 1999) or language independent hypothesis (De Bot, 1992; Green, 1986; Poulisse & Bongaerts, 1994). The models of bilingual lexical organization describe two types of representation a lexical level of representation with two language specific stores or a conceptual representation, comprising a single lexical store. According to Kroll and DeGroot (1997) word representation in bilinguals is decomposed into form and meaning, the former represented at the lexical level and latter at the conceptual level. Various models have been proposed varying the connections among lexical and conceptual level of representation.

Word association model: This model (Fig. 1A) assumes that the first language (L1) mediation is essential to gain access to concepts through second language (L2). The links between L1 and L2 are the lexical links and the links between L1 and the concepts are denoted as conceptual links. This model predicts that translation relies on lexical links and can thus bypass conceptual access (as in Edmonds & Kiran, 2004). Thus according to this model cross language processing explores the links at lexical level (Potter, 1984).

i) The concept mediation model: This model (Fig. 1B) proposes that L1 and L2 word forms are both directly connected to their corresponding concept. Access from L2 to L1 word forms occurs through access to the concept (Potter, 1984).

ii) Revised hierarchical model: This model (Fig. 1C) assumes that words in a bilingual’s languages have separate word form representations but shared conceptual representations. Two routes lead from an L2 word form to its conceptual representation, the word association route, where concepts are accessed through the corresponding L1 word form, and the concept mediation route.

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with direct access from L2 to concepts (Kroll and Stewart, 1994).

**iii) Mixed model:** This model combines the word association model and concept mediation models. This model argues that the lexicons of a bilingual are directly connected to each other as well as indirectly connected by way of shared semantic representation (de Groot, 1992).

![Diagram of the hierarchical models]

A: Word Association Model; B: Concept Mediation Model; C: Revised Hierarchical Model (Source: Potter and Mc Cormack, 1984)

**Figure 1: The hierarchical models**

However de Groot (1992) theory holds good for forward translation (L1 to L2 only) in participants dominant in their L1. De Groot, Dannenberg & Hell (1994) extended their study on two Dutch – English bilingual groups with varied L2 proficiency in order to include backward (L2 to L1) translation in addition to forward translation (L1 to L2). They analyzed six parameters (imageability, context availability, definition accuracy, familiarity, word frequency and length) and results revealed the parameter imageability to have a significant effect of on backward translation. Hence their study provides evidence for weak version of the asymmetrical model. The mixed model thus emphasizes on the link between L2 and conceptual level for backward translation, however the strength of the link from L2 to conceptual memory is relatively weaker than the link between L1 to conceptual memory.

Bilinguals may also have varying degrees of proficiency over their two languages which might contribute to their differences in lexical organization. Hence tests of language proficiency may shed more light in understanding the processes involved in organization of languages. However, testing language proficiency is a complex undertaking that continues to stir much debate among language researchers and test developers.

The bilingual ability tests have been grouped into four types namely rating scales, fluency tests, flexibility tests and dominance tests (Mac Namara, 1967). Rating scales and Questionnaires are the commonly used tools in the assessment of language proficiency which involves self assessment and reporting of language measures. The most common fluency tests used are picture naming, word completion, oral reading, and following instructions. Tasks such as synonym production, word associations and word frequency estimations have also been employed. Dominance tests assess relative dominance between two languages in various domains. These tests for dominance are generally designed with experimental tasks that range from production tasks that employ reading lists, retelling stories, picture naming, giving word associations to perception and comprehension tasks such as free recall, Stroop tests, translation, hemispheric lateralization studies, dichotic listening, hemifield presentation, concurrent activity tasks etc.,

Some of the popularly used self assessment/rating scales are the International Second Language Proficiency Ratings (ISLPR-Ingram, 1985), Language Experience and Proficiency Questionnaire (LEAP – Q, Marian, Blumenfeld & Kaushanskaya, 2007), Language Assessment scales (De Avila & Duncan 1990), IDEA Proficiency Test designed by Ballard and Tighe (2005), Test of Language Proficiency (TLP) developed by Shivshankar, Shyamal, Vasantha, Bhoomika Kar and Narang (2011) to name a few. Several test batteries have been developed and used for assessing proficiency in English acquired as a second language. The Language Proficiency Index (LPI) is a Canadian standardized test for English proficiency. The General Tests of English Language Proficiency (G-TELP) comprise a testing system designed to assess the English Language ability of non-native speakers in task oriented, real-world situations (http://www.g-telp.jp/english/). Michener English Language Assessment (MELA) describes language proficiency in terms of scores using Canadian Language Benchmarks (CLB) which are a national Canadian standard of English language proficiency. Canadian English Language Proficiency Index Program, (CELIP) is a set of computer-delivered English language proficiency tests used to assess an individual’s functional skills in English for listening, speaking, reading, and writing (http://www.paragontesting.ca/english-language-tests/celpip/).
Language proficiency tools have also been developed and routinely used in other European languages. The Minnesota Language Proficiency Assessments (MLPA) includes battery of instruments to measure proficiency in reading, writing, speaking, and listening in French, German, and Spanish (http://www.carla.umn.edu/assessment/MLPA.html). An online version of the reading, writing, and listening MLPA is also available. The Defense Language Proficiency Test (or DLPT) is another language test battery developed by the Defense Language Institute for the use of the Department of Defense (DoD) United States. The test assesses the general language proficiency of native English speakers in a foreign language, in the domains of reading and listening. DIALANG is an online diagnostic language assessment system designed to assess language proficiency in 14 European languages.

Many of the assessment tools mentioned above are subjective in nature, prone to bias as the subject himself/herself rates his/her proficiency, besides being time intensive in nature. To overcome this limitation the online tools have been developed in the recent years which measure effects occurring at various temporal points during ongoing process and are often sensitive to fast acting, automatic processes that rely on integration and interaction of several types of information (Shapiro, Swinney & Borsky 1998). The online tasks also provides insights about normal operation of language processing and allow us to learn about deficits, fundamental sparing and loss, and hence could help us to devise focused and efficacious treatment programs (Shapiro, Swinney & Borsky 1998).

Among the online tasks primed lexical decision tasks and lexical naming tasks (Meyer and Schvaneveldt, 1971) have been frequently used to study bilingual lexical organization. Priming refers to an increased sensitivity to certain stimuli due to prior experience. Priming relies on implicit memory rather than explicit memory utilized during direct retrieval processes. Research has also shown that the effects of priming can impact the decision-making process (Jacoby, 1983).

Primming can be perceptual or conceptual. Perceptual priming is based on the form of the stimulus and is enhanced by the match in terms of modality and exact format between the early and later stimuli whereas for conceptual priming, it is necessary to cue the meaning of a stimulus by providing semantic related tasks. Several studies have been reported where investigators have studied primed lexical decision task performance in individuals with varying degrees of language proficiency.

Kroll and Borning (1987) studied performance asymmetries on lexical decision tasks by fluent and less fluent English-Spanish bilinguals. The task was sentence completion in which sentence fragments in English were completed by target words in English or Spanish that rendered the sentences meaningful or not. Results revealed that fluent English-Spanish bilinguals were faster to make lexical decisions for related than for unrelated target words, regardless of the language of the target, the fluent bilinguals show effects of target relatedness only for English targets, indicating that they were unable to conceptually mediate Spanish. Keatley, Chapman, Newstrom, Mac Dade and Morellato, (1994) demonstrated priming asymmetries even in highly fluent Dutch-English bilinguals; priming was significant in the L1-L2 direction but the reverse was not significant for semantically related prime-target pairs. Similar results have been reported by Grainger and Frenc Mestre (1998) for translation primes in highly proficient French-English bilinguals.

Frenc Mestre and Prince (1997) studied French-English bilinguals second language autonomy of at two levels of proficiency. Results of their study showed individuals could access semantic and conceptual information in L2 autonomously even with limited fluency. This effect was seen even in a lexical decision task with rapid presentation conditions designed to tap automatic processing.

Literature thus reveals many studies investigating priming effects as an indicator of language proficiency for English and other foreign languages but very few studies have been reported regarding this preview in the Indian context. Bilingualism in India is different from that prevalent in the countries such as Europe and United States of America. Therefore, generalization of findings from those countries to the Indian context does not seem to be appropriate. Thus, there arises a need for the development of a quick and efficient online tool for the assessment of proficiency in Indian perspective.

The present study was undertaken as a part of main study which focused on developing a digitized test for quick, online assessment of language proficiency in Kannada English bilinguals that serves a wide range of purposes for professionals such as speech language clinicians, researchers, educational administrators involved in assessing the proficiency of languages in teachers, diplomat from different countries or the second language learners to know their success in language learning. Hence the present study was conducted to analyze the performance of Kannada-English bilinguals in primed lexical decision task in different prime conditions. The
performance on LDT was also correlated with the self rated proficiency levels of individuals.

**Method**

Objective of the study was to analyse the performance of Kannada-English bilingual adults in primed Lexical Decision Task (LDT). Thirty adults in the age range of 18-30 years with Kannada as their native language (L1 acquired first) and English as their L2 (acquired later), with a minimum educational qualification of 10 years in L2 served as participants for the study. The study was carried out in two phases.

In the first phase the participants self rated their language proficiency using LEAP-Q (Language Experience and Proficiency questionnaire). LEAP-Q (Marian, Blumenfeld & Kausanskaya, 2007) was selected for the present study as it provides elaborate information about bilingual proficiency with respect to language acquisition, language use in different language environments, along with self rating of proficiency. This tool has been constructed within the context of bilingualism theories. They have considered both language proficiency and language history variables to specify the type of bilingualism. Language competence is evaluated using proficiency, dominance and preference ratings. Hence LEAP-Q was selected and also because of the reason that it has norms for Indian languages (Ramya, & Goswami, 2009).

In the second phase participants performed a Lexical Decision Task (LDT). For which a total six hundred target items and ten trial items were selected. Out of six hundred items, three hundred each were from Kannada and English language. Three different types of primes were prepared for selected target words, the types being semantically related primes, translation equivalents primes and semantically unrelated primes. The sets were formed based on the relation of prime with that of target word, the three sets being semantically related (SR), translation equivalents (TE) and semantically unrelated (SUR) conditions. For each language 99 non words were also selected in order to achieve word to non word ratio of 0.3. The stimulus presentation for the lexical decision and the response recording were controlled using DMDX, a computer based software. Mean reaction time was computed in each of the prime categories. The mean reaction time measures were compared and correlated with proficiency levels on LEAP-Q.

**Results**

In the first phase of study the participants self rated their language proficiency using LEAP-Q. For the purpose of comparison of performance in LEAP-Q with LDT and also between the two languages, the self rating scores of the participants of their proficiency in the questionnaire under four domains namely, Understanding, Speaking, Reading and Writing in both Kannada and English languages were considered. In the questionnaire the participants rated their proficiency employing four point rating scale (4 - Native like proficiency; 3 - Good proficiency; 2 - Low proficiency; 1 - Zero proficiency).

<table>
<thead>
<tr>
<th>Participants</th>
<th>MEAN</th>
<th>N</th>
<th>S</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>KU</td>
<td>3.86</td>
<td>30</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>EU</td>
<td>3.60</td>
<td>30</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>KS</td>
<td>3.80</td>
<td>30</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>ES</td>
<td>3.40</td>
<td>30</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>KR</td>
<td>3.60</td>
<td>30</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>ER</td>
<td>3.16</td>
<td>30</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>KW</td>
<td>3.36</td>
<td>30</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>EW</td>
<td>3.06</td>
<td>30</td>
<td>0.58</td>
<td></td>
</tr>
</tbody>
</table>

KU- Kannada Understanding; KS- Kannada Speaking; KR- Kannada Reading; KW- Kannada Writing; EU-English Understanding; ES- English Speaking; ER-English Reading; EW- English Writing.

As shown in Table 1 and Figure 1, the mean and standard deviation of self ratings of the participants for the domain 'Understanding' in Kannada and English were 3.86; 0.34 and 3.60; 0.62 respectively similarly mean and standard deviation values for the domain 'Speaking' in Kannada and English were 3.80; 0.40 and 3.40; 0.67. For the domain 'Reading' in Kannada and English mean and standard deviation were 3.60; 0.67 and 3.16; 0.53 respectively and for the domain 'Writing' mean and standard deviation values of self ratings for Kannada and English were 3.36; 0.71 and 3.06; 0.58.
Further Paired sample t test was done to compare the difference in performance in Kannada and English languages in all the four domains. Results revealed that the difference was statistically significant in all the domains viz., 'Understanding' (p value 0.043, p<0.05), 'Speaking' (p value 0.008, p<0.05) and 'Reading' (p value 0.003, p<0.05) and 'Writing' (p value 0.048, p<0.05) in the two languages compared. The results thus revealed mean self ratings scores in English language to be significantly less than Kannada language.

To evaluate the performance of participants in lexical decision task, their reaction times for the task were compared for Kannada and English languages. The mean and standard deviation values of R.T. for the three types of primes (translation equivalents, semantically related and semantically unrelated) between the two languages of the bilinguals (Kannada and English) are shown in Table 2 and Figure 2.

Table 2: Mean R.T. and SD values of LDT for Kannada and English languages

<table>
<thead>
<tr>
<th>Type of stimuli</th>
<th>MEAN (range: 200-4000ms)</th>
<th>N</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>KMTE</td>
<td>1468.36</td>
<td>30</td>
<td>405.97</td>
</tr>
<tr>
<td>EMTE</td>
<td>1780.45</td>
<td>30</td>
<td>508.99</td>
</tr>
<tr>
<td>KMSR</td>
<td>1757.95</td>
<td>30</td>
<td>361.50</td>
</tr>
<tr>
<td>EMSR</td>
<td>2028.67</td>
<td>30</td>
<td>439.61</td>
</tr>
<tr>
<td>KMSU</td>
<td>2024.51</td>
<td>30</td>
<td>454.54</td>
</tr>
<tr>
<td>EMSU</td>
<td>2396.40</td>
<td>30</td>
<td>356.51</td>
</tr>
</tbody>
</table>

KM-Kannada mean; EM- English mean; TE-Translation Equivalent; SR-Semantically related; SUR-Semantically unrelated

Results followed the trend of better performance in Kannada (L1) in comparison to English (L2). However shorter R.T. was observed on TE prime type compared to the other two types (SR and SUR) in both L1-L2 and L2-L1 conditions. Further statistical analysis was carried out employing Paired samples T- test to test for statistical differences in the R.T. between three prime types in Kannada and English language. The p value obtained were 0.004, 0.001, 0.002 (p<0.05) for translation equivalents (TE), semantically related (SR) and semantically unrelated (SUR) primes respectively, suggesting significant difference between the two languages.

Table 3: Correlation coefficients and Significance levels in Kannada language

<table>
<thead>
<tr>
<th></th>
<th>KU Correlation Coefficient</th>
<th>Sig.</th>
<th>KS Correlation Coefficient</th>
<th>Sig.</th>
<th>KR Correlation Coefficient</th>
<th>Sig.</th>
<th>KW Correlation Coefficient</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE</td>
<td>-0.97</td>
<td>0.001</td>
<td>-0.89</td>
<td>0.00</td>
<td>-0.48</td>
<td>0.009</td>
<td>-0.16</td>
<td>0.043</td>
</tr>
<tr>
<td>SR</td>
<td>-0.86</td>
<td>0.02</td>
<td>-0.824</td>
<td>0.021</td>
<td>0.58</td>
<td>0.72</td>
<td>0.476</td>
<td>0.69</td>
</tr>
<tr>
<td>SUR</td>
<td>0.38</td>
<td>0.66</td>
<td>0.269</td>
<td>0.59</td>
<td>-0.16</td>
<td>0.73</td>
<td>0.19</td>
<td>0.66</td>
</tr>
</tbody>
</table>

TE-Translation Equivalent; SR-Semantically related; SUR-Semantically unrelated KU-Kannada Understanding; KS-Kannada Speaking; KR- Kannada Reading; KW- Kannada Writing.

To validate the performance of participants in the primed LDT, correlation measures were obtained for the scores on the questionnaire with that of LDT. Spearman's rank correlation test was employed to derive the correlation coefficient. The mean scores of the three prime types were tested for their correlation with the four domains of LEAP Q in each language.

The results obtained for Kannada language revealed significant negative correlation for domains Understanding, Speaking, Reading and Writing with the prime type translation equivalent. Similar trend was also seen for semantically related prime type, depicting strong negative correlation for the domains Understanding, Speaking, however no correlation was observed for Reading and Writing domains. Also, no such trend was observed for the semantically unrelated prime type as the correlation failed to reach statistical significance in all the four domains.
Table 4: Correlation coefficients and Significance levels in English language

<table>
<thead>
<tr>
<th>EU</th>
<th>Correlation Coefficient</th>
<th>Sig.</th>
<th>ES</th>
<th>Correlation Coefficient</th>
<th>Sig.</th>
<th>ER</th>
<th>Correlation Coefficient</th>
<th>Sig.</th>
<th>EW</th>
<th>Correlation Coefficient</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TE</td>
<td>-0.906</td>
<td>0.00</td>
<td>-0.864</td>
<td>0.012</td>
<td>-0.816</td>
<td>0.00</td>
<td>0.24</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td>-0.79</td>
<td>0.00</td>
<td>-0.67</td>
<td>0.04</td>
<td>-0.514</td>
<td>0.07</td>
<td>-0.43</td>
<td>0.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUR</td>
<td>-0.58</td>
<td>0.051</td>
<td>-0.26</td>
<td>0.08</td>
<td>0.05</td>
<td>0.27</td>
<td>0.16</td>
<td>0.36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TE-Translation Equivalent; SR-Semantically related; SUR-Semantically unrelated EU- English Understanding; ES- English Speaking; ER-English Reading; EW- English Writing

The mean scores of the three prime types, tested for their correlation with the four domains of LEAP Q in English language is shown above.

The results obtained for English language revealed strong negative correlation for domains Understanding, Speaking and Reading but weak correlation for Writing, with the prime type translation equivalent. For semantically related prime type strong negative correlation was seen for Understanding, Speaking and Reading but not for writing domain. However, no such trend was observed for the semantically unrelated prime type as the correlation failed to reach statistical significance similar to that observed for Kannada language.

In summary, the participants’ performance on LDT correlated with that of their self rating of proficiency on LEAP-Q questionnaire with highly significant correlation in the domains of Understanding and Speaking. Among the three types of primes studied, for the TE prime R.T. were least compared to SR and SUR. Also, SUR prime type showed highest reaction time in both the languages. It is also noteworthy that the performance on LDT in Kannada language was significantly better by most of the participants than in English language.

Discussion

The objective of the study was to analyse the performance of Kannada-English bilingual adults in primed Lexical Decision Task (LDT) employing three different prime types and also to correlate their LDT performance with the self ratings of proficiency.

The participants in the first phase self rated their proficiency using LEAP-Q. The analysis of self ratings revealed mean self ratings scores in English language to be significantly less than Kannada language. This finding may be explained by the fact that 75% of the participants in our study had acquired Kannada language first, being their native language, participants considered themselves more competent in it compared to the second language, English. One possible reason for better self ratings in Kannada language may also be because of it being Native language, participants received either little or no feedback about their skills which might have lead to over estimation of competence. English being second language and as it is learnt formally most of the time, receiving more feedback, participants were critical in estimating their competence which might have resulted in overall lower scores (Ramya & Goswami, 2009). However, these results are in congruence with the results obtained on LDT task wherein in both the tasks, participants had better scores in Kannada language than English. LDT being a task which assesses performance rather than competence as assessed by questionnaires further supports the questionnaire findings.

The participants in second phase of study performed a lexical decision task for three prime types in both languages. The reaction time (RT) scores on LDT task for Kannada language ranged from 1400 milliseconds to 2100 milliseconds and in English from 1700 milliseconds to 2400 milliseconds for the three types of primes- TE, SR and SUR (Table 2). The results revealed better performance in Kannada language (L1) relative to English for all the three prime types showing statistically significant difference between the two languages under study. This finding may be because, as 75% of the participants in our study had acquired Kannada first being their native language, and at a very young age which might have facilitated the access compared to the second language, English was acquired formally through instructions. Similar findings were reported for SR primes by Nas and deGroot (1984) who observed the effect of SR primes in L1 relative to English for all the three prime types showing statistically significant difference between the two languages under study. This finding may be because, as 75% of the participants in our study had acquired Kannada first being their native language, and at a very young age which might have facilitated the access compared to the second language, English was acquired formally through instructions. Similar findings were reported for SR primes by Nas and deGroot (1984) who observed the effect of SR primes in L1 and L2 separately.

For TE primes, the RT was lesser in L2-L1 direction compared to L1-L2. This contradicts the previous studies on Asymmetrical Cross Language Priming phenomenon which report greater facilitation in L1-L2 direction vowing to stronger links from L1 to L2 than from L2-L1. In our study the lesser RT for TE primes in Kannada language may be attributed to faster language processing in L1 which may be a result of richer and stronger representation in L1 memory system compared to L2. Supporting this view, Posner (as...
cited in Keatley et al., 1994) suggest that R.T. in a LDT reflect that a representation is available to consciousness on the basis of its threshold and activation levels of the representation of the words in both the languages. Hence the stronger representation would have facilitated the subjects to translate the prime before the presentation of target as assumed in the Prediction hypothesis (DeGroot, Nas & Nelly 1997).

There was also significant difference in RT scores observed for SUR primes between two languages. In a condition using semantically unrelated prime, the time taken for the decision making is entirely attributed to the lexicalization process without the facilitatory effect of primes. The differences observed with SUR primes further supports that processing in L1 in these participants is faster than in L2.

Hence Kannada language that is acquired first and processed better may have influenced the processing of English language resulting in activation of conceptual representations irrespective of the language order. This hypothesis is supported by Frenck-Mestre and Prince (1997) study which revealed that individuals could access semantic and conceptual information in L2 autonomously even with limited fluency. This effect was seen in a lexical decision task with rapid presentation conditions designed to tap automatic processing. Hence the connections being stronger for lexical and conceptual links in Kannada language have yielded faster R.T. in the participants. However this speculation needs further research evidence and support.

A possible explanation for the results of TE stimuli in both the languages with least R.T. compared to SR stimuli could be that though the SR primes presented before targets had conceptual overlap with the target depending on the degree of relatedness of prime with the target, the TE primes being directly linked to the concepts in both languages may have advantage of greater degree of overlap at the conceptual level (de Groot & Nas, 1991; Basnight, Brown & Altarriba, 2005). This enhanced semantic overlap that TE words have over SR words. This overlap could have led to larger priming effects leading to reduced R.T. for lexical decision in this stimuli type.

Comparison of Reaction time scores of LDT with LEAP-Q indicated significant negative correlation for Understanding and Speaking domain, weak correlation for Reading and Writing in both languages across translation equivalent and semantically related stimuli types. However no such trend was observed for the semantically unrelated stimuli type in both the languages as the correlation failed to reach statistical significance. The correlation is in the negative direction indicating increase in the self rating of individuals has led to decrease in reaction times. This in turn implies that individuals with higher level of proficiency in a language demonstrate shorter R.T. on LDT.

Several previous researchers have also demonstrated that the magnitude of priming is greater for high proficient bilinguals than for low proficient bilinguals hence shorter R.T. for lexical decision in the former group than the latter. These studies have explained the difference in performance based on the word association model. According to this model, the second language accesses concepts via words in first language (L1). This model states that lexical mediation through L1 appears to characterize the performance of non fluent or low proficient bilinguals, where as concept mediation appears to characterize the performance of more fluent or high proficient bilinguals. The developmental hypothesis put forth by this model argues that with increasing expertise in L2, processing shifts from lexical to conceptual mediation.

Results from various Stroop studies, examining interference within and across language, also support this view (Cheng & Ho, 1986; Magiste, 1984; Tzelgov, Henik & Leiser, 1990). Similar findings have also been reported in semantic priming studies which supports the hypothesis that fluent bilinguals are able to take advantage of the semantic context, even when it appears in the other language (Altarriba 1990; Chen & Ng, 1989; de Groot & Nas, 1991; Frenck & Pynte, 1987; Krisner et al. 1984; Meyer & Ruddy, 1974; Schwanenflugel & Rey, 1986; Tzelgov & Henik, 1989).

Thus the present study offers support to the premise that digitized LDT could be employed as a test for bilingual proficiency. This could also serve as either a substitute or an adjunct measure with LEAP-Q in determining proficiency in bilinguals. The TE prime type was observed to provide least RT and good correlation with self rating scores which can be employed for developing proficiency tests. Results of the study thus suggest that primed lexical decision can be used as a task for assessing proficiency based on the performance of individuals as against only competence assessed through questionnaire. The primed lexical decision can be applied to test proficiency even in clinical population such as stuttering and aphasia.

Acknowledgments

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References


COMPARISON OF WAB SCORES IN TELUGU MONOLINGUALS AND TELUGU-ENGLISH BILINGUAL SPEAKERS

Shyamala, K. C., & Swetha, G.

Abstract

Aphasia is a breakdown in the two-way translation processes that establishes the relation between thought and language. As a consequence, people with aphasia have an inability to translate, with reasonable fidelity. The Western Aphasia Battery (WAB, Kertesz, 1979) has become a popular protocol for the clinical evaluation of aphasia. The present study aimed to compare WAB scores across Normal Monolinguals (Telugu) and Bilingual (Telugu-English) Speakers across different age groups. The study was carried out among 120 typical adult Telugu speaking individuals in the age range of 20-70 years who were considered for control group. These 120 participants were categorized into five age groups like 20-30, 31-40, 41-50, 51-60 and 61-70 years with 24 participants in each group. Each group consists of 12 monolinguals (6 males and 6 females) and 12 bilinguals (6 males and 6 females). All the Participants in the study have Telugu as their native language, and with no history of any neurological or psychiatric illness, alcoholism or drug abuse. All the participants were matched for their age, gender, language level, handedness, socio-economic status and educational level. Results revealed that bilingual participants performed better than monolingual participants in all the tasks in different age groups and also across both the genders. In the present study overall performance of bilingual participants was better than monolingual participants. Bilinguals are able to mastery over two different sets of skills or strategies than monolinguals and also all the bilingual participants in the study are from higher educational qualification and socio-economic status.

Key words: Aphasia, Monolinguals, Bilinguals

Introduction

Aphasia is a language disorder which is defined as an acquired impairment of language processes underlying receptive and expressive modalities and caused by damage to areas of the brain which are primarily responsible for language function (Davis, 1983). Aphasia is generally caused by diffuse or focal injury to brain, and thus impairs a person’s ability to understand, produce and use language. Western Aphasia Battery (Kertesz, 1979) is considered as one of the important assessment tool which is most frequently used in clinics for the assessment of individuals with aphasia and allied disorders. Such a test would help in identifying the aphasic, describing the aphasia and classifying it into various subgroups for the purpose of diagnosis, therapy and prognosis. Bilingualism in India is ubiquitous and normative, meaning most people, especially literate urban adults, in India are multilingual. Considering the majority of the population in an Indian context, there arises a need to pay attention to the ‘bilingual phenomenon’ in clinical settings as well. It is thought to be an adaptive strategy of the minor and minority linguistic community for the maintenance of the mother tongue. The typical language use pattern is likely to be; use of L1 in the intimate domain, L1, L2 (both Indian languages) or even L3 (English) in the informal domain and mostly English in the formal domain. Albert and Obler (1978) in their study report that perceptual strategies of bilinguals differ from those of monolinguals. The bilinguals seem to have mastery over two different sets of skills or strategies which monolinguals use for each language. They reported that bilinguals mature earlier than monolinguals both in terms of cerebral lateralization for language and in acquisition skills for linguistic abstraction. They also reported that bilinguals have better developed auditory language skills than monolinguals but there is no clear evidence that they differ from monolinguals in written language skills.

According to Grosjean (1994) the term “bilingual” refers to all people who use two or more languages or dialects in their everyday lives. Rajasudhakar (2005) studied the effects of age, gender & bilingualism on cognitive-linguistic performance. Two group of participants participated in the study. Group one and eleven consisted of forty young and old individuals respectively. Each group had twenty monolinguals & twenty bilinguals. Equal number males & females participated in each group. The results revealed that younger individuals were better on cognitive linguistic tasks than elderly individuals. Bilinguals were better on all the domains of CLAP, compared to monolinguals. Gender difference was not observed in any of the tasks. The study highlights the age and language-related performance differences on cognitive linguistic skills. The aim of the present study was...
to compare WAB scores across Normal Monolinguals (Telugu) and Bilingual (Telugu-English) Speakers across different age groups.

**Method**

The aim of the present study was to compare Western Aphasia Battery (Kertesz, 1979) scores across typical Normal Monolinguals (Telugu) and Bilingual (Telugu-English) Speakers. The Western Aphasia Battery (WAB; Kertesz, 1982) has become a popular protocol for the clinical evaluation of aphasia. Among its advantages are the simplicity of the test, yet quantifiable scoring system and a relatively short administration time (approximately 1 hour), although for few aphasics it may take two sessions often required to complete the full battery. The Western Aphasia Battery (WAB; Kertesz, 1982) was designed to evaluate the main clinical aspects of the oral language functions: spontaneous speech, auditory verbal comprehension, repetition and naming, as well as reading, writing and calculation. Nonverbal skills are also tested, such as drawing, block design and praxis and Raven’s Progressive Matrices. In the present study Western Aphasia Battery in Telugu (WAB-T) developed by Sri Pallavi & Chengappa, (2010) was administered for both monolingual and bilingual participants. For Sentence completion task in naming question numbers 5 is modified and in responsive naming question number 2 and 4 are modified. In reading task question number 3 is modified. All the Words in writing of dictated or visually presented words in writing task were modified except for the word nose. All other tasks were same as that of Western Aphasia Battery (WAB; Kertesz, 1982) and modifications were done according to the frequent occurrence of words and linguistic principles of Telugu.

**Table 1: Age range of normal monolinguals and bilinguals groups**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Age Groups (Years)</th>
<th>Participants</th>
<th>ML Male</th>
<th>BL Male</th>
<th>ML Female</th>
<th>BL Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20-30</td>
<td>24</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
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<td>2</td>
<td>31-40</td>
<td>24</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>41-50</td>
<td>24</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>51-60</td>
<td>24</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>61-70</td>
<td>24</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

*ML- Monolingual, BL- Bilingual.

120 typical normal adult Telugu speaking individuals in the age range of 20-70 years were considered for control group. These 120 participants were categorized into five age groups like 20-30, 31-40, 41-50, 51-60 and 61-70 years with 24 participants subjects in each group. Each group consists of 12 monolinguals (6 males and 6 females) and 12 bilinguals (6 males and 6 females). All Participants in the study have Telugu as their native language and with no history of any neurological or psychiatric illness or of alcoholism or drug abuse. All the subjects were matched for their age, sex, language level, handedness, socio-economic status and educational level.

Monolinguals in the present study were selected with Telugu as their native language with no educational background. NIMH Socio economic status scale revised version developed and Standardized by Venkatesan (2011) was used in the study which includes aspects like pooled monthly income, Highest education, Occupation, Family properties was also administered for 60 monolingual participants to categorize them into different levels of socio-economic status.

**Table 2: Scores of Monolingual Participants**

<table>
<thead>
<tr>
<th>SES</th>
<th>SES I</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>5-8</td>
</tr>
</tbody>
</table>

Monolingual Participants obtained a score in the range of SES (0-4), SES I (5-8)

Bilingual participants in the present study were selected with Telugu as their native language and English as their second language. International Second Language Proficiency Rating Scale (ISLPR) was administered to 60 bilingual (T-E) speakers in order to find the second language proficiency. International Second Language Proficiency Rating Scale (ISLPR) includes speaking, listening, reading and writing tasks.

**Table 3: Scores of Bilingual Participants**

<table>
<thead>
<tr>
<th>Speaking</th>
<th>Listening</th>
<th>Reading</th>
<th>Writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4+-5</td>
<td>4+-5</td>
<td>4-5</td>
<td>4+-5</td>
</tr>
</tbody>
</table>

Table 3 shows scores obtained by the bilingual participants in all the tasks. This shows good second language proficiency in bilingual speakers.

NIMH Socio economic status scale revised version developed and Standardized by Venkatesan (2011) was used in the study which includes aspects like pooled monthly income, Highest education, Occupation, Family properties was administered to all bilingual participants.

**Table 4: Scores of Bilingual Participants**

<table>
<thead>
<tr>
<th>SES II</th>
<th>SES III</th>
<th>SES IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-12</td>
<td>13-16</td>
<td>17-20</td>
</tr>
</tbody>
</table>

Bilingual Participants obtained a score in the range of SES II (9-12), SES III (13-16), and SES IV (17-20).
Western Aphasia Battery in Telugu (WAB-T) developed by Sri Pallavi & Chengappa, (2010) was administered for both monolingual and bilingual participants and Aphasia Quotient and Cortical Quotients were calculated.

**Results and Discussion**

Western aphasia battery (WAB) scores obtained have been compared across Normal Monolinguals (Telugu) and Bilingual (Telugu-English) Speakers and mean values were also calculated across different age groups.

### Table 5: Mean values of Monolinguals and Bilinguals in different tasks

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Monolinguals</th>
<th>Bilinguals</th>
<th>Parameters</th>
<th>Monolinguals</th>
<th>Bilinguals</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>19.4</td>
<td>20</td>
<td>AQ</td>
<td>96.4</td>
<td>99.22</td>
</tr>
<tr>
<td>Y/N</td>
<td>59.6</td>
<td>59.85</td>
<td>Reading</td>
<td>77.6</td>
<td>96.3</td>
</tr>
<tr>
<td>AWR</td>
<td>59.3</td>
<td>60</td>
<td>Writing</td>
<td>55.6</td>
<td>94</td>
</tr>
<tr>
<td>SC</td>
<td>77.8</td>
<td>80</td>
<td>Apraxia</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Repetition</td>
<td>97.1</td>
<td>99.1</td>
<td>Drawing</td>
<td>21.4</td>
<td>27.9</td>
</tr>
<tr>
<td>ON</td>
<td>60</td>
<td>60</td>
<td>Calculations</td>
<td>7</td>
<td>8.6</td>
</tr>
<tr>
<td>WF</td>
<td>14.2</td>
<td>17.9</td>
<td>BD</td>
<td>10.1</td>
<td>8.76</td>
</tr>
<tr>
<td>SC</td>
<td>8.63</td>
<td>9.36</td>
<td>RCPM</td>
<td>22.5</td>
<td>19.1</td>
</tr>
<tr>
<td>RN</td>
<td>9.26</td>
<td>9.7</td>
<td>CQ</td>
<td>72.6</td>
<td>77.2</td>
</tr>
</tbody>
</table>

SS-Spontaneous speech, Y/N-Yes/no questions, AWR-Auditory word recognition, SC-Sequential commands, ON-Object naming, WF-Word fluency, SC-Sentence completion, RN-Responsive naming, AQ-Aphasic quotient, BD-Block design, RCPM-Ravens colored progressive matrix, CQ-Cortical quotient.

Tables 5 depict the mean values obtained for Bilingual Participants are better compared to that of monolingual participants. Mean values for both aphasic and cortical quotients obtained for bilingual participants were comparatively better than that of monolingual participants.

### Table 6: Mean scores of normal Monolingual male participants in Western aphasia battery (WAB) across the gender in different age groups

<table>
<thead>
<tr>
<th>Age groups</th>
<th>20-30</th>
<th>31-40</th>
<th>41-50</th>
<th>51-60</th>
<th>61-70</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>19.3</td>
<td>19.1</td>
<td>19.1</td>
<td>19.6</td>
<td>19.5</td>
</tr>
<tr>
<td>Y/N</td>
<td>60</td>
<td>59</td>
<td>60</td>
<td>60</td>
<td>58.5</td>
</tr>
<tr>
<td>AWR</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>59.5</td>
</tr>
<tr>
<td>SC</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>76.6</td>
<td>73.3</td>
</tr>
<tr>
<td>Repetition</td>
<td>98.3</td>
<td>96.8</td>
<td>97</td>
<td>95.3</td>
<td>97.6</td>
</tr>
<tr>
<td>ON</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>WF</td>
<td>16.5</td>
<td>17.3</td>
<td>14.3</td>
<td>13.5</td>
<td>15.8</td>
</tr>
<tr>
<td>SC</td>
<td>8.3</td>
<td>8.33</td>
<td>8.6</td>
<td>9</td>
<td>9.3</td>
</tr>
<tr>
<td>RN</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>8.3</td>
</tr>
<tr>
<td>AQ</td>
<td>97.1</td>
<td>96.7</td>
<td>96.3</td>
<td>96.7</td>
<td>96.1</td>
</tr>
<tr>
<td>Reading</td>
<td>85</td>
<td>89.3</td>
<td>76</td>
<td>85.3</td>
<td>84</td>
</tr>
<tr>
<td>Writing</td>
<td>74.3</td>
<td>69.1</td>
<td>59.6</td>
<td>88</td>
<td>65</td>
</tr>
<tr>
<td>Apraxia</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Drawing</td>
<td>23.5</td>
<td>25</td>
<td>23.8</td>
<td>24.6</td>
<td>22.8</td>
</tr>
<tr>
<td>Calculation</td>
<td>12</td>
<td>12.5</td>
<td>13.5</td>
<td>12.6</td>
<td>12.3</td>
</tr>
<tr>
<td>BD</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>7.5</td>
<td>7.3</td>
</tr>
<tr>
<td>RCPM</td>
<td>24.8</td>
<td>25.8</td>
<td>23.1</td>
<td>21.1</td>
<td>20.8</td>
</tr>
</tbody>
</table>

*SS-Spontaneous speech, Y/N-Yes/no questions, AWR-Auditory word recognition, SC-Sequential commands, ON-Object naming, WF-Word fluency, SC-Sentence completion, RN-Responsive naming, AQ-Aphasic quotient, BD-Block design, RCPM-Ravens colored progressive matrix, CQ-Cortical quotient.

### Table 7: Mean scores of normal Monolingual female participants in Western aphasia battery (WAB) across the gender in different age groups

<table>
<thead>
<tr>
<th>Age groups</th>
<th>20-30</th>
<th>31-40</th>
<th>41-50</th>
<th>51-60</th>
<th>61-70</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>19.5</td>
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<td>60</td>
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<td>64.7</td>
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</table>

*SS-Spontaneous speech, Y/N-Yes/no questions, AWR-Auditory word recognition, SC-Sequential commands, ON-Object naming, WF-Word fluency, SC-Sentence completion, RN-Responsive naming, AQ-Aphasic quotient, BD-Block design, RCPM-Ravens colored progressive matrix, CQ-Cortical quotient.
Table 8: Mean scores of normal Bilingual male participants in Western aphasia battery (WAB) across the gender in different age groups

<table>
<thead>
<tr>
<th>Age groups</th>
<th>20-30</th>
<th>31-40</th>
<th>41-50</th>
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</tr>
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</tr>
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</tr>
<tr>
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<td>9.6</td>
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<td>9.3</td>
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</tr>
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<td>60</td>
<td>60</td>
</tr>
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</tr>
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<td>78.1</td>
<td>78.8</td>
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</table>

Table 9: Mean scores of normal Bilingual female participants in Western aphasia battery (WAB) across the gender in different age groups

<table>
<thead>
<tr>
<th>Age groups</th>
<th>20-30</th>
<th>31-40</th>
<th>41-50</th>
<th>51-60</th>
<th>61-70</th>
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<tbody>
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<tr>
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<td>99.3</td>
<td>99</td>
<td>100</td>
</tr>
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<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>WF</td>
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<td>17.6</td>
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<td>9.3</td>
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</tr>
<tr>
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<td>66.4</td>
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</table>

Results revealed that bilinguals performed better than monolinguals across all the tasks in different age groups. Across the gender bilinguals performed better than monolinguals in all the age groups which shows that the bilinguals seem to have mastery over two different sets of skills or strategies which monolinguals use for each language. Maturity level for bilinguals is earlier than monolinguals both in terms of cerebral lateralization of language and linguistic acquisition skills. Education and socioeconomic status also plays a very important role. Monolinguals with low socioeconomic status with limited educational status performed poorer compared to that of bilinguals with higher socioeconomic status with good education compared to that of monolinguals. studied on the normative data on the Korean version of the Western Aphasia Battery K-WAB was administered to 224 normal adults in seven age groups (15-24, 25-34, 35-44, 45-54, 55-64, 65-74, and 75 years or older), in five educational levels (0, 1-6, 7-9, 10-12, and 13 years or more) and by gender to obtain the normative data by Kim & Duk (2004). The age and educational levels were influential to the K-WAB performance. Accordingly, they formed six subgroups of the normal: two groups (15-74, and 75 years or older groups) by three educational groups (0, 1-6, and 7 years or more). The highest aphasia quotient (AQ), language quotient (LQ), and cortical quotient (CQ) were achieved by 15-74 age groups with 7 or more years of education thus adults with good education got good scores which is in support to present study. According to Baker (1993) bilingual individuals by knowing two or more words for one object or idea may possess an added cognitive flexibility. Chengappa (2008) reported that cognitive expansion and flexibility in individuals exposed to two or more languages. In the present study bilinguals performed better than monolinguals in different task in western aphasia battery (WAB) due to added cognitive flexibility which is in support with the present study.

**Conclusion**

In the present study an attempt has been made to compare Western aphasia battery (WAB-T) developed by Sri Pallavi & Chengappa, (2010) was administered to both monolingual and bilingual participants to compare the performance of monolingual and bilingual participants across different age groups and gender. Bilinguals across different age groups and gender performed comparatively better than that of monolingual participants in all the tasks. Bilinguals with higher educational qualification and socioeconomic status obtained better scores than that of
monolinguals with no education and poor socio-economic status for all the tasks.

References


APPENDIX - 1

WESTERN APHASIA BATTERY

TEST BOOKLET
(Telugu Version)

ALL INDIA INSTITUTE OF SPEECH AND HEARING
Manasagangotri, Mysore -570006

C. Sentence Completion
Ask patient to complete what you say. Provide an example, such as “ice is (cold)”. Score 2 points for correct response and 1 point for phonemic paraphasias. Accept reasonable alternatives, e.g., sugar is … (fattening) but not grass is … (Brown).

1. అన్న ఉంది —— మండి? (ఎందుకు)
2. రాత్రి/రెండు దినులు —— తెలుసు? (ఎందుకు/ఎందుకు)
3. న్యాయ పని — ఉండాలి వెంటి, న్యాయ — మండి? (ఎందుకు)
4. రాత్రి ఉంది — ఉండాలి నాటికి? (ఎందుకు)
5. కవి కళాదానం న్యాయం — రెండు వారికి నాటికి? (ఎందుకు)

Maximum Score: 10
Patient’s Score——
D. Responsive Naming
Score 2 points for acceptable responses, 1 point for phonemic paraphasias

1. నీని కొండు మారంచండి నానాను (మి, వాను)
2. ఒక పెట్టడం ఏం చేసండి (వాతావరణ)
3. వాతావరణ ను మారంచండి నానాను(దాడి)
4. చనిపోతుంటే శరీర మారంచండి (మారుచండి)
5. మీ మారంచండి నానాను మారంచండి (మారుచండి, వాను)

Maximum Score 10
Patient's Score——

V. Reading
A. Reading comprehension of Sentences
Present two sentences, one per card. Instruct the patient to "Read these sentences and point to the missing word. Choose the best from those." The oral instructions should be accompanied by gesture and by pointing to the words missing and the choice of answers. The instructions may be repeated if the patient does not seem to understand. Ask the patient to do the examples. If the patient does not do it correctly, point to the correct answer and say "See, this is the missing word, e.g. the true has..." (Wheels, leaves, grass, or fish)

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
D. Writing of Dictated or Visually Presented Words.

Ask the patient to write the following words as you dictate them. If the patient does not understand, show the real object and gesture to the patient to write its name. If the patient fails to recognize a word or not written at all, spell the word orally, and if the patient still fails, provide cues to letters with 2 extra letters. Subtract 1/2 point for incorrect letters.

<table>
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<tr>
<th>Full score for either</th>
<th>1/2 score for either</th>
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</thead>
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<tr>
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<tr>
<td>Written Response visual stimulus</td>
<td>cut-out letters</td>
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</table>

<table>
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<th>Word</th>
<th>Full score</th>
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</tr>
<tr>
<td>దుస్తులు</td>
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<td></td>
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</table>

Maximum Score 10
Patient's score——
COMPENSATORY STRATEGIES AND FEEDBACK OF HYOLARYNGEAL EXCURSION FOR SWALLOW IN TREATMENT OF SWALLOWING DIFFICULTIES IN PARKINSONS DISEASE: A CASE REPORT

Gayathri Krishnan, Swapna N., & Thulasi Prasad

Abstract

Persons with Parkinson’s disease present with symptoms of dysarthria and dysphagia as secondary motor symptoms of the disease (Jankovic, 2008). These symptoms are progressive in nature and require early identification and intervention. The oral and pharyngeal phases of swallowing are affected in the early or middle stages of the disease. Though evidences for various techniques of swallowing therapy exist in literature most clinicians use client oriented combination of techniques for improving the swallowing efficiency. This case report aims in providing evidence to the effectiveness of using a combination of compensatory strategies and feedback of hyolaryngeal excursion using digital accelerometry to improve swallowing efficiency in a client with Parkinson’s plus syndrome. Training, transfer and generalization of treatment goals are also documented and discussed.

Keywords: Deglutition, Dysphagia, Biofeedback, Accelerometry, Swallowing Disorders

Introduction

Swallowing difficulty or dysphagia is a frequent problem reported in persons with Parkinson’s disease (PD). The cardinal symptoms of PD is considered to be resting tremor, rigidity, loss of postural reflexes and bradykinesia which gradually progresses and leads to the secondary motor symptoms of dysarthria and dysphagia (Jankovic, 2008). Various stages of swallow could be affected leading to dysphagia, which could be at times seen even in the early stage of the disease.

The role of laryngeal elevation in protection of airway during the pharyngeal phase of swallow is well understood. Laryngeal elevation assists in airway closure and opening of upper oesophageal sphincter during normal swallowing. The laryngeal elevation should be coordinated with initiation of swallow at the end of oral phase and respiratory apnea at the beginning of pharyngeal phase and is associated with laryngeal closure preventing the bolus from entering the laryngeal lumen when it reaches the hypopharyngeal area. A failure in laryngeal elevation can lead to poorly protected airway and thus leading to high risk of aspiration (Logemann et al., 2000). Laryngeal elevation is associated with depression of hyoid bone and posterior movement of tongue during the final stages of oral phase of swallowing. Overall, movement of hyolaryngeal complex largely depends on tongue movements but the two functions can be independent of each other. In other words, the tongue can be moved posteriorly without initiation of swallow.

