Disfluencies in 5.1 to 6 year old Kannada speaking children

Anjana B Ram & Savithri S.R

Abstract

Speech samples of 20 Kannada speaking children were analyzed to identify the disfluencies. Frequency and types of disfluencies and the effect of gender on disfluencies were analyzed. Results showed that majority of the children had almost all the disfluency types. The most prominent disfluency type was sound repetitions. Also, boys, in general, showed greater percentage of disfluencies compared to girls.

Key words: Fluency, Disfluency, Dysfluency

Fluency, according to ordinary usage, is the ability to speak a second language rapidly and continuously and without any particular effort or thought. The term fluency is derived from the Latin root “fluere”. In communication, it refers to the smooth and easy flow of utterance. Technically, fluency is the effortless production of long, continuous utterances at a rapid rate. There are several definitions of fluency stated by different authors. Fluency refers to the general phenomenon of the flow or rate of speech, influenced by variables such as duration of individual sounds and syllables, duration of sounds and syllables in relation to adjacent sounds and syllables, duration of pauses, presence of stress contrasts and degree of co-articulation (Starkweather, 1980). Adams (1982) stated that fluency connotes the continuous, forward flowing and co-ordinated manner of speech. According to Myers (1988), fluency encompasses the synchrony of the speech processes and the continuity of thought and language, as well as the synergistic interaction between the speech and language components of the communication systems.

Disfluency has been defined by the American Speech-Language and Hearing Association (ASHA) Special Interest Division (SID) 4 as speech that exhibits deviations in continuity, smoothness, and ease of rate and effort (ASHA SID4, 1999). Terms disfluency or non fluency suggest disruptions in the timing and flow of non stuttered speech such as interjections and phrase repetitions that are often perceived as being part of the normal interruptions of speech. Hence, in very simple terms, one could consider disfluency as the opposite of fluency.

Dysfluency, however, signifies abnormality of fluency; it includes, but is not limited to stuttering (Wingate, 1984). Fluency is thus the basic referent from which contrasting words are constructed by adding to “fluency,” the qualifying prefixes: “dis” (or “non”) and “dys.” Stuttering refers to “disorders in the rhythm of speech in which the individual knows precisely what he wishes to say, but at the time is unable to say it because of an involuntary, repetitive prolongation or cessation of a sound.” (WHO, 1977).

Most people experience instances of disfluency in their speech that would not be considered stuttering. Normal disfluencies reflect a temporary stage of language learning and communication development. Distinguishing between disfluencies that are normal and those that represent the danger of incipient stuttering is a critical skill for speech-language pathologists.

Interruptions in the flow of speech commonly referred to, as disfluencies are the most obvious features of stuttering. Further, disfluent events are obligatory signs of stuttering and have been the most frequently used parameter to describe, define and measure the disorder. Disfluencies, however, are also found in the speech of speakers who are not regarded as exhibiting stuttering. This fact has resulted in several different ways in which disfluencies played a prominent role in theories of stuttering especially those pertaining to the inception of the disorder during early childhood. For example, difficulties in distinguishing normal from abnormal disfluencies, causing parents to erroneously diagnose interruptions in their children’s speech as “stuttering” was at the heart of the diagnosogenic theory (Johnson, Boehmler, Dahlstrom, Darley, Goodstein, Kools, Neelley, Prather, Sherman Thurman, Trotter, Williams, & Young, 1959). Taking a different theoretical perspective, Shames & Sherrick (1963) proposed that selective reinforcement of initially normal disfluency was the essential element in operant learning processes presumed to eventuate in stuttering.

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Disfluencies have frequently been utilized in various practical applications. Yairi (1997) stated that disfluency counts have been the classic metric of the disorder for both clinical and basic research and have been employed as the dependent measure in numerous studies of stuttering. Clinically, the number of disfluencies, especially of certain types has been regarded as the most important index of stuttering severity (Van Riper, 1971). Analyses of disfluency have been weighted heavily in instruments of evaluation and diagnosis of early childhood stuttering, especially in differentiating between normal disfluency and incipient stuttering (Adams, 1977; Curlee, 1980; Pindzola & White, 1986; Campbell & Hill, 1987; Gorden & Luper, 1992, Ambrose and Yairi, 1999). Disfluency counts have also been used in formal and informal instruments designed to predict stuttering chronicity (Riley, 1981; Cooper & Cooper, 1985; Conture, 1990; Curlee, 1993). Over the years, researchers have investigated speech disfluencies of normally fluent young children. These studies have been successful in better understanding the expected speech behaviors of young children (Davis, 1939; Branscom, Hughes & Oxtoby, 1955; Egland, 1955; Yairi & Clifton, 1972; Yairi & Jennings 1974; Haynes & Hood, 1977; Wexler, 1982; Wexler & Mysak, 1982; De Joy & Gregory, 1985; Carlo & Watson, 2003).

Although the descriptions of early speech disfluencies in young children have been extensive, these investigations are almost focused on disfluencies of speech of English speaking children from Anglo-European, African-American, Hispanic, and Spanish cultures. Because stuttering is a fluency disorder observed across languages and cultures (reviews by Van Riper, 1971; Bloodstein, 1995; Cooper and Cooper, 1998; Shapiro, 1999; Van Borsel, Maes and Fonlon, 2001, among others) understanding disfluencies in the speech of young children in culturally and linguistically diverse backgrounds is essential. In the Indian context, Indu (1990), Nagapoornima (1990), Yamini (1990) and RajendraSwamy (1991) proposed a fluency test each in different age groups in Kannada, a south Indian Dravidian Language. This was based on disfluency data of 12 children in the age groups of 3-4 (Nagapoornima), 4-5 (Indu), 5-6 (Yamini) and 6-7 (RajendraSwamy) years. Simple pictures, cartoons and pictures depicting Panchatantra stories were used in these tests. A total disfluency of greater than 25 – 30 % was considered to be abnormal. The percent disfluency is high because unlike in English where several iterations of sound/syllable are considered as one instance of repetition, the authors have calculated each iteration as one repetition. Thus in order to compare with the English studies, it is essential to employ the same methodology for calculating percent disfluency. Geetha, Karanth, Rao & Ravindra (2000) developed Disfluency Assessment Procedure for Children (DAPC) in Kannada. This consists of historical indicators, attitudinal indicators, behavioral (speech) indicators, articulation assessment and language assessment. Artificial Neural Network analysis indicated behavioral indicator to be a good predictor. A score of ‘0’ on behavioral indicator was obtained in children with normal nonfluency and score ranging from 3 to 20 indicated stuttering. However, a clinician will not have problem classifying a child as having normal disfluencies if s/he has ‘0’ disfluencies. Therefore, this index may not be of clinical use. Further, frequency and type of dysfluencies were measured in these two studies and not the duration. Thus, the dysfluencies in normal speaking Kannada children is not known. Given the influence of linguistic and cultural behaviors, attitudes and beliefs on fluency, (Watson & Keyser, 1994; Cooper & Cooper, 1998; Watson, 2001), one must be cautious in generalizing findings describing English speaking children to other linguistic and cultural groups. Also, an understanding of expected speech behaviours in normally fluent Kannada speaking children will be better able to differentiate more or less typical behaviors and identify stuttering within this population. Lastly, through cross-linguistic studies of fluent and disfluent speech, our understanding of fluency development in all young children, including those children who speak Kannada should be enhanced thus ascertaining the purpose of this study.

The period between 2 to 6 years is of great concern in studying disfluency patterns. Not only are children particularly disfluent during these ages (Muma, 1971), but also, the onset of stuttering is most frequently observed during this period of development (Johnson, 1959; Van Riper, 1971). Since the relationship between normally disfluent speech and early stuttering continues to be of theoretical interest (Yairi, 1981), researchers view the establishment of “normal expectations of disfluency” (Wexler & Mysak, 1982) for various preschool age groups as theoretically and diagnostically important. Research is needed to specify the number, type and duration of speech disfluencies that occur in the speech of children between 2 to 6 years. While several studies carried out in the past are of tremendous assistance, they still do not make clear what the central tendencies and variability of speech disfluencies are for 2 yr olds, 3 yr olds and so forth. Without this information it is hard to assess
the extent to which a child suspected or known to be a stutterer deviates from his or her age norms or how closely an individual normally fluent child approximates them. Therefore, the purpose of the study was to describe the speech disfluencies in 5-6 year old Kannada speaking children. The objectives of the study were to investigate (a) number and type of speech disfluencies exhibited by 5.1-6 year old Kannada speaking children, and (b) to investigate the interaction of gender on the total percentage of speech disfluencies.

Method

Subjects: Twenty children (10 boys and 10 girls) in the age range of 5.1-6 years participated in the study. Only native speakers of Kannada and children with no history of speech, language or hearing problems, no orofacial abnormalities and no neurological problems were taken. Children were screened for voice, articulation, fluency and language. Oral mechanism examination and hearing screening was carried out to rule out any abnormality.

Material: Material was developed for the study. Material included pictures, cartoons and pictures depicting Panchatantra stories.

Procedure: Speech samples were elicited and audio-recorded using the material and care was taken to ensure that the sample was no less than 5-minute duration of the child’s talking. 500-word sample from each child was taken for the study. Conture (1990) noted that the sample size should be sufficient to permit averaging across several 100-word samples.

Analyses: The recorded samples were transcribed verbatim and the presence of the following disfluencies were analyzed, using the adaptations of classification systems described by DeJoy (1975), Yairi (1981), DeJoy and Gregory (1985), Campbell and Hill (1987) and Carlo and Watson (2003). Accordingly, various dysfluencies were described as follows.

1. Sound repetition (SR) - Repetition of a phoneme that does not stand alone as an intended syllable or word.
2. Single - syllable word repetition (SSWR) – Repetition of whole one syllable word.
3. Multi-syllabic word repetition (MSWR) - Repetition of words of more than one syllable.
4. Phrase repetition (PR) - Repetition of two or more words, with no revision or modification of content.
5. Interjection (I) - Insertion of sounds, syllables, words or phrases within an utterance. These insertions are not associated with the fluent or meaningful text and are not part of the intended message.
6. Revision(R) - Modification in the content or grammatical form of an utterance. Revision also includes changes in the pronunciation of a word.
7. Broken word (BW)- Momentary cessation of phonation within words.
8. Prolongations (P) - Audible prolongation of sounds within or at the end of words that are judged to be not intended.

The disfluencies were further classified as SLD (Stuttering like Disfluencies) and OD (Other Disfluencies) as stated by Young (1984) and Yairi and Ambrose (1992). Accordingly, Sound Repetitions, Single Syllable Word Repetitions, Broken Words and Prolongations were considered Stuttering-like Disfluencies (SLD). Although these types of disfluencies are also found in the speech of non stutterers, various investigators have reported that they are the most typical disfluencies in the speech of stutterers. Multi syllabic word repetitions, Phrase repetitions, Intejections and Revisions were classified as Other Disfluencies (OD).

The percentage of disfluencies was calculated using the formula given below:

\[
\text{% disfluency} = \frac{\text{Total number of disfluencies}}{\text{Total number of syllables}} \times 100
\]
Percentage of particular type of disfluency will be calculated as follows:

\[
\% \text{ type of disfluency} = \frac{\text{Total number of particular type of disfluency}}{\text{Total number of syllables}} \times 100
\]

Results

Disfluency analysis (Group Data)

Frequency of individual disfluency types was computed. Group mean for total disfluency was 5.16 with a SD of 3.38. Several types of disfluencies were present in the group data. Sound repetitions (SR) and Multisyllabic word repetitions (MSWR) were present predominantly for the subjects with means and standard deviations of 1.71, 2.35 and 1.47, 1.02 respectively. The least occurring disfluencies were broken words with a mean of 0.02 and SD 0.06 followed by prolongations with mean of 0.06 and SD 0.09. Table 1 shows the mean and SD values for each of the eight disfluency types.

<table>
<thead>
<tr>
<th>Type of disfluency</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
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<tr>
<td>TD</td>
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<td>5.1685</td>
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<td>2.4512</td>
</tr>
<tr>
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<td>20</td>
<td>2.9275</td>
<td>1.3226</td>
</tr>
<tr>
<td>SR</td>
<td>20</td>
<td>1.7090</td>
<td>2.3479</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>I</td>
<td>20</td>
<td>0.3810</td>
<td>0.3990</td>
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<tr>
<td>BW</td>
<td>20</td>
<td>0.0200</td>
<td>0.0615</td>
</tr>
<tr>
<td>P</td>
<td>20</td>
<td>0.0600</td>
<td>0.0940</td>
</tr>
</tbody>
</table>

Table 1: Group mean values for the different types of dysfluencies in percent (TD=Total Disfluency)

T-test indicated significant difference between genders on Sound Repetitions (t (9) =1.344, p<0.05) and Stuttering like disfluencies (t(9)=1.380, p<0.05). No significant difference (p>0.05) was found between genders on any other individual type of disfluency and on other disfluencies. However, boys had more disfluencies than girls on all types of disfluencies except MSWR, PR and prolongations. Table 2 shows percent disfluencies in boys and girls.
Subject distribution in total disfluency

All the 20 children taken for the study exhibited MSWR (other disfluency) in their speech. Almost greater than 15 children showed all the other disfluency types. The types least noted in these children were broken words followed by prolongations (stuttering like disfluencies). Figure 1 shows the frequency of distribution of children across disfluency types.

<table>
<thead>
<tr>
<th>Type of disfluency</th>
<th>Gender b/g</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t value</th>
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<td>SLD</td>
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<tr>
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<td>10</td>
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<tr>
<td>R</td>
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<td>0.49710</td>
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<tr>
<td>I</td>
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<td>g</td>
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<tr>
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<td>g</td>
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<td>0.10328</td>
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</tbody>
</table>

Table 2: The mean and SD of disfluencies per 100 words identified in the speech of 20 5-6 year old children (b-boys, g-girls).

Discussion

Percent disfluency obtained in this study is very low compared to that obtained by Yaminin (1990) in 5-6 years old Kannada speaking children. This is because Yaminin (1990) had considered each iteration as one repetition. However in the present study, several iterations of sound / syllable repetitions were considered as one instance of repetition which is in accordance with several Western studies.

The results reveal that speech of 5-6 year old normal speaking children contains almost all the disfluency types. High proportions of SR and MSWR found in this study support earlier findings by Egland (1955) and Yairi & Clifton (1972). The findings, however, are not in congruence with those obtained by Yaminin (1990) who found that syllabic repetitions occurred relatively lesser in 5-6 year old
children. Moreover, the discrepancy between the results of this study and the earlier studies could be due to variability in the amount and types of disfluencies by young children as reported by a number of investigators (Haynes & Hood, 1977; Yairi, 1981; Wexler & Mysak, 1982; DeJoy & Gregory, 1985).

Also no significant gender differences were obtained in this study for percentage of total disfluencies. This finding supports the earlier studies which have found no statistically significant differences in the total number of speech disfluencies or in most disfluency types exhibited by English speaking boys and girls (Kools & Berryman, 1971; Haynes & Hood, 1977; Yairi, 1981, 1982; Yairi & Lewis, 1984; Ambrose & Yairi, 1999; and Spanish speaking children (Carlo and Watson, 2003). In this study however significant sex differences were obtained for sound repetitions only, which is considered as an immature type of disfluency and found predominantly in the younger pre school years (Haynes and Hood, 1977, DeJoy and Gregory, 1985, Ambrose and Yairi, 1999). This supports the hypothesis that girls mature faster than boys. Also significant gender differences were also obtained for Stuttering Like Disfluencies (SLDs) with boys showing significantly higher percentage of SLDs than the girls. This shows that boys are at a greater risk for stuttering than girls.

Conclusions and implications

The results of this study provide primitive normative values of dysfluencies in 5-6 year old Kannada speaking children. The study thus provides a base for determining normative disfluency scores in other Indian languages.

Further work can be undertaken to probe into the duration and grammatical aspects of disfluencies and clustering or grouping of disfluencies in 5-6 year old Kannada speaking children. Also employing bigger sample of children is warranted to provide clear-cut normative cut off scores for the different types of dysfluencies.

References


Acknowledgements
This study is an outcome of the doctoral research of the corresponding author. The authors would like to thank Dr. Vijayalakshmi Basavaraj, Director, All India Institute of Speech and Hearing for granting permission to carry out this study.
Diversities among Individuals with Cluttering

Arpana Bagchi & Rajasudhakar. R

Abstract

Cluttering is a disorder of speech and language processing, resulting in rapid, dysrhythmic, sporadic, unorganized and frequently unintelligible speech. Accurate prevalence figures are not known due to lack of adequate definitions and a significant proportion of clutterers do not seek treatment. Lack of academic training, lack of experience with clutterers and lack of published information are some of the reasons for not focussing on cluttering, a fluency disorder. The present study made an attempt to describe four clients who exhibited cluttering - cluttering symptoms by comparing their case file information. The study focused predominantly on the differential diagnosis of cluttering and other fluency disorders. Because cluttering is a syndrome, some of its identifying symptoms are shared by individuals with stuttering. In clutterers, the distinguishing traits include lack of awareness of communication difficulties, poor self monitoring of speech output, subtle impairment of language formulation problems and family incidence of similar communication problems. Also, the study illustrates the individual variability among individuals who clutter and their heterogeneous clinical manifestations. The possible overlap of between certain features of cluttering and stuttering were also discussed. To conclude that cluttering is a fluency disorder but not same as stuttering which can be getting hold of more systematic information on the nature and symptomatology of cluttering for identifying possible subtypes.

Key words: Prevalence, Stuttering, Tachylalia, Heterogeneity

Traditionally, cluttering has been viewed as a fluency disorder. It is thought to be congenital in nature and is often called a syndrome because of the myriad of symptoms reported to characterize it. Like stuttering (a fluency disorder), cluttering is difficult to define. Weiss (1964) asserted that cluttering is not a specific, isolated disturbance of speech. He maintained that cluttering is the verbal manifestation of central language imbalance in the area of verbal utterance. St. Louis (1992) defined cluttering as a speech-language disorder whose chief characteristics are 1) abnormal fluency that is not stuttering and 2) a rapid and/or irregular speech rate. Daly (1992) defined cluttering as a disorder of both speech and language processing which manifests itself as rapid, dysrhythmic, sporadic, disorganized and frequently inarticulate speech by a person who is largely unaware of or unconcerned about these difficulties.

The definitions and descriptions mentioned above reflect researcher’s attempts to examine the specific characteristics they believe to represent cluttering. Each definition is distinguished by each author’s perception of the salient characteristics of cluttering. Froeschels (1946) believed that cluttering was caused by incongruity between thinking and speaking. Weiss (1964) listed out three obligatory symptoms that were pathognomonic and essential for diagnosis are: a) Excessive repetitions of speech b) short attention span and poor concentration and c) lack of complete awareness of the problem.

More than four decades ago, Weiss (1964) called cluttering an orphan in the family of speech-language pathology, because it had been neglected and treated as an illegitimate relative of stuttering by most Speech-language pathologists. Many researchers agree that cluttering presents as a syndrome, which may manifest itself differently in different individuals. Daly and Burnett (1999) viewed cluttering as an offspring of stuttering, but more as fraternal twins, cluttering and stuttering are similar in some ways, but vastly different in others. Weiss (1964), Lushsinger and Arnold (1965), Van Riper (1970), Daly (1996) and Daly and Burnett (1999) have compared and contrasted between cluttering and stuttering. Table 1 displays some of the similarities between cluttering and stuttering.

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Although cluttering often has been compared with stuttering and referred to as a fluency disorder. Most often, many clinicians find it difficult to differentiate between stuttering and cluttering based on judgement of discontinuities in speech being atypical or abnormal. Individuals who clutter might also stutter. Conversely, those who stutter may exhibit other concomitant speech and language problems, but the presence of other difficulties may not be indicative of cluttering.

Some of the issues and controversies about cluttering are unlike stuttering. The purpose of this study is to raise critical issues regarding the nature of cluttering and to provide some clinical guidelines for the assessment and treatment of this multifaceted disorder. That is, a) Does cluttering exists as a disorder distinct from stuttering? b) Do clutterers have co-existing articulation and language disorders? c) Is cluttering the result of an underlying organic/genetic factor? d) Are rate difficulties vital to cluttering? The answers for these questions posed might be cleared by discussing some clinical case reports. The following are summary of case profiles of four individuals with fluency problems. These clients were fascinating because there were many overlapping features of stuttering and cluttering. Also attempts were made to correlate the clinical features exhibited by individuals who clutter with the literature.

All the clients reported below were diagnosed by Speech language pathologist of more than 5 years of experience in assessing and treating fluency disorders and a clinical psychologist where, all the clients showed normal intelligence defined as a full scale IQ greater than 80 on WISC (The Wechsler Intelligence Scale for Children) and WAIS (Wechsler Adult Intelligence Scale). An ex post-facto research design was used to study the four clients with cluttering.

### Case Reports

Subject 1: A 20 year adult male was reported with a complaint of fast rate of speech since childhood. Initially, he was not aware of his problem. His parents and friends made him aware by insisting to speak slowly. His mother had the same problem during childhood but could overcome it without any speech therapy. General speech evaluation revealed fast rate of speech, festinating speech, repetition of words, occasional filled pauses, unfilled pauses, removal of natural pauses and inappropriate use of vocal punctuation marks. In addition to these dysfluencies, the evident articulatory errors noticed were week syllable deletion, cluster reduction, simplification of multisyllabic words, metathesis, omissions and distortion of /s/ and /ʃ/ sounds. His Diadochokinetic (DDK) rate was 11-13 syllables/second. Narration and conversation revealed noted simplification of sentences and poor grammar. His reading was characterised by skipping of lines and words and lack of pauses between sentences. His writing sample revealed repetition of words like ‘in’ and some grammatical errors like confusion of articles (‘a’ for ‘an’) and also with plurals (‘this’ for ‘these’ and ‘a’ for ‘an’). Some secondary behaviour noted were eye blinking, frequent gulping of air/inhalation and hand movements. The patient reported to have academic difficulties till seventh standard but after that, his academic skills has improved.

Subject 2: A 22 year male presented with a five year history of unintelligible speech. The course of onset was sudden (i.e. due to parent’s fight and family tensions). Initially he was not aware of the problem but become aware when others insisted him to speak slowly. His elder brother had the same problem. The client has difficulty in paying attention for longer time. General speech evaluation revealed fast rate of speech, festinating speech, jumbling of syntactic structure, omissions, repetitions, prolongations and pauses. Among pauses, filled pauses were more apparent. Misarticulations of /s/ and /ʃ/ sound were found to be more apparent in the initial position. His

<table>
<thead>
<tr>
<th>Features</th>
<th>Cluttering</th>
<th>Stuttering</th>
</tr>
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<tbody>
<tr>
<td>Rapid rate of speech</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Breathing dysrhythmia</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Silent pauses; hesitations</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Interjections; revisions; filler words</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Poor oral coordination</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Poor eye contact</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Family history</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 1: Similarities between cluttering and stuttering
maximum phonation duration was 32 sec for /a/ and /i/ and 28 sec for /u/. His DDK rate was 13 syllables/second and reading rate was 197 words/minute. There were very few instances of situational variability reported like avoiding speaking in professional seminars and facing interviews. Avoidance of eye contact was observed frequently.

Subject 3: A 30 year adult male reported with the complaint of mispronunciation of /l/, /η/, /ʃ/, and /ɔ/ sounds apparently more in initial position. His problem tends to worsen when he is under stressful condition like talking to elders and higher authorities. The problem was reported to have started due to wrong modelling of teachers. Poor attention span was reported. Initially he was not aware of his problem. Become aware when his friends told him to speak slowly. Reported to have problem only in Kannada language and occasionally substitutes some sounds in Tulu for Kannada. General speech evaluation revealed festinating speech and fast rate of speech, but the DDK was found to be slightly more than the normal (8-9 syllables/second). Kannada Articulation Test (KAT) was administered and it revealed that the client has distorted production of liquids and nasal sounds. Also, these errors were found to be situational (i.e. under stress, while talking to elders and higher authorities)

Subject 4: A 10 year old male child was brought with the complaint of unintelligible speech since five years. Initially, the child and his parents were not aware of the problem. They become aware when the clients’ teacher informed the parents. The client was hyperactive and talkative. General speech evaluation revealed fast rate of speech, whole word repetitions, prolongations, frequent pauses and hesitations. DDK rate was 7-9 syllables/second and maximum phonation duration was 10 seconds for /a/, /i/ and /u/. Oral cavity examination revealed normal structure and function except high arched palate, due to which the client could not make a contact with palate. KAT was administered and the sounds misarticulated in isolation and in word level included /l/, /v/, /n/, /l/, /ʃ/, /z/ and /d/. Distortion errors were more evident in clusters. His reading was characterised by repetition of sounds and words. The patient was academically an average student. Problems in writing noted were occurrence of spelling mistakes seen in Kannada.

Discussion

The common features noted in the four clients were unawareness of their problem, fast rate of speech, reduced attention span, repetition of words and phrases and articulation problem specifically in the production of sibilant sounds (subject 1 and 2 showed distortion of /s/ and /ʃ/ sounds, subject 3 showed misarticulation of /ʃ/ and subject 4 showed distortion of /s/ and /z/ sounds). This is in agreement with Weiss’s (1964) obligatory symptoms who stated that lack of awareness, poor attention and concentration and excessive repetition of words are essential for diagnosis of cluttering. In contrast, individuals who stutter do not exhibit ‘lack of awareness’ of the problem. Daly and Burnett (1999) also reported that individuals who stutter are aware of their speech problem unlike clutterers.

Daly and Burnett (1999) reported that rapid rate of speech is one of the frequently reported symptoms associated with cluttering. But it should not be used alone as an indicator to diagnose cluttering because even a person with stuttering exhibit fast rate of speech. Further, Weiss (1964) added that signs of faulty integration may be better criteria. Subjects 1 and 4 showed weak syllable deletion, cluster reduction, simplification of multisyllabic words, and additions and omissions of sounds. All these features can be attributed to the language difficulties. Hence the symptoms exhibited by four cases were in support with the findings of Daly and Burnett (1999) who reported that the clutterers have inability to integrate and execute multistep complex task or disorganized thoughts. The omission of sounds and deletion of syllables in these subjects are attributed to coarticulation effect (Preus, 1992) who reported that the high degree of coarticulation resulting in omissions of sounds and syllables.

Amazingly, all the four clients showed rapid and accelerated rate of speech. Subject 1, 2 and 3 even exhibited festinating speech, which is believed to be one of the core features of cluttering (Wohl, 1970). In contrast, individuals who stutter do not exhibit festinating speech. Many of the clients in the study were found to have anomalies in the production of sibilants (/s/, /ʃ/ and /z/), liquids (/l/, and /l/) and nasals (/n/, and /ŋ/) and stops (/d/). 26% and 29.2% of speech therapist from USA and UK respectively, reported that misarticulations were observed in individuals with cluttering (St. Louis and Hinzman, 1986; St. Louis and Rustin, 1989). Daly and Burnette (1999) also reported that the articulatory errors are seen in clutterers as a coexisting features, and the present findings (articulatory errors in clutterers) supported the previous findings.
The informal writing sample was elicited from subject 1 which is characterised by incomplete sentences, inappropriate punctuation, omission of noun phrases in sentence subjects and misspelled words. Certain reading errors observed were skipping of words and lines, lack of pauses between sentences. Whereas subject 2 also showed writing errors like jumbling of syntactic structure. This error was also seen prominently during speaking. Subject 4 showed repetition and omission of words while reading and spelling mistakes while writing. Overall the writing sample of four subjects was characterised by simple sentence structure with grammatical errors or misspellings. This can be attributed to poor language formulation. Several authors have reported that clutterers do have concomitant reading (Weiss, 1968) and writing problem (Orton, 1973; Spandino, 1941; Sheperd, 1960 and Roman-Goldzieher, 1963). The written language difficulties in clutterers were associated with disorganized expressive language (Williams and Wener, 1996). The present findings support the previous findings who reported clutterers exhibit reading and writing difficulties. Daly and Burnett (1999) and St. Louis and Rustin (1989) believed that reading and writing problems may help in differentiating clutterers. Subject 3 exhibited substitution of Tulu words for Kannada words. This code switching aspect could be attributed to learnt behaviour as a coping strategy which pays way for further investigation into code switching behaviours in clutterers.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Clinical features of stuttering seen in these subjects.</th>
<th>Clinical features of stuttering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>Fast rate, repetition of words, filled and unfilled pauses, secondaries like eye blinking, frequent gulping of air and movement of hands and presence of familial history.</td>
<td>Fast rate, repetitions, silent pauses, hesitations, prolongations, interjections, revisions, filler words, word substitution, circumlocutions, secondaries, situational variability, heightened awareness of the disfluencces and familial history.</td>
</tr>
<tr>
<td>Subject 2</td>
<td>Fast rate, prolongations, omissions, filled pauses, situational variability, secondaries like poor eye-contact and presence of familial history.</td>
<td></td>
</tr>
<tr>
<td>Subject 3</td>
<td>Fast rate, prolongations, omissions, filled pauses, situational variability and secondaries like poor eye-contact.</td>
<td></td>
</tr>
<tr>
<td>Subject 4</td>
<td>Fast rate and hesitations.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Clinical features of stuttering seen in these clients as against those in stutterers.

All the four clients exhibited stuttering-like disfluencies. Table 2 indicates the clinical features of stuttering seen in these clients as against those in stutterers. The only difference is that the stuttering repetitions are sound, syllable repetitions, whereas clutterers exhibit repetitions of longer and whole words or phrases. In the contrary, individuals who stutter exhibit repetition of sounds and short words (Daly and Burnett, 1999). Further, individuals who stutter are usually dysfluent in their initial sounds when beginning to speak and become more fluent towards the end of utterance. In contrast, clutterers are fluent at the start of utterance but their speaking rate increases and intelligibility decreases towards the end of utterance. Hence the diagnosis should be based on the nature of problem the individual manifests.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Cluttering features</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Self awareness of the problem</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Attention &amp; concentration difficulties</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>Articulation difficulties</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>Reading &amp; writing difficulties</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Rate of speech</td>
<td>Fast</td>
<td>Fast</td>
<td>Fast</td>
<td>Fast</td>
</tr>
<tr>
<td>6</td>
<td>Festinating speech</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td>7</td>
<td>Family history</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>8</td>
<td>Secondary behaviours</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>?</td>
</tr>
<tr>
<td>9</td>
<td>Respiratory dysrhythmia</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3: Summary of cluttering symptoms from four clutterers
(‘-’ indicates absent; ‘+’ indicates present; ‘?’ indicates information not available from the file)

Table 3 shows the summary of cluttering features in four clients with cluttering. Comparison of symptoms exhibited by four clients, revealed that some features are present in some clients and others are not, which suggested that cluttering is a heterogeneous group. Some of them showed reading and writing difficulties, poor attention and concentration, impulsivity and verbose, but others
did not. From the above findings, probably the clients 1, 2 and 4 could be cluttering-stuttering subjects and client 3 could be a probable clutterer. Administration of Daly’s (1992-1993) check list for possible cluttering could yield appropriate diagnosis for confirmation for subgrouping which needs to be addressed further. Clients exhibiting a combination of cluttering and stuttering symptoms may be more common than previously thought. Preus (1992) suggested that cluttering and stuttering may coexist in appropriately 35% of stuttering cases. By and large, the clinician must be aware of these individual variations in the clinical picture of certain disorders like cluttering, while diagnosing and treating the disorders.

Answering the four questions which were asked earlier, cluttering exhibits as a different entity and distinct from stuttering, but from the present study it might coexists with stuttering. Also, the clutterers do have articulation and language difficulties as a co-existing disorder. All the clients reported had some familial incidence; hence it has some organic/genetic factor. The rate was relatively higher in all the four clients than in normals (DDK rate), thus the rate difficulties are vital to cluttering.

Conclusions

Since it is a retrospective study, certain details were not available from the case files. Review of literature shows that language difficulties mentioned in these clients, reading and writing problems exhibited by them and misarticulations are the typical features of cluttering and that are not seen in stutterers. Though, there is some variations in the symptom manifestation, the clinicians must be aware of these individual variations. Also, the three obligatory symptoms given by Weiss (1964) were essential for diagnosis. Hence one should be careful in diagnosing individuals with cluttering because it is often confused with stuttering. Although, clinicians must know that individuals exhibiting features of cluttering do not fit neatly into one diagnostic category. Therefore, the assessment process must be comprehensive, with thorough data collection being essential.

From the present study, clinicians and researchers will be able to identify clusters of components that accompany or contribute to cluttering. It should be possible to subgroups of cluttering, depending on the components or combinations of characteristics found in different individuals. The possible subgrouping would have direct bearing in designing appropriate treatment programs. Hence it would become a challenge, as a professional, to participate in the discovery of evaluation and treatment strategies for cluttering. It thus remains important to carry out in-depth investigation of clients who initially show sufficient symptoms to warrant a diagnosis of cluttering. Thus, the speech language pathologists should adopt the ‘orphan’ in the family of speech-language pathology and give it the care and attention it deserves.

References


**Acknowledgments**

Authors would like to extend their gratitude to Dr. T. A. Subba Rao, Principal, College of Speech and Hearing, Dr. M. V. Shetty Institute of Health Sciences, Mangalore, for his moral support and allowing us to carry out the research.
Acoustical and Perceptual Correlates of Infant Cry in Monozygotic Twins: Preliminary Study

Santosh.M, Rajashekhar.B & Shruthi Nayak

Abstract

Monozygotic (MZ) twins are similar in various aspects. The similarities in the vocal tracts may also make their voices sound similar. The aim of the study was to investigate acoustical and perceptual characteristics of infant cries in monozygotic twins. Five pairs of MZ twins within one year of age participated in this study. Acoustical and perceptual characteristics of cry were measured from hunger cry and pain cry. The results showed significant similarities within the twins. However variability existed with respect to twin pairs and type of cry signal. The results of the present study indicated that there are other factors influencing voice characteristics along with the genetic constitution.

Key words: Monozygotic twins, pain cry, hunger cry, perceptual, acoustical

Monozygotic (MZ) twins have captured the interest of science and have been the source of one of earliest means of investigating the influence of genetics. Since twins resemble each other in many aspects, one expects that their voices also may sound similar at least to a certain degree. Studies with listeners have confirmed this perspective similarity. It has been observed that twins themselves have difficulties identifying their own voices when presented with recording, in random order, of their own voice and voice of other twin (Gedda, Fiori & Bruno, 1960). Investigators in the past have also measured and compared various acoustic characteristics of twin voices, such as voice range in semitones, speaking fundamental frequency and have reported significant similarities between monozygotic twins (Debruyne, Decoster, Gijsel & Vercammen, 2002). Ryalls, Shew & Simon (2004) compared VOT in older and younger female MZ twins. Results revealed greater similarity for the younger than for older female twin pairs. Santosh and Savithri (2004) studied acoustic and perceptual characteristics in five pairs of MZ twins. They also reported similarities between twins with respect to both temporal and spectral acoustic parameters. Despite these indications, no studies exist on early cry characteristics and vocalizations in MZ twins. Accumulation of evidence about the cry characteristics will shed light on the physiological state of the MZ infants. Therefore the goal of the present study was to investigate the acoustic and perceptual characteristics of infant cries in MZ twins.

Method

Subjects: Five pairs of monozygotic twins (MZ) participated in the present study. All the twins were within one year of age. All deliveries were normal and without complications. The infants were full term and their birth weights were normal. All the twins were screened for normal speech and language. The routine postpartum examination by a pediatrician revealed ‘healthy’ for all the babies.

Table 1 shows the demographic data for all the twin pairs.

<table>
<thead>
<tr>
<th>Pair 1</th>
<th>Pair 2</th>
<th>Pair 3</th>
<th>Pair 4</th>
<th>Pair 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>T2</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
</tr>
<tr>
<td>Age(months)</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Gender</td>
<td>f</td>
<td>f</td>
<td>f</td>
<td>f</td>
</tr>
</tbody>
</table>

Table 1: Demographic data of all twin pairs (T- twin, f-female, m-male)

Experiment I: Acoustic analyses

Samples: Two types of cries - hunger and pain cry were selected in the present study. Hunger cry was elicited after 4 hours of feeding. Pain cry was elicited by pricking the sole of the foot. The average duration of the cry sample for all the twin pairs was around 50 sec.
Procedure: The cry samples were recorded using external microphone connected to digital recorder kept at a distance of 10 cm away from the mouth of the child. The recordings were line fed to the computer memory using 16 kHz sampling frequency with 12 bit A/D converter. Waveform display and spectrogram of Computerized Speech Lab (CSL 4500, Kay Elemetrics) was used for analysis. Each sample was displayed as a broadband spectrogram with a pre emphasis factor of 0.80. The analysis size and bandwidth were set to 100 points, and ‘Hamming’ window was used. Spectrograms were displayed as monochrome (black on white) and grid size used was 8x8 pixels (x grid -8 pixels and y grid -8 pixels) with a linear vertical axis. Samples were displayed on broadband spectrograms and the target sample was ‘zoomed in’. The segment was visually and auditorily verified to make sure of the target sample. Pitch tracking algorithm and multi dimensional voice profile of CSL 4500 was used to extract fundamental frequency contours and voice related parameters. The parameters selected for study were as follows.

1. Duration of the vocalization: It is the time difference between the onset and offset of the vocalization. Figure 1 shows the waveform display of duration of vocalization. Thin line indicates the onset of the vocalization and thicker line indicates the offset of the vocalization.

![Figure 1: Waveform display of duration of vocalization (ms).](image1.png)

2. Second pause: It is the time difference between the first and second vocalizations. Figure 2 shows the waveform display of the vocalization and second pause. Thin line indicates the offset of one vocalization and thicker line indicates the onset of the next vocalization.

![Figure 2: Waveform display of the vocalizations and the second pause (ms).](image2.png)

3. Melody type: Melody type of fundamental frequency was classified as falling, rising-falling, rising, flat, falling-rising, steeply rising-falling, rising-steeply falling. Figure 3 illustrates different types of melodic patterns.
4. **Mean fundamental frequency** ($mF_0$): Average fundamental frequency for all extracted pitch periods, represented in Hertz (Hz).

5. **Highest fundamental frequency** ($HF_0$): Highest fundamental frequency for all the extracted pitch periods, represented in Hertz (Hz).

6. **Lowest fundamental frequency** ($LF_0$): Lowest fundamental frequency for all the extracted pitch periods, represented in Hertz (Hz).

7. **Jitter %**: It provides an evaluation of the variability of the pitch period within the analyzed voice sample. It represents the relative period to period (very short term) variability.

8. **Shimmer %**: It provides an evaluation of the variability of the peak to peak amplitude within the analyzed voice sample. It represents the relative period to period (very short term) variability of the peak to peak amplitude.

9. **Noise to harmonics ratio**: It is the ratio between the noise in the glottal signal and the sound pressure level of the harmonics. This can be obtained by measuring the intensity of the harmonics and the noise.

