MULTIDIMENSIONAL SPEECH NATURALNESS SCALE FOR STUTTERERS

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To

My Dearest Parents
whose unconditional love ,
watchful eyes and constant
encouragement made me
the person I am today .

CERTIFICATE

This is to certify that the dissertation entitled Multidimensional Speech Naturalness Scale for Stutterers is a bonafide work done in part fulfillment for the degree of Master of Science (Speech and Hearing) of the student with Reg. No. 9516

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DECLARATION

I hereby declare that the Dissertation entitled Multidimensional Speech Naturalness Scale for Stutterers is the result of my wn study under the guidance of Dr. S.R Savithri, Reader, Department of Speech Sciences, 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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CHAPTER I

INTRODUCTION

Stuttering is a complex speech disorder with a variety of dimensions. It can effect not only a person's speech fluency but also many aspects of interpersonal communication and functioning in the environment . A stutterer's speech is judged as normal, or unnatural compared to the speech of non-stutterers (Franken , 1980). A question arises as to wether dysfluencies are the only cause of lack of normalcy or naturalness . Wendahl and Cole (1961) concluded that the speech of stutterers from which obvious dysfluencies had been removed could be easily differentiated from the speech of non-stutterers i.e. normalcy or naturalness of speech is determined by different factors and not just dysfluency. Thus , stuttering remediations should seek to ameliorate the various dimensions of the problem and not just speech fluency. As it is defined by Speech Foundation of America (1960) , the ultimate aim of therapy should be to restore or increase the stutterers ability to speak in any situation.

Onslow and Ingham (1987) classified the present array of behaviourlly oriented treatments for stuttering into two broad categories of procedures . The first category contains treatment procedures that do not intentionally alter

only response - contingent arrangements to modify stuttering frequency (Martin , Kuhl, and Haroldson , 1972 ; Costello , 1975 ; Peters , 1977 ; Reed and Godden , 1977 ; James 1981) . The second category includes a wide variety of treatments that deliberately alter the stutterer's overall speech pattern in order to reduce stuttering . This category includes a wide variety of treatments that induce stutterers to use an unusual manner of speaking , which may then be systematically shaped into relatively normal sounding speech .Procedures under this category include those that rely on rhythmic speech and those that have been described as " prolonged speech" and its variants (Ingham, 1984).

Such treatment programs usually aim at reducing stuttering frequency and an appropriate speech rate. Also , It is usually implied that these treatments aim at procuring normal sounding speech. But absence of a clinically viable method for measuring speech quality has meant that there is little evidence that this goal is ever achieved. Desirable stuttering treatment should produce speech sounding normal and spontaneous to listeners and have speech that does not contain residual elements of slowness , monotony or stereotype (Bloodstein , 1981).

The acceptable speech quality in stuttering therapy have wider implications for treatment outcome . For instance it is quite clear that poor therapy outcome is a predictable by product of any treatment that produce unsatisfactory speech quality . Stutterers undergone such treatment may fail to

generalise and maintain therapy gains largely because they are disinclined to use unnatural sounding speech . Similar effects may also occur if those therapy gains require the speaker to maintain an unusual amount of effort in order to retain this dubious fluency .

Speech naturalness in treated stutterers has drawn researchers' attention in recent years , possibly because therapeutic approaches are focused mainly on changing the manner in which stutterers produce speech . Such information could be valuable for the evaluation of the fluent speech of treated stutterers and has possible application for measuring therapeutic progress and determining dismissal criteria .

A number of previous perceptual studies have focused on methods differentiating between the speech of stutterers and non-stutterers (Jones and Azrin , 1969 ; Runyan , 1976 ; Ingham and Packman 1978 ; Runyan and Adams 1978 , 1979 ; Runyan , Homes and Prosek 1982 ; Runyan and Prosek , 1983). These findings suggested that speech samples of treated stutterers can be differentiated from those of non-stutterers .

However , these studies did not propose any matric for such measure . Martin , Haroldson and Triden (1984) developed and tested a 9-point speech naturalness rating scale . Applying the scale , they found that speech samples of stutterers were judged as sounding more unnatural than those produced by non-stutterers . In another study , Ingham , Martin , Haroldson , Onslow and Leney (1985) found that clinicians were able to distinguish the speech quality

of treated stutterers even when the same stutterer could not be identified using stutterer - non-stutterer judgements . Subsequently a number of studies were conducted using sophisticated and unsophisticated listeners judgement (Onslow , Hayes , Hutchins , and Newmann , 1992) and for different speech tasks (Matz, et al,1990 ; Onslow et al., 1992) revealing significant findings .

However , with the exception of some very preliminary studies (Ingham , Montogomery and Ulliana , 1983 ; Angello , 1987) no serious attempt has been made to identify the necessary parameters in this speech pattern (prolonged speech) or to determine their role or potential in producing normal sounding stutter - free speech . There is a need to determine the parameters that are essential to judge the speech naturalness . In this context the present study was planned . The aim of study was to develop a speech naturalness scale based on different speech parameters contributing for speech naturalness . This naturalness scale can be used to monitor speech quality before and after the treatment . Further , having a common naturalness scale would be beneficial in comparing the efficiency of various therapies .

CHAPTER II

REVIEW OF LITERATURE

Though the study of Speech Naturalness is recent , concern regarding the speech quality of the stutterer's speech following therapy began much earlier.

Parrish (1951) may have been first to argue that *the concept of naturalness* is at the heart of many notions about desirable speech behaviour . He also highlighted the importance of distinguishing between a speaker's judgement of natural speech production and a listener's judgement of natural sounding speech . The first serious attempt to measure listener judged speech naturalness occurred in a study by Nichols (1966) . Nichols had 20 listeners rate seperately written and spoken sentences from normal speakers for levels of naturalness using a 9 - point scale that merely specified 1 as high naturalness and 9 as low naturalness . The main finding was that sentence vocabulary level appeared to influence the level of naturalness ratings . However , the individual naturalness ratings proved to be rather unreliable (although the group ratings had better reliability) , which may explain why this was not taken further for normal communication research . Nevertheless , naturalness ratings were susequently used for synthesized speech (Gramlich , and Levine 1981) , voice quality of dysphonics (Stoicheff, Ciampi , Passi , and Fredrickson , 1983 ; Blaugrund , 1984) and dysarthric speech (Wolfe , 1984).

The first investigation in this aspect in stuttering was carried out by Jones and Azrin (1969). They measured the effect of various durations of vibrotactile rhythmic signal on stuttering. A group of listeners were asked to judge speech samples obtained from four stutterers as natural or unnatural . It emerged that the highest percentage of judges scoring speech as natural was related to the speech that contained stuttrering while stuttering free speech samples received relatively few natural judgements i.e listeners regarded rhythmic speech with the stuttering as more natural sounding than stuttering - free rhythmic speech .

Ingham and Andrews (1971) compared different categories of residual stuttering that remained in the later part of intensive treatment programmes using either rhythmic or prolonged speech . Measures were made on the frequency of stuttering that occured within these categories , rather than the speech quality per se . Although it was found that more stuttering remained following therapy using prolongation , *the study failed to determine which speech quality was regarded to be superior.*

Hallard (1979) recorded preference order for stuttered speech syllable timed speech at 70 words per minute (wpm) and syllable timed speech at 100 wpm as produced by three stutterers . The listeners showed a clear preference for syllable timed speech in two subjects but their preference was reversed for the other subject. Also, all of them prefered the 100 wpm

speech over the 70 wpm speech . This study implies that *speech rate does not influence judgements.*

These were the only investigations on the speech quality of stutterers during rhythmic stimulation conditions . Following this , the other attempts to evaluate treated stutterers' speech quality emerged from investigations that used prolonged speech or its variants .

Perkins, Rudas, Johnson, Micheal and Curlee (1974) studied stuttering frequency , speech rate and listener judgement on three , four point rating scales. These scales which prescribed normal and abnormal at each extreme were used to record judgements of either fluency , prosody or speaking rate from one minute samples of the subjects speech . *A variability in the speech quality rating with respect to the treatment used was found.*

The solution to the problem of selecting an appropriate control in perceptual analysis is to use some type of pre test for selecting normaly fluent speakers . Under this strategy Frayne , Coates and Marriner (1977) employed a perceptual analysis technique to investigate the speech quality of stutterers who had been treated by a prolonged speech procedure. 27 listeners were provided with two different recordings containing speech samples of stutter-, free speech from 10 treated stutterers (6 - 18) months following therapy) and similar samples from 10 controls . For the first recording , listeners were asked to judge the speaker as normal or abnormal and make a rating for speech rate and smoothness on a 9 - point scale . Then the listener

were given different speech samples of the stutterers and rate each sample for normality , hesitation and intonation on a 9 - point scale . Results showed that their listeners generally failed to distinguish between the samples from the stutterers and non - stutterers , although the range of smoothness ratings for stutterers was greater than for non stutterers. These positive findings were attributed to two factors (a) The listener were never asked to judge whether these samples were from a stutterer or non - stutterer and (b) Listeners heard relatively short speech samples. *This was one of the first studies that used the 9-point rating scale. Although this was not used for the rating of naturalness per se in this study , it found a great deal of popularity in later studies of speech naturalness.*

Ingham and Packman (1978) used 9 non - stutterers and 9 stutterers who were stutter free after completing the initial phases of a prolonged speech treatment program as their subjects . Three different groups of listeners used the fluency , prosody and rating devised by Perkins et al . , (1974) and the natural / unnatural judgement system used by Jones and Azrin (1969) . Their results indicated that listeners failed to distinguish between the stutterers and non - stutterers samples . However , when ten other listeners were asked to make a dichotomous (stutter or normal) judgement , the judgement did distinguish between the stutterer's and non - stutterrer's samples *Although the stutterer's post - treatment speech was judged to be normal in terms of prosody , fluency , rate and naturalness , it did still retain certain identifying features.*

Also as part of their study , Ingham and Packman (1978), paired the treated stutterers speech sample with a sample from a non - stutterering speaker . Listeners were asked to choose which sample was from a treated stutterer . But this procedure has its limitation as it fails to quantify normalcy or indicate how much normalcy exists in a stutterers speech. (Jacono , 1984).

Runyan and Adams (1978 , 1979) used forced choice perceptual analysis procedure in their investigation of the speech quality of successfully treated stutterers . These stutterers were treated using different therapy techniques - Van Riperian , metronome , conditioned speech retraining , delayed auditory feedback , Operant conditioning , precision fluency shaping or holistic therapy . Stutter free speech samples from these subjects and non - stuttering speech samples were used . The sophisticated (Runyan and Adams, 1978) and unsophisticated (Runyan and Adams, 1979) listeners were asked to choose partially treated or treated stutterers. They were able to distinguish between the two groups at better than chance level of accuracy. However, the unsophisticated listeners were unable to distinguish between the Van - Riper method treated stutterers from normals. Runyan,Hames and Prosek (1982) later showed that the general findings of Runyan and Adams (1978,1979) were the same regardless of whether listeners heard paired samples (stutterer and non-stutterer) or randomly presented samples. However, it has limited practical value in a clinical setting and the nature of difference was not revealed.

In a similar study, Florence and Shames (1980) asked 19 listeners to judge the orgin of 15 second samples from 32 non-stutterers and 32 stutterers at various phases of the Florence and Shames (1980) therapy program . They found that similar number of listeners judged the non-stutterers and the stutterers (at the time of termination) samples to have come from stutterers. Thus, it was presumed that stutterers achieved essentially normal speech. However, the mere fact that the listeners made relatively few stutterer judgements is not sufficient reason to claim that the stutterers (or the non-stutterers) had achieved normal sounding speech.

In all the above mentioned studies, observers were not required to scale and quantify their perceptions of speech naturalness.However, if speech naturalness was to be used clinically, it was realised that it must be determined emperically whether speech naturalness is a useful and scalable phenomenon. Scaling naturalness should provide a means for differentiating, in terms of numerical scale values, between both groups and individuals. The procedure should provide for differentiation in terms of numerical scale values among various stages or phases of treatment. It was with this in mind that the first "naturalness" study was conducted .