The structures that participate in speech also are a part of the swallowing system, and hence a deficit to these structures can affect the function of both these systems. A disordered swallow needs to be attended early because of its implications on the quality of life. But, although swallowing difficulties may emerge in the early or middle stages in a person with PD, they are usually untreated and neglected as there are other gross limitations which capture their attention during these stages. Therapy for swallowing difficulties is most effective if started early and effectiveness largely depends on various factors associated with the client and client’s family such as severity of the disorder, cognitive status, intensity of therapy, family support and client motivation.

Persons with swallowing difficulties can be treated using compensatory approaches, indirect training or direct training (Logemann, 1984). Compensatory strategies involving postural and diet modifications do not directly affect the physiology of swallow but facilitates oral feeding. Indirect training includes techniques to train a client to perform certain exercises which improve certain processes of swallow such as lip closure, tongue movements etc. In this training, swallow function is not directly addressed. Contrary to the indirect swallow, in direct swallow training, various modifications are made so that the physiology of swallow is modified using for example, the swallow manoeuvres. Evidences for compensatory approaches, indirect and direct approaches exist in literature (Bhattacharya, Kotz & Shapiro, 2003; Blumenfeld, Hahn, Lepage, Leonard, & Belafsky, 2006; Bulow, Speyer, 1Gayathri Krishnan, Clinical Assistant, All India Institute of Speech and Hearing (AIISH), Mysore- 06, 2Swapna N., Reader in Speech Pathology, AIISH, Mysore-06, & 3Thulasi Prasad, Project Officer, AIISH, Mysore-06.
In addition to these approaches, different equipments have been used for swallowing therapy for providing a biofeedback to the client. Biofeedback, in general, has been studied for its efficacy in treatment of various disorders such as migraine headache (Medina, Diamond, & Girvent, 2006; Hamdy, Jilani, Price, Parker, Hall & Power, 2003; Leelamanit, Limsakul, & Geater, 2002; Lewin, Hebert, Putnam, & DuBrow, 2001; Ludlow, Humbert, Saxon, Poletto, Sonies, & Crujido, 2007; Power et.al., 2006; Robbins et.al., 2008; Shaker, Easterling & Kern, 2002). However, most clinicians use a combination of these approaches for bringing the best results in swallowing therapy following detailed client oriented assessment and understanding of the swallowing function.

Swallowing is an automatic process in case of persons with normal swallow. Once disordered, relearning of this skill requires intensive training because of its serious implications. Crary et. al. (2004) described a structured biofeedback program using surface electromyography (sEMG) for clients with dysphagia following stroke and cancer of the head and neck in a retrospective analysis of their clients. Effectiveness of this therapy was more for clients with stroke than with head and neck cancer when functional outcomes were measured. Flexible video endoscopic procedure was also reported to be an effective biofeedback tool in rehabilitation after head and neck surgery (Denk & Kaider, 1997). These studies reported biofeedback as a cost and time effective program (Crary et.al., 2004; Denl & Kaider, 1997) and that biofeedback therapy significantly increased the chances of success and also limited the sessions spent on conventional therapy for functional outcomes (Denl & Kaider, 1997).

Biofeedback on hyolaryngeal excursion during swallow has not yet gathered much evidence. The procedure has been validated with simultaneous videofluoroscopy and accelerometry recordings of swallow (Gupta et.al., 1995). Reddy et.al. (1996) correlated the amplitude of accelerometry recordings with the hyolaryngeal excursion during swallow. Reddy et.al. (2000) studied the effectiveness of biofeedback of hyolaryngeal excursion in the treatment of swallowing disorders and found consistent increase in amplitude of accelerometry recordings and improved functional outcomes. Their report was a compilation of five case reports of clients who had dysphagia secondary to various other disorders effectively rehabilitated using this procedure and is the only report available in this regard. This calls for a need for more evidence for this procedure for use with wider client population.

Evidence in the field of therapy for dysphagia is mostly gathered from case reports because of the heterogeneity in this clinical population. Cases act as their own controls in most of the therapy efficacy studies in dysphagia (Bryant, 1991; Reddy et.al., 1996; Reddy et.al., 2000). Though the evidence level through case studies is not high, they account for all the variables that may be present in a client. Multiple replications of similar methodology from multiple settings can be considered as a strong evidence for therapy efficacy.

In this regard, the present case study was aimed to generate evidence on a combination of biofeedback procedure applied on hyolaryngeal excursion along with compensatory strategies during swallow on a client with PD with frequent symptoms of aspiration. The digital accelerometry technique using the Digital Accelerometry for Swallowing Imaging (DASI™, Elixir Research) was used to record the hyolaryngeal excursion during assessment sessions and this technique was used as biofeedback tool in treatment of swallowing difficulty in this client.

Case report
A 77 year old Kannada speaking female reported to the Department of Clinical services of the All
India Institute of Speech and Hearing (AIISH), Mysore with speech and swallowing difficulties. The client complained of poor clarity of speech since three years. Swallowing difficulties were present since one year. Her diet was limited to semi solid and liquid. She needed support for all her daily living activities. Communication was mainly verbal, augmented with gestures. Medical history revealed a diagnosis of Parkinson’s plus syndrome, Type 2 diabetes, essential hypertension, gastric ulcer, pedal oedema and obesity and was under medication for these associated problems. She was diagnosed with Parkinson’s plus syndrome by a neurologist two years prior to the evaluation at AIISH and the client was in the middle stages of the PD (Score 3.0, Hoehn & Yahr scale, Hoehn & Yahr, 1967). She had also undergone Coronary Artery Bypass surgery one year back. Informal language assessment was carried out which revealed adequate comprehension and expression for daily conversation. A detailed speech, cognitive, sensory-motor, and swallowing evaluation were also carried out. The evaluations and its findings are detailed below:

1. **Speech evaluation**
   Oral Mechanism Examination (OME) revealed normal structure of articulators. Movement of lips and tongue were slow but symmetrical. Diadochokinetic task was performed and alternate and sequential motion rate was 2 syllables/ second. However articulation was slow and slurred. Frenchay Dysarthria assessment (FDA, Enderby 1980) was also administered to assess the extent of problem in different speech structures. A diagnosis of hypokinetic dysarthria was made following the evaluation.

2. **Cognitive/ psychological evaluation**
   The client or the family members did not report of any complaints on cognitive abilities of the client. However, on informal assessment some cognitive deficits were observed following which the Cognitive Linguistic Assessment Protocol in Kannada (CLAP-K, Kamath 2001) was administered. The results revealed mild cognitive deficits and the domain of memory were affected to a greater extent compared to other domains of CLAP-K.

3. **Sensory-motor evaluation**
   Detailed evaluation of sensory motor abilities by a physiotherapist reported rigidity in upper limbs, and bradykinesia. Observations made by physiotherapist also supported the diagnosis of hypokinetic dysarthria by speech-language pathologist.

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**Swallowing evaluation**

4.1. **Behavioural assessment:** The Clinical Protocol for Assessment of Swallowing in Adults-Part B (Meerapriya & Manjula, 2009) was administered to identify the impaired stages of swallowing. The results revealed moderate impairment in the pharyngeal phase of swallow (Score 1). Oral preparatory and oral stages of swallow were mildly impaired (Score 2).

4.2. **Instrumental assessment:** Boluses of varying consistency were used to evaluate the swallowing function: thin liquids (drinking water); solids (Idly mixed with Sambhar to a semi solid consistency). These items were selected based on the client’s preference and availability. The efficiency of the dry swallow (saliva) was also evaluated. In the evaluation session no control over volume or consistency were placed by the clinician. The client was asked to feed herself with any of the solid/liquid items presented to her as she would normally do. An ideal meal session was simulated by presenting food in containers brought from the client’s home. She was allowed to select the food item of her preference, in any order and in any volume.

Hyolaryngeal movements were recorded from the installation of the bolus to the client’s mouth to complete swallow of the bolus using the Digital Accelerometry for Swallowing Imaging (DASI™, Elixir Research). The piezoelectric accelerometer sensor was placed on the hyolaryngeal complex and a neck collar was used to keep the sensor in place during the entire evaluation session. The instrumentation used, DASI™ and placement of sensors are depicted in Figure 1.

The movement of the hyolaryngeal motion during swallow of saliva, liquid and solid bolus was recorded and displayed. The accelerometry recordings were analyzed later for wave morphology. The best waveforms obtained during the evaluation session have been shown in Figure 2a, Figure 2b and Figure 2c for dry, thin and thick bolus consistency respectively. A behavioural observation was also made during the entire process of ingestion to swallow and the findings have been depicted in Table 1.
Figure 1. The DASI™ instrumentation that was used for providing biofeedback of hyolaryngeal motion. Photographs in the inset show the DASI™ hardware and placement of piezoelectric sensors on the thyroid angle of a client (Source: http://www.elixirresearch.com/dasi.html).

Table 1: Behavioural observations made during the simulated meal session before initiation of therapy.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Observations</th>
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<tbody>
<tr>
<td>1</td>
<td>Posture erect and appropriate</td>
</tr>
<tr>
<td>2</td>
<td>Preferred hands to spoon/fork</td>
</tr>
<tr>
<td>3</td>
<td>Preference for liquids than solids</td>
</tr>
<tr>
<td>4</td>
<td>Takes a large volume of bolus into mouth, much more than manageable.</td>
</tr>
<tr>
<td>5</td>
<td>Does not wait for complete swallow of food inside the mouth before ingestion of next bolus.</td>
</tr>
<tr>
<td>6</td>
<td>Reduced range of chewing for solid food item.</td>
</tr>
<tr>
<td>7</td>
<td>Tries to soak solids in saliva to soften them so as to compensate for the reduction in range of chewing.</td>
</tr>
<tr>
<td>8</td>
<td>Mashes the food between the tongue and hard palate especially towards the final chewing sequence.</td>
</tr>
<tr>
<td>9</td>
<td>Infrequent cough post swallow for all types of bolus.</td>
</tr>
<tr>
<td>10</td>
<td>Uses hands to push the solid bolus inside when the food becomes unmanageable with tongue.</td>
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</table>

From Figures 2a, 2b and 2c, the instability of hyolaryngeal complex before and after swallow could be observed for dry, liquid and solid bolus. Instability was more evident for dry and liquid bolus than solid bolus.

For solid bolus the hyolaryngeal motion was associated with chewing and tongue movements before and after swallow but for swallow of liquid bolus the instability of hyolaryngeal motion could be associated with the movements of tongue in the attempt to control the flow of liquid inside the oral cavity. The tongue might need longer time to achieve its readiness for swallow of liquid bolus.
than in case of dry swallow. The swallow of thin liquid and thick bolus was associated with occasional cough reflex post swallow.

The peak amplitude of each swallowing event recorded using digital accelerometry was obtained (Table 2). Consistent reduction in the amplitude parameters of these accelerometry recordings of hyo-laryngeal motion suggested rapid fatigue of swallowing system in this client. This information was helpful in deciding the duration of therapy session as 30 minutes with frequent breaks between each bolus swallow.

### Table 2: Peak amplitude of swallow event recorded using Digital Accelerometry for various bolus consistencies in the assessment session

<table>
<thead>
<tr>
<th>Bolus characteristics</th>
<th>Trial</th>
<th>Peak amplitude of swallowing event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry (saliva)</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Liquids</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>No identifiable swallow</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>No identifiable swallow</td>
</tr>
<tr>
<td>Solids (Idly)</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>18</td>
</tr>
</tbody>
</table>

These observations indicated an immediate need for modification of swallow pattern. She was instructed to attend the swallowing therapy sessions (3 sessions/wk) each lasting for 30 minutes. A total of 6 sessions were carried out to facilitate safe swallow of various bolus consistencies. The client also attended therapy for improving her speech, communication and cognitive abilities simultaneously. The following compensatory strategies were implemented during the swallowing therapy sessions:

1. Reduction in the volume of bolus placed inside the mouth for swallow
2. Modification of rate of ingestion and swallow such that there was a time interval between each swallow as required for the client.

These compensatory strategies were expected to facilitate safe swallowing. There was an indication for stabilizing the hyolaryngeal movements before and after swallow from the accelerometer recordings. This goal was worked upon using the biofeedback procedure for hyolaryngeal movement using digital accelerometry. The effectiveness of compensatory strategies and biofeedback therapy was assessed in terms of frequency of aspiration and client/caregiver reported quality of feeding.

**Digital accelerometry in swallowing therapy:** The client and her caretaker were explained the physiology of normal swallow and the deviations in swallowing as observed in the client. The importance of adopting the compensatory strategies was also highlighted. The client was put on a biofeedback therapy for hyolaryngeal motion using Digital Accelerometry for Swallowing Imaging. The piezoelectric accelerometer sensor was placed on the hyolaryngeal complex and a neck collar was used to keep the sensor in place during the entire treatment session. The movement of the hyolaryngeal motion during swallow of saliva, liquid and solid bolus was recorded and displayed during each therapy session.

The client was trained to identify the swallow peak and the hyolaryngeal movements and to identify the stable and unstable hyolaryngeal activity. The client was explained to take two seconds before and after swallow to stabilize the hyolaryngeal complex. She was shown a diagrammatic representation of expected swallow pattern (Figure 3) which had a short time interval before and after swallow during which the hyolaryngeal complex was stabilized. The client was asked to mimic this pattern of swallow on the digital accelerometry during dry swallow. When the pattern could be reproduced in dry swallow, small volume of bolus was placed in the oral cavity for swallow.

![Figure 3](image)

**Figure 3:** Diagrammatic representation of an expected swallow pattern given to the client for imitation on the accelerometer recordings.

The sequence of bolus consistency followed was dry ➔ liquid ➔ semi solid ➔ solid. Though liquids were difficult to control in the oral cavity, it was thought to be best suited for initial stages of hyolaryngeal excursion biofeedback therapy as no chewing movements had to be associated with swallow and thus identification of correct and incorrect swallow pattern could be easily trained. Any symptoms of aspiration were noted in each type of bolus.

**Results**

The progression across sessions is described below.

**Session 1:** The client was asked to imitate the expected swallow pattern in dry swallow with an effort to stabilize the hyolaryngeal complex before and after swallow. Once the client could
achieve this expected swallow pattern (Figure 4), small amount of water (approximately 5ml) was given for swallow. The client was asked to maintain the pattern while swallowing the liquid bolus. Figure 5 shows the some of the accelerometry recordings obtained during swallow of thin liquids as the session progressed. There were no evident symptoms of aspiration with these modified swallow pattern. Also, the client had piece meal deglutition for 5 ml water indicating the client made an effort to incorporate the compensatory strategies advised at the beginning of the therapy session. Towards the end of the session, the client could identify the swallow peak 100% of the time without the help from the clinician.

Figure 4: Sample of the normal swallow pattern imitated by the client with the help of biofeedback information on hyolaryngeal excursion obtained through digital accelerometry during dry swallow.

Figure 5: Samples of accelerometry recordings obtained as the session 1 progressed with swallow of thin liquids. The blue and yellow peaks indicate swallow.

Session 2&3: The client was made to practise producing the normal swallow pattern as in figure 3. After succeeding, the client was given 15 ml of thin liquid (orange juice) for swallow and she was asked to maintain the normal swallow pattern. Figure 6 shows the progression of therapy with swallow of thin liquids. The client adopted piece meal swallow for 15 ml thin liquids which was evident from the multiple swallows (blue & yellow peaks) in the accelerometry recordings. This indicated the clinician that the client was successfully incorporating the compensatory strategy. This also helped the client for a safe swallow with no symptoms of aspiration for swallow of larger volume of thin liquid. Towards the end of session 3, semisolid consistency (Idly-Sambhar) was introduced for swallow.

Figure 6: Samples of accelerometry recordings obtained as the session 2& 3 progressed with swallow of 15ml thin liquid (orange juice). The blue and yellow peaks indicate swallow.

Figure 7: Samples of accelerometry recordings obtained as the session 2& 3 progressed with swallow of semisolid bolus (Idly- Sambhar). The cough reflex post swallow is indicated as 'C' in the recording 0032. The blue and yellow peaks indicate swallow.

Semi solids required some amount of chewing that made identification of swallow difficult. However, the client was asked to hold the food on the tongue and stabilize the hyo-laryngeal complex before and after swallow with feedback from accelerometry recordings. The swallow peaks had to be manually identified by the clinician. Progression of the session 3 with swallow of semisolid bolus is shown in figure 7.

There was only one instance of cough post swallow of semisolid bolus consistency. This is indicated as ‘C’ in figure 7. At the end of the third session, the client had oral intake of one glass of orange juice and one Idly-Sambhar without any evident symptoms of aspiration.
Session 4, 5 & 6: After practice of normal swallowing pattern in dry swallow (Figure 3), the client was provided with a plate of various items of varying consistency such as Idly- Sambhar, Biscuit and Dosa along with orange juice and drinking water. The client was given the freedom to select her bolus and to swallow them safe with the help of biofeedback from accelerometry recordings of hyolaryngeal movement.

Figure 8 : Samples of accelerometry recordings obtained as the session 4,5& 6 progressed with swallow of (a) drinking water (b) Orange juice (c) Biscuit (d) Dosa. The blue and yellow peaks indicate swallow.

The consistency of biscuit bolus was different from the bolus consistencies given to the client in the previous sessions as the biscuit required hard continuous chewing than the semi-solid bolus. Rapid reduction in the range of chewing was observed and the clinician provided real time hand cue as visual feedback on range of chewing. There were breaks between each bolus intake to prevent fatigue of the swallow system. The best recordings during swallow of each bolus consistency are shown in figure 8.

The client could not complete her meal in the 4th and 5th session. At the end of the 6th session, the client could finish her meal orally with no evident symptoms of aspiration with the assistance of feedback of hyolaryngeal motion. The feedback was gradually restricted by turning the computer screen away from the client so that the client learns to incorporate the strategies in swallow without the help of digital accelerometry. The client was asked to attempt the same strategies during her meal times at home but under the supervision of her caretaker. They were asked to come back for therapy sessions if there were episodes of aspiration without biofeedback. Follow up was done after a week of withdrawal of therapy. The client and her family reported better quality of meal time and significantly lesser events of aspiration at home. Further enquiries revealed that aspiration persisted when the client had a quick meal.

Discussion

The present study reported the rehabilitation program implemented on a 77years female diagnosed with Parkinson’s plus syndrome with complaints of swallowing difficulties. The client was trained on biofeedback therapy for hyolaryngeal excursion during swallowing of boluses of varying consistencies and volumes. The case report was intended to elaborate on the effectiveness of digital accelerometry in assessment of hyo-laryngeal excursion during the pharyngeal phase of swallow and its usefulness as a biofeedback tool when used along with compensatory strategies. Therapy outcomes were documented for every session as accelerometry recordings of laryngeal elevation during swallow.

Accelerometry recordings in the assessment session revealed instability of the hyolaryngeal complex before swallow. This instability was present for all bolus consistencies and volumes. This regular motion of hyolaryngeal complex gives an impression of tremor of hyolaryngeal musculature. This movement may also be recorded if there were tremors of tongue because the base of the tongue is indirectly connected to
hyoid bone and hyoid bone is connected to larynx. Since there were no evident tremors in the tongue, the instability of hyolaryngeal complex may be an indication of early involvement of external muscles of larynx in the Parkinson’s plus syndromes. This is in support with the high incidence of vertical laryngeal tremors reported in Idiopathic Parkinson’s clients by Perez, Ramig, Smith and Dromey (1996). However their study found higher incidence of arytenoid tremor in their clients with Parkinson’s plus syndrome. The presence or absence of arytenoid tremor in this case with Parkinson’s Plus syndrome could not be established physiologically; however a tremor in the voice was evident in this client. Early involvement of external muscle of larynx in PD was also reported in a study of laryngeal somatosensory function by Hammer and Burlow (2010). They explained Parkinson’s disease as a disintegration of somatosensory control of the larynx. This study only hypothesized the sensory disintegration of laryngeal structure. The tremor like movements of hyolaryngeal complex recorded before swallow in the present case report suggested an early disintegration of sensory function in the extra laryngeal musculature. The presence of hyolaryngeal tremor before and after the client attempted swallow may indicate a kinetic or an action tremor rather than a passive tremor that is usually seen in persons with PD. The usefulness of accelerometry in assessment of laryngeal tremor is indicated but needs further research.

Effectiveness of biofeedback therapy has a long history in studies using surface electromyography. Crary (1995) reported the improvements in six clients with brainstem stroke treated with sEMG biofeedback. This report also mentioned the long term maintenance of relearned swallowing in their clients. Based on the findings of accelerometry, therapy was initiated for this client using hyolaryngeal excursion as biofeedback to modify the swallow pattern. The client was trained to identify swallow peaks and to discriminate between correct and incorrect swallow patterns. The progression of this client within and across sessions for swallow of varying consistency and volume of bolus were inspiring. However, effectiveness of therapy can be attributed to the compensatory strategies adopted as well as the biofeedback procedure followed. Such combination of approaches is frequently indicated in routine clinical practice (Logemann, Gesler, Robbins, Lindblad, Hind, & Kosek, 2008)

A similar study was conducted by Reddy et.al. (2000) in which they detailed six cases enrolled in biofeedback therapy using a similar non-invasive accelerometry procedure. In the case series reported by Reddy et.al. (2000), the focus was on improving the amplitude measures of hyolaryngeal excursion because increased hyolaryngeal excursion leads to increased amplitude of accelerometer recordings. However, various factors such as thickness of skin on the neck and skin resistance can dampen the amplitude measures of accelerometer recordings. A low amplitude accelerometer recording may or may not indicate a poor laryngeal elevation. But there are lesser chances of durational measures and pattern of swallow getting affected by these variables and thus temporal parameters and morphology of accelerometer recording may provide more useful information than amplitude measures. It is the author’s observation that men generally have a high amplitude accelerometer recording than women which may be due to the prominent thyroid angle and lesser fat under the skin on the surface of the neck for male population.

The present study also indicated that swallowing is a skill that can be relearned. The client has learned to control her laryngeal instability before and after swallow of bolus leading to a safer swallow than pre-therapy. The pharyngeal phase characterized by its involuntary control mechanisms seems to constitute of certain functions that can be brought under voluntary control such as the hyolaryngeal stability before and after swallow. This relearning of swallow is the basis for success in rehabilitation of persons with swallowing disorders. However, there are a number of pre-requisites for success of swallowing therapy such as the cognitive status of the client, motivation, family support etc. In this client, bio feedback therapy proved effective probably because of her cognitive abilities were only mildly impaired. Thus the results of this study cannot be generalized and has to be understood with caution because the same technique may not work with all clients with pharyngeal phase deficits.

Swallowing is a highly heterogeneous function with no clear boundaries between the normal and abnormal. The interpersonal and intrapersonal variability in normal swallow makes generalization inappropriate. The field of dysphagia has been concentrating on case studies and case series rather than group generalizations. This study is a contribution to the existing literature on effectiveness of biofeedback in swallowing skill training when combined with some compensatory strategies. Though biofeedback is a commonly used non invasive technique which is easily available in various forms to clinicians all over the world, the number of published data in this field remains scarce. The
available data are not uniform in its methodology. There is a need to understand the factors that determine the efficacy of biofeedback procedures on clients with swallowing difficulty and the parameters that signify appropriate hyolaryngeal elevation for safe swallow. Future studies should focus on identification of predictors of laryngeal elevation in accelerometer recordings so that the procedure may be applied on the most suitable candidates. Also, there is a need to understand the effectiveness of various approaches when applied in combination because in practical situations a combination of strategies is most commonly required for rehabilitation of clients with swallowing disorders.

**Conclusion**

This study was carried out on a client diagnosed with Parkinson plus syndrome with symptoms of aspiration. The client also had associated speech related issues. Cognitive status was mildly impaired but was appropriate for daily activities. Detailed speech, cognition and swallowing evaluations were carried out. Swallowing evaluation using digital accelerometer revealed unstable hyolaryngeal complex before and after swallow for all bolus consistencies. Cough reflex was associated with swallow of thin (liquid) and thick (solid) bolus. The client was trained on an intensive biofeedback therapy using digital accelerometer for stabilising the hyolaryngeal excursion before and after swallow of various consistencies of bolus. Compensatory strategies were also warranted. The client made consistent and rapid progress when compensatory strategies were used in combination with biofeedback therapy for hyolaryngeal excursion. By the end of 6th session with biofeedback, the client was able to manage oral feeding with significantly lesser instances of aspiration. After one week of discharge from the therapy, the client was able to maintain the strategies and was enjoying a safe meal time with her family.

**Acknowledgement**

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**References**


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DEVELOPMENT OF BOSTON NAMING TEST IN TELUGU: PERFORMANCE OF TYPICAL INDIVIDUALS AND INDIVIDUALS WITH APHASIA

Sunil Kumar Ravi, Vijayetha S., Gnanavel K., & Shyamala. K. C.

Abstract

The Boston Naming test (BNT) (Kaplan, Goodglass, & Weintraub, 1983) is extensively used in the assessment of naming deficits in both typical and disordered population. This test has been adapted and translated into many languages and cultures across the world. The assessment of language deficits in individuals with acquired neurogenic language disorders has been very difficult due to lack of linguistically and culturally sensitive test batteries in Indian context. The present study aimed at adapting the BNT into Telugu language, widely spoken by 75 million people in southern part of India. A total of 20 items from the original 60 items on the test were retained based on ratings of speech language pathologists (SLP) and linguists and another 37 linguistically and culturally appropriate were added to make a total of 57 item test. Normative data were collected on a total of 100 typical individuals in the age ranges of 20–40 years, 40–60 years and 60+ years. A small group of individuals with aphasia (n=20) were also included to study the naming deficits in them. Initial normative data was measured across three age groups and 20 individuals with aphasia. Although results indicated a significant difference across age groups, age related decline in naming abilities was not found in the present study. The factors such as education and bilingualism and their effects on naming are discussed. This test could be a good tool to assess naming deficits in Telugu speaking individuals with language and cognitive deficits.

Key words: Boston naming test, aphasia, Telugu, naming deficits, normative.

Introduction

Aphasia, in general refers to the loss of language abilities following damage to brain. These impairments can be in the form of lack of fluent production, poor auditory verbal comprehension, poor repetition and/or naming skills, difficulty in reading and writing, and apraxia. These language impairments vary from person to person depending upon the site of lesion and extent of lesion. Besides these impairments, individuals with aphasia may also exhibit specific deficits in various language components such as phonological deficits, syntactic deficits, semantic/lexical deficits, and so on.

Naming is an integral part of human language by which we represent different people, objects or events with different labels. The storage of different names associated with different objects is done through various processes with the help of memory components, which comprises the lexical system. The process of acquisition of semantics or lexical system starts from birth when the child is exposed to human language in the form of verbal and/or nonverbal modes. Naming is an automatic process which is strengthened by the exposure levels. However, these naming abilities are affected in disordered populations such as aphasia (either as a standalone deficit or as an associated deficit), dementia, and so on and also in some of the typical individuals with increase in age (Albert, Heller, & Milberg, 1988; Borod, Goodglass, & Kaplan, 1980; Nicholas, Obler, Albert, & Goodglass, 1985). Several studies on typical individuals reported that word finding problems are seen in most of the geriatric population in day to day activities of life (Lezak, 2004; Schmitter-Edgecombe, Vesneski, & Jones, 2000).

A commonly seen problem in most of the typical individuals both young and geriatric is tip-of-tongue phenomenon (Burke, MacKay, Worthley, & Wade, 1991; Cohen & Faulkner, 1986), which is considered as a normal aspect. This phenomenon is also reported to be more in older adults than that of younger adults (Burke et al., 1991; Maylor, 1990). However, in some of the geriatric people, significant increase in the amount of naming difficulties is seen as the age increases. Recent studies indicate that naming problems can be an early indication of severe degenerative diseases such as dementia, primary progressive aphasia and tumors (Calero, Arnedo, Ruiz-Pedrosa, & Carnero, 2002; Goodglass, Kaplan, & Barresi, 2001). Apart from the typical individuals, naming impairments are seen in individuals with various types of cortical and subcortical dysfunction or damage. Along with the effect of age on naming, the effect of other factors such as education (Henderson, Frank,
The naming abilities are measured by tasks such as confrontation naming, generative naming, etc., in both typical individuals and in individuals with brain damage. Confrontation naming task is considered as the best task to measure word-finding abilities (Gordon, 1997; Lezak, 2004; Lopez, Arias, Hunter, Charter, & Scott, 2003). Confrontation naming is measured through picture naming of a given person, object, place or action. Boston Naming Test (BNT) (Kaplan, Goodglass, & Weintraub, 1976, 1983) is the most frequently used test for confrontation naming in typical and pathological individuals. This test consists of a set of 60 line drawings of common objects with varying difficulty range. The subject’s task is to name the picture appropriately. The test also includes a feature of providing either phonemic or semantic cues to the subjects when the subjects have not named the picture correctly.

BNT has been modified by several authors as per the requirements of various target populations since its inception. The initial test battery consists of 85 line drawings and the normative data was collected by Borod et al. 1980. Kaplan et al. (1983) have introduced the present version of BNT with 60 line drawings which is most widely used now. Later on shorter editions with 30 or 15 items have been developed to aid the examination of patients with neurological disorders (Calero et al., 2002; del Toro, Bislick, Comer, Velozo, Romero, Gonzalez Rothi, & Kendall, 2011; Fastenau, Denburg, & Maurer, 1998; Fisher, Tierney, Snow, & Szalai, 1999; Graves, Bezeau, Fogarty, & Blair, 2004; Lansing, Ivnik, Cullum, & Randolph, 1999; Mack, Freed, Williams, & Henderson, 1992; Saxton, Ratcliff, Munro, Coffey, Beckers, Fried, & Kuller, 2000). Some of these short versions have been standardized on typical individuals, and/or individuals with aphasia, and/or individuals with dementia.

BNT has been recognized as a good test to tap the naming/word finding abilities in both typical and pathological population. Hence, normative data was obtained from the other English speaking countries such as Australia (Cruice, Worrall, & Hickson, 2000), Canada (Roberts, Garcia, Desrochers, & Hernandez, 2002), and New Zealand (Barker-Collo, 2001), and the test has been developed in several languages all over the world. Currently the test is available in languages such as Korean (Kim & Na, 1999), Swedish (Tallberg, 2005), Dutch (Marien, Mampaey, Vervaet, Saerens, & DeDeyn, 1998), French (Colombo & Assal, 1992), Spanish (Allegri, Mangone, Villavicencio, Rynberg, & Baumann, 1997; Quinones-Ubeda, Pena-Casanova, Bohm, Gramunt-Fombuena, & Comas, 2004), Malaysia (Dort, Vong, Razak, Kamal, & Meng, 2007), Greek (Patricacou, Psallida, Pring, & Dipper, 2007) and Chinese (Cheung, Cheung, & Chan, 2004). Many researchers have given normative data for BNT across the globe with consideration of factors such as age, education, culture specific and so on. As the results of these studies vary from language to language and reports of cultural bias in various countries, there is a greater need to develop language and culture specific test batteries in different languages in India. Normative data needs to be measured for different languages, age groups, educations levels, and cultures within the context of India.

India has 22 constitutionally accepted languages with four languages having classical language status, while there are about 1652 languages/dialects spoken in and around the country. The major language families in India include Indo-Aryan (74.3%), Dravidian (23.9%), Austro-Asiatic (1.2%) and Tibeto-Burman (0.6%). Telugu is one of the four major Dravidian languages and it is widely spoken by 75 million people in the states of Andhra Pradesh, Tamil Nadu and Karnataka of southern India. With an increase in the geriatric population in Indian context, there is an increase in the population with adult language disorders following neurological diseases. Hence, language and culture specific language test batteries are the need of the hour in the Indian context. The present study is aimed at developing and obtaining normative data for population of various age groups in Telugu language.

Method

Development of the test: Eight speech language pathologists and two clinical linguists who were native speakers of Telugu adjudged 20 items out of 60 items of original BNT as culturally and linguistically appropriate. These 20 items were retained for the final test in Telugu. Both speech language pathologists and linguists made a list of 80 linguistically and culturally appropriate words in Telugu language which were rated for both familiarity and ambiguity. A total 37 items were selected based on the highest ratings on both familiarity and least ambiguity. Hence, a total set of 57 items were finalized for the Boston naming test in Telugu. After finalizing the list of words, line drawings were drawn for all the items on a 4’x6’ inch cards. A stimulus cue for each of the stimuli was also formulated and added to the test.
material. These items were tested on 100 typical individuals and 20 individuals with aphasia.

**Administration and scoring:** The subjects seated in a comfortable position were shown one picture at a time and were asked to name the picture. If no response was received in the first 20 seconds, a semantic cue was given. If no response or incorrect response was elicited with semantic cue, subjects were given a phonemic cue. A score of ‘2’ is given to all the correct items with or without semantic cue, whereas correct responses with phonemic cue received a score of ‘1’ and incorrect responses were given a score of ‘0’. The total score of the subject is summed up and subjected to further statistical analysis. The test was not curtailed when the subject made seven incorrect responses in a row, unlike in original BNT.

**Participants:** A total of 100 neurologically healthy individuals (typical group) and 20 individuals with aphasia (clinical group) were tested. All were native speakers of Telugu language and typical individuals were divided into three age groups: 20-40, 40-60, and 60+ years. All of the participants had minimum of 10 years of education. None of the typical participants had any history of communication disorders, neurological and/or psychiatric illness. In clinical group, 20 right handed individuals who had suffered a cerebral vascular accident or stroke in left hemisphere were taken into the study after seen by a speech – language pathologist and neurologist who diagnosed the patients as having aphasia based on speech and language examination and medical records. All the individuals were administered Western Aphasia Battery – Telugu (Sripallavi & Shyamala, 2011) to diagnose them as aphasia and to identify the type of aphasia. Participants with aphasia quotient (AQ) < 93.8 and with minimum of 6 months post onset were selected for the present study. The demographic details of clinical group are given in Table 1.

 Table 1: Participant demographics of clinical and typical groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Clinical group</th>
<th>Typical group</th>
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<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>20-40 yrs</td>
</tr>
<tr>
<td>Mean Age</td>
<td>51.6 (± 9.3)</td>
<td>33.2 (± 4.1)</td>
</tr>
<tr>
<td>Education</td>
<td>14.1 (± 2.6)</td>
<td>16.5 (± 1.8)</td>
</tr>
<tr>
<td>Months post onset</td>
<td>10.2 (± 3.5)</td>
<td></td>
</tr>
<tr>
<td>WAB AQ</td>
<td>56.7 (± 30.6)</td>
<td></td>
</tr>
<tr>
<td>Aphasia type based on WAB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anomic</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Broca’s</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Subcortical aphasia</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Transcortical motor</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Transcortical sensory</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Wernicke’s</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Results**

**Performance of typical group:** Data summary from the 100 Telugu speaking adults in the current study are presented in Table 2. The overall sample mean (N=100) score in Telugu was 105.33 and the standard deviation is 4.10. The mean score of Telugu young adults in the age range 20 – 40 years is 104.20 and S.D. is 3.54; mean score of typical adults in the age range 40-60 years is 107.11 and the S.D. is 4.17. The mean score of typical geriatric group with age above 60 years is 104.56 and the S.D is 4.03. One way ANOVA was done to find out the significant differences between the three groups and the analysis revealed significant difference (F(2, 97)=5.641, p<0.05) between the three groups and on Bonferrri post hoc analysis, significant difference was found between young adults and middle aged adult groups (p<0.05); middle aged adults and geriatrics (p<0.05). However, there was no significant difference (p>0.05) found between typical young and geriatric groups.

 Table 2: Mean and S.D of the three groups on BNT.

<table>
<thead>
<tr>
<th></th>
<th>20-40 yrs group</th>
<th>40-60 yrs group</th>
<th>60+ yrs group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>35</td>
<td>35</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Mean</td>
<td>104.20</td>
<td>107.11</td>
<td>104.56</td>
<td>105.33</td>
</tr>
<tr>
<td>S.D</td>
<td>3.54</td>
<td>4.17</td>
<td>4.03</td>
<td>4.10</td>
</tr>
</tbody>
</table>
The graphical representation of mean and S.D of all the three groups are represented in figure 1.

Figure 1: Graphical representation of mean and S.D of three age groups

Performance of individuals with aphasia: Data summary from the 20 Telugu speaking individuals with aphasia in the current study are presented in Table 3. The overall sample mean (N=20) score in Telugu is 59.85 and the standard deviation is 38.19. The mean score of anomic aphasic group (n=2) is 59.00 and the S.D. is 30.71; the mean score of Broca’s aphasic group is 72.11 and the S.D is 33.75; for global aphasics (n=1), the mean score is zero; for Subcortical aphasic (SCA) group (n=2), the mean score is 42.50 and the standard deviation is 36.06. For Transcortical motor aphasics (TMA), the mean score is 98.50 and the S.D is 0.70. The mean of Transcortical Sensory Aphasia (TSA) (n=1) is 63.00. The mean and S.D. of Wernicke’s aphasics (WA) group (n=3) are 28.33 and 19.85 respectively.

Table 3: Mean and S.D of the aphasic groups on BNT.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Type of aphasia</th>
<th>Number of subjects (N)</th>
<th>Mean (M)</th>
<th>Standard Deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anomic</td>
<td>2</td>
<td>59.0</td>
<td>30.71</td>
</tr>
<tr>
<td>2</td>
<td>Broca’s</td>
<td>9</td>
<td>72.11</td>
<td>33.75</td>
</tr>
<tr>
<td>3</td>
<td>Global</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Subcortical</td>
<td>2</td>
<td>42.5</td>
<td>36.06</td>
</tr>
<tr>
<td>5</td>
<td>Transcortical motor</td>
<td>2</td>
<td>98.5</td>
<td>0.70</td>
</tr>
<tr>
<td>6</td>
<td>Transcortical sensory</td>
<td>1</td>
<td>63</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Wernicke’s aphasia</td>
<td>3</td>
<td>28.33</td>
<td>19.85</td>
</tr>
<tr>
<td></td>
<td>Aphasia group</td>
<td>20</td>
<td>59.85</td>
<td>38.19</td>
</tr>
</tbody>
</table>

Performance of different groups on each stimulus – item analysis: Along with the normative data, item analysis in terms of percentage of correct responses was done each of the 57 items. Percentage correct per item in Telugu across three age groups is presented in Table 4.
In Telugu, all the participants of the study correctly named 40 items. Around 11 items were correctly named by 95% of the participants. Four items were correctly named only by 60-70% of the participants. ‘Cactus’ was named only by 39% of the participants.

**Discussion**

The present paper adapted the BNT to Telugu language for assessing naming deficits and presents norms for participants at different age groups and also data on performance of individuals with aphasia. Significant main effects of age were found with differences between different age groups. The results of the present study did not show the typical decline in naming with increase in age as seen in several studies (Albert et al., 1988; Borod et al., 1980; Lezak, 2004; Nicholas et al., 1985; Schmitter-Edgecombe et al., 2000). The present study only showed significant difference between young and middle aged groups as well as middle aged and geriatric groups only. The mean scores are higher in middle aged group (M = 107.11, SD = 4.17) than that of younger group (M = 104.2, SD = 3.54) and geriatric group (M = 104.56, SD = 4.03). It is likely that the factor of education played a major role in the results of present study similar to that of the study done by Van Gorp et al. 1986, while Farmer (1990) did not report age related decline in individuals with higher education levels.

The second major reason for the variations in performance in three groups is probably bilingualism. The effect of bilingualism was observed in young and middle aged groups during the testing where, many of them could name the picture in English (L2) language even though they were not able to name in Telugu language (L1). A good number of subjects have named the words cactus, protractor, and rhinoceros in English but not in Telugu which is depicted in item analysis. However, the older or geriatric group have named these words in Telugu more accurately because of the high exposure to the Telugu language than that of English language.

Indian educational system has seen recent (2–3 decades) changes where there is introduction of three language system in school education lasting for 10 years. This rule of having three languages in school education is a major factor in enhancing bilingualism and multilingualism in India. In this system, all the children have to study their native (mother tongue) language as first language, English language as second language or medium of instruction and Hindi (national language of India) as third language till 10th standard. There is a rise in the number of people studying with English as medium of instruction, in which children get more exposed to English language than that of native or third language. This exposure to English (L2) may be the possible reason for poor performance of younger group on Telugu task. As the subjects in the present study were with higher educational levels (above 15 years) only, the interaction between age and different education levels on naming could not be studied in this study.

The results of the clinical group indicate significant naming deficits in individuals with aphasia as shown in other studies (Kohn & Goodglass, 1985). Individuals with TMA performed well (M = 98.50, SD = 0.70) followed by Broca’s (M = 72.11, SD = 33.75) and TSA (M = 63.00). The other groups of aphasics, anomic, Wernicke’s, global and subcortical aphasics performed poorly on naming test. These results indicate that the BNT in Telugu is sensitive in tapping the naming deficits in individuals with aphasia. The error analysis of the responses revealed presence of both semantic and phonemic paraphasias. However, more studies on large group of aphasic subjects with varying severity and etiology are needed to generalize the results of the present study.

**Conclusion**

This study provides Boston Naming Test in Telugu language with age-wise norms, which may be useful to clinicians working with Telugu speaking individuals with neurogenic language disorders such as aphasia, dementia, PPA and so on. The study also examined the naming deficits in individuals with aphasia and found that this can be used to tap the naming difficulties in individuals with aphasia. However, as the subjects in the present study were only of higher education, further studies are required to study the effect of educational levels on naming in typical individuals and in individuals with aphasia. Also the usefulness of this BNT – Telugu on various groups of disordered population needs to be established with more studies.

**Acknowledgment**

The authors would like to thank Dr. S. R. Savithri, Director, All India Institute of Speech and Hearing, Mysore for permitting us to conduct this study. The authors would also like to thank Dr. Jaydipray Chaudary, HOD, Dept. of Neurology, Yeshoda Hospitals, Hyderabad for providing aphasic participants for the present study.
References


EFFECT OF AGING ON ORAL AND WRITTEN CONFRONTATION NAMING IN KANNADA AND ENGLISH

Preeti T. Thomas, Simmy Annie Sam, & Goswami, S. P.

Abstract

A most common feature seen in normal individuals and disordered population’s utterance is word-finding difficulty. The study was aimed to analyze the accuracy and type of responses and effect of aging in oral and written naming in orthographically regular language (Kannada) and irregular language (English) in bilingual individuals across age groups (25-45, 45-65, 65-85 years). Ten neuro-typical participants in each of the three age groups were studied. The stimuli included a set of twelve picture cards (nouns), which were presented individually. Two tasks were carried out in which one included the oral naming of the stimuli in one language and a simultaneous written naming in the other language. Similarly, the second task was carried out in the reverse order. The data was subjected to quantitative analysis and qualitative analysis. A significant difference (p < 0.05) was obtained within the English written naming tasks for the 65-85 years age group compared to the other age groups. With respect to the mode of response, the participants in both 65-85 years and 45-65 years age group showed a significantly better result in the English oral naming than the English written task. Qualitative analysis on the type of errors exhibited relatively higher semantic errors in the older age group. The results revealed an overall decline in the accuracy of naming responses with age. Semantic errors were more evident in the older age group for oral and written naming in both the languages. Kannada written naming was found to be better than English written naming across all the age groups, emphasizing the role of orthographic regularity in naming. This study also provides a basis that naming responses differ with the modality used for an irregular language.

Keywords: Word-finding difficulty, aging, oral naming, written naming, semantic errors

Introduction

Confrontation naming has been used widely to assess word finding difficulties in normals and disordered population. This is because the examiner knows the target word (i.e. the name of the presented picture or object) without any ambiguity, as compared to the studying word-finding difficulties in conversations (Deloche, Hannequin, Dordain, Perrier, Pichard, Quint, Metz-Lutz, Kremin, & Cardebat, 1996). However, the confronted target pictures could generally elicit more than one name, and hence, the reliability of the particular lexical entry the person is searching for is questioned.

The models of information processing generally distinguish three major levels in confrontation-picture naming (Deloche, Hannequin, Dordain, Perrier, Pichard, Quint, Metz-Lutz, Kremin, & Cardebat, 1996):

1. The extraction of a pre-semantic structural description requires the perceptual analysis of the picture presented
2. The preceding structural knowledge paves way for the access to stored semantic information
3. Finally, the target word to be produced is selected of the output verbal representation

This denotes that naming errors could occur at various stages (perceptual, semantic, and lexical).

Confrontation naming is studied using oral and written modalities of responses. Orthographic variables like regularity of a language can also influence naming tasks (Deloche, Hannequin, Dordain, Perrier, Cardebat, Metz-Lutz, Pichard, Quint, & Kremin, 1997).

A regular (transparent/shallow) language is a formal language which follows the phoneme-to-grapheme correspondence rules having a finite sequence of symbols from a finite alphabet; whereas an irregular (opaque/ deep) language is also a formal language which does not always follow the phoneme-to-grapheme correspondence rules using the finite set of alphabets.

Effect of aging on confrontation naming is also of interest to researchers. It is a well known fact that there is a declination of various linguistic skills as the age progresses. Thus, the effects of aging on such naming tasks have been probed widely in recent studies.
Review of Literature

Picture confrontation and oral naming have been studied widely in normals and persons with brain damage. Deloche, Hannequin, Dordain, Perrier, Pichard, Quint, Metz-Lutz, Kremin, and Cardebat (1996) studied verbal confrontation naming in neuro-typical subjects and persons with aphasia (Wernicke’s, Broca’s, anomics and globals) using a set of pictures. The study concluded that the picture-image familiarity and agreement were significant factors in the responses of neuro-typical individuals. Word and phoneme frequency were relevant in determining the responses in persons with aphasia.

Another study done by Deloche, Hannequin, Dordain, Perrier, Cardebat, Metz-Lutz, Pichard, Quint, and Kremin (1997) compared a group of persons with aphasia (Wernicke’s, Broca’s, anomics and globals) and a group of normals on the performance on written responses with that of picture confrontation naming. The results revealed the superiority of normal participants over persons with aphasia in their correct response rates. Also, there was moderate percentage of discrepancy suggesting that the misnaming were incidentally seen in neuro-typical participants, but regularly found in persons with aphasia. The two misnaming types observed in persons with aphasia were neologisms (11%) and no-responses (21%).

A longitudinal study was conducted by Ronald, Stephen, Nicole, and Deb (2005) on confrontation naming in 541 normal elderly (ages 50–99) using the 60-item Boston Naming Test (BNT). A rise in the mean rate of change on the BNT was noticed till the 50s age group with no change in the 60s age group, and a decline in the 70s and 80s age groups. These findings demonstrate that during aging, there is a well preserved lexical retrieval as measured by a visual object confrontation naming task, with only minimal variations in the seventh and eighth decades of age.