**Experiment II: Perceptual analyses**

**Material**: The recorded cry samples of experiment I served as the material for experiment II also.

**Procedure**: A 5-second cry sample from one twin was paired with the other twin sample with a gap of 5 seconds and was saved on to the computer. Separate tokens were made for hunger and pain cry. These pairs of samples were presented to ten trained listeners and they were instructed to rate the samples as ‘same’ or ‘different’ based on perceptual measures of cry signal, such as rate, quality, pitch, melody and loudness.

**Analyses**: The responses of the listeners were tabulated and mean percent “same” was calculated for all the five pairs using the following formula: Total no. of same * 100/10. A cutoff score of 70% was taken as the significant difference for the mean percent same responses.
Results

Experiment I: Acoustic analyses

Duration of the vocalization: The results of the paired sampled t-test showed significant difference only in pair1 for both hunger and pain cry and in pair 5 and pair 4 for hunger and pain cry, respectively. Table 2 shows mean, SD, t value, degrees of freedom and significant difference (2 tailed) for duration of the vocalization in all twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 1</td>
<td>228.68</td>
<td>115.44</td>
<td>2.467</td>
<td>29</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>290.41</td>
<td>99.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2</td>
<td>178.26</td>
<td>85.53</td>
<td>1.118</td>
<td>19</td>
<td>0.278</td>
</tr>
<tr>
<td></td>
<td>148.71</td>
<td>102.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3</td>
<td>274.85</td>
<td>466.60</td>
<td>0.745</td>
<td>24</td>
<td>0.463</td>
</tr>
<tr>
<td></td>
<td>209.57</td>
<td>108.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>332.11</td>
<td>979.47</td>
<td>3.297</td>
<td>19</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>167.64</td>
<td>835.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pairs</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pair 1</td>
<td>444.57</td>
<td>193.28</td>
<td>2.360</td>
<td>29</td>
<td>0.025</td>
</tr>
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<td></td>
<td>306.84</td>
<td>242.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2</td>
<td>255.52</td>
<td>94.70</td>
<td>0.725</td>
<td>19</td>
<td>0.477</td>
</tr>
<tr>
<td></td>
<td>224.59</td>
<td>158.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 4</td>
<td>202.80</td>
<td>220.01</td>
<td>2.379</td>
<td>19</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>87.99</td>
<td>57.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>257.43</td>
<td>269.13</td>
<td>2.237</td>
<td>19</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>116.24</td>
<td>54.17</td>
<td></td>
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</tr>
</tbody>
</table>

Table 2: Mean, SD, t values, degrees of freedom (df) and significant difference values of duration of vocalization (ms) for all the twin pairs for hunger cry and pain cry.

2. Second pause: Paired sampled t-test showed significant difference only in pair1 and pair 5 for both hunger and pain cry and in pair 4 for pain cry. Table 3 shows mean, SD, t value, degrees of freedom and significant difference (2 tailed) for second pause in all the twin pairs.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
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<tbody>
<tr>
<td>Hunger</td>
<td></td>
<td></td>
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<tr>
<td>Pairs</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Pair 1</td>
<td>886.72</td>
<td>361.04</td>
<td>2.334</td>
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<td>0.027</td>
</tr>
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<td></td>
<td>1105.64</td>
<td>453.92</td>
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<td>Pair 2</td>
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<td>381.81</td>
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<td></td>
<td>1089.71</td>
<td>693.85</td>
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<td></td>
<td></td>
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<tr>
<td>Pair 3</td>
<td>775.25</td>
<td>396.95</td>
<td>1.548</td>
<td>24</td>
<td>0.135</td>
</tr>
<tr>
<td></td>
<td>978.71</td>
<td>711.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>1467.44</td>
<td>883.41</td>
<td>2.398</td>
<td>19</td>
<td>0.027</td>
</tr>
<tr>
<td></td>
<td>964.21</td>
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<td></td>
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<td>Pain</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Pairs</td>
<td></td>
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</tr>
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<td>969.37</td>
<td>387.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 4</td>
<td>1406.35</td>
<td>551.88</td>
<td>2.879</td>
<td>19</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>952.38</td>
<td>450.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>1025.44</td>
<td>644.17</td>
<td>0.193</td>
<td>19</td>
<td>0.849</td>
</tr>
<tr>
<td></td>
<td>1065.04</td>
<td>806.51</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Mean, SD, t values, degrees of freedom (df) and significant difference values of second pause (ms) for all the twin pairs in hunger cry and pain cry.

3. Melody: Chi square test showed significant agreement in pair 2 and pair 4 for both hunger cry and pain cry, and in pair 1 only for pain cry. Table 4 shows the percentage of agreement for different melodic patterns within the twin pairs for both hunger cry and pain cry.
Table 4: Percentage of agreement for melodic patterns for hunger cry and pain cry.

4. **Mean fundamental frequency**: Paired sampled t-test showed significant difference (p<0.05) in pair 5 for both hunger cry and pain cry and in pair 4 for pain cry. Table 5 shows mean, SD, t value, degrees of freedom and significant difference (2-tailed) for mean fundamental frequency (Hz) in all the twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th>Type of cry</th>
<th>Pair 1</th>
<th>Pair 2</th>
<th>Pair 3</th>
<th>Pair 4</th>
<th>Pair 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td>33.3</td>
<td>66.6</td>
<td>40.0</td>
<td>60.0</td>
<td>-</td>
</tr>
<tr>
<td>Pain cry</td>
<td>100.0</td>
<td>66.6</td>
<td>-</td>
<td>80.0</td>
<td>46.6</td>
</tr>
</tbody>
</table>

Table 5: Mean, SD, t values, degrees of freedom (df) and significant difference values of mean fundamental frequency (Hz) for all the twin pairs for hunger and pain cry.

<table>
<thead>
<tr>
<th>Type of cry</th>
<th>Pair 1</th>
<th>Pair 2</th>
<th>Pair 3</th>
<th>Pair 4</th>
<th>Pair 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
</tr>
<tr>
<td></td>
<td>394.24</td>
<td>426.39</td>
<td>412.48</td>
<td>406.81</td>
<td>421.74</td>
</tr>
<tr>
<td></td>
<td>59.98</td>
<td>53.15</td>
<td>15.84</td>
<td>73.19</td>
<td>70.47</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>1.512</td>
<td>0.230</td>
<td>1.146</td>
<td>8.625</td>
<td>9.000</td>
</tr>
<tr>
<td>df</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Sig</td>
<td>0.165</td>
<td>0.824</td>
<td>0.281</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

| Pain cry    | T1     | T2     | T1     | T2     | T1     |
|             | 449.19 | 417.85 | 414.05 | 422.49 | 465.43 |
|             | 42.65  | 42.90  | 31.22  | 20.15  | 95.00  |
| Mean        |       |        |        |        |        |
| SD          |       |        |        |        |        |
| t           | 1.484  | 0.786  | 0.832  | 0.832  | 2.488  |
| df          | 9      | 9      | 9      | 9      | 9      |
| Sig         | 0.172  | 0.452  | 0.027  | 0.432  | 0.005  |

5. **Highest fundamental frequency**: Paired sampled t-test showed significant difference (p<0.05) in pair 5 for both hunger cry and pain cry and in pair 2 and pair 1 for hunger and pain cry, respectively. Table 6 shows mean, SD, t value, degrees of freedom and significant difference (2-tailed) for highest fundamental frequency (Hz) in all the twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th>Type of cry</th>
<th>Pair 1</th>
<th>Pair 2</th>
<th>Pair 3</th>
<th>Pair 4</th>
<th>Pair 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
<td>T2</td>
<td>T1</td>
</tr>
<tr>
<td></td>
<td>614.88</td>
<td>599.36</td>
<td>511.53</td>
<td>580.04</td>
<td>629.46</td>
</tr>
<tr>
<td></td>
<td>27.65</td>
<td>52.95</td>
<td>42.08</td>
<td>48.48</td>
<td>44.75</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>0.832</td>
<td>-3.273</td>
<td>-1.126</td>
<td>1.220</td>
<td>-4.429</td>
</tr>
<tr>
<td>df</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Sig</td>
<td>0.427</td>
<td>0.010</td>
<td>0.254</td>
<td>0.002</td>
<td>0.003</td>
</tr>
</tbody>
</table>

| Pain cry    | T1     | T2     | T1     | T2     | T1     |
|             | 627.39 | 578.27 | 512.94 | 543.71 | 602.67 |
|             | 23.44  | 57.68  | 50.31  | 51.18  | 94.77  |
| Mean        |       |        |        |        |        |
| SD          |       |        |        |        |        |
| t           | 2.437  | -1.188 | -0.823 | 0.432  | -2.492 |
| df          | 9      | 9      | 9      | 9      | 9      |
| Sig         | 0.038  | 0.265  | 0.032  | 0.432  | 0.034  |

Table 6: Mean, SD, t values, degrees of freedom (df) and significant difference values of highest fundamental frequency (Hz) for all the twin pairs for hunger and pain cry.
6. **Lowest fundamental frequency**: The results of the paired sampled t-test showed significant difference (p<0.05) in pair 5 for hunger cry only. Table 7 shows mean, SD, t value, degrees of freedom and significant difference (2-tailed) for lowest fundamental frequency (Hz) in all the twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>T1</td>
<td>4.16</td>
<td>1.36</td>
<td>2.352</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.88</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2</td>
<td>T1</td>
<td>1.92</td>
<td>1.057</td>
<td>0.814</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.23</td>
<td>0.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3</td>
<td>T1</td>
<td>4.10</td>
<td>1.54</td>
<td>1.026</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>3.46</td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>T1</td>
<td>1.53</td>
<td>0.94</td>
<td>0.088</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>1.58</td>
<td>1.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Mean, SD, t values, degrees of freedom (df) and significant difference values of lowest fundamental frequency (Hz) for all the twin pairs for hunger and pain cry.

7. **Jitter %**: The results of the paired sampled t-test showed significant difference (p<0.05) only in pair 1 for hunger cry. Table 8 shows mean, SD, t value, degrees of freedom and significant difference (2-tailed) for Jitter in all the twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>T1</td>
<td>2.52</td>
<td>0.96</td>
<td>0.702</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.73</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2</td>
<td>T1</td>
<td>3.09</td>
<td>2.10</td>
<td>0.220</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.87</td>
<td>1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 4</td>
<td>T1</td>
<td>1.83</td>
<td>0.76</td>
<td>0.913</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2.72</td>
<td>2.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5</td>
<td>T1</td>
<td>2.04</td>
<td>0.70</td>
<td>1.343</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>1.78</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>1.78</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Mean, SD, t values, degrees of freedom (df) and significant difference values of jitter % for all the twin pairs for hunger and pain cry.
8. Shimmer %: Paired sampled t-test showed significant difference (p<0.05) only in pair 1 and pair 2 for hunger cry and in pair 5 for pain cry.

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 1 T1</td>
<td>15.36</td>
<td>3.42</td>
<td>2.753</td>
<td>9</td>
<td>0.022</td>
</tr>
<tr>
<td>T2</td>
<td>11.60</td>
<td>2.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2 T1</td>
<td>5.70</td>
<td>3.95</td>
<td>3.004</td>
<td>9</td>
<td>0.015</td>
</tr>
<tr>
<td>T2</td>
<td>9.94</td>
<td>5.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3 T1</td>
<td>13.72</td>
<td>3.49</td>
<td>1.348</td>
<td>9</td>
<td>0.211</td>
</tr>
<tr>
<td>T2</td>
<td>11.49</td>
<td>4.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5 T1</td>
<td>7.96</td>
<td>2.27</td>
<td>2.123</td>
<td>9</td>
<td>0.063</td>
</tr>
<tr>
<td>T2</td>
<td>4.97</td>
<td>3.37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Shows mean, SD, t value, degrees of freedom and significant difference (2-tailed) for all the twin pairs for both hunger and pain cry.

9. Noise to harmonics ratio: Paired sampled t-test showed significant difference (p<0.05) in all the twin pairs for hunger cry. Table 10 shows mean, SD, t value, degrees of freedom and significant difference (2 tailed) for noise to harmonics ratio in the entire twin pairs for both hunger and pain cry.

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 1 T1</td>
<td>0.56</td>
<td>0.16</td>
<td>2.773</td>
<td>9</td>
<td>0.022</td>
</tr>
<tr>
<td>T2</td>
<td>0.36</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2 T1</td>
<td>0.15</td>
<td>0.04</td>
<td>3.226</td>
<td>9</td>
<td>0.010</td>
</tr>
<tr>
<td>T2</td>
<td>0.30</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3 T1</td>
<td>0.51</td>
<td>0.13</td>
<td>2.252</td>
<td>9</td>
<td>0.050</td>
</tr>
<tr>
<td>T2</td>
<td>0.36</td>
<td>0.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 5 T1</td>
<td>0.27</td>
<td>0.06</td>
<td>3.210</td>
<td>9</td>
<td>0.011</td>
</tr>
<tr>
<td>T2</td>
<td>0.20</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Mean, SD, t values, degrees of freedom (df) and significant difference values of noise to harmonics ratio (NHR) for all the twin pairs for hunger and pain cry.
Experiment II

Perceptual analysis: For hunger cry, all the twin pair samples were judged similar on pitch, melody and loudness. But on rate only two cry pairs and on quality, three pairs were judged to be the same. For pain cry, cries in all the twin pairs were judged similar on pitch, quality and loudness. However, two pairs on rate and no pairs on melody were judged similar. Table 11 shows the Percentage “same” response for the all the twin pairs as rated by listeners for different perceptual categories.

<table>
<thead>
<tr>
<th>Type of cry</th>
<th>Pairs</th>
<th>Rate</th>
<th>Pitch</th>
<th>Quality</th>
<th>Melody</th>
<th>Loudness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger cry</td>
<td>Pair 1</td>
<td>63</td>
<td>86</td>
<td>56</td>
<td>90</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Pair 2</td>
<td>66</td>
<td>83</td>
<td>83</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Pair 3</td>
<td>83</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Pair 4</td>
<td>80</td>
<td>93</td>
<td>93</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Pain cry</td>
<td>Pair 1</td>
<td>66</td>
<td>100</td>
<td>93</td>
<td>66</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Pair 2</td>
<td>56</td>
<td>86</td>
<td>90</td>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Pair 3</td>
<td>90</td>
<td>90</td>
<td>96</td>
<td>56</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Pair 5</td>
<td>90</td>
<td>80</td>
<td>100</td>
<td>56</td>
<td>93</td>
</tr>
</tbody>
</table>

Table 11: Mean percent “same” for all the twin pairs for different perceptual categories in both hunger and pain cry.

Discussion and Conclusion

The results of the present study showed several points of interest. Duration of vocalization, second pause, melody type, the mean fundamental frequency, highest and lowest fundamental frequency, jitter, shimmer and NHR showed significant similarities within twins. This result in general supports the previous findings that there is lot of resemblance in voice of the monozygotic twins (Shew & Simon, 2004; Santosh & Savithri, 2004). The results of the present study also shows that there is similarities within the twins in timing characteristics (duration of vocalization, second pause), acoustic parameters (\( mF_0 \), Jitt, Shim, NHR) as well as intonation (melody type) of the cry. Perceptually, except melody pattern of the cry, all the samples were rated as significantly similar within twins. The findings of the present study in general supports the previous findings that there is lot of resemblance in voice of the monozygotic twins (Ryells, Shew & Simon, 2004; Santosh & Savithri, 2004). However, variability existed with respect to twin pairs and type of cry signal. So, it is clear that individual voice is determined by much more than genetic constitution alone. However, the results of the present study are preliminary and involved only five pairs of MZ twins, which warrant a more detailed examination of characteristics of the voice characteristics in larger number of twins.

References


Efficacy of Prolonged Speech Therapy in Persons with Stuttering: Perceptual Measures

Santosh.M. & Savithri.S.R.

Abstract

Over centuries clinicians and researchers have offered different approaches to stuttering treatment. Among these prolonged speech has yielded the greatest effectiveness and appeared to be the strongest treatment in both the long- and short-term evaluations. However several concerns have been expressed with respect to type of outcome measures used and post-therapy unnaturalness sounding speech. The aim was to investigate the efficacy of prolonged speech therapy in persons with stuttering. Thirty persons with stuttering participated in the present study. A 300-word standard reading passage in Kannada, spontaneous speech/conversation was recorded before, after, and 6-month after prolonged speech therapy. Percent dysfluency, rate of reading and mean naturalness scores (MNS) were measured. Results indicated significant reduction in percent dysfluency and increase in MNS was noticed in the post therapy condition. However, percent dysfluency increased significantly in 6-month post therapy condition.

Key words: Dysfluency, prolonged speech, stuttering

Over centuries clinicians and researchers have offered different approaches to stuttering treatment (Bloodstein, 1995). Available treatment approaches differ not only in terms of the goals they seek to achieve, but also in the specific strategies used to achieve them. These treatments for stuttering can be divided into two broad categories of procedures. The first category contains treatment procedures that do not intentionally alter a stutterer's entire speech pattern. Typical of these treatments are those that are only response contingent arrangements to modify stuttering frequency. The second category contains treatments that deliberately alter the persons with stuttering overall speech pattern in order to reduce stuttering. This category includes a wide variety of treatments that induce persons with stuttering to use an unusual manner of speaking, which may then be systematically shaped (by some means) into relatively normal sounding speech. Typical example of latter type includes rhythmic speech and prolonged speech and its variants. These treatment procedures incorporate the use of a novel speech pattern to replace stuttered speech. Both the category of treatment programs in general involves the instatement, shaping, generalization, and maintenance of fluent prolonged speech.

Any treatment should include not only the quantification of the treatment targets but also a systematic evaluation of relevant behaviors. However, formal evaluations of the results of the stuttering therapies have not been carried out very often and long-term effects of these therapies have not been documented well. Studies examining the effects of stuttering therapy outcome for adults have been reviewed by Bloodstein (1995) has concluded that 'substantial improvement, as defined in these studies, typically occurs as result of almost any kind of therapy in about 60 to 80% of the cases. Andrews, Guitar, & Howie (1980) in their meta-analysis of different treatment procedures for stuttering reported that prolonged speech, gentle onset, rhythm, airflow, attitude change, and desensitization were the six most common principal treatment formats. Both prolonged speech and gentle onset yielded the greatest effectiveness and appeared to be the strongest treatments in both the long- and short-term evaluations.

Although currently prolonged speech is the most prominent among treatment procedures, several important concerns have been raised about its efficacy. First, in most the reports the type of outcome measures used are perceptual in nature, and second regarding unnaturalness sounding post therapeutic speech (Runyan, Bell & Prosek, 1990; Onslow, Mysore savithri_2k@yahoo.com

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Costa, Andrews, Harrison, & Packman, 1996; O’Brien, Onslow, Cream & Packman, 2003). Subramanian (1997) and Kanchan (1997), investigated speech naturalness rating of adult persons with stuttering who underwent nonprogrammed prolonged speech therapy. Their results showed significant increase in mean naturalness score from pre-therapy to post-therapy condition. So, findings on the change in naturalness scores after therapy have emerged as an effective tool in investigating the efficacy of therapy but discrepancies exist with respect to reported findings. Therefore, a comprehensive study on efficacy of prolongation therapy in adult persons with stuttering with perceptual measures is needed. In this context, the present study was planned. The objectives of the present study were multifold and were as follows:

- To find the efficacy of nonprogrammed prolonged speech technique in persons with stuttering (PWS),
- to find the long-term effects of nonprogrammed prolonged speech technique in persons with stuttering (PWS), and
- to find out the correlation between perceptual parameters.

**Method**

**Subjects:** Thirty persons with stuttering participated in the study. The subjects’ age ranged from 15-38 years with a mean age of 20 years. All the participants were native speakers of Kannada and were diagnosed by qualified speech-language pathologist. None of them reportedly had any other speech, neurological, hearing or any other speech/language disorders. All the subjects had gradual onset of stuttering in childhood and reported normal speech and language development. None of them had any family history of stuttering. All the subjects were right-handed. Stuttering Severity Instrument (SSI) (Riley, 1980) was administered to assess the severity of stuttering. Based on SSI, stuttering in 11 participants was mild, moderate in 8 participants, and severe in 11 participants. But irrespective of severity, all participants were enrolled in prolongation therapy. Three subjects were females and the remaining 27 subjects were males. Out of 30 participants 27 participants had not attended any form of speech therapy. Three participants had attended modified airflow therapy earlier. However, two years had lapsed between the last therapy and the present evaluation and these participants did not further follow the therapy after completion of therapy at a clinic.

**Clinical program:** All participants completed a 3-week non-programmed prolongation therapy. Each therapy session was for 45 minutes and consisted of the following steps:

Step 1: Prolongation of all the syllables in subjects with severe stuttering. Prolongation of initial syllable of the word in subjects with mild and moderate stuttering.

Step 2: Prolongation of the initial syllable of the word when stuttered or when anticipated to have stuttering – Experimenter monitoring.

Step 3: Prolongation of initial syllable of the word when stuttered or anticipated to have stuttering – Self - monitoring.

Step 4: Generalization with experimenter’s support.

Step 5: Generalization without experimenter’s support.

Step 6: Follow up after six months.

The criterion to move from one step to another was 95% fluency. In addition to therapy at the clinic, the subject practiced for four sessions of 30 minutes in a day. Subjects were terminated from therapy when they had achieved 95% fluency as assessed by a trained speech pathologist. Subjects’ written consent was obtained before starting the program.
Material: A 300-word standard reading passage in Kannada, spontaneous speech/conversation served as the material. The experimenter developed the standard reading passage. It incorporated all the phonemes in Kannada with their respective frequency of occurrence as given by Jayaram (1985). Experimenter made a set of questions about the client’s family, job, education, and hobbies to elicit spontaneous speech/conversation. Each speech sample, on an average, was of 10 minutes duration.

Procedure: Subjects were tested individually in a sound treated room. Subjects’ reading, spontaneous speech and conversation were audio-recorded on to an audiocassette of the professional stereo cassette deck (Sony TC FX 770) using the microphone (Legend HD 800) kept at a distance of 10 cm from the mouth of the subject. The recordings were done prior to the start of therapy, soon after the termination of therapy, and 6 months after termination of therapy. Care was taken to ensure that the spontaneous speech and conversation were on the same topic on all the three recordings. A multiple test design was used.

Analysis: The recorded reading and speech samples were transcribed verbatim using IPA format and the following measures were calculated.

(1) Percent dysfluency

\[
\text{Percent dysfluency in reading} = \frac{\text{Total number of dysfluent words in reading}}{\text{Total number of words read}} \times 100
\]

\[
\text{Percent dysfluency in speech} = \frac{\text{Total number of dysfluent words in speech}}{\text{Total number of utterances}} \times 100
\]

(2) Type of dysfluencies: Types of dysfluencies were identified as per Bloodstein (1995) criteria as follows:

(a) Repetitions

- Syllable repetitions: Dysfluencies characterized by repetition of syllables (for example ba ba ba: II).
- Part word repetitions: Dysfluencies characterized by repetition of part of a word (for example sne: ha sne: ha sne: hita).
- Whole word repetitions: Dysfluencies characterized by repetition of whole words (for example ball – ball).
- Phrase repetitions: Dysfluencies characterized by repetition of two or more words.

(b) Unfilled pauses: Silence longer than 300 ms.
(c) Filled pauses: Pauses with extraneous sounds such as /a/, /m/ etc.
(d) Prolongations: Dysfluencies characterized by prolonging a sound (for example naaaandi).
(e) Interjections: Dysfluencies characterized by addition of functional words such as the, well etc.

(3) Rate of reading: Subject’s reading samples were transferred onto the computer memory. All the dysfluencies pauses longer 300 ms were truncated using COOLEDIT software. The syllables per minute (SPM) were calculated using following formula.

\[
\text{SPM} = \frac{\text{Total number of syllables read}}{\text{Total time in seconds}} \times 60
\]

(4) Speech naturalness

Material: One minute stutter-free spontaneous speech and reading samples in all the three recordings (i.e. pre-therapy, post-therapy and 6-month post-therapy) were identified. Two trained speech pathologists identified samples that were stutter free. Only those samples that were identified by both the judges as stutter free were used for further
purpose. Samples were randomized and rerecorded on to two tapes, one containing speech sample and the other reading sample. In addition, 10% of the samples were also recorded on to the tapes for reliability measurement. Each tape contained a total of 99 samples (30 each of pre-therapy, post-therapy and 6-month post-therapy and 9 randomized samples). A number preceded each sample. A 30-second silence interval was inserted between two samples. Thus, a total of 198 samples formed the material.

Subjects: Ten naive listeners (5 males and 5 females) in the age range of 18-20 years served as judges. All the judges were native speakers of Kannada and literates in Kannada and English. They were first year undergraduate students of speech and hearing who were not trained in the evaluation of fluency.

Procedure: Subjects were tested individually. They were provided with a response sheet indicating speech naturalness scale. The naturalness scale included naturalness in reading and speech contexts. Subjects were instructed to listen to the audio-presented sample and carefully rate the naturalness of the sample on a binary scale, ‘1’ representing natural and ‘0’ representing unnatural (Kanchan, 1997). All the subjects had to rate 198 samples and they were instructed to stop the task when they felt fatigued. They could listen to samples as many times as required and each subject rated the sample over a week.

Analysis: Subject’s ratings were tabulated separately and were grouped under pre-therapy, post-therapy and 6-month post-therapy samples of reading and spontaneous speech tasks. The naturalness ratings given by each judge for all the three recordings were converted to percentage naturalness rating for each subject and mean naturalness score was calculated using the following formulae.

\[
\text{Naturalness rating for each subject} = \frac{\text{No. of judges rating a sample as natural}}{\text{Total no. of judges}} \times 100
\]

\[
\text{Mean naturalness score} = \frac{\text{Sum of naturalness ratings of all subjects}}{\text{No. of subjects}}
\]

Intra and Inter judge reliability: The experimenter measured 10% of the samples again (random selection) after 6 months of the first measure, for intra-judge reliability. An experienced speech pathologist, unaware of the purpose of the study, measured percent dysfluency (for both reading and speech) and rate of reading (measured in SPM), in 10% of the samples (random selection) for inter-judge reliability.

Statistical analysis: The analyzed data were tabulated for each subject in three different conditions (pre-therapy, post-therapy and after 6 months post-therapy) and subjected to the statistical analysis. SPSS (Version 10) was used for the statistical analysis. Means and standard deviations were calculated. Repeated measures ANOVA was done to find the significant difference between conditions. Pearson’s product moment correlation was used to find correlation between parameters.

Results

1. Percent dysfluency: Repeated measures ANOVA showed significant difference between conditions [Reading- F (2, 58) = 26.999, p < 0.05, Speech- F (2, 58) = 36.882; p < 0.05 respectively]. Results of the Bonferroni multiple comparisons showed significant difference across all three conditions (p < 0.05) in both the tasks. Percent dysfluency
significantly reduced in post- and 6-month post-therapy conditions compared to pre-therapy conditions. However, percent dysfluency was significantly higher in 6-month post-therapy condition compared to post-therapy condition. Also, percent dysfluency in speech was higher compared to that in reading. Table 1 shows percent dysfluency in 3 conditions and two tasks.

<table>
<thead>
<tr>
<th>Conditions/tasks</th>
<th>Reading</th>
<th>Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-therapy</td>
<td>25.40</td>
<td>21.08</td>
</tr>
<tr>
<td>Post-therapy</td>
<td>1.65</td>
<td>2.03</td>
</tr>
<tr>
<td>6-month post-therapy</td>
<td>7.03</td>
<td>13.99</td>
</tr>
</tbody>
</table>

Table 1: Mean and SD of percent dysfluency in three conditions and two tasks

2. Type of dysfluencies: The types of dysfluencies included syllable repetition, part-word repetition, word repetition, filled and unfilled pauses, interjections, omissions, and prolongations, in the pre-therapy reading and speech samples. Syllable repetition, part-word repetition, word repetition, filled and unfilled pauses were observed in post-therapy and 6-month post-therapy reading and speech samples. In addition, prolongations were observed in 6-month post-therapy reading and speech samples. Among the different types of dysfluencies, syllable repetitions were the most common and prolongations were the least common. Also, more number of subjects had dysfluencies in reading task than in speech task (except for filled pauses in pre-therapy and post-therapy conditions). Table 2 shows percentage of subjects exhibiting each type of dysfluency across conditions.

<table>
<thead>
<tr>
<th>Type of dysfluency</th>
<th>Task</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre</td>
</tr>
<tr>
<td>Syllable repetition</td>
<td>Reading</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>83.33</td>
</tr>
<tr>
<td>Part word repetition</td>
<td>Reading</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>36.66</td>
</tr>
<tr>
<td>Word repetition</td>
<td>Reading</td>
<td>36.66</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>13.33</td>
</tr>
<tr>
<td>Filled pauses</td>
<td>Reading</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>70</td>
</tr>
<tr>
<td>Unfilled pauses</td>
<td>Reading</td>
<td>43.33</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>36.66</td>
</tr>
<tr>
<td>Prolongations</td>
<td>Reading</td>
<td>25.86</td>
</tr>
<tr>
<td></td>
<td>Speech</td>
<td>16.66</td>
</tr>
</tbody>
</table>

Table 2: Percentage of subjects exhibiting each type of dysfluency across conditions

3. Rate of reading - Syllables per minute (SPM): Results revealed significant reduction in mean SPM in post-therapy condition compared to that in pre-therapy condition. However, there was significant increase in mean SPM in 6-month post-therapy condition compared to that in the pre-therapy condition. ANOVA showed significant difference between conditions [F (2, 58) = 4.191; P< 0.05]. Results of the Bonferroni multiple comparisons showed significant difference between post-therapy and 6-month post-therapy conditions (p<0.05). Table 3 shows mean and standard deviation of SPM in all three conditions.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-therapy</td>
<td>306</td>
<td>70</td>
</tr>
<tr>
<td>Post-therapy</td>
<td>290</td>
<td>54</td>
</tr>
<tr>
<td>6-month post-therapy</td>
<td>316</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 3: Mean and SD values of SPM in three conditions

Intra and inter judge reliability: The results of the reliability index showed high intra- and inter judge reliability (α = 0.9) on percent dysfluency and rate of reading.
4. **Mean naturalness score:** Repeated measures ANOVA revealed significant difference between conditions [Reading- F (2, 58) = 15.153; P < 0.05, Speech- F (2, 58) = 17.927; p < 0.05]. Mean naturalness score was higher in post-therapy condition compared to that in pre-therapy and 6-month post-therapy conditions. Bonferroni multiple comparisons showed significant difference (p<0.05) between pre-therapy and post-therapy conditions, and pre-therapy and 6-month post-therapy conditions in both the tasks. Table 4 shows mean naturalness scores in three conditions and two tasks.

<table>
<thead>
<tr>
<th>Conditions/ tasks</th>
<th>Reading Mean</th>
<th>SD</th>
<th>Speech Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-therapy</td>
<td>41.00</td>
<td>38.35</td>
<td>50.33</td>
<td>39.17</td>
</tr>
<tr>
<td>Post-therapy</td>
<td>77.00</td>
<td>30.18</td>
<td>89.33</td>
<td>18.92</td>
</tr>
<tr>
<td>6-month post-therapy</td>
<td>69.33</td>
<td>36.47</td>
<td>80.66</td>
<td>32.37</td>
</tr>
</tbody>
</table>

Table 4: Mean naturalness scores in three conditions and two tasks

**Intra and Inter judge reliability:** Reliability index showed significant high intra and inter judge reliability (α = 0.9).

**Correlation:** Results of Pearson’s product moment correlation showed significant (p<0.05) positive correlation between, percent speech and reading in pre-therapy condition, 6-month post-therapy percent dysfluency and 6-month post-therapy SPM in speech and reading tasks and MNS in two tasks in 6-month post-therapy condition. Significant negative correlation (p< 0.05) was found between MNS and percent dysfluency in pre and post-therapy conditions, SPM and mean naturalness score in post-therapy (reading) and 6-month post-therapy conditions.

**Discussion**

The results of the study revealed several points of interest. First, mean percent dysfluency decreased significantly from pre-therapy to post-therapy condition in both tasks. The results confirm the findings that prolonged speech treatment has clear and positive effects on speech of persons with stuttering. The results, in particular, are in line with the findings of Onslow, Costa, Andrews, Harrison & Packman (1996) who also that the non-programmed version of prolonged speech is effective in reducing dysfluency. However, percent dysfluency increased significantly from post-therapy condition to 6-month post-therapy condition in both tasks indicating that prolonged speech technique was not so effective in maintaining fluency over long-term at least in some subjects. This result, in particular, is not in agreement with previous reports of Onslow et. al. (1996) who reported long-term maintenance of fluency in persons with stuttering. The reason for the difference in results could be attributed to maintenance phase. Onslow et. al. included maintenance phase in which subjects had regular weekly follow-ups, and their speech was assessed. Such weekly maintenance phase was not adopted in the present study. However, subjects were followed monthly, but no audio-recordings were made. The results suggest a need for regular follow-up to maintain fluency.

Second, results indicated that certain types of dysfluencies persisted in post- and 6-month post-therapy condition. Till date no report is available on this aspect. This result indicated reduction in frequency, but not in types of dysfluencies in post-therapy speech.

Third, rate of reading (SPM) decreased from pre-therapy to post-therapy condition and increased significantly from post-therapy to 6-month post-therapy condition. The results do not support the previous findings of O’Brian et. al. (2003). This can be attributed to the difference in rate measurements. In the present study, dysfluencies, and pauses longer than 300 ms were eliminated in rate measurement while O’Brian et. al. (2003) did not. Onslow et al (1996) highlighted the importance of eliminating dysfluencies. He opined that the presence of stuttering episodes might decrease the rate; i.e., more severe the stuttering slower the rate and therefore, it is necessary to remove dysfluencies and measure rate with fluent words. The increase in rate from post- to 6-month post-therapy condition indicates that, the post-
therapeutically achieved reduction in rate of speech is not maintained in the long-term. This could be the possible reason for the increase in the percent dysfluency in the 6-month post-therapy condition.

Fourth, mean naturalness score (MNS) increased significantly from pre-therapy to post-therapy condition. The results support the findings of Kanchan (1997), and Subramanian (1997), and partially support the findings of Onslow et al. (1996). Kanchan (1997) and Subramanian (1997) reported significant improvement in MNS, while Onslow et al. (1996) reported no post-treatment regression in MNS in PWS who underwent nonprogrammed prolonged speech treatment. However, the results are not in consonance with those of Runyan, Bell & Prosek (1990). The reasons for the discrepancy in results are two fold. First, in the present study stutter-free samples were used and second, nonprogrammed prolonged speech technique was used. It appears that nonprogrammed prolonged speech technique leads to more natural sounding post-therapy speech compared to programmed prolonged speech technique in which rate is controlled.

Finally, a negative correlation between percent dysfluency and SPM, percent dysfluency and MNS and a positive correlation between SPM and MNS was observed. This is expected as MNS improves with increase in SPM.

Conclusion

The results of the present study indicated that percent dysfluency, type of dysfluency, rate and MNS can be used as perceptual measures to test the efficacy of stuttering therapy. In the present study speech and reading samples of persons with stuttering were recorded before, after and 6-months after post-therapy. Significant reduction in percent dysfluency, increase in MNS was noticed after therapy. However, percent dysfluency increased significantly in 6-month post therapy condition. Although perceptual measures have been widely used to assess the efficacy, they have been criticized for their superficiality. As an answer, acoustic analysis have been found to be informative because it affords quantitative analysis that carry potential for subsystem (respiratory, laryngeal, and articulatory) description and for determining the correlates of perceptual judgment. Further studies are needed with complementary acoustic measures which can highlight on the individual subsystem errors in these patients.

References


Base of Articulation of 13 Indian Languages

1Savithri, S.R., 2 Jayaram, M., 3Venugopal, M.B. & 4Rajasudhakar, R.

Abstract

Honikman (1964) defined base-of-articulation of a language as an articulatory setting that reflects the settings of the most frequently occurring segments and segmental combinations in the language. The present study investigated the nature of cross-language differences in base-of-articulation in 13 Indian languages namely, Assamese, Bengali, Hindi, Kannada, Kashmiri, Kodava, Oriya, Rajasthani, Malayalam, Marathi, Tamil, Telugu, and Punjabi that have phonemically unequal vowel inventories. Five males and five females speaking each language participated in the study. Non-sense V<sub>1</sub>CV<sub>2</sub> syllables were recorded from ten normal native speakers in each of the 13 languages. Frequencies of the first and second formants were measured using CSL 4500. The five common vowels existing in all languages were compared for base-of-articulation. Difference. Results indicated significant difference between languages, vowels, and gender. In brief, F<sub>1</sub> was high in Oriya and Marathi, and was low in Bengali, Punjabi and Kannada; others were in between. Prominently base-of-articulation (position of tongue, F<sub>2</sub>) is fronted in Bengali, is back in Kashmiri and other Indian languages are in between. The results of the present study have augmented the knowledge about cross-language differences in base-of-articulation in Indian languages. Also, the results help in rehabilitation process.

Key words: Vowels, Formant frequency, cross-language, acoustic analysis, Indian languages

Vowels are speech sounds produced by voiced excitement of the open vocal tract. The vocal tract normally maintains a relatively stable shape and offers minimal obstruction to the airflow. Vowel is a speech sound resulting from the unrestricted passage of the laryngeally modulated air stream, radiated through the mouth or nasal cavity without audible friction or stoppage. Vowels are the segmental sounds of speech. They carry information, as the vowels are longer in duration and higher in energy, they carry the speech for a longer distance. i.e., in speech transmission, the vowels act like carriers. Even though the consonants carry more information, due to their non-linearity, shorter duration and low energy they damp very fast. Hence it is difficult for the listener to perceive them. Vowels like string bind the consonants together and helps even in the perception of consonants and thus speech. Acoustically vowels can be classified by formant pattern, spectrum, duration and formant frequency. The formants are the resonance of the vocal tract and depend on the size and shape of vocal tract.

Fant (1960) defined formants as ‘the spectral peaks of the sound spectrum’. It is the presence of formants that enable us to recognize different speech sounds, which are associated with different positions of the vocal tract (Ladefoged, 1975). Formant frequencies of vowels depend on the tongue height and tongue position. Frequency of the first formant (F<sub>1</sub>) is inversely related to tongue height, and frequency of the second formant (F<sub>2</sub>) is inversely related to the tongue position. In the production of vowels, oral tract is roughly divided into two cavities, namely back and front cavity. Back cavity refers to the space behind articulatory constriction and front cavity refers to the space in front of articulatory constriction. Though erroneously, F<sub>1</sub> depends largely on the volume of the back cavity and F<sub>2</sub> depends largely on the volume of the front cavity (Fant, 1960). Thus, one will get a high F<sub>1</sub> if the tongue is positioned low at the back of the oral tract. High F<sub>2</sub> is obtained when tongue is positioned in the front of the oral tract. Also, one can expect high formant frequencies in oral tracts that are smaller in size (for e.g. female compared to male).
The vowel inventories of the vast majority of the world's languages include three vowels that define the extremes of the general vowel space, namely /a, i, u/. Accordingly, these three vowels are known as "point vowels." and have been afforded a special status in theories of vowel systems. The formant frequencies of the vowels are plotted on a F1 and F2 plane to provide quantitative indices of 'acoustic vowel working space area' of individual speaker. The F1 and F2 pairs of each vowel were viewed as coordinates in the x - y plane. The acoustic vowel space has been used in very many research studies both in normal as well as in clinical population.