Before reviewing the recent studies on speech naturalness, the earlier studies will be analysed briefly. The methodological considerations of these studies varies greatly. They ranged from identifying stutterer's speech,classifying speech as normal or abnormal to the presently used 9 -

point rating scale. Also, the aspects studied varied from rate, severity, intonation to nasality. While the results of some studies revealed no difference between samples of stutterers and non- stutterers, some did find these differences.

STUDIES ON SPEECH NATURALNESS

The word 'natural' does bring to mind a number of words associated with it, including the word 'normal' . While it is easy for one to define what is refered to as 'normal' , 'natural' is a much more difficult entity to define. This could be attributed to wide variations in the so-called normal speech and the wide variety of the listener types, exposure and tolerances . It is probably this that has caused all reasearchers to refrain from defining this term in their studies.

As already mentioned, prior to the study by Martin, Haroldson , and Triden (1984), there were many varied metodologies used to study naturalness. However, following their study , they managed to prove the reliability, validity and consistency of the 9- point rating scale used by them . Following this, most other studies have incorporated the methodology of not defining naturalness and using the 9- point rating scale.

In their study Martin, Haroldson , and Triden (1984) used 10 stutterers speaking under 250 ms delayed auditory feedback and 10 non-stutterers. 30 unsophisticated listeners were used as the judges. Results of this study indicated that the stutterering samples were judged as sounding significantly

more unnatural than the non-stutterer samples. The DAF stutter-free samples were also judged as sounding significantly more unnatural than the non-stutterers' samples. The stutterer's and DAF stutter - free samples were not judged as sounding significantly different in terms of speech naturalness . Such results were also replicated by Ingham , Gow , and Costello (1985); Ingham , Onslow and Finn (1989); Runyan , Bell , and Prosek (1990); Onslow , Hayes , Hutchins and Newman (1992) , Martin and Haroldson (1992) . In each of these it was found that the post - therapeutic stutterer's speech was significantly more unnatural than the non-stutterer's speech . Studies by Ingham, Costello, Onslow , and Finn (1989) ; Runyan , Bell , and Prosek (1990); Onslow et al., (1992) have also indicated that the pre-therapy speech sounded more unnatural than the speech sample obtained post - therapeutically.

LISTENER TYPES

Studies on naturalness have been carried incorporating both sophisticated and unsophisticated listeners Martin et al ., (1984) in the first study used unsophisticated listeners . They found the inter rater relaibility, inter rater agreement and rater consistency for judging speech naturalness to be satisfactory. Ingham , Gow and Costello (1985), Martin and Haroldson (1992) also were among others who incorporated unsophisticated listeners in their respective studies. They reported high degree of reliability, consistency and agreement in their judges.

Most studies incorporating sophisticated listeners are those which include treatment of the stutterers i.e. , providing naturalness ratings during the treatment phase to check for variation and treatment effects (0ngham et al . , 1989 ; Onslow and Ingham 1985 ; Runyan et al . , 1990) . However , Onslow, Adams and Ingham (1992) evaluated sophisticated and unsophisticated listeners who judged on a 9- point scale , the speech naturalness of speech samples from 10 stutterers enrolled in a treatment program incorporating prolonged speech . The ratings were made by different groups of judges at 15 second , 30 second and 60 second intervals. Interclass correlation was found to be significantly higher for the sophisticated judges , although the consistancy and agreement of unsophisticated judges was generally equivalent to that of sophisticated judges . Also , 60 second interval proved better in terms of agreement scores and interclass correlations when compared to 30 second intervals.

While studies utilised spontaneous speech samples (Martin et al ., 1984 ; Ingham et al ., 1985 ; Ingham et al ., 1989 ; Runyan et al ., 1990 ; Onslow et al., 1992 ; Martin and Haroldson 1992) . Onslow , Hayes , Hutchins and Newman (1992) studied the naturalness ratings given to monologues and consersations. The results indicated that the naturalness ratings obtained were similar regardless of the sample used.

STUTTERING SEVERITY AND SPEECH NATURALNESS

It is also reasonable to assume that there will be some relation between the pre-treatment stuttering severity and post-treatment speech quality. Clients with a severe problem may need to use a more exaggerated (less natural sounding) post treatment speech in order to eliminate stuttering . In Runyan and Adams (1978) study, cases of "severe" pre - treatment stuttering were easiest for the listeners to distinguish from non- stutterers, 'moderate' clients the next easiest to distinguish from non - stutterers and 'mild' the most difficult. Onslow et al., (1992) also found significant positive correlation between pre - treatment speech measures and measures of speech naturalness made after the establishment of stutter - free speech. The subjects whose pre - treatment stutterering was the most severe had post - treatment scores that were more than two scale values worse than the subjects whose pre -treatment stutterering was least severe. Ingham and Onslow , 1985 found that the subjects who ended therapy with the most natural speech were found to have least 'percent syllable stuttered' prior to initiation of therapy .

However, Runyan, Bell and Prosek (1990) found no difference in the post - treatment naturalness ratings of stutterers rated as mild, moderate and severe before treatment . The reasons for this variation have been attributed to reduced duration of speech samples, variety of therapy techniques used and the nominal categories for measuring pre-treatment severity (Onslow et al., 1992).

Martin and Haroldson (1992) also found that when judges were asked to rate severity of stuttering and naturalness ; samples judged as high severity were also judged as unnatural. Also, a high correlation was found to exist between mean speech naturalness and the percentage of words stuttered and the number of words in the sample .

The only study where in the rate of speech was systematically analysed was Ingham and Onslow (1985) . They found a reciprocal relationship between the increase in the subject's syllable per minute (spm) scores and naturalness ratings. Also, subjects with highest spm prior to the initiation of therapy ended therapy with the highest naturalness scores. Ingham et al ., (1984) found that only some ratings made by their listeners were influenced by the stuttering frequency and rate of speech .

THERAPEUTIC CHANGES

Perceptual analysis procedures have also been used to investigate changes in speech quality that may occure as a result of other treatment techniques. In an earlier study , Williamson , Epstein and Colburn (1981) evaluated speech quality on regulated breathing treatment by a social validation procedure in which 30 listeners were asked to rate their subjects speech sample on different scales . Their ratings indicated that as the subjects speech improved , the listeners desire to interact with them and their " global social impression" of the subject also improved . However, the scores also implied that they may not have judged subjects speech to be completely acceptable .

Although the social validation procedure has some merit , these dimentions may not always refer to the speech quality.

Ingham , Martin , Haroldson , Onslow and Leney (1985) were among the first to systematically study the effect of regular feedback to the stutterer undergoing treatment in terms of his naturalness rating on a 9-point scale. The results indicated that naturalness ratings and stuttering changed favorably for five out of six . Ingham and Onslow , (^SS^have indicated the change in naturalness ratings across the treatment phase of 5 adolescent stutterers . They found that in the first phase of therapy , when prolonged speech and shaping occurs , the subjects speech is initially extremely unnatural sounding and gradually becomes more natural as the speech rate is systamatically increased . This improvement continued until the stage of transfer phase although the individual rates of improvement of each stutterer varied . They also found that by providing feedback to the stutterer , the speech naturalness could be modified towards a target level of speech naturalness .

Ingham et al .,(l989)also evaluated the effects of specific instructions to stutterers to rate and modify how natural their speech sounds on experimenters' rating of speech naturalness , stuttering frequency and speaking rate . This study too indicated that stutterers could modify their speech to increase or decrease the naturalness ratings . These changes were found to be independent of stuttering frequency or speaking rate . Measures or ratings of how natural speech " sounded" and "felt" varied in one subject.

Runyan , Bell and Prosek (1990) compared the speech naturalness ratings of perceptually fluent speech samples produced by non-stutterers and stutterers who had been treated in different therapy programs . No significant difference was reported in the naturalness ratings depending upon the type of treatment used . Martin and Haraldson (1992) incorporated the use of unsophisticated listeners and the 9-point rating scale to judge separate audio only and audio visual presentations of stutterers and non stutteres samples . They found that the stutterers were judged more unnatural on the audio visual presentation when compared to the audio presentation . However , the magnitude of this difference was quite small.

Kalinowski, Stuart, Sark and Armson (1996) following their study on feedback delays conclude that alterations in speech motor strategies which enhance fluency usually have an adverse effect on speech naturalness ie, speech produced by concious alteration of the motor plan is percieved to sound unnatural . However , they found that fluent speech produced under altered auditory feedback is judged as sounding natural - both by subjects and the experimenter's involved .

These studies indicate the need for rating the speech naturalness of stutterers as a means of feedback for improving their speech as well as to identify the efficacy of therapy which aids in the termination of therapy. While these studies have used the term 'Naturalness' it has not been defined . It

would be better if the parameters of naturalness are specified so that the client can be directed to improve on a particular parameter . In this context the present study aims at developing a naturalness scale with specified parameters and rating the speech naturalness of stutterers using the scale.

CHAPTER III

METHODOLOGY

I. PILOT STUDY

A pilot study was conducted with the following methodology

SUBJECTS

20 stutterers in the age range of 12 to 29 years and three normals in the age range of 18 to 21 served as subjects. Table-1 shows the age and sex distribution of the subjects.

	Stutterers		Normals	
Age range	Males	Females	Males	Females
10 to 20 Years.	9	1	1	1
20 to 30 Years.	10	-		- 1
Total	19	1	1	2

Table-1 : Subject details

MATERIAL

The spontaneous speech of 20 stutterers before and after therapy were audiorecorded. Of these samples, thirteen pre-therapy and thirteen post-therapy samples were dubbed onto another cassette. Of the thirteen pre-therapy samples, two samples were repeated to check for reliability. Also, samples from three normal subjects were dubbed to this cassette. These 29 samples were randomized and audiorecorded , which formed the material.

METHOD

These samples were audio presented to three sophisticated (Post-graduates in Speech and Hearing) listeners and three unsophisticated listeners (unrelated to the field of Speech and Hearing) in the age range of 19 to 23 years They were instructed to rate the samples from one (highly natural) to nine (highly unnatural) (Appendix - A) . The definition of "naturalness" was not provided to any of the listeners. All the sophisticated listeners were to judge the samples again after a period of two or more days. This was done to check the reliability.

ANALYSIS

I . Percent dysfluency : Verbatim transcription of each sample was prepared and each stuttering event was marked. The percent dysfluency was calculated using the following formula :

$$\text{Percent dysfluency} = \frac{\text{Total number of stuttering}}{\text{Total number of words}} \times 100$$

II. **Rate of Speech :** The total time of each speech sample was calculated using a stop watch. The rate of speech was found in words per minute using the following formula :

$$\text{Rate of Speech} = \frac{\text{Total number of words}}{\text{Total time taken (in seconds)}} \times 60$$

III. **Mean Naturalness Scores (MNS)** : The ratings given by each of the listeners were used to compute the mean naturalness score for each sample

(separately for sophisticated and unsophisticated listeners). This was calculated using the following formula

$$MNS = \frac{MNS_1 + MNS_2 + MNS_3 + \ldots\ldots MNS_N}{N}$$

Where MNS_1, MNS_2, etc., are the ratings given by different listeners for a single sample and N is the total number of sophisticated /unsophisticated listeners who judged the sample.

III **. STATISTICS :** To examine the significant difference between the MNS of sophisticated and unsophisticated listeners 'T' test was carried out. Using product-moment coefficient of correlation, the correlation between mean naturalness scores and percent dysfluency , rate of speech and the reliability in the rerating task was calculated .

II **MAIN STUDY**

The results of the pilot study indicated that the 9 - point scale was unstable and 2 -point scale could be more beneficial . The main study was conducted in two parts. Part I involved development of speech naturalness scale and Part II consisted of naturalness ratings of speech samples on specified parametres by sophisticated judges.

PART I. DEVELOPMENT OF SPEECH NATURALNESS SCALE

SUBJECTS

The subjects in this part of the study were 60 Post - Graduate normal students in the age range of 20 to 23 years from the field of Speech and

Hearing (Graduate students from the University of Mysore and University of Mangalore).