Ronald, Nicole, Stephen, Deb (2007) conducted a cross-sectional study on the effects of age, education, and gender on the 60-item Boston Naming Test (BNT) in 1111 normal elderly (ages 50-101) and 61 younger adults (ages 20-49). The results revealed a significant inferior mean BNT scores with successively older age groups and lower educational grades. However, the males showed a non-significant trend to score slightly higher than females.

The above studies highlight the differences in naming across modalities and across age groups.

Need for the study

Most studies on confrontation naming have concentrated on a single language and on a single mode of naming response. However, reports which address the issue of orthographic variables across languages (such as, orthographic irregularities) are limited. Moreover, there is a dearth of such research across age groups.

Thus, the need to address the effects of aging on oral and written confrontation naming and the effects of orthographic variables in the performance across two different languages - orthographically regular language (e.g. Kannada) and irregular language (e.g. English).

Aim

- To analyze the accuracy and type of responses in oral and written naming in orthographically regular language (Kannada) and irregular language (English) in bilingual individuals across age groups.
- To study oral and written confrontation naming across the two languages in the different age groups.
- To study the effect of aging on the naming tasks in the two languages.

Method

Participants were normal individuals within the age range of 25 - 85 years. They were divided into the following age ranges with ten in each group:

1. 25 – 45 years
2. 45 - 65 years
3. 65 – 85 years.

They were bilinguals having Kannada as their mother tongue and English as their second language. They had undergone a minimum of ten years of formal training in both the languages (regular and irregular). They had no history of neurological, psychological or any known sensory or organic deficit.

Stimuli: Twelve picture cards (nouns) of size 4” x 6” (black and white line drawings) were used to elicit responses from participants. These included pictures from Western Aphasic Battery (Kertesz, 1982) and Linguistic Profile Test (Karanth, 1980). The same pictures were used across the two tasks considered in the study.

Tasks: The following two tasks were carried out in the study:

- Task 1- Simultaneous oral confrontation naming in English and written confrontation naming in Kannada.
- Task 2- Simultaneous oral confrontation naming in Kannada and written confrontation naming in English.
Each task was for the duration of five minutes with pictures randomized into two sets (set 1 and set 2).

Procedure
Task 1: Twelve picture cards were used in this task, where one picture, at a time, was placed in front of the participant. They were asked to name each picture orally in one of the languages (English) and simultaneously to write the name in the other language (Kannada). Oral responses were audio recorded and transcribed for further analysis. Written responses were recorded in a response sheet and were analyzed.

Task 2: The same twelve picture cards were used in this task, where one picture, at a time, was placed in front of the subject. They were asked to name each picture orally in one of the languages (Kannada) and simultaneously to write the name in the other language (English). Responses were recorded and analyzed in the similar way as in task 1.

Scoring

The following scores were calculated:
- For each acceptable correct response (in oral and written confrontation naming task), a score of one was given.
- Score of zero was given for each incorrect response.

The incorrect responses included semantic errors, spelling errors [grapheme-phoneme correspondence (GPC) errors] and no responses. These errors were subjected to qualitative analysis.

The same procedure was carried out in both the languages and across all three age groups for both the tasks.

Data Analysis: The data was subjected to the following statistical analysis. One-way ANOVA was carried out to make comparisons within the different parameters (language and mode of naming) across age groups. The significant measures were further analyzed using Duncan’s Post-Hoc analysis. A paired t-test was used to compare responses across each of the different parameters within each age group. Later, qualitative analysis was done to describe the type of errors.

Results

The study compared responses between oral and written naming tasks across two languages in three different age groups.

(a) Quantitative Analysis

One-way ANOVA revealed a significant difference within the English written (EW) naming task \[ F (2, 27) = 5.274, p < 0.05 \], whereas, there was no significant differences for the other parameters [English oral (EO), Kannada written (KW) and Kannada oral (KO)] across age groups. Duncan’s Post-Hoc analysis for the English written (EW) naming task was significant for individuals in the age range of 65-85 years (\( p < 0.05 \)) as compared to the other two age groups (25-45 and 45-65 years).

Table 1: Mean and Standard deviation values across age groups for the different parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Age Group</th>
<th>Number of subjects</th>
<th>Mean (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English Written</td>
<td>25-45</td>
<td>10</td>
<td>11.00 (1.24)</td>
</tr>
<tr>
<td></td>
<td>45-65</td>
<td>10</td>
<td>10.30 (1.76)</td>
</tr>
<tr>
<td></td>
<td>65-85</td>
<td>10</td>
<td>8.00 (3.05)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
<td>9.7667 (2.45)</td>
</tr>
<tr>
<td>English Oral</td>
<td>25-45</td>
<td>10</td>
<td>11.70 (.48)</td>
</tr>
<tr>
<td></td>
<td>45-65</td>
<td>10</td>
<td>11.40 (.69)</td>
</tr>
<tr>
<td></td>
<td>65-85</td>
<td>10</td>
<td>11.00 (1.24)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
<td>11.36 (.88)</td>
</tr>
<tr>
<td>Kannada Written</td>
<td>25-45</td>
<td>10</td>
<td>11.00 (.66)</td>
</tr>
<tr>
<td></td>
<td>45-65</td>
<td>10</td>
<td>11.30 (.48)</td>
</tr>
<tr>
<td></td>
<td>65-85</td>
<td>10</td>
<td>10.80 (.63)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
<td>11.03 (.61)</td>
</tr>
<tr>
<td>Kannada Oral</td>
<td>25-45</td>
<td>10</td>
<td>11.00 (.66)</td>
</tr>
<tr>
<td></td>
<td>45-65</td>
<td>10</td>
<td>11.20 (.42)</td>
</tr>
<tr>
<td></td>
<td>65-85</td>
<td>10</td>
<td>10.30 (1.49)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
<td>10.83 (1.01)</td>
</tr>
</tbody>
</table>

Within the 25-45 years age group, a significant difference was found between the English oral and Kannada oral naming tasks \[ t (9) = 2.689, p < 0.025 \]. Similarly, a significant result \[ t (9) = 2.703, p < 0.024 \] was obtained between English written and English oral tasks within the 45-65 years age group. Finally, for the 65-85 years age group, significant results were found between English written and English oral \[ t (9) = 4.108, p < 0.003 \] and also between English written and Kannada written \[ t (9) = 2.717, p < 0.024 \].
Graph 1: Mean scores across age groups for each of the tasks

![Graph 1](image-url)

(b) Qualitative Analysis

The individual responses across age groups yielded various types of errors. The errors were classified as semantic errors, spelling errors [grapheme-phoneme correspondence (GPC) errors] and no responses.

In the youngest age group, i.e., 25-45 years, the written tasks (Kannada and English) revealed semantic errors, incorrect responses and self corrections, whereas GPC errors (additions and substitutions) were found only in the English written naming task. In the Kannada oral task, semantic errors were prominent.

Individuals in the 45-65 years age group exhibited semantic and no response errors for the Kannada oral and written and English oral naming tasks. Semantic errors, GPC errors (omissions and substitutions), no response and self corrections errors were seen in the English written naming task.

Kannada oral and written and English oral naming tasks revealed semantic errors and no response errors for individuals in the 65-85 years age group. Similarly, in the English written tasks, these individuals made semantic errors and no response errors along with GPC errors (additions, omissions, substitutions and reversals) and self corrections.

Overall, individuals in the older age group exhibited more types of errors for the different tasks in both the languages compared to the younger and middle age groups.

Discussion

Poor performance in terms of the accuracy and type of responses of individuals in English written naming task compared to Kannada in 65-85 years age group could be attributed to the orthographic irregularity in English. This group had exhibited varied GPC errors in the English written naming task as English does not always adhere to the GPC rules. A great number of theorists have highlighted the fact that writing is channelized entirely by the core sound constituents of words (Geschwind, 1969 & Luria, 1960). Frith (1979) commented on the importance of phonology for writing. A decline in the short term memory with respect to the complexity of information to be recalled has been reported by Craik and Rabinowitz (1985). Further, the decline in the long term memory with age is primarily attributed to the encoding and organizational difficulties (Rankin & Collins, 1985). Dobbs and Rule (1989) reported that even though the working memory capacity remains unaffected by normal aging, the ability to manipulate information in the working memory may decline with age. Thus, the significantly poorer scores seen in this particular age group of this study could be a reflection of the effect of aging on retrieval of the written form in a regular and an irregular language. The retention and/or retrieval of orthographically irregular words are comparatively more stressful than the regular words. With age, this difficulty increases, thus, indicating a reduction in cognitive skills. Cavanaugh, (1983) reported that changes in memory with age are necessarily detrimental to the ability to use the language effectively. This was evident from the finding that Kannada being the mother tongue, showed a relatively slower decline for these tasks than the second language, i.e., English. This also highlights that the usage and storage for Kannada words is more in terms of duration, which is in agreement with the theory of evolution and dissolution of language.

In 45-65 years and 65-85 years, a significantly poorer naming scores in English written and oral naming tasks were found in comparison to the younger age group (25-45 years). This could again be an indication of the aging effect on these tasks. In the two age groups, the English oral naming task was better than the English written. Although, both oral and written naming are identically affected (qualitatively), the written responses are usually performed, to some extent, more poorly than speech (Goodglass and Hunter, 1970). The poorer written scores confirm that writing depends on a sound based strategy. In addition, English having a more irregular orthographic form, manifested GPC errors. It could also be postulated that the sub-vocal rehearsals, a phenomenon which facilitates the memorizing abilities of an individual, in turn strengthens the retention skills, facilitating oral naming. The automatic habit of continual repetition may be what helps to preserve the syntax in the elderly aphasics (Geschwind, 1972) and a similar trend has been noticed for the words
too. It has been reported that individuals with aphasia showed better performance with sub-vocal rehearsals, indicating that this strategy helps in retaining the linguistic stimuli for a longer duration (Goswami, 2004). This type of obvious strategy is not seen in a written task, showing that, while retrieving written responses, the amount of cues available are less, which has an impact on the written naming performances.

In 25-45 years age group, better performance in the English oral compared to the Kannada oral naming could be attributed to the recent trend of English language usage as a marked feature of cultural, technological and societal demands on the performances of younger population compared to the other two groups.

All groups had almost similar performances across tasks, with the exception of the older age group (65-85 years) who showed a decline in performance in the English written naming task alone, highlighting the role of factors like aging and orthographic regularity of languages.

There is greater demand and usage of the second language, resulting in better activation and hence enhancing the proficiency in the younger age group contrary to the older age groups. In the older age groups, the demand and usage of native language is more compared to the second language, bringing about a better proficiency in the native language.

With respect to the type of responses, it was observed that the older age group (65-85 years) showed relatively more semantic errors and self corrections compared to the younger age groups. In older adults, true semantic and neologistic jargons are prominent (Brown, 1978). It is considered that the conceptual system in a bilingual individual is common for all languages (based on the revised hierarchical model proposed by Kroll and Stewart, 1994). Several lexical nodes of the different languages get activated on the presentation of a stimulus, irrespective of the language in which the task is being performed. Hence, during the lexical selection, these multiple activated nodes function as competitors. Regardless of the competition, an inhibitory process mechanism suppresses the activation of the non-target language words (Green, 1998; Hermans and Schreuder, 1998; Lee & Williams, 2001). Thus, it could be stated that an inappropriate inhibition and/or selection mechanism could result in a semantic error. The increased semantic errors with age highlight a putative indication of a decreased inhibition mechanism in the conceptual system during the naming task.

Overall, the quantitative and the qualitative results reveal an obvious difference in the performances of the younger and older groups, especially in the written naming task.

**Conclusion**

The confrontation naming task has been extensively used to tap naming deficits in the elderly and in the population with disorders. Both oral and written modes of responses have been used. However, these studies have been confined to the use of only a single language for such naming tasks.

The present study was done across three age groups- young adults to old age. Oral and written naming was explored in two languages- Kannada and English. The results revealed an overall decline in the accuracy of naming responses with age. Semantic errors were more evident in the older age group for oral and written naming in both the languages. Kannada written naming was found to be better than English written naming across all the age groups, emphasizing the role of orthographic regularity in naming. There were instances of difference in responses across oral and written naming tasks in English for the age groups providing an assumption that naming responses differ with the modality used for an irregular language. The results of the study are suggestive of the importance of an active exposure and active usage of a language rather than an active exposure and passive usage. However, the results of this study need to be generalized with caution and warrants further research in this area.

**Implications of the study**

This study had attempted to compare oral and written confrontation naming in bilingual individuals across age groups. Further, the influences of orthographic variables across languages were also accounted for.

Such information can help the Speech Language Pathologists to compare the nature of responses in normals and disordered population.

Studies on confrontation naming with aging can give an insight into such patterns in normal and pathological aging conditions.

This also highlights the use of modality specific responses in naming tasks in different languages.

The results also imply that during assessment and management, the active usage of a language is an important factor to be considered.
Further extensive research in different orthographically opaque and shallow languages can provide a better insight into the variables affecting naming tests.

References


EFFICACY OF SEMANTIC FEATURE ANALYSIS AS A TREATMENT FOR WORD RETRIEVAL DEFICITS IN INDIVIDUALS WITH BROCA’S APHASIA

Revathi Magesh, & Gouri Shanker Patil

Abstract

The present study addressed efficacy of Semantic Feature Analysis (SFA) as a treatment technique for word retrieval deficits in Telugu speaking individuals with Broca’s aphasia, and to assess the generalization of trained items to untrained across the same and different semantic categories. Three Telugu speaking individuals with Broca’s aphasia participated in the study. A discrete trial treatment design was used to examine both acquisition and generalization effects of treatment. The SFA protocol using treatment pictures (animal category) was administered for 6 weeks. Naming skills were tested with untrained items within the same semantic category every 2nd week. At the end of sixth week, both trained and untrained animals names were probed. The probes for animals list continued for the next 3 weeks. At the end of 9th week, naming skills for birds and vehicles were tested and the WAB test was re-administered. Maintenance effects were assessed at the end of 12 and 18 weeks. The results of WAB before and after use of the SFA protocol, baseline naming scores, scores obtained at the end of 2nd week, 4th week, 6th week, 9th week, 12th week and 18th week were tabulated and analyzed. A <0.05 of significant difference was observed for WAB scores before and after therapy indicating an objective evidence for the efficacy of SFA as a treatment option. To establish the difference in naming skills after the use of SFA, the naming subtest scores were subjected to paired samples t-test. Mean scores in the naming subtest of WAB pre & post therapy were 3.1 & 6.2 respectively. The present study suggests SFA strengthens association between target word and its prototypical semantic characteristics thereby facilitating word retrieval.

Keywords: SFA, Word Retrieval Deficits

Introduction

Aphasia is a language disorder which frequently impairs the ability to produce a desired target word or generate sentences. Naming deficits are common in aphasia regardless of its subtype and semantically based errors are also frequently observed (Ardila & Roselli, 1993; Drew, Thompson, & Abaza, 1999; Hillis, 1989; Kohn & Goodglass, 1985). In Telugu speakers with aphasia, Bhan & Chitnis (2013) reported word finding difficulty marked by semantic and phonemic paraphasias in narrative discourse in a client with subcortical aphasia presenting both fluent and nonfluent aphasia characteristics. Previously, Nagendar and Ravindra (2012) found significant word retrieval deficits in Telugu speaking persons with left hemisphere damage (LHD). In another study, Alladi, Mridula, Mekala, Rupela, & Kaul (2010) reported word retrieval deficits in 2 persons with post-stroke fluent aphasia. In individuals with Broca’s aphasia confrontation naming is markedly affected. Treatment of naming abilities by speech-language pathologists may be the main focus of therapy if deficits are prominent (Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1986). Retraining the names of all of the objects and people in an individual’s personal lexicon is not considered an effective therapeutic method and generalization for confrontation naming tasks is often limited (Nickels, 2002). Recognizing the role of semantic system in comprehension and retrieval of words, some comprehension treatments were developed to facilitate word-retrieval abilities (Marshall, Neuburger, & Phillips, 1990). One of these types of semantic treatments, developed on the basis of cognitive theories of how semantic representations are structured is the semantic feature analysis (SFA) training. The SFA is designed to improve lexical retrieval by increasing the level of activation within a semantic network (Boyle & Coelho, 1995). The SFA rationale is based on the fact that vocabulary becomes more automatic when the neural connections between the semantic concepts within the semantic system are strengthened. The target is more likely to be retrieved and produced when the entire surrounding semantic network is activated (Davis & Thompson, 2005). The SFA procedure employs the use of multiple forms of input for naming, including the written labels of semantically related features, pictures and functional verbal prompts from the speech...
language pathologist. Peach and Reuter (2010) tested generalization of improved word retrieval to discourse production using the SFA in 2 persons with anomia. The investigators found positive impact of SFA in word retrieval at discourse level.

In SFA procedure, the client is presented with a common picture and is asked to name it. If the client is unable to do so, then he/she is given probes to produce words that are semantically related to the target and is given prompts with questions to provide information about distinctive semantic features associated with the target word that is difficult to retrieve. The therapist assists the client in answering a set of questions about the target by writing and verbalizing responses. A mapping form with sample questions listed on it is used for this process. This process provides both auditory and visual cues, and if the individual is unable to name the target once the map is completed, then the SLP provides the name of the stimulus and the client repeats it.

The mapping form of SFA is as follows:

The use of SFA for facilitating word retrieval is well documented in the western studies. The research done in this area in aphasics speaking Indian languages is little. The current study was needed to address issues related to efficacy of SFA in Telugu speaking individuals with aphasia. The current study also addresses another facet of exploring whether SFA would help in generalization from trained to untrained items within the same semantic category (e.g., animals) or a related category (e.g., birds, since both are animate) or a completely different class (e.g., vehicles).

Method

Three Telugu speaking individuals with Broca’s aphasia were selected with inclusion criteria of a single left hemisphere stroke in the middle cerebral artery confirmed by a CT/MRI scan and post stroke duration of at least 6 months. All the 3 participants in the study had received some traditional approaches of language treatment during the initial months following their stroke. The Western Aphasia Battery (WAB) was administered to establish the pre-therapy naming subtest scores and to determine the type of aphasia. The Table 1 presents WAB scores for the 3 participants.

A set of black and white line drawings belonging to semantic categories of animals, birds and vehicles were developed and standardized by 50 normal young and adult individuals for name agreement, image agreement, familiarity, and visual complexity on a Likert 5 point rating scale. These items were not part of the WAB. The name agreement was defined as relevance of the noun to that of the target item on the card. Imageability was defined as the ease with which a word gives rise to a sensory mental image (Paivio, Yuille, & Madigan, 1968).

Table 1: WAB scores of all the three participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Fluency</th>
<th>Comprehension</th>
<th>Repetition</th>
<th>Naming</th>
<th>Apraxia Score</th>
<th>WAB Impression</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>3.0</td>
<td>8.25</td>
<td>2.8</td>
<td>3.0</td>
<td>58</td>
<td>Broca’s Aphasia</td>
</tr>
<tr>
<td>P2</td>
<td>3.5</td>
<td>8.65</td>
<td>2.8</td>
<td>3.2</td>
<td>51</td>
<td>Broca’s Aphasia</td>
</tr>
<tr>
<td>P3</td>
<td>3.0</td>
<td>8.35</td>
<td>1.9</td>
<td>3.1</td>
<td>55</td>
<td>Broca’s Aphasia</td>
</tr>
</tbody>
</table>

Familiarity was defined as the degree to which one came in contact with or thought about the item on the card (George & Mathuranath, 2007). Visual complexity was defined as the amount of detail or intricacy of lines in the drawing and not the concept it represented (George & Mathuranath, 2007). The mean scores were obtained for each variable and rank ordering was carried out accordingly. After this, 4 lists - List I, List II, and List III & List IV were prepared.
Each participant received speech therapy weekly thrice for 1 hour for nine weeks during which the pre-therapy WAB scores were also taken. Semantic feature analysis (SFA) protocol was used. The training picture items list was used and the pictures were randomly presented for only once during the session. There was variability among participants with regard to the number of items completed in a session. Thus there were no fixed criteria as to how many pictures to be completed per session, although a target was set that by the end of the sixth week all the ten trained pictures should be completed. The participants were asked to name each picture and the SFA protocol was initiated even if the participant’s were able to spontaneously name the picture. The semantic features used by clinician in the initial sessions were those that were developed as per the norms of 50 neurologically normal participants, although the semantic features given by participants during the sessions were made a major focus for an easier retrieval and the features elicited varied from participant to participant. If the picture was named spontaneously without any assistance/prompts from the therapist, it was judged as correct. Incorrect responses such as phonemic paraphasias were not accepted. Prompts such as “this makes me think of,” “this is used for,” or “this is found” were used to form a web of related concepts to the target. If the subject’s were unable to provide an answer to each of the prompts, then the clinician will provide it both verbally and also in written form. Sometimes participants attempted for the target word in English. These attempts were not discouraged, but the clinician repeated the target as to “Let’s try to recollect it in Telugu and repeated the target in Telugu”. After completing the entire protocol, the subjects were again asked to name the picture. If they were still unable to do so, then the clinician provided the response verbally and requested the subjects to repeat it. Appendix II presents with the detailed description of the steps involved in the SFA protocol.

The SFA protocol was continued with the treatment pictures (List I) for six weeks. Naming probes with the untrained items (List II) within the same semantic category were conducted every 2nd week to determine the generalization of naming skills. At the end of the sixth week, naming probes with trained and untrained animal’s lists (List I & II) were conducted. After this, the SFA protocol was repeated for both trained and untrained items of animal’s category for 3 weeks. At the end of the 9th week naming probes for birds and vehicles list were conducted (List III & IV) to assess the generalization of trained probes to untrained probes across different semantic categories. At the end of the 9th week WAB test was re-administered again.
The maintenance effect was assessed at the end of 12 weeks and 18 weeks.

**Results and discussion**

(i) Efficacy of SFA in lexical retrieval of nouns belonging to treatment probes: The naming scores for the treatment probes were conducted at the end of the 6th week of SFA protocol. The results are presented in the following Figure 1. BS represents the baseline scores for the treatment probes. TP represents the naming scores of the treatment probes at the end of 6 weeks of SFA therapy. P1, P2 and P3 represent participant 1, participant 2 and participant 3 respectively. The graph shows a clear improvement in the naming skills from the baseline scores to the post therapy scores.

(ii) Efficacy of SFA generalization of the trained items to the untrained nouns belonging to the same semantic category of animals: The naming probes of untrained items within the same semantic category of animals were conducted at the end of 2nd, 4th and 6th week of the SFA protocol. During these naming probes, the participants were presented with the untrained picture sets and were asked to name them using SFA technique. No verbal and visual prompts were provided. The results are presented in the following Figure 2. The graph shows a gradual increase of the naming acquisition responses by P1, P2 & P3 for the untrained items in the semantic category of animals across the six weeks of SFA protocol. BS represents the baseline scores. This indicates that the generalization effects for the nouns within the same semantic category are high.

(iii) Efficacy of SFA in generalization of the trained items to the untrained nouns belonging to different semantic categories of birds and vehicles: At the end of 9th week of SFA protocol the naming probes were measured for the both the lists in the semantic category of animals and their generalization effects were assessed across different semantic category of birds and vehicles. The results for Participant 1 (P1) indicated the naming accuracy for List II nouns increased from 60% to 90% by the end of 9th week of SFA protocol. The increase in the naming accuracy from 10% to 40% for birds, and 20% to 40% for vehicles was evident, but it was not be considered as a generalization effect, since more than 50% criterion was not met. The naming accuracy for Participant 2 (P2) for List II nouns increased from 90% to 100% by the end of 9th week of SFA protocol. The increase in the naming accuracy from 10% to 40% for birds, and 20% to 40% for vehicles was evident, but it was not be considered as a generalization effect, since more than 50% criterion was not met. The naming accuracy for Participant 2 (P3) for List II nouns increased from 60% to 80% by the end of 9th week of SFA protocol. BS B, GE B, BS V & GE V represent the baseline scores & generalization effects of birds and vehicles respectively. The increase in the naming accuracy from 10% to 40% for birds, and 20% to 40% for vehicles was evident, but it was not be considered as a generalization effect, since more than 50% criterion was not met.

(iv) Efficacy of SFA in Maintenance effects: Maintenance of the naming skills to the trained and untrained items in the semantic categories of animals, birds and vehicles were assessed at 12th week and 18th week. The maintenance period was considered as the time after 9th week of SFA protocol. During this time, no therapy was given with respect to SFA or any other concurrent approach. The consent from the family of the participants was taken for the same. The
maintenance effects for the three participants are presented in the following figure.

![Figure 3: The maintenance effects for P1.](image)

![Figure 4: The maintenance effects for P2.](image)

![Figure 5: The maintenance effects for P3.](image)

The results from the three participants indicate greater gains in maintenance of the achieved targets in List I and List II of the semantic category of animals which were treated for 9 weeks and 3 weeks respectively. This indicates that SFA assists in improved maintenance for the treated probes. Although there was an improvement in the naming scores for all the three participants, the responses were not considered as generalization effects due to not meeting the criterion of 50% or more. Thus, poor generalization and poor maintenance scores are achieved for all the three participants in the semantic category of birds and vehicles. This indicated that SFA assists in greater gains in word retrieval for treated probes and untreated probes under the same semantic categories and modest gains for untrained probes across different semantic categories.

*(v) Pre and Post therapy WAB scores:* After the 9 weeks of therapy using the SFA protocol, the WAB test was re-administered for all the three participants. The naming subtest scores are presented in the following table.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Pre-Therapy</th>
<th>Post-Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>3.0</td>
<td>5.9</td>
</tr>
<tr>
<td>P2</td>
<td>3.2</td>
<td>6.6</td>
</tr>
<tr>
<td>P3</td>
<td>3.1</td>
<td>6.1</td>
</tr>
</tbody>
</table>

The table represents an improved score in the naming subtest of WAB from baseline to the post therapy score for all the three participants. The pre-therapy naming scores were 3.0, 3.2 and 3.1 for P1, P2 and P3 respectively. The naming scores improved to 5.9, 6.6 and 6.1 for P1, P2 and P3 indicated that a significant improvement in naming is achieved due to the use of SFA protocol for a period of 9 weeks. To establish the significant difference if any because of SFA, the overall WAB scores and the naming subtest WAB scores were subjected to paired samples t-test. Table 3 presents the mean values and the standard deviation values for the overall WAB scores.

<table>
<thead>
<tr>
<th>WAB scores before therapy</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Sig. (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.30</td>
<td>2.51</td>
<td>0.000</td>
</tr>
<tr>
<td>WAB scores after therapy</td>
<td>6.27</td>
<td>1.76</td>
<td></td>
</tr>
</tbody>
</table>

A significant difference of (<0.05) was observed for the WAB scores before and after therapy indicating an objective evidence for the efficacy of SFA as a treatment option. To establish the difference in word retrieval skills after the use of SFA, the naming subtest scores were alone subjected to paired samples t-test. The results suggested SFA facilitated improved performance of word retrieval skills for the trained items of List I in the semantic category of animals for all 3 participants. The results showed greater gains in retrieval of treatment probes following SFA. The responses from the baseline to the post therapy scores conducted at the end of 9th week and the generalization scores measured at the end...
of 12th and 18th weeks also reported greater gains in the maintenance of achieved targets even when the use of SFA protocol was terminated. This is in accordance to the study done by Boyle (2004), Boyle & Coelho (1995) and Mc Hugh & Boyle (2000) who had shown that SFA training improved word retrieval for trained items in participants with aphasia and reported positive generalization and maintenance effects. The use of SFA showed greater generalization to the untrained items within the same semantic category. This improvement in generalization can be attributed to the likelihood of the carryover of the SFA mapping technique to the untrained items. The SFA also facilitated self-generation of cues by the participants reflecting improved word retrieval for untrained items. This is consistent with the findings of Boyle, & Coelho (1995), Lowell, Benson, & Holland (1995), and Coelho, Mc Hugh, & Boyle (2000), who reported improved generalization effects of trained nouns to untrained nouns in participants with aphasia. The generalization effects of the trained items to the untrained items across different semantic categories were not reported previously. Thus it cannot be assumed that SFA may not assist in generalization of trained items to untrained items across different semantic categories based on this preliminary finding of the current study.

Conclusions

The results of the present study supports the use of SFA as a functional therapeutic means of facilitating naming. Thus it can be inferred that strengthening the associations between a target word and its prototypical semantic characteristics results in a greater ease with which the words are retrieved. As SFA is a self-generated cueing strategy, it can be inferred from the present study that self-generated cueing behaviors (client generated) should be regarded as potentially useful ways of transferring information, because a patient’s success at retrieving a specific target word bore no apparent relationship to successful observer identification (observing clinician generating cues). Certainly, a therapy focus that encourages the use of clear self-cues regardless of eventual word production should be considered for many adults with aphasia. Also, this technique teaches individuals a process of thinking and generating language using a purposeful, step-by-step format that helps in self-generating cues in non-clinical settings also.

References


Appendix I

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Target items for treatment probes</th>
<th>Target items to assess generalization within the same semantic category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>/pilli/</td>
<td>/djmka/</td>
</tr>
<tr>
<td>2</td>
<td>/te:pa/</td>
<td>/poli/</td>
</tr>
<tr>
<td>3</td>
<td>/a:vu/</td>
<td>/eluca/</td>
</tr>
<tr>
<td>4</td>
<td>/me:ka/</td>
<td>/tfirlo:poli/</td>
</tr>
<tr>
<td>5</td>
<td>/gotram/</td>
<td>/elogo: banti/</td>
</tr>
<tr>
<td>6</td>
<td>/kokka/</td>
<td>/mosali/</td>
</tr>
<tr>
<td>7</td>
<td>/enogu/</td>
<td>/kappa/</td>
</tr>
<tr>
<td>8</td>
<td>/pa:mu/</td>
<td>/dyrai/</td>
</tr>
<tr>
<td>9</td>
<td>/pi:dx/</td>
<td>/pandi/</td>
</tr>
<tr>
<td>10</td>
<td>/onte/</td>
<td>/kanga:ru/</td>
</tr>
</tbody>
</table>

Appendix II

Treatment Procedure of SFA

I. Clinician presents picture of target item in center of semantic feature chart.
A. Clinician requests naming response from participant.
   1. If correct response: verbal feedback is provided (i.e., .That’s right. Now let’s go through the features.).
   2. If incorrect response: verbal feedback is provided (i.e., .Not quite. Let’s see if we can trigger it by going through the features.).
B. Regardless of whether naming response is correct or incorrect, the participant is guided through semantic features for target item.
   1. Clinician writes features in the appropriate location on the feature chart after the participant identifies them.
   2. If participant is unable to provide a feature, the clinician provides an appropriate feature both verbally and in writing.
   3. Clinician completes all features even if correct naming response occurs while reviewing features.
C. After completing all the features, the clinician requests a naming response again.

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1. If correct response: verbal feedback is provided (i.e., ‘That’s right.’) and new stimulus item is presented.

2. If incorrect response: the clinician will model the target word and request a repetition. If correct production is still not elicited the clinician will attempt integral stimulation to elicit the target word.

3. With incorrect response: clinician reviews the features again with participant by providing a neutral beginning for each feature (e.g., ‘the place that usually belongs this is…’). If the participant is unable to complete the phrase, the clinician will complete it.

D. After completing all the features, the clinician requests a naming response again.

1. If correct response: verbal feedback is provided (i.e., ‘That’s right.’) and new stimulus item is presented.

2. If incorrect response: clinician provides a model of the correct response and new stimulus item is presented.
EVALUATING THE EFFICACY OF AN ORIENTATION PROGRAM USING TRADITIONAL AND QUALIFIER APPROACHES

1Manjula P., 2Raheela Qudsiya, & 3Sahana, P.

Abstract

To evaluate the efficacy of orientation program on communication disorders, by administering a pre- and post-test on students of Masters in Social Work (MSW). Data were collected in two phases, with 26 in Phase I and 20 participants in Phase II. An orientation program on Prevention of Communication Disorders was given to the participants in two phases. The orientation lecture was delivered by a qualified Audiologist and a Speech Language Pathologist in both the phases. A pre- and post-test was given in both phases, consisting of 10 multiple choice questions with a qualifier question of ‘Are you guessing?’ the answer was considered incorrect if the participant indicated that it was a guess. This gave information on whether the answer was a mere guess or was a result of the knowledge gained after orientation. Based on the post-test performance of Phase I, and before the initiation of Phase II, appropriate changes in the lecture were made to refine and increase the impact of the orientation program in Phase II. The pre- and post-test data of Phase II were analyzed using ‘Traditional approach’ which was scored for either correct or incorrect answer and ‘Qualifier approach’. In the qualifier approach, the number of participants scoring correct answer in the post-test was 63% and 83% when compared to their pre-test score of 19% and 23.5%, in Phase I and Phase II respectively. The program also focused on correcting knowledge of the participants and also provided the instructor the feedback on modifications in the content and technique of teaching required when a concept was not clearly understood. This study highlights the importance of evaluating the impact of the orientation program about the communication disorders, for effective dissemination of knowledge to other allied professionals.

Key words: Pre-test, Post-test, Qualifier approach, Traditional approach, Orientation program

Introduction

“To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, use effectively and communicate information in its various forms” - American Library Association (1989). The communication disorders are potentially disabling conditions with widespread implications in a person’s life.

Communication disorders include disorders in speech, language and hearing. Especially in children, communication disorders may have an impact on development of speech and language, social and emotional well-being, cognition, and behavior (Baker & Cantwell, 1987; Lewis, Freebairn & Taylor, 2000; Bryan, 2004). Lower speech and language development in children has significant effect on their educational, linguistic and auditory perceptual development and affect vocational choices later in adulthood (Ruben, 2000).

Prevention, early identification and early intervention of communication disorders are important to alleviate the impact of the communication disorders (Campbell, 2004) and should be a high priority in addressing the growing burden of communication disorders. Due to lack of manpower, especially in rural areas, speech therapy and audiological services are nonexistent. Thus, individuals with communication disorders have several barriers in accessing the rehabilitation services educating the grass-root level workers and allied professionals about the preventable causes, signs of different communication disorders that help in identification and management guidelines, will prevent the further consequences of the communication disorder. Thus, the orientation program should address all these aspects of communication disorders.

Training/orientation program is the systematic and organized procedure or act of increasing specific knowledge, attitudes, habits or skills of an employee or non-personnel to fulfill a specific purpose or for doing a particular job as well as for preparing to hold future positions (Hart, 1991). The main objective of this program to make aware of the possible causes of communication

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The role of allied professionals in the development of anti-discrimination legislation, policies that support persons with disabilities and the development of disability programs. Also, they work in conjunction with people having disabilities and families to realize social inclusion, community living, employment, family support, and rehabilitation (International Federation of Social Workers, 2013). Thus, the students of social work were chosen for the purpose of sensitization.

The training/orientation program was intended to educate students from Masters in Social Work about their role in prevention, identification of communication disorders, immunization/vaccinations for infants, adolescent girls and expectant mothers against infectious diseases such as measles, mumps, meningitis, rubella - which are directly linked to communication disorders; and various acts/regulations for persons with disability in India. The orientation program also intended to teach them to determine whether a given person/infant is at-risk for communication disorders and to provide appropriate referrals.

To determine the impact or effectiveness of the program and to assess the knowledge gained by the participants due to the orientation program, a pre-/post-test interventional study design was used. The pre-test attempted to quantify the baseline knowledge of target group and the post-test attempted to assess the impact of the orientation program. This was done by utilizing the traditional pre-test post-test approach, in which ten multiple choice questions were given before and after the orientation program. In the qualifier approach, a qualifier question of “Are you guessing” was included. If the answer to this question was “yes”, then the answer was considered as incorrect while scoring (Barge, 2007).

Hence, the present study was undertaken to find out the efficacy of the orientation program on prevention, identification and management of communication disorders through Traditional and Qualifier approaches.

**Method**

The current study used a pre-test, post-test controlled interventional design under the broad category of evaluation research.

**Participants:** The participants for the study were post-graduate students of MSW (Masters of Social Work) from a recognized university. Two separate groups of participants were included, one in each phase of the procedure. There were 26 participants in Phase I and 20 participants in the Phase II of the study.
Material: Orientation lecture in English on Prevention, early identification and management of communication disorders. Power point presentation with picture illustrations was used. Video clippings of different communication disorders were included in Phase II. A test material with ten Multiple Choice Questions (MCQs), covering different aspects of the orientation, was provided to the participants before and after the orientation program.

Procedure: The orientation program was conducted in English, in two phases, by a qualified audiologist and a speech language pathologist. In both the phases, the program was supplemented with the power point presentation. Prior to the orientation lecture, a Multiple Choice Questionnaire (MCQ) was administered which consisted of ten questions on prevention, identification and rehabilitation of communication disorders. The questions were checked by two qualified professionals for its simple and unambiguous nature, so that it was easy for the participants to comprehend the questions (Appendix 1). Each MCQ had four options, out of which three were distracters and one was the correct answer. Out of the ten questions one question (Q3) had two correct answers, which got 0.5 weightage while scoring. The questions were framed such that it did not require too much of memorization of detail but rather focused on whether the participants have learned concepts and related facts.

The questionnaire consisted of ten questions out of which three each were on prevention (Q3, Q4, Q6), identification (Q2, Q5, Q8), and rehabilitation (Q1, Q7, Q9) communication disorders respectively; and one question (Q10) focused on the role of the target participants in dealing with people having disabilities. Before the questionnaire was administered, the participants were instructed to circle the correct answer/answers and put a tick mark (✓) against the qualifier question as either “Yes, I know the answer” or “No, I am guessing” for each question.

The orientation program focused on prevention, identification and rehabilitation of communication disorders; the role of social workers for referral purpose and team work in management. A power point presentation was used with many visual illustrations for understanding of the concepts better. The duration of the lecture was two hours. The lecture was followed by visits to relevant clinical departments at the All India Institute of Speech & Hearing. The participants were instructed to ask questions or interact during the program, if any concept was not clear. The response from the group of participants in Phase I gave a feedback on the modifications required for in the orientation program. These modifications were incorporated before conducting the Phase II on a separate group of participants.

Phase I: An overview of the orientation program and the structure of the program were told to the participants. The questionnaire that was constructed and was administered on 26 participants prior to (pre-test) and after (post-test) the orientation program, to derive the knowledge gained due to the orientation program and also to study the short-term impact of the orientation program. The pre-test was given before the orientation program and the same set of questions (post-test) was provided when the orientation program was concluded. The participants were asked to provide their names to compare their pre-test and post-test scores.

Phase II: The Phase II of the study consisted of a separate group of 20 participants. The program was conducted by the same Audiologist and Speech Language Pathologist to maintain consistency across the two phases. The purpose of conducting phase II on another group of participants was to find any differences in the results after refinement of the teaching methods on the concepts surrounding the questions, which were not clearly understood in Phase I. A number of additions in the orientation program conducted were made such as inclusion of video clippings, change in the teaching methods to obtain better results in Phase II. Unlike in Phase I in which the names of the participants were used to match the pre- and post-test, the participants in the Phase II were asked to provide their date of birth and last four digits of their cell phone numbers to match the pre- / post- test scores. Thus, their identity was kept confidential during the process of evaluation. However, the procedure and the analysis of results remained the same as in Phase I.

Scoring: The questionnaire as mentioned consisted of 10 questions, each question carrying one mark. Therefore, the maximum score was 10. Each correct answer was given a score of 1 and each incorrect answer was given a score of zero. In a question which had two correct answers, a score of 0.5 was given for each correct answer.

The analysis was done in two ways. In Traditional approach, the answers are scored based on number of correct answers excluding the qualifier question (Guess: yes/no). On contrary, in qualifier approach, each correct answer was assigned one mark or half-mark (in case of two correct options for the same question). This was done only when
they were put a tick (√) mark for “Yes I know the answer”; whereas a score of zero was awarded if they “guessed” (“No, I am guessing”) the answer.

The Qualifier approach in the pattern of MCQs allowed the participants to satisfy their need to answer all the questions while giving the instructor additional information on whether the answer was a lucky guess or whether they were applying the knowledge previously gained. Any question where the participant indicated that they were guessing was counted as incorrect and was given a score of „0.0”in the qualifier approach. Thus, in qualifier approach the chance factor was eliminated. The scores were then converted to percentages for further analysis. The post-versus pre-test score differences were taken as indication of knowledge gain or loss, depending on the scores, due to orientation program. The data were fed into the SPSS version 16.0 and used for analysis in order to find out the significant difference in pre- and post-testing, if any.

Results and Discussion

The Shapiro-Wilk’s test of normality was used to know if the scores obtained on the pre-and post-tests in Phase I and Phase II were normally distributed. Table 1 shows the p values for each dependent variable under each test conditions. The p values are greater than 0.05 for all the dependent variables for the two conditions. Therefore, it can be assumed that the data represent the sample from normal distribution. Since the results showed that the groups were normally distributed, parametric tests were administered.

Table 1: Normality-test statistic (W) and p-values of Shapiro-Wilk’s test for each dependent variable under pre- and post-test, in Phase I and Phase II.

<table>
<thead>
<tr>
<th>Orientation Program Conditions</th>
<th>Traditional approach</th>
<th>Qualifier approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>P</td>
</tr>
<tr>
<td>Phase I Pre-test</td>
<td>0.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td>Phase II Pre-test</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.8</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Descriptive statistics was done on the test scores obtained during pre- and post-orientation program, under both traditional and qualifier approaches, in Phase I and Phase II in order to obtain the mean, median and standard deviation. The results are outlined in Table 2.

Table 2: Mean, median and standard deviation (SD) values of test scores (Maximum Score-10) obtained during pre- and post-test of the orientation program, under traditional and qualifier approaches, in Phase I and Phase II.

<table>
<thead>
<tr>
<th>Orientation Program Conditions</th>
<th>Traditional approach</th>
<th>Qualifier approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Phase I Pre-test</td>
<td>4.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Post-test</td>
<td>6.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Phase II Pre-test</td>
<td>4.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Post-test</td>
<td>7.9</td>
<td>8.5</td>
</tr>
</tbody>
</table>

From Table 2, it can be inferred that as expected, the mean post-test scores of the orientation program was greater than the scores obtained in pre-test condition. This was true for both traditional and qualifier approaches, in Phase I and Phase II of the orientation study. Further, the differences between the scores obtained before and after the orientation program under the two approaches, in both Phase I and Phase II, were compared. The results revealed that the mean difference in scores obtained under qualifier approach is greater than that obtained under the traditional approach, in both Phase I and Phase II (Figure 1).

Table 3: Mean and standard deviation (in brackets) of the difference scores (Post-minus Pre) under both traditional and qualifier approaches, in Phase I and Phase II.

<table>
<thead>
<tr>
<th>Orientation program</th>
<th>Traditional approach</th>
<th>Qualifier approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>2.0 (1.2)</td>
<td>4.1 (1.9)</td>
</tr>
<tr>
<td>Phase II</td>
<td>3.2 (1.4)</td>
<td>5.4 (2.0)</td>
</tr>
</tbody>
</table>

Figure 1: Mean scores for pre- and post-tests obtained under traditional and qualifier approaches, in Phase I and Phase II of the study.
Descriptive statistics as depicted in Figure 1 reveals a difference in score between the pre- and post-tests. The qualifier approach reveals a greater impact of the orientation program. To know if this difference was significant, paired samples t-test was done. The pair-wise comparison was done between pre-test scores and post-test scores computed using the two approaches, i.e., traditional and qualifier, in both Phase I and Phase II. Details of the paired sample t-test are shown in Table 4. The paired samples t-test revealed a significantly higher post-test score, under traditional and qualifier approaches, in both phases of the orientation program.

Table 4: t-values, degrees of freedom (df) and the level of significance (p) for the pair-wise comparison of test scores between pre- and post-test, under two approaches, in Phase I and Phase II.

<table>
<thead>
<tr>
<th>Orientation Program Approaches</th>
<th>t- value</th>
<th>df</th>
<th>Sig. (2 tailed) p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I Traditional</td>
<td>-6.6</td>
<td>25</td>
<td>0.00</td>
</tr>
<tr>
<td>Qualifier</td>
<td>-9.8</td>
<td>25</td>
<td>0.00</td>
</tr>
<tr>
<td>Phase II Traditional</td>
<td>-7.7</td>
<td>19</td>
<td>0.00</td>
</tr>
<tr>
<td>Qualifier</td>
<td>-13.0</td>
<td>19</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Results in Table 5 show the percentage of participants who gave correct answers using the traditional compared to the qualifier approach. Under the traditional approach, an average 50% in Phase I (Table 5) and 53% in Phase II (Table 6) of the participants scored correctly for the 10 questions in pre-test, whereas the post-test results showed an average of 70% in Phase I (Table 5) and 86.5% in Phase II (Table 6). Thus, there is 20% and 33.5% increase in the number of participants who gave correct answers due to the orientation program in Phase I and Phase II respectively.

In the qualifier approach, the number of participants scoring correct answer in the post-test was 63% and 83% when compared to their pre-test score of 19% and 23.5% in Phase I and Phase II respectively. Thus, in the qualifier approach, the actual impact of knowledge gained by the participants from the orientation program becomes 44% in Phase I and 59.5% in Phase II. Whereas, in the traditional approach, there is only 20% of participants who gained knowledge from the orientation program in Phase I and 31.5% in Phase II (Table 5 and 6).

Therefore, the qualifier approach is the better approach to assess the effectiveness of the orientation program compared to traditional approach. Alliger and Horowitz (1989) have noted a 15% difference in the knowledge gained measurement when comparing the qualifier approach to the traditional approach. Also, a 52% difference was seen in pre-/post-testing during six Soil Fertility Workshops (Barge, 2007). These two studies also complement the employment of qualifier approach in evaluating the knowledge gained by the participants.

A study done by Venkatesan (2012) investigated the evaluation of sensitivity training program on academic problems. The mean pre-test score was 22.89 (N=564) whereas post-test score 24.27 (N=548). This was done utilizing the traditional approach. If the qualifier approach was utilized in the study, then the difference between the pre- and post- test scores would have been enhanced.

Table 5: Percent of correct answer for each question in pre- and post-test conditions using traditional and qualifier approaches, in Phase I (N=26)

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-Test Results</th>
<th>Post-Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
<td>Qualifier</td>
</tr>
<tr>
<td></td>
<td>% of correct answers</td>
<td>% of correct answer, &amp; Selecting “Knew”</td>
</tr>
<tr>
<td>Q1</td>
<td>42</td>
<td>19</td>
</tr>
<tr>
<td>Q2</td>
<td>73</td>
<td>50</td>
</tr>
<tr>
<td>Q3</td>
<td>58</td>
<td>12</td>
</tr>
<tr>
<td>Q4</td>
<td>42</td>
<td>15</td>
</tr>
<tr>
<td>Q5</td>
<td>53</td>
<td>19</td>
</tr>
<tr>
<td>Q6</td>
<td>73</td>
<td>26</td>
</tr>
<tr>
<td>Q7</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>Q8</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Q9</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>Q10</td>
<td>58</td>
<td>23</td>
</tr>
<tr>
<td>Average</td>
<td>50</td>
<td>19</td>
</tr>
</tbody>
</table>

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Table 6: Percent correct answer for each question in pre- and post- test conditions using traditional and qualifier approaches, in Phase II (N=20).

