PERCEPTUAL JUDGEMENT OF SPEECH INTELLIGIBILITY IN CEREBRAL PALSIED

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To

my amma, appa,

maggie and Mama

CERTIFICATE

This is to certify that the dissertation entitled "PERCEPTUAL JUDGEMENT OF SPEECH INTELLIGIBILITY IN CEREBRAL PALSIED" is the bonafide work in part fulfilment for the Second Year Degree of Master of Science (Speech and Hearing) of the student with Register Number M-9106.

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1993

CERTIFICATE

This is to certify that this dissertation entitled "PERCEPTUAL JUDGEMENT OF SPEECH INTELLIGIBILITY IN CEREBRAL PALSIED" has been prepared under my supervision and guidance.

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Mysore
1993

DECLARATION

This dissertation is the result of my own study undertaken under the guidance of Dr.Shyamala,K.C, Lecturer, Department of Speech Pathology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any University for any other Diploma or Degree.

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CONTENTS

INTRODUCTION

"Only the feet that move in order dance,
Only the words that move in order sing"

- Alfred Noyes

It has been said, "Everytime you say a word, you perform a miracle"; yet those of us who use words so freely and so easily take them for granted, forgetting that oral communication probably is the most important and most complex of all human behaviours.

Oral communication is important because it is the primary means for interacting with others, for expressing feelings and ideas, for venting anxieties and frustrations, for effecting change and for enabling one person to find out what another person is perceiving and thinking.

The effective communication depends on how intelligible the speaker is, how well the speaker's speech meets the cultural standards, how much the listener perceives or understands of what the speaker conveys.

So, nothing is more useful than to speak clearly. Speech should be intelligible. Intelligibility can be broadly defined as the understandability of speech. Implicit in the definition is a task in which a speaker produces a message and a listener who doesn't know the content of message attempts to comprehend and/or reproduce it. It is mainly influenced by articulation, rate, fluency, vocal quality and intensity (Beukelman & Yorkston,1992).

Reduction in speech intellgibility hampers/impairs effective oral communication thus could have far reaching repercussions on the person's social emotional well being, occupation, and of course inter personal relations.

Thus it is well understood that there is a very strong correlation between speech intelligibility and information transfer in act of speech communication. Speech is a very rapid complex motor act and requires very finely tuned neurological regulation (Hixon & Hardy 1964, Kent & Forner 1980, Netsell 1984).

Human neuromotor system involves a complex act. For any motor act to take place a coordination in terms of muscle strength, speed of movement, appropriate range of excursion, accuracy of movement, motor steadiness and muscle tone is required. Damage that impairs one or more of these neuromuscular functions may affect motor production.

Cerebral palsy, is a motor dysfunction secondary to CNS damage to the organism before, during or shortly after birth, stresses three factors:

(1) The prominant typical symptoms are motor deficits,
(2) The etiology of the disorder in some kind of brain pathology
(3) The CNS disorder must originate in the young developing nervous system (probably not beyond the first six years of life). (Boone,1972)

Cerebral Palsied (CP) children have sensory, motor, perceptual, behavioural and emotional problems, etc. Speech abnormalities are often seen in them as all the subsystems of speech production respiration, phonation, resonance, articulation aand prosody are affected.

The common characteristic of Cerebral Palsied speech is dysarthria. Varying degree of reduction in intelligibility is the common finding in dysarthric speech (Darley et al, 1969, 1975,; Yorkston & Beukelman,1980; Shyamala 1987). Because of poor intelligibility CP speakers may only be readily understood by those familiar with their daily lives and activities. Communication is then restricted to familiar people and to a limited range of subjects. Such a pattern arrests normal communicative development and may pose specific difficulties.

Speech intelligibility tasks are currently applied by clinicians for the assessment and improvement of speech production and thus maximise functional communication competence in this population (Linebaugh, Baird, Baird & Armour,1983; Coombes, 1986).

Several techniques have been employed for quantifying speech intelligibility. None of which is ideal. Given however, that some atleast are viable, it is appropriate to ask whether informal treatment planning in the practical clinical situation, - helps in deciding whether or not a program of remediation is required and in monitoring progress ?

The ways in which speech intelligibility of dysarthria assessed are:

(1) scaling procedure wherein listener assigns ratings of overall speech intelligibility (Darley et al 1969, Platt, Andrews, Young & Nelson 1978, Yorkston & Beukelman 1978, Platt, Andrews, Young & Quinn,1980).

(2) Identification task wherein listeners transcribe what the speaker say. Intelligibility of single words measured by computing the percentage of correctly identified words (Tikofsky & Tikofsky 1964, Platt et al 1978; Yorkston & Beukelman, 1978).

(3) Acoustic analysis using instruments (analysis of acoustic waveforms) (Kent & Netsell,1975; Farmer,1977; Natraj et al,1982).

Inspite of the advantages of objective acoustic analysis, perceptual analysis are mostly used because of their high content validity, less time consuming and usage in an ordinary clinical settings. Though in any case there are some disputes(Schiavetti, Sitler 1980; Kent & Ansel,1992). However the value of using such measures in dysarthria depends on how well clinicians can agree on scale values and make reliable judgements. Therefore continued research into their effective use is indicated (Enderby,1983; Bassich & Ludlow,1986; Kearns & Simmons,1988; Zyski & Weisiger,1987).

Need for the study:

There have been very few studies conducted in India on speech and language behaviour of cerebral palsied (Shyamala,1987; Sharmila,1991; Nandini,1992).

The speech intellgibility which is the main hinderance in communicative ability in cerebral palsy has received no independent attention in the Indian arena.

No clinician can ignore the tremendous influence this speech intelligibility has on the communication ability as also on the all round growth of the child.

Thus the present study is intended to investigate the intelligibility in the speech of cerebral palsied. The study intended to answer the following questions specifically.

(1) Is speech intelligibility affected in the cerebral palsied population chosen for the present study?

(2) Do the two major types of CP, spastics & athetoids differ with regard to intelligibility?

(3) What are the major factors contributing or responsible for the poor intelligibility of such dysarthric speech?

(4) Can the perceptual analysis be used as a valid measure in the assessment of cerebral palsied speech?

To investigate these issues the following null hypotheses were putforth.

(1) There is no reduction of speech intelligibility in CP population.

(2) There is no significant difference between the two major types of CP, spastics and athetoids with regard to speech intelligibility on the tasks chosen for the present study.

2. REVIEW OF LITERATURE

Speech is an extremely important and a unique human activity which sets us apart from other animals. The ultimate goal of the speaker in the interpersonal relationship is to make himself understood to the listener. The importance rests on the intelligibility of speech.

Speech intelligibility can be broadly defined as the understandability of speech. Speech intelligibility score of an individual may refer to how much (normal) speech that subject can understand, or to how much of that subject's (deviant) speech is understandable to other listeners. Yorkston & Beukelman (1980) defined intelligibility as "the accuracy with which a message is conveyed". Decreased intelligibility is a common result of several communicative disorders associated with neurogenic and structural anomalies.

Intelligibility may be affected through the presence of any of a wide range of disorders. These include aphasia (Green,1969) dyspraxia (Ferry, Hall & Hicks,1975) dysarthria (Yorkston & Beukelman,1978) phonological disability (Lorentz,1974) cleft palate or poor control of velum (McWilliams,1954, Crystal,1980) somesthetic deficit (MacNeilage et al,1967) deafness (Nickerson,1975) and severe dysfluency such as cluttering. There is thus no major area of speech therapy where the issue of intelligibility does not arise.

Dysarthria may be among the most severe disorders in their effect on intelligibility because of the diverse clinical features which are manifestations of impairments across several components of the speech production system.

Darley et al (1969) defined dysarthria as " A collective name for a group of related speech disorders that are due to disturbance in muscular control of the speech mechanism resulting from impairment of any of the basic motor processes involved in the execution of speech. This involves not only articulation but the entire effector system for speech; respiration, phonation, resonance, articulation and prosody".

Hence reduced intelligibility is felt to be the most clinically and socially important aspect of the disorder and it has been the chief concern in the assessment and management of the individual with dysarthric speech.

2.1 Intelligibility as a clinical tool in quantifying dysarthria.

Intelligibility measures have been used to quantify dysarthric speech performance for a variety of reasons.

First, reduced intelligibility is a common characteristic of dysarthria and thus intelligibility measures are applicable across a wide variety of types and severity levels of dysarthria.

Second, intelligibility provides an overall index of the disorder which takes into account many different neuromuscular factors along with whatever compensatory strategies that the dysarthric speaker may have adopted.

Third, the quantitative nature of intelligiblity measures allow for monitoring of speaker performance during the course of treatment and recovery.

Finally, intelligibility measures give an indication of functional communicative performance of dysarthric speakers which can be easily communicated to the speaker, his family and members of the rehabilitation team.

Tikofsky & Tikofsky (1964) measured intelligibility in dysarthric speakers in terms of total number of correct responses made by listners to three-word lists spoken by subjects. They concluded intelligibility testing could be employed to evaluate dysarthric speech and to differentiate among dysarthrics.

Darley, Aronson & Brown (1969a) judged speech samples of 30 dysarthrics. Rating were done on 7-point scale. Analysis based on the means of three ratings on each patient indicate speech follow neuroanatomy, neurophysiology and they have classified motor speech disorders into 6 types. Flaccid, spastic, ataxic, hypokinetic, hyperkinetic and mixed type. Darley et al(1969b) judged 212 dysarthrics on 7 point rating scale and offered descriptive perceptual approach to identify 38 deviant speech dimensions. This approach focusses on differential diagnosis of dysarthric speech through the identification of deviant acoustic dimensions.

Platt, Andrews, Young, & Neilson (1978) assessed the speech competence of 50 C.P. adults (spastics and athetoids) using two

methods of articulatory impairment (articulation errors and DDK rate) and three measures of intelligibility. Results indicated athetoids are more impaired than spastics. Type of phonemic error and degree of distortion of phonemes contributed to the reduced intelligibility in athetoids. They concluded that intelligiblity measures could be used to measure speech competence, for differential diagnosis and also provide insight into the basis of an intelligiblity deficit.

Measures of intelligibility have long played a role in the description and evaluation of dysarthric speakers.

Estimates (Darley et al,1975; Enderby,1983) and actual measures of intelligibility of connected speech (Yorkston & Beukelman,1978, 1981) have served as overall indicators of speech adequacy.

The clinical use of intelligibility has also found a variety of support in the literature. As a measure of severity, intelligibility has been related to information transfer, articulatory function, fine motor control, posture and respiratory abnormalities.

2.2 Intelligibility in Cerebral Palsy.

Cerebral Palsy (CP) refers to nonprogressive central nervous system deficit. One of the earliest clinical descriptions of a child who would today be considered cerebral palsied was made about the middle of the 19th century by an English Surgeon John Little(1862). For many years thereafter the condition was known

as Little's disease. Credit for coining the term "Cerebral Palsy" is given to Phelps in 1936.

Perlstein (1961) defined "Cerebral Palsy (CP) as a condition characterized by paralysis, weakness or non-coordination or other aberration of motor function due to pathology in the motor control centres of the brain".