METHOD

The subjects were provided with a response - sheet (Appendix B) They were instructed to write the parameters that they think contribute to the naturalness / unnaturalness of speech. An introduction was given by the experimenter regarding the task. No information was provided regarding the naturalness or unnaturalness aspect of speech.

ANALYSIS

Responses were tabulated and analyzed in terms of the parameters considered by the subjects for the naturalness of speech. The percent times the parameters indicated naturalness was calculated by the following formula.

$$\%\ \text{a parameter indicated naturalness} = \frac{\text{No. of subjects indicating the parameter}}{\text{Total No. of subjects}} \times 100$$

All the parameters were ordered according to the percent weightage and only those parameters with a weightage of 20 % or more was considered in the naturalness scale.

NATURALNESS SCALE

The naturalness scale consisted of all the parameters with a weightage of 20 % or more and were arranged according to percentage weightage. It also included the overall naturalness rating. (Appendix -C)

PART II. RATINGS ON SPEECH NATURALNESS SCALE

MATERIAL

The material consisted of reading and spontaneous speech samples of 34 stutterers before and after therapy and also samples of seven normal subjects. Table 2 shows the details of the subjects.

	Stutterers		Normals	
Age range	Male	Female	Male	Female
10-20 Years	14	2	3	2
20 - 30 Years	17	1	-	2
Total	31	3	3	4

Table-2 : Subject details

Pre-therapy spontaneous speech and reading samples were recorded prior to therapy assignment and post-therapy spontaneous speech and reading samples were recorded at the time of termination of therapy. All the stutterers underwent fluency therapy with prolongation technique which included the learning of prolongation , transfer , maintenance and generalization phase. Speech therapy was terminated when stutter free speech was established outside clinic situation . Spontaneous speech samples consisted of narrations about their school / college , work schedule and for reading sample standardized reading passages (Kannada or Rainbow passage in English) were used . All the speech and reading samples were audio-recorded in the Speech Science lab of the All India Institute of Speech and Hearing. Among these speech samples , 32 were of pre-therapy , 29 post- therapy and 7 normal reading and spontaneous speech samples. They were randomized and spontaneous

speech and reading samples were separately audio recorded. 7 samples were repeated randomly in order to check intra judge reliability . Thus , the material consisted of two cassettes, viz : one with 68 one minute spontaneous speech samples and another with 68 one minute reading samples (7 normal, 32 pre-therapy , 29 post therapy samples). Each sample was preceded by a number.

SUBJECTS

Five post graduate (Speech and Hearing) students (two males and three females) in the age range of 21 to 23 years served as judges. All the subjects were experienced in the evaluation and therapy for stutterers and were familiar with Kannada and English languages.

METHOD

The subjects were tested individually. They were provided with a response sheet indicating various parameters for the speech naturalness scale (developed in Part-I of the study). They were to listen to each sample audio presented and were to rate the naturalness of the sample on each parameter on a binary scale with '1' representing natural and '0' representing unnatural. They were also to rate the overall naturalness of the sample. As the subjects had to rate 136 samples (68 reading and 68 spontaneous speech samples on various parameters), they were instructed to stop the task when they felt fatigued. Each subject rated the sample over a weeks time and they could hear the samples as many times as possible .

ANALYSIS

1. Percent dysfluency : Verbatim transcription of both the reading and spontaneous speech samples of stutterers before and after therapy was done. Percent dysfluency was calculated by the following formula :

$$\text{Percent dysfluency} = \frac{\text{Total number of stuttering}}{\text{Total number of words}} \times 100$$

2. Rate of Speech : The number of words uttered per minute were calculated by the following formula :

$$\text{Rate of Speech} = \frac{\text{Total number of words}}{\text{Total time taken (in seconds)}} \times 60$$

3. Statistical Analysis : The subjects' ratings were tabulated seperately and were grouped for normal, pre-therapy and post therapy samples of reading and spontaneous speech task. Naturalness Ratings given by each judge (for normal, pre-therapy and post-therapy samples) were caluculated in terms of percentage speech samples rated natural out of total number of speech samples under three groups :

$$\text{Judge's Naturalness Rating} = \frac{\text{No. of samples rated natural}}{\text{Total No. of samples in group}} \times 100$$

Mean Naturalness Scores (MNS) were caluculated from the percentage naturalness ratings given by five judges :

$$\text{Mean naturalness scores} = \frac{\text{Sum of naturalness ratings of judges}}{\text{No. of judges}}$$

'T' test was done to find out the significance of difference between the means of the naturalness judgement for (1) reading and speech task (2) various parameters (3) normal, pre-therapy and post-therapy samples for both reading as well as for spontaneous speech task.

Pearson's correlation was calculated to find out the correlation between overall ratings and other parameters as well as for the relationship between mean naturalness score and percent dysfluency and rate of speech , and also , correlation between overall MNS and MNS for the parameter of rate and continuity . A factor analysis was performed to find the parameters of importance for naturalness ratings for both tasks . Inter judge reliability was calculated using phi-coefficient and Spearman's rank correlation method was used to caluculate intra - judge reliability.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS

I. PILOT STUDY

Mean Naturalness scores

The MNS obtained from the ratings of sophisticated and unsophisticated judges are shown in Table-3 .

		Sophisticated	Unsophisticated
Normal	Mean	3.08	3.55
	Range	1 to 4.5	2 to 5
Pre-therapy	Mean	5.52	4.97
	Range	2 to 8.33	1.67 to 8.66
Post-therapy	Mean	4.64	4.66
	Range	2 to 7.33	2 to 9

Table-3 : Mean naturalness scores

The mean naturalness score was lowest for the normal speech followed by the ratings for post-therapy speech samples and a highly unnatural rating for pre-therapy samples. However, the range of variability in both pre-therapy and post-therapy overlap and range from 8 / 9 to 1 / 2. The results of the "T" test indicated a significant difference between the MNS of sophisticated and unsophisticated judges at 0.05 level . Also the correlation was high within

subjects (0.80, 0.77 and 0.87). Table-4 shows the rating by sophisticated judges.

	Normal		Pre-Therapy		Post-Therapy	
	1st Rating	Re-rating	1st Rating	Re-rating	1st Rating	Re-rating
S1	4	3.66	5.30	5.84	5.15	5.38
S2	2.33	2	7.15	6.53	5.69	6.15
S3	2.66	1.33	4.61	4.07	3.46	2.23

Table-4 : Rating by Sophisticated judges

Table-5 shows the MNS, percent dysfluency and rate of speech for all the subjects. The MNS is obtained for normal, pre-therapy and post-therapy samples by sophisticated and unsophisticated judges . Figure-1 has the graphical representation of MNS , percent dysfluency and rate of speech .

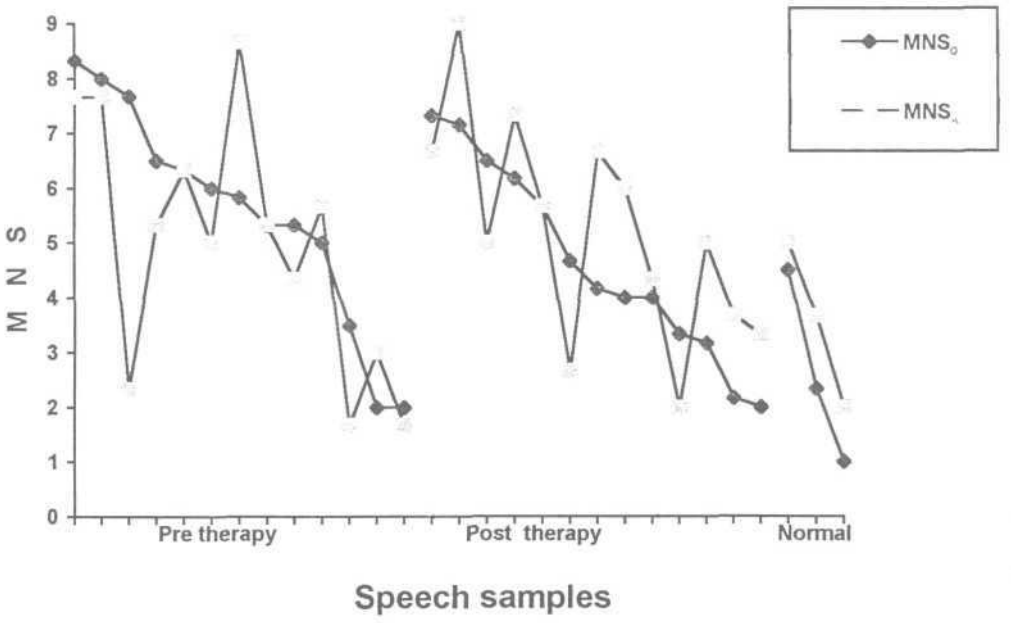

Figure - I : Mean Naturalness Scores of the Normal, Pre-therapy , Post-therapy speech samples .

Group	MNS (Soph .)	MNS (Unsoph .)	Percent dysfluency	Rate of speech
Normal	4.50	5.00	0.00	61.30
	2.33	3.66	0.00	95.00
	1.00	2.00	0.00	96.92
Pre-therapy	8.33	7.66	43.40	45.00
	8.00	7.66	21.00	49.00
	7.67	2.33	29.00	68.00
	6.50	5.33	50.00	40.00
	6.33	6.33	19.00	50.00
	6.00	5.00	18.00	59.00
	5.83	8.66	19.00	50.00
	5.33	5.33	0.00	59.00
	5.33	4.33	12.00	68.00
	5.00	5.67	2.00	58.00
	3.50	1.67	3.00	74.00
	2.00	3.00	2.27	120.00
	2.00	1.67	2.27	120.00
Post-therapy	7.33	6.67	14.00	39.00
	7.16	9.00	0.00	45.00
	6.50	5.00	6.00	64.00
	6.17	7.34	0.00	83.00
	5.67	5.67	0.00	64.00
	4.67	2.67	3.35	67.12
	4.16	6.67	0.00	54.00
	4.00	6.00	0.00	70.00
	4.00	4.33	0.00	84.00
	3.34	2.00	0.00	84.00
	3.17	5.00	0.00	96.00
	2.17	3.67	0.00	68.00
	2.00	3.33	18.00	59.00

Table - 5 : MNS , Percent dysfluency and Rate of speech

Soph . = Sophisticated
Unsoph . = Unsophisticated

Table - 6 shows correlation between MNS and percentage dysfluency which indicates that in the pre-therapeutic samples MNS appears to be directly correlated with percent dysfluency i.e., increase with percent dysfluency. This

correlation is stronger for the sophisticated judges than the unsophisticated ones.

	Pre-therapy	Post-therapy
Sophisticated	0.71	0.01
Unsophisticated	0.29	-0.15

Table - 6 : Correlation between MNS and Percent dysfluency

Table- 7 indicates a negative correlation between MNS and rate of speech i.e., MNS decrease as the rate of speech increase. Also, the correlation was high for the normal and pre-therapy speech samples for the sophisticated listeners.

	Normal	Pre-therapy	Post-therapy
Sophisticated	-0.97	-0.84	-0.47
Unsophisticated .	-0.85	-0.72	-0.43

Table- 7 : Correlation between MNS and rate of speech

DISCUSSION

The results of this pilot study reveal several points of interest. First of all, there was a difference between the naturalness ratings of the post therapeutic, pre-therapeutic stutterers and the non-stuttering population , and the pre-therapy samples were rated as highly unnatural. This is consistent with the result?of the other studies (Martin et al . , 1984; Ingham, Gow and Costello, 1985; Ingham et al 1989; Runyan, Bell and Prosek 1990). However the MNS difference between pre-therapy and post- therapy speech samples was not significant.

Second, there appeared to be significant difference between the MNS of sophisticated and unsophisticated judges . This is in contradiction to the results

of Onslow et al., (1992) . The lack of awareness of the problems, treatment options and outcomes in the area of stuttering may be an important factor in identifying the naturalness. Also to be considered is the definition of unsophisticated judges . While the present study included listeners totally unrelated to the field of Speech and Hearing, that of Onslow et al . , (1992) ; used first year under graduate students with atleast one course in Speech language pathology although without any exposure to stuttering per se.

