SPECTROGRAPHIC OBSERVATIONS OF SPEECH OF AN ATAXIC DYSARTHRIC

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Speech is a motor act. Speech results from the fine co-ordination of various speech muscles. Motor areas in cerebral hemispheres, cerebellum and other lower centres have been considered to be controlling this motor activity.

' Co-ordination of movements and maintenance of balance and muscle tones are dependent on the cerebellum and its connections' (Mysak, 1976).

' The contribution of cerebellum to the motor control of speech is not clearly understood, but some general notions about the role of this structure, have been sketched through studies of individual with cerebellar lesions. The speech disorder consequent to such lesion is called ' Ataxic dysarthria ' (Kent and Netsell, 1975).

The term dysarthria designates problems in oral communication due to paralysis, weakness or in-co-ordination of the speech musculature resulting from damage of the central or peripheral N.S.

This differentiates such problems as apraxia of speech, (disorders of higher centres related to the faulty programming of movements and sequences of movements) and aphasia (to the inefficient processing of linguistic units) i.e., the term ' dysarthria' is used ' to cover all motor disturbances of speech exclusive of symbolic and integrative function' (Peacher, 1950).

However, some (Green 1964, Peacher 1949) prefer to use the term 'dysarthrophonia' instead of ' dysarthria ' as in many cases, the respiratory, phonatory and resonatory systems are also usually being found involved; leading to not only articulation problems, but also, respiratory, phonatory, resonatory and prosodic disturbances. Thus there is a controversy in the usage of the term ' dysarthria'. But the term dysarthria, has been found to be used by most of the workers to mean motor disorders of respiration, phonation, articulation, resonance and prosody due to neurological disorders. In the present discussion, the term ' dysarthria ' will be used with the traditional meaning.

Darley *et al.* (1969), had discussed extensively the usage of the term dysarthria and other terms to describe various speech problems resulting from neurological disorders.

Darley *et al.* (1969), have described the ataxic dysarthria as having ten dominant perceptual dimensions. They are: imprecise consonants, irregular articulatory breakdown, distorted vowels, excess of equal stress, prolonged

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phonemes, prolonged intervals, slow rate, mono-pitch, mono-loudness and harsh Voice. They have classified these dominant dimensions under three major clusters.

1. Cluster of articulatory inaccuracy (imprecise consonants, irregular articulatory breakdown and distorted vowels).

2. Cluster of prosodic excess (excess and equal stress, prolonged phonemes, prolonged intervals and slow rate).

3. Cluster of phonatory proscdic insufficiency (mono-pitch, mono-loudness and harsh voice).

Further, they have inferred that the errors of (1) individual movements and dysarthria of repetitive movements (2) slow repetitive movement and (3) hypertonia as underlying neuromuscular defect for each of the above mentioned clusters, and thus they have attempted to explain speech physiology in ataxic dysarthria.

Kent and Netsell (1975), consider that two of the three above inferences are based on the earlier work of Fultan and Row (1937), the two of them being (1) errors in rate, range, direction and force of voluntary movements and (2) Hypertonia. The third inference dealing with slowness of movement has been suggested by Brown *et ah* (1970).

Kent and Netsell (1975), believe that the above mentioned neuromuscular abnormalities have certain implications which will help in the study of speech physiology in ataxic dysarthria.

' First, it appears from testing of clusters and associated neurcmuscular defects that articulatory errors as such (imprecise ccnscnants, distorted vcwels and irregular articulatory breakdown) arise from difficulties in the control of rate, range, direction, force and timing of voluntary movements. One problem in the employment of this constellation of problems as a hypothesis for physiolcgical study is that affected variables include every conceivable aspect of motor control for speech. In short, this class of defects implies that all parameters, of articulatory control may go away in ataxic dysarthria, a circumstance that complicates physiological confirmation of the hypothesized defects since the possible predictions are nebulous. Second, the cluster of proscdic excess, which is attributed to a generalised slowness of individual and repetitive movements, indicates that the overall time programme for speech is distorted, so that slowness of movements should be evident for all 3 sub-systems of speech production: respiratory, laryngeal and upper airway. Finally, the hypothesized defect of hypotonia which is supposed to be the basis of the dominant cluster of phonatory, proscdic insufficiency, carries the implications that hypotonic musculature should be observable for the respiratory and laryngeal sub-systems, but not necessarily for the upper airway subsystems. This implication derives from the identification of presence of

hypotonia with the dominant dimensions of mono-pitch, mono-loudness and harsh voice, all of which are strongly indicative of respiiatoiy, latyngtal dysfunction (or solely-laryngeal dysfunction'.)