To classify the various manifestations of CP into defined categories is very difficult, as manifestations share more than one definite feature. Generally based on the most obvious type of neuromuscular disability, three major categories are identified (Berry & Eisenson,1962) Spasticity, athetosis and ataxia.

AACP classification of the same is given below :

(1) Spasticity
(2) Athetosis
    - tension athetosis
    - non-tension athetosis
    - dystonia
    - tremor
(3) Rigidity
(4) Ataxia
(5) Tremor
(6) Atonia
(7) Mixed and
(8) Unclassified

Spasticity: Damage to pyramidal tracts arising from the primary motor area in the frontal lobe.

Spasticity is characterized by a lower threshold of the stretch reflex, an enlarged reflexogenic area, tendency towards greater involvement of contractures, affecting the antigravity muscles.

Athetosis: Damage here is in extra pyramidal system. Athetosis is characterized by abnormal, involuntary motion, normal reflexes, involuntary movements of varying degree of tension.

Rigidity: This is a disturbance of the agonist and antagonist relations with resistance to slow-passive movement of both muscle groups. If the resistance to passive motion is continuous, it is referred to as the lead pipe rigidity and if discontinuous as cog wheel rigidity.

Ataxia: Lesion is in the cerebellum. Its primary incoordination due to disturbance of kinesthetic or balance sense or both. Characterized by disturbance in the sense of equilibrium, dyssynergias, asteriognosis and disturbance of depth perception.

Tremor: It is characterized by uncontrollable, involuntary motions of a rhythmic, alternating pattern due to alternate agonist and antagonist contractions.

Atonia: This is characterized by lack of tone and failure of muscles to respond to volitional stimulation, weak stretch reflex, absence of involuntary motions are characteristic features of atonia.

Among these spastics, athetoids and ataxic CP's are commonly seen in clinical settings.

Speech characteristics of Cerebral Palsy (Aronson,1981)

	Spastics	Athetoids	Ataxics
	Spastics	Athetoids	Ataxics
Laryngeal	Hyperadduction of Vocal cords, strained harsh voice Excessively low pitch,monopitch	Quick uncontrolled movements of extrinsic,intrinsic musculature => sudden alterations of pitch and loudness strained voice.	Approximate normal=> loudness variation coarse voice, tremor present
Velopharyngeal	Incomplete => hyper nasality	Normal	Normal
Oral musculature	Slowness, weakness => slow rate. Imprecise consonants	Quick controlled movements => Sudden alterations in precision of vowels & consonants	Reduced control => articula-tory break-down imprecise consonants

The neuromuscular manifestations may be regarded as the most obvious symptom of CP. But other symptoms of mental retardation, abnormal speech and language development, disorders in sensory perception and behavioural manifestations such as distractability, hyperactivity etc. are also seen in them.

All these problems in CP including sensory, perceptual, conceptual and behavioural systems hinder, delay or arrest speech and language development. The speech and language problems may

vary from milder to severe depending on the neuromuscular and neurosensory impairments.

The activity of speech is realized by the articulatory movements of the speech organs. The speech apparatus is divided into respiration, phonation, resonance, articulation and prosody. These are exclusively under the neuromuscular control. Thus even the simplest peripheral motor pattern should reflect the coordinated function of the CNS. Since a CP child's CNS is affected, he has problem in any or combination or all of these subsystems depending upon the severity of the impairment. Communication may then be restricted to familiar people and to a limited range of subjects. Such a pattern arrests normal communicative development and may pose specific difficulties.

Although CP population is a heterogenous one, a common characteristic is dysarthric speech. There is a clear evidence of reduced speech intelligiblity (which is the significant characteristic of dysarthria) in CP children (Tikofsky & Tikofsky,1964).

Language acquisition of the child with CP has been studied by a number of authors (Byrne,1955; Hood & Perlstein,1956, Lone,1964; Wedell et al,1972). The authors indicated that the speech and language problems in the CP child are more closely related to factors such as intelligibility and motor skills rather than language processing.

Rosenbek & Lapointe (1978) write "The focus of therapy comes also from determining the relative contribution of symptoms to the patient's overall intelligiblity ..."

Fothergill & Harrington (1972) advocate the acquisition of intelligibility not normal speech as the goal for CP children. The ultimate goal of speech for CP children is the establishment of adequate communication skills in a social setting.

If changes in a dysarthric patients intelligibility can be made quickly and easily, the prognosis is better. (Rosenbek & Lapointe,1978)

There are very few studies in India conducted on Cerebral Palsied dysarthric speech compared to west. However, the studies conducted in this population were mainly on speech and language behaviour of the cerebral palsied. Studies attempted to investigate the phonological, morphological, syntactic aspects (Shyamala,1987) mean length of utterance and syntactic complexity (Nandini,1992) receptive vocabulary level (Sharmila,1991), to explore the extent of physiological integrity of the stomatological structures (Jyoti,1990; Rajashree,1991), AAC in CP children (Shylashree,1992).

But no study has been conducted purely on intelligibility aspect of the cerebral palsied speech.

Hence, the clinician should measure speech intelligiblity of the CP child and select treatment tasks that first evoke improvement in intelligiblity for adequate communication.

2.3 FACTORS RELATED TO SPEECH INTELLIGIBILITY

Many investigators have conducted studies to find out the factors related to unintelligible speech in dysarthric individual.

Sarno (1968) and Yorkston & Beukelman (1979) confirmed the close relationship between sentence intelligibility and the amount of information transferred between a dysarthric speakers and listener.

Andrews, Platt & Young (1977) evaluated the articulatory impairment and intelligibility of CP speakers. They found high correlation between articulatory errors and speech intelligibility. They found more errors were identified on word final consonants than on word initial consonants and within manner errors exceeded between manner errors. The within manner errors are place or voicing errors or both. The predominant between manner error involved liquids. They found spastics superior to athetoids.

The same findings are supported by Laing (1979), Platt (1980a, 1980b) Platt, Andrews, & Howie (1980), Platt, Young, Andrews, & Quinn (1980), Kent et al (1990).

Speech intelligibility assessments are common to non CP dysarthric speakers also. Logeman, Helda B.Fisher (1981) did phonetic feature analysis of misarticulations in Parkinson's disease. Listeners were asked to transcribe phonetic features of each error. Results revealed phoneme classes most affected were stop-plosive and affricate-fricative. It was found inadequate tongue elevation to achieve complete closure on stop plosives and affricates and inadequate constriction of the airway in lingual fricatives.

Kent et al(1992) also found most disrupted features involved are phonatory (Voicing function) velpharyngeal valving, place and manner of articulation and regulation of tongue height for vowels.

Hirose, Kiritani & Sawashima analysed the patterns of dysarthric movement in patients with 2 ALS and 2 pseudobulbar palsy. They checked DDK rate of speech and several meaningful words. It was found that the patterns of articulatory movements in ALS and pseudobulbar palsy subjects are found to be characterized by general slowness because of sluggish displacement of articulators. Zeigler & Von Cramon (1986) in their examination on spastic dysarthria found accelerating the moving strutures was limited for dipthongs.

Even non-speech activities were used in this task. Herbert Schleisser (1982) asked their CP adults to repeat /m^/, /d^/. /g^/ and 3 nonspeech motions at their fast rate and the judges judged the severity of dysarthria by the method of direct

magnitude estimation. Results indicated nonspeech motion rates have equal diagnostic usefulness in predicting severity of dysarthric speech.

Rutherford & LaBlance (1991) investigated aspects of respiratory function during quiet breathing and monologue in 6 adult dystonia and normal subjects and compared this with speech intelligibility. Dystonia subjects showed respiratory abnormalities compared to control group. This differences in breathing dynamics were strongly related to decreased speech intelligibility.

Gentil did an acoustic analysis of speakers of Fredrich's ataxia using computer system. Vowel segment duration and sentence duration was calculated. He found excessive variations in fundamental frequency, intensity and duration, speech segments, syllables, sentences were accompanied by increase in duration. This implies regulation of dynamic aspects of phonation are impaired in these patients which contributed for unintelligible speech.

Posture too contributes to speech intelligibility. Freedman & Read (1979) examined the effect of R.I.P. on voice production of 6 spastic C.P. children. Voice samples made before and after the utilization of R.I.P. indicated that the procedure had a positive effect on subjects' voice thus speech intelligibility. The effects are particularly in the area of frequency and intensity.

Rate of speech contributes a major role to intelligiblity. Yorkston & Beukelman (1981) say the process of rate control is essential in achieving maximum intelligiblity in individuals with motor speech disorder.

Many techniques have been suggested to control rate of speech in dysarthrics. Some rigid rate control techniques impose, one word at a time style upon the speaker. These rigid techniques involve pacing boards (Helm,1979) alphabet suplementation (Yorkston & Beukelman,1978), Crow & Enderby,1989). Different pacing techniques used were additive metered, additive rhythmic, cued metered and cued rhythmic (Yorkston et al,1990).

Berry & Goshorn(1972,1982) hypothesized that if a dysarthric subject could learn to slow his rate, his intelligibility would improve. They gave immediate feedback of loudness and monitor his rate by F.J.Electronics Intensity meter and multistorage oscilloscope. No specific rate strategies were taught. The subject was simply told to "go slower". They found as the rate of speech reduced with longer pauses, intelligiblity improved.

Hansen & Jeffrey metter (1983) used DAF in 2 Parkinson's disease to modify speech rate. They noticed overall improvement in speech intellgibility with DAF.

Netsell & Hixon (1978), Collins et al(1981), Caliguiri & Murray (1983), Gentile (1990), Yorkston & Beukelman (1990) also supported these findings. Yorkston, Beukelman & Tice (1988) assessed the impact of rate reduction of SP intelligibility.Using

pacer/Tally soft ware, speech can be placed at rates below the habitual rate.

Fig See appendix I.

The first speaker (ataxic) had habitual rate of 72 wpm. Intelligibility at this rate is 39%,when speaking rate paced at 60 wpm, intelligibility increased to 80%.2nd speaker (Parkinson's disease) habitual rate was 228 wpm and his intelligibility was 46%.When its slowed to 145 wpm intelligiblity increased to 94%.

Yorkston, Beukelman, Traynor & Hammen (1990) also found slowing speech improves precise articulation thus improves sentence intelligiblity.

Velopharyngeal dysfunction is a common characteristic of dysarthria contributing to reduced inteligibility. Management of velopharyngeal incompetence with patalal lift fitting has a long clinical history. Yorkston, Beukelman & Bell (1988), Yorkston, Beukelman, Honsinger & Mitsuda (1989), Honsinger, Yorkston, Beukelman a Taylor (1989), Yorkston, Beukelman & Melissa Honsinger (1989) tried palatal life fitting for their dysarthric patients and found phoneme intelligibility increased. Kent et al(1991) reported the nature of Speech and voice changes during the course of Amyotrophic lateral sclerosis. Speech intelligibility, pulmonary function and selected speech and voice functions were tested. Speech intelligiblity was measured using multiple choice-single word identification test (Kent et al,1989). This yields an overall intelligibility score expressed as the percentage of words correctly transmitted. Over the

period of 2 years, speech intelligibility declined from 98% to 48% phonetic features, voicing contrasts, pulmonary function, DOK all were affected severely. Prosody an integral part of the speech disorder with dysarthria may also be addressed via the use of visual feedback improves intellgibility (cited by Berry in clinical dysarthria).