Third, the MNS correlated with percent dysfluencies and rate of speech. In the pre-therapy samples , MNS directly correlated with percent dysfluencies i.e., MNS increased as percentage dysfluencies increased. However, the correlation between MNS and rate of speech was higher than that of MNS and percentage dysfluencies. While in the pre-therapy samples MNS and percent dysfluency had direct correlation, in the post-therapy samples MNS and rate of speech had negative correlation. In the pre-therapy samples judges appeared to consider both percentage of dysfluencies and rate for rating and in the post-therapy sample only rate was considered. Also, with respect to the type of judges , the unsophisticated judges appeared not to consider the percentage dysfluencies and rate was a better parameter for them. In general, unsophisticated judges performed poorly compared to sophisticated judges .

The higher correlation in sophisticated judges may be because a sophisticated judges are more sensitive to and less tolerant to the dysfluencies when compared to the unsophisticated judges .

Fourth, intra-judge reliability was good . However , there were extreme variations in the individual ratings of each sample. Also, the judges found the task long and difficult , reducing their concentration and interest in the task. On the basis of MNS it is not possible to distinguish pre-therapy and post-therapy samples. Therefore it appears that a two-point naturalness scale may be more appropriate than an unstable 9-point scale.

II MAIN STUDY

PART 1 . DEVELOPMENT OF SPEECH NATURALNESS SCALE

As described in the methodology , 60 post-graduate students were asked to list the parameters they think contribute to the naturalness / unnaturalness of speech . Table 8 shows percentage weightage given to each parameter contributing to naturalness of speech . Only those parameters with 20 % or more weightage are included in the table . Prolongation and silent practice which received a weightage of less than 20% were not considered .

Parameter	Percentage
Rate	80%
Stress	70%
Intonation	67%
Continuity	62%
Effort	52%
Articulation	29%
Abnormal Breathing Pattern	20%

Table - 8 : Percentage weightage given to each parameter for naturalness of speech.

Thus , the naturalness scale consisted of rate , stress , continuity , intonation , effort, articulation , abnormal breathing patterns and the overall naturalness as parameters .

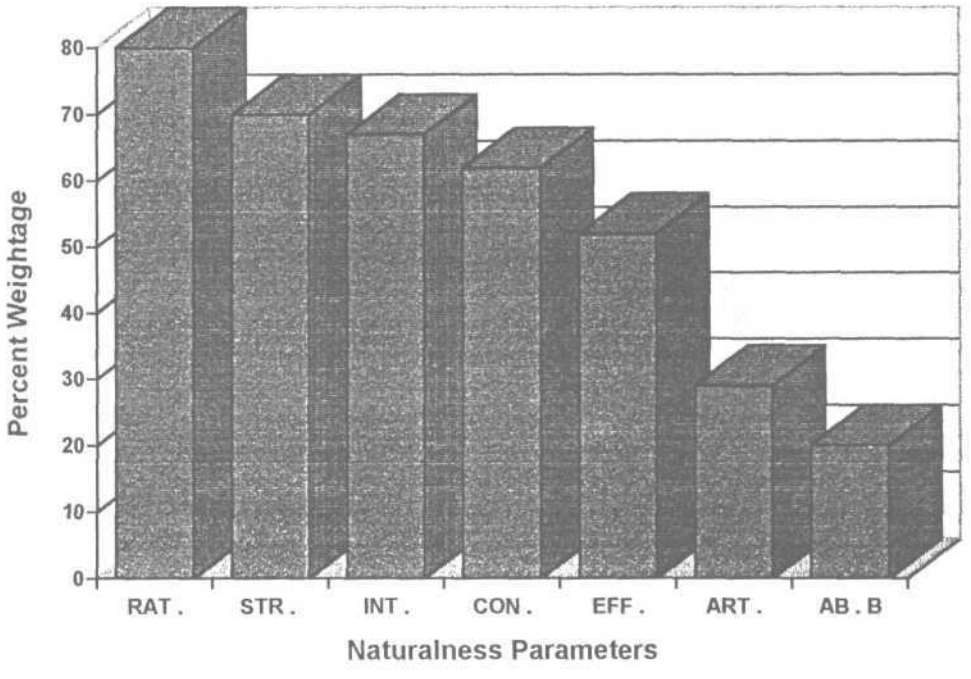

Figure - 2 : Percentage weightage given to each parameter for naturalness of speech

RAT . = RATE , STR . = STRESS , INT . = INTONATION , EFF . = EFFORT
CON . = CONTINUITY , ART . = ARTICULATION , AB . B = ABNORMAL BREATHING

PART. II

1. MEAN NATURALNESS SCORES (MNS)

Table - 9 shows the Mean Naturalness Scores (MNS) assigned for the reading and spontaneous speech tasks for all the three groups - normals , and pre-therapy and post-therapy stutterers . It was noticed that naturalness was rated high for the normals followed by speech of treated stutterers and it was least for speech in pre-therapy condition both for reading and spontaneous speech tasks. Also , spontaneous speech samples were rated being more natural sounding than the reading samples of the same speaker for all the three groups . 'T' test revealed a significant difference at 0.05 level between the spontaneous speech and reading in normals . However , no significant differenceswere found between the spontaneous speech and reading of stutterer before and after therapy. High correlation exist between the MNS of reading and spontaneous speech of the post-therapy speech . Figure - 3 shows the MNS for normals and stutterers .

Group	Mean naturalness scores		Pearsons Coefficient of correlation	Significant difference
	Reading	Spont. Speech		
Normal	80	94	0.17	+
Pre - therapy	41	50	0.02	-
Post - Therapy	46	52	0.86	-

Table - 9 : MNS of reading and spontaneous speech .

(+) = Significant difference present
(-) = Significant difference absent.

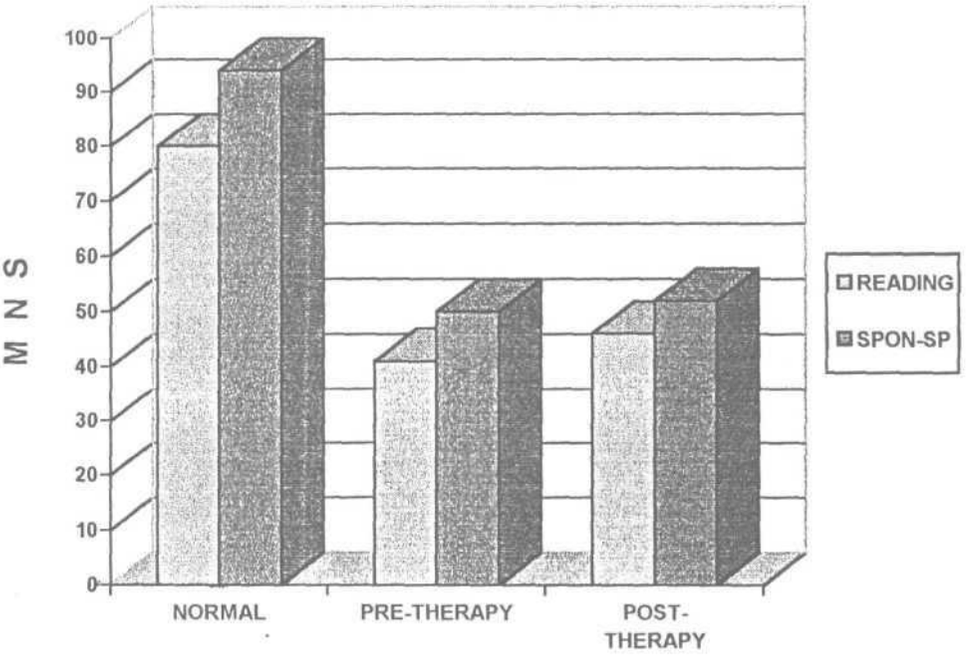

Figure - 3 : MNS of Reading and Spontaneous Speech

2. NATURALNESS RATINGS FOR VARIOUS PARAMETERS

As described in the methodology , the judges were required to rate the naturalness across various parameters . It was observed that, in normals, articulation and breathing pattern in reading and articulation and intonation in spontaneous speech received the highest naturalness scores and rate received the least naturalness scores. In spontaneous speech and reading of stutterers articulation and breathing pattern were rated as more natural and rate and continuity were rated as least natural . 'T' test indicated significant differences between normals and stutterer's across all the parameters except articulation in post-therapy spontaneous speech . High positive correlation exist between normals and stutterers (pre-therapy) rate and intonation in reading and rate, stress, intonation, breathing pattern and overall naturalness score in spontaneous speech. Table - 10 and Table - 11 show MNS for various parameters . Results indicated that listeners rated pre- therapy samples of stutterers as sounding significantaly more unnatural than that of the normal fluent speakers which is evident by the low naturalness scores for both the tasks .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Corclation	Significant Difference
	Normal	Pre-therapy		
Rate	64	48	0.98	+
Continuity	71	40	0.03	+
Effort	86	59	0.00	+
Stress	86	55	0.32	+
Intonation	74	56	0.65	+
Articulation	97	96	0.00	+
Breathing Pattern	94	85	0.00	+
Overall	80	41	0.42	+

Table - 10 : MNS of normals and stutterers (pre-therapy) for reading

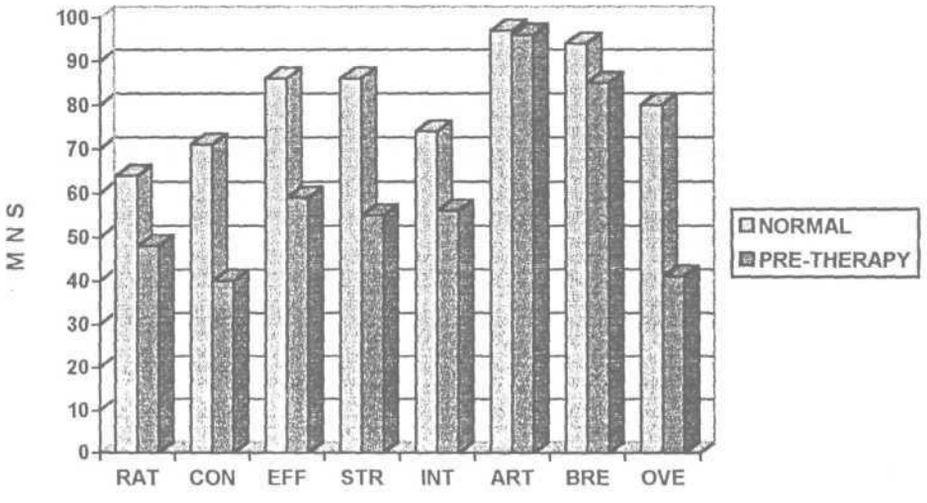

Figure-4 M N S of normals and stutterers (pre-therapy) for reading .

(+) = Significant difference present
(-) = Significant difference absent

RAT . = RATE , CON . = CONTINUITY , EFF . = EFFORT , STR . = STRESS ,
INT . = INTONATION . ART. = ARTICULATION , BRE . = BREATHING PATTERN ,
OVE . = OVERALL .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Correlation	Significant Difference
	Normal	Prc-therapy		
Rate	77	59	0.90	+
Continuity	91	29	0.21	+
Effort	100	61	0.00	+
Stress	97	76	0.89	+
Intonation	86	71	0.62	+
Articulation	100	100	0.00	-
Breathing Pattern	94	82	0.89	+
Overall	94	50	0.84	+

Table-11 : MNS of normals and stutterers (pre-therapy) for Spontaneous Speech .