<table>
<thead>
<tr>
<th>Question</th>
<th>Pre-Test Results</th>
<th>Post-Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
<td>Qualifier</td>
</tr>
<tr>
<td></td>
<td>% of correct</td>
<td>% of correct</td>
</tr>
<tr>
<td></td>
<td>answers</td>
<td>Selecting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Knew”</td>
</tr>
<tr>
<td>Q1</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>Q2</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>Q3</td>
<td>55</td>
<td>20</td>
</tr>
<tr>
<td>Q4</td>
<td>55</td>
<td>15</td>
</tr>
<tr>
<td>Q5</td>
<td>55</td>
<td>35</td>
</tr>
<tr>
<td>Q6</td>
<td>70</td>
<td>25</td>
</tr>
<tr>
<td>Q7</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>Q8</td>
<td>65</td>
<td>40</td>
</tr>
<tr>
<td>Q9</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Q10</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td>Average</td>
<td>53</td>
<td>23.5</td>
</tr>
</tbody>
</table>

The qualitative factor that can be measured from the qualifier approach is reduction in guess work after orientation. Guessing whether the answer was correct or incorrect was reduced from 31% pre-test average to a 7% post-test average in Phase I (Table 5) and from 29.5% to 3.5% in Phase II (Table 6). The orientation program significantly increased the participant’s confidence in answering correctly during the post-test, in both phases of the study.

Evaluating the individual question results in Table 7 also provides valuable feedback to the instructor/s as they refine teaching methods in the orientation programs for future audiences. In Phase I, the area represented in Q2 generated the highest percentage under correct “Knew” in the pre-test condition, and hence may require less time to teach the content, as the 50% of the target group already knew the answer. Whereas, Q7 and Q9 generated a low correct “Knew” percentage of 11% on the pre-test and also a lower post-test score of 46% (Q7) and 35% (Q9). Thus, it may require more time or a different teaching method, such as utilizing visuals/video clippings, to explain the concepts surrounding this question. Also, the pre-test and post-test score for Q1 was 19% pre-test and 88% respectively, which explains that the issue addressed in Q1 has very well reached the target group and the participants got the concept right in Phase I of the study.

Similarly, in Phase II, Q2 obtained highest correct “Knew” percentage of 45% in pre-test. On the other hand, both Q7 and Q9 generated a low pre-test percentage of 5% and a post-test score of 85% under correct “Knew” category.

Table 7: Summary of incorrect responses when the participants indicated they ‘knew’ the correct answer, in Phase I and Phase II.

<table>
<thead>
<tr>
<th>Question</th>
<th>Phase I Pre-test</th>
<th>Phase I Post-test</th>
<th>Phase II Pre-test</th>
<th>Phase II Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incorrect</td>
<td>Selecting</td>
<td>Incorrect</td>
<td>Selecting</td>
</tr>
<tr>
<td>Q1</td>
<td>23</td>
<td>7</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Q2</td>
<td>4</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Q3</td>
<td>38</td>
<td>31</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Q4</td>
<td>46</td>
<td>27</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Q5</td>
<td>30</td>
<td>8</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Q6</td>
<td>15</td>
<td>8</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Q7</td>
<td>31</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Q8</td>
<td>35</td>
<td>19</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Q9</td>
<td>58</td>
<td>23</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Q10</td>
<td>19</td>
<td>8</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Average</td>
<td>30</td>
<td>15</td>
<td>14</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note: Selecting “Yes, I know the answer” even when the answers were incorrect.

Hence, the difference in the post-test percentage scores of Phase I and Phase II of the study for both Q7 and Q9 is 50%. In other words, 17 participants have clearly understood the concept surrounding the Q7 and Q9 in Phase II compared to only 9 participants in Phase I. The difference in the scores is attributed to the teaching method being incorporated by the presenter for Q7 in Phase II of the study. Since the Q7 was based on the disability acts, more time was allotted in teaching the facilities that can be availed by a person with disability. A short interactive session was conducted in which the participants asked...
questions and clarified their queries regarding the acts mentioned. For Q9, videos were projected on the dysfluencies seen in a person with stuttering before and after the fluency shaping therapy. Thus analytical evaluation of the responses of the participants in Phase I helped in improving the effectiveness of the orientation program in Phase II.

The qualifier approach also helps to identify areas that initially seemed to receive equal emphasis but the guessing qualifier shows a difference in confidence the participants have in their answer. In Phase I, the percentage post-test scores of Q3 and Q7 are same (61%, 16 out of 26) by the traditional approach (Table 5). But, using the qualifier approach there is a substantially lower confidence in the Q7 answers (15%) when compared to Q3 (4%). In other words, 4 participants out of 16 who answered right for Q7 were guessing whereas only 1 participant guessed in Q3. Similarly in Phase II, Q3 and Q10 had same post-test scores in traditional approach (80%, N-16 out of 20 participants). Whereas, in the qualifier approach 15 participants are certain of the answer and 1 amongst the 16 participants is guessing for Q3 and all 16 participants were sure of the answer for Q10 by the end of the Phase II of the study.
The qualifier approach enables to evaluate the individual question and provides valuable feedback to the instructor(s) as they help in refining the teaching methods in the orientation programs for future target groups.

Another factor that could be evaluated with the qualifier approaches the number of participants who gave an incorrect answer but indicated they were sure of the answer. This approach will give the instructor feedback on correcting the incorrect knowledge of the participants. In Phase I, the teaching method needed to be because 6 participants learnt the concepts surrounding Q9 incorrect; whereas 11 did not learn the concepts being taught related to this question. After the modifications in the teaching methods in Phase II, Q9 generated a 85% (N-17 out of 20) Correct “Knew” responses, 0% “incorrect Knew” (Table 7) and 3 participants did not learn the concept on the post-test.

Therefore, this study highlights the necessity of such evaluation of the orientation programs to improve the impact of the orientation program. Also, such orientation programs will aid the professionals or resource persons in refining their teaching techniques during the orientation and dissemination of the knowledge to different target groups.

Directions for future research: The study can be replicated by including the follow-up paradigm on the same target groups over a period of time to ascertain the long-term retention of knowledge and assure that training was applied at the work site.

Acknowledgements

We thank the Director, All India Institute of Speech and Hearing, Mysore for permitting us to carry out the study. We also thank all the staff of Department of POCD for providing the necessary help in times of need.

References


Appendix 1

### All India Institute of Speech & Hearing
DEPARTMENT OF PREVENTION OF COMMUNICATION DISORDERS (POCD)
Pre-post efficacy form

1. The Government of India provides free body level hearing aids through the ADIP scheme to persons with hearing loss who are
   a. Below poverty line
   b. Above 50 years of age
   c. In rural areas
   d. Socially backward
   
   | Yes, I know the answer | No, I am guessing |

2. Whom do you consult, if you are suspecting a hearing problem?
   a. Psychologist
   b. Audiologist
   c. Psychiatrist
   d. Family doctor

   | Yes, I know the answer | No, I am guessing |

3. Which among the below is the cause for Voice disorders?
   a. Excessive water consumption
   b. Vocal abuse and misuse
   c. Speaking slowly and softly
   d. Excessive gargling

   | Yes, I know the answer | No, I am guessing |

4. Which among the following is the risk factor that can lead to hearing loss?
   a. Inter religious marriages
   b. Exposure to ultraviolet radiations during pregnancy
   c. Attack of rubella during pregnancy
   d. Lifting heavy objects during pregnancy

   | Yes, I know the answer | No, I am guessing |

5. How early can hearing loss be identified?
   a. 2 years
   b. 5 years
   c. At birth
   d. After schooling

   | Yes, I know the answer | No, I am guessing |
6. The cancer of larynx can be caused due to excessive
   a. Stress
   b. Injuries to the larynx
   c. Consumption of tobacco and alcohol
   d. Faulty medications
   | Yes, I know the answer | No, I am guessing |

7. Which of the following acts is catering to the equal participation and protection of rights of Persons with Disability?
   a. CPA 1986
   b. NSA 1980
   c. WLPA 1972
   d. PWD
   | Yes, I know the answer | No, I am guessing |

8. Speech and Language Disorders affect learning and academic performances at school
   a. Strongly agree
   b. Partially agree
   c. Disagree
   d. Strongly disagree
   | Yes, I know the answer | No, I am guessing |

9. Stuttering can be treated through
   a. Adopting coping mechanisms
   b. Fluency shaping therapy
   c. Escaping fearful situations
   d. Increasing the rate of speech
   | Yes, I know the answer | No, I am guessing |

10. Which among the below is NOT addressed by the Social worker for Persons with Disability?
   a. Creating a barrier free environment
   b. Rebuilding person's relation with community and integrate into society
   c. Providing speech language therapy services
   d. Referral of the cases for professional help
   | Yes, I know the answer | No, I am guessing |
EXPRESSIVE BOUND MORPHEMES IN MALAYALAM SPEAKING CHILDREN WITH SPECIFIC LANGUAGE IMPAIRMENT

1Maria Grace Treasa, & 2Shyamala, K. C.

Abstract

The present study aimed to investigate the emergence of expressive bound morphemes in 10 children, aged 3-8 years, with Specific Language Impairment (SLI) as compared to 10 chronological age (CA) controls. All the participants had a verbal repertoire of two-word phrases and were monolingual speakers of Malayalam. Expressive use of six different inflectional suffixes of Malayalam- 1./ka/-Plural, 2./e/-Accusative, 3./il/-Locative, 4./u/-Genitive, 5./ko/ & /na/-Dative case markers and 6./um/-Conjunction was examined using elicited Sentence Imitation Test in Malayalam (SIT-M) developed from our earlier research*. Results revealed that performance of SLI group was significantly (p<0.05) poorer than the CA group, suggestive of underlying morphological deficits. However, both the groups exhibited relatively better scores on Locative /il/, Dative /ko/ & /na/ case markers and Plural /ka/ than Conjunction /um/, Accusative /e/ and Genitive /u/ case markers. Implications for morphological assessment and treatment in Specific Language Impairment are also discussed.

Key Words: Bound Morphemes, Specific Language Impairment (SLI), Sentence Imitation

Specific language impairment (SLI) is characterized by marked deficits in the use of grammatical inflectional morphology (Leonard, 1998; Bedore & Leonard, 1998; Crago & Gopnik, 1994; Oetting & Rice, 1993; Rice & Wexler, 1996; Marchman, Wulfeck & Ellis Weismer, 1999). Morphosyntactic impairments in SLI have been reported to be linguistic in nature (Clahsen, 1989; Muller, 2005). Early signs of SLI include omission of inflectional suffixes, articles, propositions and conjunctions. Hence, their verbal repertoire may be limited to short agrammatic sentences with specifically impaired function words. Furthermore, research on SLI has received much attention regarding the possible markers that can differentiate between individuals with and without language disorders (Conti-Ramsden & Windfuhr, 2002).

Clinician-designed, structured grammatical tasks are valuable tools to determine expressive morphological difficulties in these children. They would aid in the assessment of morphemes that are not commonly found in normal conversation or discourse. In a recent study on SLI by Christensen & Hansson (2012), sentence completion and sentence repetition tasks were used to explore the past tense inflection of Danish. Likewise, Bedore (2001) assessed morphosyntax, using structured probes and spontaneous speech, in native speakers of Spanish. On the contrary, Seeff-Gabriel, Chiat & Dodd (2010), who developed Sentence-imitation Test-61 (SIT-61), delineated the practical advantages of sentence imitation over spontaneous speech as a means of assessing expressive language skills.

Therefore, Sentence Imitation Test in Malayalam (SIT-M, Treasa & Shyamala, 2013) was developed by the authors in our earlier research on emergence of expressive grammatical morphology in 120 Malayalam speaking typically developing children. Use of sentence imitation task to elicit inflectional grammatical morphemes suffixed to nouns was employed in SIT-M as nouns are more concrete and have a processing advantage over verbs (Colombo & Burani, 2002). There is also accumulating evidence that children with SLI and typically developing children performed better on noun morphology than on measures of verb morphology (Conti-Ramsden & Windfuhr, 2002).

Research on language acquisition in various Indian languages has been reported in the literature. Shyamala and Basanti (2006) explored the developmental milestones of language acquisition in Kannada and Hindi-speaking children. Asher & Kumari (1997) reported that syntactic and semantic functions of noun phrases in Malayalam are expressed mainly by bound case suffixes and postpositions. Highly agglutinative languages such as Dravidian languages have no prefixes and infixes for words. Words are usually formed by adding suffixes to the root word serially. Age and gender differences in the development of plurals in typically developing

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Malayalam speaking children was researched upon by Thomas, Rachel, Paul and Kumaraswamy (2013). However, there is paucity of research comparing the acquisition of various morphemes of Malayalam language.

In the Indian context, research on emergence of inflectional morphology is in its infancy. Furthermore, there is a dearth of studies on the pattern of deficits in productive use of different suffixes in SLI. Hence, the present study was carried out to examine specific expressive bound morphemes (Plurals, Case markers & Conjunctions) of Malayalam in children with Specific Language Impairment (SLI) as compared to age-matched controls (CA), using SIT-M.

Method

Participants: Participants were 10 children, aged - years, diagnosed with Specific Language Impairment (SLI; N=10) according to DSM-IV and ICD-10 criteria and 10 age-matched children learning language typically. Language was assessed using Three Dimensional Language Acquisition Test (3D-LAT, Herlekar & Karanth, 1993) and Comprehensive Language Assessment Tool for children (CLAT, Navitha & Shyamala, 2009). All the participants had a verbal repertoire of two-word phrases and were monolingual speakers of Malayalam.

Task design and stimuli: The elicited Sentence Imitation Test in Malayalam (SIT-M), developed in our earlier research on emergence of expressive grammatical morphology in 120 children with typical language development aged between 3-6 years, was employed to assess expressive grammatical morphology. The digitized stimuli included 60 simple sentences with pictures that examine six different inflectional bound morphemes of Malayalam: /kal/-Plural, /e/-Accusative, /il/-Locative, /ute/-Genitive, /kka/ & /na/-Dative case markers and /um/-Conjunction.

In SIT-M, the picture stimulus was delivered using power-point presentation with the corresponding sentence presented through headphones. The participant was seated viewing laptop monitor and was instructed to repeat the sentence heard on slide show of the stimuli. For those children who did not cooperate to put on headphones or those who got distracted from the task by wearing headphones, testing was done in free field. The maximum score for sentence imitation task was ‘60’. A score of ‘1’ was allocated for correct response; score of ‘0’ was assigned for incorrect response/ omission of morphemes and a score of 0.5 was allocated for 50% correct response.

Procedure: Data was collected from Institute of Cognitive and Communicative Neurosciences (ICCONS), Kavalappara, Shoranur, Kerala after obtaining written informed consent from the parents/caregivers and the institution authorities. All the data was video recorded for response analysis and was analyzed by three experienced Master’s degree holders. It was subjected to inter-judge reliability using (Cronbach’s α > 0.8) indicative of good inter-judge reliability across all participants. The data obtained was subjected to further statistical analyses using independent samples t-test.

Results and Discussion

The mean and standard deviations obtained by the SLI (N=10) and CA group (N=10) for the six target morphemes are shown in Table 1. Examining the two groups data reveals that the mean of the CA group is higher than the SLI group, thus supporting the notion that SLI exhibits morphological impairment. The variability of the SLI groups is higher than the CA group.

Table 1: Mean and SD scores of SLI and CA groups for six morphemes

<table>
<thead>
<tr>
<th>Group</th>
<th>/kal/</th>
<th>/e/</th>
<th>/il/</th>
<th>/ute/</th>
<th>/kka/</th>
<th>/um/</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLI Mean</td>
<td>4.2</td>
<td>3</td>
<td>7.1</td>
<td>2.4</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>SD</td>
<td>3.96</td>
<td>2.53</td>
<td>3.63</td>
<td>3.16</td>
<td>3.34</td>
<td>3.05</td>
</tr>
<tr>
<td>CA Mean</td>
<td>9.8</td>
<td>8.8</td>
<td>9.9</td>
<td>8.7</td>
<td>9.9</td>
<td>8.65</td>
</tr>
<tr>
<td>SD</td>
<td>0.42</td>
<td>2.25</td>
<td>0.31</td>
<td>2.11</td>
<td>0.31</td>
<td>1.51</td>
</tr>
</tbody>
</table>

Table 2: Comparison of morphemes (M) across SLI & CA group

<table>
<thead>
<tr>
<th>Independent t-test (df=18)</th>
<th>/kal/</th>
<th>/e/</th>
<th>/il/</th>
<th>/ute/</th>
<th>/kka/</th>
<th>/um/</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-value</td>
<td>-4.44*</td>
<td>-5.41*</td>
<td>-2.43*</td>
<td>-5.23*</td>
<td>-5.09*</td>
<td>-3.95*</td>
</tr>
</tbody>
</table>

*p<0.05
An independent samples t-test (see Table 2) was run to determine if there were differences in expressive bound morphemes between the two groups. Levene’s test for homogeneity of variances was significant (p<.05) for morphemes /kal/, /ili/, /kka/ and /um/ while it was not statistically significant (p>.05) for morphemes /e/ and /ute/. Hence, homogeneity of variances was assumed for the morphemes /e/ and /ute/. Equal variances were not assumed for morphemes /kal/, /ili/, /kka/ and /um/. Results of independent samples t-test revealed that SLI group performed significantly (p<0.05) poorer than the CA group for all the target morphemes suggestive of underlying morphological deficits. This in agreement with the past literature (Eadie, Fey, Douglas & Parsons, 2002 in English; Lukács, Leonard & Kas, 2010 in Hungarian language) that children with SLI demonstrate difficulty with the productive use of various bound morphemes as compared to age-matched controls.

However, both the groups had exhibited relatively better scores on morphemes /ili/, /kka/, /na/ and /kal/ than /um/, /e/ and /ute/. The findings suggest that the acquisition process may operate on innate principles that predispose the children to follow similar patterns. Furthermore, the difference in scores obtained for the third morpheme /ili/ across the two groups was found to be less (see Figure 1) while all the other morphemes differed significantly (p<0.05). Thus, plurals, conjunctions and case markers-accusative, genitive and dative could be used to differentiate children with and without SLI in Malayalam language.

![Figure 1: Mean scores for the target morphemes across groups](Image102x232 to 302x357)

The findings from this study lend some support for using sentence repetition with picture context as a tool to evaluate expressive grammatical morphology in SLI. There is also corroborative evidence on elicited sentence imitation as a language sampling procedure (Haniff & Siegal, 1981; Schwartz & Daly, 1976) to facilitate goal-specific assessment of children with language impairment.

Summary and Conclusions

Emergence of six expressive bound morphemes in a small sample of Malayalam speaking children with SLI was explored in the present study. The authors found elicited Sentence Imitation Test in Malayalam (SIT-M) to be useful in examining the target expressive bound morphemes. Results revealed that performance of SLI group was significantly (p<0.05) poorer than the control group, indicative of expressive bound morpheme deficits. Nevertheless, both the groups obtained higher scores on Locative /ili/, Dative /kka/ & /na/ case markers and Plural /kal/ than Conjunction /um/, Accusative /e/ and Genitive /ute/ case markers. This suggests the need for specific morphological intervention in SLI especially for conjunctions and case markers. Additional investigations in larger samples of SLI and other childhood language disorders are needed in order to better understand the pattern of morphological deficits relative to the age-matched controls. Future research on expressive bound morphemes in other Dravidian languages is recommended.

References


GESTURE COMPREHENSION IN PERSONS WITH APHASIA

\(^1\)Santosh Kumar, \(^2\)Goswami, S. P.

Abstract

The literature postulates impairment in comprehending gesture in persons with aphasia. There are very limited tests available in Indian context for assessing gesture comprehension. Hence, the present study was planned. The study was carried out in two phases. The first phase was development of the test stimuli and the second phase was to administer the test on persons with aphasia. Thirty neuro-typical adults and ten persons with aphasia (5 Broca’s aphasia and 5 global aphasia) participated in the study. It was noticed that there was a significant difference between the performance of neuro-typical adults and persons with aphasia.

Key words: Neuro-typical, assessment, comprehension

Introduction

Aphasia is a disorder that results from brain damage. The most common cause of aphasia is stroke. Additionally, infection, tumor and injury of the brain are also the leading causes of aphasia. The symptoms of aphasia have been described by Longerich and Bordeaux (1954) as an affliction that affects expressive and receptive communication in all modes including speaking, reading, writing, understanding and gesturing. Several studies reported that persons with aphasia (PWA) have difficulty in using and recognizing signs, gestures and pantomime (Duffy & Duffy, 1981; Wang & Goodglass, 1992; Bell, 1994). The evidence by Goodglass and Kaplan (1963) and Pickett (1972) substantiated the observation that persons with aphasia demonstrate significantly greater impairment in gesture and pantomime than either neuro-typical participants (NTP) or persons with non-aphasic brain damage.

Further, Netsu and Marquardt (1984) studied the effects of three types of stimuli i.e. objects, line drawings, and action pictures on the understanding of pantomimes in PWA. Fifteen PWA were included in the study. Each task contained fifteen items and was presented in random order. The investigator pantomimed a function and the participant was required to point to objects or pictures of objects. Results revealed significantly more number of proper pantomime responses for objects and action pictures compared to line drawings.

Many studies confirmed that verbal comprehension deficits lead to a greater dependency on gesture to interpret messages (Records, 1994). Further, Saygin, Wilson, Dronkers and Bates (2004) examined comprehension of visually presented action stimuli in PWA. The participants were asked to choose the object that matched visually presented stimuli. The investigators used black and white drawings of pantomimed actions. Results revealed that PWA were significantly impaired in comprehension of action.

In addition, Cocks, Sautin, Kita, Morgan, and Zlotowitz (2009) studied the consequence of aphasia on speech integration and co-speech gesture in one person with aphasia and twenty neuro-typical adults. Participants were asked to watch video vignettes of person producing twenty-one verb phrases in three different circumstances i.e. verbal, gesture, and verbal gesture combined. They were asked to choose a matching picture from four alternatives: integration target, a verbal only, a gesture only, and an unrelated foil. The results revealed that PWA acquired a notably lesser multi modal gain score as compared to NTP. PWA depended more on gesture in order to interpret the message while neuro-typical adults depended on speech in speech and gesture integration tasks. Further, PWA had better gesture comprehension than spoken word comprehension on speech only and gesture only tasks.

In conclusion, one can understand that PWA do face difficulty in comprehension of gesture. Several tests have been developed in western countries but there are limitations in using those tests in Indian context. There are very limited test available in Indian context to evaluate comprehension of gesture. Hence, there is a need to develop a test which can assess comprehension of gesture in PWA.

Method

The present study was carried out in two phases.

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The first phase consisted of the development of the test stimuli and the second phase included administration of the test on participants. All the items of the test were chosen on the basis of the culture background of the target population. Twenty five pictures of gesture were selected for the test and were given to five Speech Language Pathologists (SLPs), who have had at least two years of clinical experience were asked to rate the items for assessing comprehension of gesture in PWA. The SLPs used a two point rating scale i.e. inappropriate or appropriate to rate the stimuli. The final set of stimuli consisted of items which were rated by at least 90% of the judges as appropriate.

The finalized test consists of ten gesture pictures. Culturally appropriate picture stimuli were drawn by a professional artist. The stimuli were presented visually using pictures. The participants could respond to the question either verbally, gesturally or by pointing to cards having printed words on them. The response sheet consisted of four printed words out of which one was the target word and the other three were distracters. Different distracters were provided for different stimuli.

A three point scoring pattern was followed i.e. score of ‘2’, ‘1’ and ‘0’ were given for every ‘correct without prompt’, ‘correct with prompt’, and ‘incorrect/no response even after prompt’ respectively.

**Participants**

In the present study, 30 neuro-typical adults and 10 PWA (5 Broca’s aphasia and 5 global aphasia) participated. Table 1 illustrates the demographic details of PWA.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Age</th>
<th>Gender</th>
<th>Aphasia type</th>
<th>Time post onset</th>
<th>MRI/CT scan report</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49 yrs</td>
<td>Male</td>
<td>Global Aphasia</td>
<td>3 months</td>
<td>Left MCA territory in</td>
<td>Graduate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>temporoparietal region</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>57 yrs</td>
<td>Male</td>
<td>Global Aphasia</td>
<td>3 months</td>
<td>Left MCA territory</td>
<td>Graduate</td>
</tr>
<tr>
<td>3</td>
<td>65 yrs</td>
<td>Male</td>
<td>Global Aphasia</td>
<td>5 months</td>
<td>Left frontotemporoparietal</td>
<td>Graduate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and basal ganglia</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>58 yrs</td>
<td>Female</td>
<td>Global Aphasia</td>
<td>3 months</td>
<td>Left MCA territory</td>
<td>10+2</td>
</tr>
<tr>
<td>5</td>
<td>62 yrs</td>
<td>Female</td>
<td>Global Aphasia</td>
<td>4 months</td>
<td>Left MCA territory</td>
<td>Graduate</td>
</tr>
<tr>
<td>6</td>
<td>28 yrs</td>
<td>Male</td>
<td>Broca’s Aphasia</td>
<td>6 months</td>
<td>Left MCA territory</td>
<td>Post-graduate</td>
</tr>
<tr>
<td>7</td>
<td>42 yrs</td>
<td>Male</td>
<td>Broca’s Aphasia</td>
<td>4 months</td>
<td>Left MCA territory</td>
<td>Graduate</td>
</tr>
<tr>
<td>8</td>
<td>43 yrs</td>
<td>Male</td>
<td>Broca’s Aphasia</td>
<td>12 months</td>
<td>Left MCA territory</td>
<td>Graduate</td>
</tr>
<tr>
<td>9</td>
<td>49 yrs</td>
<td>Male</td>
<td>Broca’s Aphasia</td>
<td>7 months</td>
<td>Left MCA territory</td>
<td>Graduate</td>
</tr>
<tr>
<td>10</td>
<td>43 yrs</td>
<td>Female</td>
<td>Broca’s Aphasia</td>
<td>9 months</td>
<td>Left frontotemporoparietal</td>
<td>Graduate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and basal ganglia region</td>
<td></td>
</tr>
</tbody>
</table>

*Inclusion Criteria for the participants:* The ethical standards and considerations set by All India Institute of Speech and Hearing (AIISH), Mysore; Karnataka, India was adhered to while carrying out the study. The participants or family members or care takers were explained about the purpose and procedure of the study and an informed written consent was taken. Participants were within the age range of 18-65 years. Pre-morbidly all participants were right handed and to assess the dominance of handedness, Edinburgh Handedness Inventory (Oldfield, 1971) was administered on participants. The participants had no history of pre-morbid neurological illness, psychological disorders, and other significant sensory and/or cognitive deficits. To rule out any cognitive-linguistic deficits in NTP Mini-Mental State Examination (Folstein, Folstein & McHaugh, 1975) was administered. The participants’ cause of aphasia was diagnosed by a Neurologist/Physician using clinical examination and radiological evaluations (CT scan & MRI). Participants who had aphasia due to stroke, who were medically stable, and with post onset duration of a minimum period of three months were considered. Western Aphasia Battery test in Hindi (Karanth, Ahuja, Nagaraja, Pandit, & Shivshankar, 1986) was administered to assess the type of aphasia.

**Test administration**

Each participant was seated in front of a table at a comfortable distance from where it was easy for participants to reach and point to the test material. Further, the administration of the test was
recorded on a digital video camera recorder (Sony Handycam, model No. DCR-SR88).

Results and Discussion

The present study aimed at developing a test for assessing comprehension of gesture in PWA. The performance of NTP and PWA on gesture task is represented in Table 2.

Table 2: Mean and SD values for neuro-typical participants and persons with aphasia on gesture

<table>
<thead>
<tr>
<th>Section</th>
<th>Mode</th>
<th>Neuro-typical Mean</th>
<th>Neuro-typical S.D</th>
<th>Persons with Aphasia Mean</th>
<th>Persons with Aphasia S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestures</td>
<td>Picture</td>
<td>19.96</td>
<td>0.18</td>
<td>8.20</td>
<td>6.19</td>
</tr>
</tbody>
</table>

Neuro-typical participants (Mean=19.96) scored better than PWA (Mean=8.20) on gesture task. Mann-Whitney test was carried out to examine the significant differences between NTP and PWA on gesture task. The results revealed a significant difference between NTP and PWA for gesture (|Z|=5.95, p<0.001).

The performance of NTP, persons with Broca’s aphasia (PWBA) and persons with global aphasia (PWGA) on gesture task is represented in Table 3. It is indicated from Table 3 that neuro-typical adults (Mean=19.96) scored better than persons with Broca’s aphasia (Mean=13.80) followed by persons with global aphasia (Mean=2.60) on gesture task.

Table 3: Mean and SD values for neuro-typical participants, persons with Broca’s aphasia and persons with global aphasia on gesture

<table>
<thead>
<tr>
<th>Sections</th>
<th>Mode</th>
<th>Neuro-typical Mean</th>
<th>Neuro-typical S.D</th>
<th>Broca’s aphasia Mean</th>
<th>Broca’s aphasia S.D</th>
<th>Global aphasia Mean</th>
<th>Global aphasia S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestures</td>
<td>Picture</td>
<td>19.96</td>
<td>0.18</td>
<td>13.80</td>
<td>2.68</td>
<td>2.60</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Kruskal-Wallis test was carried out to compare the performance among NTP, PWBA and PWGA. The results revealed a significant difference for gesture ($\chi^2(2)=36.22$, p<0.001) between NTP, PWBA and PWGA. Pair-wise comparison was made and Mann-Whitney test was carried out to examine the significant difference between NTP and PWBA and the results revealed a significant difference for gesture (|Z|=5.38, p<0.001). Further, when NTP and PWGA were compared using Mann-Whitney test, results revealed a significant difference for gesture (|Z|=5.38, p<0.001). Similarly, performances of PWBA and PWGA were compared. Mann-Whitney test revealed significant difference for gesture (|Z|=2.65, p<0.05) between persons with Broca’s and global aphasia.

Performance of NTP was better than PWA on the gesture task. The results showed that NTP have good ability to comprehend gesture whereas PWA had difficulty in understanding gesture. Further, PWBA performed better than PWGA on gesture task. PWGA performed poorly in the present study. This result shows that PWA have difficulty in recognizing gesture. This also depends on the severity and type of aphasia. Goodglass and Kaplan (1963) and Pickett (1972) reported that PWA demonstrate significantly greater impairment in gesture and pantomime than either neuro-typical or persons with non-aphasia brain injured. Duffy and Dully (1975) also reported that PWA were impaired relative to persons with non-aphasia and that such impairment of gestural ability is highly correlated with impairment of verbal ability.

In addition, Gainotti and Lemmo (1976) reported that PWA performed significantly poorer as compared to any other group of brain damaged persons on the test of symbolic gesture interpretation. Within the PWA, the inability to comprehend the symbolic gestures was extremely associated to the semantic mistakes found at a verbal comprehension test. Gainotti and Ibba (1972) also reported that gesture comprehension disturbances were frequently noticed in PWA, and that they seem to be closely associated to the severity of the verbal communication disorder. Peterson and Kirshner (1981) also noticed impairment of gestural comprehension and expression in PWA. They reported that there is a close correlation among severity of aphasia and degree of gestural impairment.

In 1983, Ferro, Martins, Mariano, and Caldas suggested that gesture recognition is a multi-component task which consisted of linguistic, perceptual/conceptual symbolic and spatio-temporal demands. PWA reflects a central symbolic impairment that can affect both verbal and non-verbal processes, including pantomime recognition (Duffy & Watkins, 1984). Another study by Cocks et al., (2009) further supported the findings by reporting that the PWA performed poor than the NTP on gesture task.

Overall, the scores clearly showed that PWA have significant difficulty in comprehension of gesture. This again depends on the severity and type of aphasia.

Conclusion

The present study assesses the comprehension of gesture ability in PWA. The results of the study
conclude that there was a significant difference in performance between neuro-typical adults and PWA and thus intend toward the effectiveness of the test. This test would help in identifying the aphasics, describing the aphasia for the purpose of diagnosis, therapy and its prognosis.

Limitations of the study

The study has been carried out with a small number of PWA and different types of aphasia which restricts the generalization of the research finding for PWA.

References


MACROLINGUISTIC ANALYSIS OF DISCOURSE IN TBI: RIGHT VS LEFT HEMISPHERE INJURY

1Hema, N., & 2Shyamala, K. C.

Abstract

The present study aimed to assess and compare the macrolinguistic ability of discourse in terms of coherence measurement in predominantly right and left hemisphere injured participants among a group of traumatic brain injured (TBI). The participants included 10 each of right and left hemisphere injured. The sample for the study included elicited gist of the picture of a picnic spot taken from Western Aphasia Battery (Shyamala & Ravikumar, 2008). An attempt was made to infer the coherence ability using the macrolinguistic analysis of discourse. For the same, Discourse Analysis Scale (Hema & Shyamala, 2008) for picture description task was used to measure the time duration taken to tell the gist of the picture and this latency value was determined for each of the participants using Wave Surfer 1.5.7 computer software. The time taken to give the gist of the given picture was measured in terms of seconds. The results of the study showed a significant difference in the duration value between the TBI participants with left hemisphere injury and right hemisphere injury statistically. But the mean value for right hemisphere injured participants among the TBI group was higher which suggests that the former group took more time to give the gist of the picture compared to left hemisphere injured participants among the TBI group. The picture description task can be used as a means of eliciting discourse samples to identify the factors contributing cognitive-communication impairments. Thus, the cognitive processing speed of coherence can be inferred by using macrolinguistic analysis in TBI discourse which is important for theoretical and clinical consideration pertaining to diagnosis and management. Reaction time could be an important measure pertaining to coherence. However, this finding needs further research support.

Key words: Gist, Microlinguistic, Macrolinguistic, Predominant

Introduction

Discourse is defined as “continuous stretches of language or a series of connected sentences or related linguistic units that convey a message” (Cherney, 1998). Discourse can also be broadly defined as language use “in the large”, or as extended activities that are carried out via language (Clark, 1994). Discourse can be studied at mainly comprehension or expression level and also be examined via text view. Under comprehension or expression level it can be distinguished at microlinguistic and macrolinguistic levels. The ability to process syntactic, lexical-semantic and phonological aspects of single words and sentences are referred to as microlinguistic levels. Measures of syntactic complexity and expression at the single word level are often used here. But at macrolinguistic level it deals with the maintenance of conceptual, semantic, and pragmatic organization at the suprasentential level. Coherence and cohesion are often used as measures of macrolinguistic abilities (Halliday & Hasan, 1976). Thus, it relies on the interaction of both linguistic and non-linguistic knowledge, especially the non-linguistic systems of executive control and working memory (Cannizzaro & Coelho, 2002). Thus, the discourse linguistic units can be at microlinguistic and macrolinguistic level (Ulatowska, North, & Macaluso-Haynes, 1981; Ulatowska, Freedman-Stern, Doyle & Macaluso-Haynes, 1983; Glosser & Deser, 1990; Cannizzaro & Coelho, 2002).

Inquiries in the neurolinguistic studies of discourse by Luria (1980, 1982), has a large body of work that points to the importance of using tasks of macrolinguistic structure to assess intellectual abilities in patients with brain lesions. Many of the tasks described in his writings tap the global semantic meaning/coherence of a text. The stimuli were stories and thematic pictures with probes asking the patients to derive a theme, provide a gist, sequence a series of thematically related pictures and formulate the unifying theme as opposed to describing each picture separately. He also suggested tasks that require the patient to identify the important (essential) details in a text, to synthesize the information, and to reach an interpretation of the global theme in terms of coherence. To a large degree, the nature of these tasks involved sorting the information according to importance. This process is critical to understanding the central meaning of a text/gist.
and or/coherence. None of these tasks had objective measurements for any type of responses by the participants.

As mentioned earlier the term “coherence has been used to characterize conceptual organizational aspects of discourse at the suprasentential level or the macrolinguistic level” (Glosser & Deser, 1990). Thus, it can be considered as a substitute to measure macrolinguistic abilities of discourse. Coherence is one aspect among the list of different propositional aspects of discourse. The “global” and “local” organizations are the two separate aspects of coherence which can be more precisely quantified when computed under the propositional aspects of discourse (Agar & Hobbs, 1982; Tracy, 1984). Global coherence deals with the manner in which discourse is organized with respect to an overall organization of goal, plan, theme or topic (Kintsch & van Dijk, 1978). But according to Agar and Hobbs (1982) at least in part, the coherence of a written text or discourse depends on the individual speaker’s ability to maintain thematic unity. Since any discourse of an individual denotes conditionally related facts of the “real world”, the thematic unity can be achieved by the combination of propositions which form a coherent representation (van Dijk, 1977; Keenan, Baillet & Brown, 1984). Thus, an overall thematic unity is sustained by the effect of coherence. To achieve the impression of coherence linguistically, it is expressed through cohesive devices such as co-reference and anaphora which serve to produce the overall elements together. These are the “link” which binds the individual elements together to attain the notion of coherence. Thus, a specific relation of meaning between elements within discourse is addressed as “cohesion”. In this study, a measure of global thematic coherence is considered as an index of macro-linguistic abilities. Other ways of tapping macro-linguistic structure include generating the central event or the gist, providing a summary, and even retelling a story. Siklaki (1984) described a telegram task where the subjects were asked to leave out as much as possible of the original story while trying to retain as much as the important information as possible. In all these tasks it is necessary to extract what is relevant or essential to the central meaning based on world knowledge and textual knowledge.

All these tasks described here place heavy demands on the language system. In order to explore the cognitive factors, some investigators have designed tasks of macrostructure that reduce the linguistic demands. These tasks involve pictures or responses to probe questions like identifying the main props or characters, responding to sentence completions, answering multiple choice questions and answering questions relevant to setting information (Ulatowska & Chapman, 1991; Pierce & Grogan, 1992). Thus all these tasks target only the elicitation of correct responses, but do not discuss about the participant’s efficiency at giving correct response within minimal required time. Two points can be picked up from these various tasks that tap macrostructure, first the information from the original stimulus can be transformed or reconstructed in discourse production. This transformation involves a reduction of information while preserving the central meaning. In this process, the information is not simply deleted but, rather it is reconstructed and generalized to an abstract level. The second, intactness of macrostructure may be examined by utilizing tasks with varying demands including temporal for example on the cognitive and linguistic systems. To conclude, the clinical importance lies in its potential value in defining communicative competence of speakers in terms of coherence (organizational structure), cohesion (its linguistic form) and the speed with which it is conveyed. It also elucidates the relationship between discourse coherence and efficiency. This is checked with subjective terms like quantity of information, quality of information and manner in which the information is distributed in any discourse production. To assess the participant’s correct response efficiency objectively, all of these tasks can be modified into a timed task which results in measurable responses.

In the present study an attempt is made to objectively measure macrolinguistic ability using a timed picture description task. This reaction time measurement could be a revealing factor of how efficiently an individual is giving the required information correctly and within what time limits. Thus, an inference can be made about the cognitive processing speed of coherence. This macrostructure analysis as an implication can contribute to the process of making a differential diagnosis between different groups like focal lesions versus diffuse lesions, or right- versus left-hemisphere damage. Here, an attempt is made to use timed picture description task of macrostructure in individuals with traumatic brain injury (TBI) and compare the coherence/gist production competence between the TBI individuals with left and right hemisphere injury.

According to a set of researchers study on adults who have suffered traumatic brain injury (TBI) have revealed that they exhibit varying levels of impairment in the discourse abilities like informational content, coherence and cohesion of their extended verbal production although on
traditional aphasia tests these individuals score “normal” or “near normal” language (Hagen, 1984; Ylsivaker & Szerkeres, 1989, 1994; Hartley & Jensen, 1991; Coelho, Liles, & Duffy, 1994). A study by Ehrlich (1988) has also concluded that, for persons with TBI assessment at the discourse level should always be included. Since the deficits in established linguistic tests for these individuals are more understated than what are observed in aphasia and/or other adult communication disorders (Hough, 1990). Coelho (1995) also noted that TBI participants were comparable to the neuro-typical adults in terms of the amount of salient and critical information produced in narratives. This result of lengthier and slower spoken language of the TBI participants was noted to prove their decreased communicative efficiency. Thus, he concluded that more words and time is required to convey the important information through spoken language by the TBI participants. The earlier studies by Wyckoff (1984) on individuals with traumatic brain injury also attributed these findings to several factors like decreased cognitive processing speed, inability to assume the listener’s role, deficits in memory, and reduced linguistic abilities particularly word fluency. This research clearly attests the importance of an in depth study of the discourse capabilities of the head-injured adult. In the present study, an attempt is made to quantify the time taken and the number of sentences used to convey the important information/gist in a picture description task by the TBI participants.

Hartley and Jensen (1991) also reported that their closed head injured (CHI) participants produced only one-half or two-third the amount of accurate content produced by the neuro-typical adults. This means that in both the narrative and procedural discourse genre/tasks the CHI participants used significantly fewer cohesive ties per communication unit compared to the neuro-typical adults. Unlike the neuro-typical adults the CHI participants introduced inaccurate content into their narratives. Since the CHI participants’ failed to interpret the visual stimulus correctly, they could not determine the most relevant aspects of the pictures, and as well as during the story retelling tasks they had a reduced auditory verbal memory. These findings were felt and attributed to provide evidence that the TBI participants’ discourse lacked continuity. Snow and Douglas (2000) also reported that TBI participants when producing procedural discourse displayed greater difficulties with clarity of reference, than when producing narratives. Thus, there is evidence that different genres of discourse place various cognitive and/or linguistic demands. Whereas we can hypothesize that picture description task relatively requires less cognitive demand on CHI participants when compared to narrative and procedural discourse task. Picture description task has concrete and quicker response. Thus, in the present study picture description task is considered as a measure for global coherence and an attempt is made to study the same within the TBI group. In view of Glosser and Deser (1990) reports, the TBI participants were significantly impaired relative to the neuro-typical adults in both global and local coherence of conversational discourse. However, a greater impairment was observed for global coherence.

Any subjective measurement of discourse is done by using the principles of Gricean maxims. For instance the primary technique in explaining a novel procedure whether in terms narration or picture description to an inexperienced listener by the people who have sustained TBI have been found to exhibit difficulty observing so-called ‘Gricean maxims’. These mean the cooperative principles which include the quantity and quality of information with relevant tie and appropriate manner that should be considered in any discourse to evaluate it as normal (Grice, 1975). Following this, to elicit procedural discourse from TBI participants a number of techniques have been used. They include requests for descriptions of a few aspect of the individual’s work or treatment programme (e.g. Mentis & Prutting, 1987), outlining the sequential steps in a routine daily task, for example in an American supermarket buying groceries (Hartley & Jensen 1991), from a bank account withdrawing money (Snow, Douglas & Ponsford, 1995), making a sandwich, or changing a tyre, or mailing a letter, (Coppens 1995). As mentioned earlier, these are a subjective measurement of discourse. Thus, they show a reduced use of reference, in association with overall reduction in communicative efficiency, and in addition produce fewer target content units (Hartley & Jensen 1991; McDonald 1993). At present, there is a need for objective measurement of discourse efficiency.

Relative to neuro-typical group, the TBI participants might be expected to show impairment on both macrolinguistic and microlinguistic measures of discourse production. In the present study, the macrolinguistic abilities of discourse were assessed in terms of coherence to infer the cognitive processing speed using a timed picture description task. Here, the participants were supposed to describe the picture and provide the gist of the picture and these responses were measured in terms of reaction time. Thus, reaction time would be a possible unit to assess the coherence during the gist production and thus infer the cognitive processing speed of coherence.
Aim

To assess the macrolinguistic abilities of discourse at coherence level in TBI participants and to compare their reaction time between left vs right hemisphere injured individuals with TBI using a timed picture description task.

Method

Participants: The participants chosen for the study were 20 persons diagnosed as non-aphasic individuals with traumatic brain injury (TBI) following road traffic accidents. These were considered as clinical group and among these 16 were males and 4 were females in the age range of 20-40 years (Appendix-A). These TBI individuals were classified and diagnosed based on the first investigation of the impact side done by the neurologist and the findings of Computed Tomography (CT) scan respectively. The Glasgow Coma Scale (GCS) (Jennet & Teasdale, 1981) was administered by the neurologists to assess the severity of TBI. All the participants in the clinical group had a GCS score ranging from 12-15 and since they were all verbal only these participants were considered for the study. Thus, this GCS score corresponded to a severity of mild to moderate TBI. An individual with TBI having any other associated speech motor problems was not considered as a participant of the study. At the time of the study all these TBI participants had a post traumatic brain injury period of 3-4 months. Further this clinical group was divided into two groups, group 1 containing ten TBI individuals with predominant injury on the left hemisphere and in group 2 ten TBI individuals with predominant injury on the right hemisphere. This grouping was done because there is no specific literature which can directly support the present study where an effort is made to do the comparison between these groups based on single picture description task. All had suffered a mild to moderate traumatic brain injury with no evidence of nonlinguistic deficits like impairment of attention, memory, and executive control as confirmed by Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) (Appendix-B). Thus, they had to obtain a score of 25 or above on mini mental state examination. These participants received a confirmation from a speech language pathologist (investigator) regarding the absence of aphasia component using Western Aphasia Battery (Shyamala and Ravikumar, 2008) and their linguistic skills were found to be within normal limits. Although Kannada mother tongue was the criteria, knowledge of other languages were also noted. As per the rating on re-adapted version of National Institute of Mental Health (NIMH) Socioeconomic Status Scale, (Venkatesan, 2009), all the TBI participants belonged to a middle/high socioeconomic status.