2.4 MEASUREMENT OF INTELLIGIBILITY

In the evaluation of communicative impairments in speech and language problems both perceptual and acoustical analysis are being used. Perceptual analysis (analysis of speech errors) requires that a trained speech pathologist listen to selected speech samples of a patient and make judgements about the type and distribution of abnormalities.

Instrumental analysis (analysis of acoustic waveforms) requires that a trained speech pathologist make similar interpretations from the read-outs of instruments. Both perceptual and instrumental analysis have both advantages and disadvantages.

Early research was based on perceptual analysis. In perceptual analysis phoneme intelligibility, word intellgibility, sentence intelligibility, etc. were measured.

However an analysis of the acoustic features of the various dimensions of speech, articulation is necessary for a better understanding of the way in which the motor control system is affected in these patients. Thus later studies have attempted to explore the relationship between perceptual judgement and acoustic characteristics. (Hirose et al,1982, Kent & Netsell,1975, Kent et al,1979, Kent et al, 1992).

The two most commonly used perceptual methods of intelligibility measure are (1) Interval scaling (IS) (2) Direct magnitude estimation (DME).

Internal Scaling: Listener assigns to each stimulus a number that represents a linear partition of a scale (Darley et al 1969).

Direct Magnitude Estimation: Listener assigns to each stimulus a number representing the ratio of the stimulus to a standard (modulus) that is either specified by the examiner or selected by the listener.

Schiavetti et al(1981) studied the appropriatness of DME and IS procedures for assessing the speech intelligibility of HI adults. Intelligibility of 20 HI talkers were scaled using DME and using IS. Results indicated better construct validity for DME than for IS of speech intelligibility.

Tikofsky & Tikofsky (1964) developed estimation of single word intelligibility of dysarthric speakers. They were based on word productions of only 9 dysarthric individuals. This was not desirable to collect additional data for large number of speakers. They concluded, these measures when combined with other objective techniques will permit a better estimate of the nature and extent of dysarthric impairment.

Darley, Aronson & Brown (1969) employed 9 standard stimulus passage and scaling procedure in order to obtain an overall intelligibility measure. They gave 38 dimensions of dysarthrics based on perceptual analysis.

Tikofsky (1970) proposed a standard set of 50 single words to quantify intelligibility. Dysarthric speakers read the words and intelligibility scores were derived by computing the

percentage of words correctly transcribed by nine speakers. Flanagan (1972) measured intelligibility by counting the number of discrete speech units correctly recognized by a listener.

Canter (1971) abandoned single word tests when his pilot work revealed that certain Parkinsonian individuals performed normally on such tests yet displayed obvious articulatory difficulty in connected speech.

Nickerson & Stevens(1980) undertook acoustic studies of hearing impaired and discussed 7 approaches that could be used to investigate the relationship between physical properties of speech and intelligiblity. Out of which 3 are elaborated for application to dysarthric speech.

(1) Correlational studies that attempt to show the relationship between speech intelligibility and one/more objective measurements of the speech signal.

(2) Studies of the effects of speech training.

(3) Detailed phonetic analysis aimed at identifying the various aspects of an individuals speech that account for impaired intelligibility could be applied to dysarthric speech.

Stevens, Nickerson, Rollins (1983) proposed a set of deviant measures for a speech profile. The measures are grouped into the categories of timing, pitch, laryngeal configuration, tongue posture and control and nasalization. This was used to measure intelligibility in dysarthric speakers.

Platt et al(1977, 78, 80) determined speech intelligibility of CP speakers with a phonetically balanced list of 50 words. These studies provided general information on phonetic capabilities of the dysarthric subjects, but analyses were limited by the phonetic structure of the words. Words were not chosen for systematic variations of phonetic elements within a syllable shape. Their analyses was regarded as only tentative because the test words were selected to ensure valid phonologic analysis.

Yorkston & Beukelman (1978) compared 8 techniques for measuring intelligibility of dysarthric speech (Percentage estimates rating scale estimates, word and sentence transcriptions, word and sentence completion, word and sentence multiple choice tests). They found all except word completion rank ordered speakers similarly to transcriptions.

Frenchay dysarthria assessment (Enderby,1983) evaluated intelligibility in 3 tasks - word tasks, sentence tasks and conversation.

Performance on a word tasks is graded in 5 levels of intelligibility a to e where in

(a) refers to 10 words correctly and easily recognized, and

(e) refers to 2 or fewer words correctly recognized.

Sentence task is similar to word task in administration and scoring. Sentence task is basically like a word recognition task using carrier phrase like "say the word".

Conversation task involves about 3 minutes of conversation and graded in 5 levels:

(a) refers to no abnormality

(e) speech in totally unintelligible.

Sentence intelligibility: This combined with a measure of speaking rate, provides information about "The distance from the norm". Such information is critical in the clinical setting when one is evaluating a mildly dysarthric individual and attempting to distinguish the performance of that individual from non impaired speakers. It is also critical when monitoring the clinical course of the dysarthria, where it be progressive stable or improving. when evaluating a more severely dysarthric speaker, sentence intelligibility measures provide information that helps the clinician determine whether or not the speaker is sufficiently understandable to be a functional communicator in a variety of natural settings.

Yorkston & Beukelman (1981), Yorkston, Beukelman & Traynor (1984) described "Assessment of intelligibility in dysarthric speakers". This involves item identification at both single word and sentence level. In single word test 50 word pools each consisting of 12 similar sounding words are available. For sentence intelligiblity test, pools of different sentence length are available for test construction.

Dysarthric speakers are audio recorded as they read or imitate these sentences. The samples were timed and listeners, who have not been involved in the recording process, attempt to

orthographically transcribe the messages they hear. Results are in percentage of words correctly transcribed, speaking rate (words per minute wpm) and rate of intelligible speech (Intellgible words per minute (IWPM).

A reading task was selected because consistency across samples is important in monitoring a potentially changing clinical course. One limitation of the reading tasks is the fact that, for a small number of dysarthric speakers, sentence reading or imitation is markedly different from spontaneous speech. Although some clinical judgement must be exercised in making firm statements abovt the relationship between spontaneous productions with reading or imitation tasks, use of spontaneous speech for measurement would also be problematic. Spontaneous speech varies widely in content and utterance complexity that these variables would no doubt contribute to large variability if not controlled in some way.

There is an interaction between dysarthria severity and intelligibility on sentence Vs words (Yorkston & Beukelman). Most intelligible speakers tend to score higher on sentence transcription than single word transcription. They say the phonemic and linguistic cues and redundancy carried in the complete message may better enable the listener to recognize individual sounds or words in the message that are difficult to understand or to fill in where the message is unintelligible.

Another task selection decision involves the listener's or judges task. In case of sentence intelligibility , the task

involved orthographic transcription of the sample. But this is more time consuming than simple estimates of intelligibility.

These estimates are problematic as they are influenced by factors such as the familiarity of the listener with the passage (Yorkston & Beukelman 1980). Judges familiar with the passage tend to overestimate the intelligiblity of moderately dysarthric individuals.

Yet an another factor is "Intelligibility is not an absolute quantity but rather a relative quantity that depends on variables such as test material, personnel, training, test procedures and state of the speaker. (Kent et al,1989).

Word intelligibility with and without semantic context:

In an effort to mimic some of the features of predictable, conversational settings a contextual intelligibility task was developed (Dowden, Yorkston & Stoel Gammon,1987; Yorkston, Dowden, Honsinger,1988) severely dysarthric speakers are audio recorded as they read or imitated a list of words. These words were randomnly selected from groups of semantically related words (eg: colors, things, to drink, etc.). Judges first listened to the tapes and attempted to transcribe these words orthographically. After doing this, samples were scored second time while listeners are provided with a semantic context. Contexts are either narrow (a day of the week) or broad (an animal etc.). Here listeners are asked to guess only if the word in the context gives them some basis for the guess.

They found potential impact of semantic context on the word intelligiblity of severely dysarthric individuals in both statistically significant and clinically important. Single words were chosen because sentence material may be physically exhausting for severely dysarthric individuals.

Phoneme intelligibility:

Sentence intelligibility tasks in particular, give little information regarding the nature of articulatory error patterns in dysarthric individuals. According to Kent, Weismer, Kent & Rosenbek (in Press) intellgibility measures that provide only a single overall score give little information about why intelligibility is poor (cited by Yorkston, Beukelman & Dowden (1992) in intelligibiity in speech disorders). This test was made based on the nature of articulatory error pattern seen in dysarthric individuals.

In phoneme intelligibility, the targeted units are singleton consonants, vowels and diphthong. Speakers are audio recorded as they read/imitate a list of 57 CVC words. 41 consonants and 16 vowels and diphthongs are sampled when judging the sampel. Listeners who are naive to the identity of the target phoneme are presented with a word frame such as "ma" and are asked to identify the missing phoneme. Judges also give an indication of the level of confidence they have in their response. The phoneme intelligibility task would allow for the monitoring of change over time in final consonants as compared with changes in nontreated sounds.

The data reported are dependent upon the clinical issues being addressed eg. lip strengthening exercises in order to achieve bilabial closure in flaccid dysarthrics and severely dysarthric individual with poor respiratory support may focus on inclusion of final consonants.

Features of intelligiblity tasks utilized in clinical settings have been summarized by Yorkston, Beukelman & Dowden (1992).

	Sentence intelli-gibility	Word intelli-gibility with & without semantic context	Phoneme intelli-bility
Stimulus	Randomly selected sentences (5-15words)	Single words selected from semantic related word lists	Single words(CVC) selected from phonetically similarly word lists
Speaking task	Reading or imitation	Reading or imitation	Reading or imitation
Transmission system	Audio tape	Audio tape	Audio tape
Listner task	Orthographic transcription	Orthographic transcription	Broad phonetic transcription
Measures obtained	% of words correct speaking rate IWPM	% of words correct (with and without context)	Phonemes correct initial Vs final vowel Vs consonant consonant type
Functions of measure	Functional level-mod and mild speakes -Optimum speaking rate.	Functional level for severely involved speaker	Pattern of articu-latory errors.

Acoustic analysis:

This involves the analysis of acoustic waveform of the speech pattern. Instruments like spectrography, cineradiography, computers, etc. are used for acoustic analysis. The acoustic studies concentrate on fundamental frequency intensity, vowel and consonant duration, transition duration, vowel formant frequencies, VOT, etc.

Kent & Netsell (1975) did a single case study on cineradiographic and spectrographic analysis. Kent, Netsell & Abbs (1979) presented a report on the acoustic results from a physiological and acoustic study of individuals with cerebellar disease and ataxic dysarthria.

Hixon & Hardy (1964) found reduced articulatory motility using photographic and X-ray motion picture films. Natraj et al(1982), Pandita (1983) did spectrographic analysis of dysarthric speech.

All the studies indicated that:

-> lengthening of segments in ataxic dysarthrics
-> prosodic and phonatory insufficiency
-> abnormal transitional segments of vowels
-> substitution errors involving the feature voice occured in spastics and athetoids. VOT was prolonged in both groups but athetoids showed more longer and variable VOT than spastics. (Farmer,1977).
-> excessive variations in Fo, I, duration of speech segments.