(+) = Significant difference present
(-) = Significant difference absent

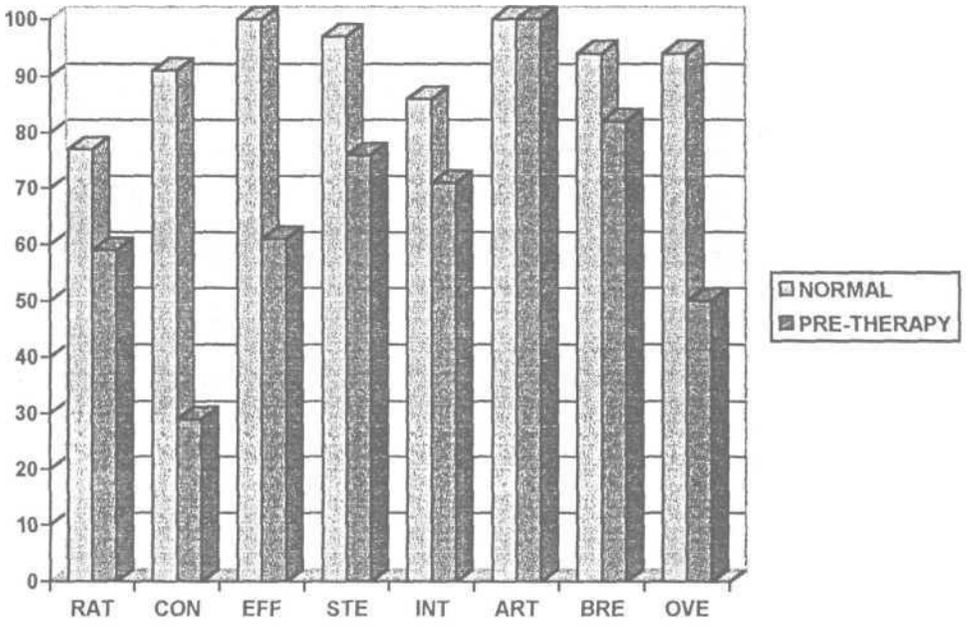

Figure - 5 M N S of normals and stutterers (pre-therapy) for spontaneous speech .

RAT . = RATE , CON . = CONTINUITY , EFF . = EFFORT , STR . = STRESS , INT . = INTONATION , ART. = ARTICULATION , BRE . = BREATHING PATTERN OVE . = OVERALL .

Of the various parameters, rate and continuity were judged to have the least naturalness in both the reading and the speech samples of the treated stutterers. Significant differences between the MNS of all the parameters of normals and treated stutterers (except for articulation in spontaneous speech) were observed. Table -12 and Table -13 show the MNS for various parameters in normals and treated stutterers .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Correlation	Significant Difference
	Normal	Post-therapy		
Rale	64	49	0.92	+
Continuity	71	49	0.93	+
Effort	86	57	0.40	+
Stress	86	61	0.69	+
Intonation	74	59	0.77	+
Articulation	97	93	0.70	+
Breathing Pattern	94	79	0.94	+
Overall	80	46	0.60	+

Table -12: MNS of normals and stutterers (post-therapy) for Reading.

(-) = Significant difference absent,
(+) = Significant difference present

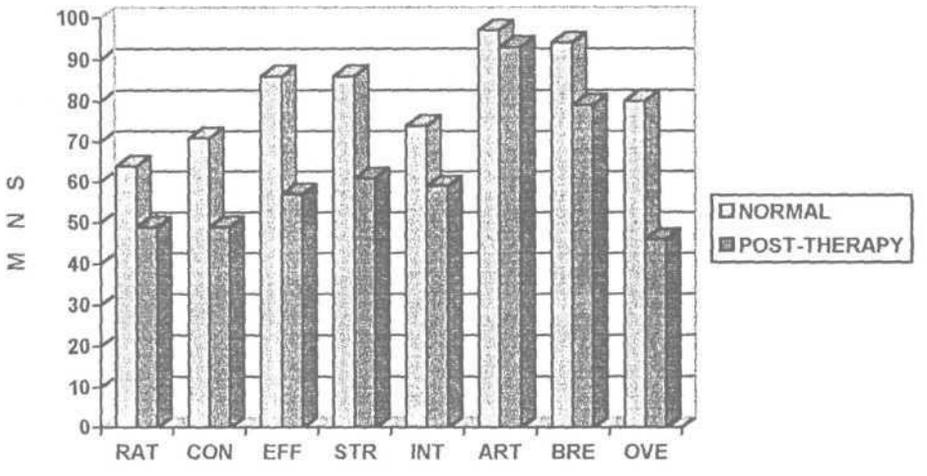

Figure - 6 M N S of normals and stutterers (post-therapy) for reading .

RAT . = RATE , CON . = CONTINUITY , EFF . = EFFORT , STR . = STRESS ,
INT . = INTONATION , ART. = ARTICULATION , BRE . = BREATHING PATTERN ,
OVE . = OVERALL .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Correlation	Significant Difference
	Normal	Post-therapy		
Rate	77	64	0.91	+
Continuity	91	48	0.00	+
Effort	100	76	0.00	+
Stress	97	79	0.98	+
Intonation	86	65	0.77	+
Articulation	100	100	0.00	-
Breathing Pattern	94	81	0.84	+
Overall	94	52	0.79	+

Table - 13 : MNS of normals and stutterers (post-therapy) for Spontaneous Speech.

(-) = Significant difference absent
(+) = Significant difference present

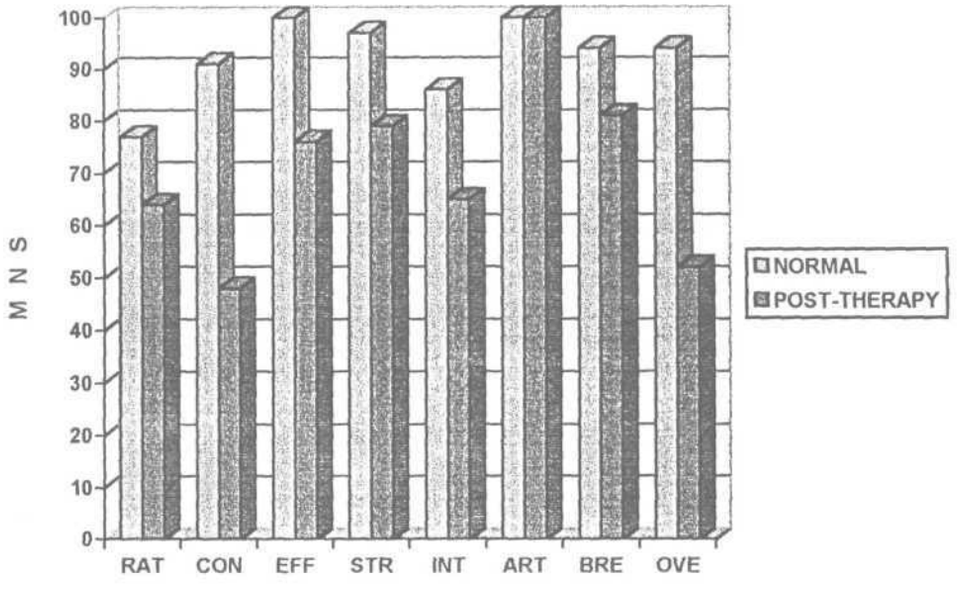

Figure - 7 M N S of normals and stutterers (post-therapy) for spontaneous speech.

RAT . = RATE , CON . = CONTINUITY , EFF . = EFFORT , STR . = STRESS , INT . = INTONATION , ART. = ARTICULATION , BRE . = BREATHING PATTERN , OVE . = OVERALL .

Table -14 Shows Mean Naturalness Scores assigned by the judges for the pre - therapy and post - therapy speech samples of stutterers for the reading

task. Results indicate no significant difference in the naturalness ratings of pre-therapy and post therapy reading at 0.05 level. However , Post-therapy speech samples were rated being more natural than pre-therapy samples of the same speakers across all the parameters except for articulation , effort and breathing pattern . In the spontaneous speech task , significant difference for the parameters continuity and effort were obsvered . Intonation , continuity and rate were the only parameters which were rated less natural in the post-therapy speech . Table 15 depicts the MNS of pre-therapy and post-therapy spontaneous speech .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Correlation	Significant Difference
	Prc-therapy	Post-therapy		
Rate	48	49	0.98	-
Continuity	40	49	0.91	-
Effort	59	57	0.71	-
Stress	55	61	0.94	-
Intonation	56	59	0.92	-
Articulation	96	93	0.77	-
Breathing Pattern	85	79	0.96	-
Overall	41	46	0.92	

Table - 14 : MNS of Pre-therapy and Post - therapy Reading .
(-) = Significant difference absent
(+) = Significant difference present

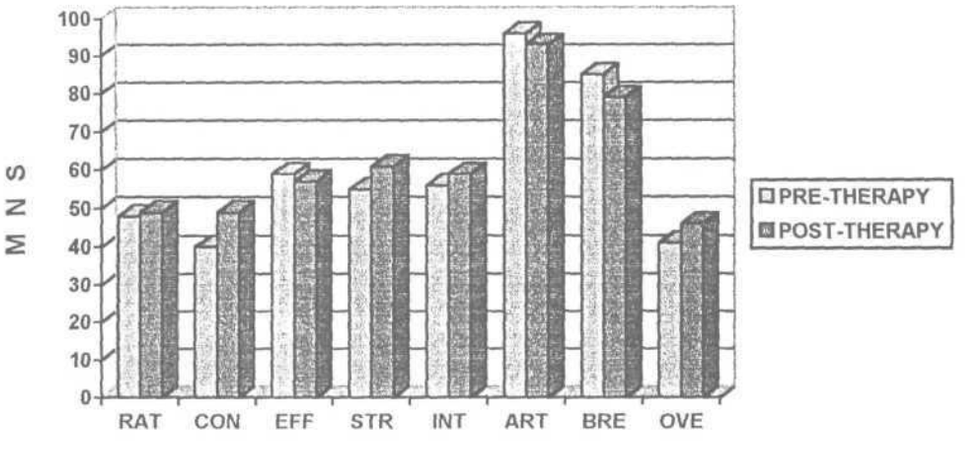

Figure - 8 M N S of pre-therapy and post-therapy reading .

RAT . = RATE , CON . = CONTINUITY , EFF . = EFFORT , STR . = STRESS , INT . = INTONATION , ART. = ARTICULATION , BRE . = BREATHING PATTERN , OVE . = OVERALL .

Parameter	Mean Naturalness Scores		Pearsons Coefficient of Correlation	Significant Difference
	Prc-therapy	Post-therapy		
Rate	59	64	0.95	
Continuity	29	48	0.86	+
Effort	61	76	0.85	+
Stress	76	79	0.94	-
Intonation	71	65	0.96	-
Articulation	100	100	0.00	-
Breathing Pattern	82	81	0.88	-
Overall	50	52	0.46	-

Table -15 : MNS of Pre-therapy and Post - therapy Spontaneous Speech .

(-) = Significant difference absent
(+) = Significant difference present

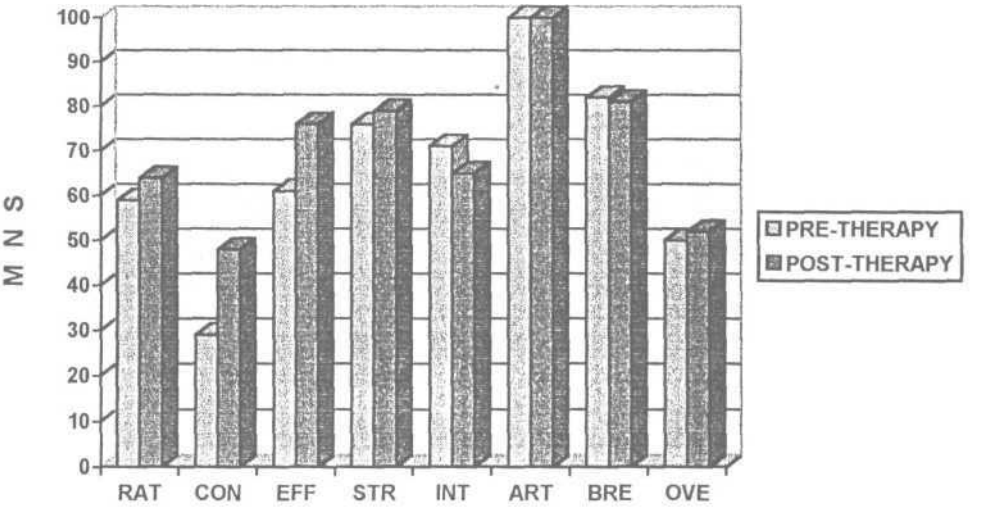

Figure - 9 M N S of pre-therapy and post-therapy spontaneous speech .