Several investigators have pointed to the importance of the notion of a base-of-articulation for providing insightful analyses of both phonological and phonetic observations. According to the Dispersion Theory (Lindblom, 1989), the vowels of a given language are organized in the acoustic vowel space in such a way that they be sufficiently distinct on the perceptual level. Honikman (1964) defined the base-of-articulation of a language as an articulatory setting that reflects the settings of the most frequently occurring segments and segmental combinations in the language. Lindau and Wood (1977), Disner (1977), Bradlow (1995), Gick, Wilson, Koch and cook (2004), Al-Tamimi and Ferrangne (2005) and Huei-Mei Liu, Feng-Ming Tsao and Kuhl (2005) have reported differences in base-of-articulation in Nigerian languages, French, German, English, Spanish and two dialects of Arabic. The results of these studies are based on measures of the first two formant frequencies.

Formant frequencies in several Indian languages have also been studied. Some of them are, acoustic parameters of Hindi vowels (Ganesan, Agarwal, Ansari and Pavate, 1985), Telugu (Majumdar, Datta and Ganguli, 1978), and Kannada (Rajapurohit, 1982; Savithri, 1989; Venkatesh, 1995; and Sreedevi, 2000). These studies were aimed to analyze some of the temporal as well as spectral properties of vowels in the respective languages. But the observation regarding the base-of-articulation was not contemplated by those researchers. While there are some studies on Asian languages, the nature and origin of cross-language differences in Indian languages are not explored. But it is possible that these languages have a distinct base-of-articulation. In this context, the present study investigated the base-of-articulation in thirteen Indian languages namely Assamese, Bengali, Hindi, Kannada, Kashmiri, Kodava, Oriya, Rajasthani, Malayalam, Marathi, Tamil, Telugu, and Punjabi that have phonemically unequal vowel inventories. It was hypothesized (Ho) that there will be no significant difference between the base-of-articulation of thirteen languages.

**Method**

Subjects: Ten normal native speakers each (5 males and 5 females) in the age range of 18 to 35 years speaking Kannada, Kodava, Tamil, Telugu, Malayalam, Hindi, Rajasthani, Marathi, Bengali, Kashmiri, Assamese, Oriya and Punjabi participated in the experiment.

**Material:** Non-sense V1CV2 words with these vowels in the initial position (V1) were considered for the study. The final vowel (V2) was always /a/. The intervocalic consonants were from five places of articulation viz.- velar, palatal, retroflex, dental, and bilabial (excluding Assamese, which does not have dental place of articulation). For example, if the target vowel is /a/, the non-sense words would be /aka/, /aca/, /at.a/, /ata/ and /apa/. Therefore, there were 40 non-sense words for Hindi, Rajasthani and Marathi, 50 non-sense words for Kannada, Tamil, Telugu, Kodava and Malayalam, 64 non-sense words for Assamese, 65 non-sense words for Bengali, 70 non-sense words for Oriya, 100 non-sense words for Punjabi and 150 non-sense words for kashmiri. These non-sense words were embedded in a phrase, "Say the word ______ now" and a total of 819 phrases, each written in their respective language on a card, formed the material.

**Procedure:** A post-test only design was used. Subjects were instructed to say each phrase three times in their respective languages with normal rate and intonation into the microphone kept at a distance of 10 cm from their mouth. All these utterances were recorded using MZ-R30 digital Sony recorder. Also, the recordings were made in a sound-attenuated booth/chamber in speech acoustic laboratory at AIISH. These recordings were digitized with a sampling rate of 12000 Hz. These target words/tokens were stored onto the computer. Wideband spectrograms with LPC superimpositions obtained from CSL 4500 were used to extract formant frequencies. Frequencies
of the first two formants were plotted on a $F_1$ - $F_2$ plane and compared across languages. Figure 1 illustrates the waveform and spectrograph with LPC superimposition and the non-word (ika).

![Figure 1: Waveform, Wideband spectrogram with LPC superimposition of non-word /ika/>.](image)

The corpus consisted of a total of 1200 tokens each (8 x 5 x 3 x 10) for Hindi, Rajasthani & Marathi, 1500 tokens each (10 x 5 x 3 x 10) for Kannada, Tamil, Telugu, Kodava and Malayalam, 1920 tokens (16 x 4 x 3 x 10) for Assamese, 1950 tokens (13 x 5 x 3 x 10) for Bengali, 2100 tokens (14 x 5 x 3 x 10) for Oriya, 3000 tokens (20 x 5 x 3 x 10) for Punjabi and 4500 tokens (30 x 5 x 3 x 10) for Kashmiri.

**Results**

The vowel inventories of the vast majority of the world's languages include mainly the three vowels, namely /a, i, u/. Accordingly, these vowels are known as the "point vowels" and have been afforded a special status in theories of vowel systems. In the present study, vowels like /e/ and /o/ as well exist along with three point vowels were studied in thirteen Indian languages. Hence the results were compared across languages on the basis of these five common vowels /a, i, u, e, o/.

Results of 3-way repeated ANOVA showed significant main effect of language, vowel and gender. Also, language x vowel interaction, gender x language, vowel x gender interaction and vowel x gender x language interaction were significant at 0.01 level. Table 1 shows the F and P values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effect of language</td>
<td>$F_1$</td>
<td>$F_{(12,3070)}=47.39$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(12,3070)}=23.35$, $&lt;0.001$</td>
</tr>
<tr>
<td>Main effect of vowel</td>
<td>$F_1$</td>
<td>$F_{(4,3070)}=4642.85$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(4,3070)}=15884.90$, $&lt;0.001$</td>
</tr>
<tr>
<td>Language x vowel interaction</td>
<td>$F_1$</td>
<td>$F_{(48,3070)}=17.62$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(48,3070)}=18.81$, $&lt;0.001$</td>
</tr>
<tr>
<td>Gender x language interaction</td>
<td>$F_1$</td>
<td>$F_{(12,3070)}=14.47$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(12,3070)}=9.28$, $&lt;0.001$</td>
</tr>
<tr>
<td>Vowel x gender interaction</td>
<td>$F_1$</td>
<td>$F_{(4,3070)}=73.49$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(4,3070)}=292.38$, $&lt;0.001$</td>
</tr>
<tr>
<td>Vowel x gender x language interaction</td>
<td>$F_1$</td>
<td>$F_{(48,3070)}=4.27$, $&lt;0.001$</td>
</tr>
<tr>
<td></td>
<td>$F_2$</td>
<td>$F_{(48,3070)}=5.32$, $&lt;0.001$</td>
</tr>
</tbody>
</table>

Table 1: F values on 3-way repeated measures ANOVA.
The results indicated that Oriya had the lowest $F_1$ and Kannada had the highest $F_1$. Also, Kashmiri had the lowest $F_2$ and Bengali had the highest $F_2$ compared to other languages. Vowel /i/ had the least $F_1$ and vowel /a/ had the highest $F_1$. Also, vowel /u/ had the lowest $F_2$ and vowel /i/ had the highest $F_2$ compared to other vowels. Females had higher $F_1$ and $F_2$ values compared to males in all languages. Table 2 shows mean $F_1$ and $F_2$ in 13 languages.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Languages</th>
<th>$F_1$ (in Hz)</th>
<th>$F_2$ (in Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>1.</td>
<td>Kannada</td>
<td>467</td>
<td>527</td>
</tr>
<tr>
<td>2.</td>
<td>Tamil</td>
<td>445</td>
<td>469</td>
</tr>
<tr>
<td>3.</td>
<td>Telugu</td>
<td>461</td>
<td>489</td>
</tr>
<tr>
<td>4.</td>
<td>Malayalam</td>
<td>482</td>
<td>486</td>
</tr>
<tr>
<td>5.</td>
<td>Hindi</td>
<td>397</td>
<td>482</td>
</tr>
<tr>
<td>6.</td>
<td>Rajasthani</td>
<td>450</td>
<td>516</td>
</tr>
<tr>
<td>7.</td>
<td>Marathi</td>
<td>406</td>
<td>432</td>
</tr>
<tr>
<td>8.</td>
<td>Bengali</td>
<td>445</td>
<td>528</td>
</tr>
<tr>
<td>9.</td>
<td>Oriya</td>
<td>431</td>
<td>507</td>
</tr>
<tr>
<td>10.</td>
<td>Assamese</td>
<td>458</td>
<td>502</td>
</tr>
<tr>
<td>11.</td>
<td>Punjabi</td>
<td>442</td>
<td>540</td>
</tr>
<tr>
<td>12.</td>
<td>Kashmiri</td>
<td>452</td>
<td>497</td>
</tr>
</tbody>
</table>

Table 2: Mean $F_1$ and $F_2$ of common vowels in thirteen languages between genders.

Results of Duncan’s post-hoc test showed significant difference between languages on $F_1$ and $F_2$. Table 3 and 4 show results of post-hoc (Duncan’s) test for $F_1$ and $F_2$. Languages in the same column are not significantly different in tables 3 and 4. Results indicated significant difference between Oriya, Marathi, Hindi and Tamil and other languages. These languages had low $F_1$ compared to other languages. Rajasthani, Malayalam, Bengali, Punjabi and Kannada were significantly different from other languages on $F_1$, in that these languages had high $F_1$. Similarly, Kashmiri, Oriya, Assamese, Kodava and Tamil were significantly different from other languages in that they had low $F_2$. Also, Telugu, Hindi, Rajasthani and Bengali were significantly different from other languages in that they had high $F_2$.

<table>
<thead>
<tr>
<th>Sub-sets</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oriya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marathi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hindi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kodava</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telugu</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kashmiri</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assamese</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rajasthani</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Malayalam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bengali</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Punjabi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Punjabi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kannada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Results of Duncan post-hoc test for $F_1$ (Languages in same columns are not significantly different).
Table 4: Results of Duncan post hoc test for $F_2$ (Languages in same columns are not significantly different).

Results of Duncan’s post-hoc test for the vowels showed significant difference between vowels. Table 5 shows results of post-hoc (Duncan’s) test for $F_1$. Vowels in the same column are not significantly different in tables 5 (vowel /o/ and /e/). Results indicated significant difference between vowels /a/, /i/, /u/, /e/ and /o/. Vowel /i/ has low $F_1$ whereas vowel /a/ has high $F_1$.

Table 5: Results of Duncan’s Post hoc test for $F_1$ (Vowels in same columns are not significantly different).

Table 6 shows results of post-hoc (Duncan’s) test for $F_2$. Results indicated significant difference between these common vowels /a/, /i/, /u/, /e/ and /o/. Vowel /u/ has low $F_2$ whereas vowel /i/ has high $F_2$.

Table 6: Results of Duncan’s Post hoc test for $F_2$ (Vowels in same columns are not significantly different).

Discriminant analysis showed two functions namely function 1 and function 2. Based on combined effects of 2 functions, four clusters of languages were identified. Cluster 1 included Bengali and Rajasthani; but there was a vast distance between these two languages. Bengali had higher function 1 and function 2 compared to Rajasthani. Cluster 2 consisted of Kannada, Tamil, Telugu, Kodava, Malayalam (all Dravidian languages), Assamese and Punjabi. Languages in cluster 2 had relatively high function 1 compared to other clusters. Cluster 3 had Hindi, Marathi, and Oriya. These languages are not closely clustered, but were dispersed widely. Languages in cluster 3 had typically low function 1. Cluster 4 consisted of Kashmiri with a low function 1 and function 2. Figure 2 shows Canonical Discriminant functions and table 7 shows Eigenv values of function 1 and function 2. Both the function 1 and function 2 of Eigenv values were significant at 0.05 level.
Figure 2: Graphical representation of Canonical discrimination functions of languages shows group centroid.

<table>
<thead>
<tr>
<th>Functions</th>
<th>Eigen values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.026</td>
</tr>
<tr>
<td>2</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Table 7: Eigen values of function 1 and function 2

Discussion

The results indicated several points of interest. **First**, F1 was higher in Kannada, Punjabi and Bengali than other languages. This indicates that the Kannada, Punjabi and Bengali speakers tend to use lower tongue position or have smaller vocal tracts. As the subjects are selected randomly, it cannot be generalized that those speakers have smaller vocal tracts compared to other speakers. Thus, it can be concluded that high F1 is because of low tongue position and lesser back cavity volume. Whereas, Oriya, Marathi, Hindi and Tamil had lower F1, that indicates that Oriya, Marathi, Hindi and Tamil speakers tend to use higher tongue position. Consequently, languages ordered from low to high (in terms of tongue height) are Kannada, Punjabi, Bengali, Malayalam, Rajasthani, Assamese, Kashmiri, Telugu, Kodava, Tamil, Hindi, Marathi, and Oriya. In brief, height of the tongue is high in Oriya and Marathi and it is low in Bengali, Punjabi and Kannada; others are in between.

**Second**, F2 was higher in Bengali than in other languages. This can be attributed to fronting of tongue position, or difference in co-articulation effect. The values of first two formants were taken from the steady state of the vowels. Hence, the effect of co-articulation will be negligible. Therefore, it could be predicted that high F2 in Bengali is because of tongue fronting. Hence, the languages can be orders from back to front (in terms of tongue advancement) are Bengali, Rajasthani, Hindi, Telugu, Malayalam, Kannada, Marathi, Punjabi, Tamil, Kodava, Assamese, Oriya, and Kashmiri. In short, position of the tongue is fronted in Bengali and it is back in Kashmiri; others are in between. From the literature (Honikman, 1964; Sweet, 1890 and laver, 1978), only F2 counts for the base-of-articulation differences. Hence, the base-of-articulation is fronted in Bengali and back in Kashmiri; rest of the languages is in-between. The significant differences between these languages can be attributed to the organic basis, Sweet (1890) and Laver (1978) who observed differences in general pronunciation tendencies of languages in seventh century AD. Sweet (1890) defined organic basis of a language, "Every language has
certain tendencies which control its organic movements and positions, constituting its organic basis or base of articulation”.

**Third**, vowel /i/ has low F1 whereas vowel /a/ has high F1. According to Fant (1960) the F1 is inversely related to tongue height. In the production of vowel /i/ the height of the tongue is high, which results in lower F1 whereas, for the production of vowel /a/ the tongue height is low, which results in higher F1. The obtained results are in agreement with the findings of (Fant, 1960). The second formant frequency (F2) is inversely related to tongue advancement. In the production of vowel /u/, formants tend to be lower due to lip rounding effect. In the production of vowel /i/ tongue is more fronted which results in high F2 (Fant, 1960). The results obtained supports the findings of Fant (1960).

**Fourth**, females had higher F1 and F2 values compared to males in all languages (table 2 and appendices I, II). These present findings are in consonant with the findings of Peterson and Barney (1952), Eguchi and Hirsh (1969), Fant (1973), Venkatesh (1995) and Sreedevi (2000) who reported higher formants in females than in males. In adult females, vocal tract tend to be smaller than adult males, which results in higher resonance and accordingly female formants tend to be higher in frequency. This can be attributed to differences in vocal tract morphology for example, Fitch and Giedd (1999) who found that adult males have a disproportionately longer pharynx in comparison with adult females.

Very limited cross-linguistic studies in Indian languages have been reported in literature. Bradlow (1995) reported average F1 and F2 for the vowels /a/, /i/, /u/, /e/ and /o/, in Spanish which is 432 Hz and 1465 Hz, respectively; and in English, it is 457 Hz and 1647 Hz, respectively. From table 2, the average F1 for the vowels /a/, /i/, /u/, /e/ and /o/, is 467 Hz and average F2 for vowels /a/, /i/, /u/, /e/ and /o/, is found to be 1595 Hz. In Indian languages F1 is found to be higher than Spanish and English whereas F2 falls in-between Spanish and English. Therefore, it can be inferred that the base-of-articulation is in-between Spanish and English. The results of the present study support the notion of base of articulation proposed by Honikman (1964), Sweet (1890) and laver (1978). Based on the results the null hypothesis that there is no significant difference between base-of-articulation of Indian languages was rejected.

**Conclusion**

The present study investigated the nature of cross language differences in base-of-articulation in thirteen Indian languages namely Assamese, Bengali, Hindi, Kannada, Kashmiri, Kodava, Oriya, Rajasthani, Malayalam, Marathi, Tamil, Telugu, and Punjabi that have phonemically unequal vowel inventories. Equal number of males and females participated in the study. Non-sense V1CV2 words were recorded from ten normal-native speakers in each of the thirteen languages. The first and second formant frequency was measured using the software CSL 4500. The five common vowels exists in all languages were compared for base-of-articulation difference. The results indicated significant difference between languages, vowels and gender. In brief, height of the tongue (F1) is high in Oriya and Marathi and it is low in Bengali, Punjabi and Kannada; others are in between. Prominently, base-of-articulation (position of the tongue, F2) is fronted in Bengali and it is back in Kashmiri; other Indian languages are in between. The results of the study have augmented the knowledge about the cross-language differences in base-of-articulation in Indian language. Also, the results help in rehabilitation process. For example, if the base-of-articulation is towards the extremes of oral cavity, then articulatory references could be set towards the extremes of the oral cavity and also applicable in learning second language (L2). Also, the findings obtained from the present study provide normative data for clinical purposes.
References


Development of voicing contrast: A comparison of voice onset time in stop production

\(^{1}\)Savithri, S. R., \(^{2}\)Pushpavathi, M., \(^{3}\)Sujatha V. Shastry

Abstract

The study investigated the development of voicing contrast in normal Kannada speaking children in the age range of 4-7 years and adults. Six children in the age range of 4-5, 5-6 and 6-7 years and 6 adults participated the study. They spoke 6 Kannada words with stop consonants in the initial position 5 times that were recorded and analyzed to measure voice onset time (VOT). The results indicated that voiced stops were characterized by lead VOT and unvoiced stops were characterized by lag VOT. Also a development trend was observed.

Key words: Kannada, Voice onset time, S-ratio

Voice onset time (VOT) denotes the time difference between the release of a complete articulatory constriction and the onset of phonation (Lisker & Abramson, 1964). In voiced stop consonants the voicing precedes the release of the articulator and hence is termed lead VOT. In unvoiced stops, the voicing follows the articulatory release and is termed lag VOT. VOT has been the one of the acoustic features investigated to indicate development of voicing contrast. The acquisition of voicing contrast using VOT is of interest as (a) a wide variety of languages employ VOT to distinguish homorganic stop consonants, (b) languages partition the VOT continuum yielding varied voicing contrast among homorganic stops, (c) infants are able to perceive some characteristics of voicing in stop consonants from soon after birth, and (d) linguistic experience has been shown to effect the discrimination of certain categories of voicing in stop consonants. Earlier investigations have shown that VOT is affected by language (Ravanan, 1993), age (Menyuk & Klatt, 1975), and gender (Ravishankar, 1981).

Research on speech development in children has indicated VOT to be longer during early childhood (Preston, Yeni-Komshian & Stark, 1967). Also, the changes in VOT distribution that occur during the first six years of life appear to be fairly systematic. VOT is also helpful to assess the general process of motor skill acquisition since VOT production distributions are appropriate to the children’s language that is acquired during the period of speech sound learning (Eguchi & Hirsh, 1969). Macken & Barton (1980) report three stages in the acquisition of voicing contrast – (a) with no contrast, (b) with short lag, and (c) voiced and voiceless contrast. A shorter VOT for children compared to adults and a clear distinction between voiced and voiceless cognates by the age of 6 years is reported (Zlatin & Koenegskenecht, 1976).

The above studies are mostly in English and therefore, do not provide sufficient data for generalization to other languages. There is a need for studies with large number of subjects across various age groups in different languages. In this context a project was undertaken to investigate the development of voicing contrast in Kannada speaking normal children in the age range of 4-7 years. This paper presents the results of investigation on development of VOT in such children.

Method

Material: Three voiceless unaspirated plosive (velar /k/, dental /t/ and bilabial /p/) and their voiced cognates (/g/, /d/ and /b/) in the initial position of six Kannada words (kadi, gadi, tada, dada, padi, badi) formed the material.

Subjects: Six Kannada speaking normal children each in the age ranges of 4-5, 5-6, and 6-7 years and 6 adults participated in the study. All the subjects had normal speech and hearing. The study is on development of voicing contrast. Therefore, in order to observe whether development was complete by 7 years of age, adults were considered.

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\(^{2}\)Reader and HOD-Clinical services, AIISH Mysore 570 006 \(^{3}\)Clinical Assistant, Department of Speech Language Pathology, AIISH, Mysore 570 006
Procedure: Subject’s speaking of the words five times were audio-recorded and subjected to acoustic analysis. The samples were fed to DSP Sonograph 5500 (Kay Elemetrics) and the waveform along with wide band spectrograms were displayed on the dual channel. VOT was measured as the time duration between the burst and the onset of phonation. Lag VOT in unvoiced stops and cessation of voicing, if any, were noted.

Analysis: The data was tabulated and mean, range of VOT and S-ratio (difference between VOT of voiced and unvoiced stops) were calculated.

Results

Voiced stops were characterized by lead VOT and unvoiced stops were characterized by lag VOT. Among unvoiced stops VOT was longest in velar /k/ and in voiced stops in alveolar /t/. Lag VOT (unvoiced stops) was longer and lead VOT was shorter in children compared to adults. Lead VOT decreased from 4 years to 7 years. But there was no specific change in lag VOT. Table 1 shows the mean VOT in all groups.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Unvoiced stops</th>
<th>Voice stops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k</td>
<td>t</td>
</tr>
<tr>
<td>4-5</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td>5-6</td>
<td>53</td>
<td>31</td>
</tr>
<tr>
<td>6-7</td>
<td>36</td>
<td>21</td>
</tr>
<tr>
<td>Average</td>
<td>42</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 1: Mean VOT (ms) in children and adults

The range of VOT was wider in children compared to adults. The range decreased from 4 years to 7 years. Also, the range was wider for voiced stops compared to unvoiced stops in both children and adults. Table 2 shows the range of VOT in all groups.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Unvoiced stops</th>
<th>Voice stops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k</td>
<td>t</td>
</tr>
<tr>
<td></td>
<td>(38)</td>
<td>(31)</td>
</tr>
<tr>
<td>5-6</td>
<td>34-68</td>
<td>19-46</td>
</tr>
<tr>
<td></td>
<td>(34)</td>
<td>(27)</td>
</tr>
<tr>
<td>6-7</td>
<td>24-46</td>
<td>13-38</td>
</tr>
<tr>
<td></td>
<td>(22)</td>
<td>(25)</td>
</tr>
<tr>
<td>Average</td>
<td>25-57</td>
<td>14-35</td>
</tr>
<tr>
<td></td>
<td>(31)</td>
<td>(27)</td>
</tr>
<tr>
<td>Adults</td>
<td>27-45</td>
<td>10-21</td>
</tr>
<tr>
<td></td>
<td>(18)</td>
<td>(11)</td>
</tr>
</tbody>
</table>

Table 2: Range of VOT (ms) in children and adults

S ratios were higher in children compared to adults. Also, S ratio decreased from 4 to 7 years except in p/b. Table 3 shows the S ratio in all groups.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>k/g</th>
<th>l/d</th>
<th>p/b</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5</td>
<td>103</td>
<td>98</td>
<td>71</td>
</tr>
<tr>
<td>5-6</td>
<td>129</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>6-7</td>
<td>77</td>
<td>68</td>
<td>72</td>
</tr>
<tr>
<td>Average</td>
<td>103</td>
<td>100</td>
<td>104</td>
</tr>
<tr>
<td>Adults</td>
<td>113</td>
<td>87</td>
<td>74</td>
</tr>
</tbody>
</table>

Table 3: S ratio (ms) in all groups

Children in the age group of 4-5 years showed lag VOT for voiced stops. The mean lag voicing was 3.3 ms, 13.2 ms, and 9.9 ms in 4-5, 5-6, and 6-7 years, respectively. None of the adults had lag VOT for voiced stops. Also, children showed cessation of voicing in voiced stops. The mean duration of voicing cessation was 9.9 ms, 16.4 ms, and 3.3 ms in 4-5, 5-6, and 6-7 years, respectively. Voicing cessation was not observed in adults.
Discussion

The results revealed several points of interest. First of all voiced stops were characterized by lead VOT and unvoiced stops were characterized by lag VOT. This is in consonance with the results of earlier studies in Kannada (Lisker & Abramson, 1964; Sridevi, 1990). The expiratory air is utilized in vocal fold vibration in voiced stops resulting in lead VOT. In unvoiced stops, the subglottal and supraglottal pressure is equal during closure. Voicing starts when the transglottal pressure drop is sufficient to initiate voicing after the articulatory release.

Second, VOT, and the range of VOT decreased non-linearly from 4 to 7 years indicating a developmental trend. However, even at 7 years of age, it was not adult like. The development could be attributed to better co-ordination, and maturation of speech mechanism as children grow. It appears that as children grow, their articulation becomes more precise and hence follows more adult like patterns. However, it is implied that the co-ordination and maturation in 7 year old Kannada speaking children is not as well developed as in adults.

Third, voicing cessation was observed in some children. A prerequisite for voicing is a difference in supraglottal and subglottal pressure. In children, owing to the small vocal tract, the supraglottal pressure equals to the subglottal pressure very fast. Mueller & Brown (1980) report of two mechanisms facilitating voicing (a) glottal and supraglottal articulatory adjustments, and (b) internal laryngeal adjustments. It has also been reported that voicing can be continued by active or passive expansion of pharynx and opening of nasopharyngeal port. However, children might not have developed these mechanisms resulting in cessation of voicing during closure of voiced stops.

To summarize, the study indicated a developmental trend in VOT in children from 4 to 7 years. However, even at the age of 7 years children don’t appear to acquire adult like patterns. This warrants continuation of study till the age at which children acquire adult like patterns.

Conclusions

Previous studies on voice onset time in various languages have indicated that unvoiced stops are characterized by lag VOT and voiced stops are characterized by lead VOT. The results of the present study is in consonance with the previous studies in that in Kannada, voiced stops were characterized by lead VOT and unvoiced stops were characterized by lag VOT. Also a development trend in VOT was observed.

References


**Acknowledgements**

This research was made possible by grants received from the Department of Science and Technology, Govt. of India (No. SP/ SO/ No 2/ 91). The authors acknowledge the financial support of DST. The authors are thankful to the Director, All India Institute of Speech and Hearing, Mysore for providing the infrastructure to carry out the project.
Development of voicing contrast: A comparison of voice onset time in stop perception

Savithri, S. R., Pushpavathi, M. & Sujatha V. Shastry

Abstract

The study investigated development of voicing contrast in 4-7 year old Kannada speaking children. Six children each in the age range of 4-5, 5-6, and 6-7 years participated in the study. Voice onset time (VOT) continuum of /g-k/, /d-t/, and /b-p/ were synthesized. Subjects listened to the tokens and identified the stops on a binary forced-choice format. The results indicated that VOT was a strong cue in perception of voicing in Kannada.

Key words: Voice onset time, continuum, binary forced-choice method, 50% cross over, boundary width

Voice onset time (VOT) is the time difference between the release of a complete articulatory constriction and the onset of phonation (Lisker & Abramson, 1964). Voiced stop consonants are characterized by lead VOT; that is the voicing precedes the release of the articulator. Unvoiced stop consonants are characterized by lag VOT; that is, the voicing follows the articulatory release. Several studies have been conducted on VOT as a cue for perception of voicing. The results of these studies indicate that there is a developmental trend in VOT (Zlatin & Koenegskenecht, 1976) and that a poor performance in disordered population compared to normal controls (Elliot, Hammer, & Scholl 1989; Thibodau & Sussman, 1979). All these studies are in English. Therefore, these data can’t be generalized to other languages owing to the differences between stops among languages. English has a two-way classification of stops (voiced – unvoiced) where as Kannada has a four-way classification (unvoiced unaspirated, unvoiced aspirated, voiced unaspirated and voiced murmured). Therefore, the present study investigated the development of voicing contrast in Kannada speaking children.

Method

Stimuli: Three meaningful Kannada words (gadi, dadka, badi) with velar /g/, dental /d/, and bilabial /b/ in the initial position as uttered by a 22 year old Kannada speaking normal female subject were audio recorded and digitized and stored on to the computer memory. Using the waveform display program of the SSL (Voice and Speech Systems, Bangalore) lead VOT was truncated in steps of 2 pitch pulses till burst was reached. Following this, silence in steps of 10 ms was added till the lag VOT approximated adult values. Thus synthetic tokens for VOT continuum of /g-k/ (-96 to +30), /d-t/ (-70 to +30), and /b-p/ (-89 to +30) were generated. The tokens were randomized and iterated 10 times with an inter token interval of 3 seconds and interest interval of 5 seconds. A total of 330 tokens formed the material.

Subjects: Six Kannada speaking normal children each in the age ranges of 4-5, 5-6, and 6-7 years and 6 adults participated in the study. All the subjects had normal speech and hearing.

Procedure: Subjects were tested individually. Stimuli were binaurally presented through heard phones at comfortable listening levels. Subjects were instructed to listen to the token carefully and identify the token as having voiced / unvoiced stops. Subjects pointed to toys representing words with voiced / unvoiced stops. Prior to the testing subjects were provided with a training session where they pointed to the toys on listening to natural tokens. The experimenter recorded subject’s response on a binary forced-choice format. Percent response of subjects for each stop was calculated and an identification curve was plotted from which 50% cross over point (point where the 50% of percent was for voiced / unvoiced stop), lower limit (point which had 75 % response for voiced stop), upper limit (point which had 75 % response for voiced stop), and phoneme boundary width (time difference between upper and lower limit) were calculated.

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2Reader and HOD-Clinical services, AIISH Mysore 570 006
3Clinical Assistant, Department of Speech Language Pathology, AIISH, Mysore 570 006
Results

In general, the 50% cross over from voiced to unvoiced stops occurred in the lead VOT region. The shift occurred earlier in velar followed by bilabial and dental stops. 6-year old children showed earlier cross over compared to 7-year old children except for bilabial stop. Also, children in the age range of 4-5 years showed earlier cross over compared to adults. Table 1 shows the 50% cross over points.

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>4-5</th>
<th>5-6</th>
<th>6-7</th>
<th>Average</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>g-k</td>
<td>-17</td>
<td>-30</td>
<td>-10</td>
<td>-19</td>
<td>-19</td>
</tr>
<tr>
<td>d-t</td>
<td>-28</td>
<td>-7</td>
<td>-9</td>
<td>-14</td>
<td>-18</td>
</tr>
<tr>
<td>b-p</td>
<td>-12</td>
<td>-14</td>
<td>-26</td>
<td>-17</td>
<td>-5</td>
</tr>
</tbody>
</table>

Table 1: 50% cross over (ms) in all groups

Lower limit was observed in the lead VOT region for all age groups. Lower limit occurred earlier in children in the age range of 5-6 years compared to other age groups. In general, it was highest for dental place of articulation followed by velar and bilabial place in both children and adults. Table 2 shows the lower limit in all age groups.

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>4-5</th>
<th>5-6</th>
<th>6-7</th>
<th>Average</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>g-k</td>
<td>-44</td>
<td>-50</td>
<td>-18</td>
<td>-37</td>
<td>-37</td>
</tr>
<tr>
<td>d-t</td>
<td>-32</td>
<td>-34</td>
<td>-63</td>
<td>-43</td>
<td>-43</td>
</tr>
<tr>
<td>b-p</td>
<td>-5</td>
<td>-65</td>
<td>-4</td>
<td>-25</td>
<td>-36</td>
</tr>
</tbody>
</table>

Table 2: Lower limit (ms) of phoneme boundary width in all groups.

Upper limit of the boundary width occurred in lead VOT region in children in most stops except for g-k (6-7 years) and b-p (4-5 years). No development trend was seen in children. Table 3 shows the upper limit of phoneme boundary width in all age groups.

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>4-5</th>
<th>5-6</th>
<th>6-7</th>
<th>Average</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>g-k</td>
<td>-2</td>
<td>-5</td>
<td>+2</td>
<td>-1.8</td>
<td>-2</td>
</tr>
<tr>
<td>d-t</td>
<td>-5</td>
<td>-16</td>
<td>-22</td>
<td>-15</td>
<td>+8</td>
</tr>
<tr>
<td>b-p</td>
<td>+18</td>
<td>-5</td>
<td>-7</td>
<td>-2</td>
<td>-3</td>
</tr>
</tbody>
</table>

Table 3: Upper limit (ms) of phoneme boundary width in all groups.

The boundary widths were higher in velar followed by dental and bilabial in children. The boundary width decreased from 4 years to 7 years (except d-t) though not linearly. Also children had higher boundary width compared to adults. Table 4 shows the boundary widths in all groups of subjects.

<table>
<thead>
<tr>
<th>Stimuli</th>
<th>4-5</th>
<th>5-6</th>
<th>6-7</th>
<th>Average</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>g-k</td>
<td>42</td>
<td>45</td>
<td>16</td>
<td>34</td>
<td>25</td>
</tr>
<tr>
<td>d-t</td>
<td>27</td>
<td>19</td>
<td>41</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>b-p</td>
<td>13</td>
<td>60</td>
<td>3</td>
<td>25</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 4: Phoneme boundary width (ms) in all groups

Discussion

The results indicated a 50% cross over in the lead VOT region with an average of −17 ms in children and −5 ms in adults. A comparison of 50% cross over points as obtained by various authors is in table 5.
Table 5: 50% cross over as obtained by various authors.

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Language</th>
<th>Stimuli</th>
<th>50 % cross over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeni Komshian et al. (1967)</td>
<td>English</td>
<td>/g/</td>
<td>-35</td>
</tr>
<tr>
<td>Zlatin et. al. (1975)</td>
<td>English</td>
<td></td>
<td>+25</td>
</tr>
<tr>
<td>Flege &amp; Eefting (1986)</td>
<td>Spanish</td>
<td></td>
<td>+36.2</td>
</tr>
<tr>
<td>Williams (1977)</td>
<td>English</td>
<td></td>
<td>+25</td>
</tr>
<tr>
<td></td>
<td>Spanish</td>
<td></td>
<td>-4</td>
</tr>
<tr>
<td>Lisker &amp; Abramson (1967)</td>
<td>Thai</td>
<td></td>
<td>-20</td>
</tr>
<tr>
<td>Sathya (1996)</td>
<td>Telugu</td>
<td>g, d, b</td>
<td>-10 (children)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-20 (adults)</td>
</tr>
<tr>
<td>Present study (1996)</td>
<td>Kannada</td>
<td>g, d, b</td>
<td>-17 (children)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-5 (adults)</td>
</tr>
</tbody>
</table>

Williams (1977) speculated that Spanish listeners give greater weight to prevoicing as a cue to voicedness than English listeners and greater weight to the presence of an audible release burst and the lack of low frequency energy immediately following it, as cues to voiceless. The finding of Williams (1977) that the category boundary between /b/ and /p/ occurred along a VOT continuum occurred around –4 ms for Puertorican who were monolingual Spanish speakers suggest that the phonetic processing of speech may be slowly attuned to the acoustic properties of stops found in a particular language (Aslin & Pisoni, 1980). Flege & Eefting (1986) imply that cross language research suggest that speakers of different languages may learn to perceive stops differently because they are exposed to different kinds of stop consonants. Further, English language environment listeners tend to identify both /b/ as the phoneme /b/ and the presence/ voiced contrast is physiologically irrelevant in English. This contrast is perceived categorically in other languages – for example Hindi, Spanish and Thai (Burnham, Earnshaw & Clark, 1991).

In addition to VOT there are three additional acoustic properties that vary in degree across art of the synthetic speech series (Williams, 1980). These variations are restricted to the voicing lag region of the continuum and are as follows:

(a) The presence/ absence of varying duration of aspiration or aperiodic energy in the interval between articulatory release and the onset of voicing. The presence of aspirated formants is an acoustic property that has been demonstrated to provide a positive cue for initial voicelessness to English listeners (Winitz et. al., 1975), (b) The absence of periodic acoustic energy at the level of F1 during periodic excitation of the vocal tract referred to as first formant cut back (Liberman, Delattre, & Cooper, 1958). There is also evidence that the presence or absence of periodic energy in the region of F1 provides a perceptual cue for an initial contrast in voicing for English listeners (Delattre, Liberman, & Cooper, 1955; Liberman et. al., 1958; Lisker, 1975), and (c) Differences in the degree and temporal extent of formant transitions under conditions periodic excitation of the vocal tract. There is some evidence that this acoustic variable may also provide a cue for initial voicing in English (Cooper, Delattre, Liberman, Borst, & Gerstman, 1952; Stevens & Klatt, 1974; Summerfield & Haggard, 1974).

An examination of spectrograms of /b/ and /p/ taken from a Kannada speaker and those provided by Williams (1980) reveals that the stop consonants in Kannada are entirely different from that of English in all the 3 parameters listed above. Neither aspiration in the lag VOT region, nor F1 cut back is present in Kannada stop consonants. These differences in the acoustic properties of stops in English and Kannada might be reflected in the perception also with a 50% cross over in the lag VOT region for English and lead VOT region for Kannada. Also, syllable has been synthesized in the other studies and waveform editing has been used in the present study.

While comparing the discrimination data obtained from adult speakers of Thai and English for synthetic bilabial consonants, Aslin & Pisoni (1980) comment that the relative discriminability in the 20 ms of voicing lag is greater than in the – 20 ms region of voicing lead despite that fact that the slopes of the labeling functions for Thai subjects in these regions are very nearly identical. They propose that the smaller incidence of discrimination of VOT (and TOT) differences in the minus region of voicing lead value is probably due to the generally poorer ability of the auditory system to resolve temporal differences in which a lower frequency component precedes a higher frequency component (for un
voiced stop and lower frequency component – voicing – precedes a higher frequency component for – burst release – for voiced stop). Aslin & Pisoni (1980) further commenting on infant studies on VOT suggest that the discrimination of the relative order between the onset of first formant and higher formants is more highly discriminable at certain regions along the VOT stimulus continuum corresponding roughly to the location of the threshold for resolving these differences phycho-physically. In the case of temporal order processing, this falls roughly near the region surrounding +/- 20 ms, a value corresponding to the threshold for temporal order processing (Hirsh, 1959). Further commenting on Pisoni’s (1977) experiment on TOT (tone onset time), Aslin & Pisoni say that two distinct regions of high discriminability are present in the discrimination functions. Evidence of discrimination of VOT contrasts that straddle the –20 and + 20 ms regions of the stimulus continuum probably results from general sensory constraints on the mammalian auditory system to resolve small differences in temporal order and not from phonetic categorization.

The results also indicated wider boundary widths in children as compared to adults. Also, the boundary width decreased from 4 to 7 years. This indicates that there is a developmental trend in children on VOT perception. Based on the above findings it could be concluded that VOT is a cue for voicing distinction in Kannada and there is evidence for development of speech perception (VOT).

