SPECTROGRAPHIC ANALYSIS OF DYSARTHRIC SPEECH

RAJKUMAR PANDIT A

"Speech basically results by three motor processes ; exhalation, phonation and articulation. For each speech sound there is a separate neuromuscular configuration that involves as a functional unit, all the musculature of the speech organ" (West and Ansberry, 1968).

Any disturbance of this neuremuscular configuration as a result of the weakness, paralysis or inco-ordination of the speech musculature as a result of lesions in the nerves supplying the musculature, results in speech dysfunction which are known as dysarthria.

Green (1964) and Peacher (1949) use the term 'Dysarthrophonic' (instead of 'dysarthria'). Here the respiratory and resonatory systems are also being found leading to (i) Articulatory breakdown ; (ii) Respiratory (iii) Phonatory and (iv) Resenatory and (v) Prosodic disturbances.

The most acceptable definition of dysarthrias now is by Darley (1969), Darley Aronson and Brown (1975). . . . ."Dysarthrias are manifested as disrupted oral communication due to paralysis, weakness abnormal tone or inco-ordination of the muscles used in speech and encompass coexisting motor dis-orders of respiration, phonation. resonation, articulation and prosody.

The traditional method of speech evaluation of dysarthric patients by neurologists were, use of tongue twists, eg: "Peter piper picked a pale of pickled pepper". The present speech evaluation strategies have come a long way since then.

Netsell et al (1975), and Leanderson et al (1970), observed the neural and muscular events by electromyography in dysarthrics.

Movements of the lip, jaw, tongue, velum, pharynx and larynx can be observed by cinefluorography. Kent and Netsell and Bauer (1975), Netsel (1969). The dysarthric speech was studied by the above technique by Logeman (1974) and Netsell and Kent (1976). The aerodynamics of dysarthric speech was studied by Hixon (1972) using elaborate instrumentation. Marquarlt (1973) Netsell (1969) and Netsell, Daniel and Celesia (1975; have reported volume, pressure and flow characteristics in dysarthrics. The acoustic/spectrographic analysis requires

instrumentalion to obtain a visual representation of the spetch signal. Primary measures include observations of the physical propertiss of sounds ; frequency. intensity and temporal relations. Kent and Netsell (1975) Lebrun, Buyssens and Hanneaux (1973) and Kehistu (1965) have used acoustic analysis to describe dysarthric speech. Speech spectrograph has been used for analysis of dysarthric speech by Kent and Netsell (1975).

Perceptual measures of dysarthric speech do not require elaborate instrumentation Hence, these measures are convenient. Certain clinician have used phonetic inventories. Templin, Darley Test (I960), McDonald Dup Test (1969).

Intelligibility rating techniques were used by Sarno (1968) Darley (1969) and Beukelman and Yorktar (1979). Measures of rate of speech and diadochokinetic rates of various dysarthrics was done by Mueller (1971) and Kruel (1972). Darley Aronson and Brown known as the 'Mayo Clinic Study' used thirty eight deviant speech dimensions of speech and voice analysis.

The techniques employed in the present study incorporation both the acoustic as well as perceptual measures.

The problem was to study and differentiate the deviant speech dimensions of dysarthric patients and normals based on the twenty eight deviant speech dimensions.

The purpose of the study was to test the following hypothesis :

1. There will be difference in the speech dimensions between dysarthrics and normals and the deviations can be described using twenty eight dimensions.

2 There will be difference in the rate of speech of dysarthrics and normals.

3. No correlations exists between the perceptual and acoustic measures of dysarthric speech.

To test these hypotheses, ten dysarthrics and ten normals for the age range (mean age of dysarthric group was 41.9 years and normal 33.6 years). The dysarthrics were diagnosed as by both a neurologist and speech pathologist- All the subjects knew to read Kannada.

The speech material comprised of words and sentences. There were twenty, words and three passages. These were selected from the Diagnostic Articulation Test in Kaanada made by Ram Mohan Babu, et al (1972). The first two passages contained all the consonants excluding the aspirated in Kannada. The third

passage contained all the consonants including the aspirated. The test material was written in bold and clear hand.

The recording of the dysarthric and normals speech was done on a National Panasonic UM-IRQ 2157 cassette Tape Recorder attached with a Piezo Dynamic External Microphone. The tape recorder was battery operated. All the recordings were done at constant intensity levels in a sound treated room used for audiological evaluation.