Kent et al(1989) studied the relationship between speech intelligibility on a single word identification test and the average F_2 slope of selected test words for a group of 25 men and 10 women with Amyotrophic Lateral Sclerosis (ALS). It was concluded F_2 slope index is most sensitive to intelligibility variations. The slope of the F_2 transition in single syllable test words, is correlated with the intelligibility of patients with ALS.

Perceptual judgement Vs Instrumental analysis:

Many studies have been conducted to find the correlation between perceptual and instrumental analysis in evaluating dysarthric speech adequacy.

Kearns & Simmons (1986) examined the reliability of ratings of perceptual characteristics for 10 ataxic dysarthric subjects. Results indicated that overall interobserver agreement were above levels of agreement expected on the basis alone.

Yorkston (1990) says perceptual technique in assessment of dysarthric individuals represent an attempt at the development of clinically practical, physiologic measures of speech production. This is important as it provides.

(1) near real time analysis capabilities necessary for clinical feasibility.

(2) It provides a normative database against which to compare speech impaired individuals.

Gentile,1990 studied speech characteristics using perceptual and acoustic analysis and found acoustic analysis supports the perceptual observations of speech in dysarthrics (Fredrich's disease)

There are also investigators who refute this (Rosenbek & Lapointe,1978; Ludlow & Bassich,1984). Barbara Jean, Zyski & Weisiger,(1987) identified dysarthria types based on perceptual analysis and concluded use of perceptual analysis in conjunction with physiologic measurements or neurological examination is required. They found perceptual analysis alone is not adequate.

Ansel & Kent (1992) evaluated the relationship between specific acoustic features of speech and perceptual judgements of word intelligibility of adults with CP dysarthria. They say combined acoustic and perceptual studies are needed to explain the intelligibility impairments in different speech disorders.

However, perceptual analysis could be used in judging the dysarthric speech adequacy for many reasons.

(1) Subjective intelligibility tests elicit a judgement of understanding from the listener objective procedures in contrast rely on the tester to evaluate the listener's understanding.

(2) Subjective method produces data much more rapidly.

(3) This method allows ready quantification of intelligibility of speech passages that are similar to everyday connected speech.

(4) This approach may afford a more valid measures of speech understanding because a subjective estimate quantifies the proportion of speech that is understood. whereas an objective method relies on repetition of words without considering comprehension.

(5) Perceptual ratings have high context validity because they are able to measure the multiple facets of speech.

Hunter, Pring & S.Martin(1991) experimentally evaluated the effects of strategies on the intelligiblity of cerebral palsied speech. Listeners were asked to identify words in sentences spoken by subjects whose dysarthria was rated to be either moderate or severe. Results indicated that strategies increased intelligibility and that different strategies were appropriate at different levels of severity. The results suggested that many speakers will be unable to use simple strategies to improve intelligibility to levels that may be needed for adequate information transfer.

It is needless to say that perceptual judgements on the characteristic of dysarthric speech are clinically significant and helpful for diagnostic purposes. Darley et al(1969) have reported extensive perceptual studies on various types of dysarthria and attempted to establish a concept of clusters of deviant speech dimensions characteristic of different categories of neuromuscular abnormality. Fukusako et al (1983). Hirose (1973), Fujibayastu et al(1977) have done perceptual analysis of

dysarthric speech. Thus, its is clear that perceptual studies provide a new scope for the study of dysarthria.

Therefore the present study is an attempt at studying the speech intelligibility of cerebral palsied group by perceptual judgement method.

3. METHODOLOGY

The aim of the present study was to investigate the intelligibility of the cerebral palsied speech and identify the factors contributing to the reduced intelligibility of their speech based on listener judgement.

The study involved the following parts:

(1) Selection of subjects.
(2) Selection of speech material.
(3) Recording of speech sample.
(4) Listener judgement
(5) Analysis

Selection of subjects: The subjects comprised of two groups viz. the first group consisting of six spastics and the second group consisting of six athetoids. Subjects were diagnosed and categorized as being spastic and athetoid groups of CP with mild to moderate degree of neuromuscular involvement. All the subjects had normal hearing, vision and IQ of average level (80-90).

The subjects selected were in the age range of 10-20 years. All of them were using verbal mode for their communication and could read textual material selected for the study. All the subjects had Tamil as their mother tongue.

Selection of speech material:

Speech material consisted of words, sentences and story narration. The word list consisted of 25 words. The words were

selected according to the following criteria.

-> easily produced by the subjects

-> commonly used words

-> occur frequently in their repertoire

Reading material consisted of 6-7 lines which was taken from the first grade Tamil book. The material was selected in such a way that it consisted of all vowels and consonants of Tamil language. The material is given in the Appendix.

Story narration: A story which was very common and familiar to all subjects, "The crow and the fox" was selected. Subjects were asked to narrate the story.

Word intelligibility task was chosen to find out the nature of articulatory error patterns in the cerebral palsied and how much they contributed to speech intelligibility in these subjects.

Reading task: This was selected because in severe cases of dysarthria, use of spontaneous speech was difficult both for analysis and interpretation. It was also felt that in reading, consistency across the sample could be monitored.

Story narration task was selected because this was different from reading and repetition.

This spontaneous speech varies widely in context. While assessing the severe CP cases the linguistic cues and redundancy carried in the message enable the listener to judge them easily and accurately or provided clues for judgement.

Recording of speech sample: Recording of speech sample was done using Philips AM125 tape recorder. Recording was done in a quiet room, away from external noise.

Recording involved 3 tasks:

-> repetition of words

-> reading task

-> story narration task

The speech samples of 3 tasks for each child was obtained separately. The duration of recording of all 3 tasks taken for each child was half an hour. Before each task, the children were instructed clearly.

For repetition of word task, instruction given was "I will be reading out 25 words, you please immediately repeat each word after me please note I will not repeat any word".

For reading task, the instruction given was, "You'll be given a reading material of 6-7 lines, read as you read usually".

For story narration task, the instruction was "please narrate - "The Crow and the Fox story". The pictures were kept in front of them in case they needed any additional clues.

Listener judgement:

The speech samples were given to three trained listeners (Speech & Language pathology students). Trained listeners refer to listeners who were exposed to dysarthric speech or had an experience of working with CP population. Listeners had Tamil as

their mother tongue or had minimum of 10 years exposure to Tamil and could speak, understand, read and write Tamil well.

Judgement task consisted of two parts. Prior to the judgement listeners were instructed clearly of what should be done.

Part-1: Listeners were asked to judge each task separately.

Word intelligibility task:

Instruction given was "You'll hear a series of words; you are requested to listen carefully and transcribe (orthographic) what you hear". Sample was played again when needed. Word intellgibility was calculated as the percentage of words correctly transcribed by the listeners.

$$\frac{\text{Number of words correctly transcribed by the listener}}{\text{Total number of words in the sample}} \times 100$$

Reading Task:

Instruction, "You'll hear to a reading sample and you are requested to rate the sample on a 5 point scale according to the speech intelligibility". Intelligibility was defined as "how much of the subject's speech was understandable to the listener".

5 point scale refers to:

1 - Speech is intelligible (no impairment)

2 - Mildly unintelligible

3 - Moderately unintelligible

4 - Severely unintelligible

5 - Profound unintelligibility of speech

Sentence intelligiblity was calculated from the ratings of 5 point scale.

Story narration task:

The above said instruction was given for story narration task too. Intelligibility was calculated from the ratings of 5 point scale.

Part - 2:

The listeners were given 7 factors (Rate, Voice, Resonatory incompetence, Stress, Pitch, Intensity & Articulatory inadequacy) with description and they were asked to write down the factors they felt were responsible for the unintelligible speech. If needed, the sample was played to them again. Then the percentage of each factor reported by the listeners was calculated.

Listener judgement tasks were repeated thrice with the interval of a week each for reliability measures. A week gap each was given to reduce the influence of content familiarity on judgement of speech sample.

The following factors were selected for the study, after a careful review of literature for their presumed contribution to unintelligibility.

Factors used in perceptual judgement:

I. Rate control:

(i) Rate of actual speech is abnormally slow or fast.

(ii) Variable rate -> rate alternates between slow and fast.

(iii)Inappropriate silence -> There are inappropriate silent intervals.

II. Voice quality:

(i) Harsh voice -> Voice in harsh, rough and raspy

(ii) Breathy voice -> voice is breathy, weak and thin

(iii)Strained-strangled -> voice sounds like an effortful squeezing of voice through glottis.

(iv) Voice stoppages -> There are sudden stoppages of voiced airstream.

III. Resonatory incompetence:

Hypernasality -> voice is excessively nasal

Hyponasality -> voice is denasal

IV. Stress control:

(i) Reduced stress -> Speech shows reduction of proper stress

(ii) Excess stress -> There is excess stress on usually unstressed parts of speech.

V. Pitch control:

(i) Pitch level -> Pitch of voice sounds too low/too high for individuals age and sex.

(ii) Monopitch -> voice lacks normal pitch and inflectional changes.

(iii)Pitch breaks -> Pitch of voice shows sudden and uncontrolled variation.

(iv) Voice tremor -> Voice shows shakiness/tremulousness

VI. Intensity control:

(i) Overall loudness -> loudness is either too low or too high

(ii) Uncontrolled loudness variation -> voice shows sudden

(iii) uncontrolled variations.

(iv) Monoloudness -> voice lacks normal variations in loudness

VII. Articulatory inaccuracy:

(i) Imprecise consonants -> consonant sounds lack precision. They show slurring, inadequate sharpness, distortions, etc.

(ii) Phonemes prolonged -> There are prolongations of phonemes.

(iii)Repetition of phonemes

(iv) Vowels distorted -> vowel sounds are distorted throughout their total duration.

(v) Irregular articulatory breakdown -> Intermittent nonsystematic breakdown in accuracy of articulation.

4. RESULTS AND DISCUSSION

The speech sample of six spastics and six athetoids in the age range of 10-20 years were recorded. Each speech sample consisted of three parts - word identification task, reading task and story narration task. Speech samples were judged perceptually by three trained listeners for inter listener reliability. The judgements were repeated thrice for intra listener judgement with an interval of one week to reduce the familiarity effect.

For word identification task, the listeners were asked to transcribe identified words and intelligibility was measured from the number of correctly identified words. For reading and story narration task, listeners judged the sample on a five point scale as indicated earlier.

Statistical Analysis:

The raw scores were tabulated averaged and checked for intra and inter listener reliability using ANOVA. And finally the averaged scores of two groups were compared to find out if there were significant differences between the two groups on all the tasks.

This section consists of two sub sections:

(1) Intelligibility rating of the speech samples by the listeners which includes -

(a) intra listener reliability

(b) inter listener reliability

(c) comparison of two groups

(2) Factors contributing to the reduced intelligibility of cerebral palsied speech.

Section-1:

The raw scores obtained thrice from the three listeners for 3 tasks, averaged and these are given separately in the following tables.

TABLE-1 : Judgements given by the listener for spastics and athetoids thrice on 3 tasks.