An attempt by Kent and Netsell (1975), has been made to study the speech physiology in a case of ataxic dysarthria using spectrcgraph and cineradicgraphy. And they believe that the study of acoustic and physiolcgical aepects in ataxic dysarthria and correlating that with perceptual characteristics will be of value. As Leburn *et al.* (1973), states ' There is no doubt that perceptual characteristics are valuable in themselves, but the inference of acoustic dimensions can be difficult and uncertain. Therefore, attempts to collect data regarding the acoustic and physiological aspects in dysarthria and correlating them with perceptual characteristics will be helpful in understanding the physiology of normal and abnormal speech.

The present report is an attempt to note the acoustic aspects of speech of an ataxic dysarthric and correlating them with the perceptual characteristics of speech.

Case report

The case was brought to the clinic with the complaint of no speech after four months from the date of accident.

It was reported by the informant, the brother of the case as follows: The case met with an accident while riding a motor-cycle. He was admitted to the hospital immediately after the accident, when he was in an unconscious stage. On the third day, he became semi-conscious and spoke few words, but later again he became unconscious. Then he slowly regained consciousness after three weeks. The problem was diagnosed as ' Cerebral Contussion'.

The case was not speaking, when he was brought to the clinic. He could follow the written instructions and used wr iting to express his needs. The writing was not completely legible, however, the family members could read it.

Memory was reported to be good by the informant. It was reported that the case could hear door tapping, rain-fall and other sounds, but net speech sounds. It was observed that the case could not walk on his own.

On the first visit of the case, voice, articulation and rhythm cculd net be tested as the case did not speak or vocalize. However, the diadec he kinetic rate for lip, jaw and tongue movements were found to be poor. Comprehension was found to be good by presenting questions in writing. Hearing tests revealed moderate bilateral S.N. loss, with poor discrimination.

Neurological report indicated the cerebral darrage (bilateral). The case showed in co-ordination of muscles, poor diadochokinetic rate with intentional tremors.

He was advised to under go Speech Therapy and Physiotherapy.

The case attended therapy regularly. He was well motivated.

During therapy, first few sessions were spent in making the case to phonate and make him believe that he can produce voice and he can use it for speech, after which he started using speech for communication. The speech was described as prolonged, monotonus, laboured and unintelligible, i.e., the speech was characterized by mono-pitch and mono-loudness, mis-articulations (rrainly distortions) and prolonged vowels. However, abrupt variations in loudness were also observed. The voice was also observed to be hoarse.

The therapy was basically aimed at articulation correction. Correcting intonation, rhythm, and improving the rate of speech.

The speech emphasis indicator, an equipment which displays intensity Vs. time on a screen, was used for therapy. The case attended therapy for more than three months and showed improvement. The speech was intelligible. The family members and others could also understand his speech. On follow-up it was found that the case was continuing practicing at home and had shown further improvement.

The purpose of the present report is to note the acoustic characteristics of speech in Ataxic Dysarthric and correlating them with the perceptual aspects of speech.

Analysis of Speech Sample

Samples of the following words and sentences were obtained after twenty days of therapy. These were arbitrarily chosen from the sentences spoken by the case.