RAT . = RATE , CON . = CONTINUITY , EFF. = EFFORT , STR . = STRESS , INT . = INTONATION , ART. = ARTICULATION , BRE . = BREATHING PATTERN , OVE . = OVERALL .

3 . CORRELATION BETWEEN OVERALL MNS AND MNS OF OTHER PARAMETERS.

Table -16 shows the correlation between the MNS of various parameters and overall naturalness score for reading and spontaneous speech tasks in normals . The results reveal that for the reading task the overall naturalness score highly correlated with the MNS of intonation , articulation and breathing pattern and in the spontaneous speech task it correlated with the MNS of continuity, effort, stress and breathing pattern .

Parameters	Task	
	Reading	Spontaneous Speech
Rate	-0.28	-0.49
Continuity	-0.24	0.61
Effort	-0.02	0.61
Stress	0.02	0.61
Intonation	0.76	0.31
Articulation	0.61	00.32
Breathing Pattern	1.0	0.61

Table - 16 : Correlation between Overall MNS and MNS of other parameters in Normals .

In the pre-therapy samples of stutterers while the MNS of stress, rate and intonation correlated with the overall MNS in reading , in spontaneous speech the MNS of effort, stress , intonation , articulation and breathing pattern correlate with the overall MNS . In the post-therapy samples high positive correlation existed between the overall MNS and the MNS of stress and MNS of intonation, stress, articulation and breathing pattern in reading and spontaneous speech respectively. Thus , it appears that the naturalness scores assigned for the pre-therapy samples can be attributed to the poor rate and intonation patterns (reading) and to increased effort (spontaneous speech)

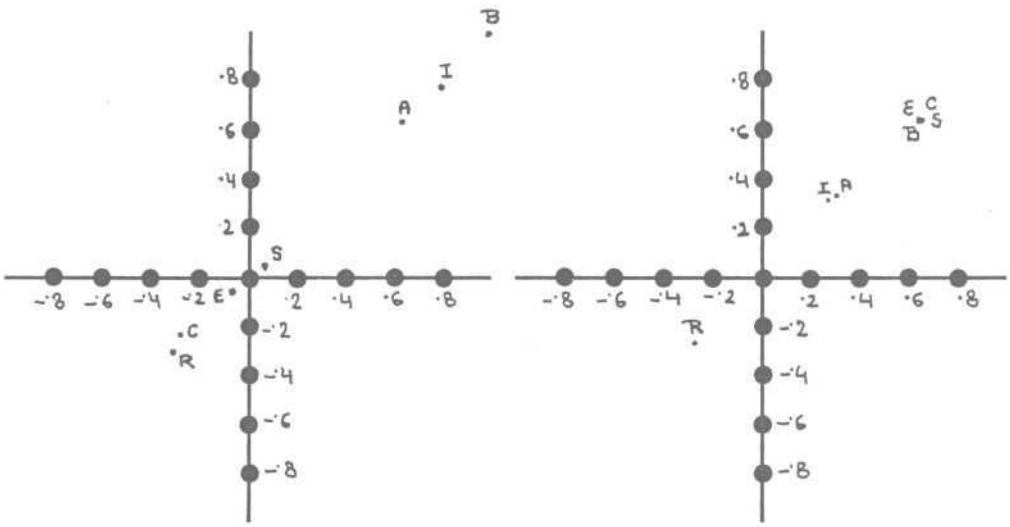

Figure - 10 Overall MNS and MNS of other parameters in normals for (a) Reading , (b) Spontaneous Speech

R = Rate , E = Effort , S = Stress , C = Continuity , A = Articulation
I = Intonation , B = Breathing Pattern

Table - 17 shows the correlation between Overall MNS and MNS of various parameters .

Parameter	Pre - Therapy		Post - Therapy	
	Reading	Speech	Reading	Speech
Rate	0.60	-0.44	0.26	0.22
Continuity	0.52	-0.46	-0.10	0.10
Effort	0.49	0.96	-0.35	-0.13
Stress	0.90	0.78	0.86	0.70
Intonation	0.59	0.67	0.12	0.80
Articulation	-0.47	0.68	0.43	0.81
Breathing Pattern	0.25	0.62	-0.45	0.69

Table - 17 : Correlation between overall MNS and MNS of various parameters in Stutterers .

Figure - 11 and Figure - 12 shows correlation between overall MNS and MNS of other parameters in stutterers for the reading and spontaneous speech task .

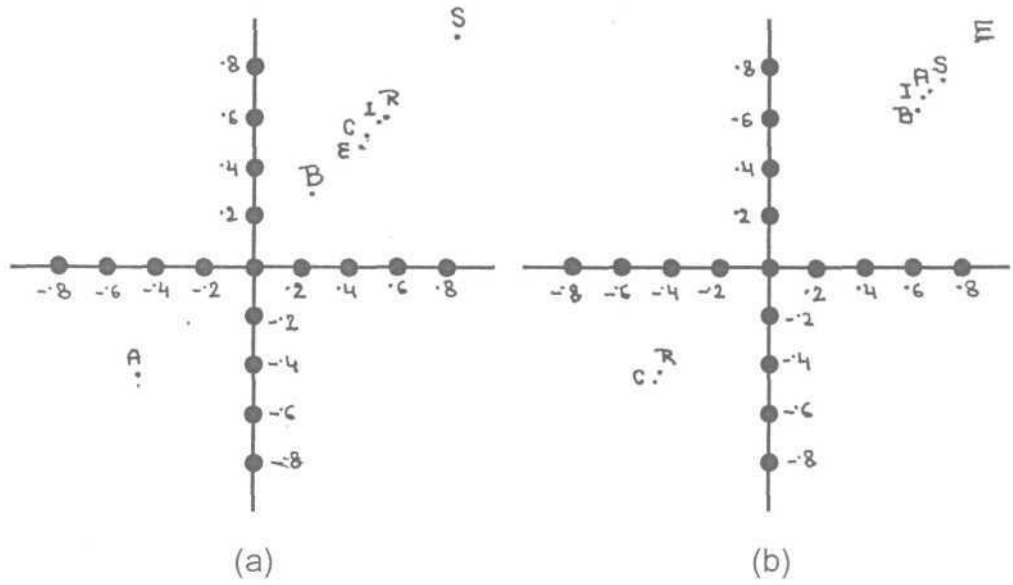

Figure - 11 Overall MNS and MNS of other parameters in Pre-therapy (a) Reading (b) Spontaneous Speech

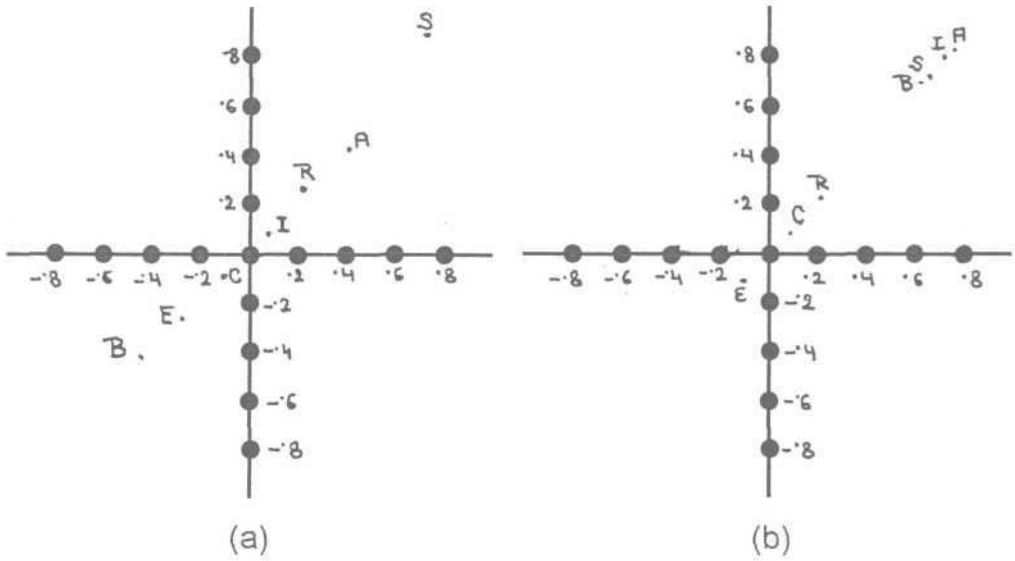

Figure - 12 Overall MNS and MNS of other parameters in Post-therapy (a) Reading (b) Spontaneous Speech

R = Rate , E = Effort , S = Stress , C = Continuity , A = Articulation
I = Intonation , B = Breathing Pattern

4. OTHER CORRELATIONS

It was observed that the overall MNS negatively correlated with percent dysfluency (% SS) and positively correlated with the number of words per minute (W P M) uttered indicating that the naturalness scores increased as the % SS decreased and WPM increased . Also , rate and WPM were positively correlated (though low) indicating that WPM determined the rate and % SS determined the continuity . Table-18 and Table-19 shows the correlations.

Task	Percent Dysfluency (% SS)	Rate of Speech (WPM)
Reading	-0.45	-0.53
Speech	0.53	0.63

Table - 18 : Correlation between Overall M N S and % SS , WPM .

Task	Rate Vs WPM	Continuity Vs % SS
Reading	0.30	0.49
Speech	-0.31	-0.40

Table - 19 : Correlation between Rate Vs WPM and Continuity Vs % SS.

Table-20 shows MNS scores assigned by the judges for different speech samples and the % SS and WPM of the corresponding speech samples .

Table - 20 MNS , WPM and % SS of speech samples

	READING			SPONTANEOUS SPEECH		
SAMPLE	**MNS**	**WPM**	**%SS**	**MNS**	**WPM**	**%SS**
NORMAL	100	145	0	100	97	0
	100	144	0	100	75	0
	100	140	0	100	72	0
	100	123	0	100	70	0
	100	102	0	100	68	0
	60	70	0	80	80	0
	20	120	0	80	61	0
PRE-THERAPY	100	98	0	100	120	2
	100	98	2	100	80	8
	100	79	5	100	80	7
	100	77	0	100	74	3
	100	72	10	80	55	5
	100	65	0	80	50	18
	100	46	5	60	72	23
	80	82	5	60	68	12
	80	62	0	60	65	15
	60	82	0	60	60	10
	60	77	0	60	59	18
	60	58	0	60	55	0
	60	57	0	60	52	3
	40	82	7	60	48	0
	40	77	2	40	74	3
	40	65	10	40	70	31
	40	63	0	40	70	30
	20	70	0	40	58	2
	20	68	0	40	15	19
	20	60	12	40	50	26
	0	82	0	40	48	4
	0	62	2	40	42	15
	0	62	54	40	41	23
	0	59	10	40	40	18
	0	53	39	40	29	48
	0	52	0	20	59	0
	0	50	20	20	49	21
	0	48	24	20	45	43
	0	39	32	20	40	31
	0	34	7	20	40	50
	0	32	41	20	37	23

		READING			SPONTANEOUS SPEECH	
SAMPLE	**MNS**	**WPM**	**%SS**	**MNS**	**WPM**	**%SS**
	0	**24**	**7**	**0**	**68**	**29**
POST -	100	91	0	100	96	0
THERAPY	100	83	0	100	84	0
	100	82	2	80	68	0
	100	79	0	80	67	3
	100	77	0	80	58	0
	100	75	0	80	57	7
	100	75	7	80	55	0
	100	58	0	80	54	0
	100	46	0	80	51	6
	100	45	0	60	83	0
	80	85	5	60	70	0
	40	52	7	60	70	7
	40	38	0	60	64	6
	20	88	2	60	61	3
	20	85	8	60	60	3
	20	68	0	60	59	18
	20	59	20	40	84	0
	20	59	39	40	75	3
	20	28	44	40	68	2
	0	62	34	40	64	0
	0	59	40	40	55	4
	0	55	24	40	50	9
	0	53	17	40	39	14
	0	51	0	20	43	30
	0	50	7	0	65	17
	0	49	5	0	63	8
	0	44	39	0	55	3
	0	30	54	0	45	0