Procedure: The target task was a timed picture description task; picture was taken from adapted version of Western Aphasia Battery in Kannada (Shyamala & Ravikumar, 2008) (Appendix-C). A picture was shown to the TBI individuals and there were two kinds of instructions to expect a correct response from this picture description task. In first condition they were asked to give the gist of information 'a picnic spot' from the picture and then describe the picture in detail (Appendix-D). The same timed picture description task had a second condition where participants were asked or assisted to first describe the picture in detail and then give the gist of information ‘a picnic spot’ (Appendix-E). In the present study the first condition was followed and the verbatim instruction provided was like “I am going to show you a picture, please tell me the scene depicted in the picture”- the gist of the picture picnic spot. If there was an inaccurate response (example: village scene, school set up etc) from the participant, then the second condition was followed with another verbatim instruction. That was to “describe the picture using sentences and then give the gist of the picture”. Thus, among these accurate or inaccurate types of responses individuals with TBI may demonstrate any one type of response. Among the total 20 TBI participants, a majority of 16 participants (group 1- 8 participants and group 2- 8 participants) followed the first instruction and had a correct response (picnic spot) with specific reaction time measurements. Only this value in seconds was noted and considered for the statistical analysis. The remaining 4 participants had to follow the second instruction to get an accurate response and they used few sentences to get an accurate response. For the same the maximum duration considered was up to three minutes and at the same time, recording was done. The WaveSurfer 1.5.7, computer software program was used to record the picture description. The TBI individuals were aware that their speech was being audio recorded. Multimedia microphone was used for the recording and the microphone to mouth distance was kept constant by 5 cm. The recordings were carried out in a quiet room surrounding an environment with no distraction during or in between the recordings. The time taken by the TBI individuals to give the gist of information from the given picture was noted from the same WaveSurfer 1.5.7 computer software. From the recorded audio sample, transcription was done using Schiffman (1979) symbol of IPA. During transcription, initiation time, pause time, filled pauses, unfilled pauses...
and false start etc, were carefully noted, for each episode.

Scoring: Using Discourse Analysis Scale for picture description task in Kannada language (Hema & Shyamala, 2009) (Appendix-C) the sample of picture description task was analyzed for ‘information adequacy’, ‘information content’, ‘message accuracy’, ‘global coherence’, ‘response time’ and ‘gist of information’. All these parameters can be assessed under the propositional aspects of discourse (Hartley, 1995) and a high score for each parameter indicates the appropriateness of the behaviors and thereby infer good coherence efficiency. Among these, the parameter ‘gist of information’ was only the parameter which is the sum of all the parameter and objective in evaluation. Thus in the present study, only this parameter ‘gist of information’ is considered for statistical analysis and a general discussion is made to assess the minimum number of sentences used to get the gist of information and by this means the coherence efficiency can be inferred.

Results

In the present study, the TBI participants who told the gist of the picture as per the first instruction only were considered for analysis (Appendix- D). These individuals’ responses were measured in terms of time duration under the parameter ‘gist of information’ and only this parameter was considered for statistical analysis. The scores of eight TBI individuals with predominant injury on the left hemisphere and eight TBI individuals with predominant injury on the right hemisphere were considered for statistical analysis to see the significant difference between the two groups. The SPSS (PASW) Version 18 was used to execute the statistical analysis. The mean and standard deviation were calculated for the parameter ‘gist of information’. From Table 1, the mean value for the TBI group with injury on right hemisphere was higher which suggests that they took more time to tell the gist of the picture compared to TBI group with injury on left hemisphere. Since the overall discourse assessment was based on a three point perceptual rating scale and the standard deviation for the parameter ‘gist of information’ was high and not within the normal distribution, the non-parametric Mann Whitney test was carried out to study the significance of the value obtained between group 1 and group 2. Results showed significant difference between the TBI individuals with injury on left hemisphere and right hemisphere at 0.05 level. Thus, RT measurement conveys how efficiently one is giving a correct coherence.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Results of Mann-Whitney test (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gist of information</td>
<td>LHD</td>
<td>85.10</td>
<td>19.48</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>RHD</td>
<td>115.66</td>
<td>25.27</td>
<td></td>
</tr>
</tbody>
</table>

Note: Legend: LHD- Left Hemisphere Damage/Insult, RHD- Right Hemisphere Damage/Insult.

Discussion

From Table 1, the results reveal an inference that the right hemisphere injured group was taking more time to give the gist of information compared to left hemisphere injured group. This result is in support with Zalla, Phipps and Grafman (2002) who reported that right hemisphere damaged participants had difficulty in processing inference, recalling narrative components of a story, and appreciating the gist or story’s thematic aspects distinctively in the context of story-telling task. Yet another study by Long, Baynes and Prat, (2005) is also in support with the results of the present study, where they used lateralized item-priming-in-recognition paradigms with reaction time measurements. They found that the left hemisphere and the right hemisphere were equally sensitive to discourse model relations. There is however, no specific literature which can directly support the present finding based on single picture description task.

Most studies have examined changes in the expressive language of TBI participants using referential communication tasks. One such example is a study by Wyckoff (1984) who published her doctoral thesis on referential communication task. She compared the procedural and narrative discourse genre in terms of expressive language of head-injured adults who showed fairly early recovery with those of matched neuro-typical speakers. Among the head-injured group an overall reduction in discourse abilities were found. The participants all of whom were considered under head-injured group had some degree of oral language impairment. They produced fewer meaningful words and cohesive ties, reduced syntactic complexity and more inaccurate content with increased dysfluencies such as repetitions, revisions, and fillers as a hesitating phenomenon. She attributed these findings to several factors like decreased cognitive processing speed, inability to assume the listener’s role, deficits in memory, and reduced linguistic abilities particularly word fluency. This research clearly attests the importance of an in depth study of the discourse...
capabilities of the head-injured adult. In comparison with the Wyckoff’s research finding, results of the present study are in support for picture description task. In TBI individuals the longer reaction time in discourse production predicts the propositional aspects of discourse to be poorer and consequently infers the poor cognitive processing speed.

Another supporting study was by Ehrlich (1988) who noted that TBI subjects were comparable to the neuro-typical subjects in terms of the amount of critical and salient information produced in narratives. Like the lengthier and slower spoken language of head injured individuals was noted to result a decreased communicative efficiency. Ehrlich also concluded that to convey the important information through spoken language by the head-injured individuals, more time and words may be required. Thus, in the present study also the TBI participants have taken more time to convey the gist of the information.

Hartley and Jensen (1991) also reported that their CHI participants were poorer in producing accurate content. They produced only one-half or two-thirds the amount of accurate content produced by the neuro-typical groups. In contrast to the neuro-typical group, the CHI participants introduced inaccurate content into their narratives. As mentioned in the earlier sections these findings are attributed to the CHI participants’ reduced auditory verbal memory during the story retelling task as well as failure to determine the most relevant aspects of the pictures, or interpret the visual stimulus correctly. But in the present study, TBI individuals did not fail completely to interpret the visual stimulus correctly, but took more time to interpret. Thus, our study contradicts with Hartley and Jensen’s study and gives new result w.r.t TBI individuals having a delay in giving the gist of the picture while still maintaining fair amount of coherence in their discourse topic. This could be due to the impact and other compounding variables like severity of CHI. Thus longer reaction time is reflective of the reduced efficiency in giving correct coherence, while shorter reaction time and correct gist production reflect better proficiency.

Overall, left hemisphere injured group performed better compared to right hemisphere injured group in all the aspects of discourse. Although difference is seen with respect to the side of injury in TBI participants, this cannot be generalized, because in spite of strict selection criteria, there could be individual variations among the participants selected in this group, sample size considered was also small and the picture description task was the only single discourse genre used in the present study. Thus, this procedure will help in assessment of discourse deficits in individuals with TBI. It would further help in formulation of therapy baseline and development of appropriate treatment strategies for such population.

Of the many possible narratives types, picture description during diagnostic assessment remains as a most commonly used task. Since it is the interesting and simplest of tasks to elicit a discourse sample. But the discourse typically generated through picture descriptions has led to respond some research questions in brevity, like whether such tasks present great enough cognitive-linguistic challenges and elicit acceptable language to reveal the language production abnormalities of adults with TBI. This has been justified, taking into consideration that this task with short duration is having the additional benefit of predictable content that yields relatively brief language samples and requires less time to assess, transcribe, infer the abstract information, and check the efficiency of coherence among concrete items in the stimuli. Another question is describing a picture scene that the listeners and speakers are simultaneously viewing is not representative of most everyday communicative interactions. The answer for this question is that the day-to-day communicative interactions are very highly influenced by a few extraneous variables like world’s knowledge and individual’s intelligence. Using a timed standard picture stimulus possibly may rule out the above mentioned extraneous variables. Thus, make the task more comparable among different participants. Thus, among the clinical populations it may help in making differential diagnosis and also to establish the normative data in discourse.

**Conclusion**

Discourse analysis scale was used to assess the macrolinguistic ability in terms of coherence in individuals with TBI using a timed picture description task. Using this paradigm of testing the discourse parameter “coherence” was mainly inferred by means of testing the “gist of the information” parameter in Discourse Analysis Scale. Participants’ response to tell the gist was measured in terms of reaction time and was only considered for statistical analysis. A non-parametric test showed a significant difference for reaction time measurements on comparison across TBI participants with left hemisphere insult and right hemisphere insult. However the mean reaction time measure was higher for right hemisphere damaged than left hemisphere. It is concluded that TBI participants have a delay in inferring discourse coherence because of cerebral
insult. This time delay can be objectively measured using a picture description task. This reaction time measurement corresponding to the efficiency in giving correct gist reveals and infers the cognitive processing speed. Thus, by analyzing the concrete content of TBI participants’ picture descriptions, the current findings suggest that the clinicians can obtain significant information specifying the nature of cognitive-communication impairments. This means comparing measured reaction time value as individual’s score and carefully taking into consideration the potential factors prompting the generation of coherence and gist. The clinical importance lies in its potential value in defining and objectively measuring the communicative competence of speakers in terms of coherence (organizational structure) and cohesion (its linguistic form) in gist production. Thus, this macrolinguistic analysis in these participants is important for theoretical and practical reasons. Hence, as an implication it contributes to the process of making a differential diagnosis between TBI individuals with left and right hemisphere injury. A larger sample study however, is necessitated to facilitate generalization. In diagnostic settings, time is a valuable commodity and using picture description task can significantly facilitate objective results. This task can speed up the process and performance of the discourse analysis procedure that can be used as a means of eliciting discourse samples to identify the factors contributing to cognitive-communication impairments. Thus, the limitations associated with tasks like natural conversation, narration, and procedural discourse may be outweighed by using picture description.

Acknowledgement

We would like to express our sincere thanks to Dr. S. R. Savithri, Director, All India Institute of Speech and Hearing for permitting us to do this study. Our heartfelt gratitude to the participants in the study for their cooperation.

References


APPENDIX- A

Demographic details of TBI participants with left hemisphere insult under Group 1.

<table>
<thead>
<tr>
<th>SL No</th>
<th>Age</th>
<th>LK</th>
<th>Lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/M</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>40/F</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>20/M</td>
<td>K, H, E</td>
<td>RTA with severe concussive head injury. Fracture of right temporal bone and right zygoma with multiple intra cerebral contusion in left frontal and temporal region with gross cerebral edema</td>
</tr>
<tr>
<td>4</td>
<td>40/M</td>
<td>K, E</td>
<td>RTA with moderate head injury with left frontoparietal subdural haematoma with faciomaxillary injury</td>
</tr>
<tr>
<td>5</td>
<td>38/M</td>
<td>K, E</td>
<td>RTA with severe head injury</td>
</tr>
<tr>
<td>6</td>
<td>40/M</td>
<td>K, E, H, Te</td>
<td>RTA with concussive head injury with left temporomastoid bone fracture with left parietal bone fracture with underlying pneumozephalum</td>
</tr>
<tr>
<td>7</td>
<td>45/M</td>
<td>K, E</td>
<td>RTA with severe head injury with large temporal contusion</td>
</tr>
<tr>
<td>8</td>
<td>34/M</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>
</tr>
<tr>
<td>9</td>
<td>26/M</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>10</td>
<td>23/M</td>
<td>K, E, H, Ta</td>
<td>RTA with severe head injury with right temporal bone fracture with mild cerebral edema</td>
</tr>
<tr>
<td>11</td>
<td>50/M</td>
<td>K, E, H</td>
<td>RTA with concussive head injury with right temporal bone fracture with mild cerebral edema</td>
</tr>
<tr>
<td>12</td>
<td>45/M</td>
<td>K, E</td>
<td>RTA with concussive head injury with hematoma in occipital region</td>
</tr>
<tr>
<td>13</td>
<td>28/M</td>
<td>K, E</td>
<td>RTA with severe head injury</td>
</tr>
<tr>
<td>14</td>
<td>50/M</td>
<td>K, E</td>
<td>RTA with concussive head injury with soft tissue injury. Right parieto occipital scalp haematoma</td>
</tr>
<tr>
<td>15</td>
<td>23/M</td>
<td>K, E, H</td>
<td>RTA with severe concussive head injury with traumatic subarachonoid haemorrhage with extensive faciomaxillary injury</td>
</tr>
<tr>
<td>16</td>
<td>26/M</td>
<td>K, E</td>
<td>RTA with concussive head injury left temporal lobe small hyperdense area ? contusion</td>
</tr>
<tr>
<td>17</td>
<td>50/M</td>
<td>K, E</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 pneumozephalus</td>
</tr>
</tbody>
</table>

*Note* - M-Male, F-Female, RTA-Road Traffic Accident, LK-Language Known, K-Kannada, E-English, Te-Telugu, Ta-Tamil.
## APPENDIX-B

### The Mini-Mental State Exam

Patient…………………………………… Examiner …………………………………………

Date………………………………

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Maximum</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the (year)(season) (date) (day) (month)?</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Where are we (state) (country) (town) (hospital) (floor)?</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

### Registration

Name 3 objects: 1 second to say each. Then ask the patient all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record.

| Trials | 3 |

### Attention and Calculation

Serial 7’s. 1 point for each correct answer. Stop after 5 answers. Alternatively spell “world” backward.

|                      | 5 |

### Recall

Ask for the 3 objects repeated above. Give 1 point for each correct answer.

|                      | 3 |

### Language

Name a pencil and watch.

|                      | 2 |

Repeat the following “No ifs, ands, or buts”

|                      | 1 |

Follow a 3-stage command: “Take a paper in your hand, fold it in half, and put it on the floor.”

|                      | 3 |

Read and obey the following: CLOSE YOUR EYES

|                      | 1 |

Write a sentence.

|                      | 1 |

Copy the design shown.

|                      | 1 |

### Total Score

ASSESS level of consciousness along a continuum- Alert Drowsy Stupor Coma
APPENDIX- C
Discourse Analysis Scale for picture description task

(Hema & Shyamala, 2008)

Points to be considered while using Discourse Analysis Scale:
The parameters of propositional and non-propositional aspect of picture description can be quantified with few general instructions to the evaluator as follows:
1. Initially read the keys provided in the sub headings which explain the exact meaning of the parameters to be scored as good, fair and poor with respect to the particular context of conversation.
2. Scoring procedure involves the use of rating scale. Three points perceptual rating scale is used to evaluate each parameters.
3. Each appropriate behavior (normal) is given a higher score and the inappropriate behavior (abnormal) is scored low.

Propositional aspects of communication.
This includes the notion of relevancy, clarity of reference and coherence of information. It deals with how discourse is organized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to main theme/topic.

1) Discourse Structure

**Good**- The discourse is organized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to maintain unity.

**Fair**- The discourse is partially confusing even if it is partially organized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to main theme/topic.

**Poor**- The discourse is completely confusing since it is unorganized with respect to overall plan, theme or topic and how individual utterances are conceptually linked to each other.

a) Discourse forethought---------------------------------------
[Score: 0-Poor, 1-Fair, 2-Good]

b) Organizational planning ---------------------------------
[Score: 0-Poor, 1-Fair, 2-Good]

2) Communication intent
This parameter can be evaluated using frequency count, so check for the presence or absence. If present, make a note whether an individual use this parameter only in required circumstances or in all the circumstances.

**Good**- Individuals using this parameter in all required circumstances.

**Fair**- Individuals using this parameter inconsistently in the required circumstances.

**Poor**- This parameter is absent in the entire context of picture description.

a) Initiation of picture description----------------------------
[Score: 0-Poor, 1-Fair, 2-Good]

b) Asks for assistance in understanding picture-----------------
[Score: 0-Poor, 1-Fair, 2-Good]

c) Criticizes the picture by agreeing/disagreeing to a part in the picture-
[Score: 0-Poor, 1-Fair, 2-Good]

d) Imagines events correctly---------------------------------
[Score: 0-Poor, 1-Fair, 2-Good]

3) Coherence

a. **Global coherence**----------------------------------------

**Good**- Presence of good relationship between the meaning and context of verbalization with respect to the general topic of picture description.

**Fair**- Presence of partial relationship between the meaning and context of verbalization with respect to the general topic of picture description.

**Poor**- Relationship between the meaning and context of verbalization with respect to the general topic of picture description is completely absent.

b. **Local coherence**----------------------------------------

**Good**- Presence of good relationship between the meaning and context of verbalization with that of the immediately preceding utterance produced by the participant.
Fair- Presence of partial relationship between the meaning and context of verbalization with that of the immediately preceding utterance produced by the participant.
Poor- Relationship between the meaning and context of verbalization with that of the immediately preceding utterance produced by the participant is completely absent.

[Score: 0-Poor, 1-Fair, 2-Good]

4) Topic management
a) Introducing topic------------------------------- ( )
Good- Correctly introducing the topic.
Fair- Partial but correct introduction to topic.
Poor- Irrelevantly introducing topic or no response.

b) Topic shift-------------------------------------------- ( )
Good- Staying within the given topic.
Fair- Gradual shift from the given topic.
Poor- Rapid shift from the given topic.

[Score: 0-Poor, 1-Fair, 2-Good]

c) Topic changes-------------------------------------- ( )
Good- Coherent topic change where the topic is within the context of verbalization.
Fair- Partially inappropriate topic change but still the topic is within the main context of verbalization.
Poor- Non coherent topic change is present.

[Score: 0-Poor, 1-Fair, 2-Good]

d) Perseveration in the topics---------------------------- ( )
Good- Perseveration not present.
Fair- Perseveration partially present.
Poor- Perseveration continuously present.

[Score: 0-Poor, 1-Fair, 2-Good]

e) Minimal elaboration------------------------------------- ( )
In presence of prompts from the investigator, the participants attempting to give yes/no responses along with very few sentential level discourse to elaborate the topic.
Good- Minimal elaboration appropriately present in all required circumstances
Fair- Minimal elaboration partially present in all required circumstances.
Poor- Minimal elaboration absent in required circumstances or minimal elaboration only present throughout the context of picture description.

[Score: 0-Poor, 1-Fair, 2-Good]

f) Elaboration of topics----------------------------------- ( )
Good- Adequate elaboration of topic.
Fair- Partial elaboration of topic.
Poor- Extra elaboration of topic.

[Score: 0-Poor, 1-Fair, 2-Good]

5) Information adequacy
Good- Completely adequate picture description at word level/ single sentence level/ multiple sentence level without any prompts from the investigator.
Fair- Partially adequate picture description at word level/ single sentence level/ multiple sentence level in the presence of few prompts from the investigator.
Poor- No picture description at word level/ single sentence level/ multiple sentence level despite several prompts from the investigator.

a. Word level/ Single sentence level/ Multiple sentence level----- ( )
Underline the level at which the participant is positioned.
[Score: 0-Poor, 1-Fair, 2-Good]

6) Information content
Good- Meaningful and adequate information of the picture description in terms of initiating and/or sustaining the task.
Fair- Meaningful and adequate information of the picture description in terms of initiating and/or sustaining the task or if you know what the person is talking about, even if the information doesn't appear to be available or more than half of the picture described.
Poor- Nonmeaningful and inadequate information of the picture description in terms of initiating and or/sustaining the task or less than half of the picture described.

a. Meaningful and adequate information------------------------------- ( )
[Score: 0-Poor, 1-Fair, 2-Good]

7) Message Accuracy ----------------------------------- ( )
Good- An attempted picture description involving correct descriptions of picture without any confabulation or any inaccurate information within the same context of picture description.
Fair- An attempted picture description involving correct description of picture and few accurate information without any confabulation within the same context of picture description.
Poor- An attempted picture description involving incorrect descriptions of picture with confabulation within the same context of picture description with all inaccurate information.

[Score: 0-Poor, 1-Fair, 2-Good]

8) Vocabulary specificity

Good- Using specific vocabulary when specific information is required.
Fair- Partially using specific vocabulary when specific information is required.
Poor- Overuse of generic terms such as "thing" and "stuff" when more specific information is required.

[Score: 0-Poor, 1-Fair, 2-Good]

9) Linguistic fluency

Good- Fluent discourse without any repetition, unusual pauses or hesitations.
Fair- Partially fluent discourse with very few repetitions, unusual pauses or hesitations.
Poor- Presence of repetition, unusual pauses, hesitations

[Score: 0-Poor, 1-Fair, 2-Good]

10) Speech Style

Good- Appropriate use of any dialectal structural forms, code switching and style-shifting.
Fair- Inappropriate use of dialectal structural forms, code switching, style-shifting is partially present.
Poor- Presence of totally inappropriate dialectal structural forms, code switching, style-shifting.

[Score: 0-Poor, 1-Fair, 2-Good]

11) Intonation

Good- Absence of any inappropriate or abnormal rising, falling, flat intonation with respect to a particular context of picture description.
Fair- Inappropriate or abnormal rising, falling, flat intonation with respect to a particular context of picture description is partially present.
Poor- Presence of inappropriate or abnormal rising, falling, flat intonation with respect to a particular context of picture description.

[Score: 0-Poor, 1-Fair, 2-Good]

12) Response time

Time taken to start the picture description and is measured in terms of seconds.
Good- Response at 0.5-2sec.
Fair- Response at 3-5 sec.
Poor- Response delayed beyond 6-8 sec.

[Score: 0-Poor, 1-Fair, 2-Good]

13) Gist of information

What does the whole picture represent as? Please record the time (in seconds) taken to carry out this particular task.
Good- Presence of correct depiction (picnic spot).
Fair- Partially correct depiction (picnic spot) with good local and poor global coherence.
Poor- Completely wrong depiction (picnic spot) with poor local and global coherence.

[Score: 0-Poor, 1-Fair, 2-Good]

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. (Note: In picture description it is only from participants’ point of view)

The following subcategories are considered:

1) Revision behaviors

Good- Absence of false starts and self interruptions in the entire context of picture description.
Fair- Presence of false starts and self interruptions in some contexts of picture description.
Poor- Continuous presence of false starts and self-interruptions in the entire context of picture description.

[Score: 0-Poor, 1-Fair, 2-Good]

2) Repair strategy

This parameter can be evaluated using frequency count, so check for the presence or absence. If present, make a note whether an individual use this parameter only in required circumstances or in all the circumstances.
Good- Individuals using this parameter in all required circumstances.
Fair- Individuals using this parameter inconsistently in the required circumstances.
Poor- Individuals not using this parameter at all in the entire context of picture description.

a) Use of self correction

[Score: 0-Poor, 1-Fair, 2-Good]
Participants find a word or sentence after giving a small pause and continue the topic of picture description.

[Score: 0-Poor, 1-Fair, 2-Good]

b) Use of repair through repetition/revision-----------------------------→ (      )
   Repeating themselves and correcting the discourse without the investigators help.
   [Score: 0-Poor, 1-Fair, 2-Good]

c) Use of other initiated correction------------------------------→ (      )
   Participants not able to find the right word, so the investigator fills it with the correct word to continue the topic of picture description.
   [Score: 0-Poor, 1-Fair, 2-Good]

d) Use of request for clarification ------------------------------------→ (      )
   Requesting the investigator to modify the discourse and use the corrected version of discourse to continue the topic of picture description.
   [Score: 0-Poor, 1-Fair, 2-Good]

Picture card from Western Aphasia Battery, (Shyamala & Ravikumar, 2008)
APPENDIX- D
Sample of a TBI participant following the first instruction where there is no delay in giving the gist of the information.

P: pravasakke bandidaare, ondu naayi ide. matte ella avara kelasaddali toDagiddare. appa amma avara kelasam aDataa iddare. ondu huDuga gaalLi paTa haarisutta iddane. idu ondu citra ashTe. naahi nintide. ondu dvajaaroohaNa naDedide. aa pravasi taaNada mundane ondu dvaja ide. aa ganDasu appa avana cappal biTTu caape mele kuuttiddare. hengasu kaafi baeraesutta iddare. ondu buTTi ide avara munde, ivaru ondu doDDa marada keLagaDe kuLiivishranti paDedu koLLutta iddare. alli haaDu keLutta iddare. ivaru kaarinalli bandu kaaranu pravaasi gruhadalli nillisiddare. pakkadalli ondu samudra atava nadi ide. alli ondu dooNi ide. pakkadali jana eno baTTu hogeysutta kelasam aDutta iddare. (They have come for a picnic. One dog is there and all are involved in their work. Dad and mom are doing their work. One boy is playing with kite. This is one picture that is all. Dog is standing. One flag hoisting is done. aa.. In front of the guest house flag is there. That men dad has left his chappal and is sitting on the mat. A woman is preparing coffee. One basket is there in front of them. They are sitting under a big tree and taking rest. There they are listening to music. They have come by a car and car is parked in the guest house. Near by there is sea or river. There one boat is there. Near by some people are washing their cloths and doing some work.)

APPENDIX- E
Sample of a TBI participant following the second instruction where there is a delay in giving the gist of the information.

P: ii citra... ii citra nooDidare ondu haLLiyalli jana jiivan naDesuta iirodu. (This picture.. This picture depicts a village scene where people are leading their life.)
I: nooDi... yaava samayadalli tige kuutakotare?Ellige hoodaagga tige kuutakotiivi (See... When do they sit like this? Where do we go and sit like this?)
P: ondu mane ide, samudrada pakka ide. ondu huDuga, hengasu, ganDasu, naayi, kaaru ede. ivaru avara kelasaddali toDagiddare. elaaru vishranti togotaa iddare; pravasakke bandiddare. (One house is there. It is next to the ocean, one boy, women, men, dog, car is there. These people are involved in their work. All are taking rest. They have come for a picnic.)
POSITION EFFECTS OF LETTER PRIMING ON CVC WORD NAMING IN ADULT SPEAKERS OF ENGLISH AS SECOND LANGUAGE

1Varun Uthappa, A. G., & 2Priyanka Shailat

Abstract

The segmental overlap effects of intra-word constituents in naming CVC type of monosyllabic words by second language speakers of English has been established. However, the relative effect of position of the constituents when presented independently is not known. The present study investigated the effects of the initial, medial and final letter overlap on word naming in 30 second language speakers of English through a masked priming paradigm. The results revealed the presence of facilitation only by overlapping letters in the initial position, thereby signifying the role of ‘position’ in primed naming with overlapping components.

Key words: word naming, letter priming, segmental overlap, letter position

Introduction

Word naming refers to the simple task of reading a written word. Although apparently simple, the task requires an individual to recognize the components of the written word and formulate its production through appropriate lexical selection and phoneme sequencing, as the case may be. These stages of processing render the task temporal so that the steps involved in the process of naming are in a timed sequence (Glushko, 1979; Seidenberg, 1985a). When these processes are theoretically or practically delineated, they offer a scope for intervention in to the processes through priming experiments. The general premise is that word naming may be facilitated when components of the word are presented prior to its actual introduction, as in the ‘segmental overlap hypothesis’ (Schiller, 1998; 2000).

Several studies have documented these facilitating effects of form-based priming in different languages (e.g.: Forster & Davis, 1991; Ferrand, Grainger & Segui, 1994; Chen, Chen & Dell, 2002; Roelofs, 2006; Verdonschot et al., 2011), where word naming is speeded with an increase in overlap of segments / components between the prime and target. The minimal unit considered a ‘segment’ for facilitation to occur however, has seen variations across languages. Chen and Dell (2002) and Ferrand, Segui and Grainger (1996) found the ‘syllable’ as a minimal unit providing facilitatory effects in Mandarin Chinese and French, respectively. Schiller (1998) and Roelofs (2006) on the other hand have found that the ‘segmental overlap’ holds true at the phonemic level itself in English for native speakers.

Primarily, although segmental overlap facilitation on serial presentation is confirmed with certain constraints, the influences of the individual components in terms of their position in the word are unclear. An early attempt by Grainger and Jacobs (1991) to study the effects of words with embedded target letters as primes on alphabetic decision timing revealed the presence of position specific facilitation where alphabetic decisions were faster when the embedded letters occupied the same position in the word string that of the target. The processing requirements of the task however, are widely different from that of word naming. In this regard, Schiller (2004), on the basis of a series of experiments revised the ‘segmental overlap hypothesis’ and emphasized on the concept of ‘onset form priming’, implying that the overlapping onset of a certain word is primary for facilitation and that words with non-overlapping onsets do not yield the same extent of facilitation even if the subsequent segments share their components.

Most models of word recognition and the ensuing process of naming also complement the idea of component based activation either by spreading of activation (connectionist models such as Seidenberg & McClelland, 1989) or generation of and selection from cohorts (modular models such as Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001). The extraction of these components are serially based in modular models and distributed in connectionist models. If the primes are letters of the word in their corresponding positions, the activation should be limited to initial letter presentation if the serial processing accounts ought to stand. On the contrary, if distributed networks in parallel systems operate, the word may well be primed by subsequent letters of the word too.

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What remains to be discerned is whether and how these varied propositions interact on behavioural tasks such as a simple primed naming paradigm for monosyllabic words. Moreover, some implicit mechanisms involved in word naming have been found to be different in first and second language speakers of English (Uthappa, Shailat & Shyamala, 2012) in that phonological overlap does not elicit facilitation as in native speakers of English, which adds to the existing dilemma.

It is apposite to examine these relative mechanisms involved using a single type of monosyllabic words, which aid in discounting several factors influencing the reading of longer linguistic chunks such as word length, number of syllables, syllable structure etc. Thus, the present study aims to evaluate the position effect of letter priming in adult second language speakers of English using simple meaningful monosyllabic words with a C1V1C2 structure (e.g.: mel). It is hypothesized that the presentation of any of the three letters among C1, V1 and C2 as primes would facilitate the speed of reading the word. In other words, any isolated letter, considered segment, of a word presented as a prime to the word would decrease naming latency irrespective of its position (i.e. position-invariant isolated segmental overlap facilitation).

Method

Participants: Thirty healthy individuals (27 females and 3 males) aged between 21 and 27 years participated in the study. The participants fulfilled the following criteria:
1. English as the medium of instruction in school / college for a minimum of 10 years
2. Native speakers of a Dravidian language (Malayalam – 13, Kannada - 11, Telugu - 4, Tamil - 2)
3. May or may not have had exposure to a third / fourth / fifth language
4. Normal or corrected to normal vision

Stimulus: The stimulus comprised a list of 120 ‘prime-target pairs’ programmed to run on the DMDX software. They were borrowed from Uthappa, Shaait and Shyamala (2012) and selected as follows:
1. The original list comprised a set of 240 C1V1C2 words represented by words

beginning from letter ‘b’ to ‘t’. These words were chosen based on a search for words with the above syllable structure in series from the Webster’s New World College Dictionary by Agnes in 2000. There was no restriction on the grammatical category of the words with the exception of proper nouns, historical names and those representing scientific units
2. The words were arranged in alphabetic order and every alternate word beginning with the first was chosen
3. Thus a set of 120 target words were obtained (Appendix 1)
4. These words were arranged in alphabetic order from right to left in four columns to derive four lists of 30 words each for each of the four types of primes (C1% - C1V1C2, %V1% - C1V1C2, %C1C2 & %%% - C1V1C2; e.g.: m%% - mel, %e% - mel, %m% – me & %%% - mel). This method of selection was used to ensure an equivalent distribution of words beginning with each letter in each of the lists
5. The 120 ‘prime-target pairs’ were programmed for use in DMDX for the masked priming experiment
6. The presentation of each item was programmed as follows: An initiation point ‘*’ was set to be displayed for 500 milliseconds. This would be followed by the forward masker ‘###’ for 500 milliseconds. The prime would follow for 100 milliseconds after which a backward masker ‘###’ for 15 milliseconds would appear. This would be followed by the target which would remain displayed for 2000 milliseconds. This paradigm was considered to allow a relative comparison with the findings of Uthappa, Shailat and Shyamala (2012), where 50 milliseconds primes failed to produce significant facilitation on onset-letter priming (C1%,%), while 100 milliseconds primes of the same type exhibited speeded naming. Also, masked priming was employed in order to primarily elicit the action of implicit mechanisms alone (Evett and Humphreys, 1981). An example of stimulus presentation for an initial letter overlap prime (C1% - C1V1C2, i.e. m%% - mel) is illustrated in Figure 1

![Figure 1: An illustration of the pattern of stimulus presentation](image-url)
7. A set of twelve practice items were also programmed. The target items for practice were taken from the set of 120 words that were not considered for the study, randomly.

Instrumentation/Software: A Compaq Presario CQ 60 laptop with a 17” screen was used to present the stimulus through the DMDX software. A Mipro MM-107 microphone was used to record the responses of the participants. The Check Vocal software was used to view and analyze the waveform and spectrograms of the recorded samples for naming latency. The Statistical Package for Social Sciences (SPSS) – version 18 software was used for statistical analyses.

Procedure: The participants were comfortably seated before the laptop in a well lit and silent room. The inclination of the laptop screen was adjusted for visibility as per participant requirements. The participants were asked to maintain the distance of the microphone from the lip within a range of 4 to 6 inches. They were instructed to begin looking at the laptop screen on the appearance of ‘*’. They were asked to continue looking as entities (masker and prime) flashed, before a word stabilized on the screen. They were instructed to read this word that followed the fleeting elements on the laptop screen as soon as possible. The practice items were run prior to the experiment. They were then asked to read the list of target items aloud once, so as to provide an opportunity for the experimenter to correct any deviant pronunciation and to ensure that all the words were familiar to the participants. This was followed by the experiment in which the stimulus items were presented in random order as decided by DMDX. On completion of the experiment, the participants were provided an edible token of appreciation.

Analysis of the samples: The naming responses for each item of every participant were analyzed to calculate the reaction time at onset by inspecting the waveform, spectrogram and auditory playback. The responses that were erroneous or disfluent were omitted (35 in all, maximum of two errors per participant). The average values of reaction time (in milliseconds) of the correct responses for each participant for each type of ‘prime-target’ pair were considered for statistical analyses.

Results and Discussion

The outcome of the analysis using Check Vocal software was the average values of reaction time for each ‘prime-target’ condition for each participant. The mean and standard deviation values for the same were calculated in SPSS 18 (Table 1).

Table 1: Mean and S.D. values of reaction times across the four ‘prime-target’ conditions

<table>
<thead>
<tr>
<th>‘prime-target’</th>
<th>Mean</th>
<th>S. D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1%% - C1V1C2</td>
<td>541.87</td>
<td>98.37</td>
</tr>
<tr>
<td>%V1%-C1V1C2</td>
<td>565.03</td>
<td>96.11</td>
</tr>
<tr>
<td>%C2 - C1V1C2</td>
<td>560.59</td>
<td>100.94</td>
</tr>
<tr>
<td>%%% - C1V1C2</td>
<td>570.43</td>
<td>95.08</td>
</tr>
</tbody>
</table>

The data were subsequently subjected to Repeated Measures ANOVA [F (3, 87) = 18.792] which revealed a significant difference (p < 0.001) between the conditions as a whole. In order to identify pair-wise differences, Bonferroni’s comparison was made. The outcome is represented in Table 2. The ‘no prime’ (%%% - C1V1C2) condition was found to be significantly different (p < 0.001) from the initial letter overlap (C1%% - C1V1C2) condition. The C1%% - C1V1C2 condition also differed significantly (p < 0.001) from the medial (%V1%- C1V1C2) and final letter (%%C2 - C1V1C2) overlap conditions. There were no significant differences between the ‘no prime’ condition and medial / final letter overlap conditions. The medial and final letter overlap conditions were also not different from each other.

Table 2: Bonferroni’s pair-wise comparison across the four ‘prime-target’ conditions

<table>
<thead>
<tr>
<th>‘prime-target’</th>
<th>C1%% - C1V1C2</th>
<th>%V1%-C1V1C2</th>
<th>%C2 - C1V1C2</th>
<th>%%% - C1V1C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1%% - C1V1C2</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<tr>
<td>%V1%-C1V1C2</td>
<td>NS</td>
<td>NS</td>
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<td>%C2 - C1V1C2</td>
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<td>%%% - C1V1C2</td>
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</table>

Note. S - Significant difference (p < 0.001), NS – No significant difference

The findings clearly reveal the presence of facilitation of word naming when the prime is an overlapping letter in the initial position (e.g: b%%% - bad). The finding is in consonance with the studies of Schiller (1998), Roelofs (2006) and Uthappa, Shailat and Shyamala (2012) in speakers of English, both as first and second language. It is also in accordance with the modular models of word recognition (Coltheart et. al., 2001) where the choice of words for naming that form a cohort is guided based on an initial activation by the first serial element of the word. When an initial letter (say ‘b’) is presented as a prime, the possible
subsequent target is reduced to one among the words starting with the letter ‘b’, thereby increasing the speed of lexical selection for naming.

On the contrary, the overlapping segments in the medial (e.g.: %a% - bag) and final (e.g.: %%g - jog) segments are not statistically significant in their facilitation. It implies that only a serially activated cohort promotes naming swiftness. For instance, a prime that overlaps with a target as in ‘%a% - men’ or ‘%a% – met’ does not facilitate naming speed as a prime such as ‘m%a% - mel’ when compared to the naming latency for a non-primed naming condition such as ‘%a% - mob’. Moreover, the dissimilarity in the extent of facilitation caused by the initial letter versus that of the medial / final letters emphasizes the importance of position in letter priming and affirms the idea of onset based priming under the revised segmental overlap hypothesis (Schiller, 2004) even for second language speakers of English.

Although second language speakers of a language are known to employ more explicit learning strategies (Kescskes & Albertazzi, 2007), which may be assumed to reflect in the recognition of each letter in a word irrespective of positional preponderance, the present findings do not earmark any difference with first language speakers of English in terms of the position effect of primes. It may thus be identified that ESL speakers also adhere to the basic principles of modular activation through cohorts, in the current context.

In addition to the salient findings, observation of descriptive data provides information regarding the subtleties of position-based component priming. The latencies of naming are faster than the no prime condition in each of the prime conditions as indicated by the mean values, although the difference between them is negligible in absolute terms. It implies that the direction of influence of the primes is facilitative (with all the primed conditions, e.g.: %a% - tin, %a% - tip, %a% - tod, exhibiting faster naming than the no prime condition, e.g.: %a% - top), although not statistically significant, with the exception of initial overlap primes.

On closer inspection, it can be noted that the effect of priming is not governed based on serial positioning (i.e. the initial, medial and final letter overlapping primes yielding decreasing facilitation in the same order), as the final letter overlap yielded faster naming than the medial. The greater relevance of consonant segments to word representation and activation, compared to vowels may be a possible explanation for the faster response to primes with a final consonant overlap (e.g.: %%g – jog) than a medial vowel overlap (e.g.: %a% - job). Also, contrary to the outcome of the study by Grainger and Jacobs (1991) on an alphabetic decision task, each letter / component presents a specific position variant alteration to the word naming latency.

Although, the initial segment (letter) led to a strong facilitation statistically, the following letter did not trace the pattern, implying that cohort based selection is purely based on the activation of an initial component owing to ‘bottom-up priority’ (Marslen-Wilson, 1989). If this holds true, the observations made on the medial and final letter positions would require an alternate explanation. It may only be speculated that contextually relevant segments of a word are activated better, whose relevance are determined by their contribution to the word in terms of content (i.e. consonants).

Summarily, the experiment has revealed that the position effects of letter priming on C1V1C2 word naming is pertinent and that only letters in the initial position yield facilitation of significant quantity. Thus, the hypothesis that supports position-invariant isolated segmental overlap facilitation is rejected.

**Conclusions**

The study confirmed the supremacy of segments in the initial position over those in the medial and final positions in accelerating the process of word naming temporally, as far as CVC type of monosyllables are concerned in second language speakers of English. It largely supports the initial selection process described in cohort models of word selection and provides further evidence to ‘onset form priming’. The direction of movement of the mean reaction times for the medial and final position segmental primes from the no prime conditions leaves scope for alterations in the experimental paradigm for finer investigation in to the processes involved. It also provides a platform for further study in discerning the positional influence of consonant segments versus vowel segments in word naming facilitation.

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References


### Appendix 1

Target words for the four prime types

<table>
<thead>
<tr>
<th>C1</th>
<th>V1</th>
<th>C2</th>
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<tbody>
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</table>
TEST OF READING READINESS IN TYPICALLY DEVELOPING ODIA SPEAKING CHILDREN (TORR-O)

1Anima Mishra, & 2Premalatha, B. S.

Abstract

The objective of the current study was to develop a screening tool in Odia for reading readiness in pre-primary children which was to be named as TORR-O. The subjects of the study were 248 children (135 boys; 113 girls) speaking Odia as mother tongue and studying in schools with Odia as medium of instruction. The study was conducted in 2 phases. Phase-I was Pilot Study, as a part of which TORR-O was constructed with 30 questions which were designed to assess skills like print identification, shape and color matching, visual discrimination, letter recognition, alliteration, rhyming, blending, deletion and segmentation through a series of picture pointing tasks. The test was then administered on 12 children between the ages of 3.5 to 4.5 years. Based upon the results obtained, appropriate modifications were made. In Phase II, the Main Study, the revised version of the test was then administered to 168 children between 3.5 to 4.5 years from various Odia medium schools across the two districts of Orissa. Item analysis and analysis of correlation was done. Item analysis included computation of discriminative power (DP) and difficulty index (DI) of the test items. DP gave a measure of competence of the test material to discriminate between poor and good readers and DI indicated difficulty of the test items. It was found that 17 test items were within the DP range of 0.2 to 0.8 and 21 were within the DI range of 30 to 70%. ANOVA was done to arrive at a correlation between age of children and reading readiness skills which concluded that the above mentioned skills are age dependent. The test findings concluded that the TORR-O can be used to assess reading readiness in typically developing Odia speaking children between ages of 3.5 years to 4.5 years excluding the items out of the DI-DP range.

Keywords: Early Reading Skills, Pre Reading Skills, Emergent Literacy, Dyslexia, Learning Disability

Introduction

Oral language abilities & early literary experiences mark the basic foundation of literary development in children. “Emergent literacy” (van Kleeck, 1990; Sulzby & Teale, 1991) experiences are those in where in children develop ideas about written language and its use even before they actually start decoding prints.

Reading readiness refers to the skills in pre-reading period when children begin to acquire experiences essential for learning to read. Experiences such as understanding spoken vocabulary, auditory and visual discrimination, memory and retention skills, attention and favorable circumstances that facilitate mental and physical growth, help the child to be ready to read in due course of time.

Every child doesn’t learn to read on his/her own. Children need stimulation, be it at home or outside. They need to be introduced to the world of print and letters. Reading is perceiving language by eye, hence, the first requirement of reading is that the child should be able to segregate the letter segments and identify them with accuracy and speed. But not all children master this level. Some are unable to meet the mark, both at the linguistic level and perceptual level and hence, exhibit difficulties in learning to read and write.

In the Indian scripts, reading is taught syllable by syllable as syllables are the subunits of words (Karanth, 1985). These subunits are called ‘akshara’ which consist of i) an independent vowel, ii) a consonant with inherent or attached diacritic vowel, or iii) two or three consonants plus a vowel forming a ‘graphic syllable’ (McCawley, 1997). Diacritics are used to change the form of the inherent vowel; they are attached to the vowels and can be placed above, below, before or after. Diacritics occurring before the beginning of a syllable indicate that vowels are written as independent letters and when consonants occur together, special conjunct symbols are used to denote the parts of each consonant symbol that are combined.

Phonological awareness develops as a function of the writing system and its characteristics of any language. In Indian languages the time between the appearance of different levels of awareness and time between the stages till mastery of the skills vary according upon the nature of the script.

In a series of studies on phonological awareness in adults and children (literate versus non-literate) in the Indian languages/scripts of Hindi and Kannada, Prakash and Rekha (1992), Prakash (2003) and Prema and Karanth (2003) observed that phonological awareness is not crucial to successful reading in those languages. It was seen

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that on rhyme recognition, syllable deletion, phoneme deletion and phoneme oddity tasks, children learning to read alpha syllabaries performed well in rhyme recognition and syllable deletion tasks but not in phoneme segmentation tasks.

Children who fail to achieve ability to learn to read and write have been grouped under the umbrella term “Learning Disability”. Learning disability encompasses a wide range of developmental disorders, primarily, dyslexia, dysgraphia & dyscalculia. Children with dyslexia, i.e. disorder of reading, usually have developmental language impairment. These children though have normal intelligence, fail to acquire reading skills appropriate for their age. Perfetti (1985) stated that a child with dyslexia is one who is normal/ above at least in nonverbal Intelligent Quotient (I.Q), two years behind the reading achievement and with a reading disability that is not explainable primarily by social, economic, motivation, or emotional factors.

The United States National Joint Committee on Learning Disabilities (NJCLD) (1981) defined it as - a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction and may occur across life span. Problems in self regulatory behaviors, social perception and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example sensory impairment, mental retardation, serious emotional disturbance) or with extrinsic influences such as cultural differences, insufficient or inappropriate instruction, they are not the result of these conditions or influences.

Identification of children at risk of dyslexia can be done early by assessing pre-reading or reading readiness skills.

Several tests such as, Dyslexia Early Screening Test (Nicholson and Fawcett, 1996), and Get Ready to Read (Lonigan & Whitehurst, 2001) are available in Western context for assessment of the same. These tests help in early identification of dyslexia in children and also warn parents of children who are at risk of any form of reading disabilities. The tests help by giving the parent, teacher or therapist an overview of the child’s skills and help in planning of appropriate intervention.

In India around 10 to 15 percent of all school children suffer from learning disability (Santhanam, Babu, Sugandhi, Rao, 2011). As reading abilities are language dependent, there is need for developing tests (screening and/or diagnostic) in various languages for assessing literary skills. Odia is one of the primary languages spoken in eastern India; with a population of 33 million speaking it. Odia is an alphabetic-syllabic type of phonetic orthography having invariant grapheme-phoneme conversion rules (Sahu & Kar, 1994).

There is dearth of research related to literary and language based disorders in Odia. The study aimed at developing a screening tool for reading readiness in pre-primary children in Odia.

**Method**

The test of reading readiness in Odia (TORR-O) was developed based upon the Get Ready to Read Test and the Malayalam Reading Readiness Test (Unpublished Master’s Dissertation; Rajan, 2009). It consisted of 26 questions which assessed print identification skills, gross visual discrimination & fine visual discrimination skills, size discrimination, shape matching, color matching, and neatness and length judgments, followed letter recognition, alliteration rhyming, blending (at word and syllable level) and on deletion abilities.