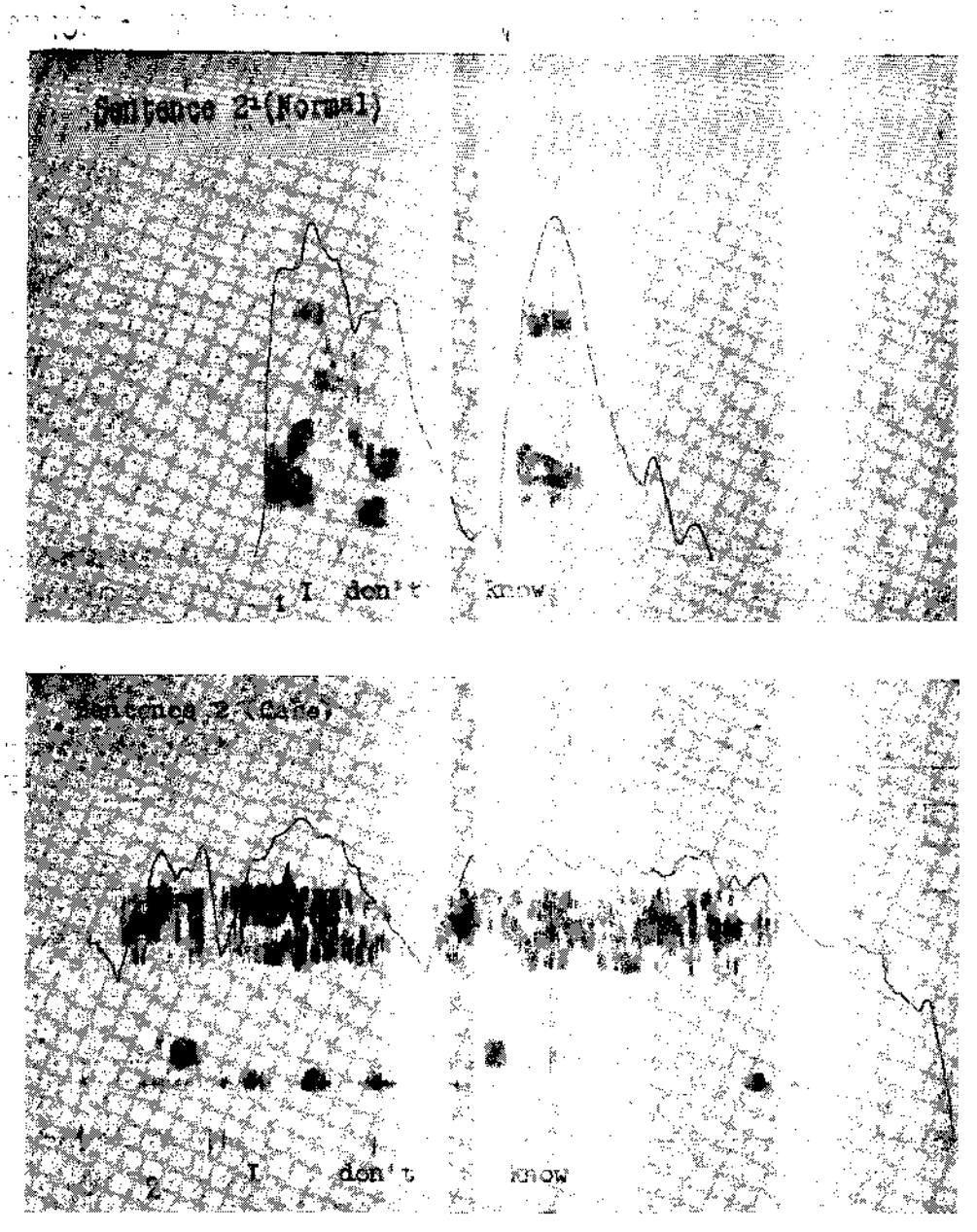
List of Words

Kashmir: State: Beautiful: Ancestors: Mountains: Pakistan: Maharaja.

List of Sentences

1. Mountain tops and snow
2. I do not know
3. Between India and Pakistan
4. He joined Pakistan

Spectrographs of these speech samples (wide band, linear) were obtained using the Spectrograph (voice identification—incorporated). Further, analysis was also done to obtain the average amplitude curve for each word and sentence. For the purpose of comparison, all the words and sentences were speken by a normal adult male of 32 years and recorded. Spectrograms and average amplitude curves for all the words of sentences were obtained.



Further, the speech samples of the case, along with the same word or sentence spoken by the normal subject were presented to judges, who were post-graduate students of Speech Pathology. The judges were requested to listen to these samples and to describe the articulatory, prosodic and phonatory aspects of each speech sample using the list of characteristics of speech provided. The list consisted of the following speech characteristics :

1. Imprecise consonants
2. Irregular articulatory breakdown
3. Distorted vowels
4. Excess and equal stress
5. Prolonged phonemes
6. Prolonged intervals
7. Slow rate
8. Mono-pitch
9. Mono-loudness
10. Harsh voice

An attempt has been made to find correlation between perceptual descriptions of the speech samples given by the judges and the acoustic characteristics of speech samples depicted by the spectrograms.