Table - 20 MNS , WPM and % SS of speech samples

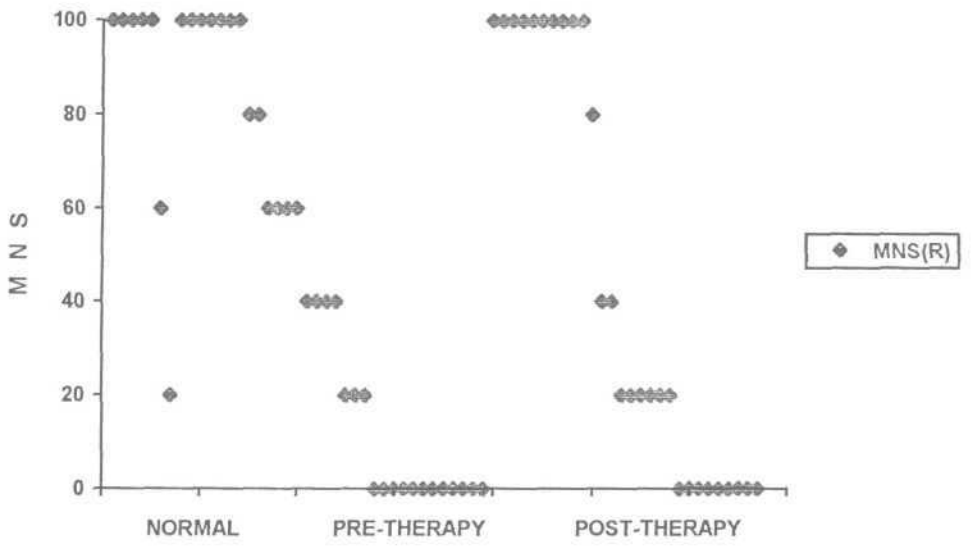

Figure - 13 Mean Naturalness Scores of Reading Samples

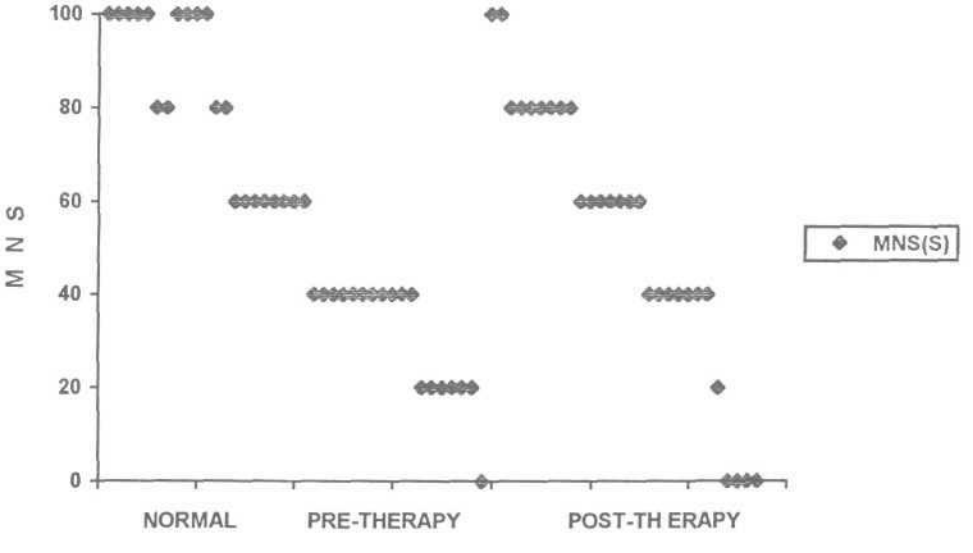

Figure - 14 Mean Naturalness Scores of Spontaneous Speech Samples

5. FACTOR PATTERNS

In order to calculate the relative contribution of various parameters for naturalness a factorial analysis was done . The results indicate that in normals , while factor 1 consists of overall MNS and MNS of intonation, articulation , breathing pattern , factor 2 consists of rate , continuity and effort and stress forms factor 3 . Among stutterers (both in pre-therapy and post - therapy reading samples) , the first factor consisted of rate , continuity , effort and stress , and the 2nd factor was formed by intonation , articulation and breathing pattern . This indicates that of all the parameters tested , rate , continuity , effort and stress could be retained for further naturalness measures. Table -21 shows the factor pattern for reading . The factorial analysis could not be performed for spontaneous speech task as the MNS did not permit the analysis.

Parameter	Normal			Pre - Therapy			Post - Therapy		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Rate	-	.8821	-	.9565	-	-	.9440	-	-
Continuity	-	.7721	-	.7756	-	-	.6348	-.7103	-
Effort	-	.8021	-	.8434	-	-	-.9384	-	-
Stress	-	-	.8300	.9087	-	-	-.8401	-	-
Intonation	.9764	-	-	-	.7336	-	-	-.8372	-
Articulation	.8825	-	-	-	.8388	-	-.6910	-.5852	-
Breathing	.8057	-	-	-	.7475	-	-	.6788	-
Pattern Overall	.8057	-	-	.8109	-	-	.5676	-	.6864

Table-21 Factor Patterns (Reading Task)

6. RELIABILITY

In order to measure inter-judge reliability , Phi-Coefficient was calculated . Table 22 shows a moderate to high correlation between the judge for the reading task . However , for the spontaneous speech task , except judge-3 , there existed moderate correlation between the other judges .

	Reading					Spontaneous Speech				
	J1	J2	J3	J4	J5	J1	J2	J3	J4	J5
J1	-	.58	.52	.49	.47	-	.33	.16	.44	.40
J2	.58	-	.68	.66	.71	.33	-	.06	.50	.45
J3	.52	.68	-	.66	.91	.16	.06	-	.07	.09
J4	.49	.66	.66	-	.71	.44	.49	.07	-	.44
J5	.47	.71	.91	.71	-	.39	.45	.09	.44	-

Table 22 : Correlation in naturalness ratings between judges .

Within the judges there was more consistancy in rerating the reading samples than in rerating spontaneous speech samples . Table 23 shows the correlation coefficient in reratine the samples .

Judges	Reading	Spontaneous Speech
J1	1.00	0.92
J2	1.00	0 .92
J3	0.88	0 .92
J4	1.00	0 .92
J5	1.00	0 .92

Table - 23 : Rank difference correlation coefficient (within - judge reliability)

DISCUSSION

The results reveal several points of interest . *First of all , it was obsen'ed that the speech naturalness depends upon parameters of rate, stress, continuity, intonation, effort, articulation and abnormal breathing pattern* which is consistent with the notion by Wandahl and Cole (1961) that normalcy or naturalness of speech is determined by different factors and not just dysfluency.

Second , *speech of normals sound more natural than stutterers . Stutterer's speech , not only prior to therapy , but also after therapy , can be differentiated from the normal in terms of speech naturalness* . This finding is consistent with the research findings of Ingham et al ., (1982); Runyan et al., (1990); Onslow et al ., (1992). Results also indicated no significant difference between the speech naturalness for the two tasks among stutterers in the pre-therapy and post-therapy condition . However , this difference was found to be significant for the speech samples of normals which could be due to significant difference in the speech rate . Onslow et al., (1992) reported no significant difference in the naturalness scores assigned to coversational and monologue speech for either treated stutterers or non-stutterers . However , in the present study reading and spontaneous speech were used .

Third , *various parameters were rated as unnatural in the samples of stutterers both before and after therapy* . Of these rate and continuity were the parameters judged to be least natural. Of the two , continuity is rated to be

poorer in reading than in spontaneous speech and it is rated poorer in pre - therapy samples in comparison with the post-therapy samples . Fluency is defined as continuous , effortless speech at a fast rate of speech (Starkweather , 1980) . Disruptions of continuity and rate are considered by the judges to affect the naturalness of speech . Also , it could be noticed that though articulation and intonation patterns were listed as affecting naturalness, they were never considered to be affected in stutterers .

Fourth , *though not significantly , an improvement in the naturalness was evident in the treated stutterers* . Though the present study has used a different naturalness scale (Binary), the results is in agreement with those of Ingham et al ., (1989) and Packman et al ., (1994) who reported improvement in speech naturalness in stutterers at various stages of treatment on a 9 - point scale . Also , there was reduction in the MNS of intonation after therapy . This finding is consistent with unresolved outcome issue associated with prolonged speech treatments that post - treatment speech is likely to sound unnatural and may be distinguished from the speech of those who do not stutter (Ingham et al ., 1978 ; Runyan et al ., 1978 ; Ingham et al ., 1985 ; Harold et al ., 1986 ; Onslow et al., 1992).

Fifth , *correlations between overall MNS and MNS of various parameters were found suggesting that the low MNS in pre-therapy samples can be attributed to slow rate of speech , disrupted intonation patterns and to increased effort.* This indicates that the listener's judgement of naturalness for

the reading task depend on intonation , articulation and breathing pattern and for spontaneous speech continuity , effort and stress also contribute significantly . This difference could be due to the fact that for the spontaneous speech task, speech naturalness is affected by speaker's intention to converse and emotional state which influences continuity, effort and stress pattern of utterrances unlike the task of reading , where such active involvment of speaker's effort are not required . For the spontaneous speech task , speech naturalness ratings are highly correlated with parameters of stress, intonation, articulation and breathing pattern . The role of suprasegmental features becomes more evident in speech task because it reflects speaker's intention and emotional state to communicate .

Sixth, *Mean Naturalness Scores increased with increase in the rate of speech and decrease in percent dysfluency* . Also , MNS of rate increased with increase in the number of words per minute and MNS of continuity increased with decrease in percent dysfluency . This indicates that speech naturalness increases as the speech becomes stutter free and as its rate increases to a normal range . This is consistent with the findings of Onslow et al ., (1992) and Packman et al ., (1994) . The degree of correlation also implies that there are other aspects of speech which might be affecting speech naturalness which is evident in the other findings of the present study .

Seventh , *a factorial analysis indicated that rate , continuity , effort and stress are factors which are to be considered as important for judging the*

naturalness of spontaneous speech and reading . These factors may be considered in the future naturalness scales .

Last, *(hough high intra -judge correlation was present inter -judge correlations were moderate* . Especially judge - 3 was very poor and inconsistent in her ratings which might have affected the overall naturalness scores.

To summarize , stutterers speech (reading), both pre-therapy and post - therapy can be differentiated from normals in that it sounds unnatural. The speech naturalness increases after therapy and it increases with the increase in rate of speech and decreases in percent dysfluency . Of all the factors , rate , continuity , effort and stress can be considered for the speech naturalness scale. It appears that the binary scale provides more consistency and it can be used clinically to improve rate , continuity , effort and stress . However it should be kept in mind that even normals did not obtain 100 % speech naturalness .

It is suggested that this naturalness scale be utilised in evaluating the efficiency of therapy . As of now , the therapy is being evaluated on a subjective basis by the fluency depicted by the patient in the clinic , use of this scale may prove to be more fruitful and it can be common to all the therapist so that therapies can be compared .

CHAPTER V

SUMMARY AND CONCLUSIONS

The acceptable speech quality in stuttering therapy determines the treatment outcomes . Thus , it is very important to assess the naturalness of speech in stutterers after the treatment . Such information could be valuable for the evaluation of the fluent speech of treated stutterers and has possible application for measuring therapeutic progress and determining dismissal criteria.

The present study was conducted to construct a speech naturalness scale which can be used to monitor the speech quality in stutterers before and after the treatment . A pilot study was conducted in which a 9-point rating scale was used . As the results indicated that the 9-point scale may not be useful it was decided to make a binary scale. In part I of the study , 60 post graduate students from the field of Speech and Hearing were given the task of listing speech parameters they feel responsible for the naturalness of speech . Based on their responses percent weightage obtained by each parameter was calculated . A naturalness scale was constructed with parameters of rate ,

continuity , effort , stress , intonation , articulation and breathing pattern and overall rating with binary choice of natural or unnatural speech .