TABLE la: Intelligibility scores obtained for the word identification task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	20	24	20	19	21	20	16	16	16	14	17	13
Trial 2	21	25	18	20	20	20	14	16	17	14	18	13
Trial 3	22	23	20	21	21	21	15	15	16	14	17	14
Average	21.00	24.00	19.33	20.00	20.66	20.33	15.00	15.66	16.33	14.00	17.66	13.66

From this table it is understood that number of words spoken by the spastics were better identified by the listener. The average number of words identified from the spastic speech sample ranged from 19-20 words and athetoids were 13-17 words.

TABLE lb: Intelligiblity ratings on the reading task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	2	2	2	2	1	4	3	3	4	3	4
Trial 2	1	1	1	2	2	2	4	3	3	4	4	4
Trial 3	1	1	1	3	2	1	3	3	2	4	3	4
Average	1.00	1.33	1.33	2.33	2.00	1.33	3.66	3.00	2.66	4.00	3.33	4.00

From this table it is seen that intelligibility rating for the speech sample of spastics ranged from 1 to 2.33 indicating better intelligiblity and for athetoids the ratings ranged from 2-4 indicating poor intelligibility.

TABLE lc : Intelligibility ratings on story narration task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	2	2	2	1	1	3	2	3	4	3	4
Trial 2	1	1	1	2	2	. 2	4	2	3	4	3	4
Trial 3	1	1	2	1	2	1	2	3	2	4	2	5
Average	1.00	1.33	1.66	1.66	1.66	1.33	3.00	2.33	2.66	4.00	2.66	4.33

This table shows that intelligibility rating for the speech sample of spastics ranged from 1-2 while for athetoids it ranged from 2 - 4.33 indicating the better intelligiblity for spastic's speech.

Judgements given by the listener 2 for spastics and athetoids thrice on 3 tasks.

TABLE 2A : Intelligibility scores obtained for the word identification task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	23	22	17	21	20	22	16	15	16	15	17	13
Trial 2	22	24	18	21	22	21	16	15	15	14	16	14
Trial 3	24	24	19	22	21	20	15	15	16	15	17	14
Average	23.00	23.33	18.00	21.33	21.00	21.00	15.66	15.00	15.66	14.66	16.66	13.66

This table shows that number of words identified from the speech sample of spastics were greater in range(18-24) than the words identified from the athetoid speech sample (range 14-17)

TABLE 2b: Intelligibility ratings obtained for the reading task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	2	1	2	2	2	3	4	3	4	4	3
Trial 2	1	1	2	3	2	1	3	3	3	4	3	4
Trial 3	1	1	1	2	2	2	4	3	2	4	3	4
Average	1.00	1.33	1.33	2.33	2.00	1.66	3.33	3.33	2.66	4.00	3.33	3.66

From this table it is seen that intelligiblity rating of the speech sample of spastics ranged from 1 - 2.33 and in that of athetoids ranged from 2 - 4 indicating better intelligibility in spastic's speech compared to that of the athetoids.

TABLE 2c : Intelligibility ratings obtained on story narration task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	2	2	2	1	1	3	3	3	4	3	4
Trial 2	1	1	1	2	2	2	3	2	3	4	2	5
Trial 3	1	1	2	1	2	1	3	4	2	4	3	4
Average	1.00	1.33	1.66	1.66	1.66	1.33	3.00	3.00	2.66	4.00	2.66	4.33

This table shows that intelligibility rating ranged from 1- 1.66 for spastics and 2 - 4.33 for athetoids on the story narration task indicating better intelligibility of spastics speech than of athetoids speech.

Judgements given by the listener 3 for spastics and athetoids thrice on 3 tasks.

TABLE 3a : Intelligibility scores obtained for the word identification task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	24	25	19	21	20	18	16	15	16	14	16	13
Trial 2	24	23	19	22	21	19	15	16	16	14	17	14
Trial 3	24	24	20	22	21	20	15	15	15	13	17	13
Average	24.00	24.00	19.33	21.66	20.66	19.00	15.33	15.33	15.66	13.66	16.66	13.33

This table shows that the number of words correctly identified were more for spastics than for athetoids speech sample. This indicates that the listener could perceive the spastic's speech better than athetoid speech.

TABLE 3b : Intelligiblity ratings for the reading task.

	Spastics						Athetoids					
Trial No.	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	1	1	2	2	2	3	3	2	4	4	4
Trial 2	1	1	2	3	3	1	3	3	3	4	4	3
Trial 3	1	2	1	2	2	1	3	3	3	4	4	4
Average	1.00	1.33	1.33	2.33	2.33	1.33	3.00	3.00	2.66	4.00	4.00	3.33

This table shows the average rating from 1 - 2.33 for spastics and 2 - 4 for athetoids. This indicates that there was better intelligibility for spastics speech than for that of athetoids speech sample.

TABLE 3c : Intelligibility ratings for the story narration task.

Trial No.	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Trial 1	1	1	2	2	1	2	3	2	3	4	4	5
Trial 2	1	1	2	2	2	1	2	2	3	4	3	5
Trial 3	1	1	1	2	2	2	4	3	2	4	3	4
Average	1.00	1.00	1.66	2.00	1.66	1.66	3.00	2.33	2.66	4.00	3.33	4.66

This table shows that intelligibility rating for the speech sample of spastics ranged from 1-2 and for athetoids 2 - 4.66 on story narration task. This indicates poor intelligibility for athetoid speech sample than for spastic's speech sample.

These averaged independent scores were checked for intra and inter listener reliability on the tasks for both groups separately.

Intra listener variability:

For this, the analysis of variance (ANOVA) was used and the "F" value was obtained.

The following tables show the "F" values obtained for intra listener reliability of different listeners for both groups.

TABLE 4a : "F" values of intra judgement reliability for spastics and athetoids by the three listeners on word identification task.

Listeners	Spastics	Athetoids
Listener 1	1.083	0.1218
Listener 2	1.1446	0.769323
Listener 3	1.595	2.4999

These "F values were derived from the tables la, 2a & 3a using ANOVA. These "F" values obtained were not statistically significant at 0.01 and 0.05 levels. This indicates that the judgements made by the listeners for the word identification task were reliable on all the three times.

TABLE 4b : "F" values of intra listener reliability for spastics and athetoids by the listeners on reading task.

Listeners	Spastics	Athetoids
Listener 1	0.218	3.181966
Listener 2	0.217	0.17241
Listener 3	0.7723	0.45449

The above "F" values were derived from the tables lb, 2b & 3b using analysis of variance (ANOVA). These "F" values obtai;ned were not statistically significant at 0.01 & 0.05 statistical levels. This indicates that the judgements made by the listeners all the three times were reliable for both groups.

TABLE 4c: "F" values of intra listener reliability for spastics and athetoids on story narration task.

Listeners	Spastics	Athetoids
Listener 1	0.1728	0.3845
Listener 2	0.9996	0.14287
Listener 3	0.000	0.3846

The above "F" values were derived from the tables lc, 2c & 3c using analysis of variance. These "F" values obtained were statistically not significant at 0.01 or 0.05 levels. This indicates that the judgements made by the listeners were reliable for both groups.

The above tables showed that there was intra listener agreement or that there was no significant difference among the judgements made by the same listener at different times.

Inter listener reliability:

The scores were checked for inter listener reliability on all the tasks. The averaged scores were taken for each task and ANOVA was applied to get "F" ratio to check whether there was agreement among the scores of each subject made by the three listeners.

This inter listener reliability check was done for each group and each task separately and showed in the following tables.

Inter listener reliability for spastics and athetoids on all the tasks.

TABLE 5a : Inter listener reliability for word identification task.

Listeners	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Listener 1	21.00	24.00	19.33	20.00	20.66	20.33	15.00	15.66	16.33	14.00	17.66	13.66
Listener 2	23.00	23.33	18.00	21.33	21.00	21.00	15.66	15.00	15.66	14.66	16.66	14.66
Listener 3	24.00	24.00	19.33	21.66	20.66	19.00	15.33	15.33	15.66	13.66	16.66	13.33
Average	22.66	23.77	18.88	21.00	20.74	20.11	15.33	15.33	15.88	14.10	16.99	13.88

From the above table, the "F" value obtained for spastics was 0.5498527 and for athetoids it was 1.33267. Both were not statistically significant at 0.01 and 0.05 levels indicating there was good agreement among the judgements made by the listeners for each subject.

TABLE 5b : Inter listener reliability for reading task.

Listeners	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Listener 1	1.00	1.33	1.33	2.33	2.00	1.33	3.66	3.00	2.66	4.00	3.33	4.00
Listener 2	1.00	1.33	1.33	2.33	2.00	1.66	3.33	3.33	2.66	4.00	3.33	3.66
Listener 3	1.00	1.33	1.33	2.33	2.33	1.33	3.00	3.00	2.66	4.00	4.00	3.33
Average	1.00	1.33	1.33	2.33	2.11	1.44	3.33	3.11	2.66	4.00	3.66	3.77

From this table the "F" value obtained for spastics was 0.4545 and for athetoids 0.044508. Both were not statistically significant at 0.01 & 0.05 levels, indicating that there was good inter listener reliability found among the subject scores.

TABLE 5c : Inter listener reliability for story narration task.

Listeners	Spastics						Athetoids					
	1	2	3	4	5	6	1	2	3	4	5	6
Listener 1	1.00	1.33	1.66	1.66	1.66	1.33	3.00	2.33	2.66	4.00	2.66	4.33
Listener 2	1.00	1.33	1.66	1.66	1.66	1.33	3.00	3.00	2.66	4.00	2.66	4.33
Listener 3	1.00	1.00	1.66	2.00	1.66	1.66	3.00	2.33	2.66	4.00	3.33	4.66
Average	1.00	1.11	1.66	1.77	1.66	1.44	3.00	2.66	2.66	4.00	2.88	4.44

The "F" obtained for spastics was 0.306652 and 0.0551287 for athetoids which were not statistically significant at 0.01 & 0.05 levels which indicates that there was good agreement among the judgements made by all three listeners for each subject.

Thus from the above Tables, it is concluded that there was good inter listener reliability among the judgements of each subject on all three tasks.

Comparison of two groups on different tasks:

The averged scores of all the judgements made by the three listeners were averaged and the two major groups spastics and athetoids were compared for their comparison on three tasks separately. "T" test was done to find out the significant difference between two groups.

TABLE 6 gives the comparison of two groups on intelligibillity tasks.

TABLE 6a: Comparison on word identification tasks.

Subjects	1	2	3	4	5	6	Mean
Spastics	22.66	23.77	18.88	21.00	20.74	20.11	21.19
Athetoids	15.33	15.33	15.88	14.10	16.99	13.88	15.25

This table shows that in case of spastic's speech sample more number of words were identified by the listeners as compared to that of athetoids speech sample. The more the number of words identified, better was the intelligibility. The mean score of words identified for the spastic group was 21.19 and for athetoids 15.254. The higher mean scores indicating that spastic's speech was better perceived by the listeners than the athetoids speech. The "T" value obtained was 6.94 which was

statistically significant at 0.01 level. So the hypothesis that "there is no significant difference between spastics and athetoids on word identification task among the judgements made by the listeners" is rejected.

TABLE 6b: Comparison of two groups on reading task.