An audiocassette consisting of synthetic tokens for VOT has been prepared. This can be used with the clinical population to test the speech perception abilities in clinical population. Also, further studies can focus on various Indian languages and clinical population.

Conclusions

Earlier studies on perception of voicing contrast indicated change from voiced to unvoiced percept in the lag VOT region. But, the results of the present study indicated a 50% cross over in the lead VOT region with an average of –17 ms in children and –5 ms in adults. The results indicate that there are language differences in the perception of voicing contrast. This difference may be attributed to the differences in stops in a language.

References


Acknowledgements

This research was made possible by grants received from the Department of Science and Technology, Govt. of India (No. SP/ SO/ No 2/ 91). The authors acknowledge the financial support of DST. The authors are thankful to the Director, All India Institute of Speech and Hearing, Mysore for providing the infrastructure to carry out the project.
Effect of Age on Vowel Duration in Kannada

N. Sreedevi

Abstract

The present study investigated the developmental changes in vowel duration in Kannada (Mysore dialect) in normal subjects. Audio recordings of 73 bisyllabic words (CVCV) incorporating one of the 10 vowels of Kannada in a carrier phrase served as the material. Ten subjects each in the age groups of 7-8 years; 14-15 years and 20-30 years participated in the study. Using the software package SSL (VSS, Bangalore) vowel duration was extracted. The results indicated a decrease in vowel duration from children to adults. Also, this developmental trend was more evident in short vowels compared to long vowels. The data can be used for vowel synthesis and recognition. The data can also be used as norms in the assessment and therapeutic aspects of speech disorders.

Key words: Vowel duration, Kannada, Children, Adolescents, Adults

Vowel duration is the time duration from the onset to the offset of the vowel (Gopal, 1987). Many have investigated the duration of these vowels in English (Peterson & Lehiste, 1960) and other western languages like German (Zwirner, 1959), Danish (Fischer-Jorgensen, 1955) and Swedish (Engstrand & Krull, 1994). However, there are only a few studies in the Indian languages. These include studies in Telugu (Majumder, Datta & Ganguli, 1978; Nagamma Reddy, 1988) Tamil (Balasubramanian, 1981) Malayalam (Velayudhan, 1994). Since acoustic phonetic techniques reached a relatively high level in English speaking countries earlier than elsewhere, English has been most extensively studied, and there has been a tendency to assume that what holds for English is true in general.

Vowel duration is an important parameter which provides information on the prosodic as well as linguistic aspects of speech. Vowel duration can be used to signal the stressed syllable, mark the word boundaries, identify the syntactic units, and distinguish between similar phonetic segments. Duration data is of immense use in applied research, viz., automatic generation of speech for a reading machine for the blind and automatic recognition of speech from the acoustic waveforms. Thus it is essential to study vowel duration to understand the speech production, perception and the language structure.

There are several studies comparing the temporal parameters of children with adults. Mc Neill (1974) reported speaking rates of slightly over three words/sec for adults, about 2.5 words/sec for children above two. Not surprisingly, then the duration of individual segments are longer in children’s speech (Smith, 1978; Kent & Forner, 1980). Kent & Forner (1980) measured duration of phrases and short sentences and found them to be 8% longer for 12 year olds and 16% longer for 6 year olds than for adults. Children’s speech differed from adult speech in terms of it’s variability also. When children make the same utterance several times, the duration of individual segments vary more than for adults (Eguchi & Hirsh, 1969; Tingley & Allen, 1975; Kent & Forner, 1980). This difference in reliability of production may be an index of the child’s linguistic and neuromotor immaturity. In general, a young child’s speech patterns were less controlled than the adult’s and there was evidence that the control continues to improve until the child reaches puberty (Kent, 1976).

Extensive research on various aspects of vowel duration has been done. Di Simoni (1974 c) studied the developmental changes in vowel duration in child speakers (3-, 6- and 9 year old). It was observed that average durations of segments decreased with age, as did the variation in subject productions. In the Indian context, Rashmi (1985) studied vowel duration in children from 4-15 years old and reported that both males and females show a consistent decrease in vowel duration as a function of age.
Earlier research on vowel duration in Indian languages has unraveled interesting findings which are contrary to English language. Language differences exist because of various reasons. The efforts put forth in this area are scanty and more systematic study in different Indian languages is warranted. In this context the present study investigated the developmental changes in vowel duration across three age groups in Kannada language. Specifically, the study investigated the effect of age on vowel duration.

**Method**

**Subjects:** Ten subjects with normal speech and hearing, each in three age groups of 7-8 years (children), 14-15 years (adolescents) and 20-30 years (adults) participated in the study. Each group had five male and five female subjects. All the 30 subjects in the three groups had Kannada (Mysore dialect) as their dominant language. Kannada is a Dravidian language spoken by around 20,000,000 people in Karnataka, a state of South India (Nayak, 1967).

**Test Material:** There are ten vowels in Kannada according to Upadhyaya (1972) Schiffman (1979) and Andronov (1982). These 10 vowels are as follows:

- /a/ : Short low central vowel
- /a:/ : Long low central vowel
- /i/ : Short high front unrounded vowel
- /i:/ : Long high front unrounded vowel
- /u/ : Short high back rounded vowel
- /u:/ : Long high back rounded vowel
- /e/ : Short mid front unrounded vowel
- /e:/ : Long mid front unrounded vowel
- /o/ : Short mid back rounded vowel
- /o:/ : Long mid back rounded vowel

In the present study, these 10 vowels were embedded in meaningful bisyllabic words. Totally there were 73 test words. These 73 test words were embedded in the medial position of a three word carrier phrase. The carrier phrase used was “/I: pada _________ a:guide/” (This word is ________). These 73 sentences formed the test material.

**Procedure:** The subjects were seated comfortably in the sound treated room of the Speech Science Lab at AIISH and were tested one at a time. Subjects were instructed to read the test sentences, each printed on a card, three times into the Cardioid dynamic microphone (AKG D-222). All these were audio-recorded using a Sony deck. The best of the three trials were considered for acoustic analysis. The reading samples were digitized at a sampling frequency of 16 kHz. The program “DISPLAY” of the software SSL (VSS) was used to extract the vowel duration. Vowel duration was measured as the time difference between the onset to the offset of voicing of the vowel $V_1$ in the word $/C_1V_1C_2V_2/.$

**Results**

The purpose of the study was to measure the vowel duration in the ten vowels of Kannada in children, adolescents and adults and to compare the duration values across the three groups. The results are discussed under the following four objectives of the study.

- To estimate the mean and standard deviation of vowel duration in the three age groups
- To compare the vowel duration across age
- To compare the vowel duration across gender
- To delineate short VS long vowel ratio in the three groups

**Mean and Standard Deviation of Vowel Duration**

Using Descriptive statistics of the SPSS Statistical package, mean and standard deviation were calculated for all the ten vowels of Kannada in the three age groups studied. The results indicated that vowel /u/ was the shortest and vowel /o/ was the longest among short vowels. Also, vowel /u:/ was the shortest and /a:/ was the longest among long vowels. This was observed in both genders and all three age groups studied. Standard deviation reduced from children to adults. Table 1 depicts the Mean and Standard Deviation of vowel Duration in m sec for short and long vowels of Kannada in children, adolescents and adults for males and females.
Table 1: Mean and Standard Deviation (in parenthesis) of Vowel Duration (in m sec) for short and long vowels of Kannada in children, adolescents and adults for males and females

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>F</th>
<th>Average</th>
<th>M</th>
<th>F</th>
<th>Average</th>
<th>M</th>
<th>F</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>101(28)</td>
<td>112 (38)</td>
<td>107 (33)</td>
<td>87 (16)</td>
<td>107 (20)</td>
<td>97 (18)</td>
<td>83 (17)</td>
<td>104 (24)</td>
<td>94 (21)</td>
</tr>
<tr>
<td>i</td>
<td>103 (29)</td>
<td>100 (23)</td>
<td>102 (26)</td>
<td>82 (16)</td>
<td>100 (25)</td>
<td>91 (21)</td>
<td>82 (20)</td>
<td>95 (23)</td>
<td>89 (22)</td>
</tr>
<tr>
<td>u</td>
<td>97 (35)</td>
<td>88 (27)</td>
<td>93 (31)</td>
<td>75 (14)</td>
<td>88 (23)</td>
<td>82 (19)</td>
<td>71 (17)</td>
<td>81 (22)</td>
<td>76 (20)</td>
</tr>
<tr>
<td>e</td>
<td>102 (30)</td>
<td>105 (23)</td>
<td>104 (27)</td>
<td>86 (18)</td>
<td>101 (24)</td>
<td>94 (21)</td>
<td>83 (21)</td>
<td>99 (25)</td>
<td>91 (23)</td>
</tr>
<tr>
<td>o</td>
<td>110 (36)</td>
<td>107 (31)</td>
<td>109 (34)</td>
<td>94 (22)</td>
<td>110 (30)</td>
<td>102 (26)</td>
<td>84 (20)</td>
<td>104 (31)</td>
<td>94 (26)</td>
</tr>
<tr>
<td>Avg</td>
<td>103 (32)</td>
<td>102 (28.4)</td>
<td>103 (30.2)</td>
<td>84.8 (17.2)</td>
<td>101.2 (24.4)</td>
<td>93.2 (21)</td>
<td>80.6 (19)</td>
<td>96.6 (25)</td>
<td>88.8 (22.4)</td>
</tr>
<tr>
<td>a:</td>
<td>190 (31)</td>
<td>208 (45)</td>
<td>199 (38)</td>
<td>159 (26)</td>
<td>196 (27)</td>
<td>178 (27)</td>
<td>162 (26)</td>
<td>206 (44)</td>
<td>184 (35)</td>
</tr>
<tr>
<td>i:</td>
<td>157 (37)</td>
<td>175 (37)</td>
<td>166 (37)</td>
<td>142 (33)</td>
<td>157 (37)</td>
<td>150 (35)</td>
<td>146 (26)</td>
<td>179 (43)</td>
<td>163 (35)</td>
</tr>
<tr>
<td>u:</td>
<td>148 (38)</td>
<td>173 (35)</td>
<td>161 (37)</td>
<td>124 (25)</td>
<td>154 (33)</td>
<td>139 (29)</td>
<td>146 (25)</td>
<td>174 (46)</td>
<td>160 (36)</td>
</tr>
<tr>
<td>e:</td>
<td>176 (35)</td>
<td>193 (33)</td>
<td>185 (34)</td>
<td>142 (21)</td>
<td>173 (31)</td>
<td>158 (26)</td>
<td>157 (25)</td>
<td>195 (41)</td>
<td>176 (23)</td>
</tr>
<tr>
<td>o:</td>
<td>160 (29)</td>
<td>177 (30)</td>
<td>169 (30)</td>
<td>132 (19)</td>
<td>166 (28)</td>
<td>149 (24)</td>
<td>153 (25)</td>
<td>185 (35)</td>
<td>169 (30)</td>
</tr>
<tr>
<td>Avg</td>
<td>166.2 (34)</td>
<td>185.2 (36)</td>
<td>176.35 (2)</td>
<td>139.8 (24.8)</td>
<td>169.2 (31.2)</td>
<td>154.8 (28.2)</td>
<td>152.8 (25.4)</td>
<td>187.8 (41.8)</td>
<td>170.4 (31.8)</td>
</tr>
</tbody>
</table>

It was observed that the standard deviation and range reduced from children to adults. The overall average duration of short and long vowels in Kannada for children, adolescents and adults is shown in Graph 1.

Comparison across age: Scaling was done for comparing the vowel across the three groups as a function of age and sex. Earlier scaling was made by Kent (1976) for comparing the formant frequencies of adults and children. On scaling of vowel duration in the present study, the following observations were made:

Scaling across age it was found that in males a) short vowels were longer in children compared to adults by 21% and compared to adolescents by 17% b) Adolescents had longer short vowel duration than adults by 5%. In females, a) children had longer short vowel duration than adults and adolescents by 6% and 1% respectively b) Similarly adolescents had longer short vowel duration than adults by 5% (Table 2).

In case of long vowels, children had longer duration than adolescents and adults by 16% and 8% and in females they were 9% and 1% respectively. However in long vowels for both males and females, adults had longer duration than adolescents by 9% and 11% respectively (Table 2). Hence even though there was a decrease in vowel duration as age increased, it was not linear in case of long vowels. That is vowel duration decreased from children to adolescents markedly and later again increased gradually to adults in both males and females.
Table 2: Shows the percentage by which vowel duration is longer in children (Ch) than in adolescents (Ado) & adults (Ad) and longer vowel duration in adolescents compared to adults.

On statistical analysis using ANOVA it was observed that there was significant difference in vowel duration across the three age groups for all the vowels in male subjects. The F values are shown for all the 10 vowels in Table 3 (p<0.05). The F values indicate that the main effect across the three groups of males was age. The vowel duration was longest in child males followed by adolescent males and adult males respectively. However there was an exception for long vowels as adolescent males had significantly longer vowel duration compared adult males for the vowels /e:/, /a:/, /u:/ and /o:/.

Table 3: F values at degrees of freedom (2,12) across male subjects

Using Duncan’s test, pair wise differences were tested across the three groups of males at 5% level of significance and the results are given in Table 4. It is seen that there was significant difference in vowel duration for nine out of ten vowels between children and adolescent/adult males and for six vowels across adolescent and adult males. A linear decrease in vowel duration was observed for short vowels as age increased in male subjects.

Table 4: Shows the significance of difference across the three age groups of males for short vowel duration in Kannada at 0.05 level

Similarly using ANOVA, it was observed that there was significant difference in vowel duration across the three groups of female subjects for all the vowels except for the short vowel /u/. The F values are shown for all the 10 vowels in Table 5 below (p<0.05). The F values indicate that the main effect across the three groups of females was age. The results indicated that children had longer vowel duration than adolescents and adolescents had longer vowel duration than adults in the female groups also. Nevertheless, as seen in males here also there was an exception in the case of all the five long vowels which had significantly longer duration in adult females compared to the adolescent females.

Table 5: F values at degrees of freedom (2, 12) across female subjects
Using Duncan’s test, pair wise differences were tested across the three age groups of females at 5% level of significance and the results are given in Table 6. It is seen that in female subjects, there was significant difference in vowel duration between children and adolescents (6/10) rather than between children and adults (2/10). Comparing adolescents and adults, the vowel duration was significantly longer in adults for five out of ten vowels.

<table>
<thead>
<tr>
<th></th>
<th>/i/</th>
<th>/I/</th>
<th>/æ/</th>
<th>/e/</th>
<th>/a:/</th>
<th>/u/</th>
<th>/u:/</th>
<th>/o/</th>
<th>/o:/</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ChVsAd</td>
<td>A</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>6/10</td>
</tr>
<tr>
<td>ChVsAd</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>P</td>
<td>A</td>
<td>A</td>
<td>P</td>
<td>2/10</td>
</tr>
<tr>
<td>AdVsAd</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td>5/10</td>
</tr>
</tbody>
</table>

Ch - Children, Ado- Adolescents, Ad- Adults  
P - Significant difference present  
A - Significant difference absent

Table 6: Shows the significance of difference for the three age groups of females for vowel duration in Kannada at 0.05 level

Comparison across gender: On scaling across gender, in children, males and females had almost equal short vowel duration. In adolescents and adults, short vowels in females were longer by 16% and 17% respectively compared to their male counterparts (Table 7).

On scaling across sex for long vowels, in children, females had longer duration by 10%. In adolescents and adults also females showed longer vowel duration than males by 17% and 19% respectively (Table 7).

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Children</th>
<th>Adolescents</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>0%</td>
<td>16%</td>
<td>17%</td>
</tr>
<tr>
<td>Long</td>
<td>10%</td>
<td>17%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Table 7: Percentage by which the female subjects had longer vowel durations compared to their male counterparts in different age groups.

On statistical analysis using t test, it was observed that there was significant difference in vowel duration across gender in all the three groups for all the vowels except for /e/ and /o/ in children. The F values are shown for all the 10 vowels in Table 8 below (p<0.05).

<table>
<thead>
<tr>
<th>M vs F</th>
<th>/i/</th>
<th>/I/</th>
<th>/æ/</th>
<th>/e/</th>
<th>/a:/</th>
<th>/u/</th>
<th>/u:/</th>
<th>/o/</th>
<th>/o:/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch</td>
<td>3.13</td>
<td>2.41</td>
<td>1.92</td>
<td>2.92</td>
<td>2.90</td>
<td>2.95</td>
<td>2.51</td>
<td>2.88</td>
<td>1.63</td>
</tr>
<tr>
<td>Ad</td>
<td>4.19</td>
<td>2.59</td>
<td>2.92</td>
<td>3.53</td>
<td>3.19</td>
<td>2.73</td>
<td>2.83</td>
<td>3.63</td>
<td>3.92</td>
</tr>
<tr>
<td>Ad</td>
<td>4.45</td>
<td>3.03</td>
<td>2.86</td>
<td>3.01</td>
<td>4.04</td>
<td>4.09</td>
<td>4.13</td>
<td>4.11</td>
<td>4.2</td>
</tr>
</tbody>
</table>

* indicates p < 0.05,  
Ch- Children,  
Ado- Adolescents,  
Ad- Adults  
Ch - Children,  
Ado- Adolescents,  
Ad- Adults  
P- Significant difference present  
A- Significant difference absent

Table 8: Shows the F values at degrees of freedom (2, 12) across males & females subjects

Table 9 shows the presence and absence of significant difference in short and long vowel duration across the different age groups of males and females separately.

<table>
<thead>
<tr>
<th>M vs F</th>
<th>/i/</th>
<th>/I/</th>
<th>/æ/</th>
<th>/e/</th>
<th>/a:/</th>
<th>/u/</th>
<th>/u:/</th>
<th>/o/</th>
<th>/o:/</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>A</td>
<td>P</td>
<td>P</td>
<td>8/10</td>
</tr>
<tr>
<td>Ad</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>10/10</td>
</tr>
</tbody>
</table>

Ch - Children,  
Ado- Adolescents,  
Ad- Adults  
P- Significant difference present  
A- Significant difference absent

Table 9: Shows the significance of difference between males and females for vowel duration in Kannada at 0.05 level

Short vs. Long vowel ratio: On calculation of short versus long vowel ratios, it was observed that the ratio increased from children to adults. In adult males and females the long vowels were almost twice the length of the short vowel. But in children and adolescents the difference in short/long vowel duration was less distinct compared to adults. Table 10 shows these ratios in males and females for different age groups.
### Table 10: Short Vs long vowel ratios in children, adolescents and adults for males and females.

<table>
<thead>
<tr>
<th></th>
<th>Children (M)</th>
<th>Children (F)</th>
<th>Avg</th>
<th>Adolescents (M)</th>
<th>Adolescents (F)</th>
<th>Avg</th>
<th>Adults (M)</th>
<th>Adults (F)</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>1:1.6</td>
<td>1:1.8</td>
<td>1:1.7</td>
<td>1:1.6</td>
<td>1:1.7</td>
<td>1:1.65</td>
<td>1:1.9</td>
<td>1:1.9</td>
<td>1:1.9</td>
</tr>
</tbody>
</table>

**Discussion**

The initial part of the study dealt with the mean values and standard deviation of vowels in the three groups. The study showed that the high vowels /u/ and /u:/ among the short and long vowel categories were shortest in all the three age groups studied. This is exactly in consonance with the earlier study in Kannada on adult vowel duration by Venkatesh (1995). Also the mid vowel /o/ and low vowel /a:/ were longest in all the age groups in the present study. Data of Venkatesh (1995) also revealed that /e/ and /a:/ in males and /e:/ in females were the longest which are again mid and low vowels. These findings indicate that as the tongue height increased, the duration of the vowel decreased. The shorter duration of high vowels may be due to the requirement of greater effort to produce them. This finding is also in agreement with Savithri (1984) in Sanskrit and Savithri (1986) in Kannada.

It was also observed that the variability and range of vowel duration decreased from children to adults. These findings are also in support of earlier studies, where in they report that temporal variability decreased as children get older (Eguchi & Hirsh, 1969, Tingley & Allen, 1975; Kent, 1976; Smith, Sugarman & Lang, 1983).

The second part of the study focuses on comparison of vowel duration across age. It was seen that vowel duration in Kannada decreased from children to adults. The findings are in support of earlier studies by Smith (1978) and Kent & Forner (1980) where they have reported that children’s speech segments are frequently longer in duration than those of adults. As the young children’s speech segment duration are often longer than those of adults, Smith and Gartenberg (1984) hypothesized that at least two factors could be responsible for the temporal differences which have been observed in acoustic measurements of children’s and adult’s speech. They state that “it is possible that physical characteristics of children’s less mature speech mechanisms might limit the rate at which they perform articulatory movements due to factors such as development of the nervous system and/or growth of the orofacial region (Crelin, 1973).

The second factor for children’s longer vowel durations could be a result of not yet having learned to anticipate and plan sequences of speech gestures in the same manner as adults do (Kent & Forner, 1980). Smith and Gartenberg (1984) suggested that the longer acoustic durations on children’s versus adult’s speech seemed to involve both physical level and organizational level factors. Rashmi (1985) reported that both males and females show a consistent decrease in vowel duration as a function of age from 4 to 15 years. Elizabeth (1998) has reported longer vowel duration in children aged between 7-8 years than in adults of Malayalam language. She attributed the reduction in vowel duration to neuromuscular maturation and progress in speech motor control.

There seems to be no obvious reason for the longer duration observed in the adult group compared to the adolescent group in the present study. It is possible that a more homogenous group was selected in the 14-15 year group compared to the adults whose age range varied from 20-30 years and moreover the rate of speech was not controlled during the recording procedure. Most previous studies have examined the acoustic differences between children and adults. As acoustic data on 14-15 year group is limited, further research should help clarify this finding.

The next part considered in the study was the comparison of vowel duration across sex. The study revealed that females had longer vowel duration than males which is also in consonance with several earlier reports. Zue and Lafferiere (1979) observed that longer vowel duration characterized female speech. Rashmi (1985) has reported longer vowel duration in female subjects compared to males in the age range of 4 to 15 years. Savithri
(1984) in Sanskrit and Savithri (1986) and Venkatesh (1995) in Kannada, observed that the vowels produced by female speakers had longer duration than the male speakers. Similar results were reported by Elizabeth (1998) in Malayalam for both children and adults. The longer vowel duration in females may be related to the higher fundamental frequency used by them. Further the vowel duration decreased as a function of age in both males and females which may possibly be due to the decrease in fundamental frequency with age. Study by Nataraja and Jagadish (1984) has also shown a relationship between the vowel duration and fundamental frequency, that is the duration of vowels /i/ and /u/ at high and low frequencies were significantly longer than at the normal fundamental frequency in case of males and females.

The fourth objective of the present study was to establish the short versus long vowel ratios. It was observed that the ratio of short versus long vowel duration increased from children to adults. In adult males and females the long vowels were almost twice the length of short vowels as reported earlier by Savithri (1989) in Sanskrit and Venkatesh (1995) in Kannada. Shalev, Ladefoged, & Bhaskararao, (1993) found that in Toda language, the mean duration of short vowels was 68 ms and that of long vowels, 139 ms. The short-long ratio was therefore 1:2.04. Sasidharan (1995) reported that in Malayalam, the short-long vowel ratio was 1:1.89. Engstrand and Krull (1994) studied vowels in Swedish, Finnish and Estonian languages and found short and long vowel contrasts, similar to the earlier studies. Therefore the relationship between short and long vowels must be language dependent. In some languages, it may be invariant across contextual influences, whereas in other languages it may vary as a function of various other factors. In languages like Kannada, which have distinct duration differences, duration also acts as a cue for stress.

**Conclusion**

The findings of this study are that, in Kannada, mean vowel duration its variability and range decreased from children to adults. The developmental trend was more evident for the short vowels than for the long vowels of Kannada. In all the three groups studied, female subjects had longer vowel duration compared to their male counterparts. And the durational ratio of short versus long vowels increased from children to adults. This study provides vowel duration data in children, adolescents and adults where as most of the literature reports confine to either children or adults. The data obtained is useful in synthesizing Kannada vowels and recognition of the same. This information can be used in the assessment of speech deviations in patients with hearing impairment, stuttering, dysarthria etc. It can also aid in post therapy validation of such cases.

**References**


Savithri, S.R. (1984): Relationship between the fundamental frequency and duration. Unpublished research, conducted at All India Institute of Speech and Hearing, Mysore


Acknowledgements

The author wishes to thank Dr. Vijayalakshmi Basavaraj, Director, AIISH, for her kind permission to submit this study, Prof. N P Nataraja, Director, JSS Institute of Speech and Hearing for his guidance and Prof. S R Savithri, Head, Dept. of Speech Language Sciences for all her help and support during this study.
Classification of Developmental Language Disorders (DLD) - An Exploratory Study

Y. V. Geetha & K.S. Prema

Abstract

Developmental Language Disorders (DLDs) pose a great diagnostic challenge to the practicing speech language pathologists in view of the complexities and variability in their manifestations. This is more so in a country like India where multi-lingual and multi-cultural factors influence the acquisition of speech and language in a child. Most of the children are exposed to a minimum of two languages during their preschool and early school years. The diagnostic process is further complicated by the non-availability of standardized language assessment tools in the Indian languages. The present study aimed at developing Checklist for the Assessment of Language and Behavior (CALB) that would help in classification of children with DLDs, based on literature and case file information with respect to history of onset and development of language disorder, language comprehension, expression and behaviors associated with DLDs. CALB clearly differentiated 7 groups of children with DLD. Further, the classification of DLDs on the basis of Artificial Neural Network and Discriminant analysis is also discussed.

Key words: Developmental Language Disorders (DLDs), Artificial Neural network, Discriminant Analysis

Communication using language is a complex process requiring years of exposure and practice to master the skills. It involves both the understanding and expression of various linguistic parameters including phonology, morphology, semantics, syntax and pragmatics at various levels of complexities. Children who are unable to communicate effectively through language or to use language as a basis for learning are known as children with Developmental Language Disorders (DLD's). Cantwell and Baker (1987) define DLD as “a disturbance or delay in language acquisition that is unexplained by general mental retardation, hearing impairment, neurological impairments or physical abnormalities”.

Children with DLDs are a heterogeneous population varying widely with respect to the etiological aspects and various linguistic and nonlinguistic characteristics. The estimates of the prevalence of DLDs vary widely ranging from 10% for two year olds (Rescorla, 1989) to approximately 1% for older children (Enderby & Davies, 1989). Developmental disorders of language in children may manifest in different degrees of severity across different modalities. Therefore, it is necessary to carry out a comprehensive evaluation before classification of these conditions. Classification or sub-typing of children with DLDs facilitate better communication of information among the members of the professional team, promotes further understanding of the nature of these disorders for academic and research purposes, helps to develop more effective assessment and intervention strategies.

Classification of language disorders in children has always posed many challenges. The causative categories are not predictably related to language attributes (Bloom & Lahey, 1978). Besides, the heterogeneity within the diagnostic categories with blurred distinctions across categories most often leads to validity and reliability problems.

A number of classifications of DLD have been proposed, of which the most common is the distinction between expressive and receptive disorders (Myklebust, 1983; American Psychiatric Association, 1994). Recent trends in classification have moved away from considering whole population of language-impaired children towards more refined analysis-based divisions within an identifiable clinical entity (Fletcher 1991; Miller 1991). Subsequently, various authors have proposed finer subdivisions in the classification of DLDs as shown in Table-1.
Table 1: Classification of DLD’s

<table>
<thead>
<tr>
<th>Author</th>
<th>Types</th>
</tr>
</thead>
</table>
| Aram & Nation, 1975           | Repetition strength  
Non-specific formulation-repetition deficit  
Generalized low performance  
Phonologic comprehension-formulation-repetition deficit  
Comprehension deficit  
Formulation-repetition deficit |
| Bloom & Lahey, 1978           | Impairment in form  
Impairment in content  
Impairment in use |
| Denckla, 1981                 | Anomic disorder  
Anomic disorder with repetition deficits  
Dysphonemic sequencing disorder  
Verbal memory disorder  
Mixed language disorder  
Right hemi-syndrome with mixed language disorder |
| Bishop & Rosenbloom, 1987     | Phonology  
Grammar  
 Semantic  
Pragmatics |
| Rapin & Allen, 1988           | Disorder of phonological decoding  
Disorder of phonological encoding  
Disorder of morphological-syntactic decoding & encoding  
Disorder of higher level processing |
| American Psychiatric Association, DSM IV, 1994 | Expressive language disorder  
Mixed expressive-receptive language disorder  
Phonologic disorder |
| Korkman & Hakkinen-Rihu, 1994 | Specific dyspraxic subtype  
Specific comprehension subtype  
Specific dysnomia subtype  
Global subtype |

Most of these classification systems are based on various language tests and detailed assessment of children with DLDs. However, this procedure is very time consuming and is not feasible in routine clinical practice. Further, in the Indian context with its multilingual and multicultural backgrounds, this becomes even more difficult because of the non-availability of standardized tests in different languages covering all aspects of language behavior. Also, most children are exposed to more than one language during the pre-school years, which makes formal assessment of language functions all the more complex. Therefore, there is a dire need for an easy and quick evaluation procedure incorporating the major characteristic features for the diagnosis and classification of children with DLDs. The main objectives of the present study, therefore, are:

1. To identify the essential language/linguistic and other behavioral characteristics in children with DLD’s.
2. To develop a checklist for the quick screening and diagnosis of children with DLDs.
3. To classify DLDs using Discriminant Analysis and Artificial Neural Network (ANN), a computer software program that recognizes patterns.

ANN has been successfully employed to classify childhood fluency disorders (Geetha, Prathibha, Ashok, & Ravindra, 2000). Therefore, the present study also attempts to classify children with DLDs with the help of ANN program. Further, discriminant analysis was also employed to identify the crucial variables to facilitate classification of DLD’s.

Method

A. Development of tool: 100 case files of children with childhood language disorders were reviewed to analyze the patterns of language and other behavioral characteristic features and the types of DLDs. As the information obtained from the survey of files appeared inadequate to draw any conclusions, a checklist was prepared (CALB) for the assessment of children with different language disorders (see Appendix). The checklist was prepared on the basis of a detailed literature search.
The checklist comprised of:

- 12 items pertaining the history, onset and development of the problem to rule out other associated conditions
- 10 items pertaining to language comprehension including verbal, gestural and reading comprehension and in terms of phonology, syntax, and semantics.
- 10 items pertaining to expression of language including, in addition to those listed under comprehension, repetition skills, pragmatics and writing skills.
- 12 items pertaining to behavioral characteristics six items each for abnormal linguistic and non-linguistic behaviors.

This checklist (CALB) served as a tool for assessing the children with DLDs.

**B. Participants:** 30 children diagnosed as developmental language disorders were taken as subjects for the study. There were 21 male and 9 female children and their age ranged from 3 years to 12 years. There was a positive family history of language problems in 4 (13%) of the training subjects. Four of the children in this group were ambidextrous and one was left-handed. A significant proportion of these children, that is more than 60% were reported to have inadequate language exposure or exposure to more than one language. Further, four new children were selected for checking the prediction of ANN based on their scores obtained on the checklist. None of the children in the training group or those in the prediction group had any significant cognitive, sensory and neuro-motor disabilities.

**C. Procedure:** The language and related behaviors in the CALB were subjectively rated on a 5-point scale to obtain scores for language comprehension, expression and associated abnormal linguistic and nonlinguistic behaviors. 30 children diagnosed as DLD were assessed using the checklist by the undergraduate and graduate student clinicians handling them, after a minimum of five therapy sessions. This was cross-checked by the two investigators of the present study. The data thus obtained for each child was compared across participants and across different types of DLDs. The data obtained from the 30 children with DLDs based on the checklist was used for training ANN and the data on four new children between 3-4 years was used for prediction.

**D. Reliability:** Reliability was checked only for intra-subject ratings. Three children selected on a random basis were re-rated on the CALB by the clinicians who had rated them earlier. The intra-rater reliability was 73%. Variability and developmental trends in language and behavior patterns with age did not seem to affect the intra-rater reliability despite the subjectivity of the procedure. Further, most of these children were in the language therapy program which could have resulted in improved ratings subsequently. Inter-tester reliability was not verified as the criteria for rating (handling the child for a minimum of 5 sessions for language therapy) could not be met.

**Results and Discussion**

A Multiplayer-Perceptron classifier was used for the classification of DLD children. It has wide practical application for pattern recognition and is the most appropriate when binary representations are possible. This kind of network has input, output and hidden layers with variable number of nodes in the hidden layers (Fig.1). ANN is a machine designed to model the way in which the brain performs a particular task or function of interest by using electronic components or simulated in software on a digital computer. It resembles the brain in two respects: Knowledge is acquired by the network through a learning process, and inter-neuron connection strength, known as weights are used to store knowledge. That is, ANNs are biologically inspired networks having the apparent ability to imitate the brain’s activity to make decisions and draw conclusions when presented with complex and noisy information (Haykin, 1995). ANN derives its computing power through its massively parallel distributed structure and its ability to learn and generalize, by which it means that it produces reasonable outputs for inputs not encountered during training (learning).
Empirical classification techniques such as cluster analysis provide methods for grouping individuals who show similar pattern or response on a given set of variables. However, they do not ensure that they (the clusters) are psychologically or educationally meaningful or predictive.

In the present study 32 variables based on the scores for language comprehension (10), expression (10), behavior - nonlinguistic (6) and behavior- linguistic (6) were used as input for training the ANN. Based on these variables, seven classes or groups of children diagnosed as DLD were differentiated. The scores obtained on these 32 variables for the 30 children were normalized or decoded to get scores within zero and one (relative scaling of numbers between maximum and minimum to be mapped to numbers between 0 and 1).

The data obtained for the 30 children with DLD on 32 variables were used to train the ANN. For the classification purpose a Multiplayer Perceptron was adopted with three binary output units (000, 001, 110) representing seven groups. After training ANN with this data for one, two and three hidden layers, with 3-10 units in the hidden layers, output was generated for the 4 new children with DLD for predicting the classification.

Although the training sample and the sample for the output generation were highly inadequate (larger the training sample for the ANN better will be the prediction), there was 50% prediction accuracy for classification using the ANN. This was achieved using one hidden layer with seven nodes as well as two hidden layers with three nodes. Improving the training sample could have enhanced the predictive accuracy of the ANN. This is especially important in view of the large number of variables used for the prediction. Further, all types of DLDs were not incorporated in the training sample and only two types were used for the prediction. Due to the problems in getting adequate number of children with DLDs this could not be done.

As frequently reported by the researchers, most language-impaired children do not fit neatly into one of the descriptions. According to Rapin and Allen (1987), edges of the subtypes are not sharply delineated and that as the child develops, he/she may change from one syndrome to the other. For this claim to be substantiated there would have to be many more finely constructed syndromes than are currently available. Bishop and Rosenbloom (1987) prefer the term ‘disorder’ to syndrome for this condition because according to them a loosely associated set of behaviors relating to language use and content describe the condition (Semantic-Pragmatic syndrome), which shade into autism at one extreme and normality at the other.
Discriminant analysis

ANN analysis revealed that although the training sample was limited and the sample used for prediction did not represent all the groups taken in the training sample, it is possible to classify the DLD children into subgroups based on the variables selected in the study. Canonical Discriminant Analysis was used in order to check for the classification functions and the variables crucial for these groupings.

Table 2 gives the Wilke’s Lambda, Chi square, Eigen values, percent of variance, and the canonical correlations for the six functions that were identified in the analysis. Wilke’s Lambda is a multi-variable measure of group differences over several discriminating variables. Although 6 functions were identified, first three functions accounted for 98% of variance and highly significant. The Eigen values, which are crucial for identifying the discriminant functions show that the first three functions have very high values compared to the rest. The canonical correlations aid in judging the importance of discriminant functions along with the relationship between the functions and the group variables.

Table-2: Wilkes’ Lambda, Chi-square, Eigen values, % of variance, cumulative % and canonical correlations for the six functions

Table 3: Standardized Canonical Discriminant Function Coefficients

BL: Behavior Linguistic; E: Echolalia; P: Perseveration; APR: Apraxia; NEO: Neologisms; M: Mutism; TS: Telegraphic
Speech; BNL: Behavior Non-Linguistic; IT: Incoherent Thought process or behavior; HA: Hypersensitive to Auditory stimuli; IS: Insistence on Sameness; IB: Inappropriate Behavior;
Table 3 and Figure 2 shows the groupings of the children with DLDs with respect to Function 1 and Function 2. Although raw data seemed to indicate wide variability in the spread of scores across all the variables and across groups, it was interesting to see clear separation of the seven groups, without any overlap. Function 1 separates the groups on the linguistic behavior dimension with learning disabled children on the negative end to those with associated problems such as tic disorder at the positive end, those with phonetic disorder and developmental dysphasia lying in the middle. Function 2 separates the groups across nonlinguistic behavior dimension with delayed language at the negative end to autism at the positive end of the continuum.

### Table 4: Structure matrix

<table>
<thead>
<tr>
<th>Functions</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BLTS 0.532, BLNEO 0.319, BLAPR 0.199, BNLIT 0.145, BNLHA -0.113, BNLS -0.076, BLE -0.069, BLP -0.054</td>
</tr>
<tr>
<td>2</td>
<td>BNLIB 0.296, BLP 0.237, BNLS -0.198, BNLIT -0.160, BLTS -0.125, EARTI -0.106, CSYN -0.081, CG -0.073</td>
</tr>
<tr>
<td>3</td>
<td>BLP -0.375, BLTS -0.370, BNLIB -0.368, BNLIT -0.260, BLAPR -0.217, BNLIT 0.233, EPS -0.127, EPRA -0.101</td>
</tr>
<tr>
<td>4</td>
<td>BLAPR 0.338, EPRA 0.244, BNLIT -0.368, CPROS -0.233, BLP -0.221, BLTS -0.202, ENAM -0.192, BLMUTE -0.155</td>
</tr>
<tr>
<td>5</td>
<td>CPAM -0.406, BNLIT 0.396, CAV -0.359, CAP -0.552, CSYN -0.342, EPRA -0.333, ESEM -0.333, BNLG -0.299</td>
</tr>
<tr>
<td>6</td>
<td>BNLIB -0.317, BLAPR 0.299, BNLIB -0.279, BLNEO -0.239, ESPELL 0.204, BLE -0.200, CPRO -0.194, EPS -0.180</td>
</tr>
</tbody>
</table>

### Functions

1. Linguistic behavior dimension
2. Non-linguistic behavior dimension
3. Phonological dimension

Standardized discriminant function coefficients computed provide a measure of the relative contribution of the associated variable to that function. Table 4 provides the discriminant function coefficients for each of the functions. The signs indicate whether they are making a positive or negative contribution on a continuum. In the structure matrix variables are ordered by size of correlation within the function. From this variables having high correlations were separated for each function, irrespective of their signs (Table 4) and each function was named according to the variables contributing maximum for the separation of discriminant functions, after separating the common variables across two functions.

Accordingly, the six functions were named as:

1. Linguistic behavior dimension
2. Non-linguistic behavior dimension
3. Phonological dimension
4 - Expressive dimension  
5 - Comprehension dimension and  
6 - Reading and spelling dimension.

