EFFECT OF BINAURAL MASKING NOISE ON STUTTERING-A SPECTROGRAPHIC ANALYSIS

A Dissertation
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In partial Fulfillment
of the Requirements for the Degree
Master of Science in Speech and Hearing

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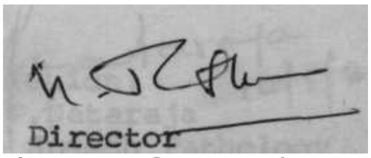
CERTIFICATE

This is to certify that the dissertation entitled "Effect of Binaural Masking Noise on Stuttering - A Spectrographic Analysis" is the bonafide work done in part fulfilment for the degree of Master of Science (Speech and Hearing) of the student with Register No. 3



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CERTIFICATE

This is to certify that this dissertation entitled "Effect of Binaural Masking Noise on Stuttering - A Spectrographic Analysis" has been prepared under my supervision and guidance.

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DECLARATION

This dissertation entitled "Effect of Binaural Masking Noise on Stuttering - A Spectrographic Analysis" is the result of my own study undertaken under the guidance of Mr. N.P. Nataraja, Lecturer in Speech Pathology, All India Institute of Speech and Hearing, and has not been submitted earlier at any University or Institution for any other diploma or degree.

Register No.9

Mysore

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"How can he forget Mr. M.H.Sanjeeva Murthy?"

CONTENTS

CHAPTER I

INTRODUCTION

> "Stuttering has been called a riddle.... stuttering is more than a riddle. It is at least a complicated multidimentional jig jaw puzzle, with many pieces still missing"
>
> (Van Riper, 1971)

Van Riper (1971) has surveyed the vast literature and concluded that the core of the disorder is a disruption of timing of the motor sequence of sound, syllable and word production.

It is certain that speech learning depends on audition. Normal speech is affected by changes in auditory feedback and some kind of deviant speech are obviously the result of such conditions.

Several attempts have been made bo account for stuttering as caused by some anomaly in auditory feedback (Cherry and Sayers (1956), Wolf and Wolf (1959), Mysak (1960), Gerber (1965), Bulter and Stanley (1966), Webster and Lubker (1968) and Van Riper (1971)).

There have been several reports in the literature indicating substantial reduction in stuttering during auditory masking (Shane (1946), Cherry and Sayers (1956), Maraist and Hutton (1957), Stromsta (1957), Sutton and Chase (1961), Murray (1967) and Ham and Steev (1967)).

The following effects of masking noise on stuttering have been reported.

Masking does reduce the frequency and severity of stuttering and also alters the usual manner of initiating phonation. It makes the stutterer to speak more slowly and loudly (Cherry and Sayers, 1953? Hanley and Steer, 1949; Adams and Hutchinson, 1974).

Auditory masking by noise bring about a reduction in secondary behavior, mostly while using automatic feedback masking. Expressionless speech and reduction in speech intelligibility observed (Dewar et al 1976).

Fundamental frequency of the voice was found to increase under masking (Black 1950, Atkinson 1952).

Word rate was same as normal and did not change significantly under masking (Martin et al., 1977).

Masking helps the stutterers to learn to monitor their speech primarily by proprioceptive, tactile and kinesthetic feedbacks. It also distracts the subject's attention from his speech and reduces anxiety and also changes the manner of speech (Van Riper, 1973).

Wingate (1970) has opined that the reduction in stuttering which is associated modification of auditory function, whether this modification is induced through deafness or less severe naturally reduced hearing acuity or delayed side-tone would seem to result adventitiously from the fact that alterations in auditory feedback induce certain changes in vocalization.

Yaire (1976) indicated that binaural noise caused significant decrement in stuttering associated with increased vocal level and faster speaking rate.

Bryton and Conture (1978) had investigated the effects of noise and rhythemic stimulation on stutterers' vocal fundamental frequency, vocal level and vowel duration and the relation have to one another and to stuttering. Results of this study indicated that stuttering was significantly reduced during noise and rhythemic stimulation. Decrease in stuttering was correlated with increase in vowel duration in both conditions.

In recent years there have been few studies in the application acoustic analysis to study the problem of stuttering

(Montgomery and Cooke, 1976; stromsta, 1965; Agnello, 1966; Lisker and Abramson, 1964).

However, most of the spectrographic studies on stuttering have focused their attention on Voice onset Time (VOT). Several authors have reported that stutterers vary from normal in terms of VOT measurements (Adams and Hayden, 1974; Starkweather et al, 1976; and Hillman and Gilbert, 1977).

The effect of masking noise on VOT of stutterers has not been studied. Moreover, most of the studies on auditory masking have dealt primarily with effect of variables associated with noise on the frequency of stuttering and rate of speech.