The participants were 286 Odia speaking children between ages of 3.0 to 5.0 years, who were selected based upon the following inclusion and exclusion criteria:

**Subject selection criteria-**
- Subjects having Odia as their mother tongue.
- Subjects enrolled in anganwadi, balawadi, prarambha and/or bodha (preschool, montessory and lower and upper kindergarten)
- Subjects having satisfactory classroom performance
- Subjects whose parents were literates
- Subjects with no known sensory deficits
- Subjects with any other known speech-language and physical handicaps
Table 1: Distribution of population taken for the study

<table>
<thead>
<tr>
<th>School/district</th>
<th>No. of boys</th>
<th>No. of girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>School-1 Saraswati Shishu Vidya Mandir, Sector-9, Cuttack</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>School-2 Sishu Bharati high school, Cuttack</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>School-3 Saraswati Shishu Vidya Mandir, Sector-6, Cuttack</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>School-4 Saraswati Shishu Vidya Mandir, Banki, Cuttack</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>School-5 Shishu Mandir, Tulasipur, Khurda</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>School-6 Balawadi, Banki, Khurda</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2: Distribution of population across age groups

<table>
<thead>
<tr>
<th>Age group (in years)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 to 3.5</td>
<td>30</td>
</tr>
<tr>
<td>3.5 to 4.0</td>
<td>84</td>
</tr>
<tr>
<td>4.0 to 4.5</td>
<td>84</td>
</tr>
<tr>
<td>4.5 to 5.0</td>
<td>30</td>
</tr>
<tr>
<td>Pilot study (3.5 to 4.5)</td>
<td>12</td>
</tr>
<tr>
<td>&gt;5.0</td>
<td>3</td>
</tr>
<tr>
<td>Poor academic performers</td>
<td>5</td>
</tr>
</tbody>
</table>

The study was conducted in two phases.
Phase I: Pilot Study
Phase II: Main Study

Phase I: Pilot Study

Development of screening tool: This test of reading readiness in Odia (TORR-O) was developed based upon the Get Ready to Read Test and the Malayalam Reading Readiness Test. Initially the TORR-O was constructed with 28 questions which were designed to assess skills like print identification, shape and color matching, visual discrimination, letter recognition, alliteration, rhyming, blending, deletion and segmentation through a series of picture pointing tasks. The test was then modified due to difficulty in putting forth the question across children as young as 3.5 years; 2 questions to test segmentation ability at word and syllable level were dropped; and options in 3 questions were changed in color to facilitate optimum responses from children.

The test was administered on 12 children between the ages of 3.5 to 4.5 years. Based upon their responses appropriate modifications were made related to choice of pictures i.e. with regard to colors and iconicity.

Phase II: Main Study

The test was revised based upon responses obtained in pilot study. The Main Study consisted of 26 questions which assessed print identification skills, gross visual discrimination skill, size discrimination shape matching, color matching, the fine visual discrimination abilities and neatness and length judgments, followed letter recognition, alliteration skills, rhyming, blending and deletion. The revised version of the test was then administered to 168 children between 3.5 to 4.5 years from various Odia medium schools across the two districts of Orissa.

Procedure: Before beginning the test, demographic data and information about performance in class, involvement in extracurricular activities if any, parental education & habit of reading at home were collected. Inclusion criteria considered subjects having Oriya as their mother tongue, with hearing and visual sensitivity within normal limits and enrolled in anganwadi, balawadi, prarambha and/or bodha. The exclusion criteria omitted children with other known speech-language deficits and children whose parents were not literate.

The process of data collection spanned over a period of 1 month and covered 2 districts of Orissa (Cuttack and Khurda) and their urban (Cuttack) and rural (Banki, Tulsipur) population across 3 well-known Odia medium schools (Sishu Bharati, Sishu Mandira and Bal Bharati) and their sister concerns and 1 balawadi.

The instructions for the administration of the test were constructed in short and simple sentences. The instructions were predefined to be repeated only twice in itself and once with preset examples (for specific questions). Instructions to each child were to be given in Odia. The test administration time was approximately 15-20 minutes per child.

The test was also administered on 60 children (30 in each group) between the ages of 3.0 years to 3.5 years and 4.5 years to 5.0 years to check for any deviations in number of correct responses in the lower and upper age groups. The TORR-O was also administered to 3 children >5.0 years and 5 students rated as underperformers or having difficulty in academics by their teachers. The collected data was analyzed using SPSS Statistics 17.0.2.

Results and Discussion

Appropriate statistical analysis was done in 2 domains.

1. Domain 1: Item analysis: It was done to find out strength and weakness of each test item.
   i) Difficulty Index (DI)
   ii) Discriminative Power (DP)
2. Domain 2: Analysis of Correlation: It was done to see the effect of age on reading readiness skills.

Domain 1: Item Analysis
A detailed item analysis was done to assess the effectiveness of each test item by analyzing the students’ responses to it. The results of the item analysis focus on:
- If the item functions as intended, i.e. is the question capable to discriminate between children of high and low performances, and
- If the test items were appropriate in terms of difficulty.

The test questions were subjected to the following 2 analyses.

i) Discriminative Power (DP): An item’s discriminative power is the capability to differentiate between children with high and low achievements. A small segment of 25% of high scores and 25% of low scores was used to identify the upper and lower groups. The sizes of the groups vary but here for the simplification of analysis, 25% of the total group is taken for the analysis.

For calculation of Discriminative Power, results of the target group, i.e. 168 children have been considered; it revealed that 17 test items fall within the DP range of 0.2 to 0.8. The items that did not meet the specified criteria were related to print identification, visual discrimination, color matching, neatness judgment, blending and deletion.

ii) Difficulty Index (DI): It determines if the items are too easy or too difficult. In part, it determines standard deviation of scores of the test items. The difficulty index of each item is 100%. If everyone obtains the same score, the standard deviation will be zero. Conversely, if everyone makes mistake with that particular item, then the standard deviation will be zero.

The TORR- O has 4 alternatives. Hence, one fourth (25%) of the children will get the correct answer by just hit and trial or guessing the options. Hence, it is difficult to find the DI of an item below 25%. The ideal DI range lies between 30 to 70%.

The discriminative power (DP) of the items should be between 0.2 and 0.8. It can be seen from table 4 that nine test items don’t fall between the specified criteria. Those questions are not capable to differentiate between high and low performing children.

The analysis of difficulty index (DI) revealed that all but five of the test items lied between the DI of 30% to 70%. Those items were based upon phonological awareness skills. Hence, it can be concluded that the items are neither too easy nor too difficult.

Domain 2: Analysis of correlation
Analysis of variance was done to find out effect of ages on reading readiness skills. During the process it was observed that factors such as classroom performance, parental education, socio-economic status, family size, and region influenced readiness skills. Further, ANOVA was carried out to study the influence of above mentioned factors on pre-reading skills. For this purpose data obtained from 228 children was considered. Information obtained from pilot study (12 children), >5.0 years of age (3 children), and poor academic performers (5 children) were excluded. Due to impenetrability, information from each of the 228 children could not be obtained and results were computed based upon the available data.

Age and reading readiness
Analysis of effect of age on reading skills was done by comparing mean scores of children in each age group. The following table shows the results.

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Mean scores</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 to 3.5 years</td>
<td>40.94%</td>
<td>12.18%</td>
</tr>
<tr>
<td>3.5 to 4.5 years</td>
<td>70.99%</td>
<td>10.15%</td>
</tr>
<tr>
<td>4.5 to 5.0 years</td>
<td>93.97%</td>
<td>5.68%</td>
</tr>
</tbody>
</table>

The table reveals the difference between mean test scores across different age groups of children. It can be seen from the table that there is a difference between mean test scores across different age groups. Children below age of 3.5...
years have poorer mean scores as compared to children between ages of 3.5 years and 4.5 years. While, children above the age of 4.5 years have higher mean test scores than the target group. The group, 3.0 to 3.5 years, has poor reading readiness skills. It was found that during the process of data collection, over half of the children could not complete the test. Some couldn’t understand the questions, some pointed to multiple items while few others didn’t attempt to answer. The results of this study are in accordance with results of Oliver (1975). He found that over half of 3 year olds and one third of four year olds interviewed said they knew how to read although they didn’t know how to. Only a few five year old said they knew how to read, indicating a developmental progression with this concept. Most children develop reading readiness during ages of 4.5 to 6 years of age based upon school curriculum and training. Formal teaching takes place from first standard onwards, i.e. after the age of 5 years. The poor performances of 3.0 to 3.5 year olds can be attributed to lack of formal exposure to prints and books. To test for the significance of the score differences, ANOVA was applied; results are as shown in Table 4.

Table 4: Results of ANOVA for effect of age on reading readiness skills

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>46727.074</td>
<td>2</td>
<td>15575.691</td>
<td>154.281</td>
<td>0.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>22715.189</td>
<td>226</td>
<td>100.956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>69442.262</td>
<td>228</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ANOVA was calculated by taking The ANOVA results reveal that the differences in mean test scores across the age groups are significant with a 0.000 level of significance. It can be seen that with increase in age there is a significant increase in performance scores by the children. It can be concluded that age influences reading readiness skills. This is in accordance with studies done by Chall (1983) and Firth (1985), wherein, it was concluded that reading skills or phonological awareness skills show a developmental progression with age.

Also, a descriptive analysis of the test scores of children >5years of age was done. Following table shows their test scores.

Table 5: Results of children >5 years of age on TORR-O

<table>
<thead>
<tr>
<th>Student Sl. no.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
</tr>
</tbody>
</table>

The variation in mean scores, as depicted in table 3 and table 5, is from 40.94%, to 70.99%, 93.97% and 98.71%. Hence, with increase in age, it is suggested that children acquired more complex reading skills than at a younger age.

Conclusion

An attempt was made to develop a test of reading readiness for pre-primary children. The target population was typically developing Odia speaking children between ages of 3.5 to 4.5 years. 286 children were tested for their awareness of pre-reading skills like print awareness, book conventions, neatness judgments, color concept, visual discrimination, letter recognition and metaphonological skills, which were assessed through multiple choice pictorial representations of test items. Analysis of discriminative power (DP) and difficult index (DI) for each test item was done which revealed that 17 test items were within the DP range of 0.2 to 0.8 and 21 within the DI range of 30 to 70%. 17 test items fall within the DI range of 0.2 to 0.8 and 21 fall within the DI range of 30 to 70%.

9 test items of TORR-O do not satisfy the criteria for effectively discriminating good and poor readers, but, can be used as a screening tool for early identification of reading difficulties in preprimary school children i.e. between the ages of 3.5 to 4.5 years.

Implications

- This test can be used to early identify children who are at risk of reading disability.
- Skills assessed can be targeted for intervention process.
- Test can be administered within 10 minutes.
- It doesn’t require special training to administer the test. It can be administered by Speech Language pathologists, special educators, teachers and parents of children.
Limitations

- Care should have been taken to obtain complete information regarding parental education, socio-economic status and family sizes.
- Study was carried in only 2 districts of Orissa.
- Readiness skills in terms of gender variation were not studied.
- 9 test items don’t fall within the range of Discriminative Power, hence are not effective enough in discriminating good and poor readers.

Future directions

- Aspects of auditory discrimination can be included.
- Test can be administered to a larger population across various districts.
- Test can be administered on a larger sample of poor achievers to find its reliability.
- Test can incorporate information reading habits of children at home.

References


THE DIVERSITY OF BURDEN FOR SIGNIFICANT OTHERS OF PERSON WITH APHASIA

1Pinki, & 2Apoorva Pauranik

Abstract

When a person suffers from a stroke and aphasia, life not only changes for him or her, but also for significant others (SO). Standardized and valid measures are available to identify severity and diversity of burden reported by SO of person with aphasia (PWA). The present aimed to investigate the extent of post stroke changes in experiences of SO of PWA in terms of daily situation and during conversation with PWA of different age groups. To describe changes in SO experiences in terms of educational status, family type, aphasia type and severity of PWA. Twenty five participants were rated on questionnaire related to extent of changes, interactional competence (IC), language and communication related activities (LCA), communication effectiveness (CE) and their own perspectives about PWA. 56% PWA were of 40-60 years of age, 40% were graduates, 56% had anterior aphasia, 48% had moderate severity and 52% were staying in nuclear families. Paired t-test indicated significant mean difference between pre and post stroke experiences of SO at 0.001 level. Majority of the SO perceived their conversations with the PWA as being less stimulating and enjoyable than conversation before stroke onset. The communicative responsibilities of the SO were perceived to have increased consequentially; interaction competence and communication effectiveness of population has decreased significantly. Chi square result suggests highly significant (p< .001) association of education, type, severity and IC, CE and LCA of PWA. On the other hand, relation between competencies of PWA and type of family had border-line association (p≤ 0.046). Denial or unawareness about the perceptions of burden was found particularly in nuclear families. Post stroke aphasia leads to emergence of negative psychosocial consequences and apportionment of communicative burdens to SO. Future direction: To design and conduct family oriented intervention that includes communication partner training and to investigate its outcome combination of impairment based language intervention.

Key words: Interactional competence, communication effectiveness, language and communication related activities.

Introduction

Communication burden may be defined as the share of responsibility of each participant in a conversation must bear to ensure the adequate transfer of information. Mostly communication burden is vast on significant others (SO) of person with aphasia (PWA). In this paper, the term “significant other (SO)” is used instead of “caregiver” in order to include family members, friends and other persons important to the person with aphasia. “Caregiver” could be perceived to imply a nursing role that may not be present, and “family” is too narrow a term.

Previous research about SO of stroke survivors has found evidence of negative impact on relationship with (PWA), when the possibilities of having conversations decrease or even cease altogether. The impaired communicative and physical ability caused by aphasia is a major problem of its own because of misunderstandings that cause irritation and frustration to both PWA) and their SO. These frequent misunderstandings, guessing about communication intent of PWA could create interpersonal problems and increase communication burden on SO. Blom (2012) found that 43% of SO spent less time on conversations compared with before the onset of aphasia, but almost 30% of SO spent more time than before speaking with each other. Draper, Bowring, Thompson, Heyst, Conroy, (2007) used General Health Questionnaire (GHQ) and Relatives stress Scale to measure caregiver’s stress and burden on 31 subjects and planned four session weekly caregiver programme that included element of education, support and communication skills conducted by a speech pathologist, social worker and clinical psychologist. After three-month follow-up, it was revealed that these programmes have no significant effects on communication skills or on caregiver burden. So, it was suggested to have ongoing involvement of all strategies in daily situation to maintain long term effect of these programmes. Thus, there is a need to understand as to how significant others of PWA perceive the extent of changes about their family member. What characteristic of difficulty they are facing in daily situation related to either physically, mentally, socially and economically? It would be of great importance to develop or adapt a SO oriented evaluation and intervention plan to provide complete rehabilitation and to reduce

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risks of negative psychosocial consequences and burden for significant others.

**Aims and objectives**

1. To investigate the experiences of significant others (SO) of persons with aphasia (PWA) in terms of extent of post stroke changes in daily situation.

2. To explore experiences of significant others (SO) during conversations with person with aphasia (PWA) of different age groups.

3. To compare the significant others (SO) experiences in terms of educational status, family type, aphasia type and its severity of person with aphasia (PWA).

**Method**

**Participants**

**Inclusion Criteria:** Significant other of PWA (n=25)
- Experiences of dealing with person with aphasia for at least 3 months on a regular basis (pre and post stroke)
- 18 years or older
- Understand and write Hindi or English in written or verbal mode

Person with Aphasia (n=25)
- Post stroke aphasia of all types and severity of 3 months or longer duration.
- 18 years or older
- Only left hemisphere lesion
- Should be awake and communicable (give eye contact, try to communicate, and have an ability to express him-/herself beyond a pain reaction)

**Exclusion Criteria:** Significant other of PWA (n=25)
- Significant hearing or vision problems
- Diagnosed dementia or any other known significant cognitive impairment

Person with Aphasia (n=25)
- Diagnosed dementia or any other known significant cognitive impairment
- Significant hearing or vision problems
- Known alcohol or drug abuse

**Test Material**

Questionnaires were developed in both Hindi and English to assess all aspects of Communication and language related burden in following subheadings: (i) communication effectiveness, (ii) interaction competence and (iii) language and communication related activities. Pilot study was done to assess the ease of administration of questionnaire i.e. whether the terms and phrases in the questionnaire are comprehensive to SO of PWA or not. Five questionnaires were used, among which two were based on SO’s self-experiences and three, on SO’s experiences with their PWA about communication abilities.

**Table 1: Description of Questionnaire.**

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Domains to be assessed</th>
<th>No. of Questions</th>
<th>Purpose</th>
<th>Scale to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extent of changes in experience (physical, cognition) of SO with Person with aphasia (PWA).</td>
<td>7</td>
<td>To assess changes in experiences of SO related to changes in communication and personal activity after stroke.</td>
<td>Likert’s scale (7 point rating scale)</td>
</tr>
<tr>
<td>2</td>
<td>Language and Communication related activity (LCA)</td>
<td>11</td>
<td>To assess language and communication related activity of PWA.</td>
<td>5 point rating scale</td>
</tr>
<tr>
<td>3</td>
<td>Interaction competence (IC)</td>
<td>7</td>
<td>To assess level participation of PWA in terms of communication with others.</td>
<td>7 point rating scale</td>
</tr>
<tr>
<td>4</td>
<td>Communication effectiveness (CE)</td>
<td>8</td>
<td>To estimate communication ability of PWA in different communicative situations (i.e Basic needs, Social needs, life skills)</td>
<td>5 point rating scale</td>
</tr>
<tr>
<td>5</td>
<td>Significant others oriented</td>
<td>7</td>
<td>To investigate mental status of SO of PWA.</td>
<td>5 point rating scale</td>
</tr>
</tbody>
</table>

**Procedure**

Twenty five consecutive SO of PWA were interrogated through semi structured interview after written informed consent. Demographic data, clinical history, change in experience of SO with PWA and extent of problem of both (PWA and SO) were documented. All five questionnaire were given to SO for rating about their experiences/responses towards PWA after instruction i.e., How to rate?
Results and Discussion

Twenty five PWA with mean age 48.6 years (21yrs- 77yrs) and mean time since stroke onset of 5yrs (4mths-8yrs) were included in this study.

Table 2: Description of Participants (PWA).

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Age</th>
<th>Sex</th>
<th>Educational status</th>
<th>Family status</th>
<th>Type of relationship</th>
<th>Aphasia type</th>
<th>Aphasia severity</th>
<th>Time of Onset</th>
<th>Physical limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20-40</td>
<td>Male</td>
<td>Illiterate</td>
<td>Nuclear</td>
<td>Cohabitant (spouse)</td>
<td>Anterior</td>
<td>Mild</td>
<td>&gt;3mths-2yr</td>
<td>Normal</td>
</tr>
<tr>
<td>2</td>
<td>40-60</td>
<td>Female</td>
<td>High school</td>
<td>Joint family</td>
<td>Siblings/progeny/ Parents</td>
<td>Posterior</td>
<td>Moderate</td>
<td>2-4yr</td>
<td>Minimal</td>
</tr>
<tr>
<td>3</td>
<td>≥60</td>
<td>Female</td>
<td>Higher secondary</td>
<td>Alone</td>
<td>Others (e.g. Friends/ caregivers)</td>
<td>Global</td>
<td>Severe</td>
<td>&gt;4yr</td>
<td>Mild</td>
</tr>
<tr>
<td>4</td>
<td>Graduate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Anomia</td>
<td>Moderate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Post graduate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Severe (2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This figure depicts relationship between age of PWA with language and communication related function (LCRF), communication effectiveness (CE) and Interaction competence (IC) of PWA from SO’s perspective. Younger group i.e. below 40 yr of age group has better LCRF, CE and IC than other age group. Ferro (1988) studied 254 young adults with stroke and found that cardiac embolism was the most common cause of stroke in patients younger than 40, while atherosclerosis was the most frequent etiology among those aged 41-50 years. Kertesz (1981) found that in comparison to older aphasic population, young patients had significantly more non-fluent aphasias and fewer comprehension deficits. In fact, aphasia types characterized by impairment of comprehension, whether non-fluent (global) or fluent (wernicke’s, transcortical sensory), were less frequent in young patients. This finding indicates that comprehension deficits are either less prevalent or have a superior recovery in young adults. Consequently, less comprehension deficits lead to fewer burdens to SO of PWA in terms of interactional competence, communication effectiveness and language and communication related activities.

**Aim 3:** Chi square data analysis has shown highly significant (p< .001) association of education, severity, type of aphasia and interaction competence, communication effectiveness and language-communication related activities of PWA. On the other hand, relation between competence of PWA with type of family (i.e. joint family, nuclear family and alone) is border-line acceptable (p≤ 0.046).

The figure reveals that those having education up to higher secondary (37.5%) and graduation (35%), always use language and communication related activities effectively with a good interactional competence as reported by SO. Consequently, it reduces the dependency of PWA on their SO and decreases the burden of SO.

Printz-Feederson (1990) also found that advanced education, high income and moderate physical disabilities were related to reduce feeling of burden. On the other hand, Reis (2003) has stated that studies about the influence of educational level and literacy (or illiteracy) on aphasia severity have yielded conflicting results.

50% mild aphasics and 29.6% moderate aphasics communicate effectively and have good interaction competence as shown in figure 3. On the other hand, SO of severe aphasic has reported limited competency and infrequent communication effectiveness of PWA. Since individuals with severe (global) aphasia often remain severely impaired, despite of some improvement in comprehension (Paolucci Antonucci, Pratesi, Traballesi, Lubich, & Grasso, 1998), which in turn increases dependency and burden of PWA on their SO. Blake and Lincoln (2000) by using caregiver strain index (CSI) found that increased stroke severity causes poorer caregiver health and physical burden.

As indicated in fig.4, 42% and 33% person with anomic and anterior aphasia respectively, have
more competencies and less burden on SO in comparison to posterior and global aphasia. Godefroy (2002) assessed syntactic comprehension of PWA through word and sentence-picture matching tasks and observed that Broca’s aphasic has performed well than other types of aphasic and showed mild impairment on syntactic comprehension tasks. Murray & Chapey (2001) also stated that anterior and anomic aphasias have often good prognosis over time and relatively preserved comprehension than Wernicke’s aphasia.

Figure 5: Representing responses of SO towards PWA in terms of types of family.

37% & 35% of PWA staying in either nuclear family or alone are having better communication effectiveness and competency in comparison to those residing in joint family. It could be due to the reason of appropriate demand and performance or due to usage of one to one communication (which is more facilitating) or more focused interaction with PWA residing in nuclear family and alone (with caregivers/others).

Mekala, Mioshi, Alladi, Fathima, Poodipeddi, & Kaul, (2012) studied SO of Person with dementia and found that Carer’s burden is a multifaceted construct, which is not easily explained by severity, but atleast partly can be explained by carer anxiety, depression and stress. Thus, burden of SO were assessed on the basis of ratings on “Significant others’ oriented questionnaire”. Through questionnaire it was found that despite of long-term intensive effort, challenges and expensive intervention programme after Aphasia, they do not get impatient, annoyed with PWA during conversation. Even they do not find that intensive care of their relative lead to dearth of time and rest for themselves. Surprisingly, they were totally disagreed with the statements e.g. “Do you think your family member’s illness is main cause of your poor economical status?”, “Do you think intensive care of your family member (PWA) leads to feeling of burden”. These apparent paradoxical results may be due to unawareness about self feelings or cultural factors. Since, SO’s burden is a complex construct that is likely to be modulated by cultural background. People may be in denial mode or did not properly express or do not know the exact status of their view about their relatives.

Conclusion

Impaired communicative ability is an important factor for the emergence of negative psychosocial consequences (post stroke changes in social, physical, economical, personal and professional) and apportionment of communicative burdens to SO.

56% of aphasic can respond to pain and other basic physical needs whereas only 28% frequently tries to communicate ideas but rarely able to make other understand. So, SLP should provide services that especially facilitate operational and strategic competency of SO to achieve optimal communicative competence of PWA.

Burden of SO is difficult to study not only due to various dysfunction following stroke and other influencing factors such as educational status, family type, severity and type of aphasia but also due to the diversity about importance of communication in any society (especially for creating and maintaining relationships) and usage of communications strategies by SO.

Future direction

Use/improve coping strategies through all modalities i.e., spoken, comprehension, reading, writing, pictorial representation and others to reduce communicative burden of SO.

Learn more about how to design and conduct family oriented interventions that include communication partner training.

To investigate outcome of combination of impairment based language intervention alongwith family oriented intervention.

To assess facilitating factors that increases the possibility of PWA for being an active participant in social life.

References


TRENDS AND IMPACT OF EARLY INTERVENTION FOR COMMUNICATION DISORDERS AT AIISH

1Malar, G., 2Sreedevi N., & 3Suresh, C. B.

Abstract

Presence of disabilities like hearing impairment, mental retardation, cerebral palsy, autism spectrum disorders, etc. are found to inhibit the personal, social and productive life of any individual (INDG, 2011; Mauro, 2010; NICHCY, 2010). However, contemporary evidences in the field of rehabilitation for communication disorders suggest that early identification followed by prompt intervention to produce effective results in later educational and social life of the individual (Berrueta-Clement et al., 1984, qtd. in OERI, 2011; Hall, Oyer & Haas, 2001; Moeller, 1991). As a pioneering institute not only in India, but in the south-Asian region for rehabilitation for communication disorders; All India Institute of Speech & Hearing (AIISH) has been a trend setter in early intervention for children with communication disorders for nearly five decades. The current study was undertaken to examine the trends in early intervention at AIISH and its impact on beneficiaries. Two-hundred and five former early intervened clients of AIISH since 2003 were reached out through a survey type of research. Antecedent details of the nature of early intervention services availed, consequent progress in early communication skills, as well as current school performances of the participants were compiled. Analysis of the information using simple descriptive and correlation statistical measures revealed a satisfactory trend in early identification and timely intervention ensued by commendable influence on development of communication and academic skills, as well as social integration in the educational mainstream. The findings reaffirm convictions about need for early identification and comprehensive intervention for successful rehabilitation of young children with communication disorders (Hammes et al., 2002; Yoshinaga-Itano et al., 1998; Robinshaw, 1995; Ramkalawan & Davis, 1992; Markides, 1986).

Keywords: Early identification, Multidisciplinary intervention, Mainstreaming, School performance

Introduction

Early intervention generally implies rehabilitative services provided to children below school age, who are discovered to be developing a handicapping condition or other special needs that may affect their development (LEAP, 2007). Nevertheless more recently, special needs in children are being identified soon after birth, followed up with effective intervention so that they could be mainstreamed at the age of three, that is, at preschool stage itself.

Early Intervention for Communication Disorders

One such group of special needs requiring early intervention is communication disorders. Communication problem could be briefly described as any difficulty faced by an individual in comprehending speech and language of others and/or use speech and other manifestations of language effectively in order to relate with people around him/her. Such difficulties could be consequent to presence of disabilities like autism, cerebral palsy, hearing impairment, learning disabilities and mental retardation, or due to disorders like aphasia and developmental phonological disorders among others. These problems have the potential to disturb the entire realm of an individual’s life beginning from fulfilment of basic physical needs, through education, vocation; and to social integration and attainment of self-actualisation in life (Mauro, 2010; NICHCY, 2010). In India according to NSSO 2002 and Census 2001, approximately 1.9% to 2.13% of the population suffer from some or other kind of disability. NSSO (2002) reports that 15% of the above are with communication disorders. These databases provide further evidences that among these persons with disabilities, only 49% are literate, and there is a looming doubt of how many of them are functionally literate. Census 2001 also reports that only 34% of the persons with disabilities in the country are employed and that too mostly in unorganised and unskilled sectors (INDG, 2011).

However, these dire consequences could be prevented or alleviated with early identification of the communication disorders or their causative conditions followed with timely intervention services for the afflicted children. Depending on the nature of communication disorder, comprehensive early intervention services could include services like screening followed by multidisciplinary diagnostic services; direct

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intervention like fitment of necessary assistive aids/devices followed by therapeutic training like listening speech therapy, occupational therapy and physical therapy; and if necessary special early childhood care and education, that is, preschool training. These services are organised with the premise that intervention provided early, especially before manifestation of the problem, will address any delays in development, so that the child can integrate well in the society and may not need services later on (Girolametto & Weitzman, 2006; Beckman-Bell, 1981; Cooper, 1981).

These services might be provided in varied settings like clinical-centres, schools, hospitals, homes or combined settings depending on circumstantial needs and available facilities. Comprehensive early identification and intervention services not only cater to the rehabilitative needs of the child, but also extend supports to the parents and families (Hammes, Novak, Rotz, Willis, Edmondson, & Thomas, 2002; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998; Robinsiw, 1995; Ramkalawan & Davis, 1992; Markides, 1986).

**Evidences from Early Intervention Practices**

Early identification and timely intervention services for communication disorders in young children have been found to help children with communication disorders acquire typical development, avail age appropriate education, and reduce the need for rehabilitative services later in life (Beckman-Bell, 1981; Cooper, 1981). There have been several follow-up studies on the efficacy of such early intervention programmes around the world for children with varied disadvantages. Ypsilanti Perry Preschool Project was an early intervention programme for disadvantaged children, which generated evidences through a longitudinal study that by 19 years of age the beneficiaries had attained significant gains. They demonstrated better academic performance through all grades at school with need for less special educational support, higher success rates of school completion, continuance with postsecondary education and/or employment compared to children who did not attend special preschool. The beneficial effects were found to extend even outside school in that the early intervened children had displayed less anti-social and delinquent behaviour (Burrerua-Clement et al., 1984, qtd. in OERI, 2011).

There have been studies on children with specific communication disorders, like that of Moeller (1991) with 112 children with hearing impairment. The findings suggested that earlier the intervention (within the first year of life) better was the development of vocabulary and verbal reasoning skills by five years of age. Another study (Hall, Oyer & Haas, 2001) again with children with hearing impairment, reported that early intervention combined with appropriate cognitive exposures led to better development of language skills, as well as speech intelligibility. Recent evidences (Yoshinaga-Itano, 2003) following a decade long study at the Colorado Home Intervention Programme suggest that children with hearing impairment who were identified and intervened in the natural settings of home as early as six months of age had evinced better linguistic, as well as socio-emotional development. Nevertheless, most of these research evidences cited have been generated from well developed communities in American and European countries. Developing communities from countries like India are short of ample, authentic evidences.

**Early Intervention Practices in Developing Nations**

Reports of early identification and timely intervention processes from developing countries, mostly Afro-Asian nations, have not been very encouraging. Gopal and team (2001) from Mauritius report of early intervention for 37 subjects with hearing impairment where the median age of identification was 24 months, but followed with fragmented management processes. Similar studies from other developing nations like Malaysia (Mukari, Vandort, Ahmad, Saim, & Mohamed, 1999) reiterate this notion. These lacunae are typical of any developing community and on the long run could lead to severe deprivations for the individuals, as well as burdens to the family and society.

In India, considerable work has been carried out on the early intervention front. One of the notable has been the Parent Infant Programme for children with hearing impairment being organised since 1992 at the Ali Yavar Jung National Institute for Hearing Handicapped in Mumbai. A follow-up study carried out between 2001 and 2004 revealed all round positive impact of the programme in improving communication and academic skills among others (Basavaraj, Nandurkar & Bantwals, 2005). This apart several non-governmental agencies like AURED in Mumbai, Bala Vidyalaya in Chennai, COMDEALL in Bengaluru, and EAR Centre in Mumbai have been providing early intervention services for children with communication disorders, especially hearing impairment (Alexander Graham Bell Association for the Deaf
& Hard of Hearing, 2005). Efforts for taking services to the homes of young children with special needs are also being made by the Indian National Portage Association (INPA, 2009). And all these programmes report of reaching considerable numbers of young children with various kinds of communication disorders. However, evidences on the qualitative impact of the efforts are scanty.

The All India Institute of Speech and Hearing (AIISH) as a national pioneer in rehabilitation for communication disorders has been extending early identification and timely intervention for its young clients over the years. On an average, clients under 6-years of age account to 15% of the total clientele (Personal communication from Medical Records Officer, AIISH on 10.05.2012). The wide range of services includes neonatal screening, multidisciplinary diagnosis, and fitment of necessary assistive aids, relevant therapeutic training, and preschool education. Over the Institution’s almost half-a-century of existence, these services have been up graded from time to time, and it was time to take stock of the efficacy of the efforts. Thus, an AIISH Research Funded Project was undertaken between February 2010 and February 2012 to appraise the efficacy of the early multidisciplinary preparatory services provided at AIISH, especially its impact on mainstreaming children with communication disorders, under the supervision of former Director of AIISH, Dr. Vijayalakshmi Basavaraj. This article has been generated on the sidelines of this research titled ‘Efficacy of Multidisciplinary Preparatory Services at AIISH in Mainstreaming Children with Communication Disorders’, which examined the nature of early intervention services provided for communication disorders provided, and investigated its developmental and rehabilitative consequences.

**Method**

**Participants:** The study covered 205 children with communication disorders who had formerly received early intervention services at AIISH since 2003 (when the preschool curriculum had been revamped), against a set target of 423. These children were from the states of Karnataka and Kerala, to where more than 90% of the young clientele of AIISH belong to. And the shortcomings in covering the original target was primarily due to inaccurate addresses provided at the time of enrolment to services, change of residences, and contact phone numbers that were changed/non-functional. Another 33 children from other states were tentatively overlooked at the time of planning for data collection, as it was figured that accessing these children located far and wide across the country may not be cost-effective. Purposive sampling was employed to collect data from as many former clients of early intervention services at AIISH as possible. The demographic and disability composition of the research population is presented in Figure 1.

![Figure 1: Composition of the research population.](image-url)

**Tool:** The investigators had compiled a 63-item tool for the purpose of collecting data about the child-participants, including demographic information on 14 aspects collated from official records and/or face-to-face interview; antecedent information on 29 aspects related to early intervention measures and consequent development that were accrued from clinical and
preschool records; and current information on 20 aspects related to school placement and performance, as well as existing level of communication skills that were compiled from interviews, clinical records and/or administration of assessment procedures. The profile of the tool to collect data about the children with communication disorders is represented in Figure 2.

Apart from this tool compiled exclusively for the research, certain other screening tools like 3-Dimensional Language Assessment Test – 3D-LAT (Herlekar, 1986); Linguistic Profile Test – LPT (Karanth, 1980); Developmental Screening Test – DST (Bharathraj, 1985); and Ling’s 6-sound Test (Ling, 1989) had been used to appraise the current level of hearing, speech-language, cognitive, and other developmental skills in the young participants in absence of recent evaluation reports.

**Procedure:** Over a period of 24 months, collection and analysis of data from former young clients of early intervention services at AIISH was carried out following the protocol provided in Figure 3.

**Data Collection and Analysis:** Data was collected through perusal of the clinical files of the young clients covered under the study; perusal of academic documents like progress reports and other school records; and interviews with caregivers, preschool and school educators. In certain instances where recent clinical reports on speech, hearing and other developmental abilities were not available, the research staff had carried out assessments using screening tools like LPT, 3D-LAT for speech-language abilities, DST for developmental abilities, and Ling's test of 6 sounds for aided hearing abilities. All face-to-face data collection procedures were conducted on one-to-one basis, and prior written consent was taken from the caregivers of the young participants after orienting them about the purpose and nature of the research.

**Results**
At the start, the compiled data were analysed to find out if there were any perceivable trends in early identification and intervention for communication disorders at AIISH.

**Trends in Early Identification and Intervention**
The numbers of children who were identified and/or intervened in each of the early years of life were accrued, and have been presented in Figure 4. It is evident from the figure that majority of the children (61.46%) have been identified for their...
special needs within the first year of the life, and another 20% by the 2nd year. However the age of intervention seems to peak between the 3rd and 5th years. Twenty-four, twenty-seven and twenty-five percent of children had begun receiving remedial services during the 3rd, 4th and 5th years of their life, respectively. Eleven percent of children had started intervention in the 6th year and 10% only after the early childhood years. In contrast only a miniscule number of 2% of children with communication disorders had started with intervention during the crucial first 2 years of life.

**Nature and Quantum of Early Intervention Services**

**Table 1: Quantum of Early Intervention Services received by Child-Participants**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Number of Services</th>
<th>No. of Recipients</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>3 types of services</td>
<td>24</td>
</tr>
<tr>
<td>02.</td>
<td>4 types of services</td>
<td>35</td>
</tr>
<tr>
<td>03.</td>
<td>5 types of services</td>
<td>141</td>
</tr>
<tr>
<td>04.</td>
<td>6 types of services</td>
<td>02</td>
</tr>
<tr>
<td>05.</td>
<td>7 types of services</td>
<td>03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>205</strong></td>
</tr>
</tbody>
</table>

As evident from the data on Table 1, the child participants had received at least three types of early intervention services, namely, diagnostics, speech-language therapy and special preschool training (except 2 from Kerala who were mainstreamed by preschool age). Depending on the nature of the special needs, additional services like behavioural modification therapy, listening training, occupational/physiotherapy, sensory integration training, therapy for autism spectrum disorders, etc. had also been provided. At the utmost, some children had received up to of seven types of services, especially in case of multiple special needs.

Details of the duration of the services received have been presented in Figure 5, and it is found that most of the child-participants had received services of four years or less. Sixty-seven percent of child-participants in the study had received preschool services for duration of one to three years, as recent norms stipulate preschool services for a maximum period of three years. Whereas clinical services for training in listening, speech, language, behavioural and cognitive skills were availed during the entire early childhood period, though the numbers drastically diminished beyond four years of duration.

**Figure 4: Trends in early identification & intervention for communication disorders.**

**Figure 5: Duration of services received.**
Impact of Early Intervention on Early Childhood Development and Learning

The next stage of data analyses was directed towards discerning the nature and extent of influence of early intervention efforts. To begin with, influences of early identification and better intervention practices on early developmental and learning skills in the child participants were investigated by analysing the correlation between the two sets of factors.

Table 2: Correlation of early intervention (EI) parameters with early developmental skills

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Early Intervention Status</th>
<th>Age of Identification</th>
<th>Age of Intervention</th>
<th>Range of Services</th>
<th>Duration of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Listening skills (only for CWHI)</td>
<td>–0.226***</td>
<td>–0.416***</td>
<td>+0.149*</td>
<td>+0.343**</td>
</tr>
<tr>
<td>02.</td>
<td>Speech-language skills</td>
<td>–0.152*</td>
<td>–0.363**</td>
<td>+0.166*</td>
<td>+0.205**</td>
</tr>
<tr>
<td>03.</td>
<td>Cognitive skills</td>
<td>–0.176*</td>
<td>–0.046</td>
<td>+0.082</td>
<td>–0.020</td>
</tr>
<tr>
<td>04.</td>
<td>(Pre)Academic skills</td>
<td>–0.066</td>
<td>–0.276***</td>
<td>+0.218**</td>
<td>+0.221**</td>
</tr>
<tr>
<td>05.</td>
<td>Behaviour problems</td>
<td>+0.205**</td>
<td>+0.200***</td>
<td>–0.360***</td>
<td>–0.118</td>
</tr>
</tbody>
</table>

* - p < 0.05; ** - p < 0.01; *** - p < 0.001; no* - no statistical significance

*CWHI – Children with Hearing Impairment

The four early intervention parameters that were taken for consideration (namely, age of identification, age of intervention, range of services and duration of services) were correlated with the communication skill development in terms of listening and speech-language, cognitive skill development, performance in (pre)academic skills, and frequency of incidences of behavioural problems which had rated by caregivers on a 4-point Likert’s scale. The results on Table 2, indicate negative and significant correlation between age of identification and intervention with development of listening (p<0.001 in both instances), speech-language (p<0.05 with age of identification, and p<0.01 with age of intervention), cognitive (no statistical significance) and pre-academic skills (p<0.001 with age of intervention).

On the other hand, there is positive and significant correlation for the age of identification and intervention (p<0.01) and intervention (p<0.001) with behaviour problems in the children. The range of services, that is, the number of early intervention services availed has a positive relationship with developmental aspects and negative relationship with behavioural problems, and that too statistically significant except for cognitive skills. Again the duration of services also has a positive and mostly statistically significant relationship (p<0.01, except for cognitive skill) with the development of various skills, and negative relationship with behaviour problems.

Impact of Early Intervention Services on Later Schooling

The bearing of early intervention efforts in mainstreaming children with communication disorders in the educational milieu was taken for consideration. Besides being an indicator of successful schooling, it could also be deemed to be a precursor to successful integration in the society later. The compiled results, in terms of numbers of child participants placed in mainstream and other educational streams, have been displayed in Figure 6.
The information on Figure 6, highlights that majority of the children (approx. 70%) who had received early intervention services at AIISH had been mainstreamed in regular schools. Approximately 14% of them had been pursuing education in special, segregated schools, and around 6% were out of school. Further scrutiny of the influence of the nature of special needs in children on their educational placement was also carried out. As per results displayed in Figure 7, children with severe and multiple special needs formed the major chunk of those who were pursuing non-formal educational streams like open schooling, or were out of school. Whereas, children with isolated special needs like hearing impairment (84%) and mental retardation (16%) constituted the mainstream group of children.

![Figure 7: Educational placement of children with different kinds of special needs.](image)

Table 3: Correlation of early intervention (EI) parameters with current school performances

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Early Intervention Status</th>
<th>Age of Identification</th>
<th>Age of Intervention</th>
<th>Range of Services</th>
<th>Duration of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Core curricular performance</td>
<td>−0.166*</td>
<td>−0.287***</td>
<td>+0.273**</td>
<td>0.314**</td>
</tr>
<tr>
<td>02.</td>
<td>Co-curricular participation</td>
<td>−0.068</td>
<td>−0.174*</td>
<td>+0.328**</td>
<td>0.333**</td>
</tr>
<tr>
<td>03.</td>
<td>Social integration</td>
<td>−0.148*</td>
<td>−0.178*</td>
<td>+0.285**</td>
<td>0.390**</td>
</tr>
<tr>
<td>04.</td>
<td>Grade placement</td>
<td>−0.067</td>
<td>−0.076</td>
<td>−0.232**</td>
<td>0.135</td>
</tr>
</tbody>
</table>

* - p<0.05; ** - p<0.01; *** - p<0.001; no* - no statistical significance

The constructive influence seems to continue in later school years, as it could be observed from the results in Table 3. There was a consistent negative correlation between the age of identification and intervention and the school performances in core, as well as co-curricular aspects, social integration in learning environment and grade placement. The core curricular performances were assessed in terms of the marks scored in the school examinations, while participation in co-curricular activities and social integration in the learning environment were graded on a 5-point Likert’s scale by the school teachers. The appropriateness of grade placement was recorded on a 3-point scale of age-appropriate, 1-year below age, and more than 1-year below-age.

The relationship of early intervention parameters was with statistical significance for performance in core academic areas (p<0.05 with age of identification & p<0.01 for age of intervention), co-curricular areas (p<0.05 with intervention age) and social integration in learning environment (p<0.05 for both identification and intervention age). The range of services, as well as the duration of early interventional training seems to have extended an all-round, beneficial influence on the all aspects of performance at school. The progress achieved by children with communication disorders during the early intervention years is also seen as a significant indicator of their performances in the school years as elicited by the results displayed in Table 4. The communication skills developed during the early intervention years have a positive correlation with all aspects of school performances, especially in significance (p<0.05) with core curricular achievements. The (pre)academic and co-curricular performances at preschool have exhibited all-round, positive and highly significant (p<0.001) relationship with current school performances.
Table 4: Correlation of progress in early intervention (EI) years with school performances

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Educational Status</th>
<th>Performances in Core Curriculum</th>
<th>Participation in Co-Curricular Activities</th>
<th>Social Skills in Learning Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Communication abilities during EI years</td>
<td>+0.209*</td>
<td>+0.074</td>
<td>+0.057</td>
</tr>
<tr>
<td>02.</td>
<td>Preschool performances</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) (Pre)Academics</td>
<td>+0.437***</td>
<td>+0.421***</td>
<td>+0.346***</td>
<td></td>
</tr>
<tr>
<td>(ii) Co-curriculum</td>
<td>+0.476***</td>
<td>+0.459***</td>
<td>+0.390***</td>
<td></td>
</tr>
</tbody>
</table>

* - p < 0.05; ** - p < 0.01; *** - p < 0.001; no* - no statistical significance

Discussion

Trends in Early Identification and Intervention: Time and again, researchers in the field of disability rehabilitation have emphasised the need for early identification as a prerequisite for better remedial prospects (Hammes, et al., 2002; Yoshinaga-Itano, et al., 1998; Robishaw, 1995; Ramkalawan & Davis, 1992; Markides, 1986). Still further researchers like Wake et al. (2005); Martineau et al. (2001); and Moeller (2000) insist that early identification should be followed-up with prompt intervention; and just identification without appropriate intervention might turn out to be futile.

Investigations of this study revealed that communication problems had been identified within the first year of life in almost 62% of the young clients at AIISH, and in another 20% by the second year of life. This implies that an amassing 82% of young children with communication disorders had been identified well within the critical years. These appreciable developments are similar to trends observed in developed countries like USA, where communication disorders like hearing loss have been identified in children between one-and-half and three years of life (Morbidity & Mortality Weekly Report, 2003). This could be attributed to the extensive preventive, outreach and public education measures undertaken at AIISH.

At the same time it is slightly disappointing to note that the delivery of intervention services peak well beyond the critical years between three and five years of age. However, this study had considered only children enrolled for preschool services at AIISH. On the other hand more recently there are instances of children who after receiving effective intervention right from the first or second year of life have been successfully integrated by preschool age itself. Systematic inclusion of children intervened in the early years of life in the study could have led to more comprehensive findings.

Nevertheless, such arguments cannot be augmented without empirical evidences. Research evidences (Wake et al., 200) imply that early identification, unless followed up with effective intervention, may not be rewarding. However a positive correlation observed between chronological and intervention age (r = +.161; p<0.05) in younger children among the participants of this study implies that the age of intervention is coming down for good over the years.

It could also be observed that among the children with different kinds of special needs; those with severe, multiple and visible conditions were prone to be identified early by birth (80%). Children with inconspicuous sensory impairments like hearing loss were identified between 1st and 2nd year of life (70%) when problems in expressive communication begin to manifest outwardly.

Nature and Quantum for Early Intervention Services: After enrolling for services, most child-participants of the study had received a minimum of three different types of rehabilitation services following diagnosis; namely preschool training, along with therapies/training for autism spectrum disorders, behaviour modification, listening, speech–language, occupational and physical competencies, sensory integration, and fitment of assistive devices depending on the nature of their special needs. Global evidences on rehabilitation for communication disorders also recommend a similar range of services (Kan, Walsh & Burns, 2008). As per results in Table 1, bulk of the child-participants (68.78%) had benefitted from five different types of early intervention services, while children with multiple special needs had received up to seven types of services. All said, a progressive trend could be observed at AIISH in meting out timely and comprehensive supports to young children with communication disorders.