As noted earlier, the sample of children with DLD taken for the study did not represent all varieties that are available and those that are identifiable as per the currently available tests or tools. To account for these it is proposed to classify them based on the language and behavioral (both linguistic and nonlinguistic) characteristics that are possible. This would include:

<table>
<thead>
<tr>
<th>Disorders</th>
<th>Modalities affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Phonological disorder</td>
<td>Comprehension</td>
</tr>
<tr>
<td>II. Syntactic disorder</td>
<td>Expression</td>
</tr>
<tr>
<td>III. Semantic disorder</td>
<td>Verbal</td>
</tr>
<tr>
<td>IV. Pragmatic disorder</td>
<td>Gestural</td>
</tr>
<tr>
<td>V. Behavioral disorder</td>
<td>Reading</td>
</tr>
<tr>
<td>VI. Mixed disorder</td>
<td>Spelling</td>
</tr>
<tr>
<td>- Linguistic/Nonlinguistic</td>
<td></td>
</tr>
</tbody>
</table>

**Summary and Conclusion**

The study aimed at classification of children with DLDs based on a checklist developed for the purpose – Checklist for the Assessment of Language and Behavior (CALB). It was possible to classify 7 groups of DLD children (N=30) without overlap using Canonical Discriminant Function Analysis. The results of the analysis clearly indicate that CALB may be used for quick screening of children with language disorders and to classify them based on the scores obtained. A new approach for the classification of DLD children incorporating various language comprehension, expression and behavioral (both linguistic and nonlinguistic) characteristics has been proposed. ANN, a computer based neural network program was also adopted to check for the efficacy of the program in predicting the classification. Though the training sample and the sample for predicting the accuracy of classification was very small, it could yield more than 50% accuracy in the ANN prediction.

Improving the training sample and inclusion of all varieties of DLD children would definitely provide better prediction and ANN could be used effectively in sub-grouping these children.

The study has great implication for the identification/classification of children with developmental language disorders, which in turn will facilitate better management options. This is especially so in the Indian context with its multi-lingual and multi-cultural background. However, this needs to be tried on a larger population of DLDs including all possible varieties or types of cases.

**Limitations of the study**

- Assessment of language and behaviors were based on subjective ratings by the student clinicians
- Limited number of subjects used for both training groups
- Limited variety of DLD groups
- Limited number and variety of subjects for prediction group
References


Acknowledgements

The authors wish to thank the Director, AIISH, Mysore for permission to carry out the study. The help rendered by Dr. Ashok Rao (CEDT, IISc, Bangalore) and Dr. Ravindra Shetty (Honeywell, Bangalore) for the ANN analysis is gratefully acknowledged. The earlier version of the paper was presented at the International conference on Language, Neurology and Cognition held at Trivandrum on 21-22 Dec 2000.
APPENDIX
CHECKLIST FOR ASSESSMENT OF LANGUAGE AND BEHAVIOR (CALB)

Case name: No: Age: Sex: PD: Clinician: No. of sessions: Date:

I. Brief h/o the problem:
1. Onset: 0 – sudden 1 – gradual/developmental
2. Family h/o speech/lang. problem: 0 – No 1 – Yes (specify)
3. H/o brain damage: 0 – No 1 – Yes
4. Handedness: 0 – Right 0.5 – Ambilateral 1 – Left
5. Exposure to language: 0 – Adequate 1 – Inadequate
6. No. of languages: 0 – Monolingual 0.5 – Bilingual 1 – Multilingual
7. H/o any neuro-motor disorder: 0 – No 1 – Yes (specify)
8. H/o any sensory impairment: 0 – No 1 – Yes (specify)
9. H/o any cognitive impairment: 0 – No 1 – Yes (specify)
10. H/o any other problem: 0 – No 1 – Yes (specify)
11. Motor development: 0 – Normal 0.5 – delayed 1 – Deviant
12. Speech mechanism: 0 – Normal 1 – Defective (specify)

Please rate the child’s speech, language and other skills on a five point scale as:

[1 – Very poor 2 – Poor 3 – Average 4 – Good 5 – Very good]

II. Comprehension:

1. Auditory verbal comprehension:
2. Gestural comprehension
3. Reading comprehension
4. Auditory perception
5. Visual perception
6. Phonological awareness and memory
7. Syntax
8. Semantics
9. Prosodic variations
10. Overall comprehension abilities

III. Expression:

1. Phonological processes
2. Phonetic expression (articulation)
3. Phonological sequencing
4. Syntactic expression
5. Semantic expression-Vocabulary Naming
6. Pragmatic skills
7. Repetition
8. Writing skills - Copying
9. Spelling

IV. Behavioral/ Social skills:

[ 1- Nil; 2- Occasional; 3- Frequent; 4- Very frequent; 5- Always]

A. Non-linguistic:
1. Poor attention and concentration
2. General behavioral irregularities (Please specify)
3. Inappropriate behaviors (Please specify)
4. Hypersensitivity to sensory stimuli
5. Insisting on sameness
6. Incoherent thought processes or behavior

B. Linguistic:
1. Echolalia
2. Perseveration
3. Apraxic errors
4. Neologisms
5. Mutism
6. Telegraphic speech
Visual Word Recognition in Reading Kannada

Jayashree C Shanbal & K.S. Prema

Abstract

Reading is a complex cognitive process. It is a process that requires co-ordination of a series of sub-functions, which include visual functions, verbal functions and other cognitive functions like memory and attention. Impairment in any one or more of these functions can affect reading. Amongst a host of reading processes, visual word-recognition in children is widely investigated. There are many models proposed to explain visual-word recognition. The most widely discussed model is the 'Dual route cascaded (DRC) model' (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). The purpose of the present study is to explore visual-word recognition in Kannada in children with normal reading abilities. Further, the study also investigated if lexical processing in reading Kannada is through serial or parallel processing.

The subjects consisted of 10 children in the age range of 10-12 years with normal reading ability. Children within a minimum of four years of exposure to Kannada reading were selected. Basic reading level in Kannada was established using the Kannada Reading Test developed by Purushothama (1992). The children were required to identify the word in a given word-nonword pair presented through DMDX software program. The reaction time of their responses to identify the word in a given word-nonword pair was measured and recorded with the help of the DMDX software. The results of the study are discussed in light of the existing literature on 'Dual route cascaded (DRC) model'.

Key words: Reading, visual-word recognition, dual route, lexical processing, non-word, reaction time

Reading is a complex cognitive process. It involves the co-ordination of a series of functions which include visual functions such as orthographic (word form) analyses and verbal or language functions such as phonological, semantic and syntactic coding in addition to other cognitive functions like memory, attention and motor skills. Reading can be disturbed by faulty mechanisms in any one or several of these above functions (Lachmann, 2001).

The recognition of words and its relation to reading is one of the core topics in reading research and has been studied extensively in the recent years (Besner, Waller & MacKinnon, 1985; Coltheart, 1987). The study of word recognition is important because identification of a word entails the activation of several types of associated information or codes, each of which contributes to the interpretation of the text material. Further, deficits at the level of word-recognition have been found to be characteristic of children who fail to acquire age-appropriate reading skills (Perfetti, 1985; Stanovich, 1986).

There are many documented empirical research reports on visual word recognition. Various reading models have been proposed in order to understand the mechanisms involved in visual word recognition. A number of other models also attempt to explain visual word recognition and its role in reading related tasks (Marshall & Newcombe, 1973; Meyer, Schvaneveldt, & Ruddy, 1974). These models try to explain the processing of words, irregular words and nonwords- that irregular words and nonwords require separate mechanisms for their recognition: irregular words require lexical lookup because they cannot be pronounced by rule, whereas nonwords require a system of rules because their pronunciations cannot be looked up. Forster’s (1976, 1979, 1989) autonomous search model views word recognition system as one divided into several parts. It talks of a master lexicon which contains all linguistic information about a word (e.g., semantic, phonological, spelling, and grammatical class). The master lexicon is arranged into bins with most frequent entries on top. Entries are searched serially until an exact match is found. If the match is correct, the search is terminated. If the match is incorrect (as in reading non-words) it will be rejected unless they have properties similar to real words. The search will take longer for regular non-words than for irregular non-words. This makes the model more similar to activation models like the logogen model. While in logogen model (Morton, 1969, 1970; Morton, 1979; Morton & Patterson, 1980), the words are processed as composite units, each word operating with an optimum threshold of its own, but not relying on the search process as in the autonomous search model (Forster, 1976, 1979, 1989).
Word recognition which involves lexical decision as well as word naming is explained with the help of Seidenberg and McClelland's (1989) connectionist model. The orthographic characteristics of words form the basis for the model. On the basis of this model, the regular and irregular words are learned through experience with spelling-sound correspondences. There is no mechanism that looks up words, no lexicon, and no set of phonological rules. Instead, words are activated by input from connecting sub-lexical nodes. The key feature is that there is a single procedure for computing phonological representations that works for regular words, exceptional words, and non-words. Yet another connectionist model of visual word recognition is the Interactive Activation model (IA) (McClelland and Rumelhart, 1981). Information is represented as a network of parallel distributed processes (PDP). It consists of a connected network of processing units or nodes that are used to perceive acoustic features, phonemes and words. These are connected at different levels. As excitatory and inhibitory activation is passed through the network of nodes, the pattern of activation is developed to represent the history of the input prior to activation.

Amongst a host of models existing, to date, Coltheart et al.’s Dual Route Cascaded Model (DRC) is considered to be the most successful one to explain the processing of both words and non-words.

**The Dual Route Cascaded model**

The Dual Route Cascaded model (DRC) (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001) has two core assumptions: that the processing throughout the model is cascaded. That is, any activation in earlier units immediately starts flowing to later units. Second, there are two routes for translating print into sound - a lexical route, which utilize word-specific knowledge, and a non-lexical grapheme-to-phoneme conversion (GPC) route, which utilize a sub-lexical spelling-sound correspondence rule system. These routes are depicted in Figure 1.

![Figure1: The DRC model of visual word recognition](image_url)

DRC is an extension of the IA model, in which the essentials of the feature and letter level processing modules (top part of Figure 1) are maintained. The assumption of cascaded processing is derived from McClelland and Rumelhart’s (1981) work on the Interactive Activation model (IA) of context effect in letter perception. Another feature of the IA model and most of DRC is that processing is done in parallel. For example, all features across the stimulus array are extracted in parallel. Similarly, all the letters units are activated in parallel. Indeed, processing occurs in parallel within all modules except the GPC module, where processing is serial.
The Two Routes

A second major assumption of DRC is that there are two routes underlying the process of converting print to sound (Coltheart, 1978). One is the lexical route and the other is the non-lexical GPC route. The lexical route translates the recognition of a word based on word specific knowledge. The route consists of three components: the semantic system, the orthographic lexicon, and the phonological lexicon, as seen in the left part of Figure 1. The semantic system computes the meaning of a word, whereas the lexicons compute the words’ orthographic and phonological form. Representations of a word in the orthographic lexicon and the phonological lexicon are linked so that activation in one leads to activation of the other. For instance, the letters “c,” “a” and “t” will activate the orthographic representation of “cat,” which will then activate its phonological representation of /kat/. The non-lexical route generates the recognition of letter string via a set of sub-lexical spelling-sound correspondence rules. The set of rules is within the GPC module. The GPC module applies rules serially left to right to a letter. That is, letters activate phonemes in a serial, left to right fashion. Activation of the second phoneme does not start until a constant number of cycles after the start of activation of the first letter. For example, given a non-word like “bant”, the corresponding translation would be: B -> /b/, A -> /æ/, N -> /n/, and T -> /t/.

The lexical route utilizes word-specific knowledge to determine the corresponding recognition, whereas the non-lexical route translates graphemes into phonemes via a set of sub-lexical spelling-sound correspondence rules. Thus, given a word that is known to the reader, the correct recognition is quickly generated by the lexical route. A non-word that cannot be found in the orthographic lexicon and hence cannot be read by the lexical route can be read by the non-lexical route. Together, an intact system of lexical and non-lexical routes is capable of recognizing both words and non-words.

The above cognitive models of reading mainly emerged from the studies of reading in a deep or alphabetic orthography like English (Coltheart, 1985; Frith, 1985; Seymour, 1986). Alphabetic orthographies differ in complexity of their grapheme-phoneme- correspondence rules (GPCRs). In shallow or transparent orthographies (i.e., Italian, German, Serbo-Croatian, Spanish and to a certain extent Portuguese) the GPCRs are highly consistent, whereas in deep or non-transparent orthographies they are quite consistent and unpredictable. The latter, feature many words whose spelling does not convey their pronunciation clearly and have numerous exceptions and many irregular words (English being the extreme case). Studies carried out in orthographies as different in their degree of transparency as Italian, German, English, French, Greek and Brazilian Portuguese have evidenced important differences in children’s reading strategies (Cossu, 1999; Frith, Wimmer & Landerl, 1998; Harris & Giannouli, 1999; Pinhiero, 1995; Porpodas, 1991; Sprenger-Charolles & Bonnet, 1996; Wimmer & Goswami; 1994; Wimmer & Hummer, 1990).

Wimmer & Hummer (1990) found that German beginning readers appear to rely mainly on an alphabetic strategy and display little evidence of the use of logographic strategies. Their errors in word reading are mostly pseudo words, which indicates that German beginning readers use the sub-lexical route and move into reading by assembling pronunciations through the use of GPCRs. Studies comparing German and English (Frith et al., 1998; Wimmer & Goswami, 1994) showed that German children read better, faster and with fewer errors than English children. Moreover, the performance of German children in pseudo word reading correlated highly with the reading of familiar words whereas the same correlation was not significant among English children of the same age. This means that although German children use the same procedure (a phonological, sub-lexical or indirect one) to read both words and pseudo words, English children use a visual, lexical or direct procedure to read words and phonological, indirect procedure to read pseudo words. A similar pattern of results was obtained when reading in English was compared to reading in other shallow orthographies such as German, Italian and Spanish (Cossu, Gugliotta & Marshall, 1995; Goswami, Gombert & Barrera, 1998; Thorstadt, 1991). These studies also showed that more complex orthographic systems are more difficult and they entail the use of different reading strategies.

Until a few years ago, it was assumed that the word recognition procedures occurred across all writing systems, regardless of their orthographic depth and consistency. However, a set of recent studies comparing reading in different alphabetic systems pointed out that, factors such
as the level of orthographic transparency of the alphabetic rendition of the language and even the characteristics of the spoken language may influence the process of word recognition.

The present research makes an attempt to understand whether the existing cognitive models of reading, which emerged to explain word recognition in alphabetic languages like English, can explain the same in a non-alphabetic language like Kannada. Amongst a host of models existing, to date, Coltheart et al.’s (2001) Dual Route Cascaded Model (DRC) is considered to be the most successful one to explain visual word recognition while reading. DRC model has been adopted to explore visual word recognition in one of the non-alphabetic languages of India i.e., Kannada. Kannada is an example of a shallow orthographic system. Most of the graphemes in Kannada have a clear and precise phoneme translation. The GPCRs allow readers to determine the phoneme corresponding to each specific grapheme without ambiguity and thus reading is controlled by a set of consistent rules. For e.g., the grapheme ‘Pï’ is read as /k/ in any context within a word. When it is followed by a vowel like /i/, the written form gets modified to ‘Q’ (/ki/) where the vowel gets fused with the consonant. Thus the rule remains the same except for the irregularity of ‘arka’ (ð) in Kannada. While writing ‘arka’, the form is written after a consonant but read out before reading the consonant.

For e.g., ‘PÀªÀÄð’ (CVCV) is read as /karma/ (CVCCV). The form ‘ð’ (arka) is read before /m/ in /karma/ whereas written after /m/ as in ‘PÀªÀÄð’.

Need for the study

Writing system of a language plays a major role in the acquisition of word recognition skills in children. Constraints on the forms of written words impose significant impact on the process of word recognition. In other words if a language is very regular in spelling as in syllabic language, children naturally practice the predictable phonology of the language much more easily as they learn to read than do children who learn an alphabetic language like English where the frequency of irregularities inhibits such practice.

Most of the experimental research conducted in English presents a l view that irregular words and non-words require separate mechanisms for their recognition. To explain further, irregular words require lexical lookup because they cannot be recognized by rule, whereas nonwords require a system of rules because their pronunciations cannot be looked up. An attempt has been made in the present study to explore the visual word recognition in Kannada which is an Indo-Dravidian language following the semi-syllabic orthographic system of language.

Aim of the Study

The aim of the present study is to explore the process of visual word recognition in reading Kannada script.

Method

Subjects

Ten children in the age range of 10-12 years with average intelligence, normal hearing and normal vision were selected. Children with a minimum of four years of exposure to Kannada reading were selected. Basic reading level in Kannada established using the Diagnostic reading test in Kannada developed by Purushothama (1992).

Test Material

The test material included tri-syllabic words in Kannada and corresponding nonwords (non-words were prepared by retaining the first syllable of the word and interchanging the second and the third syllables) were prepared. These words were non-geminate and non-cluster tri-syllabic words. The list consisted of 15 words and 15 nonwords as target words. The list consisted of 30 target stimuli presented randomly. The stimuli were typed on to software called ‘Baraha Version 6.0’.
The stimuli were presented in black font on a white background on the middle of the computer screen. The stimuli were presented visually at random on a computer screen. The stimuli were presented through the DMDX software. The DMDX software is a Window-based program designed primarily for language processing experiments. It can be used for the presentation of text, audio, graphical and video material. It enables the measurement of reaction times to these displays with millisecond accuracy. The reaction time was measured and recorded with the help of the DMDX software.

**Procedure**

The study taken up was carried out in the following phases.

**Phase: 1:** A tri-syllabic word was presented to the subject for 500 ms visually on a computer screen through the DMDX software. Prior to the task, practice items were given with immediate feedback of whether the response was correct or incorrect.

**Phase: 2:** After the presentation of the target stimulus a gap of 500 ms was given after which a pair of word and non-word was presented for 4000 ms. The subjects were instructed to identify the target stimulus from the word-non-word pair by pressing the left or the right arrow key on the key board. The software was programmed in such a way that the left arrow key corresponded to the stimulus on the left side of the screen and the right arrow key corresponded to the right side of the screen. Immediate feedback was given on the screen after the subject presses the key whether the response was correct, wrong or there was a no response. For e.g., a word /karaDi/ is presented for 500 ms and then the word- non-word pair “/karaDi/ /kaDira/” is presented. This pair remains on the screen for 4000 ms. The subject was required to give a response as fast as possible by using the left and the right arrow keys on the key board.

All the stimuli were presented one by one. A total number of thirty target stimuli were presented and the subjects were instructed to identify as fast and accurately as possible. Each experimental session lasted for approximately 20 minutes.

**Scoring**

The responses are analyzed for accuracy and for the time taken to give the accurate response i.e., the reaction time as recorded by the DMDX software. The software automatically saves the reaction time values on a Microsoft-Excel Sheet. These reaction time measures are measured and recorded. The data was subjected to statistical analysis through the SPSS Version 10.0 software.

The data was subjected to statistical analysis and the results are summarized in the following tables. The data was analyzed using paired sample t-test to see the performance of children on visual word recognition task. The reaction time for words and non-words for all the subjects were analyzed.
Results

The results of the study are summarized in the following tables.

Table-1: Mean Reaction Time (in ms) for words and non-words

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean Reaction Time (in ms)</th>
<th>t-value</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Words</td>
<td>Nonwords</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>1380.6807</td>
<td>1737.0913</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>1187.4453</td>
<td>1161.8527</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>2185.6780</td>
<td>2823.5967</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>1572.0680</td>
<td>1707.0307</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>985.2047</td>
<td>1423.8667</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>883.6740</td>
<td>856.6200</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>1094.4407</td>
<td>1162.7820</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>1106.0267</td>
<td>1082.0747</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>997.7580</td>
<td>1098.0487</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>1015.0727</td>
<td>1760.2907</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.05

Table-1 shows the mean reaction time measures for words and non-words of all the subjects. From the table we can see that the reaction time for non-words is comparatively greater than for words in almost all the subjects. It also shows that there is a significant difference between the RTs for words and non-words (0.026 at p<0.05).

Figure 2: Mean Reaction Times (in ms) for words and non-words in all the subjects

From the figure it is evident that the reaction time for non-words is greater than that of words in almost all the subjects. This indicates that the subjects take longer time to identify non-words from a given pair of word and non-word compared to that of words.

Figure 3: 95% Confidence Interval for the Mean RTs for words and non-words
Figure 3 shows the error bar at 95% confidence interval between words and non-words for all the subjects.

**Discussion**

The main aim of this study was to examine the process of visual word recognition in reading Kannada script that may be different compared to a deep orthography like English.

The results of the present study indicate that the children take longer time to recognize non-words when compared to words presented visually. The performance of children the on visual word recognition task can be interpreted using the ‘Dual route cascaded (DRC) model’ (Coltheart, Rastle, Perry, Langdon & Ziegler, 2001). According to this model, in reading, it is generally agreed that there are two routes for accessing information. One is a lexical route and the other is the non-lexical GPC route. The lexical route translates the recognition of a word based on word specific knowledge. The other route i.e., non-lexical route generates the recognition of letter string (be it a word or a non-word) via a set of sub-lexical spelling-sound correspondence rules (See Figure 1).

For example, the children will take longer time to recognize ‘PĀ®Ā®’ /kΛlΛmΛ/ (which is a non-word) when compared to ‘PĀ®Ā®’ /kΛmΛlΛ/ which is a word and which means ‘lotus’. This difference in processing /kΛlΛmΛ/ and /kΛmΛlΛ/ can be explained using the DRC model.

Initially the printed visual stimulus ‘PĀ®Ā®’ /kΛlΛmΛ/ is loaded into the visual feature units (See fig. 1). The lexical route translates the recognition of /kΛmΛlΛ/ based on word specific knowledge. The route consists of three components: the semantic system, the orthographic lexicon, and the phonological lexicon, as seen in the left part of Figure 1. The semantic system computes the meaning of a word which means ‘lotus’ in Kannada, whereas the lexicons compute the words’ orthographic and phonological form. Representations of /kΛmΛlΛ/ in the orthographic lexicon and the phonological lexicon are linked so that activation in one leads to activation of the other. For instance, the letters “PĀ” /kΛ/, “Ā®” /mΛ/ and “Ā®” /lΛ/ will activate the orthographic representation of “PĀ®Ā®,” which will then activate its phonological representation of /kΛmΛlΛ/. Whereas, the non-lexical route differs from the lexical route in both the knowledge base and the type of processing it employs.

While processing a non-word, initially the printed visual stimulus ‘PĀ®Ā®’ /kΛlΛmΛ/ is loaded into the visual feature units (See Figure 1). The features are made up of each letter of the word i.e., PĀ /kΛ/, Ā® /lΛ/ and Ā® /mΛ/. Activation is passed from the feature units to the letter units in parallel across all features and letter positions. Because the processing at the letter level is parallel and cascaded, all letter positions are activated at the same time and activation cascades to the orthographic level and GPC module immediately. Unlike the orthographic level, where activation occurs in parallel, the GPC module is constrained by its serial processing. At this level the GPC module starts processing the first letter. The sub-lexical spelling-sound correspondence rule system is searched until a rule is matched to the first letter. The GPC module receives the same letter input until the first letter of the word reaches its threshold. Once the letter is recognized with maximal activation, the second letter is admitted to the GPC module. Once the second letter is recognized with maximal activation threshold, the first two letters are fed into the GPC module. The rule system is then searched until a rule matched the first two letters. If such a rule cannot be found, the rule system will find a rule matching the first letter, and another rule matching the second letter. That is, the rule system will always try to match the longest grapheme. The translation process continues with the GPC module receiving an additional letter every cycle, until all letters have been translated to phonemes.

In the whole process, the time taken to recognize non-word increases due to the serial processing that takes place at the GPC module before it is recognized. Whereas, the processing of words does not go through the GPC module and is processed as a whole unit, which is compared with the available knowledge of the word in the semantic system. Hence, it takes lesser time to process and recognize words than non-words presented visually (Coltheart, 1978; Marshall & Newcombe, 1973; Meyer, Schvaneveldt, & Ruddy, 1974).
Lexical errors generally reflect a failure in the use of the direct route to access the mental lexicon. A reader addresses word representations without accomplishing an analysis of the orthographic segments of the printed word. Because Kannada orthography is shallow, children may be making a predominant use of the phonological route in the first stages of reading acquisition. When they become skilled and familiar enough with many of the words, they turn to a predominant use of the lexical or direct route. In short, the present results suggest that subtle differences in the degree of predictability of GPCR in Kannada orthography may influence not only the timing of reading acquisition, but also the relative use that children make of the direct and the phonological routes in different phases of reading acquisition. Finally, consideration must be given to the generalization of the results of this research. It is widely accepted that the reading of pseudowords is a good indicator of knowledge of the alphabetic code. Researchers in the field consider this task to be proof of the comprehension of the basic reading mechanisms (Frith et al., 1998; Goswami et al., 1998; Wimmer & Goswami, 1994). However, we are aware that the tasks we used are mainly related to word recognition skills. We must therefore be careful to keep in mind that there are other processes of a higher level that also play a role in reading skills.

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Mother-Child Communication Interaction in Children with Cerebral Palsy

Preeja Balan & R. Manjula

Abstract

Verbal and nonverbal communication fulfills various communicative functions. Intention to communicate is an important communicative function, which further includes functions such as; (i) request for information; (ii) request for attention; (iii) request for object; (iv) information; (v) instruction (action); (vi) instruction (speech); (vii) confirmation (viii) denial. Typically developing children use intentional communication to have a preplanned effect on the mother; who is the most available communication partner for communication. It is clinically observed that in children with cerebral palsy (CP), the intentional communication between the child and the mother is often impaired. However, very few studies have addressed this issue in greater detail. The aim of this study is to describe the factors in intentional communication between the mother and nonspeaking child with cerebral palsy. Amongst the factors analyzed, instruction (action) and information were the most predominant functions observed in mother and child respectively. The other functions showed a hierarchical trend which is discussed in detail. The results revealed a communication asymmetry in the use of various communicative functions between mothers and their non-speaking children with CP. Mothers were dominant communication partners while children were passive communicative partner as revealed from the frequency of occurrence of various communicative function.

Key words: Communication function, Nonspeaking children, Cerebral palsy

Communication is a highly complex and dynamic phenomenon whereby the sender and receiver of the message are continuously coordinating and modifying their present and anticipated actions according to others signals (Fogel, 1993). As Shames, Wiig, & Secord, (1998) puts it, communication is a process wherein we exchange information, feelings, opinions and news. Communication is also multimodal. Though most of the communication is attained through speech, the process is enhanced by the use of facial expressions, gestures, eye gaze, etc.

Children with developmental disability such as cerebral palsy unlike typically developing children have issues in different spheres of life such as feeding, motor control and communication. The term cerebral palsy, as defined by Hagberg, (1989) includes different syndromes, all depending on a non-progressive damage of the immature brain resulting in motor impairment. Depending on the damage, individuals present either anarthria, (inability to produce speech) or dysarthria (unable to produce intelligible speech). Children with anarthria are the non-speaking children who depend on typically available nonverbal strategies such as eye-gaze, facial expressions, gestures, and vocalization to communicate. Often such children are recommended Augmentative and Alternative communication (AAC) strategies for enhancing communicative skills. AAC is “an area of clinical practice that attempts to compensate for the impairment and disability patterns of individuals with severe expressive communication disorders” (ASHA, 1989). Individuals, who use AAC, like their verbal counterparts, have a variety of interaction goals within their social roles. Light (1988) proposed four main goals in such communicative interactions namely:

1. Express needs and wants,
2. Develop social closeness with others
3. Exchange information with others and
4. Fulfill social etiquette expectations.

The communication demands differ across these interactions in order to fulfill the intended purposes. In the first year of life, typically developing children move from the preintentional stage of communication to the intentional stage of communicatio (Bates, Beningni,
Camaioni & Volterra (1975). Intentional communication elicits more contingent responses from mothers as they are easier to interpret or mothers attribute meaning to subtle cues elicited by the child (Yoder & Warren, 1999). Communication development is shaped by the cumulative experience of the interactive process between a parent and child. Children have the ability to use vocalizations, eye-gaze, and motor control of arms and hands, and the caregiver has the intuitive ability to read these potential communicative signals.

Physical limitation as imposed by the physical impairment seen in children with cerebral palsy reduces the opportunities for exploration and object-based play (Cress, Linke, Moskal, Benal, Anderson & LaMontagne, 2000) that are most essential for communication development. Since most of the early learning experiences involve physical acts performed in a given environment, learning language through exploration is rendered equally difficult. The early cognitive and communicative skills are reported to be learnt through social play interactions as compared to object play in typically developing children (Cress et al. 2000). Children with severe physical impairments on the other hand, rely on vocalizations, eye-gaze, and gestures during interactions with their communication partners (Light, Collier and Parnes 1985c). Children with severe or multiple disabilities, have limited ability to use the same repertoire available to typically developing children, and the ability of the caregiver to read these signals will thus be inevitably affected (Carter and Hook 1998). Depending on the characteristics of the behavior, that convey the intent, either singly or in a combined form, there is obvious confusion on the part of the communication partner about interpretation of the child's behaviors and for associating meanings to their communication intentions (Iacona, Carter & Hook 1998). The caregivers make inferences on the basis of other available source of information such as the context, basic understanding of the nature of the child, previous interaction experiences and kinds of verbal and nonverbal expressions (Iacono et al, 1998).

Infants with severe communication disability also fail in exerting communication control, because of caregiver’s problems in reading the early signals from the infant or the infant’s ability to act on objects. This in turn results in failure to develop contingency awareness, in children i.e. the understanding that a behavior has an effect on the environment. This further leads to reduced motivation to act on the environment, thereby initiating a cycle of learned helplessness (Schweigert, 1989). The long-term effect of this learned helplessness is passivity in communication or even a failure to develop intentional communication to develop (Basil, 1992).

Most of the studies have focused on factors related mother–child interaction in typically developing children and patterns of language development through this interaction process. There are limited studies evaluating the mother-child interaction in children with severe physical impairment and specifically in children with cerebral palsy. This study is an attempt to analyze mother-child interaction in nonverbal children with cerebral palsy during the development period. To develop communicative competency in such children a basic understanding of the communicative repertoire used by mother and child during communicative interaction needs to be looked at. Thus the main focus of this present study is to analyze the communication patterns in mother-child communication interactions specific to children with cerebral palsy and who are non-speaking.

Method

The aim of the study was -
- To analyze the communicative functions of mothers while interacting with non-speaking children with cerebral palsy between the ages ranging from 2 to 3 years.

The communication functions studied were as follows (refer appendix 1 for details):
1. Request: (a) Request for information (b) Request for attention (c) Request for object
2. Information
3. Instruction (for action)
4. Instruction (for speech)
5. Confirmation
6. Denial

Subjects

The subjects were selected from centers catering to services to children with special needs. Children within the age ranges of 2 to 3 years with the primary diagnosis of cerebral palsy confirmed by the medical professionals and physiotherapist/occupational therapist were selected. The demographic details of the subjects are presented in Table no 1. None of them had undergone any formal speech and language intervention. All the subjects were quadriplegic (four limbs involvement) and were not independently mobile. Their peripheral hearing and vision were normal (as per the reports available) and had age appropriate receptive language age based on REELS (Receptive Expressive Emergent Language Scale, Bzoch and League, 1971). They were exposed at home to Kannada language. Expression was primarily through non-verbal modalities and none of them had meaningful speech in their expressive vocabulary. Since there are no standardized tools available for measuring nonverbal expressions, expressive language were mainly profiled based on clinical observation and parental interview. Expression was mainly through use of unaided communication strategies such as gestures, pointing, facial expression and/or voicing.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age/Sex</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.0 yrs/F</td>
<td>Spastic Quadriplegic</td>
</tr>
<tr>
<td>B</td>
<td>2.10 yrs/M</td>
<td>Spastic Quadriplegic</td>
</tr>
<tr>
<td>C</td>
<td>2.6 yrs/M</td>
<td>Spastic Quadriplegic</td>
</tr>
<tr>
<td>D</td>
<td>2.11 yrs/M</td>
<td>Dyskinetic Quadriplegic</td>
</tr>
</tbody>
</table>

Table 1: Demographic data of the subjects

Mothers were selected as communication partners as the mothers accompanied most of the subjects attending intervention. Though the contributions from fathers are well acknowledged, mothers play a significant role and are the available partner for communication in most cases. Mothers were in the age range of 21- 25 years and they were literate with a primary education of higher secondary grade. They had no speech, language or other sensory deficits.

Procedure

The four dyads were familiarized with the clinical settings. The principal investigator built rapport with the mother-child dyad. They were instructed to interact with the child using available set of materials/toys, as they would normally do at their homes. Few sessions of feeding, physiotherapy/infant stimulation and play were video recorded to familiarize the dyad with the recording procedure and to desensitize them for the physical presence of the investigator during video recording, and to help overcome shyness/fear if any. Informed consent was obtained from mothers for video recording, prior to their inclusion in the study. The actual procedure consisted of 3 audio-video taped sessions of 15 minutes of each dyad interacting with the selected toys and suggested activities.

Before the recording, mothers were instructed on how to use the material and the activity that was required to be carried out with the child. A semi-structured interaction mode was chosen primarily to increase the chances of occurrence of communicative function, which were intended to be studied. The toys were selected such that it suited the age, physical condition of the child and that, which provided better communication interaction in the dyad. The same toys were provided to all the dyads. The material included ball, building blocks, car, noisemakers, marker pens, kitchen set, doll and accessories of doll, cars, papers, flash cards and picture books. Three sessions were chosen to provide maximum opportunity for a communicative function to occur, and to rule out the contextual limitation (as in selection of a particular toy). Three audio-video recordings were carried out on separate days, within a period of one month, with a gap of a week between consecutive recordings.
Phase 1: Mothers used both verbal and nonverbal strategies to communicate. Due to the inherent difficulty in transcribing the verbal and nonverbal behaviors of the mothers separately and since the aim of the study was to analyze mothers’ overall communication strategies; only the verbal behaviors of mothers were transcribed. Child’s communication strategies were not noted down in this transcription. Taxonomy of the communicative functions was based on review of literature on mother child communicative interaction (Dore, 1978, Wetherby, Cain, Yonclas, Walker, 1988). Two judges, who were postgraduates in speech-language pathology with a minimum of 2 years of experience in intervention of childhood language impairment, were selected. A list of communicative functions, (see Appendix 1), along with the definition and examples were coded for training the judges. A sample video recorded clip of a 6-year-old child meeting all the criteria as specified for subject selection in this experiment except for the age was selected for practice purpose. This recording was used to familiarize and train the judges with respect to the terminology and coding procedure. Both the judges were trained for a period of 4 hours. The judges were given enough opportunity and practice along with ample discussion to familiarize them with the actual rating procedure.

Phase 2: After the training the actual experiment involved the judges, viewing the transcribed version of each session along with the recording of each dyadic session completely for 2-3 times. Once the judges were comfortable and were familiarized with the dyadic sessions. Each transcribed utterance elicited by the mother was coded based on the taxonomy of communicative functions provided to the judges. Similarly the recording was viewed again for coding communicative function elicited by the child. Finally the recording was viewed in total to reconfirm and check the coding offered for the mother and the child’s communicative functions. Both the judges carried out this procedure separately, with the principal investigator helping them with the technical aspects of the recorded samples like switching off the sample at particular point so that they could code the utterance. No discussion regarding the coding, with the principal investigator was entertained during this process. Both the judges rated the sample separately.

Scoring and reliability

The frequency of occurrence of each mother-child communicative function was calculated. The percentage ratio was calculated for each a) mother elicited function to total functions, b) child elicited function to total child function. Inter-judge reliability using alpha coefficient, for the communicative functions of the dyad were carried out. Inter judge reliability ratings for the communicative function of the child ranged from 80% to 99% whereas for mothers, the inter-judge reliability was 99%. The mean percentage of each function for mother and child was calculated. Mean percentages for the three recordings were calculated for each judge. Since the inter-judge reliability of the total of the frequency functions was high, (99%), the mean percentages of each judge were further tabulated to provide a composite mean rating for each communicative function for all the 4 subjects.

Results and Discussion

The aim of the study was to analyze the type and frequency of communicative function in mothers and nonspeaking children with cerebral palsy during semi structured communication interaction. Since verbal and nonverbal responses in mothers were difficult to differentiate, the judges coded the combined communicative strategies of mothers and compared them with nonverbal strategies of the children. The type and frequency of the coded communicative function data, by all the four dyad subjects by both the judges for each recording were calculated. Mean response for all the subjects by both the judges for the type of communicative functions used by the mother and child were calculated. Most of the communicative utterances were mainly by the mothers and they often consisted of multiple utterances with same functions repeated or comprising of multiple functions. On the other hand, nonspeaking children’s communicative function were limited and comprised of single function. The children being nonverbal, mothers seemed to provide a linguistically stimulating environment for them to facilitate language
development. Children exhibited limited repertoire of communicative skills as reflected in their limited communicative functions.

Graph 1: Mean percentage of occurrence of communicative functions (mother and child)

The mean percentage occurrences of various communicative functions are presented in graph 1. Result in graph 1 reveals that there is significant difference observed in various communicative functions in children and mothers. Mothers showed a higher frequency and varied communicative functions as compared to children, which is also supported by other studies (Light et al, 1985 a, b; Pennington and McConachie, 1999). Mothers of nonspeaking children take a larger proportion of communicative turn evident by the higher frequency of communicative functions, thus depicting unequal partnership, dominating the communication interaction (Light et al, 1985b, Pennington & McConachie, 1999). Motor impairment in itself could be the prime reason for the same. The physical dependence of these children could be compelling mothers to be over protective and to assume charge of their life in all spheres including communication.

Request for information had a mean of 36.05%, while request for object and request for attention had a mean percentage of 18.07% and 17.54%. Majority of communicative functions in mothers during dyadic communication interaction were instruction (action). The mean percentage of instruction (action) in mothers was found to be 42.01%. This is possibly because of the inherent mothering pattern often reported in most typically developing children (Wetherby et al. 1988). The initial interactive games of mother and typically developing child are dominated by motoric activities as children learn to speak. It is through these interactive games that rules of language are learnt. In the instances of children with motor impairment, and concurrent delay in attaining motor milestones, mothers seem to continue to provide instructions for actions and encouraging them to perform it. Mothers mostly ignore the limitations imposed by the physical condition. The children selected for the study continued to be on physiotherapy/occupational therapy program. This would have probably influenced the mothers’ communication interactions, which were more inclined towards motoric activities. The significant fact that emerged is the unrealistic expectation of mothers from their children for example, picking up objects, reaching out for an object, etc. were predominant strategies seen in the mothers’ communication.