Subjects	1	2	3	4	5	6	Mean
Spastics	1.00	1.33	1.33	2.33	2.11	1.44	1.59
Athetoids	3.33	3.11	2.66	4.00	3.66	3.77	3.42

This table shows that the mean rating for spastic group was 1.59 and for athetoids was 3.423 indicating speech intelligibility ranging from normal - mild unintelligible speech and for athetoids mod to severe unintelligible speech. According to the rating scale used in the present study, lower the mean score better the inteeligibility. This indicates that poor intelligibility was seen in athetoid group as compared to spastic group. The "T" value obtai;ned was 6.32 which was significant at 0.01 and 0.05 levels indicating the significant difference between the scores. Thus the hypothesis "there is no significant difference in the listener perception of spastics and athetoids on reading task" was rejected at 0.01 and 0.05 levels. Spastic group performed significantly superior to athetoid group.

TABLE 6c: Comparison of two groups on story narration task.

Subjects	1	2	3	4	5	6	Mean
Spastics	1.00	1.11	1.66	1.77	1.66	1.44	1.44
Athetoids	3.00	2.66	2.66	4.00	2.88	4.44	3.27

This table shows the mean rating of spastic group on story narration task was 1.44 indicating mild unintelligible speech and for athetoids 3.273 indicating mod-severe unintelligible speech. As per the rating scale higher the mean score, poorer the intelligibility. "T" value obtained was 5.98 which was significant at 0.01 and 0.05 levels indicating the difference between two groups. Thus the hypothesis "There is no significant difference in the listener perception of spastics and athetoid speech sample on story narration task" was rejected.

The speech samples produced by the spastics were better understood by the listener than speech samples produced by athetoids. A good intra and inter listener reliability was found in all the tasks.

SECTION-II: Factors contributing for the unintelligible speech.

In the second part of the listener judgement, the listeners were given 7 factors with description and asked to note down the respective factors contributing or responsible for the reduced intelligiblity of the cerebral palsied speech.

From the raw data, the percentage of each factor reported by the listeners thrice on different tasks was calculated by

$$\frac{\sum Nij}{n \times i \times j} \times 100\%$$

Where N refers to the number of times the particular factor was accounted by the listeners.

n = number of subjects

i = number of trials

j = number of listeners

The percentage of each factor reported for both groups are mentioned below. Each factor is given separately in descending order.

TABLE 7 : Factors reported to be contributing for the poor intelligibility in two groups.

Spastics	Athetoids
I. Rate control	
Normal -> 51.85%	Slow rate -> 61.11%
Slow rate -> 35.18%	Inapp. silence -> 33.33%
Inapp. silence 7.4%	Variable rate -> 3.71%
Variable rate -> 5.55%	Normal rate -> 1.85%
II. Voice control	
Normal -> 35.18%	Voice stoppages -> 40.7%
Strained/Strangled -> 33.33%	Normal -> 29.6%
Voice stoppages -> 12.96%	Strained/Strangled -> 18.5%

Harsh voice -> 9.25%	Breathy voice -> 7.4%
Breathy voice -> 9.25%	Harsh voice -> 3.7%
III. Resonatory incompetence	
Normal -> 85.18%	Hyper nasality -> 64.8%
Hyper nasality -> 14.8%	Normal -> 27.77%
	Hypo nasality ->
IV. Stress control	
Normal -> 64.81%	Excess stress -> 59.25%
Reduced stress -> 22.22%	Reduced stress -> 25.9%
Excess stress -> 12.96%	Normal -> 14.8%
V. Pitch control	
Normal -> 57.4%	Mono pitch -> 46.29%
Monopitch -> 27.77%	Voice tremor -> 22.22%
Low pitch -> 9.25%	Pitch breaks -> 9.25%
Voice tremor -> 5.55%	Normal -> 9.25%
	High pitch -> 7.4%
	Low pitch -> 5.55%
VI. Intensity control	
Normal -> 51.85%	Monoloudness -> 40.7%
Monoloudness -> 33.33%	Uncontrolled variation->25.92
Uncontrolled variation->14.8%	Normal -> 18.51%
	High intensity -> 9.25%
	Low intensity -> 5.55%

VII. Articulatory Inaccuracy

Imprecise consonants -> 50%	Imprecise consonants ->27.77%
Irregular articulatory breakdown -> 20.37%	Irr.Arty.breakdown -> 18.5%
Normal -> 12.96%	Vowels distorted -> 18.5%
Phonemes prolonged -> 5.55%	Phonemes prolonged -> 18.5%
Repetition of phonemes -> 5.55%	Repetition of phonemes ->16.6%
Vowels distorted -> 5.55%	

This table shows different factors present in different subjects. If we consider each factor separately in terms of rate spastics were reported to have normal rate 51.85% of the time. Slow rate was reported 35.18% of the time.

No spastic was judged as having fast rate of speech. Among athetoids 61.11% of the time slow rate of speech was reported and 33.33% of the time inappropriate silence was reported. None had fast rate of speech.

In the parameter voice 35.18% of the time spastics were judged as having normal voice. Other main contributing factor reported was strained strangled voice 33.33% of the time and among athetoids 40.7% of the time voice stoppages and 18.5% of the time strained/strangled voice were reported.

In resonation, 85.18% of the time spastics had normal resonation and 14.8% of the time had hypernsasality while none had hypo nasality. Athetoids were reported to have hyper nasality 64.8% of the time and hypo nasality 7.4% of the time.

If we take stress factor, 64.8% of the time spastics had normal stress pattern and the main contributing factor reported was reduced stress 22.22% and mong athetoids excessive stress factor was reported 59.25% of the time 25.9% had reduced stress.

In pitch, more than half of the time 57.4% of the time the spastics were reported to have normal pitch patterns. The major contributing factor for the reduced intelligibility reported was monopitch, 27.77% of the time and 46.29% of the time athetoids were reported to have monopitch.

If we consider intensity factor, 51.85% of the time spastics were reported to have normal intensity and monoloudness 33.33% of the time. 40.7% of the time athetoids were reported to have monoloudness and 25.92% of the time uncontrolled variation and 18.51% of the time they had normal intensity range.

Considering articulatory adequacy, imprecise consonants among spastics were reported 50% of the time, irregular articulatory breakdown 20.37% of time. Among athetoids, 27.77% of the time were reported as having imprecise consonants and other factors like prolongation of phonemes, irregular articulatory breakdown, distortion of vowels, each were reported 18.5% of the time in athetoids. The listener judgements were found to have good intra and inter judge reliability.

DISCUSSION

SECTION-I:

It is thus clear from the foregoing results that, listeners did have problem of varying degree in perceiving both spastics and athetoid speech sample.

Speech intelligibility is definitely affected in the cerebral palsied, as reported by several investigators as Tikofsky & Tokofsky (1964), Yorkston & Beukelman (1978, 1980), Darley, Aranson & Brown (1969), Platt et al(1977). Rosenbek and Lapointe (1978) Shyamala (1987) who conducted study on dysarthric speech and evidenced reduced speech intelligibility in CP population.

The present study agrees with the above findings in the literature. In view of this result, null hypothesis (1) was rejected.

Between the two major types of CP, spastics and athetoids, there was difference in the performance cm all the intelligiblity tasks. Thus the null hypothesis 2 was rejected.

Spastics were found to have better speech intelligiblity than athetoids. Observation seems to correspond with the others in the literature (Lencione 1966, Irwin 1967, Irwin,1972, Andrews, Platt and Young,1977, Laing 1979, Platt 1980a, 80b, Platt, Andrews, Howie, 1980; Platt, Young, Andrews & Quinn 1980, Clark & Hoops 1980, Shyamala 1987, Kent et al 1990). This poor

speech intelligibility of athetoids could be attributed greately by the neuroanatomy and neurophysiology of their motor system like inconsistent and irregular articulatory patterns, poor motor control, postural irregularities, respiratory abnormalities etc. Neuromuscular limitations imposed on the dynamic process of speech production in CP are more severe in athetoids than in spastics.

SECTION II:

The major factors reported to be contributing for the unintelligible speech are given below. Factors reported by the listeners most of the times were taken and given in the table in descending order of their contribution.

Factors	Spastics	Athetoids
Rate control	Slow rate	Slow rate and inappropriate silence
Voice control	Strained/ strangled voice	Voice stoppages and strained/strangled voice
Resonatory inadequacy	Hyper nasality (reported sometimes)	Hyper nasality
Stress control	Reduced stress	Excess stress and also reduced stress was reported frequently
Pitch control	Monopitch	Monopitch, voice tremor and pitch breaks
Intensity control	Mono loudness	Mono loudness, uncontrolled variation and high intensity

Articulatory inaccuracy	Imprecise consonants and irregular articulatory breakdown	Imprecise consonants, irregular articulatory breakdown, distortion of vowels, prolongation of phonemes and repetition of phonemes

The subjects (both the groups) mainly had problem with consonants and athetoids were reported to have distorted vowels too. Voicing errors and the phonetic errors included affricates, fricatives and stop-plosives. These findings were supported by Andrews, Platt & Young 1977, Platt et al 1980, Platt, Young, Andrews & Quinn 1980, Logeman, Hild B.Fisher 1981, Shyamala 1987, Kent et al 1990). They conducted studies and attributed reduced intelligiblity in dysarthric speakers to the articulatory function.

Vowel distortions were attributed to the inability to achieve full vocal tract target shapes for the extreme positions of the vowels (Kent et al 1975, Logeman et al 1981, Kent & Netsell 1978).

CP speakers in the present study exhibited slow rate of speech. This slow rate has been attributed to the sluggish displacement and inappropriate movement of the articulators according to the previous findings reported in the literature (Yorkston & Beukelman 1978, Hirose, Kiritani & Sawashima 1980). These, however, were not studied in detail.

Abnormalities of resonance were also evidenced in the results of the present study which also have contributed to the reduced intelligibility. Both spastics and athetoids were found to have hypernasality, however hypo nasality also was reported in athetoids. This could be attributed to the velopharyngeal dysfunction. Yorkston, Beukelman & Bell 1988, Yorkston et al 1989, Honsinger et al 1989 evidenced velopharyngeal dysfunctionas a common characteristic of dysarthria contributing to reduced intelligibility in CP and non CP dysarthric speakers.

In the present study, spastics were found to have reduced stress while athetoids showed excessive stress pattern. Both groups were reported to have monopitch and monoloudness strained, strangled voice . Adding to these athetoids had voice stoppages; voice tremor, pitch breaks, and uncontrolled variation in loudness too.

Though these factors were reported to be contributing for the unintelligible speech in CP population, the causative attributes underlying such a perception were not studied in depth as they were beyond the scope of the present study.

5. SUMMARY AND CONCLUSION

Cerebral palsied speech is characterized by reduced intelligibility. Intelligibility is the degree of clarity with which one's utterances are understood. It is contributed by several factors such as articulation, fluency, vocal quality and intensity, etc.

General proficiency of a CP child can best be considered in terms of language development and the degree of intelligibility. Intelligibility measures quantify the index of the disorder and help in the differential diagnosis of dysarthric speech.

The purpose of the present study was to know the following:

-> Is there any reduction in intelligibility of CP speech?

-> Is there difference between the two major types of CP, spastics and athetoids with regard to intelligibility?

-> What are the factors frequently reporting to be contributintg to the reduced intelligibility of CP speech? and

-> What is the efficacy of perceptual analysis of intelligibility of cerebral palsied speech?