Impact of Early Intervention Services: The results on Table 2 provide evidence to the positive impact of early intervention services on early developmental skills in children. Age of identification and intervention have negative, and
in most instances significant relationship with development of listening, speech-language, cognitive and pre-academic skills. Implying that the earlier the identification and intervention, better was the progress in these areas. And again, the lower age of identification and intervention was found to lead to lowered incidences of behaviour problems in these children, as indicated by the positive correlation between the two factors. The range of services (that is, number of services) also has a positive and significant relationship with all areas of early development, and negative relationship with problem behaviours. The overall impression is that comprehensive early intervention services, in terms of time of inception, duration and range; have resulted in positive, all-round development in children with communication disorders, while bringing down incidences of problem behaviours. Consistent and systematic exposure to early intervention services is also seen to have substantial impact in development in all areas (p<0.01, except for cognitive skills), as well as in lowering behaviour problems. The findings reinforce time-tested certainty of the positive impact of early identification and timely intervention (Geers, Nicholas & Sedey, 2003; Yoshinaga-Itano & Gravel, 2001; Moeller, 2000; Yathiraj, 1994; Ling, 1989; Guralnick, 1981; Boothroyd, 1978).

The efforts towards rehabilitation of persons with communication disorders at AIISH work with the underlying motto of providing effective communication to one and all, so that persons with communication disorders could integrate themselves into the mainstream society. Educational mainstreaming is widely considered as the stepping stone to social integration. In this context, early intervention efforts at AIISH have been successful in leading more than 70% of its young clientele with communication disorders to the mainstreams of education as per data presented in Figure 6. Children who are out of school and children who are pursuing education through segregated or non-formal means were mostly children with multiple special needs as indicated by the information provided in Figure 7. Thus, the findings of the study bolster the universal conviction (Yoshinaga-Itano, 2003) that prospects for educational mainstreaming of children with communication disorders is further strengthened by early intervention.

Results in Table 3 indicate that early identification and intervention have lead to better attainment in all areas of school life, namely age appropriate grade placement, performances in core-curricular as well as co-curricular aspects, and social participation in the learning environment, as indicated by the negative correlation with the above factors. It is also noticeable that the age of intervention has more significant relationships with all factors. This reiterates evidences provided by researchers like Beckman-Bell (1981) and Cooper (1981) suggesting that educational attainment is better in children with communication disorders who had been early intervened, irrespective of the educational setting they are in. The comprehensiveness of services in terms of their range and duration were also seen to extend a positive influence on the current school life endorsing earlier evidences of comprehensive, early intervention having led to improved school performances in children with communication disorders like hearing loss (Vohr, Jodoin-Krauzyk, Tucker, Johnson, Topol, & Ahlgren, 2008; Watkin, McCann, Law, Mullee, Petrou, Stevenson, Worsfold, Yuen, & Kennedy, 2000; Yoshinaga-Itano, 1999; Downs & Yoshinaga-Itano, 1999; Yoshinaga-Itano et al., 1998).

Data from Table 4 further implies that progress of the children in the early developmental skills, as well as in the core and co-curricular areas of preschool training (especially, the latter) were found to be strong, positive indicators of current school performances as reported in earlier researches (School Assessment & Curriculum Authority, 1997, qtd. in Thomas, 1998). Evidences from other parts of the world (Blamey et al., 2001) also suggest that receptive and expressive communication skills developed early in life of children with communication disorders serve as effective precursors of later educational attainments.

Conclusions

The findings of the study lead to a positive impression about the nature and efficacy of early intervention for communication disorders carried out at AIISH, though there are hints indicating scope for improvement in terms of age intervention and increased impetus on mainstreaming. There are concerted efforts on part of the departments at AIISH for prevention of communication disorders, delivery of clinical services, special educational services and distance mode rehabilitation and education in perpetuating early identification and intervention, social and educational mainstreaming, and follow-up supports and services consequent to mainstreaming.

Acknowledgements

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References


A NEW ALGORITHM FOR FREQUENCY TRANSPOSING IN DIGITAL HEARING AIDS

Ajish, K. Abraham, & Surya, D.

Abstract

Frequency transposition is a signal processing strategy of transposing high frequency acoustic content in a speech signal to a low frequency range. This technique has been widely discussed for a long period of time as the conventional amplification strategies are not beneficial to those suffering from the specific condition of high frequency hearing loss. But still, this strategy as a corrective option, never gained a good momentum or interest amongst audiologists as most of the technological solutions developed have got one or the other drawback. The present study was aimed at developing a new algorithm exploring frequency transposition and testing its effectiveness both objectively and subjectively. The developed algorithm involves transposing the significant high frequency acoustic content based on an adaptable threshold, to a specific region in low frequency band, frame by frame. The algorithm also incorporates a compression strategy to adjust the transposed speech content to the hearing loss pattern of the client. The new algorithm eliminates most of the limitations of the existing technologies. Objective evaluation is done with the help of three signal processing software and subjective evaluation with five subjects of normal hearing and ten subjects of moderate to severe sloping hearing loss who are native Kannada speakers within the age range of 20 to 80. 100% detection score is obtained for all the five normal hearing subjects and in high frequency hearing impaired subjects a significant 22% increase is achieved with transposition. The score obtained sufficiently prove that the transposed words have satisfactory sound quality and transposition has increased the speech cues for detection of words. The results hold good for further research in this area and offers a potential rehabilitation technology for persons with high frequency hearing impairment.

Key words: Algorithm, High frequency hearing loss, Frequency lowering, Frequency compression, Frequency transposition.

Introduction

Audible spectrum extends from 20 Hz to 20 kHz with frequencies up to 8 kHz adequate for normal speech perception. Any degree of impairment of the ability to perceive sound is referred as hearing loss and is defined as the difference between the hearing threshold of the impaired person and that of persons with normal hearing. High frequency hearing loss is a condition in which a person has normal or near normal hearing in the low frequencies up to 1000Hz, but it falls like a ski slope in the higher frequencies. High frequency hearing loss is not an acceptable loss, as speech is reasonably intelligent only with the presence of high frequency content (Berlin, 1982).

Among all types of hearing disorders, occurrence of high frequency hearing loss in persons with hearing impairment is more than 60%. Reasons for this can be many; it can be of genetic factors, due to aging, through infectious agents or due to the retardation of cochlear hair cells by continuous exposure to high energy sounds. High frequency hearing loss is a sensory neural hearing loss where high frequency hair cells are not competent of responding to vibrations or the hair cells may be completely absent (dead region).

Persons with high frequency hearing impairment find difficulty in adjusting to the natural environment as our world is full of high frequency sounds whether it be telephone ringing, approaching train or bus, birds etc. High frequency sounds are vital cues for recognising words, awareness of environment, speech comprehension, enjoying music and gives sharp features of naturalness and clarity to the sound. Energy for many voiceless consonants (For eg: /s/, /θ/, /t/, /ʃ/, /t/) which are critical for speech understanding lies in this frequency region. Hence, it is necessary that the high frequency sounds are made audible.

Traditional correction technique for hearing loss is amplification. But this does not work well for persons with high frequency hearing loss. The main reason is that, it is not possible to provide high gain in high frequency region as it would result in low maximum power output, limited...
bandwidth and an increased chance of acoustic feedback before desired gain (Kuk, Keenan, Korhonen & Lau, 2009) is reached. The situation is further worsened by the poor frequency response of the hearing aid receiver above 4000 Hz, as the receiver is the transducer at the final end, which converts electrical signal to acoustic form and delivers it to the ear canal. Moreover, persons suffering from hearing impairments due to dead cochlear region do not get any benefit from high gain. Sometime high gain provides more negative effect as because of loudness recruitment, they can’t tolerate increment in loudness and in some other cases, high gain result in pain. McDermott & Dean (2000) quotes that when sounds are presented at frequencies where sensitivity loss is maximum, it leads to anomalous qualities such as abnormal pitch or timbre. Thus persons with sloping high frequency hearing loss never use their hearing aids or use them irregularly. Cochlear Implant is another choice for rehabilitation for individuals with severe to profound loss at frequencies above 1 kHz. (Simpson, 2009). Even though many of such individuals fitted with Cochlear Implant showed improvements in identification scores, the enormous cost involved prevents common man from availing this option. Hence, alternative approaches which shift components from inaudible high frequency areas of speech to audible low frequency areas are needed to tackle this issue.

Frequency transposition, the signal processing strategy with which high frequency components of speech are shifted to lower frequencies, is one such approach. Several attempts were made in this direction over the years. (Ling, 1968; Beasley et al., 1976; Reed et al., 1985; Posen et al., 1993). As summarized by Katz (2009), most of these attempts were not very successful because of limitations such as changes in pitch, variations in the temporal nature of acoustic signal and loss of naturalness in sound quality. Another approach to tackle the high frequency hearing loss was the use of proportional frequency compression. This addressed some of the issues with frequency transposition as this technique preserved the normal frequency relations between the fundamental frequency and the formants. In this approach, the entire range of speech frequencies is compressed to a lower range and the spectrum is thinned down. The first hearing aid with this type of signal processing was introduced in 1991 (Katz, 2009) and subsequently followed by several manufacturers. Third approach in this direction is through bringing down all frequency components in the speech signal by a fixed ratio which is called frequency shifting. A comparison of all these three approaches has been carried out by Simpson (2009).

Studies conducted on the performance of these devices in comparison with traditional hearing aids have shown mixed results. Study conducted by Parent et al (1998) on four adults reported improvement in speech perception for two of the four subjects. Another study by McDermott et al (1999) on five adult subjects reported small improvements in speech perception for two subjects. No significant difference was found in the study conducted by McDermott and Knight (2001) when they compared the speech perception scores between traditional hearing aids and hearing aids with frequency compression.

One reason pointed out by McDermott et al (1999) for the disappointing results is the fact that the frequency transposition did not preserve important features depicting the spectral pattern of the original speech. Another reason for insignificant differences between the conventional aid and the one with transposition may be due to the fact that the high frequency signals when transposed will result in the masking of low frequency components of speech (McDermott et al., 1999). Another drawback of the existing techniques is that, after transposition sound quality is reduced and low frequency speech content gets distorted. It was reported by Aguileru, Nelson, Rutledge & Gaga (1999) that, transpositions that involve shifting or modifying fundamental frequency and formant frequency leads to poor speech discrimination scores. They also reported that, the poor discrimination scores may be due to alteration of ratio of fundamental and formant frequency, as this ratio is an invariant cue for vowel and speech perception. Thus, there is a need to develop a new algorithm for frequency transposition which preserve the significant details of the spectral shape, retains the ratio of fundamental and formant frequencies as well as prevents masking of low frequency components of speech.

The objectives of the study were 1) to develop a new algorithm for shifting information from inaudible high frequency areas of speech to audible low frequency areas overcoming the limitations of existing ones and 2) to evaluate the effectiveness of the developed algorithm through subjective and objective evaluation.
Method

Algorithm for frequency transposition: The incoming speech signal is segmented to 32 msec frames and convolved with hamming window. Spectral domain processing is done with the help of Discrete Fourier Transform as it gives a good approximation of speech signal in spectral domain with a reasonably good frequency resolution (Burrus & Parks, 1985). Discrete Cosine Transform (DCT) and Reeds Equation are used for compression and Inverse Discrete Fourier Transform (IDFT) is used for transforming the signal back. Sampling frequency of 16 kHz and overlap factor of 25% are used in the algorithm. The algorithm first executes a check to find out whether there is any speech content in the 2 kHz to 8 kHz range of the speech signal. This is done by comparing the amplitudes in this frequency range with a set threshold. If more than 30% (arrived empirically) of the samples are above the threshold, then only transposition is done. The threshold value is arrived in real time for every frame on the basis of the sample values of the previous frame. Once significant amount of speech content is identified in the high frequency region, then the transposition begins by accentuating the high frequency content to a compact array. This array is then added to low frequency region specifically from 2 kHz onwards. The method is illustrated in the figure 1.

![Figure 1: Method used for frequency transposition.](image)

The transposed array can be further accentuated by a scaling element (based on subjective preference) before getting added to low frequency region from 2 kHz onwards. In this algorithm, the need of frequency compression is not for frequency lowering but more for fitting the transposed acoustic content to individual requirement. Fitting is important as the start frequency of the person with hearing impairment need not always be 2 kHz or above. Two compression methods are incorporated in the algorithm design, linear and non-linear. Option of selecting between the two is again a subjective element. Linear compression is done with the help of DCT. The dimension of DCT coefficient is modified, if required, by the simple technique of zero padding. Zero padding can result in compression of speech signal at required extend but with the disadvantage of modifying pitch periods. Nonlinear compression is done with help of Reeds equation which is widely used in various speech compression algorithms. In the algorithm, parameters chosen for optimization of the equation are sampling frequency of 16000 Hz, K as 2 and therefore value of wrapping parameter is 1/3 (0.333).

Recording of speech material: Ten words are selected from the phonetically balanced (PB) high frequency word list. It is a list of monosyllabic words selectively chosen so that they approximate the relative frequency of phoneme occurrence in each language (Browman & Goldstein, 1995). The selected high frequency test words (Appendix 1) were uttered by an adult Kannada speaking female speaker (age 35) into a condenser microphone placed at 15 cm from the speaker. The words were recorded through a precision sound level meter (B & K 2250) with sound recording facility (B & K 7226) in a sound treated room. Recorded samples were digitized at a sampling frequency of 22 kHz and 16 bits per sample.

Participants: Ten persons (S1-S10) with moderate to severe sloping hearing loss and within an age range of 20 to 80 were recruited for perception test. Their audiograms are shown in figure 2. Five normally hearing participants who were native Kannada speakers with no experience of using any hearing aids also participated in the study. The hearing impaired participants were not having any experience of using frequency transposition hearing aids.

Outside the candidacy criteria, three non-native/ non-Kannada speakers belonging to the same age group as in the candidacy criteria with moderate to severe high frequency hearing loss were considered for study as a separate group. Along with them, three children in the age range of 8 to 14 who are native Kannada speakers with moderate to severe sloping hearing loss were also included as another separate group.
Speech material for the study: The ten recorded PB words were processed by the algorithm to prepare the transposed version. In a random order the sets of transposed and un-transposed words were mixed and a new list of twenty words was generated and stored as wave files in the computer.

Procedure: The test words were delivered from the computer through a precision power amplifier (B & K 2716C) through a headphone with a constant gain for frequencies up to 10 kHz. The participants were made to listen to the sounds in a sound proof room from the headphone. The stimuli were presented at 40 dB SL for each participant. Level adjustment was done with the gain control of B & K 2716C power amplifier (flat frequency response from 20 Hz – 20 kHz). The participants were made to hear the test words one by one and were instructed to repeat back as well as write down what they have heard as soon as they perceive it. The responses were recorded instantly using a binary scoring pattern. Correct identification of the score was awarded with 1 and otherwise 0. Finally a total score of transposed and un-transposed speech is made and the effectiveness of algorithm was measured by calculating the percentage increase in the score.

Analyses: The following analyses were carried out: a) Objective analyses of the transposed and un-transposed words using PRAAT software, b) measurement of speech identification score for transposed and un-transposed words. SPSS software was used to carry out the statistical analysis. Paired 'T' test was carried out to find out the significance of improvement in intelligibility of transposed words. As 'N' was only ten, nonparametric test was also administered.
Results and Discussion

Performance of the developed algorithm: The algorithm uses a new approach of transposition. In the developed algorithm, the edge frequency or cut off frequency is taken as 2 kHz with region from 125 Hz - 2 kHz kept unmodified during transposition. Selection of scale factor is an additional feature included in the algorithm to enhance the performance. This factor is kept as a subjective element based on the patient’s hearing loss pattern. Increasing the scale factor linearly scales the generated array for transposition. It builds the effect of adding noise, since high frequency sounds are mostly fricatives and has a noise like characteristics, doing so can potentially add more speech cues.

The compact array generated after extracting the high frequency content is added from 2 kHz. Through this, the main advantage is over all distortion that can occur due to transposition of the speech signal will be least, with 125 Hz - 2 kHz unaffected. Since transposition is done always in the frequency range of 2 kHz - 8 kHz, in long term, the listener will be more comfortable in identifying the same speech sound.

Linear frequency compression, one of the existing techniques, which works by lowering all frequencies contained in the speech signal by a constant factor, keeps the ratio between fundamental frequency and formant frequencies unchanged (Turner & Cummings, 1999). For vowel intelligibility these ratios are significant, but this technique has the serious drawback that the speech will become unnatural due to lowering of pitch. The technique used in our algorithm is different, as the frequency compression is done only for the transposed speech segment whereas the frequency region upto 2 KHz is untouched. Accordingly the developed algorithm overcomes the drawback of unnatural sound quality associated with linear frequency compression.

Nonlinear frequency compression also involves lowering of all frequency components but by different factors at different frequencies, the factor going high at higher frequencies. Thus the frequency ratios are not preserved, which may reduce the speech perception. In the developed algorithm, the frequency range from 0 to 2 KHZ is unaffected. For the reason that all the main vowel formants and fundamental frequency are concentrated in the 125 Hz - 2 kHz range, (Raphael, Borden & Harris, 2011) the ratio between fundamental frequency and formant frequency is unchanged. Accordingly the algorithm overcomes the drawback of both linear and nonlinear frequency compression, preserving the advantages of both.

Objective evaluation: Objective evaluation of the performance of the algorithm is done with the help of three signal processing software namely Matlab, Praat and CSL. The time and frequency domain plot along with spectrogram (figure 3) and LTA plot (figure 4) of transposed sounds with un-transposed sounds clearly indicate that there is no significant speech component in high frequency region of the transposed sound. Analysis of the LTA plot can also prove that frequency transposition has taken place in transposed sound provided scaling value is sufficiently increased.

Subjective evaluation: Subjective evaluation is done in two phases: 1) pilot test with five listeners with normal hearing and 2) intelligibility tests in listeners with moderate to severe sloping hearing loss. Perceptual evaluation of five normal hearing native Kannada speakers showed a 100% intelligibility score for transposed as well as un-transposed words. It could be inferred clearly that after significant spectral modification there is still a good amount of speech cues in transposed version.

The results obtained for intelligibility tests for listeners with hearing impairment are tabulated in table 1. A mean increase of 22% (Table 2) is recorded for transposed sound over un-transposed sound. In other words, it could be concluded that from the list of ten words, two more transposed words were intelligible compared to un-transposed words. Paired ‘T’ test showed a statistically significant mean improvement of 22% (t (9) = 8.820, p<0.001). As ‘N’ is only 10, Wilcoxon’s signed rank test was employed which also showed a significant improvement in intelligibility (|Z| = 2.842, p<0.05).
The data is obtained for an untrained adult population without the use of hearing aids in a soundproof room. So it could be expected that the result will be more positive for trained candidates for long term use of frequency transposition hearing aids in a natural environment (Simpson, 2009). As reported by Simpson (2009), among the existing technologies, the maximum statistically significant improvement of 20% in speech identification was observed with the transposition technique devised by Robinson, Baer and Moore (2007). For the nonlinear frequency compression technique developed by Simpson, Hersbach and Mcdermott (2006) the reported improvement is 6%. The developed algorithm showed a statistically significant mean improvement of 22% in the intelligibility score, thus proving that the performance of the newly developed algorithm is better than the existing technologies.

Table 1: Intelligibility score obtained for hearing impaired participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Intelligibility score of un-transposed words</th>
<th>Intelligibility score of transposed words</th>
<th>Percentage increase in score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>7</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Participant 2</td>
<td>7</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Participant 3</td>
<td>6</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Participant 4</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Participant 5</td>
<td>7</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Participant 6</td>
<td>6</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Participant 7</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Participant 8</td>
<td>6</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Participant 9</td>
<td>6</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Participant 10</td>
<td>7</td>
<td>9</td>
<td>20</td>
</tr>
</tbody>
</table>

Overcoming the limitations of existing techniques:

As pointed out by Simpson (2009), masking of useful low frequency content is one of the disadvantages of existing methods of transposition. This algorithm overcomes this limitation as the frequency region from 125 Hz to 2 kHz, where most of the useful low frequency information is present, is kept unmodified.

Another drawback of the existing method was that it may transpose undesirable high frequency noise (Simpson, 2009). This is taken care to a certain extent in the new algorithm by fixing an amplitude threshold to decide whether transposition is required or not. A serious limitation of the frequency compression technique was that it does not preserve the harmonic relationship between formants (Simpson, 2009). This drawback is also eliminated in the new algorithm as all the main vowel formants lie in the unmodified region from 125 Hz to 2 kHz. Limitation of the existing frequency shifting algorithm was the lowering of the pitch which leads to unnatural sound quality (Simpson, 2009). As the new algorithm does not shift the fundamental and formant frequencies, the pitch remains unchanged.

Limitations of the new algorithm: Shortcomings were observed while testing children as well as non Kannada speaking adult population. The scores obtained for these two populations shown in figure 5 were not satisfactory in comparison with the participants chosen through the described candidacy criteria. Even though the hearing loss pattern is moderate to severe sloping hearing loss, the candidate could not find or perceive any additional speech cue in transposed sound than
that in the un-transposed sound. And hence the number of correctly identified words is less with almost similar score in transposed and un-transposed sound. This unsatisfactory performance is due to the fact that, in both these populations the words selected for testing were unfamiliar. In children, especially with high frequency hearing loss, language development is a slow process and they may not have acquired the high frequency phonemes and the words containing them. In adult population, even though they have acquired high frequency phonemes, they were not familiar with Kannada words containing these phonemes. The algorithm is designed not for perceiving high frequency sounds as high frequency sounds, but for detecting the presence of occurrence of high frequency phoneme in a word through a substitute in low frequency speech sounds. In other words, through transposition algorithm, the user listens to a low frequency speech sound which is super imposed by features of high frequency sound.

![Figure 5: Recognition scores for non-Kannada speaking adults (N1-N3) and Kannada speaking children (C1-C3)](image)

Positive result obtained for adult native Kannada speakers is due to the auditory processing mechanism in the brain, as the test words are familiar. Auditory processing in brain includes a large amount of pattern matching processes to make sense out of them through the speech sounds that were heard before and hardwired in memory. So when transposed speech sounds are given as stimuli, the memory of the listener could have helped in judging the stimuli and came up with a better understanding of the situation. This cannot be expected from a population of non Kannada speakers and children.

Effect of transposition on children could be studied only after long term training with usage of frequency transposition hearing aids. Minimum ten to twenty hours of listening exposure to transposed speech is required (Simpson, 2009). Training should be given for children in using the transposed high frequency speech cues in low frequency sound and speech production of proper high frequency sound when they are perceived. Children have an advantage of powerful and developing brain which can remodel to include the new challenges. So it could be expected that performance of children and adult could be improved with sufficient training.

**Conclusion**

Modified frequency transposition algorithm has been developed which overcomes most of the drawbacks of the existing techniques. The effectiveness of the algorithm has been tested through objective and subjective methods, which showed a positive result. Because of less number of participants included in the study, generalization of results is not possible. However, the transposed speech has shown satisfactory sound quality with minimal level of distortion and the participants with high frequency hearing loss were able to perceive transposed sounds, 22% more than un-transposed original sound. To prove it conclusively, a testing methodology with sufficient training should be adopted in a larger population including children and listeners who speak other languages. Natural sound quality, preserving harmonic relationship between frequency components, good Signal to Noise Ratio (SNR) and less overlap of frequency components are features looked in a good transposition algorithm, all of which have been achieved in the new algorithm. The results hold good for further research in this area and offers a potential rehabilitation technology for persons with high frequency hearing impairment.

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**Annexure 1**

List of Phonetically Balanced Words (Kannada) used for Speech Intelligibility test

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ista</td>
</tr>
<tr>
<td>2.</td>
<td>kulli</td>
</tr>
<tr>
<td>3.</td>
<td>ṭamataḷa</td>
</tr>
<tr>
<td>4.</td>
<td>viṭṭaḷa</td>
</tr>
<tr>
<td>5.</td>
<td>irali</td>
</tr>
<tr>
<td>6.</td>
<td>ṭaḷaka</td>
</tr>
<tr>
<td>7.</td>
<td>sikku</td>
</tr>
<tr>
<td>8.</td>
<td>hasivu</td>
</tr>
<tr>
<td>9.</td>
<td>keiḷu</td>
</tr>
<tr>
<td>10.</td>
<td>serisi</td>
</tr>
</tbody>
</table>
A STUDY ON VISUAL DEPENDENCY IN HEARING IMPAIRED CHILDREN FOR PERCEPTION OF SPEECH

1Shruthi, M. N., & 2Nagaraja, M. N.

Abstract

Visual speech perception is also known as lip reading and speech-reading. Visual speech is used by hearing impaired individuals, as well as individuals with normal hearing. The dependency of auditory performance on visual cues can be accounted to the concept of sensory integration. The aims of the study are: To assess the performance of children with hearing impairment in visual only and combined audio-visual tasks and to derive the implications of visual dependency in auditory performance based on their respective age and gender and also complexity of speech stimuli (words and sentences). Method included two groups of severe to profound sensorineural hearing impaired subjects. Each Group consists of 25 hearing impaired individuals. The stimuli were divided into visual (lip-read), auditory and picture stimuli presented in three conditions auditory only, audio and visual and audio-visual accompanied with the picture. The total combined Mean scores for words and sentences were slightly higher for the audio-visual with picture presentation when compared with the visual only presentation. Standard deviation scores of audio visual with picture presentation is lesser than visual only condition. Overall condition which was associated with picture presentation was more likely to receive higher scores than visual alone condition.

Introduction

It was proposed by Immanuel Kant (1760) that modes of perception determine our knowledge about the outside world. Perception through senses can be of five types: Sight, Smell, taste, touch and hearing. Each of these senses have receptor cells which is linked to the nervous system and thus to the brain. At primary levels of the cells sensing is initiated and further integrated in to sensations at the level of the nervous system. Hearing is the second sense to be developed in humans, first being sight. Different type of environment energy is transduced by the nervous system. As light energy is transuded by the retina similarly sound energy is transduced by the cochlea. When neurological processing of these two energies is combined which results in a unified perception of the object or event occurred. Speech reading is important for both hearing impaired individuals and individuals with normal hearing. Individuals with Hearing impairment perceive speech through watching the face of the talker while listening through the amplification system. Also Normal hearing persons tend to rely on visual cues in difficult situations such as communication in noisy or reverberant environment.

As individuals with hearing impairment can’t rely completely on auditory cues with amplification for perception of speech. Comprehension of the message increases with the integrated cues of both audition and vision. To improve the perception of the speech signal this technique of integration can be used by hearing impaired listeners along with the amplification.

Speech perception requires decision to be made both about the trends and also about the speaker’s language pattern. It has been commonly observed that addition of even small amount of auditory input to the visual stimulus greatly enhances perception of a speech signal. As stated earlier by Erber (1979) this enhancement effect usually found in Profound Hearing loss subjects, In whom the available auditory evidence from the acoustic speech signal is limited due to cochlear pathology. Barbara Dodd (2009) reported that as soon as birth and four months of age infants are aware that lip movements match the speech sound and they also have language specific speech-reading skills.

In another study by Bernstein et al., (2000) explains the importance of perceiver’s hearing history as a factor while determining conducive environment for enhanced speech-reading skills. In subjects where hearing loss have an early-onset of Severe to Profound hearing degree, only minimal auditory cues are available, Therefore increasing the speech-reading skills for communication.

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An extensive research has been conducted to address effectiveness of speech reading when paired with amplification. Ross (1998) estimated that about 30 to 40% of speech is recognized only through visual cues.

Persons with hearing impairment are known to maximally use their other senses including vision. Their daily performance in all aspect including audition can be supplemented by visual information. Hence a protocol that would act as a prognostic indicator with regard to person’s auditory performance in daily living situations and also aids in decision making regarding appropriate rehabilitation measures should be incorporated. Since previous studies have incorporated visual and audio-visual conditions to assess speech perception most of the language used is English and other native languages. Very few materials are available to assess Kannada speaking hearing impaired individuals. Most of the studies conducted have used vowel or consonant perception (Erber, 1972) and also words, but there are very limited studies on using sentences for visual speech perception which suggest as a useful measure for daily consequences and challenges encountered by the hearing impaired individuals.

The aims of the study are: To assess performance of the hearing impaired individuals in visual only and combined Audio-Visual tasks and to derive the implications of visual dependency on auditory performance. To investigate the difficulty in perception of speech as the complexity of the stimuli increases and to notice if there is any altering in the modality of speech perception due to complex stimuli. To derive affect of age of the hearing impaired children on speech perception mode. Also to see if there is any difference between genders of hearing impaired children in mode of perception of speech.

**Method**

*Subject:* Two groups of sensorineural hearing impaired subjects were included in the current study. Participants attended a special school for hearing impaired incorporating total communication as the mode of communication and all participants had Kannada language as their medium of instruction. Group I consists of 25 hearing impaired individuals with bilateral severe to profound hearing loss within the age range of 8 to 13 years studying in primary level. Group II includes 25 subjects with the similar type and degree of loss within the age range of 13 to 18 years studying in secondary level. In both the groups, subjects had normal visual acuity and were using Kannada as their first language.

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>GROUP I</th>
<th>GROUP II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>Pure tone average (Mean)</td>
<td>91.61</td>
<td>88.29</td>
</tr>
<tr>
<td>Pure tone average (Range)</td>
<td>28</td>
<td>35</td>
</tr>
</tbody>
</table>

**Material Development:** The stimuli were divided into visual (lip-read), auditory and picture stimuli. Eighty high frequency words were identified on the basis of participant’s vocabulary which were distributed among five special educators from the special school (Hearing impaired children school) for familiarity testing of the participants. The final 50 words, 10 phrases and 5 sentences were selected on the basis of special educator’s responses.

All the stimuli were recorded through Cannon Power shot digital camera with high resolution (with 8 megapixels) and recordings were done in double walled sound booth. Recording were loaded into Compaq CQ60 laptop and presented through a VLC media player on 17 inch monitor display. Five recordings of stimuli were obtained from five different female speakers and evaluated by 10 individuals whose mother tongue was Kannada.

Five individuals who were not aware of the aim of the study and not from speech and hearing background and whose mother tongue was Kannada were asked to evaluate the recordings. Each individual had to rate all the five stimulus recordings. They were asked to rate for naturalness of speech using a rating scale from 0 to 5 where 0 was rated as poor natural speech and 5 as natural speech. The five individuals rating for five different stimulus recordings were averaged and the recording which received best average rating was selected for the study.

Pictures representing all the stimuli (words and sentences) were selected and the special educators of the participants were asked to evaluate them based on picture clarity and comprehension. Those pictures which were difficult to comprehend and contained more distractions were replaced by better pictures.

**Instrumentation:** Recorded stimuli were presented through Compaq CQ60 laptop and Sound-Level-Meter (SLM) was used to determine output dB SPL for each word and sentence. Bruel & Krjaer SLM type 2231 connected to half inch microphone type 4155 using the adaptor ZC002.
were used and measurement was done in the sound proof booth. SLM settings was kept at ‘A’ weighting, fast network was used for each sentence and word. SLM was held at patient’s ear level 3 feet away from the monitor and measured output at each word level when volume of laptop was 100% and VLC media player volume was 50%. Stimulus was presented using VLC media player 0.9.2 through widescreen 17 inches Compaq CQ 60 laptop. Stimulus was presented in a double walled sound proof booth with adequate lighting. Output dBSPL of words and sentences was obtained individually and the Average output ranged from 60 to 70dBSPL.

Test procedure: Stimulus was presented in three conditions:

Condition 1: Visual presentation: The recorded visual stimuli were presented by muting the speakers of the laptop and the participants could visualize the speaker’s face at 0 degree azimuth.

Condition 2: Visual +Auditory Presentation: Both recorded auditory and visual stimuli were given together.

Condition 3: An Audio-Visual stimulus was presented simultaneously with the corresponding picture.

The speaker’s view was frontal from the head to the shoulders and approximately 3 feet distance from the seating of the participant. Response sheets were provided to the participants to write down the words and sentences. Three response sheets were used for three respective conditions: Response sheet 1 (Visual only); Response sheet 2 (Visual+Auditory only); Response sheet 3 (Visual+Auditory+Pictures only): participants were asked to write down words and sentences perceived in all the three conditions.

Pictures were presented in a closed set. Four alternative choices were provided, one among them was target picture stimulus which corresponds to the word stimuli presented Audio-Visually. The participant should identify the picture depicting the word and sentence, presented audio-visually. The pictures were randomly selected and shuffled for alternative choices.

Session starts with the presentation of visual stimulus which had a time interval of 10 sec between each word and 20 sec between each sentence and also a pause is provided for the participant to write down the responses. Participants who fail to perceive stimulus in visual only condition was subjected to the audio-visual condition for the same word or sentences. If participants fail to pass in the first two conditions, then they were provided with third condition (auditory + visual + picture). Participants were encouraged to guess the word and write down the responses for all the stimuli.

Scoring: Scoring was done separately for three conditions and total number of correct words under each condition was calculated. The correct written word was scored as 1. Phrase and Sentence scoring depended on the number of correct content words and functional words exist among them. If the words in the phrases and sentences were completely correct then the subject was given a score of 3. If there are all content words and few functional words then it was scored as 2, few correct content words without any functional words then it was scored as 1, if there was no response the subject gets the score of 0.

The data was tabulated using Microsoft Excel and statistical analysis was done by SPSS software. Comparison of between groups and within groups were done using Four way Analysis of covariant for investigating difference between groups (group 1 v/s group2), gender(Male v/s Female), types of stimuli( words v/s sentences) and modes of presentation (visual v/s visual+audition v/s visual+audition+picture).

Results and Discussion

Participants were compared for age, gender, mode of presentation and types of stimuli presented.

1) Visual only presentation (For words and sentences):

<table>
<thead>
<tr>
<th></th>
<th>Visual for words</th>
<th>Visual for sentences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.9167</td>
<td>18.0000</td>
</tr>
<tr>
<td>SD</td>
<td>4.44069</td>
<td>2.06522</td>
</tr>
<tr>
<td>Total</td>
<td>12.4583</td>
<td>19.0833</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>15.0000</td>
<td>20.1667</td>
</tr>
<tr>
<td>SD</td>
<td>4.02146</td>
<td>3.69274</td>
</tr>
<tr>
<td>Females</td>
<td>12.4583</td>
<td>19.0833</td>
</tr>
<tr>
<td>Males</td>
<td>4.02146</td>
<td>3.69274</td>
</tr>
<tr>
<td>Total</td>
<td>15.0000</td>
<td>20.1667</td>
</tr>
<tr>
<td>Visual for sentences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.4167</td>
<td>2.06522</td>
</tr>
<tr>
<td>SD</td>
<td>3.0000</td>
<td>3.0000</td>
</tr>
<tr>
<td>Total</td>
<td>3.0000</td>
<td>3.0000</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.0000</td>
<td>3.0000</td>
</tr>
<tr>
<td>SD</td>
<td>2.2083</td>
<td>2.2083</td>
</tr>
<tr>
<td>Total</td>
<td>3.0000</td>
<td>2.2083</td>
</tr>
</tbody>
</table>
2) **Audio-visual presentation** (For words and sentences):

Table 3: Depicts the mean and standard deviation values for words and sentences in audio-visual mode of presentation for group I and group II males and females.

<table>
<thead>
<tr>
<th>Audio visual for words</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Mean</td>
<td>7.2500</td>
<td>9.9167</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.37888</td>
<td>5.74390</td>
</tr>
<tr>
<td>Group II</td>
<td>Mean</td>
<td>10.5833</td>
<td>7.5000</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>5.96137</td>
<td>3.06001</td>
</tr>
</tbody>
</table>

Audio visual for Sentences

| Group I                | Mean  | 5.4167  | 3.8333 | 4.6250 |
|                        | SD    | 3.67939 | 2.69118| 3.25460|
| Group II               | Mean  | 6.5833  | 7.1667 | 6.8750 |
|                        | SD    | 5.35059 | 3.33768| 4.44593|

3) **Audio-visual and pictures presentation** (For words and sentences):

Table 4: Represents the mean and standard deviation values for words and sentences in audio-visual with pictures mode of presentation for group I and group II males and females.

<table>
<thead>
<tr>
<th>Audio visual and picture for words</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Mean</td>
<td>18.0000</td>
<td>17.0000</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>3.27525</td>
<td>5.89299</td>
</tr>
<tr>
<td>Group II</td>
<td>Mean</td>
<td>17.0833</td>
<td>18.0833</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>4.07784</td>
<td>3.11764</td>
</tr>
</tbody>
</table>

Audio visual and picture for sentences

| Group I                           | Mean  | 18.0000 | 17.0000| 17.5000|
|                                   | SD    | 3.27525 | 5.89299| 4.69042|
| Group II                          | Mean  | 17.0833 | 18.0833| 17.5833|
|                                   | SD    | 4.07784 | 3.11764| 3.58641|

4) **Comparison of overall response for type of stimuli and mode of presentation:**

a) Total scores for words:

Figure 5: Shows the total score of Mean and standard deviation values for words for group I and group II males and females.

b) Total scores for sentences:

Figure 6: Shows the total mean and standard deviation values for sentences of group I and group II males and females.

The Mean and standard deviation scores for sentences were greater for the visual only presentation when compared with the audio-visual only presentation. Whereas audio-visual only condition had lower scores when compared to other two conditions.

c) Total scores for words and sentences

Figure 7: Shows the total scores of Mean and standard deviation values for words and sentences for males and females of group I and group II.

The total Mean and standard deviation scores were higher for words than for sentences in all three modes of presentation for both males and females of group I and group II.
The total combined Mean scores for words and sentences were slightly higher for the audio-visual with picture presentation when compared with the visual only presentation. Standard deviation scores of audio visual with picture presentation is lesser than visual only condition. Whereas Audio-visual only condition had lower Mean and standard deviation scores when compared to other two conditions.

Summary and Conclusion
The study aimed at assessing dependency of children with hearing impairment on visual cues for perception of speech using words and sentences in Kannada as the stimuli. The constructed test material was administered for 50 hearing impaired children of Severe to Profound degree containing both male and female subjects from two age groups. Group I consisted of 25 subjects with an age range of 8 to 13 years and Group II which consisted of 25 subjects with an age range of 13 to 18 years. Words and Sentences selected for the study checked for similarity and matched the vocabulary of the subjects participated. All the stimuli were recorded and presented through a wide screen laptop.

The test stimuli were presented in three conditions: visual only (V) presentation in which only speaker’s face and lip movements were visible with no additional cues. Second, Audio-visual (AV) mode in which visible face and lip movements simultaneously accompanied with auditory signal. Third mode included, Audio-visual with picture (AVP) presented simultaneously, where the picture depicted the word or sentence presented Audio-visually.

All the words and sentences used in the test were presented to all the participants in when subject failed to perceive word or sentence in visual only condition then he/she was subjected to the second condition where the stimuli was presented Audio-visually, if the difficulty still persist then the third mode of presentation Audio-visual with picture was administered. Responses were in written form of perceived word or sentence from the subjects. The statistical analysis revealed that best performance of the subjects was for Audio-visual with picture condition followed by visual only condition. The Audio-visual only presentation received least scores among the other two conditions. Group II male and female subjects outperformed Group I male and female subjects in all three visual tasks.

The results revealed the Group II subjects performed better when compared to Group I subjects because of experiential influence. Condition which was associated with picture presentation was more likely to receive higher scores than visual alone condition. Performance of both group I and group II were least for Audio-visual only presentation because of limited benefit from hearing aid.

Limitations of the study
1. Only limited number of subjects could be taken for the study and was not compared with control group
2. Study could be extended to cochlear implant group to assess difference in modality of perception.

Future directions
The stimulus used in this study can be used as a test in Kannada for assessing visual dependency in hearing impaired children for perception of speech.

References


The objective of the study was to compare the specific patterns in distortion product oto-acoustic emissions (DPOAE) spectra and its relationship with speech identification scores in individuals with auditory neuropathy spectrum disorder (ANSD). The DPOAE spectra and speech identification scores of 15 normal hearing and 30 individuals diagnosed as having auditory neuropathy spectrum disorder were studied and compared. DP-gram Spectra was also analyzed in patients with auditory neuropathy spectrum disorder who were further divided into good and poor performers based on their speech identification scores. The results indicated that the mean DPOAE amplitudes across frequencies obtained for good and poor performers of ANSD suggests that the irregularity in DPOAE spectra is more for poor performers than the good performers. The number of notches, depth of notches and the width of the notches are more for poor performers with ANSD. In conclusion, the findings of the present study suggest that individuals with auditory neuropathy spectrum disorder exhibit subtle abnormality in the peripheral auditory system.

Key words: Auditory Neuropathy Spectrum disorder, DP-gram Spectra, Irregularities, Speech Identification Scores.

Introduction

Oto-acoustic emissions (OAEs) are usually inaudible sounds measured in the ear canal through a sensitive microphone. Otoacoustic emissions are derived from the active amplification by outer hair cells and linked to outer hair cell electro-motility (Brownell, 1990). These are used extensively in the recent years for different clinical applications. Otoacoustic emissions can be generated spontaneously (SOAEs) and can also be evoked using clicks (transient-evoked otoacoustic emissions, TEOAEs), pure tones (stimulus-frequency otoacoustic emissions, SFOAEs), or two tones presented together (distortion product otoacoustic emissions, DPOAEs). DPOAEs are one type of evoked OAEs that are produced by the ear in response to two primary tones (f1 and f2; f2 > f1) presented simultaneously to the same ear. The most robust DPOAEs are measured at the 2f1-f2 frequency (Lonsbury-Martin & Martin, 2001). DPOAEs reflect the audiometric threshold at the measured frequencies. DPOAEs are absent in cochlear loss of 30-40 dB at a particular frequency. The level of DPOAE responses tends to decrease following exposure to intense sounds or in response to certain drugs that induce OHC damage (Attias & Bresloff, 1996; Bhagat & Davis, 2008; Knight, Kraemer, Winter & Neuwelt, 2007).

One of the explanations for the origin of 2f1-f2 DPOAEs is the two-source interference model involving nonlinear generation near the place of maximum overlap of the primary tones on the basilar membrane, and the liner reflections between the place of distortion product on the basilar membrane and the oval window (Dhar, Talmadge, Long, & Tubis, 2002; Talmadge, Long, Tubis, & Dhar, 1999; Talmadge, Tubis, Long, & Piskorski, 1998). DPOAEs are characterized by a rippled pattern of maxima and minima when recorded with high resolution primary-tone frequencies. This results in a fine structure DPOAEs, which is believed to emerge as a result of interference between the generator and reflecting sources. Depth of the notches of DPOAE fine structure varies up to 20 dB regardless of frequency (Gaskill & Brown, 1990; He & Schmiedt, 1993; Heitmann, Waldmann & Plinkert., 1996) and a periodicity of 3/32 octave (He & Schmiedt, 1993; Mauermann, Uppenkamp, van Hengel & Kollmeier, 1999).

Reuter and Hammershei (2006) developed an algorithm to measure the occurrence of notch height, and spacing of peaks in the DPOAE fine structure of normal-hearing individuals. They suggested that in addition to DPOAE levels, the DPOAE spectral profile may be useful in distinguishing between individuals with varying degrees of hearing sensitivity within the normal range. This information may be useful in
identifying subtle impairment in outer hair cells (OHC). Zhao and Stephens (2006) also reported notches in fine structure DPOAE amplitude in individuals with family history of hearing impairment. Mathew (2003) observed abnormal DPOAE fine structure notches in parents of children with hearing impairment between 1-3 KHz regions in a majority of the possible carriers. She concluded that analyzing the fine structure of DPOAEs may be useful in finding sub-clinical and subtle deviations from normal hearing individuals.

DPOAE fine structure can provide additional information on cochlear status, but the measurement of fine structure DPOAEs are time consuming for many commercially available instruments and uses low primary-tone resolution of around 1/8 octaves. He and Schmiedt (1993) reported DPOAE spectra shows more peaks with of around 1/8 octaves. He and Schmiedt (1993) and thus DPOAE spectra can measurements with lower resolution of the primary tones also.

OAE measure has been an integral part of audiological test battery to identify Auditory Neuropathy Spectrum disorder. ANSD is described as a hearing disorder characterized by abnormal auditory nerve functioning in presence of normal cochlear receptor hair cell activity (Starr, Picton, Sininger, Hood & Berlin, 1996). Cochlear responses like otoacoustic emissions and /or cochlear microphonics are present indicating normal functioning of outer hair cells (Berlin, 1999; Santarelli & Arslan, 2002; Starr et al., 1996). However, most of the studies have used the conventional DP gram to measure DPOAE amplitude in individuals with ANSD. There is dearth of information regarding the fine structure DPOAE amplitude in individuals with ANSD. Thus, in the present study DPOAE spectral characteristics were considered, to determine whether individuals with ANSD would exhibit any specific pattern in DPOAE spectra.

Speech identification ability varies considerably among individuals with Auditory Neuropathy Spectrum disorder. However, approximately 60 to 70% of individuals exhibit poor correlation between their speech identification scores and the pure-tone thresholds (Sininger & Oba, 2001, Zeng, Oba, Garde, Sininger, & Starr, 1999). In the present study, an attempt was also made to determine the relationship between the DPOAE spectra and varying speech identification scores in individuals with ANSD.

Objectives of the study: The primary objective of this study was to determine whether DPOAE spectral peaks in distortion product grams (DP-grams) obtained with 1/8 octave primary-tone steps significantly differed between individuals with normal hearing and Auditory Neuropathy Spectrum disorder and also to observe whether there is any specific DPOAE spectra patterns in relation to speech identification scores that is obtained in individuals with Auditory Neuropathy Spectrum disorder.

Ethical Considerations: In the present study, all the testing procedures done were using non-invasive technique and all the procedures were explained to the patients and their family members before testing and informed consent has been taken from all the patients and their family members for participating in the study.

Method

Participants: The participants were categorized into two groups with control group consisting of 15 (7 males and 8 females) with normal hearing and a mean age of 23.5 years. Participants in the control group had pure tone thresholds within 15 dB HL and speech identification scores of 100 % in quiet at 40 dB SL on routine speech audiometry. They also had normal tympanometric results with both ipsilateral and contralateral reflexes present. The experimental group consisted of 30 individuals (15 males and 15 females) with acquired Auditory Neuropathy Spectrum disorder with a mean age of 30.2 years. The participants in the clinical group had pure tone thresholds less than 60 dB HL and had symmetrical sensorineural hearing loss in both ears. These participants had normal tympanometric findings with absent ipsilateral and contralateral acoustic reflexes and auditory brainstem responses. An otological evaluation was also performed to rule out any middle ear disorders. All the participants in the experimental group had TEOAEs suggestive of normal hair cell functioning and absent abnormal auditory brainstem responses was the basis to diagnose them as having Auditory Neuropathy Spectrum disorder. A neurologist confirmed the diagnosis with a detailed clinical neurological examination.