The judges considered that these speech samples spoken by the case are prolonged or dragging.

The duration of the words of both the speech samples are determined using the spectrographs. Table-1 shows the duration of each word as spoken by the case and the normal subject.

TABLE 1

Duration of Words

Words	Normal	Abnormal
Kashmir	0.4 Secs	0.94 Secs
State	0.19 Secs	0. 5 Secs
Beautiful	0,59 Secs	USSecs
Ancestors	0.91 Secs	2.02 Secs
Mountain	0.52 Secs	0. 9 Secs
Maharaja	0.64 Secs	1.83 Secs

The study of the table reveals that almost all the words spoken by the case are of longer duration when compared to the normals, i.e., the words spoken by the case are prolonged almost twice in terms of duration. This observation is in support of the findings reported by Darley *et al.* (1969), i.e., prolonged phonemes, a part of the cluster of prosodic excess.

Further, comparison of duration of sentences is made, which is shown in Table-2.

TABLE 2

Duration of Sentences

Sentence 1 : Mountain tops and snow
Normal : 2.09 Sees
Abnormal : 2.28 Sees

Duration of each word in the sentence

Words	Normal	Abnormal
Mountain	0.00—0.28=0.28 Secs	0.00—0.74=0.74 Secs
Tops	0.45—-0.95=0.5 Secs	1.02—1.36=0.34 Secs
And	1.45—1.64=0.19 Secs	0.3 Secs
Snow	1.67—2.09=0.42 Secs	0.48 Secs

The earlier findings of cluster of proscdic excess (prolonged phenemes, prolonged intervals and slow rate) are confirmed i.e., the case has taken a lenger duration to speak each sentence when compared to the normal subject. This also indicates the slowness of articulately movements and prolonged intervals between the words in a sentence and between the syllables in a word.

Sentence 2 : ' I don't know'
Normal : 0.72 Secs

Abnormal : 1.38 Secs

Words	Normal	Abnormal
I	0.14 Secs	0.24 Secs
Don't	0.18 Secs	0.29 Secs
Know	0.26 Secs	0.72 Secs

Sentence 3 : ' Between India and Pakistan'
Normal : 1.02 Secs.
Abnormal : 4.20 Secs

Words	Normal	Abnormal
Between	0.31 Secs	0.77 Secs
India	0. 4 Secs	0.63 Secs
And	0. 1 Secs	0.55 Secs
Pakistan	0. 5 Secs	1.36 Secs

Sentence 4 ; ' He joined Pakistan
Normal 1.34 Secs
Abnormal : 2.13 Secs

Words	Normal	Abnormal
He	0.15 Secs	0.25 Secs
Joined	0.32 Secs	0.61 Secs
Pakistan	0.54 Secs	1.23 Secs

The judgement regarding the articulatory behaviour reveals that the consonants are imprecise or distorted, there is irregular articulatory breakdown, and they have also considered vowels as abnormal, in the speech samples of the case presented.

The spectrographic analysis also indicated distortion or omission of consonants, abnormal intervals between syllables and distorted vowels, which are indicated by the presence of imprecise or weak release of stop sounds and not too clear formant frequencies with noise components in the vowels, when compared to the speech samples of the normal subject.

The study of average amplitude curves of the words and sentences show equal stress on each syllable in the speech samples of the case and variations in terms of intensity on each syllable in the sample of the normal subject. This can be made out from the sample spectrograms given. The judges indicated that there is excess stress in the speech sample of the case. However, this is not indicated when the average amplitude curves of the case and the normal are compared.

The voice of the case was considered to be harsh or hearse by the judges. This is further confirmed by the spectrographic analysis of speech samples of the case which is indicated by the presence of noise components.

Thus, it is possible to find a correlation between the perceptual description and acoustic characteristics of speech, in the speech sample of the case.

This case has shown most of the deviant dimensions which have been classicfied under 3 major clusters, i.e., of articulatory inaccuracy, cluster of prosodic excess and cluster of phonatory-proscdic insufficiency (Darley *et al.,* 1969), clinically, these dimensions seem to be useful in describing the speech behaviour.

Studies of this nature would help in better understanding of speech physiology normal and abnormal as pointed by Leburn *et al.* (1973).

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