In the second part of the study , 5 judges (Post-graduate students from the field of Speech and Hearing) were asked to rate 68 speech samples of reading and spontaneous speech which were audio dubbed on two different sets of cassettes for each task seperately . These samples included 7 normal speakers , 32 pre-therapy and 29 post-therapy spontaneous speech and reading samples of stutterers . 6 samples were repeated to check intrajudge reliability. Speech samples were dubbed randomly and presented through audio headphones to judges seperately Judges were asked to listen to each sample audio presented and were to rate the naturalness of each speech sample on each parameter of naturalness scale on a binary scale with 1 representing natural and 0 representing unnatural . They were also to rate the overall naturalness of the sample . Ho time restrictions were imposed on judges for the task completion.

Judges ratings were tabulated seperately and were grouped for normal, pre-therapy and post-therapy samples of reading and spontaneous speech task. Mean Naturalness ratings given by each judge for three groups (normal, pre-therapy , post-therapy) were calculated for each parameter . 'T' test was done to findout the significance of difference between means of the naturalness judgements for (1) reading and spontaneous speech task (2) across various parameter (3) norma, pre-therapy and post-therapy samples for both reading

as well as for spontaneous speech task . Pearson's correlation was calculated to find correlation between overall ratings and other parameters , relationship between , overall mean naturalness scores and percent dysfluency as well as rate of speech and also, over all mean naturalness scores and mean naturalness score for parameters of rate and continuity . Factor analysis was performed to find parameters of importance for naturalness ratings for both task . In order to calculate inter judge and intra judge reliability Phi-Coefficient and Spearman's rank correlation method respectively were used .

The following conclusions were drawn from the study :

1 . Speech of normals were rated as more natural than stutterers speech . The samples of stutterers not only prior to therapy but also after therapy , could be differentiated from the normals in terms of speech naturalness .

2 . T test indicated significant difference between the MNS of normals vs pre-therapy and normals vs post-therapy.

3 . An improvement in the naturalness of speech in stutterers after the treatment, though not significant was observed .

4. Correlations between overall Mean Naturalness score and MNS of various parameters were found suggesting that the low MNS in pre-therapy samples can be attributed to slow rate of speech , disrupted intonation pattern and increase effort.

5 . MNS increased with increase in the rate of speech and decrease in percent dysfluency .

6 . Factor analysis indicated rate , continuity , effort and stress are factors

which are to be considered as important for judging the naturalness of spontaneous speech and reading .

7. High inter judge and intra judge correlations while using binary scale for speech naturalness rating were observed . However , ratings of one of the judge was found to be relatively inconsistent.

IMPLICATIONS OF THE STUDY

1 . Results indicate that the Multidimentional Speech Naturalness Scale could be a useful clinical tool to assess the efficacy of treatment approaches for stuttering management .

2 . This naturalness scale could be valuable for monitoring therapeutic progress and determining dismissal criteria .

3 . Results indicate an important role of suprasegmental features contributing for speech naturalness which should be taken care in the management of stuttering disorder .

SUGGESTIONS FOR FUTURE RESEARCH

1 . In the present study speech naturalness was assessed in treated stutterers on the "last day of therapy", further study need to be done with respect to assessment of speech naturalness in later follow up sessions .

2 . The Multidimentional Speech Naturalness Scale can be used to assess the improvement of speech naturalness with feedback of MNS .

3. Better defined parameters, such as stress, intonation would make the scale more objective .

4. To study , if any, relationship between speech naturalness at the time discharge and relapse of the problem

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APPENDIX 'A'

SPEECH NATURALNESS RATING

RESPONSE SHEET

INSTRUCTIONS: We are studying what makes speech sound natural or unnatural. You will hear a number of speech samples. The samples will be separated by a few seconds of silence. Each sample will be introduced by the sample number. Your task is to rate the naturalness of each speech sample. If the speech sample sounds highly natural to you, circle the 1 on the scale. If the sample sounds highly unnatural, circle the 9 on the scale. If the sample sounds somewhere between highly natural and highly unnatural, circle the appropriate number on the scale. Do not hesitate to use the ends of the scale (1 or 9) when appropriate. **"Naturalness"** will not be defined for you. Make your rating based on how natural or unnatural the speech sounds to you.

Task:

Sample No.	RATING SCALE VALUE								
	(Highly Natural)								(Highly unnatural)
38	1	2	3	4	5	6	7	8	9
39	1	2	3	4	5	6	7	8	9
40	1	2	3	4	5	6	7	8	9
41	1	2	3	4	5	6	7	8	9
42	1	2	3	4	5	6	7	8	9
43	1	2	3	4	5	6	7	8	9
44	1	2	3	4	5	6	7	8	9
45	1	2	3	4	5	6	7	8	9
46	1	2	3	4	5	6	7	8	9
47	1	2	3	4	5	6	7	8	9
48	1	2	3	4	5	6	7	8	9
49	1	2	3	4	5	6	7	8	9
50	1	2	3	4	5	6	7	8	9
51	1	2	3	4	5	6	7	8	9
52	1	2	3	4	5	6	7	8	9

Sample No.	RATING SCALE VALUE								
	(Highly Natural)								(Highly unnatural)
53	1	2	3	4	5	6	7	8	9
54	1	2	3	4	5	6	7	8	9
55	1	2	3	4	5	6	7	8	9
56	1	2	3	4	5	6	7	8	9
57	1	2	3	4	5	6	7	8	9
58	1	2	3	4	5	6	7	8	9
59	1	2	3	4	5	6	7	8	9
60	1	2	3	4	5	6	7	8	9
61	1	2	3	4	5	6	7	8	9
62	1	2	3	4	5	6	7	8	9
63	1	2	3	4	5	6	7	8	9
64	1	2	3	4	5	6	7	8	9
65	1	2	3	4	5	6	7	8	9
66	1	2	3	4	5	6	7	8	9
67	1	2	3	4	5	6	7	8	9
68	1	2	3	4	5	6	7	8	9
69	1	2	3	4	5	6	7	8	9
70	1	2	3	4	5	6	7	8	9

Name::

Age/Sex:

Occupation:

Date:

APPENDIX -B

INSTRUCTIONS :

Describe the parameters which you think are responsible for the naturalness and unnaturalness of speech (especially fluency).

NATURAL	UNNATURAL

NAME :

AGE / SEX :

OCCUPATION

APPENDIX - C

SPEECH NATURALNESS SCALE

INSTRUCTIONS

Rate the speech samples provided to you on audio - cassettes, based on the following dimensions as natural or unnatural . Assign the value of 1 for natural and 0 if it is unnatural under different parameters listed for each sample . There are 68 speech samples serially arranged at an intervel of 10 sec. between them . Rate the naturalness of each sample on the response sheet provided to you .

Naturalness and Unnaturalness criteria for various parameters are listed below :

SL. NO.	Parameters	Natural	Unnatural
1	Rate	Normal rate of speech	Fast or Slow rate of speech
2	Continuity	Smooth flow of speech	Continuity is disturbed by dysfluencies (hesitations, repetitions , filled pauses , unfilled pauses.prolongation)
3	Effort	Effortless speech	Effortful speech
4	Stress	Proper stress	Improper stress
5	Intonation and Rhythm	Adequate inflections and temporal aspects -	Monotonous and improper timing
6	Articulation	Proper articulation	Improper articulation
7	Breathing pattern	Normal	Abnormal

Name:

Age / Sex :

RESPONSE SHEET

Sample No.	Rate	Continuity	Effort	Stress	Intonation & Rythm	Articulation	Breathing Pattern	Overall
1.	☐	☐	☐	☐	☐	☐	☐	◯
2.	☐	☐	☐	☐	☐	☐	☐	◯
3.	☐	☐	☐	☐	☐	☐	☐	◯
4.	☐	☐	☐	☐	☐	☐	☐	◯
5.	☐	☐	☐	☐	☐	☐	☐	◯
6.	☐	☐	☐	☐	☐	☐	☐	◯
7.	☐	☐	☐	☐	☐	☐	☐	◯
8.	☐	☐	☐	☐	☐	☐	☐	◯
9.	☐	☐	☐	☐	☐	☐	☐	◯
10.	☐	☐	☐	☐	☐	☐	☐	◯
11.	☐	☐	☐	☐	☐	☐	☐	◯
12.	☐	☐	☐	☐	☐	☐	☐	◯
13.	☐	☐	☐	☐	☐	☐	☐	◯
14.	☐	☐	☐	☐	☐	☐	☐	◯
15.	☐	☐	☐	☐	☐	☐	☐	◯
16.	☐	☐	☐	☐	☐	☐	☐	◯
17.	☐	☐	☐	☐	☐	☐	☐	◯
18.	☐	☐	☐	☐	☐	☐	☐	◯
19.	☐	☐	☐	☐	☐	☐	☐	◯
20.	☐	☐	☐	☐	☐	☐	☐	◯
21.	☐	☐	☐	☐	☐	☐	☐	◯
22.	☐	☐	☐	☐	☐	☐	☐	◯
23.	☐	☐	☐	☐	☐	☐	☐	◯
24.	☐	☐	☐	☐	☐	☐	☐	◯

RESPONSE SHEET

Sample No.	Rate	Continuity	Effort	Stress	Intonation & Rythm	Articulation	Breathing Pattern	Overall
25.	☐	☐	☐	☐	☐	☐	☐	◯
26.	☐	☐	☐	☐	☐	☐	☐	◯
27.	☐	☐	☐	☐	☐	☐	☐	◯
28.	☐	☐	☐	☐	☐	☐	☐	◯
29.	☐	☐	☐	☐	☐	☐	☐	◯
30.	☐	☐	☐	☐	☐	☐	☐	◯
31.	☐	☐	☐	☐	☐	☐	☐	◯
32.	☐	☐	☐	☐	☐	☐	☐	◯
33.	☐	☐	☐	☐	☐	☐	☐	◯
34.	☐	☐	☐	☐	☐	☐	☐	◯
35.	☐	☐	☐	☐	☐	☐	☐	◯
36.	☐	☐	☐	☐	☐	☐	☐	◯
37.	☐	☐	☐	☐	☐	☐	☐	◯
38.	☐	☐	☐	☐	☐	☐	☐	◯
39.	☐	☐	☐	☐	☐	☐	☐	◯
40.	☐	☐	☐	☐	☐	☐	☐	◯
41.	☐	☐	☐	☐	☐	☐	☐	◯
42.	☐	☐	☐	☐	☐	☐	☐	◯
43.	☐	☐	☐	☐	☐	☐	☐	◯
44.	☐	☐	☐	☐	☐	☐	☐	◯
45.	☐	☐	☐	☐	☐	☐	☐	◯
46.	☐	☐	☐	☐	☐	☐	☐	◯
47.	☐	☐	☐	☐	☐	☐	☐	◯
48.	☐	☐	☐	☐	☐	☐	☐	◯

RESPONSE SHEET

Sample No.	Rate	Continuity	Effort	Stress	Intonation & Rythm	Articulation	Breathing Pattern	Overall
49.	☐	☐	☐	☐	☐	☐	☐	◯
50.	☐	☐	☐	☐	☐	☐	☐	◯
51.	☐	☐	☐	☐	☐	☐	☐	◯
52	☐	☐	☐	☐	☐	☐	☐	◯
53.	☐	☐	☐	☐	☐	☐	☐	◯
54.	☐	☐	☐	☐	☐	☐	☐	◯
55.	☐	☐	☐	☐	☐	☐	☐	◯
56.	☐	☐	☐	☐	☐	☐	☐	◯
57.	☐	☐	☐	☐	☐	☐	☐	◯
58	☐	☐	☐	☐	☐	☐	☐	◯
59.	☐	☐	☐	☐	☐	☐	☐	◯
60.	☐	☐	☐	☐	☐	☐	☐	◯
61.	☐	☐	☐	☐	☐	☐	☐	◯
62.	☐	☐	☐	☐	☐	☐	☐	◯
63.	☐	☐	☐	☐	☐	☐	☐	◯
64.	☐	☐	☐	☐	☐	☐	☐	◯
65.	☐	☐	☐	☐	☐	☐	☐	◯
66.	☐	☐	☐	☐	☐	☐	☐	◯
67.	☐	☐	☐	☐	☐	☐	☐	◯
68.	☐	☐	☐	☐	☐	☐	☐	◯