The participants in the clinical group were further categorized into two sub groups’ namely good performers (15 individuals with ANSD) and poor
performers (15 individuals with ANSD) based on their speech identification scores in quiet for phonemically balanced words developed by Yathiraj and Vijayalakshmi, (2005). The individuals with speech identification scores of more than 50% were considered as good performers and the individuals with speech identification scores of less than or equal to 50% were considered as poor performers (Narne & Vanaja, 2008). However, all the participants in the clinical group exhibited very poor speech identification scores at 0 dB Signal-to-Noise ratio (SNR).

Procedure: To estimate the pure-tone air conduction thresholds and speech identification scores, a calibrated dual channel Grason Stadler (GSI-61) diagnostic audiometer with TDH-39 headphones housed in MX-41/AR ear cushions was used. The bone conduction thresholds were estimated with a Radio Ear B-71 bone vibrator. Pure tone testing was done with a Modified Hughson and Westlake procedure (Carhart & Jerger, 1959). Speech identification testing was done with monitored live voice presentation of phonemically balanced words in Kannada (Yathiraj & Vijayalakshmi, 2005) at 40 dB SL (re: SRT). Speech Perception in Noise test was also administered at 0 dB SNR using the word list developed by Yathiraj and Vijayalakshmi (2005). Immitance evaluation (tympanometry and acoustic reflex testing at 500, 1000, 2000 and 4000 Hz) was carried out with a calibrated middle ear analyzer (GSI-Tympstar V 2.0) and a 226 Hz probe tone.

TEOAEs were measured with a calibrated OAE analyzer ILO (V6) for non-linear click trains presented at 80 dB peak equivalent SPL. An emission was considered to be present if the waveform reproducibility was more than 50%, and the overall signal to noise ratio was more than 3 dB at least at two frequency bands. Auditory Brainstem Responses (ABR) were recorded using Intelligent Hearing Systems (IHS) instrument with ER-3A insert earphones, and 100 μsec click stimuli at a level of 90 dB nHL, at 11.1 Hz presentation rate with a filter setting of 100 Hz to 3000Hz. An identical protocol was incorporated to test all subjects. ABR testing was performed twice to ensure reproducibility of waveforms. All testing was completed in a sound treated room.

DPOAE measurement was done using the same ILO V6-USB system (Otodynamics Ltd.) along with a periodically calibrated probe. The primary frequency tones were generated through the ILO V6 software and the F2 frequency varied from 842 – 7996 Hz. The data was collected for 8 points per octave for two sweeps across the frequencies tested. To determine the optimal DPOAE responses, a constant F2 and F1 frequency ratio of 1.22 was used as recommended by Harris, Lonsbury-Martin, Stagner, Coats, and Martin (1989). The levels of the primary tones were 65 dB SPL for L1 and 55 dB SPL for L2. DPOAE measurement was done for each ear separately. DP-grams were obtained by plotting the amplitude of the DPOAE as a function of f2 frequency. Each f2 frequency was presented a minimum of two times, and when the DPOAE levels had stabilized, the testing was terminated.

The parameters that were considered from each DP-Gram acquired are:

1. Grand mean average: The average of DPOAE absolute levels for all the 25 frequencies for each ear.
2. Number of notches: A notch was defined when the difference in amplitude of peak and trough of the notch was at least 6 dB.
3. Depth of the largest notch: A notch was decided as the largest if it had maximum amplitude among the notches in the DP-gram and its amplitude was considered.
4. Width of the notch: the difference in frequency (Hz) between the two extreme edges of the notch.

![Figure 1: The figure depicts the method used in measurement of width of the notch and depth of the largest notch.](image)

The data points at the low- and high-frequency endpoints 842 Hz and 7996 Hz respectively of the DP-Grams were excluded for further analysis. The low frequency end point was contaminated by noise and high frequency end point had very less amplitude in majority of the subjects. The values of the above mentioned parameters were noted and used for comparison across the group and also with the speech identification scores obtained in the clinical group.
Results and Discussion

The grand mean average of DPOAE amplitude, number of notches in each DP-gram, depth and average width of notches was calculated for each group (control group and two clinical groups). The grand mean average of DPOAE amplitude was calculated at all 25 frequencies for the three groups. The mean, standard deviation and range of DPOAE amplitude obtained from the both subgroups of ANSD are depicted in Table 1.

Table 1: The mean, standard deviation (SD) and range of the DPOAE amplitude in dB SPL of individuals with Auditory Neuropathy Spectrum disorder of both the groups

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Poor Performers of ANSD</th>
<th>Good Performers of ANSD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
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<tr>
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The mean DPOAE amplitude obtained for normal hearing, good performers of ANSD and poor performers of ANSD were plotted across all the 25 frequencies and shown in figure 2. The figure shows that the mean DPOAE spectrum curves obtained were smooth for normal hearing individuals. However, mean DPOAE spectrum amplitude curves were more irregular for individuals with ANSD. The irregularities are more for poor performers than the good performers. It can be observed that, at mid-frequencies both ANSD and normal hearing group showed similar OAE amplitude. However, at high frequencies, normal hearing individuals had higher OAE amplitude and individuals with Auditory Neuropathy Spectrum disorder had relatively lesser amplitude.

The results suggest that there was a significant difference in DPOAE amplitude \([F (3, 100) = 122.9, p < 0.01]\) across the three groups. Duncan’s Post hoc test was carried out to determine which of the groups were significantly different from each other. The results are depicted in Table 2. It shows that there was a significant difference between normal and both the clinical groups. There was no significant difference between good and poor performers with ANSD.

Figure 2: The darker bands represent the mean DPOAE amplitude in all the three groups and the lighter bands represent the noise floor in the respective groups.
The notches found in DPOAE spectrum in individuals with Auditory Neuropathy Spectrum disorder were more at high frequencies. The number of notches and larger depth of these notches might have reduced the amplitude of DPOAE, at high frequencies in individuals with ANSD. The higher amplitude of evoked otoacoustic emission in patients with Auditory Neuropathy Spectrum disorder can be attributed to lack of efferent suppression of otoacoustic emissions. Thus, the larger amplitude at low frequencies compared to high frequencies might suggest that there could be lack of efferent inhibition which is prominent at low- and mid-frequency region of the cochlea in individuals with ANSD resulted in greater amplitude at those frequencies compared to high frequencies.

The studies reported in literature have used either 1/32 (Mathew, 2003) or 3/32 (He & Schmiedt, 1993; Mauermann et al., 1999) per octave DPOAE fine structure measures and reported the presence of notches in normal hearing individuals. In the present study, 8 points per octave was considered for measuring DPOAE amplitude. The wider range used to record DPOAE amplitude might have resulted in smoothening of curves in individuals with normal hearing.

The irregularities in peaks and notches in DPOAE were observed in both the sub groups of ANSD. DP-gram obtained for a participant with normal hearing, a patient with ANSD who had good speech identification scores and another patient with ANSD with poor speech identification scores are shown in figure 3. The number of notches, depth of notches and the width of the notches are more for the participant who is a poor performer. It can also be observed that the notches are confined more at the high frequencies in the poor performer compared to the good performer.

DPOAE spectral characteristics were calculated and its relationship with speech identification scores was determined. The normal hearing group had smooth curve with slight irregularities but the amplitude of these dips was less than 6 dB. Hence, the number of notches, depth of the largest notch and the average width of the notch was also more in individuals with ANSD who had poor speech identification scores. Independent sample t-test was carried out to determine whether the parameters were significantly different across the two sub groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Number of Notches</th>
<th>Depth of largest notch (dB)</th>
<th>Average width of notch (Hz)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>ANSD good performer</td>
<td>15</td>
<td>2</td>
<td>0.65</td>
<td>1-3</td>
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<tr>
<td>ANSD poor performer</td>
<td>15</td>
<td>3.42</td>
<td>1.01</td>
<td>2-5</td>
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</table>

The statistical analysis of the DPOAE spectral parameters suggests that the number of notches which had amplitude of greater than 6 dB was more in poor performers of ANSD. The depth of the largest notch and the average width of the notch was also more in individuals with ANSD who had poor speech identification scores.
of ANSD (good and poor performers). The results of independent t-test showed that there was a significant difference in the number of notches \([t (27) = 4.53, p < 0.001]\) and average width of the notch \([t (27) = 8.33, p < 0.001]\) between good and poor performers with ANSD. However, there was no significant difference \([t (27) = 1.49, p > 0.05]\) between the two groups when the depth of largest notch was compared across the groups.

The increased number of notches and larger average width of notch in the DPOAE spectra are seen in individuals with poor speech identification scores with ANSD. This could possibly indicate abnormal frequency resolution in individuals with ANSD. Thus, the impaired frequency resolution at the level of cochlea would lead to poor speech perception. Dhar et al. (2009) also reported correlation between brainstem evoked responses for speech and DPOAE responses. They suggest that poor coding at the level of brainstem can be correlated with abnormal DPOAE measures and there can be a correlation in clinical population. Thus, the abnormal brainstem responses seen in patients with ANSD could also be related to abnormal DPOAE spectra. Zhao and Stephens (2006) also reported dips and notches in individuals with obscure auditory dysfunction whose pure-tone thresholds are normal but have difficulty listening in presence of noise. Mathew (2003) reported abnormal notches in fine structure DPOAE even when the overall DPOAE amplitude was normal in individuals in possible carriers. This suggests that the abnormal DPOAE spectral pattern observed in individuals with ANSD in the present study is associated with subtle abnormality in auditory system and might be resulting in poor understanding of speech in individuals with ANSD.

Conclusions

The results of the current study show that normal hearing individuals had smooth DP-gram, whereas, individuals with Auditory Neuropathy Spectrum disorder showed notches in DP-gram. This study also reveals that with the increase in the number of notches and/or increased depth of notch, there is a significant reduction in the speech identification scores. The average peak width is also more in individuals with ANSD with poor speech identification scores. The average peak width of notch in the DPOAE spectra are 0.05) between the two groups when the depth of notch \([t (27) = 8.33, p < 0.001]\) between good and poor performers with ANSD. However, there was no significant difference \([t (27) = 1.49, p > 0.05]\) between the two groups when the depth of largest notch was compared across the groups.

The increased number of notches and larger average width of notch in the DPOAE spectra are seen in individuals with poor speech identification scores with ANSD. This could possibly indicate abnormal frequency resolution in individuals with ANSD. Thus, the impaired frequency resolution at the level of cochlea would lead to poor speech perception. Dhar et al. (2009) also reported correlation between brainstem evoked responses for speech and DPOAE responses. They suggest that poor coding at the level of brainstem can be correlated with abnormal DPOAE measures and there can be a correlation in clinical population. Thus, the abnormal brainstem responses seen in patients with ANSD could also be related to abnormal DPOAE spectra. Zhao and Stephens (2006) also reported dips and notches in individuals with obscure auditory dysfunction whose pure-tone thresholds are normal but have difficulty listening in presence of noise. Mathew (2003) reported abnormal notches in fine structure DPOAE even when the overall DPOAE amplitude was normal in individuals in possible carriers. This suggests that the abnormal DPOAE spectral pattern observed in individuals with ANSD in the present study is associated with subtle abnormality in auditory system and might be resulting in poor understanding of speech in individuals with ANSD.

Conclusions

The results of the current study show that normal hearing individuals had smooth DP-gram, whereas, individuals with Auditory Neuropathy Spectrum disorder showed notches in DP-gram. This study also reveals that with the increase in the number of notches and/or increased depth of notch, there is a significant reduction in the speech identification scores. The average peak width is also more in individuals with ANSD with poor speech identification scores. The findings of the present study suggest that individuals with Auditory Neuropathy Spectrum disorder are likely to have more problems in understanding speech as the number of notches increases. The multiple notches and the increased width of notches could indicate a subtle abnormality in the auditory system which needs to be delineated. Thus, analyzing the DPOAE spectra of individuals with ANSD is useful in understanding sub-clinical and subtle deviations from normal.

Implications of the study: The study provides an insight into the subtle abnormalities in finer aspects of DPOAE in individuals with Auditory Neuropathy Spectrum disorder. DPOAE spectra could be used as a tool to identify severity of difficulty in speech perception. It also suggests that DPOAE spectra curve can be used to predict perceptual consequences of Auditory Neuropathy Spectrum disorder in pediatric population in whom speech identification scores cannot be obtained. It also highlights the need for further studies to identify whether any specific gene is related to this type of pattern which leads to Auditory Neuropathy Spectrum disorder.

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References


ETIOLOGICAL FACTORS OF CONGENITAL HEARING LOSS IN CHILDREN – A HIGH RISK REGISTER BASED STUDY

Jijo, P.M., Vipin Ghosh, P.G., & Prawin Kumar

Abstract
The study aimed to investigate the possible etiological factors of congenital severe to profound sensorineural hearing loss in children. The study also analyzed any difference in etiology, as a factor of geographic locations, socio-economic status, religious-community and gender. A survey-based study was carried out at the Department of Audiology, AIISH. A high-risk register was administered on parents of 70 children with congenital severe to profound sensorineural hearing loss. It was found that 73% of the participants had at least one causative factor associated with their condition whereas the remaining 27% had idiopathic onset of hearing loss. Parental consanguinity (31%) was the most common cause followed by maternal infections (13%), history of high fever (7%), NICU care more than a week (6%), family history of congenital hearing loss (4%), neonatal hyperbilirubinemia (4%) delayed birth cry (4%) medications in the first trimester (3%). Additionally, the etiological factors were analyzed in terms of geographic locations, socio-economic status, religious community and gender. Results revealed a significant difference in occurrence of consanguinity between the two geographical locations, religious community and gender. It can be concluded that consanguineous marriage as a major etiological factor that lead to congenital severe to profound hearing loss should be discouraged. Preventive measures should focus on geographic locations, socio-economic status, and religious community that exhibit higher rate of consanguineous marriages. Public education should be carried out regarding the adverse effect of interrelated marriages. Genetic counseling has to be carried out at least for those at risk of developing genetic diseases, including hearing impairment. Premarital and antenatal screening can also be utilized.

Introduction
Congenital, severe to profound hearing impairment is one of the disabilities that have severe impact on speech and language abilities, academic achievement, social development and vocational preferences. In India, hearing impairment is the second most common disability after locomotor impairment (National Sample Survey, 2002). Furthermore, hearing impairment accounts for 10% of all disabilities in the rural population and 9% in the urban population. It was also revealed that nearly 7% of the people in India are born with hearing loss (NSS, 2002). High incidence of deafness insists the need for preventive research in this area.

Diverse etiological factors have been associated with congenital hearing loss. Medical conditions that occur during prenatal, perinatal and postnatal periods can results in pre-lingual deafness. Maternal rubella, cytomegalovirus, syphilis, ototoxic drugs during pregnancy are a few of the prenatal conditions leading to deafness. Hypoxia, neonatal hyperbilirubinemia, ototoxic drugs, infections etc. in the perinatal and postnatal periods can also lead to hearing loss (Northern & Downs, 2002). However, nearly 50% of the congenital hearing loss has been reported to be of genetic in origin (Fraser, 1976). Additionally, a large majority of genetic deafness has been reported to be due to autosomal recessive inheritance (Smith, 1986). Autosomal recessive inheritance is considered, when other causative factors such as infections, trauma, ototoxic drugs are not plausible. Such an inheritance is probable when the parents of those with hearing impairment are known to be relatives. In developing countries, consanguineous marriage is one of the major causes of hereditary sensorineural hearing loss. Zakzouk (2002) reported that prevalence of hearing impairment was significantly higher in children whose parents were related. Similarly, Bener, EHakeem and Abdulhadi (2005) reported that parental consanguinity was significantly higher among infants with hearing loss compared to those with no hearing loss. Both the studies were carried out in developing countries of Middle East. In India, higher rate of consanguineous marriages have been found in the southern states than that of north and northeastern states (National Family and Health Survey, 1992-1993). Indian states of Andhra Pradesh, Karnataka and Tamil Nadu had higher rate of consanguineous marriages whereas, in Kerala it is the lowest (Bittles, 2002). In this context the present study attempts to compare the etiological factors of congenital hearing loss in two south Indian states of India, Kerala and Karnataka.
There have been reports of different rate of consanguineous marriage in different religious communities. Further, those belong to poor socio-economic status had higher prevalence of consanguineous marriages (Bittles, 2002). Higher rate of consanguineous marriages have been in the illiterate community than that of literate community (Zakzouk, 2002). Hence, the present study also investigates the association between geographic locations, socio-economic status, and religious community on etiological factors especially consanguineous marriage.

**Method**

**Participants:** The high-risk register (Anitha & Yathiraj, 2001) was administered on parents of children with hearing impairment (APPENDIX -A). There were 70 children (37 Male and 33 Female) in the age range of 2 to 9 years with the mean age of 4.3 years and standard deviation of 1.4. All the children were diagnosed at the Department of Audiology, AIISH. All the children had congenital, bilateral, severe-to-profound sensorineural hearing loss. All of them were fitted binaurally with hearing aids and attending listening training. Hearing loss was the major compliant in all the children with no associated conditions such as mental retardation, cerebral palsy or autism. Participants from two different geographic locations (33 Kerala & 37 Karnataka) were chosen, as majority of the patients at AIISH belong to these locations. In addition to the questions in the HRR, information regarding religious community (27 Muslim & 43 Hindu) and socio-economic status (59 Slab I & 11 Slab II) were also collected (Table 1). Slab I consisted of patients with monthly income less than 10,000. Those with monthly income between 10,000 to 20,000 were grouped into slab II.

<table>
<thead>
<tr>
<th>Religious community</th>
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<tr>
<td>Hindu</td>
<td>7(21%)</td>
<td>36 (97%)</td>
</tr>
<tr>
<td>Muslim</td>
<td>26 (79%)</td>
<td>1 (3%)</td>
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<table>
<thead>
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<th>Economic status</th>
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<tbody>
<tr>
<td>Slab 1</td>
<td>25 (76%)</td>
<td>34 (91%)</td>
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<td>Slab 2</td>
<td>8 (24%)</td>
<td>3 (9%)</td>
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<table>
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<th>Gender</th>
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<tr>
<td>Male</td>
<td>20 (60%)</td>
<td>17 (46%)</td>
</tr>
<tr>
<td>Female</td>
<td>13(40%)</td>
<td>20 (54%)</td>
</tr>
</tbody>
</table>

The HRR consists of two questionnaires; one can be administered by a medical professional and the other one by a non-medical professional. Each of the questionnaires had two sub divisions; one consists of risk factors that can occur during birth to 28 days and the other one between 28 days to 3 years. Both the questionnaires were administered on each parent. After collecting information, the data was analyzed descriptively.

**Procedure:** As the HRR was developed in English, each question was translated to respective mother tongue of the participants. The questions were explained orally to each participant in person. The data was collected from each parent in a silent room within the premises of the institute. Information given by each parent was verified with their case history that was collected earlier. The responses were collected in the form of yes or no format. All the parents were assured that the information collected would be used for research purpose and an informed consent was obtained.

**Results**

It was observed that 73% of the participants had one or the other etiological factor associated with hearing loss. However, remaining 27% had no relevant clinical history. Among the etiological factors noticed, consanguineous marriage, maternal infections during pregnancy, high fever, NICU care more than a week, neonatal hyperbilirubinemia, family history of congenital hearing loss, delayed birth cry, medications in the first trimester were found. It can be noted in Figure 1 that parental consanguinity (31%) was the most common cause followed by maternal infections (13%). There were patients with a history of high fever (7%), NICU care more than a week (6%), family history of congenital hearing loss (4%), neonatal hyperbilirubinemia (4%) delayed birth cry (4%) medications in the first trimester (3%). Premature birth was associated with the above etiological factors in 15% of the participants. However, none of them who had parental consanguinity exhibited any other associated etiological factors indicating a hereditary hearing loss.

The above etiological factors were further grouped in terms of geographic locations, socio-economic status, religious community and gender.
Geographic locations: Among the 70 patients, 47% were from Kerala and 53% were from Karnataka. It can be found in Figure 2 that, consanguineous marriage was noted in 49% of the participants from Karnataka whereas, only 12% of the participants from Kerala had history of parental consanguinity. Chi square test revealed that there was a significant difference in consanguinity between the two geographical locations ($p < 0.05$). Maternal infections during pregnancy were found in 24% of the participants from Kerala. However, there were only 3% of the participants from Karnataka had maternal infections as an etiological factor. Similar number of participants from Kerala (24%) and Karnataka (29%) had idiopathic onset of hearing loss. Other etiological factors also exhibited similar percentage of occurrence between the two geographical locations.

**Religious community:** Among the 70 patients, 61% belonged to Hindu community and 39% belonged to Muslim community. It can be found in Figure 3 that, consanguineous marriage was noted in 42% of the participants belonged to Hindu community whereas, only 15% of the participants belonged to Muslim community exhibited parental consanguinity. Chi square test revealed that there was a significant difference in consanguinity between the two religious communities ($p < 0.05$). Maternal infections during pregnancy were found in 26% of the participants from Muslim community nevertheless, there were only 5% of the participants belonged to Hindu community who had maternal infections as an etiological factor. Other etiological factors exhibited similar percentage of occurrence between the two religious communities.

**Socio-economic status:** Out of the 70 participants, 84% belonged to slab I and 16% belonged to Slab II. It can be found in Figure 4 that, etiological factors such as consanguineous marriage, maternal infections during pregnancy, idiopathic onset, family history and history of NICU were found to be higher in slab I. In slab II conditions such as delayed birth cry, neonatal hyperbilirubinemia and high fever were not observed.

**Discussion**

It was noted that 73% of the participants with congenital severe to profound hearing loss had at least one causative factor associated with their condition whereas the remaining 27% had idiopathic onset of hearing loss.
Figure 4: Number of participants belonged to two socio-economic background with different etiological factors

It was observed that parental consanguinity was the most commonly observed etiological factor (31%) followed by maternal infections (13%). Studies have reported higher rate of parental consanguinity in children with congenital hearing loss (Reddy et al. 2004). They reported that 58% of 138 children with syndromic hearing loss had history of parental consanguinity. Higher rate of consanguinity in the present study might be due to the geographic location where the study was carried out. It has been noted that compared to northern and northeastern states consanguineous marriages are highly common in southern states of India (Kapadia, 1958).

It was found that those who had parental consanguinity did not exhibit any other associated etiological factors indicating a hereditary hearing loss. Hence, the marriages between people having common ancestor increase the risk of transmitting the detrimental recessive gene that they inherited from their common ancestor. Autosomal recessive inheritance was found to be the major cause of such hereditary hearing loss (Smith, 1986).

Geographical locations: It was found that consanguineous marriages were significantly higher among those from Karnataka (49%) than that of Kerala (12%). Further, maternal infection was found in 24% of the participants from Kerala whereas; only 3% of the participants from Karnataka had history of maternal infection. State wise difference in consanguinity found in the present study is in accordance with the reports of National Family and Health Survey (1992-1993). They reported, higher rate of consanguineous marriages in the south Indian states of Andhra Pradesh, Karnataka and Tamil Nadu whereas, in Kerala it is the lowest. Additionally, Bittles et al. (1991) reported 31.4% consanguinity all over Karnataka whereas in Kerala only 13% was observed (Ali, 1968). Though the number consanguineous marriages were found to be lesser in Kerala, the prevalence of hearing impairment was found to be higher than the other south Indian states (NSS 2002). This highlights the need for multicenter studies in different geographic locations to explore the etiological factors leading to congenital hearing loss.

Religious community: The results revealed that consanguineous marriages were significantly higher among those belonged to Hindu community (42%) than that of Muslim community (15%). Additionally, maternal infection was found in 26% of those belonged to Muslim community and 5% of the Hindu community. Reddy et al. (2004) had similar findings where 87% of their patients belong to Hindu community in which 58% had history of consanguinity. Increased rate of consanguinity among Hindu community is accounted to the custom followed in Hindu families of south India (Bittles, 2002). Further, Hindu marriage act of 1955 and Hindu code bill of 1984 recognized cross-cousin and uncle-niece marriages. This was reported to be the probable cause for increased rate of consanguineous unions in Hindu community. In contrast, consanguineous marriages in south Indian Muslim community (10%) were found to be lesser than that of northern states (43.3%).

Increased rate of maternal infections observed in the Muslim community (26%) than that of Hindu community (5%) is unclear. Similarly, 24% of the participants from Kerala had maternal infections whereas in Karnataka only 3% had history of maternal infections. Additionally, it was found that 80% of the participants from Kerala belong to Muslim community. However, it is hard to explain the association between increased rate of maternal infection and geographical location or religious community.

Socio-economic status: It was found that consanguineous marriages accounted 82% of the etiological factors in those belong to slab I. In contrast, in slab II consanguinity accounted only 18% of the etiological factors. Higher rate of consanguineous marriages have been reported among those belong to rural areas, low in socio economic status and poor literacy (Bittles, 2002). It was believed in rural areas that such a custom might reduce the financial and health uncertainties that arise due to marriage with other families. Further, consanguineous unions might
simplify the premarital arrangements and lead to better couple and in law relationships (Bittles, 2002).

**Conclusions**

The survey based study revealed that a consanguineous marriage was found to be the most common etiology followed by maternal infections. Additionally, it was noted that there was a significant difference in rate of consanguinity between geographical locations as well as religious community. Hence, it can be concluded that consanguineous marriages as a major etiological factor that lead to congenital severe to profound hearing loss should be discouraged. As there was a significant difference in consanguinity between different geographical locations and religious community, preventive measures should be focused on these groups. Public education should be carried out regarding the adverse effect of interrelated marriages. Genetic counseling, to be carried out at least for those at risk of developing genetic diseases, including hearing impairment. Premarital and antenatal screening can also be utilized. However, the results of the study should be interpreted with caution due to its small sample size. Further, large-scale epidemiological studies need to be carried out to confirm the results.

**References**


**APPENDIX-A**

**HIGH RISK REGISTER FOR NON-MEDICAL PERSONS**

**Birth – 28 days**

1. Are the parents of the child blood relatives?
2. Did anyone in the child’s family have hearing loss in early childhood?
3. Did the child’s mother have any serious illness during pregnancy?
4. Did the child’s mother take any medicines for illness during pregnancy?
5. Was the baby born before the due date given by the doctor (before 37 weeks from last menstrual period)?
6. Did the child appear yellow or blue at birth?
7. Did the child cry immediately after birth?
8. Was the child’s weight low at birth (less than 1.5 kg)?
9. Was there any defect of the head and face when the child was born?
10. Was the child kept in hospital for treatment after birth?
29 days – 3 years

1. Was there parental or caregiver concern regarding the child’s hearing, speech or developmental milestones?
2. Did anyone in the child’s family have hearing loss in early childhood?
3. Did the child’s mother have any infections during pregnancy?
4. Was there any defect of the head and face when the child was born?
5. Did the child’s skin appear yellow?
6. Did the child have brain fever, measles or mumps?
7. Did the child have head injury associated with loss of consciousness, skull fracture, bleeding or discharge from ear following injury?
8. Did the child have ear discharge for at least 3 months?

NOTE: If the answer to any of the questions is ‘YES’, get the child’s hearing evaluated by a qualified Audiologist.

HIGH RISK REGISTER FOR MEDICAL PROFESSIONALS

Birth – 28 days

1. Was the marriage of the child’s parents consanguineous?
2. Was there any family history of permanent early childhood sensorineural hearing loss?
3. Did the child’s mother have any conditions during pregnancy such as measles, mumps, chickenpox, herpes, syphilis, cytomegalovirus, rubella or toxoplasmosis?
4. Was the child’s mother hospitalized for long prior to delivery of the child?
5. Did the child’s mother take any ototoxic medication for illness during pregnancy?
6. Was the child born prematurely?
7. Was the child’s birth cry delayed?
8. Did the child weight less than 1500 grams at birth?
9. Did the child have hyperbilirubinemia at a serum level requiring exchange transfusion soon after birth?
10. Did the child have Apgar scores of 0-4 at 1 minute or 0-6 at 5 minutes?
11. Was there any craniofacial anomalies including those with structural abnormalities of the pinna and ear canal?

29 days – 3 years

1. Was there parental or caregiver concern regarding the child’s hearing, speech or developmental milestones?
2. Was there any family history of permanent childhood sensori-neural hearing loss.
3. Did the child’s mother have any infections such as herpes, cytomegalovirus, toxoplasmosis, syphilis or rubella during pregnancy.
4. Did the child have any craniofacial anomalies, including those with structural abnormalities of the pinna and ear canal?
5. Did the child have hyperbilirubinemia at a serum level requiring exchange transfusion soon after birth?
6. Did the child have any of the conditions known to be associated with sensori-neural hearing loss such as mumps, measles, bacterial meningitis, viral encephalitis or labyrinthitis?
7. Did the child have any trauma associated with loss of consciousness, skull fracture, bleeding or discharge from ear following trauma?
8. Did the child have recurrent or persistent otitis media with middle ear effusion for at least 3 months?

NOTE: If the answer to any of the questions is ‘YES’, get the child’s hearing evaluated by a qualified Audiologist.
INTENSITY DISCRIMINATION IN INDIVIDUALS WITH AND WITHOUT COCHLEAR DEAD REGIONS

Apoorva. H. M., 2Kruthika. S., 3Saranya, V., & Rajalakshmi, K.

Abstract

Objective: The objective of the present study was to analyze intensity discrimination between individuals with and without cochlear dead regions using SISI test. Method: Thirty ears diagnosed as having sensorineural hearing loss were considered for the present study, out of which 15 were individuals without cochlear dead regions and 15 with cochlear dead regions. The age criterion ranged from 20 to 75 years (mean age=55.16 years) and the degree of hearing loss ranged from mild to moderately-severe. The TEN test was administered to detect the presence or absence of cochlear dead regions. Short Increment Sensitivity Index (SISI) was administered to find out the ability of each individual to detect small intensity changes (1 dB increment) at equal sensation levels (SLs). Results: The analysis of the data collected revealed statistically significant difference in SISI scores between the individuals with and without cochlear dead regions, i.e., SISI scores were better in individuals having cochlear dead regions when compared to those without cochlear dead regions. The results also showed significant difference in SISI scores across frequencies in the group with cochlear dead regions and increase in SISI scores with increase in frequency. Conclusion: Cochlear dead region is associated with a better ability for intensity discrimination and this effect may reflect cortical re-organization and over representation induced by the cochlear dead regions.

Key words: Cochlear dead region; Cortical re-organization; SISI; Loudness perception

Introduction

The human ear is a complex organ performing a vital role in our daily life. Both in terms of its absolute sensitivity and in terms of the range of intensities to which it can respond, the human ear plays a major function. Loudness corresponds to the subjective impression of the magnitude of a sound. Loudness if defined formally is that attribute of auditory sensation in terms of which sounds can be ordered on a scale extending from quiet to loud (ANSI, 1994). The smallest perceivable difference in decibel (dB) between two intensities is called Difference Limen for Intensity (DLI) or just noticeable difference (jnd). There are various methods such as modulation detection, increment detection and intensity discrimination of gated or pulsed stimuli through which the smallest detectable change for intensity can be measured.

Intensity discrimination has been studied widely in individuals with cochlear hearing loss. Glasberg and Moore (1989) reported that at equal sensation levels (SLs), subjects with cochlear damage have smaller values of DLI than normals, whereas at equal SPLs, they have DLI values that are similar to normal or still worst than in normal. The authors attribute this to the larger spread of excitation that is utilized by cochlear impaired ears at relatively higher SPL. Schroder, Viemeister and Nelson (1994) also reported that at same SLs, the Weber fraction (ratio of difference limen for intensity to its starting intensity) was smaller in individuals with cochlear impairment than in normal hearing listeners.

Loudness perception of the human ear can be affected by changes in the cochlear mechanism (Moore, 2007) and one such change can be complete loss of Inner Hair Cells or functional neurons at some regions in the cochlea which is referred to as Cochlear Dead Regions (CDR). In a CDR, little or no information is transmitted to the brain about basilar membrane vibration. However, a tone producing peak vibration in that region may be detected by off-frequency listening (Kluk & Moore, 2006). The extent of a cochlear dead region is indicated in terms of its edge frequency (fe). This fe corresponds to the characteristic frequency (CF) of the inner hair cells and/or neurons, which are immediately adjacent to the cochlear dead regions (Moore, Huss, Vickers, Glasberg & Alcantara, 2000).

Research carried out in animals suggests that any injury in the basal region of the cochlea results in high-frequency cochlear dead region which in...
turn leads to cortical reorganization, such that frequencies just lower than the edge frequency of the cochlear dead region get over-represented. This is because the neurons that are cut down from the peripheral inputs start responding to the stimuli with frequencies close to the fe of the hearing loss.

Various studies have been carried out in the human ear as well and have evidenced cortical reorganization and over representation in the auditory cortex of individuals with cochlear dead regions. This has been widely studied and depicted through frequency discrimination abilities in those with cochlear dead regions (Thai-Van, Michelyl, Norena & Collet, 2002; Thai-Van et al., 2007; Kluk and Moore 2006). Thai-Van et al., 2007, reported that changes in tonotopic maps in the central auditory system are induced due to the cochlear damages. Also, they observed a local improvement in the difference limens for frequency (DLFs) at or near the edge frequency. Moore and Vinay (2009) studied and compared frequency discrimination, intensity discrimination and consonant identification in two groups, i.e., with and without acquired high-frequency cochlear dead regions. For the first task with frequency-discrimination, the ears with cochlear dead regions demonstrated improved thresholds for frequencies just lower than the fe. Also, for those subjects with unilateral cochlear dead regions, the betterment in the thresholds was seen only for those ears with cochlear dead regions. For the next task with amplitude-modulation detection, the DLIs were smaller for the ears with cochlear dead regions than for the ears without. Lastly, with the consonant identification it was found that the scores were significantly better for the ears with than without cochlear dead regions. This finding was reflected even in the case of individuals with unilateral cochlear dead regions.

Ability to detect small intensity changes can be studied using Short Increment Sensitivity Index (SISI) test (Jerger, Shedd & Harford, 1959). Typically, cochlear hearing loss leads to enhancement in the ability to detect small changes in the intensity level. Buus, Florentine and Redden (1982) reported that subjects with cochlear impairments showed higher SISI scores, and smaller difference limens (DLs) for detecting intensity modulations when compared to normal listeners at equal SLs. Difference Limen for intensity has not been studied much in individuals with cochlear dead regions. Thus, in the present study SISI test has been used to study the intensity discrimination in individuals with cochlear dead regions and also the SISI scores obtained were compared between individuals with and without cochlear dead regions.

Aims of the study

To study and compare the intensity discrimination ability in individuals having cochlear losses with and without dead regions using the SISI test.

Method

Participants: Thirty ears diagnosed as having cochlear hearing loss served as participants. The participants were divided into 2 groups, with 15 ears having CDRs and 15 ears without CDRs. All the listeners with hearing impairment underwent a battery of audiological tests to rule out conductive component (Tympanometry) and retrocochlear pathology (Reflex decay). The degree of hearing loss for the inclusion criteria for the present study ranged from mild to moderately-severe sensorineural hearing impairment. The audiometric thresholds were matched between the two groups considered in terms of degree of hearing loss and the mean thresholds for the two groups are given in Table 1. The age range of participants ranged from 20-75 years with the mean age being 55.16 years.

Table 1: Mean Audiometric thresholds and standard deviation for individuals without and with cochlear dead regions.

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Without CDRs Mean</th>
<th>Without CDRs S.D</th>
<th>With CDRs Mean</th>
<th>With CDRs S.D</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 Hz</td>
<td>33.33</td>
<td>5.56</td>
<td>29.33</td>
<td>5.97</td>
</tr>
<tr>
<td>500 Hz</td>
<td>37.00</td>
<td>5.92</td>
<td>34.66</td>
<td>6.21</td>
</tr>
<tr>
<td>750 Hz</td>
<td>43.00</td>
<td>8.62</td>
<td>42.33</td>
<td>8.88</td>
</tr>
<tr>
<td>1000 Hz</td>
<td>47.33</td>
<td>9.04</td>
<td>47.00</td>
<td>8.88</td>
</tr>
<tr>
<td>1500 Hz</td>
<td>51.33</td>
<td>6.93</td>
<td>57.00</td>
<td>6.81</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>59.33</td>
<td>5.30</td>
<td>61.66</td>
<td>5.21</td>
</tr>
<tr>
<td>3000 Hz</td>
<td>64.00</td>
<td>5.73</td>
<td>67.33</td>
<td>6.12</td>
</tr>
<tr>
<td>4000 Hz</td>
<td>67.33</td>
<td>6.78</td>
<td>70.00</td>
<td>7.04</td>
</tr>
</tbody>
</table>

Test environment: All the evaluations were carried out in a sound-treated suite. The noise levels were maintained within permissible limits, as per ANSI S3.1-1999.

Instrumentation: A calibrated two channel diagnostic audiometer, ORBITER-922, version-2 coupled with headphones (TDH-39) and bone vibrator (B-71) were used to estimate the pure-tone thresholds and speech identification abilities. A calibrated middle ear analyzer, GSI Tymptstar version-2 was used to carry out immittance evaluation. A Philips 729K CD player was used to present the stimulus to carry out TEN test.
Procedure

**Pure Tone Audiometry:** Madsen Orbiter 922 clinical audiometer was utilized to obtain the audiometric thresholds. Frequencies from 250 Hz to 8000 Hz were tested for air conduction thresholds using TDH-39 headphones. Bone conduction thresholds were measured for frequencies from 250 Hz to 4000 Hz using a Radio Ear B-71 bone vibrator. Modified Hughson-Westlake (Carhart & Jerger, 1959) was used to measure the audiometric thresholds.

**Immittance evaluation:** Tympanometry and reflexometry were carried out to confirm normal middle ear functioning. Acoustic reflexes were obtained at 500, 1000, 2000 and 4000 Hz.

**The Threshold Equalizing Noise (TEN) test:** Once the diagnosis of sensori-neural hearing loss was made, each subject was subjected to TEN (HL) test (Moore, Glasberg & Stone, 2004) for the identification of cochlear dead regions. For the administration of this test, the TEN (HL) CD was played utilizing a Philips 729K CD player and the stimuli were presented through the Madsen Orbiter-922 clinical audiometer with TDH-39 earphones. Test was carried out at 500, 750, 1000, 1500, 2000, 3000 and 4000 Hz. The attenuators controlled the level of the signal and the TEN level in the audiometer. As recommended by Moore et al. (2004), the level of the signal was varied in 2 dB steps to obtain the masked thresholds. The criteria as suggested by Moore et al. (2004) were incorporated to determine the presence or absence of a cochlear dead region at a particular frequency. If the masked threshold in the TEN was 10 dB or more above the TEN level/Equivalent Rectangular Bandwidth Noise (ERBN), and the TEN elevated the absolute threshold by 10 dB or more, then a cochlear dead region was assumed to be present.

**SISI test:** Short Increment Sensitivity Index (SISI) test (Jerger, Shedd, & Harford, 1959) was administered in each subject to find out the individual’s ability to detect 1 dB increments. A continuous tone was presented at 20 dB above the absolute threshold (20 dB SL). The presentation level for SISI administration ranged from 45 to 90 dB HL. The level was increased by 1 dB every five seconds, with a rise or fall time of 50 ms, and steady state duration of 200 ms. Larger 5 dB and 2 dB increments were used to familiarize the patient with the task. Catch trials were presented to control false positives and to eliminate rhythmic responding. The subject was asked to indicate whenever a small jump in loudness was heard and 20 test increments were presented. The number of increments to which a patient responded multiplied by 5 gave the SISI scores in percentage.

Results

The data collected for the present study from 30 ears, were subjected to statistical analyses using SPSS version 15.0. Statistical analyses were done to compare the data for intensity discrimination across the two groups i.e. participants with cochlear losses without dead regions and participants with cochlear dead regions. Analyses revealed that the mean percentage SISI scores were more for the individuals with cochlear dead regions than in the individuals without cochlear dead regions. The mean and standard deviation for the intensity discrimination for both the groups are given in Table 2.

**Table 2: Mean and standard deviation of SISI scores for individuals with and without cochlear dead regions.**

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Individuals with cochlear dead regions (%)</th>
<th>Individuals without cochlear dead regions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Standard deviation</td>
<td>Mean Standard deviation</td>
</tr>
<tr>
<td>250</td>
<td>38.67 34.19</td>
<td>12.67 17.41</td>
</tr>
<tr>
<td>500</td>
<td>36.67 34.36</td>
<td>9.67 14.81</td>
</tr>
<tr>
<td>750</td>
<td>34.62 36.65</td>
<td>8.57 14.6</td>
</tr>
<tr>
<td>1000</td>
<td>37.69 38.97</td>
<td>8.93 17.77</td>
</tr>
<tr>
<td>1500</td>
<td>45 38.27</td>
<td>10 22.18</td>
</tr>
<tr>
<td>2000</td>
<td>53.13 32.61</td>
<td>11.43 23.81</td>
</tr>
<tr>
<td>3000</td>
<td>81.43 36.71</td>
<td>20 11.43</td>
</tr>
<tr>
<td>4000</td>
<td>90 15.49</td>
<td>22.92 36.58</td>
</tr>
</tbody>
</table>

As depicted in Figure 1, it can be seen that the SISI scores in percentage was more for individuals with cochlear dead regions when compared to the individuals without cochlear dead regions at all the frequencies. Also, it can be noticed that there was an increase in SISI scores with increase in frequency.
Repeated measure ANOVA was done to compare the percent SISI scores among the two groups. The analysis revealed a significant difference at 250 Hz \[ F (1, 28) = 6.88, p < 0.05 \]; 500 Hz \[ F (1, 28) = 7.80, p < 0.01 \]; 750 Hz \[ F (1, 28) = 6.05, p < 0.05 \]; 1000 Hz \[ F (1, 28) = 6.24, p < 0.05 \]; 1500 Hz \[ F (1, 28) = 8.24, p < 0.01 \]; 2000 Hz \[ F (1, 28) = 11.94, p < 0.01 \]; 3000 Hz \[ F (1, 28) = 12.72, p < 0.01 \] and 4000 Hz \[ F (1, 28) = 18.08, p < 0.01 \]. The results also showed significant difference in SISI scores across frequencies in the group with cochlear dead regions \( p < 0.05 \) but the SISI scores across frequencies in the group without cochlear dead regions did not approach statistical significance \( p > 0.05 \).

**Discussion**

The Threshold Equalizing Noise (TEN) test was used in the present study to detect cochlear dead regions, to group them into individuals with and without cochlear dead regions. TEN test was preferred over the psychophysical tuning curves (PTCs) as recent studies report higher sensitivity of TEN to detect cochlear dead regions when compared to PTCs (Vinay & Moore 2007).

Based on the results obtained by the statistical analyses, there was a significant difference in SISI scores between individuals with and without cochlear dead regions at equal SLs. The possible reason for the increase in SISI scores in individuals with cochlear dead regions may be due to enhanced intensity discrimination abilities in parallel with the enhanced frequency discrimination on the task for DLF (Kluk & Moore, 2006; Thai-Van et al., 2007).

Studies have reported that there is enhancement in the frequency discrimination in participants with cochlear dead region. This enhanced frequency discrimination was reported at the frequencies near the f<sub>e</sub> of the cochlear dead region (Thai-Van et al., 2002; Thai-Van et al., 2007; Kluk & Moore 2006). Modified neural representation of the primary auditory cortex has been demonstrated in those with cochlear damages (Robertson & Irvine, 1989). When the auditory threshold due to a peripheral damage at a particular frequency become abnormally elevated, the neurons with initial characteristic frequencies falling in such a place will develop lower threshold to frequencies whose cochlear place was at the f<sub>e</sub>. This is because, auditory cortical neurons to which direct cochlear input are cut down due to a cochlear dead region starts responding to cochlear regions for which significant input is still present (Thai-van et al. 2002).

Thai-van et al. (2002) reports locally improved thresholds near the edge frequency of the cochlear dead region and attributes it to cortical reorganization. Cortical re-organization and over-representation may be the reason for enhanced loudness perception in the present study. However, at higher presentation levels the responses may have been from adjacent frequency regions.

Better abilities in intensity discrimination abilities were also obtained in a study conducted by Moore and Vinay (2009). Amplitude-modulation detection was the task used where in statistically significant enhanced (better) threshold was obtained for the ears with cochlear dead regions than for the ears without. Also, for those individuals with unilateral cochlear dead regions, thresholds were enhanced for the ears with cochlear dead regions than for the ears without. They reported that this improved amplitude modulation detection thresholds could be associated with loudness recruitment. However, they believed that loudness recruitment was unlikely to have influenced the difference in the results obtained between the two groups as the ears were matched in terms of audiometric thresholds for low-frequencies, with the amount of loudness recruitment caused by cochlear hearing loss being closely related to the amount of hearing loss (Miskolczy-Fodor, 1960; Moore, Vickers, Plack & Oxenham (1999); Moore, et al., 2004). Thus, the most likely explanation they reported for obtaining better amplitude modulation detection for ears with than without cochlear dead regions was that the enhanced loudness perception was an outcome of cortical re-organization for the ears with cochlear dead regions. The authors thus concluded that the cortical over-representation of the low-frequency region of the cochlea that happens as a consequence of high-frequency cochlear dead region might result in a more rapid than normal growth of loudness as the intensity increases, and this in turn might lead to enhanced ability in terms of loudness perception.

The Increase in SISI scores with increase in frequency in the present study was unlikely, as these frequencies fell within the cochlear dead region. This can possibly be attributed to the larger excitation pattern seen at the higher frequencies as the presentation level was high at higher frequencies. This large excitation pattern would initiate the firing of the surviving neurons by off-frequency listening and because the surviving neurons have larger representation in the cortex, it may aid in better detection of small changes in intensity, which is reflected in SISI.
scores at high frequencies. The same was not seen in the lower frequencies, which can be attributed to relatively smaller excitation because of a lower presentation level. Unlike the DLFs, where there is local improvement near edge frequency, improved amplitude detection thresholds across the frequencies were also seen in the study conducted by Moore and Vinay, 2009 and the effect was not confined to a narrow frequency range just below the edge frequency.

Conclusions

The present study was carried out to analyze intensity discrimination in participants with cochlear losses with and without dead regions using the SISI test. Individuals with cochlear dead regions obtained good SISI scores at all frequencies which is typical of cochlear hearing loss. Individuals with cochlear dead regions obtained better SISI scores when compared to individuals without cochlear dead regions. Hence, individuals with cochlear dead regions exhibited better intensity discrimination ability at equal SLs.

The enhanced intensity discrimination can be attributed to cortical reorganization and over-representation in the auditory cortex for intensity in individuals with cochlear dead regions. However, increase in SISI scores at higher frequencies could be because of the larger excitation pattern as the presentation level was high at these frequencies.

Future considerations

Further studies need to be carried out on a larger population, with slope matched controls. Studies on intensity discrimination in cochlear dead regions have to be carried out incorporating other tests or methods to measure smallest detectable changes like modulation detection, discrimination of gated or pulsed stimuli. Comparison across edge frequencies is suggested.

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References