Provision of information had a mean percentage occurrence of 21.23%. The reduced frequency of information by mothers could also be due to poor response on the part of the child.
It was also observed that among these provisions of information, there were higher instances where mothers requested for information, which was followed by provision of information by her. The mean percentage for instruction for speech in mothers was found to be 5.54%. Though this is considerably less than instruction for action, it again reflects on the belief by mothers that speech would develop in their children over a period of time like other motor milestones, such as partial neck control, or sitting with support/aid. Confirmation attained a mean percentage of 3.4%. Confirmation usually followed child’s response, and was observed to be linked with mothers’ attempt to encourage the child to communicate. The mean percentage of denial was 2.3%. The strong dominance of mothers in the communication interaction can be inferred based on the high percentage of communication function such as instruction for action request for information, and provision of information and a poor regard to other functions such as requesting for attention towards the activity, confirmation, denial or request for object. Pennington et al. (1999) states that communicative functions such as request for information by the mothers actually tend to restrict the communication interaction. Most of this request for information in the dyadic interaction were either asking for label, or expecting a yes/no response, or ‘test questions’ for which the mothers already knew the answers. Light et al (1985b) also observed similar findings in their study. Presence of these functions in mothers’ interactions further restrain the children’s’ conversation. Provision of information is believed to be one of the language stimulation strategies, especially in the developmental period. In typically developing children this has been well correlated with children’s expressive language development. A low proportion of this function is thus a concern in this population. However such interactive strategy in children with cerebral palsy could further reduce the active participation of the child in the communication process and makes the child assume a responsive role.

Contrary to the mothers’ findings in the study, children exhibited restricted range of type of communicative function. They were found to be compliant in the communication interaction. The reason could be that mothers have least communicative expectation from these children especially during this period, when they are struggling to attain physical developmental milestones. Since different communicative functions are derived from the interactive process between children and their primary caregivers, namely the mothers, such lowered expectations actually hamper the communication development in these children. The motor impairment restricts the movement and ability of the children to perform tasks. Simple physical movements like pointing, reaching out or even touching are time consuming if not impossible. It was observed during interaction that, children were seldom provided with the time or opportunity to produce many of the functions resulting in restricted and low frequency of communicative function. It is possible that the communicative abilities of nonspeaking children were restricted due to limited social stimulation and opportunities to explore. The results of the analyses of the communication samples are presented in table 2.

<table>
<thead>
<tr>
<th>Functions</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request for information</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Request for attention</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Information</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Instruction (for action)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Instruction (for speech)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Confirmation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Denial</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Request for object</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 2: Communicative function elicited by nonspeaking children (A, B, C, D) within the dyadic interaction.
None of the children requested for action or instructed the mother to perform an action or speak. Child D was the only one who requested for information, whereas, child A and D were the only children who requested for attention. Provision of information was observed in all the four children. Child B, C & D used only information, denial and request for object. Request for object indicated either the choice of activity, or a material required to produce the action in response to instruction for action. The presence of this function indicates that the children with cerebral palsy are actually not as passive as they are assumed to be. They do have an ability to indicate their preferences or need. This information could be further used as an activity to obtain goal directed behavior, and to control the environment to a certain extent. The communicative functions most commonly and most frequently used were provision of information, which was seen in all the four children’s communication repertoire (Refer table 2). This is in agreement with studies of Light et al, 1985 b, Pennington et al, 1999). The high incidence of request for information by mothers could have obliged the children to provide information, or it could be that the high incidence of mothers’ provision of information could have produced such an effect.

Mean percentage of information was 61.44 %, which was the highest of the communicative turns in children followed by denial (29.6 %). The requests for object occurred 18.07 % of times in children. Request for attention had a mean of 1.85 % whereas request for information had a mean percentage of 0.135%. None of the children confirmed, instructed for action or instructed for speech from mothers, Communication strategies such as eye gaze, facial expressions, gestures, and vocalizations are usually subtle, effortful, time consuming and unconventional. Conditional limitation in such children also limit their ability to use behaviors (such as eye gaze, motor control etc.) and as caregivers’ ability to read these behaviors as communicative signals are inevitably affected (Dunst & Wortman Lowe, 1986). For mothers to attend and interpret their attempt to communicate, such occurrence needs to be brought to the mothers’ attention. A failure to do so, evident in the lower mean percentage prevents the provision of contingent responses by the mothers which otherwise leads to development of learned helplessness (Schweigert, 1989) in the later period. The high frequency of occurrence of functions such as provision of information, denial or request for object probably could be functions that are possible for the child to perform within the limitation imposed by the severe physical and speech impairment whereas other functions such as request for information, instructing the mother for an action or for speaking require a higher potential which is lacking in these children. Probably these functions are interpreted strongly based on the context in which it occurs and the chances of this being missed out by the judges are high. The reduced type and frequency of communicative function could be also a result of limited ability or possibility to use the naturally available unaided strategy by the children. These limitations could be overcome with the provision of AAC system. Possibly a previous experience in interacting with these children to familiarize them with their communicative repertoire would have prevented the likelihood of omission of such function.

An overview of the interaction pattern between mothers and children with cerebral palsy using AAC show an asymmetrical pattern wherein mothers dominate the conversation while children usually tend to be a respondent in most instances. These findings are supported by Calculator and Dollaghan, 1982; Light, Collier and Parnes, 1985a. It is also observed that mothers provide fewer opportunities to their children to communicate. This is again supported by Calculator and Luchko (1983). Several factors could be contributing to this unequal participation by the non speaking individual. Lack of conversational experience and dependence of partner for message interpretation (Culp, 1982; Colquhoun, 1982), developmental constraints, which may limit physical and cognitive experiences and restriction imposed due to the inability of these children to speak, could be some of the reasons for this asymmetry in communication interaction.
Conclusion

Communication is a dynamic and transactional process, in which communication partners continually influence each other throughout the course of their interactions (Blackstone, 1991, 1999). The communicative interactions are dependent on the communication skills of each individual participating in the interaction. The study analyzed the communication interaction strategies in mothers and nonspeaking children with cerebral palsy. Mothers communication strategies were dominated by instructions (actions) followed by request for information, provision of information followed by request for attention. Instruction for speech, confirmation denial and request for object had fewer occurrences in the communication process. Results of the study revealed an apparent disparity between the types and frequency of communicative function used by the dyads. Mothers seemed to dominate the communication process. Contrary to this, children demonstrated more of provision of information, followed by self centered communication strategies which were need/preference based such as request for object and denial whereas instructing mothers to perform an action or for speaking never occurred in the interaction. Request for attention were evident in few instances.

This study is a preliminary attempt in analyzing the communication patterns in the dyad. It does not provide the complete picture of the interaction strategies such as which function/modality were mainly used for initiations or for responding, or which function or modality had more cause-effect relationship etc. However it still enlightens professionals on numerous aspects while working with such children. There is a dire need for rehabilitators engaging in dealing with communication to focus not only on the child but also on mothers and other caregivers and train them on facilitating communication skills. Further research is needed to evaluate how severity of the impairment contributes to the communication patterns. The subjects studied had no formal speech and language therapy. A similar study with subjects who are undergoing speech and language therapy would provide information on whether there is any difference in the communication interaction patterns in mothers and children.

Counseling mothers on the condition of the child and the process of rehabilitation is the prime necessity. Providing a true picture of the child's capabilities could help parents to have realistic expectation from their children, which could further promote better communication skills. Environmental exposure in various ways, in the absence of the normal process and modification of the typical language stimulation behaviors, exploratory play by mothers to particularly suit the needs of the child would facilitate the child in developing skills to communicate. Communication is the right of every individual and it hold true for every child and it holds true for such children too. Expression of thoughts, needs and wants in whatever modality should be encouraged by the mothers. Awareness to the different interaction styles by mothers and its effect could provide insight to mothers on how to handle children with such special needs. Guidelines specific to stimulating these children for communication readiness, and to become an active communicator could prevent communication difficulties in the later date.

References


## APPENDIX 1: DEFINITION OF COMMUNICATIVE FUNCTIONS

<table>
<thead>
<tr>
<th>Communicative functions</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request for information</td>
<td>Turn that serves as request for information about the speaker, about the object, about the action.</td>
</tr>
<tr>
<td>Request for attention</td>
<td>Turns that served as to gain attention towards himself, the object or action</td>
</tr>
<tr>
<td>Request for objects</td>
<td>An intentional communicative act verbal or nonverbal used to demand a desired tangible object.</td>
</tr>
<tr>
<td>Information</td>
<td>Turn that either commented on objects, actions or as to partners comment.</td>
</tr>
<tr>
<td>Instruction for action</td>
<td>An intentional communicative act (verbal or nonverbal) used to command another to carry out an action or instructing to speak.</td>
</tr>
<tr>
<td>Instruction for speech</td>
<td>An intentional communicative act (verbal or nonverbal) used to command another to speak.</td>
</tr>
<tr>
<td>Confirmation</td>
<td>Turn that indicated affirmation, liking or acceptance to partner’s comment.</td>
</tr>
<tr>
<td>Denial</td>
<td>Turn that revealed dislike, or an indication of do not want, negative responses to partner’s comment.</td>
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</tbody>
</table>
A Tachistoscopic Study of Monolingual and Bilingual Children

Dr. Shyamala Chengappa & Jayanti Ray

Abstract

A tachistoscopic study of 10 monolingual and 10 bilingual children, was taken up to investigate the effect of hemispheric processing in Kannada and English language using concrete nouns from both the languages. A comparison of monolingual and bilingual performance on Kannada revealed a better performance by monolingual over bilinguals. The bilinguals however, did not show a significant difference in performance on three language lists viz. Kannada-Kannada, Kannada-English and English-English. On both intergroup and intergroup performance, of monolinguals and bilinguals, a consistent left visual field superiority was found. Possible contributing factors are discussed in relation to the performance of the two groups.

Key words: Tachistoscopic study, Monolingual, Bilingual, Cerebral Asymmetry

Cerebral asymmetry, with respect to language functions has been an area of interest for several decades. The early localizationist’s view that language is represented solely in the left hemisphere is no longer accepted. In order to determine the functions of the two hemispheres, there arose a need for behavioral tests of laterality in normal subjects. Laterality tests have been done, using the auditory modality and visual modality. The dichotic listening tests uses the auditory mode while the tachistoscopic test uses the visual mode. “Tachistoscope” is an instrument which provides a brief viewing of stimuli. It has been extensively used to answer questions regarding hemispheric asymmetry. The lateral visual field hemisphere relationship, in which the stimulation falling upon the left hemiretinae of the eyes is propagated to the occipital areas of the right hemisphere, while stimulation falling upon the right hemisphere, provides the anatomic basis for visual laterality research. Such a procedure has been extensively used for testing the language processing in monolingual and bilinguals.

It is being increasingly argued that the right hemisphere of a bilingual may be participating in language functions to a greater extent in comparison to a monolingual (Bentin, 1981, Chernigovskaya et al. 1983). Tachistoscopic studies and other electrophysiological studies yield clues as to the neurological organization of a bilingual brain. This neural organization is dependent on several variables of a bilingual, viz. handedness, sex, type of language, script, age of acquisition which have their effect on his neurological organization for the two languages.

Only a few tachistoscopic studies on the Indian population have been reported so far. Such tachistoscopic studies, specifically regarding bilingual and monolingual children, are none. In view of this lacunae, on the Indian front, a study was conducted in order to explore the issues regarding the processing of Kannada in Kannada monolinguals and bilinguals and processing of English and Kannada by bilinguals.

Forgays (1963) studied children of 7-16 years and found that less errors were found in right visual field in case of unilateral presentation of 3-4 letter words. McKeever et al. (1973), Olsen (1973), Marcel et al. (1974) and Miller (1981) are authors who followed the similar method of unilateral presentation through a tachistoscope and studied identification of 3-4 letter familiar words and found the superiority of right visual field over the left. Hines (1975) studied the functioning of bilaterally presented tachistoscopic stimuli and found large left visual field superiority for verbal stimuli processing. He also gave the notion that unilateral presentation does not produce a significantly larger visual hemispheric field superiority. Hines (1977) also reported that high frequency abstract words showed a significantly larger right visual hemispheric field asymmetry than high frequency moderately concrete words. Walters and Zatorre (1978) studied English bilinguals and reported left hemisphere superiority for common nouns.

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Genesee et al. (1978) investigated language processing strategies of three subgroups of adult bilinguals with different histories of language acquisition. The adolescent group seemed to rely more on a right hemisphere based strategies.

Handyk et al. (1978) studied English and Chinese bilinguals. Tachistoscopically and found no cerebral lateralization effects, suggesting that active ongoing cognitive processing is independent of lateralization. Zaccolotti and Oltman (1978) studied lateralization of verbal processing in 18-30 year old males and found right visual field asymmetry in letter discrimination tasks with respect to reaction time strategies. Jones (1978) reported of no difference between the visual fields in detection of single letters. Walters and Zatorre (1978) studied laterality difference for word identification in bilinguals and stated that a left hemispheric advantage was present for processing both Spanish and English, regardless of which language was learned first. Silverberg et al. (1979) studied the visual field preference for English words in native Hebrew speakers and found that left visual field preference was present in the youngest group and right visual field preference in the oldest group.

Obler et al. (1982) had presented a precise report on the methodological issues in determining the cerebral lateralization in bilinguals, with respect to stimuli, language set, practice effects, perception, word length, recall, etc. Elman et al. (1981) reported that adjectives and verbs were processed more rapidly and correctly in right visual field. Soares (1984) tested Portuguese-English bilinguals and a group of English monolinguals on a series of concurrent activity, on time sharing tasks. There were no lateralization differences across the bilinguals and monolinguals and equal levels of left hemispheric dominance was found. Albanese (1985) reported that growing bilingual proficiency dues increase left ear/right hemispheric participation, but in intralingual situations only. Vaid (1987) did a tachistoscopic study on rhyme and syntactic category judgement in monolinguals and fluent early and late bilinguals. A right visual field superiority was obtained for both types of tasks and this effects was more pronounced in late bilinguals and monolinguals. Paradis (1990) reported that both languages of bilinguals are subserved by the left hemisphere in the same proportion as in unilinguals.

There have been a couple of tachistoscopic studies in the Indian context using Kannada-English bilingual subjects. Bharathi (1987) did a tachistoscopic study on Kannada English bilingual adults with concrete nouns, presented bilaterally and found that subjects identified more words correctly in the left visual field. Radhika (1987) did a tachistoscopic study in Kannada monolingual adults with abstract and concrete nouns in Kannada, presented bilaterally. The results showed no visual field differences in terms of concrete and abstract nouns.

However, no studies on language processing in monolingual or bilingual children in the Indian context have been reported. In this context the present study was planned. The aim of the present study was to investigate the effects of hemispheric processing in monolinguals and bilinguals.

Method

Subjects

Subjects were 10 monolingual and 10 bilingual children, in the age-range of 8 to 10 years. Monolinguals were selected on the basis that they are continuing their education in the school, where Kannada is the medium of instruction and they use extensive Kannada in all situation. Similarly, 10 bilinguals were selected who are continuing languages Kannada and English. The mother tongue of all the subjects was Kannada. The bilingual group was checked on their fluency, comprehension and expression in the second language, English. The subjects were all right handed and had no family history of left handedness. They all had normal threshold of visual acuity. The subjects were screened for their language competency in the acquired language, except their mother tongue. The screening was based on interview with the school teachers regarding their proficiency on fluency, comprehension and expression in the language. They were not exposed to tachistoscope testing procedures earlier.
Material: The stimulus materials were prepared on white cards (4 x 6") in size. 20 stimulus cards were in Kannada-Kannada, 20 in Kannada-English and 20 in English were prepared with the following criteria.

1) Stimulus words were high frequency concrete nouns. In English, the words were bisyllabic and four lettered. (adapted from Walters and Zatorre's study). In Kannada, high frequency concrete nouns were selected from the work of Ranganatha (1982).
2) Each word appeared in each visual field only once.
3) The same word pair was not repeated anywhere.

Four extra word pairs were prepared for the practice. Each card contained two words and a randomly assigned central digit one through nine. The letters presented horizontally were approximately 2.2 cm. in size and prepared in black colored stencils (upper case). A fixation card was employed, having the picture of a wheel.

Method: The subjects were instructed Kannada and they were asked to concentrate on the visual field inside the instrument (gerbrands 3 channel tachistoscope, model 1/32, T-3, B-2). They were first asked to look at the wheel on the fixation card. As they looked into the central field of vision, the subject was instructed to set the concentration on either side of central field, as words were presented. They were asked to report the central digit first and then the words, as quick as possible. The subjects were asked to guess the words after each presentation period and the order of reporting of the words was not specified. The fixation card was projected for 90 msec. and the stimulus card appeared in the channel for 40 msec. and then a blank flash card was presented for 1 sec. 90 msec (considered as it was found optimal for ensuring that the information is relayed to only one hemisphere at a time) was chosen for the duration of fixation card, based on the studies by Hines (1975), Handyck (1978) and, Bharathi (1987) and Radhika (1987) and 40 msec. was chosen as the duration of exposure of stimulus based on studies by Bharathi (1987) and Radhika (1987). Familiarization before the test was done with four practice cards. Two channels were used, one for fixation and the other for presenting the stimulus material. Subject's responses were recorded verbatim, on a tape-recorder.

Analysis

Recorded responses were transcribed verbatim and then analyzed. For the purpose of analysis, data from those stimulus cards, where the central digit was either missed or reported wrong, was not taken. The recorded responses were categorized as follows:

1) Accurate if correctly reported;
2) Inaccurate if these were omitted or substituted. A maximum score of one could be achieved in each visual field.

Mean raw scores, standard deviation and mean percentage scores of performance of all the groups in the three test lists were listed.

Independent t-test was used to see the difference between Kannada monolinguals and bilinguals on Kannada word pairs. Paired t-test was used to test the difference between RVF and LVF in monolinguals and bilinguals separately. Repeated measure ANOVA was used for testing significance between inter-lingual lists in bilinguals and Bonferroni’s test was done for pair wise comparisons.

Results

The response of the Kannada monolingual children and Kannada-English bilingual children, ranging in age from 8-10 years were analyzed in terms of correct responses and incorrect responses (omissions and substitutions). Table-1 shows the distribution of subjects in terms of age and sex.
Table-1: Age and Sex distribution of subjects

Table-2 shows the performance of ten Kannada monolingual children on Kannada word pairs in terms of correct words reported and errors in the form of substitutions and omissions. The result reveal a better left visual field scores ranging from 15-20 as compared to those of right visual field (Range: 3-16). Even, the number of substitutions and omissions were more in right visual field (4.2 & 8.4) than the left visual field (1.1 & 0.7).

Table-2: Showing the performance of Kannada monolinguals on the Kannada word pairs, in terms of correct words reported, the number of substitutions and the number of omissions.

Table-3 shows the bilingual and monolingual children's mean performance (on Kannada-Kannada list). The mean percentage score (e.g. 91%, 74%) reveals a better performance by monolinguals than bilinguals. Also, the left visual field was found to be superior.

Table-3 Showing the bilingual and monolingual children Average percentage performance on Kannada

Table-4 shows the bilingual children's performance on English-English word pairs, including correct responses and incorrect responses (omissions and substitutions). Substitutions and omissions were comparatively less in the left visual field, (ranging from 0 to 4) than in the right visual field (ranging from 1 to 15) as noted.
Table-4: Table showing the bilinguals children’s performance on English-English word pairs, including correct responses and incorrect responses (omissions and substitutions).

Table-5 shows the bilingual children’s performance on Kannada-English word pairs. The mean of correct response was 18.4 for the left visual field, while it was only 3.4 for the right visual field. Substitutions and omissions were again relatively less in left visual field as compared to the right visual field.

Table-6: Showing the bilingual children’s performance on Kannada-Kannada word pairs.

Table-6 shows the bilingual children’s performance on Kannada-Kannada word pairs. The mean of correct responses, (16.3 & 3.1, respectively) obtained in the left visual field was higher than that in the right visual field revealing that left visual field performance was better than that of the right visual field. Also the number of substitution and omissions were lesser in the left visual field, as compared to the right visual field.
Table 7 shows the mean percentage performance of bilinguals on the 3 word lists viz. (Kannada-Kannada English-English). The mean percentage performance of Kannada-Kannada; English-English and Kannada-English lists in the left visual field was 81.5%; 91.5% and 92% respectively. This shows that the performance was better in the Kannada-English list. The performance in English-English list almost parallelled with that of Kannada-English list. The mean percentage of performances in the right visual field in terms of Kannada-Kannada, English-English and Kannada-English lists were 15.5%, 25.5% and 17% respectively. This shows that the performance in English-English list was comparatively better than the other two lists in the right visual field. Again, the performance in Kannada-English list was better than the Kannada-Kannada list. Substitutions and omissions were again more in number in right visual field in case of all the three lists.

<table>
<thead>
<tr>
<th>Left visual field</th>
<th>Right visual field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lists</td>
<td>Correct</td>
</tr>
<tr>
<td>Kannada-Kannada</td>
<td>81.5%</td>
</tr>
<tr>
<td>English – English</td>
<td>91.5%</td>
</tr>
<tr>
<td>Kannada – English</td>
<td>92%</td>
</tr>
</tbody>
</table>

Table 7: Showing the Average Percentage performance of bilinguals on the 3 word lists viz (Kannada, English and Kannada-English)

Table 8 shows comparison between groups. The difference between the mean of performance of Kannada monolinguals and bilinguals in Kannada-Kannada list was significant at both levels, in the combined visual field conditions. In both bilinguals and monolinguals, left visual field performance is highly significant at 0.001 level. Amongst the bilinguals, there was significant difference between the performances in the three lists. From Bonferroni’s test it is evident that there was no significant difference between the performance of Kannada-English and English-English, whereas rest of the 2 pairs were significant.

<table>
<thead>
<tr>
<th>Groups of comparison</th>
<th>Results of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kannada Monolinguals versus bilinguals on Kannada word pairs (Independent Test)</td>
<td>t (18) = 1.737, p &lt; 0.05</td>
</tr>
<tr>
<td>Amongst bilinguals inter-lingual lists comparison (Repeated Measure ANOVA)</td>
<td>F (2,18) = 10.268, p&lt;0.01</td>
</tr>
<tr>
<td>RVF vs. LVF performances in bilinguals (paired t-test)</td>
<td>t (9) = 15.231, p &lt; 0.001</td>
</tr>
</tbody>
</table>

Table 8: Table showing the results of significance based on group comparisons for correct responses

Discussion

The results obtained indicate that the left visual field performance was superior, compared to that of right visual field regardless of language variation or subject categories (bilinguals and monolinguals). The fact that the left visual field recognizes concrete-nouns supports the earlier findings of Hines (1975, 1977), Genessee et al. (1978), Albert and Obler (1978), Silverberg et al. (1979), Albanese (1985), Bharathi (1987) and Radhika (1987). The finding that the group of monolingual and bilingual children show left hemisphere superiority in any of the tasks, might be because of the reading habits. According to Heron (1957), people tend to read from left most corner to the right. More over, Kannada and English do follow the left-to-right rule. Right visual field errors were more than the left visual field errors. It could have been reduced probably if the duration of exposure of the stimuli was little more than 40 msec. It would be interesting to investigate the reading like in Arabic and the pattern of performance of monolingual and bilingual when stimuli are presented vertically in contrast to horizontal pattern. More number of omissions in the right visual field may also be due to the fact that the test groups involved were children whose performance might have reduced because of attentional deficits. Another attribute for the poor performance in right visual field is that the subjects would have consumed more amount of time, in reporting the central digit and hence less attention was paid for right visual field stimulus, inspite of repeated instructions. More substitution and omission errors were made in the right visual field. Mostly, substitution occurred for words, which were visually more or less similar to the largest word in phonological form. For e.g. ‘Mane’ was substituted by ‘Mara’ and ‘Ane’ ‘Gida’ was substituted by Gudi. Mostly, addition errors were noticed in English-English and English-Kannada word lists, where the ‘plural marker’ /s/ was added. For e.g. lock was told as locks,
'Head' as 'Heads'. It might be due to over generalization of some of the words in the list ('Ears' 'Eyes', 'Cats', 'Dogs' etc.) were plurals which had already occurred earlier in the visual paradigm. Thus, no significant difference in terms of right visual field and left visual field processing of concrete nouns in bilingual children was found. Consistent superior performance in the left visual field appears to be more a function of testing variables than supporting right hemispheric language processing in either of the monolingual and bilingual groups.

References


Neologisms in Child Language: A Case Study of a Bilingual Child

Shyamala Chengappa

Abstract

Surprising parallels with Schizophrenia and Jarganaphasia were found on a linguistic analysis of the neologistic utterances encountered in a normal 3+ year old bilingual child. The analysis in terms of phonological, semantic, grammatical, as well as a few paralinguistic features including mortality and awareness of these neologisms uttered by the normal bilingual child revealed similarities with those of schizophrenics and jarganaphasics reported in literature. This speech sample was also compared with the abnormal utterances of normal speakers. A need for both qualitative and quantitative assessment, in addition to obtaining a total picture of communication was felt in order to categorize a speaker as abnormal or pathological. It is also speculated that bilingual children may undergo such transitory phases of neologistic utterances in their language(s) acquisition process because of the very nature of bilingual / multilingual exposure.

Key Words: Neologisms, Bilingual, Child language

It is recognized that children undergo stages of free vocalization, babbling jargon, echolalia and similar processes leading on to meaningful speech. Additionally, there may also be a stage beyond these elementary ones, beyond the first word stage where in the children exhibit a tendency to coin new words that bear little or no resemblance to the words in the adult language, a tendency to talk at free will irrespective of the stimulus provided or the questions put across, to talk out of context, to talk inappropriately with regards to the stimulus and to show incoherence of thought and language in their speech, thus revealing a certain deviance or abnormality. This raises questions about the present concepts of “normality” and “abnormality”. Child language as it appears, stands for both normal and abnormal language. It is normal since all human beings pass through a similar process and abnormal because the child language deviates from or is different from the standard language of reference, that of the adults. It may also be pointed out that there could be similarities between the language of the adult abnormal (which may or may not be pathological) and some of the stages of language acquisition by normal children. This paper highlights and describes the characteristics of child language vis-à-vis the language of the abnormal adult exploiting the neologisms found in child language acquisition. The neologism are those words which deviate from adult language which the child has formed either by derivation, compounding or using a completely new sequence of phonemes (Virittaja, Lehti, & Hakemistot, 1998). The neologisms uttered by a normal 3 years and 3 months old Kannada-Kodava bilingual girl are analyzed as to their phonological, syntactic and semantic features.

Method

Subject

Subject was a normal, intelligent girl of 3:3 – 3:10 years at the time of this study. Her DQ was 4 years as assessed in psychology department and language age was 4 years on RELT at AIISH. Her comprehension and production of utterances both in Kannada and Kodava were good. Her parents spoke to her each in their respective languages (father was a native Kannada speaker and mother was a native Kodava speaker).

Definition of Neologism: We define a neologism as a phonological form not found in the adult lexicon of the languages (either Kannada, Kodava or even English as generally spoken in Mysore). We also term the words found in child’s language as neologisms when they are employed with a new or deficient semantic charge based on the position adapted by Chaika (1974).
The Data

The Data for this paper was actually an accidental sample obtained in the process of recording spontaneous, narrative and imitative speech (recorded in interaction with parents, peers, investigator, servants at home) recorded for the investigation of the simultaneous acquisition process in Kannada and Kodava used by the bilingual child. The sample constituted a total of 12 hours of speech recorded across a month in the initial period of data collection (3:3 – 3:4) and another in the latter period (3:9 to 3:10) [For a detailed study of the child’s bilingual behaviour refer Thirumalai and Chengappa (1988)]. The data constituted roughly one and a half hour’s sample a week. This total speech sample contained roughly about 421 utterances, which were transcribed and analyzed.

Analysis

The 421 neologistic utterances (including repetitions) analyzed were found to be of two types:

Type I Neologisms: These 228 utterances were lexical items not found to occur in Kannada, Kodava or English. This category also included perseverations or repetitions of whole or part of the utterance. These types of neologisms are illustrated below since the whole list cannot be cited due to lack of space and time.

a:libans comic gatito jakki
ball da:ru lttas inni
Segmental repetitions across several stretches of utterance
na:be akalla a: sade: na:be akalla a:
sabe: I: sade: a: sade

Type II Neologisms: These 193 utterances were recognizable and acceptable lexical items in the languages of the child, but the relations between the words in the stretches of utterances were anomalous and therefore the strings of utterances appeared absurd or empty. This type of utterances did not carry the same semantic content as in the normal adult lexicon and therefore meaningless to the analyst. If they were meaningful to the child, these meanings were not deciphered based on the contextual appraisal by the analyst or when sentences were meaningful they were inappropriate to the given context. Some of these are illustrated below:

1. mammi bae : le mammi bae:le
   mother dal (red gram) mother dal
   mammi na: le rail:lu ka: ru
   mother tomorrow train car

Discussion

The data analyzed revealed several types of deviant language segments in child language acquisition that are on par with those reported in the literature to be present in schizophrenia and jargon aphasia.

Phonologically, all the phonemes used were those found in the phonological inventories of the languages as also were the phonemic sequences. There were normal intonation and stress patterns (no formal tests were used, though) seen except when there were instances of rhyming which, in turn, were found quite often in the sample of neologisms.
There were several characteristics attached to those neologisms, single or whole stretches; contextual indices gave no clue as to the appropriateness and occurrence of most of these neologisms as well as stretches of neologic utterances; there were some neologisms which were consistently used with the same semantic charge and also those which were not repeated; there were stretches of neologic utterances interspersed with recognizable words neologisms were, in majority, nouns or content words; neologisms had partial or no resemblance to the actual words in the language lexicons; some neologisms were words that were part of the language inventories but were given in appropriate usage and hence are termed neologistic (since one is not sure whether the child had any message at all or if she had the intended message did not conform to those in the language repertories), the language specificity could not be determined because of the inconsistent and unexpected occurrences of the neologisms. However, two observations to this effect could be made:

(a) Some neologisms occurred in contexts exclusively belonging to one or the other of languages and some occurred in both the languages.
(b) Some neologisms had partial resemblance to a specific language rather than to the other (as in the use of phonological variables or case endings, to name two instances) and some had no resemblance to either of the languages.

Neologisms were uttered in the course of expositional (conversational) speech, during the repetition programmes (conducted by the investigator), and as imitations of reading (read by the investigator).

Neologisms were uttered regardless of whether the appropriate words were known or not known, and no pauses of hesitations were noticeable prior to the utterance of neologisms to account for the child’s inability to retrieve. It was felt that a failure to restrict, an inclination to indulge in verbal play, lack of inhibition in speaking at free will might have led to the picture of incoherence sighted in the neologic utterances of the child.

The most important feature of such neologic utterances is the high mortality rate of the words across the duration of six months. These utterances were abundant in the speech of the child at the age of 3:3 (or one could say 3 plus since it was highly possible that they existed before the period of elicitation of the sample) and disappeared by the age of 3:10. This points to the transitoriness or the temporary nature of such verbal performances.

Chaika (1974) highlighted the significance of neologisms and gibberish in schizophrenic speech. She observed three varieties of neologisms: single utterances, stretches of neologic utterances constituting gibberish, and a third phenomenon of assigning wrong or insufficient semantic features to recognized words in the vocabularies. All these three types of neologisms have been noticed in our study of a child in the process of language acquisition. However, Chaika remarks that such neologisms were used due to a disruption in the ability to match semantic features to actual words in the lexicon which was a part of the general disability in ordering linguistic elements into meaningful structures while in our study it was more a case of inadequate ability to process the structures (inadequate learning) rather than a disruption. The highlight of Chaika’s study was an analysis of discourses the results of which are also on par with those of the present study. Lack of a consistent subject matter, the absence of discourse markers that orient the listeners to the topic lack of markers that show connections characterizing schizophrenic discourse were seen to characterize our data collected from a normal child. The topic and the selective attention that should be paid only to those semantic features that are pertinent to the context, were both found violated in the case of our normal child’s speech sample as it did in Chaika’s schizophrenic cases. Chaika (1974) also remarked that normal individuals would never utter stretches of gibberish, rhymed or free-associated or misused common words as the schizophrenics did. But surprisingly, we found that this was just our normal child did, revealing the similarities in language use by schizophrenics and young children in the process of language acquisition.
Patients with schizophrenia often display language impairments, Covington et al. (2005) survey their language level by level, from phonetics through phonology, morphology, syntax, semantics and pragmatics. Phonetics, is often abnormal but phonology structure, morphology and syntax are normal or nearly normal.

One could speculate, perhaps not too wildly, that this phase, one abundant with neologistic utterances is a stage which almost all the children pass through as they do with babbling and other stages. However, this stage is beyond the stage of first word, beyond a stage where a child is well on the way of mastering language with a good work able vocabulary for functional purposes. This phase could be hypothetically placed around the age of 3 years (as supported by an observation of two more children of similar set up) although it needs further strengthening before it is specified. One could also speculate, not without reasons, that this phase is especially true of children who are subjected to bilingual or multilingual exposure from birth. This would be appropriate considering that this situation, simultaneous bilingual acquisition, would offer more freedom to the child in terms of formation and use of words. This would mean that, because of the loose attachment of sound and meaning (form, structure and functions of linguistic elements), as seen in the exposure to two lexical equivalents for a single concept (as against that of a single language exposure), the child learns to be more creative and innovative. Thus, there is a stage of experimentation and hence, the neologistic utterances. These neologisms would continue to dominate the child’s linguistic performance only till the time when there is a negative reinforcement for such utterances by the social milieu and an eradication of such utterances is enforced. Even then, some neologisms would continue to exist in the child’s repertoire, with a semantic charge (not common to the dialect of the child’s community) with a tolerance and the acceptance of the term and with it its semantic notion by the social milieu.

References


Acknowledgements

I am grateful to Dr. M.S. Thirumalai, Professor & Dean, College of Missions, Bloomington, USA, for the guidance and discussion during the preparation of this paper.
Linguistic Profile Test – Normative Data for Children in Grades VI to X (11+ Years – 15+ years)

M.G. Suchithra & Prathibha Karanth

Abstract

In view of the near total absence of literature on language acquisition in older children, in the India context, this study focused on the collection of normative data for older school going children from Grades VI to X on the Linguistics Profile Test (LPT). One hundred and fifty children ranging in age from 11+ years to 15+ years were the subjects in the current study. There were 30 subjects in each age group. The mean and SD of each of the three sections (Phonology, Syntax and Semantics) of LPT was obtained. It was found that the mean scores gradually increased over years. The findings of this study are on line with the earlier studies on Hindi Speaking adults as well as children of same age group. The norms thus established may be used for evaluation and identification of delayed language acquisition in older children in Kannada.

Key words: LPT, Normative data, Children

rehabilitating patients to their best possible level of functioning. To accomplish that goal, the best quality of speech-language services must be provided. The Speech-Language Pathologists must use language assessment programs that have proved to be efficacious, so that the Speech-Language Pathologists share with other professionals the goal of ey can be reliably utilized by all clinicians.

The 1960’s saw an enormous spurt in the influence of linguistics on Speech Pathology. An increasing awareness of the benefits that accrue in terms of an understanding of the disorder and the increase in precision of the assessment and remediation process led to an incorporation of linguistic theory and principles in the assessment and remediation of speech-language disorders. The why of assessment has shifted from differential diagnosis to establishment of norms for providing a basis for remedial procedures both descriptive and prescriptive (Karanth, 1995).

The current study aimed at collection and analysis of large scale normative data on LPT on older school going children between 11+ years to 15+ years an extension of a previous study (Suchithra & Karanth, 1990) on a group ranging in age from 6+ years to 10+ years.

Method

Subjects: 30 children each from Grade VI (11+ years) to X (15+ years) were the subjects in the current study. These children were:

1) Healthy normal children with no physical or sensory disabilities.
2) Native speakers of Kannada.
3) Were studying in Kannada medium.
4) All the subjects belong to middle socio-economic status
5) As there was no other Indian Standardized Language Screening Test to screen language of children in grades VI to X (namely 11 years to 15 years), the scores of the upper most grade i.e. V grade on LPT (Suchithra M.G. & Karanth, 1990) which was already standardized was used as a cut off score and children who scored above the specified score (for grade V) were considered as subjects for the present study.
The subject details are given in Table 1.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>No. of subjects</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>11+ years</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>12+ years</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>13+ years</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>14+ years</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>15+ years</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1: Age groups and the No. of Subjects in each age group

Procedure

The Linguistic Profile Test (LPT) was administered during the second term of the academic year. In the earlier studies (Karanth, 1984, Kudva, 1991) each subject was tested individually on all items of all subsections. The subsequent study (Suchithra & Karanth, 1990) focused on normative data for children in Grades I to V. The procedure of test administration for the present study which aimed at collecting normative data in the higher age groups i.e. children in grades VI to X (11+ years to 15+ years) was same as the earlier study except that the test items administered in groups of 15 in the previous study (Suchithra & Karanth, 1990) where as the test items were administered to group of 30 in the present study.

Results

The Mean and Standard Deviation of LPT scores (total scores) are given in Table 2.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mean Scores (Total Scores)</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11+ years</td>
<td>266.21</td>
<td>19.43</td>
</tr>
<tr>
<td>12+ years</td>
<td>279.67</td>
<td>8.10</td>
</tr>
<tr>
<td>13+ years</td>
<td>282.36</td>
<td>6.87</td>
</tr>
<tr>
<td>14+ years</td>
<td>286.60</td>
<td>5.58</td>
</tr>
<tr>
<td>15+ years</td>
<td>287.38</td>
<td>4.94</td>
</tr>
</tbody>
</table>

Table 2: Mean and S.D. of LPT Scores

The results indicate that the mean score ranged from 266.2 to 287.4. It is observed that the mean scores have increased gradually over years i.e. from 11+ years to 15+ years.

In mean scores and SD of the three sections of LPT, namely phonology, syntax and semantics are given in Table 3.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Phonology Mean</th>
<th>S.D.</th>
<th>Syntax Mean</th>
<th>S.D.</th>
<th>Semantics Mean</th>
<th>S.D.</th>
<th>Total Scores Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (11+ yrs)</td>
<td>100 0.00</td>
<td>85.83</td>
<td>4.02</td>
<td>83.73</td>
<td>10.56</td>
<td>266.21</td>
<td>19.43</td>
<td></td>
</tr>
<tr>
<td>II (12+ yrs)</td>
<td>100 0.00</td>
<td>85.70</td>
<td>4.87</td>
<td>93.96</td>
<td>4.05</td>
<td>279.67</td>
<td>8.10</td>
<td></td>
</tr>
<tr>
<td>III (13+ yrs)</td>
<td>100 0.00</td>
<td>85.68</td>
<td>5.65</td>
<td>96.70</td>
<td>2.08</td>
<td>282.36</td>
<td>6.87</td>
<td></td>
</tr>
<tr>
<td>IV (14+ yrs)</td>
<td>100 0.00</td>
<td>86.40</td>
<td>5.51</td>
<td>100.00</td>
<td>0.00</td>
<td>286.60</td>
<td>5.58</td>
<td></td>
</tr>
<tr>
<td>V (15+ yrs)</td>
<td>100 0.00</td>
<td>87.41</td>
<td>4.92</td>
<td>100.00</td>
<td>0.00</td>
<td>287.38</td>
<td>4.94</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Means and Standard Deviations for Different Age Groups

Especially with a close observation at the Means and SD, the following aspects can be visualized. It is found that mean scores (please see Table 3) have gradually increased over years from 11+ years to 15+ years. Maximum scores have been obtained by children of 11+ years for phonology and 14+ years for semantics sections of LPT.
The maximum score is not obtained even by children of 15+ years (i.e. maximum age limit for this study) for syntax section. Further it is also observed that over years, as the mean scores increase the SD is found to decrease. This is indicative of the validity and reliability of the sample. The sample studied here is thus representing the population and can be used as norms during routine speech and language evaluation. The significance of difference (on Newman / Keul’s Range test) between Means indicated no significant differences in higher age groups (i.e. 11+ to 15+ years). But, when compared with the younger age groups (i.e. 6+ - 10+ years) indicated significant differences at 0.05 levels.