The subjects included 6 spastics and 6 athetoids both males and females, ranging in age from 10-20 years. Sample included 3 tasks i.e. word identification, reading and story narration task. The speech samples were recorded and 3 trained (speech & language pathology students) listeners were asked to perceptually judge

each subject on all the tasks separately and also asked to report the major factors contributing for the reduced intelligibility.

On the basis of analysis of the results the following conclusions were drawn:

(1) Reduced intelligibility is the major characteristic of CP speech, which hinders the normal communicative behaviour in them.

(2) The two major types of CP differed significantly in their performance on all the three tasks.

(3) Listeners perceived spastics speech better than athetoids speech inplying better speech intelligibility was found in spastics as compared to athetoids.

(4) The major factors reported to be contributing for poor intelligibility in spastics are slow rate of speech, strained, strangled voice, hyper nasality, reduced stress, monopitch, monoloudness and articulatory errors such as imprecise consonants and irregular articulatory breakdown.

The factors reported for athetoid group included, slow rate, inappropriate silence, voice stoppages, strained/ strangled voice, hyper nasality, excessive stress, monopitch, voice tremor, monoloudness, uncontrolled variation and articulatory errors like imprecise consonants, prolonged phonemes, distortion of vowels and repetition of phonemes.

(5) Perceptual analysis can be used effectively as a measure of assessing speech intelligibility as it quantifies CP speech, easily applicable to any clinical setting when sophisticated equipments are unavailable, cost effective and convenient in using.

Implications for therapy:

One of the chief concerns of the clinician who deals with CP population, is to measure speech intellgibility of cerebral palsied and identify factors responsible for their unintelligible speech, select or develop treatment protocols or compensated intelligibility treatment tasks, for the particular communication need of the individual.

Thus it would help in improving speech intelligibility and establish adequate communication skills in the social setting.

Implications and suggestions for further research:

(1) The present study was conducted limited number of subjects. Future research can include all types of CP population of greater number using control subjects. Thus the results could be generalized.

(2) Other types of CP and non CP dysarthric speakers can be studied.

(3) A comparative study of both objective and subjective analysis would give us better understanding of the efficacy of the two methods and the correlation between them.

(4) Comparison of both trained and untrained listener judgements could be made to see the variations in speech intelligibility ratings for both CP dysarthrics and other dysarthric population.

BIBLIOGRAPHY

- Ansel,B.M. & Kent,R.D.(1992). Acoustic - phonetic contrasts and intelligiblity in the dysarthria associated with mixed CP. Journal of Speech & Hearing Research, 35(2),296.

Bellaire,K., Yorkston,K.M. & Beukelman,D.R.(1986). Modification of breath patterning to increase naturalness of a mildly dysarthric speaker. Journal of Communication Disorders, 19, 271-280.

Beukalman,D.R. & Yorkston,K.M.(1980). Influence of passage familiarity on intelligiblity estimates of dysarthric speech. Journal of Communication Disorders, 13, 33-42.

Boone,D.R. Cerebral Palsy. The Bobbs-Merril Co., Inc. Indianapolis, New York, 1972.

Brown,W.S., Goldberg,D.M.(1990). An acoustic study of the intelligible utterances of hearing impaired speakers. Folia Phoniatrica, 42, 230.

Chenery,H.J., Murdoch,B.C. & Ingram,J.C.C.(1988). Studies in Parkinson's disease, perceptual speech analysis. Australian Journal of Communication Disorders, 16, 17-20.

Clement,M. & Twitchell,T.(1959). Dysarthria in C.P. Journal of Speech and Hearing Disorders, 24, 118-122.

Darley,F.L., Arnold,E., Aronson & Brown,J.R.(1969). Differential diagnostic patterns of dysarthria. Journal of Speech and HEaring Research, 12, 246.

Darley,F.L., Aronson,A.E. and Brown,J.R.(1969). Clusters of deviant speech dimensions in the dysarthrias. Journal of Speech and Hearing Research, 12, 462.

Denhoff,E. & Robinault,I.P. Cerebral Palsy and related disorders: A developmental approach to dysfunction. The Blakiston Division, McGraw Hill Book Company, New York (1960).

Enderby,P.(1980). Frenchay Dysarthria Assessment. British Journal of Disorders of Communication, 51(3), 165-174.

Enderby,P.(1986). Relationships between dysarthric groups. British Journal of Disorders of Communication, 21, 189-197.

Farmer,A.(1977). Stop cognate product patterns in adult athetotic C.P. speakers. Folia Phoniatrica, 29, 154-162.

Fitzpatrick,P.A., Darlene Gould, and Alan C.Nicholas (1980). Self administered intelligiblity practice for esophageal speakers. Journal of Communication Disorders, 13, 341-346.

Frearson,B.(1985). A comparison of the AIDS sentence list and spontaneous speech intelligibility scores for dysarthric speech. Australian Journal of Human Communication Disorders, 13(5),

Freedman & Read,C.(1978-79). A study of the effects of positioning on voice and speech production in young C.P. children. Human Communication Disorders, 3-4, 235.

Gentile,M.(1990). Dysarthria in Freidrick's ataxia. Brain and Language, 36, 438-448.

Grunwell,P. & Huskins,S. (1979). Intelligiblity in acquired dysarthria - a neurophonetic approach, 3 case studies. Journal of Communication Disorders, 12, 9-22.

Grunwell,P. Developmental speech disorders. Clinical issues and practical implications. Churchill Livingstone: Medical Division of Longman Group,U.K. Ltd.(1990)

Hanson,W.R. & Metter,E.J. "DAF Speech rate modification in Parkinson's disease. A report of two cases" in "Clinical Dysarthria", Berry (Ed.), College-Hill Press, SanDiego, California (1983).

Hardy,J.C.(1961). Intraoral breath pressure in cerebral palsy. Journal of Speech and Hearing Disorders, 26, 309.

Hirose,H., Kiritani,S., Oshijima,T., Yoshioka,H., Sawashima,M.(1981). Patterns of dysarthric movements in patients with Parkinsonism. Folia Phoniatrica, 33(4), 204.

Hirose,H., Kiritani,S. & Sawashima,M. (1982). Patterns of dysarthric movement in patients with amyotrophic lateral sclerosis and pseudobulbar palsy. Folia Phoniatrica, 34, 106-112.

Hirose,H.(1986). Pathophysiology of motor speech disorder. Folia Phoniatrica, 38(2-4), 59-87.

Hixon and Hardy (1964). Articulatory motility in children with C.P. Journal of Speech and Hearing Disorders, 29, 293-305.

Hunter,L., Pring,T. & Martin,S.(1991) The use of strategies to increase speech intelligiblity in cerebral palsy. An experimental evaluation. British Journal of Disorders of Communication, 26,

Iyer,N.(1992). "Mean length of utterance and syntactic complexity in the speech of the cerebral palsied". Unpublished dissertation, University of Mysore, Mysore.

Kearns,K.D. & Simmons,W.N.(1988). Inter observer reliability and perceptual ratings: More than meets the ear. Journal of Speech and Hearing Research, 31, 131-136.

Kelter,E., Vigneur,P. & Laframboise,M.(1991). Acoustic analysis of neurologically impaired speech. British Journal of Disorders of Communication, 26, 75.

Kent,R.D. & Netsell,R. & Bauer,L.L. (1975). "Cineradiographic assessment of articulatory mobility in the dysarthrias". Journal of Speech and Hearing Disorders, 40, 467.

Kent,R., Netsell,R. & Abbs,J.H.(1979). Acoustic characteristics of dysarthria associated with cerebellar disease. Journal of Speech and Hearing Research, 22, 627-648.

Kent,R.D., Weismer,G., Kent,J.F. & Rosenbek,J.C. (1989). Toward phonetic intelligibility in dysarthria. Journal of Speech and Hearing Disorders, 54 (4), 482-499.

Kent,R.D., Weismer,G., Martin,R.E., Sufit,R.g., Rosenbek,J.C. & Brooks (1989). Relationship between speech intelligibility, the slope of F2 transition in dysarthric subjects. Clinical linguistics and phonetics, 3, 347-358.

Kent,R.D., Kent,J.R., Weismer.G, Sufit,R.C, Rosenbek,J.C, Martin,r.E. & Brooks(1990). Impairment of speech intelligibility in men with ALS. Journal of Speech and Hearing Disorders, 55(4), 721-728.

Kent,R.D., Sufit,R.G., Rosenbek,J.G.(1991). Speech detrioration in ALS: a case study. Journal of Speech and Hearing Research, 34, 6.

Kent,R.D.(Ed.) (1992). Intelligibility in speech disorders. John Benjamins Publishing Co., Amsterdam/Philadelphia.

Lass,N.J., Ruscello,D.M. & Lakawicz,J.A.(1988). Listeners perceptions of nonspeech characteristics of normal and dysarthric children. Journal of Communication Disorders, 21, 385.

Lencione (1968). A rationale for speech and language evaluation in C.P. British Journal of Disorders of Communication, 3, 161-170.

Logeman,J. & Fisher,H.(1981). Vocal tract control in Parkinson's disease: Phonetic feature analysis of misarticulations. Journal of Speech and Hearing Disorders, 46, 348-352.

Ludlow,C.L. & Bassich,C.J. "The results of acoustic and perceptual assessment of two types of dysarthria" in "Clinical Dysarthria". Berry,W.R.(Ed.) 1983. College-Hill Press, San Diego, California.

Mc Donald,E.T. & Burton Chance Jr.(1964). Cerebral Palsy. Prentice Hall, Inc. Englewood Cliffs, New Jersey.

Menche,E.O., Ochsner,G.J., & Testert,E.W.(1983). Listener judges and speech intelligibility of deaf children. Journal of Communication Disorders, 16, 175-180.

Metter,J. " Motor speech production and assessment neurologic perspective" in "Speech and language evaluation in neurology-adult disorders". Darby,J.(Ed.) 1983. Grune & Straton, Inc., Harcourt Brace Jovanovick Publishers.

Metter,J. & Hanson,W.R.(1986). Clinical and acoustical variability in hypokinetic dysarthria. Journal of Communication Disorders, 19, 347-366.

Nataraja,N.P. & Nandiyal,I.(1982). Spectrographic observations of speech of an ataxic dysarthria. AIISH, XIII, 56.

Nataraj,J.(1990). Deglutition and related speech performance in normals and spastic cerebral palsied. Unpublished Master's Dissertation submitted as part fulfilment for the Second Year M.Sc. (Speech & Hearing) to the University of Mysore, Mysore.

Netsell,R.(1969). Evaluation of velopharyngeal function in dysarthria. Journal of Speech and Hearing Disorders, 34, 113.

O'Dwyer,N., Neilson,P.O., et al(1983). Control of upper airway structures during nonspeech tasks in normal and C.P. subjects. Journal of Speech and Hearing Research, 26, 162-170.

Pandita,R. (1983). Spectrographic analysis of dysarthric speakers. Unpublished Dissertation, University of Mysore, Mysore.

Platt,L.J., Andrews,G., Young,M. & Neilson,P.O. (1978). The measurement of speech impairment of adults with cerebral palsy. Folia Phoniatrica, 30, 50-58.

Platt,L.J., Andrews,G. & Howie P.M.(1980). Dysarthria of adult C.P. Phonemic analysis of articulation errors. Journal of Speech and Hearing Research, 23, 41-55.