Very few studies have appeared in literature which attempted to acoustically analyze the stutterers speech under auditory masking.

Thus, the present study was aimed at spectrographically analyze the different parameters of speech - fundamental frequency, vowel duration, Voice Onset Time, vocal level, rate of speech and stuttering blocks of stutterers and normals in reading condition, in the absence and in the presence of binaural masking noise.

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Statement of the problem

The problem was to find out the effects of masking noise on rate of speech, fluency, fundamental frequency, voice onset time, vowel duration and vocal level in stutterers and normals.

Purpose of the Study

Purpose of the study was to test the following hypotheses:

Hypothesis No. 1

(a) There will be no significant difference in rate of speech of stutterers under reading in the absence and in the presence of masking noise.

(b) There will be no significant difference in mean rate of speech values of normals (non-stutterers) under reading in the absence or in the presence of masking noise.

Hypothesis No. 2

(a) There will be no significant difference in mean values of stuttering blocks of stutterers under reading in the absence and in the presence of masking noise.

(b) There will be no significant difference in mean values of disfluents of normals under reading in the absence or in the presence of masking noise.

Hypothesis No. 3

(a) There will be no significant difference in mean fundamental frequency values of stutterers under reading in the absence or in the presence of masking noise.

(b) There will be no significant difference in mean fundamental frequency values of non-stutterers under reading in the absence or in the presence of masking noise.

Hypothesis No. 4

(a) There will be no significant difference in mean voice onset time values in two readings of stutterers in the absence and in the presence of masking noise.

(b) There will be no significant difference in mean voice onset time values in two readings of non-stutterers in the absence and in the presence of masking noise.

(c) There will be no significant difference in mean voice onset time values of stutterers and non-stutterers under reading in the absence of masking noise.

(d) There will be no significant difference in mean voice onset time valuesof stutterers and non-stutterers in the presence of masking noise.

Hypothesis No. 5

(a) There will be no significant difference in the mean vocal intensity values in two readings of stutterers in the absence and in the presence of masking noise.

(b) There will be no significant difference in the mean vocal intensity values in two readings of non-stutterers in the absence and in the presence of masking noise.

(c) There will be no significant difference in mean vocal intensity values of stutterers and normals under reading in the absence of masking noise.

(d) There will be no significant difference in the mean vocal intensity values of stutterers and non-stutterers under reading in the presence of masking noise.

Hypothesis No. 6

(a) There will be no significant difference in the mean vowel duration values of stutterers under reading in the presence and in the absence of masking noise.

(b) There will be no significant difference in mean vowel duration values of non-stutterers in the absence and in the presence of masking noise.

To test these hypotheses, 4 stutterers and 4 non-stutterers (all males) in the age range of 18-28 years were selected. They were asked to read a passages in two conditions - Reading in the absence and in the presence of masking noise. Samples were recorded on a professional tape recorder and spectrographically analyzed for the purpose of VOT, vowel duration, vocal level was measured using AF Analyzer. Fundamental frequency was measured using a digipitch and rate of speech was measured by counting the number of syllables read per second.

Limitations of the study

1. The study was conducted on a small population.

2. Only white noise was selected as a variable which would affect speech.

3. Effects of binaural masking only at 90 HTL was studied

4. Limited age group was taken in this study.

5. The study was done in Kannada language only.

Definitions of some of the key words used in the study:

Stuttering:

"The term stuttering means: I (a) Disruption in the fluency of verbal expression, which is (b) characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sounds, syllables, and words of one syllable. These disruptions (c) usually occur frequently or are marked in character and (d) are not readily controllable. II. Sometimes the disruptions are (e) accompanied by accessory activities involving the speech apparatus, related or unrelated body structures, or steriotyped speech utterances. These activities give the appearance of being speech-related struggle. III. also, there are not infrequently (f) indications or report of the presence of an emotional state, ranging from a general condition of 'excitement' or 'tension' to more specific emotions of a negative nature such as fear, embarrassment, irritation, or the like, (g) The immediate source of stuttering is some incoordination expressed in the peripheral speech mechanism; the ultimate cause is presently unknown and may be complex or compound." (Wingate 1964).

Voice onset time (VOT):

"The duration between the release of a complete articulatory constriction or burst transient and the onset of phonation" MLisker and Abramson 1964, 1971)

Voiceless stop:

A voiceless stop is a speech sound produced by (1) a complete oral closure (2) a velic closure and (3) absence of voicing during complete oral closure.

Vowel duration:

Vowel duration is the duration for which the vowel is present in a word as shown by the spectrogram, expressed in terms of seconds.

Vocal Intensity:

Vocal intensity is the intensity of the speech signal as measured by using the sound level meter expressed in terms of dB.