It was already observed in the earlier study (Suchithra & Karanth, 1990) that the mean scores obtained for Phonology was significantly higher reaching the maximum limit (i.e. 100) by 6+ years. The same results are maintained throughout this study across age groups 11+ years to 15+ years.

The Mean scores obtained for the other two sections – Syntax and Semantics also increased gradually with age. The Mean scores in the Syntax section ranged from 85.8 to 87.4 (see Table 4). Thus, the maximum limit was not reached even at 15+ years. It is evident that the increase is very gradual over years (i.e. from 11+ years to 15+ years).

Table 4: Mean scores and SD for different items of the Syntax section of LPT

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Items</th>
<th>11+ years</th>
<th>12+ years</th>
<th>13+ years</th>
<th>14+ years</th>
<th>15+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Morphophonemic Structure</td>
<td>8.3</td>
<td>3.0</td>
<td>8.5</td>
<td>0.6</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7</td>
<td>8.6</td>
<td>0.7</td>
<td>8.7</td>
<td>0.9</td>
</tr>
<tr>
<td>B.</td>
<td>Plural Forms</td>
<td>4.3</td>
<td>0.4</td>
<td>4.7</td>
<td>0.6</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6</td>
<td>4.6</td>
<td>0.4</td>
<td>4.8</td>
<td>0.3</td>
</tr>
<tr>
<td>C.</td>
<td>Tenses</td>
<td>4.3</td>
<td>0.6</td>
<td>3.8</td>
<td>0.7</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8</td>
<td>4.5</td>
<td>0.6</td>
<td>4.6</td>
<td>0.6</td>
</tr>
<tr>
<td>D.</td>
<td>PNG Markers</td>
<td>8.3</td>
<td>0.6</td>
<td>9.4</td>
<td>0.7</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8</td>
<td>9.1</td>
<td>0.9</td>
<td>9.2</td>
<td>0.6</td>
</tr>
<tr>
<td>E.</td>
<td>Case Markers</td>
<td>8.7</td>
<td>0.7</td>
<td>8.7</td>
<td>0.6</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>8.3</td>
<td>1.2</td>
<td>8.3</td>
<td>0.8</td>
</tr>
<tr>
<td>F.</td>
<td>Transitive Intransitive &amp; Causatives</td>
<td>7.6</td>
<td>0.8</td>
<td>8.2</td>
<td>0.8</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>8.5</td>
<td>0.9</td>
<td>8.2</td>
<td>0.9</td>
</tr>
<tr>
<td>G.</td>
<td>Sentence Types</td>
<td>9.0</td>
<td>0.5</td>
<td>9.3</td>
<td>1.3</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>9.4</td>
<td>1.1</td>
<td>9.2</td>
<td>0.9</td>
</tr>
<tr>
<td>H.</td>
<td>Predicates</td>
<td>9.4</td>
<td>0.3</td>
<td>9.5</td>
<td>0.8</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>9.4</td>
<td>1.1</td>
<td>9.2</td>
<td>0.9</td>
</tr>
<tr>
<td>I.</td>
<td>Conjunctives Comparatives &amp; Quotatives</td>
<td>8.1</td>
<td>1.4</td>
<td>7.5</td>
<td>1.3</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3</td>
<td>8.2</td>
<td>1.4</td>
<td>7.5</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.7</td>
<td>8.2</td>
<td>1.7</td>
<td>8.9</td>
<td>1.5</td>
</tr>
<tr>
<td>J.</td>
<td>Conditional Clauses</td>
<td>7.9</td>
<td>1.5</td>
<td>8.0</td>
<td>1.7</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8</td>
<td>8.3</td>
<td>1.3</td>
<td>8.3</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Table 5: Mean Scores of Index of Sensitivity (A) for different age groups

As seen from Table 5, it is evident that plurals were the most sensitive in all the five age groups studied here. The items of Predicates, Sentence types, Tenses, PNG markers were relatively more sensitive compared to other items. The sensitivity to predicates exhibits a constant and higher sensitivity throughout the 5 age groups studied (11+ - 15+ years). There is a steep rise in sensitivity to tenses at around 13+ years, after which a more gradual rise is noticed from 14+ years to 15+ years. The items Morphophonemic structures, case markers, Conditional clauses, Conjunctions, Comparatives and Quotatives exhibit a lower sensitivity.
compared to other groups. The item of Participial construction exhibits lowest sensitivity. These findings are in line with the findings of previous study with younger age groups (6+ years – 10+ years). The Ranking of subcategories (items of Syntax section) based on sensitivity index is given in Table 6.

<table>
<thead>
<tr>
<th>Rank</th>
<th>11+ yrs. Items</th>
<th>Rank</th>
<th>12+ yrs. Items</th>
<th>Rank</th>
<th>13+ yrs. Items</th>
<th>Rank</th>
<th>14+ yrs. Items</th>
<th>Rank</th>
<th>15+ yrs. Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>G &amp; H</td>
<td>1</td>
<td>H</td>
<td>1</td>
<td>B</td>
<td>1</td>
<td>H</td>
<td>1</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>B 2.5</td>
<td>2</td>
<td>G &amp; D</td>
<td>2.5</td>
<td>G &amp; H</td>
<td>2.5</td>
<td>G &amp; B</td>
<td>2</td>
<td>H</td>
</tr>
<tr>
<td>4</td>
<td>I 4</td>
<td>4</td>
<td>B 4.5</td>
<td>E &amp; A 4</td>
<td>D 3</td>
<td>G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>E 6</td>
<td>I &amp; A &amp; E 6</td>
<td>D 5.5</td>
<td>F &amp; C 4.5</td>
<td>C &amp; D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>A 8</td>
<td>F 7.5</td>
<td>C &amp; F 7</td>
<td>A 6</td>
<td>J 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>F 9</td>
<td>J 9</td>
<td>I 8.5</td>
<td>E &amp; J 7.5</td>
<td>A &amp; E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>D 10</td>
<td>K &amp; C 10</td>
<td>J 10</td>
<td>I 9</td>
<td>F 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>J 11</td>
<td>K 11</td>
<td>K 10</td>
<td>I 11</td>
<td>K 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Ranking of subcategories (items of Syntax section) based on sensitivity index

The Mean scores and Standard deviation for different items of the Semantic section are given in Table 7. The Mean scores in the Semantic section ranged from 83.7 to 100. The maximum score i.e. 100 was scored by children of 14+ years.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>11+ yrs.</th>
<th>12+ yrs.</th>
<th>13+ yrs.</th>
<th>14+ yrs.</th>
<th>15+ yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>X</td>
<td>SD</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>1</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>2</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>3</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>X</td>
<td>SD</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>2</td>
<td>10.98</td>
<td>19.8</td>
<td>19.8</td>
<td>19.8</td>
<td>17.5</td>
</tr>
<tr>
<td>3</td>
<td>4.70</td>
<td>4.7</td>
<td>4.7</td>
<td>4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>4</td>
<td>4.03</td>
<td>4.7</td>
<td>4.7</td>
<td>4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>5</td>
<td>2.96</td>
<td>1.74</td>
<td>3.0</td>
<td>1.56</td>
<td>5.0</td>
</tr>
<tr>
<td>6</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>7</td>
<td>3.68</td>
<td>4.8</td>
<td>4.8</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>8</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>9</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>10</td>
<td>3.8</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>5.0</td>
</tr>
<tr>
<td>11</td>
<td>3.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Table 7: Mean and S.D. for different items of the Semantic Section of LPT

In the Semantic section, better performance is observed for all items under Section III-A Semantic Discrimination (viz. Colours, Furniture, and Body parts) – maximum scores have been obtained by children of 11+ years, the lowest age group in the present study. Under Section III-B Semantic Expression, better performance is observed for item Nos. 1, 6, 8 and 9 (i.e. Naming, Polar Questions, Paradigmatic relations, Syntagmatic relations respectively). Maximum scores have been obtained by children of 11+ years. The scores for the rest of the item Nos. 3, 4, 5, 7, 10 and 11 reaches maximum level at around 13+ years (viz., Synonyms, Antonyms, Homonyms, Semantic Anomaly, Semantic contiguity, Semantic similarity). For item No. 7 (i.e. Lexical category) maximum scores are obtained only by 14+ years.

Discussion

The results of the studies son older children (Bohannon 19786, Scholl & Ryan, 1980) suggest that children gradually make judgements more and more like those of adults focusing attention on evaluating the properties of the sentence per se.

In a study on acquired language disorders (Karanth, Ahuja, Nagaraja, Pandit and Shivashankar 1990, 91) 100 normal literate and illiterate adults were evaluated on the Syntax section of LPT. It was found that for literate group the Mean index of sensitivity was 0.95 and
for illiterate group it was found to be 0.72 leading to the observation that literacy in itself is an important variable affecting grammaticality judgements. The Mean index of sensitivity is 0.93 for the 15+ years age group i.e. the highest age group in the present study (Karanth, Ahuja, Nagaraja, Pandit and Shivashankar 1990, 91) where the index in literate adults is 0.95.

The findings of the study (Sharma 1995) on a similar group (11+ years – 15+ years) on Hindi speaking population is in agreement with the findings of the current study with the Mean index of sensitivity of that study (Sharma 1995) being 0.96 for 15+ years. Thus, the overall findings of the present study also confirms the findings of the previous study (Karanth, 1984) that adult like sensitivity to grammar judgement is acquired by adolescence.

The findings of the present study support the earlier findings by Pereira (1984) who reported that accusative, infinitive constructions, relative clauses and complement clauses are acquired by older age group (i.e. not below 9 or 10 years of age).

The findings of studies by sociolinguists that accusative and infinitive constructions (represented by the Chomsky Model) are found only in very formal English and are not learnt in years between 5-11 years, but only in Secondary School (Pereira 1984) support the findings of the present study. Pereira (1984) also observed that the relative clauses with “whom” “whose” or “preposition are the product of mature writers. Complement clauses in subject position are also produced by older or abler children, and these constructions are typically not used by children before 9 to 10 years and many do not use them until they are in their third or fourth grade of secondary schooling.

The results are in agreement with the earlier study (Suchithra & Karanth 1990, Karanth & Suchithra 1993) that the emergence of grammatically judgement and literacy acquisition has a definite role in Metalinguistic awareness and skills such as grammaticality judgement and agrees with the notion reported in the above study that this has an important implication for agrammatic judgement in linguistic theory and interrelationship between metacognitive and metalinguistic abilities.

Scholes (1993) study on utterance acceptability criteria showed increased sensitivity to written presentation, concluding that written presentation enhances subject’s sensitivity to correctness. Similar findings are reported in study by Miller (1993) and our earlier study by Karanth & Suchithra (’1993). In the current study i.e. the children of age ranging from 11+ years to 15+ years have more exposure to written presentations and hence performance on judgement tasks have improved gradually. The results of the study by Kudva (1991) are on similar lines i.e. grammaticality judgement skills increase with age in childhood and are apparently enhanced by the acquisition of literacy, a consistently significant better performance was seen in school going children of comparable age.

Under semantic section, the scores for item No. 2 (furniture) under Semantic Discrimination III-A, the maximum scores have been obtained in the earlier age group in the previous study by Suchithra & Karanth (1990) and the same has been maintained throughout. The results of Hindi speaking population (Sharma 1995) is in agreement with the present study but in Sharma’s study maximum score was obtained by the lowest age group itself i.e. 6+ years. Istomia (1963) and Johnson (1977) from their study report that even though among earlier adjectives used by children are ‘colour’ words – yet young children are notoriously bad at using colours appropriately. The results of their investigation support the result of the present study. For item No. 3 (body parts) Maximum score has been obtained in the present study even in the lowest age group studied i.e. 11+ years. In Sharma’s (1995) study maximum score has been explained as a result of the constant use of English words (for names of body parts) in Hindi speaking population.

The results of sub-items III-B Semantic Expression are in close agreement with Sharma’s (1995) study. For item Nos. 1, 4, 6, 7, 8, 9, 10 and 11 i.e. Naming, Antonyms, Polar questions, Semantic Contiguity and Semantic similarity respectively – maximum score has been obtained by 14+ years in the current study and by 13+ years in Sharma’s (1995) study.
Conclusion

The normative data is useful as it gives a clear picture of individual linguistic profiles at various age levels. Norms are essential for comparing the performance of the patient with the various age levels and finding out the age level at the patient performs.

References


Acknowledgements

We are extremely thankful to the authorities, the Head Master and Staff, JSS High School, Head Mistress and Staff, JSS Primary School, Saraswathipuram, for granting permission and cooperating with us during data collection at their school. We also thank the children who enthusiastically participated as subjects for the study.
Professional help Seeking Behavior Patterns in Parents of Children with Developmental Disabilities

S. Venkatesan

Abstract

When parents discover that their child has developmental delay, they undergo an emotionally shattering experience. This grim situation predisposes them to shop for professional advice, drugs or other palliatives to overcome their predicament. While there is justification in seeking a professional second opinion on their child's condition; for some parents, the shopping spree for seeking professional help becomes an endless and futile exercise. This results in loss of precious time that could otherwise be profitably utilized in implementation of early infant stimulation program to optimally benefit their child. This paper attempts to discover the nature, frequency and duration of professional consultations sought by parents of children with developmental delays. The results show that parents go through a long drawn out itinerary of shopping for professional help. This is influenced by variables like severity, sex, age, diagnostic condition of the child as well as allied socio-demographic variables. The details are presented and discussed in the light of the need and importance to curb such treatment seeking practices in parents of children at risk or those with developmental delays.

Key words: Developmental Delays – Professional Help Seeking – Parents/Caregivers

Upon discovering that their child has developmental delay (DD), parents experience a wide range of emotional reactions including shock, denial, anger, depression, overprotection, blame, guilt and shame until eventually, they learnt to accept the inevitable condition (Akhtar and Verma, 1972; Peshawaria et al, 1994; Venkatesan, 2007). During the early emotionally shattering experience, many parents shop for professional advice with an ardent hope to derive drugs or other palliatives to overcome their predicament.

While there maybe justification for seeking a second opinion from professionals about their child's condition; for some parents, the shopping spree itself becomes an ever elusive camouflaged pilgrimage in search of a wonder drug or panacea for all their problems. Indeed, there are variations in the specific pattern of treatment search of these parents. In an earlier longitudinal follow up study on treatment seeking behaviors of parents of mentally retarded children, Chaturvedi and Malhotra (1982) reported that nearly half of their sample did not seek second help from professionals within that year. They found more shopping behaviors in parents from higher educational and socioeconomic levels.

It was the aim of this study to discover the nature, frequency and duration of professional consultation sought by parents of children with developmental delays in relation to child variables like sex, severity, chronological age and diagnostic status as well as allied variables like type or size of family, socioeconomic status and informants' education.

Method

Sample

The present study was conducted by drawing the required sample (N: 97) from Diagnostic Services at All India Institute of Speech and Hearing (AIISH), an autonomous agency under Ministry of Health and Family Welfare, Government of India, located at Mysore, India. Among many other activities, the AIISH provides clinic based services, home based training program, preschool services, and other support services like diagnosis, certification for social security schemes, etc., for individuals with mental handicaps. Upon initial registration, each child is screened, diagnosed and intervened by multidisciplinary team comprising of specialists like speech and language specialists, audiologists, otolaryngologists, clinical psychologists, pediatrician, special educator, physiotherapists, occupational therapists, etc. Only cases of children with DDs below six years were considered for inclusion in this study. This was to obviate the possibility of retrospective falsification and recall bias that would likely contaminate reports of parents of older children.
Procedure

Data collection involved use of a semi structured interview schedule to elicit information on each child’s list of previous consultations in a chronological sequence. Wherever possible, the derived information was corroborated by pursuing actual evidence from available prescriptions and medical records about the child. The raw data from this study included the nature, type, duration and frequency of consultations sought for overall and sub samples of children with DDs (Table One).

<table>
<thead>
<tr>
<th>SNo</th>
<th>Variables</th>
<th>N</th>
<th>Levels of Consultation (+)</th>
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<th>Mean</th>
<th>Chi Square</th>
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<td>20</td>
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<td>Post Graduates</td>
<td>7</td>
<td>7</td>
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</table>

(*) p < 0.05; (**) p < 0.01; (***) p < 0.001; (+) indicates the sequential level of consultation ranging from first to eighth.

Table 1. Distribution of Frequency of Consultations in relation to various variables

In order to determine the time gap between consultations, the mean number of consultations sought by parents for a given child was divided by his/hr chronological age. For example, if a 24 month child had three consultations, his mean time gap between consultations was computed as 8.00 months. The combined mean and SDs was then determined for overall sample and sub samples (Table Two).
Table 2. Mean Number of Consultations sought by Parents in Relation to Various Variables

Data was also compiled on specific type of specialists consulted by parents at various points of their treatment seeking. There were four classes of such consultations, viz., pediatricians, individual or institutional services and the AIISH respectively. Invariably, all cases had consulted AIISH since it was the last point of their contact at the time of this study. The distribution of frequency and types of specialists/institutional services approached by parents at various points of their treatment seeking was calculated for overall sample as well as sub samples (Table Three).
Table 3: Distribution of Frequency and Types of Specialists Consulted by Parents of Children with Developmental Delays

<table>
<thead>
<tr>
<th>SNo</th>
<th>Type of Consultation</th>
<th>Levels of Consultation (*)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1</td>
<td>Pediatrician</td>
<td>61</td>
<td>28</td>
</tr>
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<td>2</td>
<td>AIISH</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Institutional</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>Individual</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>97</td>
<td>88</td>
</tr>
</tbody>
</table>

(*) indicates the sequential level of consultation ranging from first to eighth; (Chi Square: 63.15; df: 12; p: <0.001; VHS)

Results and Discussion

The results are presented and discussed under the following headings:

(i) Frequency of Consultations:

For the overall sample (N: 97), parents have sought 342 (Mean: 3.53) consultations from various specialists or service delivery institutions for their children with DDs (Table 1). In terms of severity, parents of children with moderate DDs (Mean: 4.00) have sought more frequent consultations than parents of children with mild DDs (Mean: 3.57) or Borderline DDs (Mean: 2.63). Probably, the parents of children with severe-profound DDs have sought lesser consultations (Mean: 2.91) owing to a subjective resignation that nothing can be done for these children. There is greater frequency of treatment seeking for females (Mean: 3.67) than males with DDs (Mean: 2.43). The parents of children with multiple diagnostic complaints and those from nuclear family backgrounds (Mean: 3.90) seek more consultations than children with singular diagnostic conditions or those from non-nuclear family backgrounds (Mean: 2.56). This may be explained by the palliative advice, supports and assurance that ‘children will eventually grow into normalcy’ often given in Indian joint or extended families. The influence of other associated socio demographic variables like SES, size of family and informant’s education appears to be insignificant on the frequency of treatment seeking behaviors of parents in this sample.

(ii) Mean Time Lag between Consultations:

For the overall sample, parents seek at least one consultation per child in 11.09 months (SD: 9.50) for their children with DDs (Table 2). The time gap for consultations for children with severe-profound DDs (N: 11; Mean: 20.58; SD: 11.66) is greater than for children with mild DDs (N: 54; Mean: 9.77; SD: 7.95) or moderate DDs (N: 24; Mean: 10.47; SD: 9.86). Probably, parents of children with mild and moderate DDs still see a positive hope for improvement in their children (p: <0.001). The temporal proximity of consultation sought by parents of female children (N: 39; Mean: 10.38; SD: 7.75) is closer than for males (N: 58; Mean: 11.86; SD: 10.47) with DDs.

There appears to be a progressive linear relationship between chronological age of the DD children and mean time lag between consultations sought by parents. The older children above 49 months (N: 19; Mean: 19.80; SD: 10.70) are not taken as frequently for consultations as children below 24 months (N: 46; Mean: 5.71; SD: 4.68). The children with dual/multiple diagnostic labels (N: 33; Mean: 10.19; SD: 8.72) seek consultations with greater rapidity than those with single diagnosis (N: 11; Mean: 16.74; SD: 14.46). The parents from non-nuclear family backgrounds (N: 27; Mean: 13.82; SD: 10.56) and with small family sizes...
seek consultations with shorter time lag than parents from nuclear family (N: 70; Mean: 10.28; SD: 8.66) and large size families (N: 24; Mean: 14.80; SD: 14.44) (p: <0.01). Further, children with DDs from higher SES (N: 54; Mean: 13.26; SD: 10.90) and those with lower educational backgrounds (N: 57; Mean: 12.33; SD: 8.95) show greater time lag between consultations than parents from lower classes and higher educational backgrounds (p: <0.05).

(iii) Type of Services or Specialists Consulted:

Parents show a range of one to eight consultations for their children with a progressive decrement, both, in number and percentages of treatment seeking behaviors over various levels/points of consultations. The trend analysis reveals a gradual decrement to around 2% of the cases seeking consultations by the eighth round from a base index of 97 cases (100%) at first consultation (Table 3). Further, most consultations in this sample have been with pediatricians (N: 121; 35.38%) followed by consultations at AIISH (N: 97; 28.36%), other institutional services (like general or specialist hospitals) (N: 73; 21.35%) and individual physicians/specialists (like orthopedics, ophthalmologists, psychiatrists, etc) (N: 51; 14.91%) respectively (p: <0.001).

(iv) Mean Time Points for Consultation:

A series analysis of mean temporal points of consultation by parents for overall sample shows the mean age for first consultation at 12.52 (SD: 10.88) months. Gradually, this progresses at regular intervals to culminate at mean age for eighth consultation at 40 (SD: 4.00) months. The mean age for first and last consultation for children with borderline DDs is much earlier (9.50; SD: 7.79) than cases for severe-profound DDs (21.00; SD: 10.96). The mean age of first consultation is similar for males (12.66; SD: 11.92) and females (12.31; SD: 9.11). But, parents of males begin with more frequent and rapid consultations followed by a period of slackening, which is rather caught up in case of females with DDs. The mean age of last consultation for males halt much earlier to females (p: <0.01). The children with dual/multiple diagnosis have significantly more early and prolonged first to last consultation than children with singular diagnosis. The plurality of their problems may be the reason for parents to seek repeat consultations (p: <0.001).

There is apparently no difference in the age of consultation for children from nuclear families (Mean: 12.36; SD: 11.13) and/or non nuclear families (Mean: 12.96; SD: 10.18). However, children from nuclear families attrition rapidly by their fifth consultation in comparison to those from nuclear family backgrounds, who continue to seek treatment up to their eighth consultation. Further, children from small families seek their first consultation early and move rapidly to their last consultation in contrast to children from large families (p: <0.001). The children form higher social class seek their first consultation much later than children from lower class as also they continue to go for their last consultation at comparatively later date. Likewise, parents with higher educational levels seek their first consultation much later than parents with lower educational qualifications.

Conclusion

In sum, the present study highlights that parents have sought 342 (Mean: 3.53) consultation for their children with DDs. The frequency of treatment seeking behaviors is influenced by variables like sex, diagnosis or severity of their child’s condition; financial variables like type or size of family, parents education, etc. On an average, parents seek at least one consultation per child in 11.09 months with a progressive decrease in their number and percentages of their treatment seeking behaviors over time. The mean age of first consultation for the children is 12.52 (SD: 10.88), which progresses at regular intervals to culminate at mean age for their eighth consultation at 40 months (SD: 4.00).

These findings appraise the importance and need to restrict the superfluous shopping sprees of parents having children with DDs. Rather, the emphasis must be on improving quality of services so that parents are weaned away from the tendency to waste the precious and early years of their children. They may have to be guided to concentrate on the
implementation of home based early infant stimulation programs. This study also throws the need to investigate the mean age of authentic consultation even for older children with communication disorders and mental disabilities.

References


Building National Capacity for the Provision of Hearing Aids and Services: The Indian Scenario

Vijayalakshmi Basavaraj

India, with a population of over one billion has an area of 3.288 million km². It is a ‘Potpourri’ of all possible terrains spread across the 35 states and union territories having snow clad mountains, deserts, coastal areas, valleys and hill stations. From time immemorial India has promoted an inclusive society for the persons with disabilities.

Estimates about number of persons with Hearing Impaired:

The focus of the government of India on persons with disabilities was enhanced from the year 1980 after the observance of the International Year of the disabled. The census of India data included information on persons with disabilities. A separate National sample survey of persons with disabilities was instituted. Since then, this is being done every ten years. Thus, India has some estimates regarding persons with hearing impairment.

As per the National Sample Survey Organization (NSSO) report of 2002, there are 30.62 lakhs number of persons with hearing impairment in the country with more number in rural than in the urban sectors. As per the report, there were 3 lakhs children with hearing impairment who are below 6 years age in the year 2000. This is considered as a very rough estimate as the personnel involved in the survey did not have the skills and tools to identify hearing loss of less than moderate in one or both ears. In addition to this figure, it is estimated that about 21,000 children are born with bilateral severe to profound loss every year as the birth rate in the country is 21 (per 1000).

There have been attempts to estimate the number of persons with hearing impairment in the country by various small-scale survey by Government and Non Government organizations. A WHO project entitled “Prevention of Deafness and Communication Disorders” was undertaken at All India Institute of Speech and Hearing, Mysore in the year 2001. It has now become an ongoing project with the institute research funds. The extrapolated estimates from the project data (1996 till date) puts the incidence of hearing impairment (i) in infants as between 3.29% to 7.67%; (ii) in school going children as between 9.07% to 38.1%.

Sporadic studies on neonate hearing screening programs are also underway. One such program undertaken by Ali Yavar Jung National Institute for Hearing Handicapped (AYJNIHH), Mumbai in collaboration with King Edward Memorial (KEM) Hospital, Mumbai reports that the incidence of hearing impairment in high risk neonates is 3.97% (Basavaraj & Nandurkar, 2006).

Available infrastructure for service provision

There are about 20 government organizations, which have “the state of art” facilities for early identification, diagnosis and intervention of persons with hearing impairment. AIISH, Mysore and AYJNIHH, Mumbai are among the leading organizations. In addition to this, there are about 150 government organizations, 350 NGOs and about 500 private clinics providing such services. The Ministry of Social Justice & Empowerment, Government of India has set up about 130 District Disability Rehabilitation Centers (DDRC’s) covering all zones in the country in the year 2001. There are five Composite Rehabilitation Centers (CRCs) providing services to persons with all types of disabilities. It is envisaged to setup DDRCs in all the 600+ districts in the country in the next 5 years to come.

Director, All India Institute of Speech and Hearing, Mysore 570 006

Further, there are about 270 medical colleges in the country. It is mandatory for the medical colleges to have facilities for audiometry, hearing aid evaluation and dispensing as per the Medical Council of India requirements.
Manpower available for service provision

There has been a slow but steady attempt to develop manpower to serve persons with hearing impairment. Undergraduate (UG) and postgraduate (PG) programs were on from 1967 albeit in few institutes. As on today, there are 26 Rehabilitation Council of India (RCI) accredited training centers, which offer the 4-year UG program or 2-year PG program in Audiology & Speech-Language Pathology. A couple of institutions are recognized to run the PhD program as well. An estimated 1500 qualified Speech Language Pathologists / Audiologists have been trained in the country till today. However, over 50% of them have migrated to other countries with brighter job prospective. Those with PG and PhD are more involved as master trainers than direct service providers.

The RCI has recognized Diploma in Hearing, Language & Speech disorders (DHLS) since 1984. The entry level for enrollment is 10+2 education for this 10 months' duration course. Currently there are about 400 diploma holders in the country. This program is now offered at 12 training centers across the country awarding about 180 persons with the diploma every year. Diploma (of 2 years duration), graduates and PG programs (of one year duration each) in special education are also available in the country. As per the estimation of RCI (RCI, 1996) there are about 20,000 trained special educators.

The other potential manpower who can be included for hearing screening and assisting service delivery are the gross root workers such as the Anganwadi workers, Multipurpose Health workers, the Accredited Social Health Activists (ASHA). As per the information available from the website and the annual reports of Ministry of Health and Family Welfare, Government of India, there are about 11 lakh anganwadi workers who are available in the ratio of one per 1000 population. The ASHAs are a relatively new concept and hence their exact number is not documented yet.

The status of hearing aid

Prior to 1960s, opticians imported and dispensed hearing aids in India. The first indigenous hearing aid (body worn) was reported by Arphi Pvt. Ltd., in 1962. Hearing aids on donation from Denmark, called as Danaid, were distributed through central government schemes from 1960s to 80s. Several other Indian makes of hearing aids have come into the market in the last two decades. There are about 8 to 10 hearing aid manufacturers offering over 40 models today.

The quality control of body worn hearing aids is done by International Standards Institute (ISI), now known as Bureau of Indian Standards (BIS). Their first standard for hearing aid was published in 1967 (IS: 4406 & 4482).

Today, with the liberalization of import policies, all the well-known international brands of hearing aids are available in the Indian market. The body worn hearing aids cost between Rs. 500 to 10,000 (i.e. US$ 10 to 200) and the Behind-the-Ear (analogue & digital) cost between Rs. 2,500/ to 80,000/ (i.e. US$ 50 to 1,600). It is estimated that the MRP of an aid is never less than 10 times the manufacturing cost of the aid. The money consumed in the pipeline of distribution is alarmingly high making the product cost exorbitant.

Of the 3 million hearing aids available to the developing countries 1.0 to 1.25 lakh of them are manufactured and distributed in India every year. In addition, 50-60 thousand hearing aids are annually imported from other countries. Thus, less than 2 lakh hearing aids are available to the estimated 30 lakh population with hearing impairment.
The status of hearing aid provision

The hearing aids are either purchased from various procurement channels or received through the schemes of Government of India. The sources to purchase hearing aids are Otolaryngologist, Audiologist / Speech Language Pathologists, Special Educators, Opticians, Pharmacists and even grocers and ‘Panwalas’ (beetle leaf vendors). There is no government policy of licensing for dispensing hearing aid.

In 1981, the Ministry of Social Justice & Empowerment, Government of India introduced a scheme entitled “Assistance to Disabled Persons Scheme” (ADIP scheme) for distributing hearing aids at 50% or 0% of cost. From those whose family monthly income is less than Rs. 6500 (i.e. US $ 130) is eligible for free hearing aids and those whose monthly family income is between Rs. 6501 to 10,000/ (i.e. between US $ 130 to 200) are eligible for 50% concession. Under the ADIP scheme, hearing aids and its accessories are selected under a rate contract. Presently only body worn hearing aids are distributed through the scheme whose cost varies from Rs. 440 to 1,500/ (i.e. US $ 10 to 35). There are 38 models of 4 to 5 manufacturers listed in the rate contract for the year 2007-08.

Along with the hearing aids, AA solar battery chargers (with two chargeable batteries) are also provided. The solar battery costs about Rs. 214 (i.e. US $ 4.5). Provision to provide aids and appliances costing upto Rs. 8000/- (i.e. US $ 160) for each ear is made under the ADIP scheme. Children studying in upto 10th standard are given binaural hearing aids. They are eligible for new hearing aids every two years. It is estimated that about 90,000 hearing aids manufactured in India are distributed through the ADIP scheme by about 200 implementing agencies (both government & NGOs) spread across the country. The ADIP scheme has also made provision for reimbursement of earmold and travel expenses to avail the services.

A project to study the feasibility of providing binaural BTE under the ADIP scheme is underway. The project is expected to throw light on the cost effectiveness of providing binaural BTE hearing aids and the issues involved in its maintenance etc.

A couple of government institutions are dispensing hearing aids of all makes and models at the dealers' rate. This has enabled the beneficiaries to obtain good quality hearing aids with a discount of 25 to 50% on the MRPs. It is estimated that about 1000 hearing aids are dispensed in this manner every year.

The other sources of funds for the purchase of hearing aids are the Central Government Health Scheme (CGHS) which provides upto Rs.60,000/ (i.e. US $1200) for digital hearing aids, Employees Scheme of Insurance (ESI) and charitable organizations.

Other indigenous technological development

Apart from the body level hearing aids manufactured in India, attempts have been made to develop hearing screening devices and other aids and appliances. Handheld hearing screeners costing Rs. 1500 to 2000 (i.e. US $ 30 to 40) have been developed by AYJNIHH, Mumbai and AIISH, Mysore. CROS hearing aids using two BTE shells is yet another development at the Eastern Regional Center (ERC), AYJNIHH, Kolkata. Solar battery chargers have been developed which are distributed through the ADIP scheme. Prototype development of digital hearing aids by All India Institute of Medical Sciences (AIIMS), New Delhi, Indian Institute of Technology (IIT), New Delhi, Impact, New Delhi, Center for Design of Advance Computing (CDAC) of Ministry of Information and Technology, Government of India, in collaboration with AIISH, Mysore are also worth mentioning. A prototype of FM hearing aid has also been designed at AIISH, Mysore. However, none of these developments (except solar pentorch battery charger) has seen the market for wider use and distribution through a manufacturer.

Recent developments in National Capacity building in India

The Ministry of Health & Family Welfare, Government of India, has drafted a proposal to launch the ‘National Program of Prevention & Control of Deafness’ in the 11th Five-year plan of
the country (w.e.f April, 2007). The pilot phase of the program has been initiated in August 2006. The overall objective of the program is to prevent hearing loss due to disease or injury, carry out early diagnosis, treatment, medical rehabilitation, strengthen linkages, creation of database and facilitation of need based research. The long term objective is to reduce the total disease burden from 6.3% to less than 3% in the designated areas by 2012. The strategies planned are:

- To strengthen the service delivery including rehabilitation.
- To develop human resources for ear care.
- To promote outreach activities and public awareness through innovative and effective Information, Education and Communication (IEC) strategies with special emphasis on prevention of deafness.
- To develop institutional capacity.

In the preparatory phase of the program, it is envisaged to plan training activities to train health workers; sensitize the state health society and State Medical College staff regarding the national program; fund the state health society / District Health Society for the procurement of equipment, aids and appliances. In the second phase, active manpower trainings and capacity building will be undertaken. Hearing screening at schools and camps will be conducted followed by rehabilitation of the identified population. The third phase would focus on monitoring and evaluation of manpower training, capacity building, service provision and IEC activities.

Answering to the call to speedup manpower development, AIISH, Mysore is launching the DHLS program using alternate strategy of education, i.e., through e-mode. The program, which was launched in the year 2007-08, will have AIISH as the nodal implementing center providing the e-mode theoretical input. This will be supported by the course material being developed at the institute. The collaborating medical colleges / institutes will provide the clinical training. It has been planned to enroll at least 100 candidates across the country in the first year.

As a next stage, course material will be developed in the regional languages and candidates will be enrolled from all over India. The program also plans to enroll international students.

To conclude, India is gearing up to cater to the needs of over 3 million persons with hearing impairment by:

- Launching a National program for Prevention & Control of Deafness,
- Producing large number of low end manpower (who would work at district levels) adopting the distance education strategy.
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India seeks cooperation and extends its cooperation to other countries in strengthening the national capacity for the provision of hearing aids and services.

(Presentation made at the 4th WHO / CBM workshop on the provision of Hearing Aids & Services for Developing Countries. 9-10 November 2006 at WHO Headquarters Geneva)

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Building National Capacity for the Provision of Hearing Aids and Services: The Indian Scenario

Vijayalakshmi Basavaraj

India, with a population of over one billion has an area of 3.288 million km². It is a ‘Potpourri’ of all possible terrains spread across the 35 states and union territories having snow clad mountains, deserts, coastal areas, valleys and hill stations. From time immemorial India has promoted an inclusive society for the persons with disabilities.

Estimates about number of persons with Hearing Impaired:

The focus of the government of India on persons with disabilities was enhanced from the year 1980 after the observance of the International Year of the disabled. The census of India data included information on persons with disabilities. A separate National sample survey of persons with disabilities was instituted. Since then, this is being done every ten years. Thus, India has some estimates regarding persons with hearing impairment.

As per the National Sample Survey Organization (NSSO) report of 2002, there are 30.62 lakhs number of persons with hearing impairment in the country with more number in rural than in the urban sectors. As per the report, there were 3 lakhs children with hearing impairment who are below 6 years age in the year 2000. This is considered as a very rough estimate as the personnel involved in the survey did not have the skills and tools to identify hearing loss of less than moderate in one or both ears. In addition to this figure, it is estimated that about 21,000 children are born with bilateral severe to profound loss every year as the birth rate in the country is 21 (per 1000).

There have been attempts to estimate the number of persons with hearing impairment in the country by various small-scale survey by Government and Non Government organizations. A WHO project entitled “Prevention of Deafness and Communication Disorders” was undertaken at All India Institute of Speech and Hearing, Mysore in the year 2001. It has now become an ongoing project with the institute research funds. The extrapolated estimates from the project data (1996 till date) puts the incidence of hearing impairment (i) in infants as between 3.29% to 7.67%; (ii) in school going children as between 9.07% to 38.1%.

Sporadic studies on neonate hearing screening programs are also underway. One such program undertaken by Ali Yavar Jung National Institute for Hearing Handicapped (AYJNIHH), Mumbai in collaboration with King Edward Memorial (KEM) Hospital, Mumbai reports that the incidence of hearing impairment in high risk neonates is 3.97% (Basavaraj & Nandurkar, 2006).

Available infrastructure for service provision

There are about 20 government organizations, which have “the state of art” facilities for early identification, diagnosis and intervention of persons with hearing impairment. AIISH, Mysore and AYJNIHH, Mumbai are among the leading organizations. In addition to this, there are about 150 government organizations, 350 NGOs and about 500 private clinics providing such services. The Ministry of Social Justice & Empowerment, Government of India has set up about 130 District Disability Rehabilitation Centers (DDRC’s) covering all zones in the country in the year 2001. There are five Composite Rehabilitation Centers (CRCs) providing services to persons with all types of disabilities. It is envisaged to setup DDRCs in all the 600+ districts in the country in the next 5 years to come.

Further, there are about 270 medical colleges in the country. It is mandatory for the medical colleges to have facilities for audiometry, hearing aid evaluation and dispensing as per the Medical Council of India requirements.
Manpower available for service provision

There has been a slow but steady attempt to develop manpower to serve persons with hearing impairment. Undergraduate (UG) and postgraduate (PG) programs were on from 1967 albeit in few institutes. As on today, there are 26 Rehabilitation Council of India (RCI) accredited training centers, which offer the 4-year UG program or 2-year PG program in Audiology & Speech-Language Pathology. A couple of institutions are recognized to run the PhD program as well. An estimated 1500 qualified Speech Language Pathologists / Audiologists have been trained in the country till today. However, over 50% of them have migrated to other countries with brighter job prospective. Those with PG and PhD are more involved as master trainers than direct service providers.