Platt,L.J., Andrews, G., Young,M. & Quinn,P.(1980). Dysarthria of adult C.P. Intelligibility and articulatory impairment. Journal of Speech and Hearing Research, 23, 28-40.

Rai,R.(1992). Oral form discrimination and alternate articulatory motion rate in the cerebral palsied. Unpublished Dissertation, University of Mysore, Mysore.

Rajashree,S.(1991). Assessment scale for cerebral palsied. Unpublished Master's Dissertation, University of Mysore, Mysore.

Rosenbek,J.C. & Lapointe,L.L. "The dysarthrias: Description, Diagnosis and Treatment" in "Clinical management of neurogenic communicative disorders". Johns, D.F. (Ed.)1978. Little, Brown and Company, Boston.

Schiavetti,N., Meet,C. & Setler (1981). Construct validity of DME and IS of speech intelligibility. Evidence from a study of the hearing impaired. Journal of Speech and Hearing Research, 24(3), 441.

Schliesser.H.(1982). Alternate motion rates of the speech articulators in adults with cerebral palsy. Folia Phoniatrica, 34, 258-264.

Seikel,A.J., Wilcox,K.A. & Davis,J.(1990). Dysarthria of motor neuron disease clinical judgements of severity. Journal of Communication Disorders, 23, 417-432.

Seikel,A.J., Wilcox,K.A. & Davis,J.(1991). Dysarthria of motor neuron disease, longitudinal measure sof segmental durations. Journal of Communications Disorders, 24, 516.

Shailashree,C.N.(1992). "Orthography as an augmentative system in cerebral palsied". Unpublished Master's Dissertation, University of Mysore, Mysore.

Sharmila (1991). Receptive vocabulary testing in cerebral palsied population. Unpublished Master's Dissertation, University of Mysore, Mysore.

Sheard,C., Adams, R.D. & Davis,P.J.(1991). Reliability and agreement of ratings of ataxic dysarthric speech samples with varying intelligiblity. Journal of Speech and Hearing Research, 34(2), 285.

Shyamala,K.C.(1987). Speech and Language behaviour of the cerebral palsied. Central Institute of Indian Languages,Mysore.

Sitler,R.W., Schiavetti,N. & Mertz (1983). Contextual effects in the measurement of hearing imapired speaker's intelligibility. Journal of Speech and Hearing Research, 26, 30-34.

Thompson (1978). A clinical rating scale of speech dysfunction of Parkinson's disease. South African Journal of Communication Disorders, 25, 39-52.

Thompson,G.H.(1983). "Comprehensive management of cerebral palsy". Grune & Stratton, A subsidiary of Harcourt Brace Jovanovich Publishers.

Tiffany,W.R.(1980). The effects of syllable structure on DDK & reading rate. Journal of Speech & Hearing Research, 23, 894.

Tikofsky,R.S. & Tikofsky,R.P.(1964). Intelligibility measures of dysarthric speech. Journal of Speech and Hearing Research, 7, 325-333.

Tikofsky,R.S., Glattke,T.J. & Tikofsky,R.P.(1966). Listener confusions in response to dysarthria speech. Folia Phoniatrica, 18, 280-292.

Tikofsky,R.S.(1970). A revised list for the estimation of dysarthric single word intelligiblity. Journal of Speech and Hearing Research, 13, 59-64.

Till,J.A. & Toye,H.R.(1988). Acoustic-phonetic effects of two types of verbal feedback in dysarthric subjects. Journal of Speech and Hearing Disorders, 53(4), 449-458.

Yorkston,K.M. & Beukelman,D.R.(1978). A comparison of technique for measuring intellgibility of dysarthric. Journal of Communication Disorders, 11(1), 499-512.

Yorkston, Beukelman & Minifie,F.D.(!979). Computer analysis of some acoustic parameters of ataxic dysarthric speech. American Speech and Hearing Association, 11,

Yorkston,K.M. and Beukelman,D.R.(1980). A clinician judged technique for quantifying dysarthric speech based on single word intelligibility. Journal of Communication Disorders, 13, 15-32.

Yorkston & Beukelman (1981). Communication efficiency of dysarthric speaker as measured by sentence intelligibility and speaking rate. Journal of Speech and Hearing Disorders, 46(3), 296-301.

Yorkston,K.M. & Beukelman,D.R.(1981). Ataxic dysarthria: Treatment sequences based on intelligiblity and prosodic considerations. Journal of Speech and Hearing Disorders, 46(4), 398-404.

Yorkston,K.M., Beukelman,D.R. and Charles,D. Traynor (1988). Articulatory adequacy in dysarthric speakers. A comparison of judging formats. Journal of Communication Disorders, 21, 351.

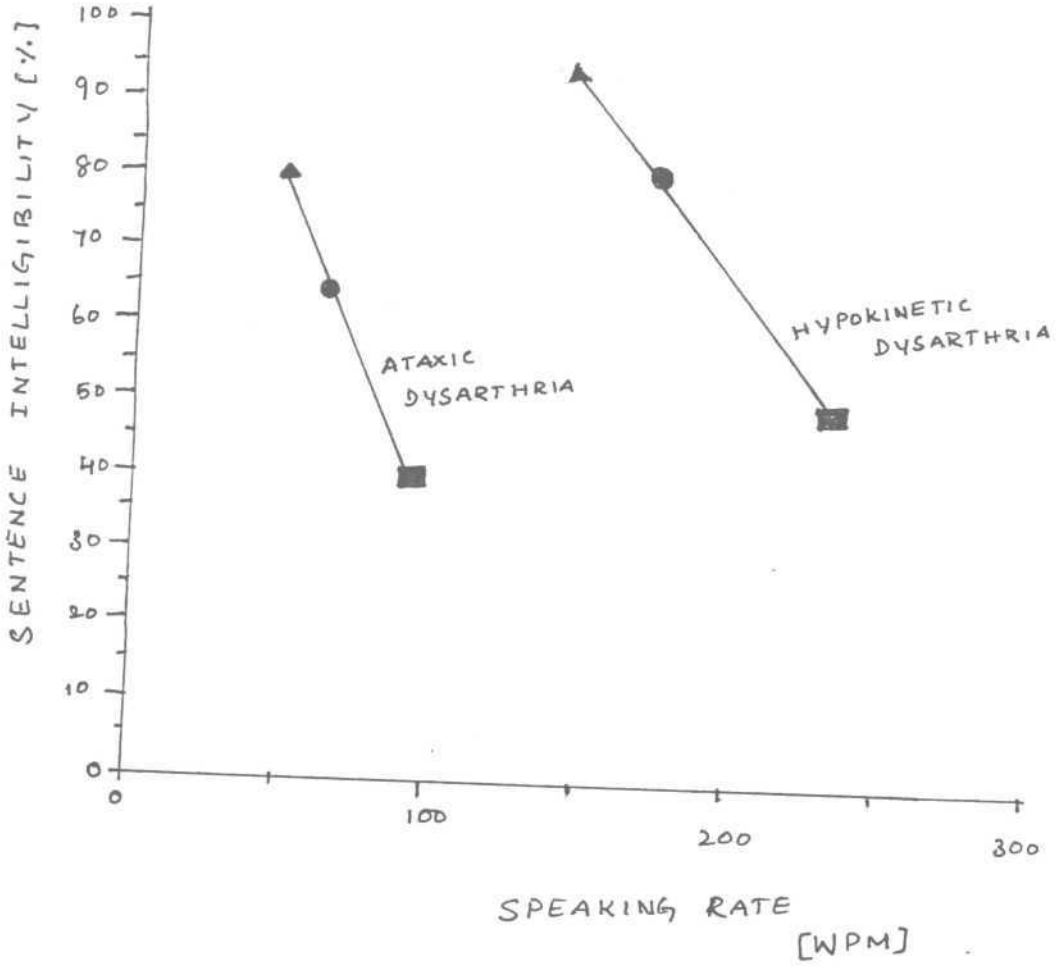
Yorkston,K.M., David,R., Beukelman & Honsinger,M.J.(1989). Perceived articulatory adequacy and velopharyngeal function in dysarthric speakers. Arch. phy. med. Rehab. 70, 313-317.

Yorkston,K.M., Vickie,C, Hammen, Beukelman,D.R. & Traynor.C.D. (1990). Effect of rate control on the intelligiblity and naturalness of dysarthric speech. Journal of Speech & Hearing Disorders, 55, 550-560.

Ziegler & Voncramon,D.(1986). Spastic dysarthria after acquired brain injury - an acoustic study. British Journal of Disorders of Communication, 21(2), 173-187.

Zyski,B.J. & Weisiger,B.E.(1987). Identification of dysarthria types based on perceptual analysis. Journal of Communication Disorders, 20, 367-378.

APPENDIX . I



■ HABITUAL

● 80 percent

▲ 60 PERCENT.

APPENDIX II

World List

1.	Puli	(Tiger)
2.	Palli	(Lizard)
3.	tavaḷai	(Frog)
4.	Pūchi	(Insect)
5.	jannal	(Window)
6.	dappa	(Box)
7.	jadai	(Plait)
8.	sāvi	(Key)
9.	bommai	(Doll)
10.	karumbu	(Sugurcane)
11.	muṭṭai	(Egg)
12.	Vaḷayal	(Bangal)
13.	vaṭṭam	(Circle)
14.	marundu	(Medicine)
15.	māngāi	(Mango)
16.	sūriyan	(Sun)
17.	tēngāi	(Coconut)
18.	sōppu	(Soap)
19.	pandal	(Pandal)
20.	veṭṟilai	(bettle leaf)
21.	diratsai	(grapes)
22.	gadikāram	(Clock)
23.	vavāl	(Bat)
24.	tupaki	(Gun)
25.	vāḷaipaḷam	(banana)

Engaḷ Ūr (My Village)

Engaḷ Ur oru cit̤t̤ur	(Ours is a small village)
Inge Pala terukaḷ uṇḍu	(There are many streets here)
Vīḍugaḷ varisaiyaga irukind̤rana	(There are row of houses in the street)
terukaḷil marangaḷ uḷḷana	(There are many trees on the street)
Vīḍugaḷin Pinpuratil tōṭangaḷ uṇḍu	(Each house has a garden at the back)
Ūrukku arugil oru kuḷam irukiradu	(There is a pond in my village)
Ūrai cut̤ri vaiyalgaḷ uḷḷana	(There are fields around the village)
Engaḷ ūril oru Paḷḷi uḷḷadu	(There is a school in my village)
inda Paḷḷiyildān nān Padikiṟen	(I am studying in this school)

APPENDIX III

System of transcription used (Roman Script)

a	ā	i	ī	u	ū	e	ē	ai	o	ō	au
அ	ஆ	இ	ஈ	உ	ஊ	எ	ஏ	ஐ	ஒ	ஓ	ஔ

k	g	ṅ	c	ñ	ṭ	ḍ	ṇ	t	d
க	க	ங	ச	ஞ	ட	ட	ண	த	த

n	p	b	m	y	r	l	ḷ	v	ḻ
ந	ப	ப	ம	ய	ர	ல	ள	வ	ழ

ṟ	n	h	s
ற	ன	ஹ	ஸ