The analysis of speech sample was carried out both perceptually and acoustically.

For the perceptual analysis even judges who were post graduate and doctoral research students in Speech Pathology. The tapes were played on a Philips Sterio Cassette Deck F 6112 Tape Recorder and an amplifier Philips Integrated Amplifier 15 AH 824 attached to two speakers (Cosmic 1500) Thus good listening conditions were ensured.

Prior to the analysis, the judges were provided with a scoring sheet having the list of the 28 deviant speech dimensions. The speech characteristics were made to be marked on a fine point resting scale. The scale was :

1. Profound Impairment
2. Severe Impairment
3. Moderate Impairment
4. Mild Impairment
5. No Impairment

The definition of each dimensions were read out to the judges before hand and the judges were requested to listen to the speech sample and describe (Mark in the scoring sheet). The scoring sheet was based on the phonatary, resonatory, articulatory and prosodic aspects of speech.

The dysarthric Cases No. 1, 5, and 10 were re-analysed by all the judges to find out the reliability of the judgement.

The acoustic analysis included the following measurements:

The rate of speech in syllables per minute for all the dyasrthric and normal subjects was found out, using a stop watch.

Spectrographic analysis was done for the 1st, 5th, 15th and 20th sentences for all the dysarthrics and compared to that of normals. Spectrographs were

obtained, using the spectrographic (Voice Identification Incorporated 700 series). Linear and wide band setting were employed.

Further, analysis was also done to obtain the average amplitude curve for each sentence of all the subjects. Using DIGI pitch on optional part of the spectrogram, pitch variations ia sentences 1st, 5th and 10th of the third passage were obtained

An attempt was made to find correlation between perceptual description of the speech samples given by the judges and the acoustic characteristics depicted by the spectrogram.

The mean rate of speech for the dysarthric group was 143.92 syllables minute and the normal was 264.27 svllables/minute. The 't' value obtained was 3.91 which was fairly significant at .01 level.

Also the cumulative scores for the dysarthrics and normals and marked by the judges were determined. Wilcoxins matched pair sign rank test showed a 'T' value of 10 for all the deviant speech dimensions which is fairly significant at .005 level of significance, except for the deviant speech dimension-nasal emission of air. The reanalysis of 15th and 10th dysarthrics showed a high reliability of judgement.

A severity index was made use of for finding the most deviant speech dimensions (This was done by adding the scores of all the judges for the ratings 1, 2 & 3.) A dimension was considered to be significantly deviant where the severity index was equal or more than 5.

The spectrographic analysis for each dysarthric revealed certain common ladings as :-

1. Irregular vocal cord striations
2. Noise components components in the formant frequencies
3 Work release of slop sounds
4. Prolonged duration of syllables and words
5. Decrease in loudness at the end of the sentence
6. No pitch variation
7. Silent intervals with noise components

The average fundamental frequency was found for each cases.

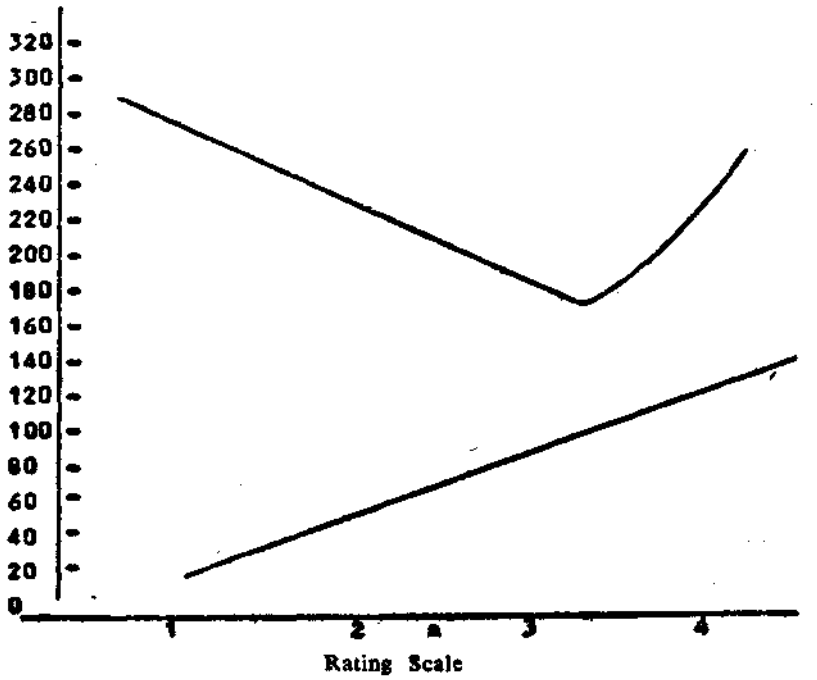
A case by ease analysis of both the most deviant speech dimensions was done and correlated to the spectrographic findings. It was seen that the sptctrographic findings most of the times correlated with the perceptual findings.