The RCI has recognized Diploma in Hearing, Language & Speech disorders (DHLS) since 1984. The entry level for enrollment is 10+2 education for this 10 months' duration course. Currently there are about 400 diploma holders in the country. This program is now offered at 12 training centers across the country awarding about 180 persons with the diploma every year. Diploma (of 2 years duration), graduates and PG programs (of one year duration each) in special education are also available in the country. As per the estimation of RCI (RCI, 1996) there are about 20,000 trained special educators.

The other potential manpower who can be included for hearing screening and assisting service delivery are the gross root workers such as the Anganwadi workers, Multipurpose Health workers, the Accredited Social Health Activists (ASHA). As per the information available from the website and the annual reports of Ministry of Health and Family Welfare, Government of India, there are about 11 lakh anganwadi workers who are available in the ratio of one per 1000 population. The ASHAs are a relatively new concept and hence their exact number is not documented yet.

The status of hearing aid

Prior to 1960s, opticians imported and dispensed hearing aids in India. The first indigenous hearing aid (body worn) was reported by Arphi Pvt. Ltd., in 1962. Hearing aids on donation from Denmark, called as Danaid, were distributed through central government schemes from 1960s to 80s. Several other Indian makes of hearing aids have come into the market in the last two decades. There are about 8 to 10 hearing aid manufacturers offering over 40 models today.

The quality control of body worn hearing aids is done by International Standards Institute (ISI), now known as Bureau of Indian Standards (BIS). Their first standard for hearing aid was published in 1967 (IS: 4406 & 4482).

Today, with the liberalization of import policies, all the well-known international brands of hearing aids are available in the Indian market. The body worn hearing aids cost between Rs. 500 to 10,000 (i.e. US$ 10 to 200) and the Behind-the-Ear (analogue & digital) cost between Rs. 2,500/ to 80,000/ (i.e. US$ 50 to 1,600). It is estimated that the MRP of an aid is never less than 10 times the manufacturing cost of the aid. The money consumed in the pipeline of distribution is alarmingly high making the product cost exorbitant.

Of the 3 million hearing aids available to the developing countries 1.0 to 1.25 lakh of them are manufactured and distributed in India every year. In addition, 50-60 thousand hearing aids are annually imported from other countries. Thus, less than 2 lakh hearing aids are available to the estimated 30 lakh population with hearing impairment.
The status of hearing aid provision

The hearing aids are either purchased from various procurement channels or received through the schemes of Government of India. The sources to purchase hearing aids are Otolaryngologist, Audiologist / Speech Language Pathologists, Special Educators, Opticians, Pharmacists and even grocers and ‘Panwalas’ (beetle leaf vendors). There is no government policy of licensing for dispensing hearing aid.

In 1981, the Ministry of Social Justice & Empowerment, Government of India introduced a scheme entitled “Assistance to Disabled Persons Scheme” (ADIP scheme) for distributing hearing aids at 50% or 0% of cost. From those whose family monthly income is less than Rs. 6500 (i.e. US $ 130) is eligible for free hearing aids and those whose monthly family income is between Rs. 6501 to 10,000/ (i.e. between US $ 130 to 200) are eligible for 50% concession. Under the ADIP scheme, hearing aids and its accessories are selected under a rate contract. Presently only body worn hearing aids are distributed through the scheme whose cost varies from Rs. 440 to 1,500/ (i.e. US $ 10 to 35). There are 38 models of 4 to 5 manufacturers listed in the rate contract for the year 2007-08.

Along with the hearing aids, AA solar battery chargers (with two chargeable batteries) are also provided. The solar battery costs about Rs. 214 (i.e. US $ 4.5). Provision to provide aids and appliances costing upto Rs. 8000/- (i.e. US $ 160) for each ear is made under the ADIP scheme. Children studying in upto 10th standard are given binaural hearing aids. They are eligible for new hearing aids every two years. It is estimated that about 90,000 hearing aids manufactured in India are distributed through the ADIP scheme by about 200 implementing agencies (both government & NGOs) spread across the country. The ADIP scheme has also made provision for reimbursement of earmold and travel expenses to avail the services.

A project to study the feasibility of providing binaural BTE under the ADIP scheme is underway. The project is expected to throw light on the cost effectiveness of providing binaural BTE hearing aids and the issues involved in its maintenance etc.

A couple of government institutions are dispensing hearing aids of all makes and models at the dealers’ rate. This has enabled the beneficiaries to obtain good quality hearing aids with a discount of 25 to 50% on the MRPs. It is estimated that about 1000 hearing aids are dispensed in this manner every year.

The other sources of funds for the purchase of hearing aids are the Central Government Health Scheme (CGHS) which provides upto Rs.60,000/ (i.e. US $ 1200) for digital hearing aids, Employees Scheme of Insurance (ESI) and charitable organizations.

Other indigenous technological development

Apart from the body level hearing aids manufactured in India, attempts have been made to develop hearing screening devices and other aids and appliances. Handheld hearing screeners costing Rs. 1500 to 2000 (i.e. US $ 30 to 40) have been developed by AYJNIHH, Mumbai and AllISH, Mysore. CROS hearing aids using two BTE shells is yet another development at the Eastern Regional Center (ERC), AYJNIHH, Kolkata. Solar battery chargers have been developed which are distributed through the ADIP scheme. Prototype development of digital hearing aids by All India Institute of Medical Sciences (AIIMS), New Delhi, Indian Institute of Technology (IIT), New Delhi, Impact, New Delhi, Center for Design of Advance Computing (CDAC) of Ministry of Information and Technology, Government of India, in Collaboration with AllISH, Mysore are also worth mentioning. A prototype of FM hearing aid has also been designed at AllISH, Mysore. However, none of these developments (except solar pentorch battery charger) has seen the market for wider use and distribution through a manufacturer.

Recent developments in National Capacity building in India

The Ministry of Health & Family Welfare, Government of India, has drafted a proposal to launch the ‘National Program of Prevention & Control of Deafness’ in the 11th Five-year plan of
the country (w.e.f April, 2007). The pilot phase of the program has been initiated in August 2006. The overall objective of the program is to prevent hearing loss due to disease or injury, carry out early diagnosis, treatment, medical rehabilitation, strengthen linkages, creation of database and facilitation of need based research. The long term objective is to reduce the total disease burden from 6.3% to less than 3% in the designated areas by 2012. The strategies planned are:

- To strengthen the service delivery including rehabilitation.
- To develop human resources for ear care.
- To promote outreach activities and public awareness through innovative and effective Information, Education and Communication (IEC) strategies with special emphasis on prevention of deafness.
- To develop institutional capacity.

In the preparatory phase of the program, it is envisaged to plan training activities to train health workers; sensitize the state health society and State Medical College staff regarding the national program; fund the state health society / District Health Society for the procurement of equipment, aids and appliances. In the second phase, active manpower trainings and capacity building will be undertaken. Hearing screening at schools and camps will be conducted followed by rehabilitation of the identified population. The third phase would focus on monitoring and evaluation of manpower training, capacity building, service provision and IEC activities.

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Artifactual Responses in Auditory Steady State Responses Recorded Using Phase Coherence Method

Vijaya Kumar Narne, Arivudai Nambi P, CSC Vanaja

Abstract

It has been reported that artifacts at high stimulus levels contaminated auditory steady state responses (ASSR) when weighted averaging method was used to detect the responses. A few commercially available instruments use phase coherence method to detect the presence of ASSR. The current study investigated the presence of artifactual responses in ASSR when a phase coherence method is used. ASSR was recorded in fifteen adult participants with profound hearing loss, who did not show any behavioral responses. The upper limits of stimulation for obtaining artifact free ASSR, using supra aural headphones, insert earphones and a bone vibrator were determined. Analysis of the results revealed that the upper limit of stimulation for obtaining artifact free ASSR is 95 dBHL for supra aural headphones, 105 dBHL for insert earphones and 50 dBHL for a bone vibrator. Phase analysis of the artifacts suggested that artifacts were either due to non-auditory physiological responses and/or electromagnetic aliasing artefacts.

Key words: ASSR, Air conduction, Bone conduction, Phase Coherence, Artifacts

The human auditory steady state responses (ASSR) can provide rapid and objective assessment of auditory thresholds (Picton, John, Dimitrijevic & Prucell, 2003). ASSR is recorded for sinusoids that are either amplitude, frequency or mixed modulated. As continuous modulated stimuli are used for recording ASSR, stimuli can be presented at intensities higher than that normally used for auditory brainstem responses (> 95 dBHL) and this in turn helps in differentiating severe to profound hearing loss (Rance, Dowell, Rickards, Beer & Clark, 1998; Rance, Rickards, Cohen, Burton & Clark, 1993; Swanepeol, Hugo & Roode, 2004). However, Gorga et al. (2004) initially questioned the reliability of ASSR in predicting hearing thresholds in individuals with severe to profound hearing loss. They observed the presence of artifactual ASSRs at higher levels (> 95 dBHL) in ten individuals with profound hearing loss, who did not show any behavioural responses to modulated stimuli even at the upper limits of the ASSR system. Small and Stapells (2004) also reported the presence of artifactual responses in 55% of their subjects for air conduction stimuli and 80% of their subjects for bone conduction stimuli.

Investigators have hypothesized that electromagnetic stimulus artifacts do not interfere with the responses even when ASSR is recorded for very high levels of stimuli, as ASSRs are elicited by the envelope of the stimuli rather than by the carrier. Picton and John (2004) have reasoned out that, “aliasing” error cause the occurrence of artifacts at higher levels in ASSR. Aliasing occurs when a signal is sampled at a rate lower than twice its frequency as such a signal will have energy at a frequency equal to absolute frequency and its closest multiple integer of sampling rate (Picton, Hink, Perez-Abalo, Linden & Wiens, 1984). Small and Stapells (2004) explained that the frequency of the aliasing error is equal to the difference between the closest integer multiple of sampling frequency and input frequency. For example a 1000 Hz tone that is amplitude modulated at 80 Hz would have energy at 920, 1000, 1080 Hz. If 920 Hz is present in the EEG being digitized at 500 Hz, the alias frequency would be 1000 Hz-920 Hz = 80 Hz which is exactly the same as the modulation rate for this 1000 Hz carrier frequency. Figure 1 shows the graphical representation of an example of aliasing error.

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Figure 1 - Graphical representation of aliasing error

The studies that have reported artifacts in ASSR have recorded ASSR using instruments which use weighted averaging method. These instruments analyse the amplitude of the responses at modulation frequency with respect to side bands using Fast Fourier Transform (FFT). Hence there are chances that the aliasing artifacts can be sensed by the instrument as a response. One another method used to identify the responses in ASSR is phase coherence. If the phase of artifactual response is different across the averages, there may not be any artifact when ASSR is recorded using phase coherence method. The current study was designed to investigate if artifacts occur while recording ASSR in an instrument which uses a phase coherence method to detect responses and if it occurs to determine the upper limits at which artifact free ASSR could be recorded using supraaural headphones, insert phones and a bone vibrator.

Method

Participants

Fifteen participants with profound hearing loss, ranging in age from 18-30 years participated in the present study. Only those ears in which there was no behavioural response to modulated stimuli even at the upper-limits of the ASSR instrument at octave frequencies from 500 Hz to 4000 Hz were considered for the study. A total of 24 ears met these criteria (12 for air conduction and 12 for bone conduction) and six ears were not considered as they had minimal residual hearing.

Instrumentation

A calibrated two channel diagnostic audiometer with TDH 39 head phones housed in supra aural ear cushions and a bone vibrator, Radio ear B-71 was used to carry out pure-tone audiometry. GSI- Audera ASSR, Version-2 system was used to estimate the behavioural thresholds for modulated signal as well as to record ASSR using supra aural head phones (TDH-49), insert ear phone (ER-3A) and bone vibrator (Radio ear B-71).

Procedure

Pure-tone thresholds were obtained using the modified Hughson and Westlake procedure (Carhart & Jerger, 1959), across octave frequencies from 250 to 8000 Hz for air conduction and 250 to 4000 Hz for bone conduction stimuli. Behavioural thresholds were also assessed for mixed modulated stimuli used for recording ASSR, across octave frequencies from 500 to 4000 Hz.

ASSR was recorded for the participants who did not show any behavioural thresholds for mixed modulated stimuli even at the upper limits of the ASSR system. While recording ASSR, the
participants were seated comfortably on a chair. Silver chloride (AgCl) electrodes were placed using conventional three-electrode placement (M1, M2, Fz), after cleaning the electrode site with skin preparing paste. It was ensured that impedance at each electrode site was less than 5 kΩ and inter electrode impedance was less than 2 kΩ. The participants were asked to relax and sleep while recording ASSR. While recording ASSR for bone conducted stimuli M1, M2, and Cz electrode placements were used and the bone vibrator was placed on the forehead.

ASSR measurements were performed using high modulation frequency of 74, 81, 88, 95 Hz for 500, 1000, 2000 and 4000 Hz respectively. The raw EEG was recorded and pre-amplified by 1 lakh time and sampled at 500 Hz A/D conversion rate. The sampled data was filtered using a band pass filter of 30-300 Hz. Phase and amplitude of the responses were obtained after performing FFT. Phase coherence was determined using the statistical software incorporated in the instrument. Based on the “phase coherence” the instrument determined the presence or absence of a response automatically. The ASSR threshold was determined using a bracketing method and the minimum intensity at which a phase locked response was present was considered as the ASSR threshold. The recordings were replicated to ensure the presence of a response. The phase delay for the lowest stimulus level at which responses were present was considered for the analysis.

**Results**

It was observed that phase locked responses (artifacts) were present in all the 12 ears for stimuli presented through both the air conduction transducers where as for stimuli presented through a bone vibrator only 11 ears had artifacts. The lowest intensity at which artifactual responses occurred was 95 dBHL for the supra-aural headphones, 100 dBHL for the insert earphones and 50 dBHL for the bone vibrator. As shown in the Fig-2, there was higher probability of occurrence of artifactual responses for stimuli presented through supra aural headphones than insert earphones at 1 kHz and 2 kHz. The occurrence of artifacts was less for bone conducted stimuli when compared air conducted stimuli.

![Figure 2](image-url)

**Figure 2.** Number of ears having artifactual responses for different transducers at different frequencies.

**Figure 3** shows the lowest intensity at which artifactual responses were observed across frequencies for different transducers. It was observed that the artifactual responses were observed below 110 dBHL for stimuli presented through supra-aural head phones and insert earphones and below 60 dBHL for stimuli presented through the bone vibrator for low frequencies, where as for high frequencies, artifacts were observed only at high stimulus level.
Phase Delay

For the ears in which artefacts were present, phase delay was calculated. The general inspection of the data revealed that ASSR recorded through supra aural headphones and insert earphones, the phase variability was more for ASSRs recorded across subjects for intensities above 110 dBHL. Whereas phase delay of the responses was within 90° for the responses recorded for intensities below 110 dBHL. The phases of the responses were almost similar for ASSRs recorded through supra aural head phones and insert earphones. So the data from the two transducers were combined for further analysis. Fig-4 compares the phase of the responses when the intensity was above 110 dBHL and when it was below 110 dBHL for 500 Hz and 1000 Hz stimuli. Data for 4000 Hz and 2000 Hz were not considered as less number of ears had artifactual responses at low stimulus level. It can be observed that for responses recorded below 110 dBHL, the phase delay of the responses for a majority of the data was in the same quadrant, whereas at intensities above 110dBHL stimulus level the phase delay was not same across the participants. The data also indicates that at low stimulus levels phase delay is in the range of 0° to 90°. However a few ears had phase delay which was distributed across the quadrants.

Figure 3. Lowest intensity at which artifacts occurred for different transducers and frequencies.

![Figure 3](image3)

Figure 4. Phase delay of the artifactual responses below and above 110dB for head phones and insert ear phones.

![Figure 4](image4)

Figure 5. Phase delay of the artifactual responses below for bonevibrator.
Phase delay of responses for stimuli presented through the bone vibrator was recorded for those frequencies where responses were present. Fig-5 depicts the phase delay of the responses for frequencies 500 Hz and 1000 Hz and 2000 Hz. It can be observed from the figure that phase delays for most of the data were in same quadrant that is $0^\circ$ to $90^\circ$. Data for 4000 Hz was not considered as less number of subjects had artifactual responses at a low stimulus level for 4000 Hz.

**Discussion**

Results of the present study indicate that artifactual responses were present for stimulus levels above 95 dBHL for supraaural head phones and insert ear phones when ASSR was analyzed using phase coherence method. For stimuli presented through a bone vibrator, artifacts occurred when the intensity of the stimuli was above 50 dBHL. The presence of artifacts was less for bone conducted stimuli compared to air conducted stimuli probably because the bone vibrator was away from the electrodes. The occurrence of artifactual responses was more for supra-aural headphones when compared to insert earphones. This may be probably because the diaphragm of the insert earphone was away from the electrodes, and hence reduced the strength of the electromagnetic field that reached the electrodes in comparison to that of supra aural earphones.

Artifacts occurred more for low frequency stimuli when compared to high frequency stimuli. For high frequencies artifacts were observed only at high intensities. Earlier investigators (Small & Stapells, 2004; Gorga et al., 2004) have also reported that artifacts reduced as the frequency of the stimuli increased. Small and Stapells (2004) attribute this to less energy required to derive the oscillator at high frequencies when compared to low frequencies, which in turn produces less electromagnetic field at high frequencies. This reduces the amplitude of the artifactual responses and hence probably artifacts were present only at very high intensities for high frequencies.

Two possible explanations have been attributed for the presence of artifactual responses at low frequencies, one due to aliasing of electromagnetic stimulus energy and non-auditory physiological responses (Small & Stapells, 2004; Picton & John, 2004). To investigate the probable origin of artifacts seen in present study, the phase delay of ASSR responses were analyzed. The results of the phase delay analysis suggested that phase delay was variable at intensities above 110 dBHL at all the frequencies. Investigators have reported in the literature that phase delay is replicable and follows a specific trend in normal individuals. Low carrier frequencies have higher phase delay than high frequencies (John & Picton, 2000). The variability of the phase delay of the responses across all frequencies was probably due to aliasing of electromagnetic stimulus energy, where the phase becomes unpredictable across recordings due to the variability in strength and phase of electromagnetic stimulus energy. Phase was further reported to be modified by A/D conversion, filtering and amplification of electromagnetic stimulus energy (Picton & John 2004). So, artifactual responses in the present study may be due to aliasing of electromagnetic stimulus energy at high intensities (> 110 dBHL) in majority of the ears.

Phase delay of the responses were in the same quadrant ($0^\circ$ to $90^\circ$) for low stimulus levels in 60-70% of the ears for 500 Hz and 20% of the ears for 1000 Hz stimuli. Even for the bone conducted stimuli, the phase delay of the responses was with in $90^\circ$ for a majority of the ears. The predictability of the phase delay suggests that it may not be due to electromagnetic artifact. Latency of these responses can be estimated using formula $P/360 \times Fm$, where $P$ is phase delay and $Fm$ refers to modulation frequency (John & Picton, 2000). The latency of the responses observed in the present study was in the range of three-five milli seconds (3-5 msec). Similar results were reported by Small and Stapells (2004) for bone conducted stimuli. Probably they did not observe these results for air conduction stimuli because they did not place the ear tip of the insert earphone in the ear canal while recording ASSR for air conduction stimuli. The latency of the artifactual responses observed in the present study is comparable with the latency of N3 reported by Nong, Ura, Owa and Noda (2000). Therefore, these artifactual responses may be of physiological origin and may be similar to the negative peak (N3) seen at 3 msec in individuals with profound hearing loss. It has been reported that the N3 is generated in brainstem vestibular nuclei by activating the saccule (Nong, Ura, Owa & Noda, 2000).
Conclusion

It can be concluded from the present study that artifactual responses occur above 95 dBHL for supra aural headphones, 105 dBHL for insert earphones and 50 dBHL for bone vibrator. The artifacts observed may be due to non-auditory physiological responses at intensities below 110 dBHL and due to electromagnetic artifacts at intensities above 110 dBHL for air conduction transducers. The important clinical implication of the current study is that, the audiologists should be cautious while interpreting the ASSR at high intensities.

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Acknowledgements

We thank the Director, All India Institute of Speech and Hearing, for allowing us to conduct the study. We extend our thanks to Head of Department of Audiology, AllISH, for permitting us to use the instruments. We also thank all our participants for their cooperation. Part of this study was presented in 38th annual conference of ISHA.
Clustering of Disfluencies in 2.1 to 3 Year Old Kannada Speaking Children

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Disfluency – Definition and a Brief Review

Interruptions or breaks in the normal flow of speech are termed as disfluencies, i.e., disfluency is anything that impedes the forward movement of speech. The preschool child is developing vocabulary, grammatical structures and the ability to talk about abstract ideas and events. Because these skills are not yet fully developed, there is a lack of automaticity. Hence, the child might struggle to find the word he wants to say to communicate his idea. Hence, it appears that for most youngsters, disfluency is part of the developmental process.

In the period between two to three years, children start acquiring early syntactic skills as they learn to join two or more words together. It has been observed that normally speaking children exhibit interruptions or breaks in fluency even in these early utterances (Yairi, 1981, 1982; Colburn and Mysak, 1982).
In the earlier studies, disfluency analyses were limited to defining and identifying only single instances of disfluencies (Johnson, Boehmler, Dahlstrom, Darley, Goodstein, Kools, Neelley, Prather, Sherman, Thurman, Trotter, Williams & Young) 1959; Haynes and Hood, 1977; Yairi, 1981, 1982). However, it can be noted that while some disfluencies appear to occur singly, there is a tendency for disfluencies to join or cluster together on same or adjacent words. Some studies have thrown light on the clustering phenomenon in preschoolers’ speech (Silverman, 1973; Colburn, 1985, Logan and LaSelle, 1999; Korah, Manuel and Narayanan, 2011).

It can be presumed that disfluencies cluster together just as a matter of chance. In this view, various speech disfluencies that constitute a cluster would be seen as being unrelated to one another. This view cannot be considered because studies [Silverman (1973), Colburn (1985) Hubbard and Yairi (1988) LaSelle and Conture (1995)] have shown that speech disfluencies appear to cluster together at levels significantly greater than expected by chance.

Also, most studies focusing on disfluencies and their clusters have been predominantly carried out using English speaking children (e.g., Johnson et al., 1959; Silverman, 1973; Colburn, 1985; Ambrose and Yairi, 1999; Hubbard and Yairi, 1988; Logan and LaSalle, 1999). Since stuttering and disfluencies are observed across cultures and languages (Bloodstein, 1995; Cooper and Cooper, 1998; Shapiro, 1999, Carlo and Watson, 2003), studies involving children from culturally and linguistically diverse backgrounds becomes essential. Several studies on the disfluencies of Kannada speaking children have been carried out (Nagapoornima, 1990; Indu, 1990; Rajendrashwamy, 1991; Yamini, 1990; Geetha, Karanth and Shetty, 2000; Korah, Manuel and Narayananan, 2011). However, most of these have focused on the measurement of single instances of disfluencies. Further, clustering phenomenon has been studied only in the disfluencies of 5-6 year old Kannada speaking children (Korah, Manuel and Narayanan 2011) and the authors suggest the need to probe into the cluster disfluencies of younger children. Also, none of the previous studies involving both English and Kannada speaking children have probed into the possible gender differences with respect to the clustering phenomenon.

Further, data on clustered disfluencies in typically developing children would be essential for the diagnosis of stuttering. Hence the following study investigated clustering of disfluencies in the speech of 2-3 year typically developing Kannada speaking children. Specifically, the extent of clustering, the disfluency types that cluster together more frequently, and gender differences in clustering were investigated.

Method

Subjects: Ten children (5 boys and 5 girls) in the age group of 2-3 years participated in the study. Only native speakers of Kannada and children with no history of speech, language or
hearing problems, no orofacial abnormalities and no neurological problems were considered. Screening procedures were used to rule out voice, articulation, fluency and language anomalies. Oral mechanism examination and hearing screening was done to rule out any abnormality.

**Material:** Material was specially developed. It included pictures (common objects, body parts, vehicles, fruits, vegetables, vehicles, action verbs) and cartoons depicting simple stories.

**Procedure:** Speech samples were elicited using the material developed in conversation and narration task. Simple questions were asked to involve the child in conversation and for narration task, pictures and cartoons were used. Care was taken to ensure that the sample was no less than 5-minute duration of the child’s talking. Conture (1990) noted that the sample size should be sufficient to permit averaging across several 100 word samples. Hence, a 1000 word sample from each child was considered for the study. The speech samples from the children were audio recorded using a digital sound recorder.

**Analyses:** The recorded speech samples were transcribed verbatim and the presence of the following disfluencies were analysed using the adaptations of classification systems given by DeJoy (1975), Yairi (1981), DeJoy and Gregory (1985), Campbell and Hill (1987) and Carlo and Watson (2003). Accordingly, the disfluencies analysed included: interjections (I), sound repetition, part-word repetition (PWR), word repetition (WR), phrase repetition (PR), revisions, dysrhythmic phonation (DP), tense pause (TP). The description of these disfluencies has been provided in Appendix A.

The disfluencies were further classified as stuttering-like disfluencies (SLD) and other disfluencies (OD) as stated by Young (1984) and Yairi and Ambrose (1992). Accordingly, sound repetitions, single-syllable word repetitions, dysrhythmic phonations were considered stuttering-like disfluencies (SLD) (found more evidently in the speech of children with stuttering). Word repetitions, phrase repetitions, interjections and revisions were classified as other disfluencies (found more in typically developing children as part of the normal non-fluency stage.)

A single instance of disfluency was defined as a disfluency within an utterance. For example, [da daddy dropped me to school] which comprises of one instance of part word repetition. Clustering was defined as “.... the occurrence of two or more instances of disfluency on the same word and/or consecutive words” (Silverman, 1973). For example, [my dad mummy dr drops me to um school]. This comprises of revision, part word repetition and interjection.

While calculating % disfluency for clusters each cluster was considered as one unit and added to the single instances to compute total % disfluency (e.g., in an utterance, my my mommy sent me to school dance cclass, WR has occurred as single instance and a cluster of R and PWR is seen.
The percentage of each child’s total frequency of utterances containing single instances of disfluency, and utterances containing clusters of two through four disfluencies were calculated using the following formulae.

\[
\text{\% disfluency} = \frac{\text{Total no. of disfluencies}}{\text{Total no. of syllables}} \times 100
\]

\[
\text{\% single disfluency} = \frac{\text{Total no. of single disfluencies}}{\text{Total no. of syllables}} \times 100
\]

\[
\text{\% clustered disfluency} = \frac{\text{Total no. of clustered disfluencies}}{\text{Total no. of syllables}} \times 100
\]

**Results**

**Single vs. Clustered Disfluencies**

Of the total number of subjects with 5 boys and 5 girls in the age group of 2-3 years, in a speech sample comprising of 1000 syllables, 2.5% occurred as single instances of disfluencies and 0.41% clustered disfluencies were observed.

The average percent of single disfluencies was six times more than the average percent of clustered disfluencies in the 10 children. Also, boys showed relatively higher percentage of disfluency compared to the girls with a ratio of 1.3 for overall disfluency and for single and clustered disfluencies. Table 1 shows the percent of single and clustered disfluencies.

<table>
<thead>
<tr>
<th>Mean % disfluencies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Mean</td>
</tr>
</tbody>
</table>

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Table 1: Percent Disfluency for Single and Clustered instances

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Single Disfluencies</td>
<td>3.34</td>
<td>2.52</td>
<td>2.93</td>
</tr>
<tr>
<td>% Clustered Disfluency</td>
<td>2.88</td>
<td>2.16</td>
<td>2.52</td>
</tr>
<tr>
<td>% Disfluency</td>
<td>0.46</td>
<td>0.36</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Within the disfluencies, around 14% of the disfluencies were clustered and 86% occurred as single instances as shown in table 2.

Table 2: Percentage of single vs. clustered disfluencies among total disfluencies

<table>
<thead>
<tr>
<th>Subjects</th>
<th>% Single Disfluencies</th>
<th>% Clustered Disfluency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>86.23</td>
<td>13.77</td>
</tr>
<tr>
<td>Girls</td>
<td>85.71</td>
<td>14.28</td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
<td>13.99</td>
</tr>
</tbody>
</table>

Analysis of Single disfluencies

Among the single disfluencies, Interjections were seen predominantly (31%), followed by part word repetitions (16%), Revisions (16%), Word Repetitions (14%), Dysrhythmic Phonations (8%), Phrase Repetition (6%), Tense Pause (6%) in the decreasing order of percent disfluency. The least frequently occurring disfluency was Sound Repetitions (3%). Thus overall, other disfluencies (interjections, part word repetitions–here predominantly multi syllabic part word repetitions, revisions and word repetitions) occurred with a greater frequency than Stuttering–Like Disfluencies (disrhythmic phonation, tense pause). Phrase repetitions were found less in speech of children between 2 to 3 years. Table 3 shows percent of each disfluencies.

<table>
<thead>
<tr>
<th>Disfluency type</th>
<th>% Disfluency (Total)</th>
<th>% Disfluency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interjection (I)</td>
<td>31.06</td>
<td>28.14</td>
</tr>
<tr>
<td>Sound repetition (SR)</td>
<td>3.41</td>
<td>2.99</td>
</tr>
<tr>
<td>Part-word repetition (PWR)</td>
<td>16.69</td>
<td>13.77</td>
</tr>
<tr>
<td>Word repetition (WR)</td>
<td>14.03</td>
<td>14.97</td>
</tr>
<tr>
<td>Phrase repetition (PR)</td>
<td>6.82</td>
<td>5.99</td>
</tr>
<tr>
<td>Revision (R)</td>
<td>16.72</td>
<td>16.17</td>
</tr>
<tr>
<td>Dysrhythmic Phonation (DP)</td>
<td>8.29</td>
<td>11.98</td>
</tr>
<tr>
<td>Tense Pause (TP)</td>
<td>6.82</td>
<td>5</td>
</tr>
</tbody>
</table>

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Table 3: Percentage disfluency for each disfluency type.

Also, among the other disfluencies, girls showed a higher frequency of occurrence for interjections, part word repetitions and revisions. Word repetitions were found more in boys compared to those in girls. Phrase repetitions were not seen in girls. Results of Mann Whitney test showed significant difference between genders on Dysrhythmic Phonations. Boys showed more Dysrhythmic Phonations compared to girls. Figure 1 and tables 4 and 5 show mean frequency of disfluencies in both genders, and results of Mann Whitney test, respectively.

Fig. 1: Mean frequency of disfluency for boys and girls (I = interjection; PWR = part-word repetition; WR = word repetition; R = revisions; DP = dysrhythmic phonation)

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Table 4:

Mean frequency and Standard Deviation Values for the disfluency seen in majority of the subjects

<table>
<thead>
<tr>
<th>GENDER</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5</td>
<td>9.4000</td>
<td>8.26438</td>
<td>6.0000</td>
</tr>
<tr>
<td>PWR</td>
<td>5</td>
<td>4.6000</td>
<td>3.36155</td>
<td>4.0000</td>
</tr>
<tr>
<td>WR</td>
<td>5</td>
<td>5.0000</td>
<td>2.54951</td>
<td>4.0000</td>
</tr>
<tr>
<td>R</td>
<td>5</td>
<td>5.4000</td>
<td>2.96648</td>
<td>5.0000</td>
</tr>
<tr>
<td>DP</td>
<td>3</td>
<td>4.0000</td>
<td>2.00000</td>
<td>4.0000</td>
</tr>
<tr>
<td>Girl</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5</td>
<td>8.8000</td>
<td>4.86826</td>
<td>8.0000</td>
</tr>
<tr>
<td>PWR</td>
<td>4</td>
<td>5.2500</td>
<td>3.50000</td>
<td>5.5000</td>
</tr>
<tr>
<td>WR</td>
<td>4</td>
<td>3.0000</td>
<td>1.41421</td>
<td>2.5000</td>
</tr>
<tr>
<td>R</td>
<td>5</td>
<td>4.4000</td>
<td>2.60768</td>
<td>4.0000</td>
</tr>
<tr>
<td>DP</td>
<td>4</td>
<td>1.2500</td>
<td>.50000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>10</td>
<td>9.1000</td>
<td>6.40226</td>
<td>7.0000</td>
</tr>
<tr>
<td>PWR</td>
<td>9</td>
<td>4.8889</td>
<td>3.21887</td>
<td>4.0000</td>
</tr>
<tr>
<td>WR</td>
<td>9</td>
<td>4.1111</td>
<td>2.26078</td>
<td>3.0000</td>
</tr>
<tr>
<td>R</td>
<td>10</td>
<td>4.9000</td>
<td>2.68535</td>
<td>5.0000</td>
</tr>
<tr>
<td>DP</td>
<td>7</td>
<td>2.4286</td>
<td>1.90238</td>
<td>2.0000</td>
</tr>
</tbody>
</table>

b. Grouping Variable: GENDER

Table 5: Mann Whitney test results
Analysis of Clustered Disfluencies

Of the total disfluencies approx., 86% disfluencies occurred as single instances while 14% appeared to be clustered. Among the clustered disfluencies, around 11.2% appeared as 2-cluster disfluencies, 2.05% appeared as 3 cluster disfluencies and 0.68% appeared as 4 cluster disfluencies. Overall the girls showed higher percent of cluster disfluencies, specifically 2 cluster disfluencies compared to the boys. No 4 cluster disfluencies were seen in the girls. Table 6 shows distribution of clustered disfluencies.

Table 6: Distribution of clustered disfluencies

Interjections, Part word repetitions, Word Repetitions and Revisions tended to occur more frequently as singles than in clusters. This shows that the “Other Disfluencies” have a tendency to occur more as single instances though they can occur in combination with other types of disfluencies in clusters. Table 7 shows mean frequency of disfluency types occurring as single and clusters.

Table 7: Mean frequency of disfluency types

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Table 7: Mean Frequency of disfluency types occurring as singles and in clusters (I = interjection; SR = syllable repetition; PWR = part word repetition; WR = word repetition; PR = prolongation; R = revisions; DP = dysrhythmic phonation; TP = tense pause)

Discussion

The results of the study revealed several interesting points. First of all, all the children had less than 5% disfluency and hence could be considered as being only normally nonfluent as per the reports of several Western studies like Wexler and Mysak (1982), Haynes and Hood (1977), Yairi (1981), DeJoy and Gregory (1985, Pellowski and Conture (2002).

Second, the average percent of single disfluencies was six times more than the average percent of clustered disfluencies in the 10 children. Also, boys showed relatively higher percentage of disfluency compared to the girls with a ratio of 1.3 for overall disfluency and for single and clustered disfluencies. This is in congruence with Yairi (1981) who reports slightly higher disfluency values for 2-3 year old children, although this difference is not statistically significant.

Third, other disfluencies (interjections, part word repetitions –here predominantly multi syllabic part word repetitions, revisions and word repetitions) occurred with a greater frequency than Stuttering –Like Disfluencies (dysrhythmic phonation, tense pause). This is in accordance with previous studies which have found occurrence of Stuttering like disfluencies to be lower than other disfluencies in typically developing preschool children (Ambrose and Yairi, 1995, 1999)

Fourth, phrase repetitions were found less in speech of children between 2 to 3 years. This is in congruence with the explanation given be DeJoy and Gregory (1985) that, 2 year olds may be relatively restricted in the structures they have available to use, i.e. as they are just beginning to use syntax in speech, they may not be formulating many combinations of words/phrases. Table 3 shows percent of each disfluencies.

Fifth, results of Mann Whitney test showed significant difference between genders on Dysrhythmic Phonations. Boys showed more Dysrhythmic Phonations compared to girls. Since Dysrhythmic Phonations form an important part of Stuttering like disfluency, it can be assumed that boys produced more SLDs than the girls. This is in congruence with previous studies (Ambrose and Yairi, 1995, 1999).

Lastly, within the disfluencies, around 14% of the disfluencies were clustered and 86% occurred as single instances. Colburn (1985) however found 64% of disfluencies to be single and 36% to be clustered. Silverman (1973) also reported that her subjects (4 year old) produced 38% of their disfluencies in clusters. The ratio of single vs. clustered disfluencies obtained in the Language in India www.languageinindia.com
present study is slightly higher owing to the subjects being from different cultural and linguistic background i.e., the previous studies were based on English speaking children, while the present study employed Kannada speaking children. The results of this study thus warrant the need for age and language specific analyses of clustered disfluencies. Among the clustered disfluencies, around 11.2% appeared as 2-cluster disfluencies, 2.05% appeared as 3-cluster disfluencies and 0.68% appeared as 4-cluster disfluencies. This is in accordance with Colburn (1985) who reported high occurrence of 2-cluster disfluencies compared to the higher combinations. Overall the girls showed higher percent of cluster disfluencies, specifically 2-cluster disfluencies compared to the boys. This may be attributed to faster maturity and rate of speech and language development in girls in contrast to the boys i.e., the girls acquire syntactic skills (i.e. stringing words together) earlier than the boys (Colburn, 1985).

Conclusions and Implications

The study throws light upon the clustering phenomenon seen in the speech of very young typically developing Kannada speaking children in the age range of 2 to 3 years. Thus as children begin to use syntax they start exhibiting clustering phenomenon even in their normal disfluencies. Since it may not be worthwhile generalising findings from western studies, attempt was made to collect and analyse data from Indian population. This study thus provides a base for studying clustering phenomenon in other languages and for different age groups among the pre-school population. Given that disfluencies are influenced by gender, an attempt was made to study gender differences in clustering phenomenon. Although statistically gender difference could not be computed, this study warrants the need for computing gender differences in the higher age groups. Also, employing a bigger sample would provide clear cut normative values for clustering phenomenon in the speech of preschool children and aid in better statistical computation.

References


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**APPENDIX A**

1. **Interjection (I)** - Insertion of sounds, syllables, words or phrases within an utterance. These insertions are not associated with the fluent or meaningful text and are not part of the intended message.

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2. Sound repetition (SR) - Repetition of a phoneme that does not stand alone as an intended syllable or word.
3. Word repetition (WR) – Repetition of whole words. I went to school school
4. Part word repetition (PWR) - Repetition of part of words.e.g., mom mommy
5. Phrase repetition (PR) - Repetition of two or more words, with no revision or modification of content.e.g., I have I have a book
6. Revision(R) - Modification in the content or grammatical form of an utterance. Revision also includes changes in the pronunciation of a word.e.g., I went home I went to school
7. Dysrhythmic Phonation (DP) – it includes prolongations and broken words.
   Broken word (BW)- Momentary cessation of phonation within words.
   Prolongations (P) - Audible prolongation of sounds within or at the end of words that are judged to be not intended.
8. Tense Pause (TP)- Long pauses between words during which audible tense vocalizations are present.

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