On analysing the Wilcoxins matched pair against test and those of the cumulative scores obtained from all the judges, the first hypothesis was accepted. The findings of the rate of speech of both the dysarthrics and by both acoustically and perceptual methods result in the acceptance of the second hypothesis.

And the confirmed high positive correlation between the acoustic and perceptual measures lead to the rejection of third hypothesis.

The present study thus described the deviant speech dimensions of dysarthric and the result of this study were incorporation was other studies describing the dysarthric spent. Hence, the dysarthric speech can be described objectively by acoustic analysis. Based on the deviant speech characteristics the underlying neuronal pathology can be assessed. Thus it may be of a great deal of help for a neurologist in labelling a neurological point of disorder and for a Speech Pathologist in his diagnosis and therapeutic intervention strategies.

Cumulative Score graph of all the dysarthrics all the normals for all deviant, speech dimensions against the rating scale as judged by all the judges combine.



DEVIANT SPEECH DIMENSIONS

Case No:

DIMENSIONS	Rating	Scale			1 = most improved
	1	2	3	4	5
Phonatory-Respiratory:					
1. Low pitch level					
2. Pitch breaks					
3. Harshness					
4. Breathiness					
5. Hoarseness					
6. Strained-strangled sound					
7. Voice stoppages					
8. Audible inhalation					
9. Forced inhalation/ exhalation					
Articulatory :					
1. Imprecise consonants					
2. Vowels distorted					
3. Irregular break downs					
4. Phonemes repeated					
5, Phonemes prolonged					

Resonatory: 1. Hypernasality					
2. Nasal emission of air					
Prosodic : 1. Monopitch					
2. Monoloudness					
3. Excessive loudness variation					
4. Loudness decay					
5. Slewed rate					
6. Rapid rate					
7. Variable rate					
8. Short rushes of speech					
9 Reduced stress					
10. Excess & Equalized stress					
11. Intervals prolonged					
12. Inappropriate silences					

REFERENCES

Benkelman, D. R , and Yorksten, K. M., Influence of passage familiarity on intelligibility estimates of dysarthric speech.
J. Comm. Disord. 13 : 33, 1980.

Darley, F., The Dysarthrias-Distinguishing features and Gestalts of the major types.

Australian Journal of Human Communication Disorders, 20 ; 28, 1975.

Darley, F. L., Aronson, A. E., and Brown, J. R., Cluster of deviant speech dimensions in the Dysarthrias.
J. Speech. Hear, Res. 12 : 462, 1962.

Darley, F. L., Aronson, A. E., and Brown, J. R , Differential diagnostic pattern of dysarthria.
J. Speech Hear. Res. 12 : 246, 1969.

Darley, F. L., Aronson, A. E., and Brown. J. R., Motor Speech Disorders.
Philadelphia : Saunders, 1975.

Kent, R. D., Netsell, R., and Bauer, L.L., Cineradiographic assessment of articulatory mobility in the dysarthrias.
J. Speech Hear. Disord. 40 : 467, 1975.

Kent, R. D., Netsell, R., & Abbs., J. H., Acoustic characteristics of Dysarthria associated with cerebcllar disease.
J. Speech. Hear. Disord. 22 : 627, 1979.

Kent., R. D., and Netsell, R., A Case Study of an ataxic dysarthric :. Cineradiographic and Specrtographic observation.
J. Speech. Hear. Disord. 40 : 115, 1975.

Rosenbeck, J. C , and LaPointe, L.L., The Dysarthrias : Description Diagnosis and Treatment ; In D. F. Johns (Ed) Clinical Management of Neurogenic Communicative Disorders. Boston : Little and Brown, 1978