Fundamental frequency:

Fundamental frequency is the frequency of the speech signal as shown by the "Digipitch" expressed in terms of Hertzs.

Rate of Speech:

Rate of speech is the number of syllables produced by the individual per second.

CHAPTER II

REVIEW OF LITERATURE

"Stuttering has been called a riddle. . . . Stuttering is more than a riddle. It is at least a complicated multi-dimensional jig-jaw puzzle, with many pieces still missing" (Van Riper, 1971).

Further on. Van Riper (1971) states that "many good minds have attempted definitions of stuttering but the vari-ability among them makes clear the complex and variable disorder is hard to delimit".

Attempts have been made to explain stuttering on the basis of learning theories (Johnson, 1958; Johnson, Brow, Curtis, Edney and Keaster, 1967; Brutten and Shoemaker, 1967 and many others.) Green and Wells (1927) have attributed stuttering to the disorders of the nervous system. Wyke (1974) hypothesized that stuttering of laryngeal origin may be a form of phonatory ataxia arising either because of disordered voluntary phonatory tuning of the vocal fold musculature or from incoordinated reflex modulation of the activity of this musculature during actual utterance.

Schwartz (1974) has explained the "core of the stuttering block". He believed that "the disorder is essentially an inappropriate, vigorous contraction of the posterior cricoarytenoid muscle in response to the subglottal air pressures required for speech".

Some of the other main theories are cerebral dominance theory by Orton (1927), Travis (1931), Brynglson (1935). Conflict theory by Sheehan (1958), Diagnosogenic theory of stuttering by Johnson (1957), Wischner's anticipatory theory of stuttering (1947), (1950), (1952). Robert West (1958) considers stuttering to be a form of pyknolepsy affecting the fine muscles of speech.

Ainsworth (1972) has classified the theories of stuttering into 2 types. Under the first type, he grouped those theories looking for an active agent which causes stuttering within the child. He said that "active agent" may be constitutional or psycodynamic in nature. Constitutionally the exact agent may lie in the relatively generalized cortical activity affecting the speech areas (West, 1958; Eisenson, 1958) may involve relatively complex auditory feedback circuits (Mysak, 1960) or may be a more precise auditory feedback disturbance (Stromsta, 1959). Psycodynamically the interruption in neural flow may be tregelled by a primary anxiety (Travis, 1972).

Ainsworth (1972) says that these theories consider stuttering as growing out of what the individual is. These theories tell "this is the kind of person he is, therefore he stutters".

On the contrary, there are theories that seek active agent outside the child - in the listener, in the immediate environment or in the culture (Johnson, Brown, Curts, Edney and Keasta 1967).

He also mentions that some theories combine the possibilities in the active agent category - certain attitudes within the child plus factors in the environment (Bloodstein 1958) or constitutional elements plus social presences (West 1958).

Still ainsworth (1971) who attempted to integrate the theories of stuttering has concluded "the process of attempting to provide a way of integrating the multiplicity of ideas and facts concerning the nature and source of stuttering continues to be frustrating and fragmentary".

Thus the theories of stuttering are too divergent from each other.

Van Riper (1971) surveyed the vast literature and concluded that the core of the disorder is a disruption of timing of the motor sequence of sound, syllable and word production.

Travis (1931) writes that "Rational analysis, clinical investigation and systematic research are lending support to an old suspicion - many of the abnormal disfluencies judged as stuttering involve problems of smooth coordination of phonation with articulation and respiration.

Several attempts have been made to account for stuttering as caused by some anomaly in auditory feedback.

Mysak (1960, '66) views stuttering as a disturbance of verbal automobility internal flow due to disruption in any one of the series of internal or external servo-loop circuits.

Stromsta (1956) hypothesized that discrepancies in arrival times of bone conducted and air conducted side tones may be different in stutterers than in normal speakers.

Wolf and Wolf (1959) considered stuttering as being due to a "dead-time lag" between the auditory input and motor output of speech.

Tomatis (1963) considered stutterer's speech in terms of a delay created by the use of the non-dominant for the self-perception of the speech. This intracerebral delay interval acts much in the same way as that involved in DAF.

According to Gruber (1965), too much information load in the auditory system as compared with the tactual and kinesthetic feedback circuits may produce the fluency breaks.

Van Riper (1971) opined that stutterers have distorted auditory feedback system.

But according to Lani and Tranel (1971), stuttering results from excessive use of feedback rather than feedback distortion.

Several authors have reported that stutterers become more fluent under the condition of auditory masking.

Cherry and Sayers (1956) mention that Kern (1932) had stressed the need to examine the feedback function of auditory perception in stuttering and that he had reported reduction of stuttering associated with accompanying masking noise produced by beating on a drum.

Cherry and Sayers (1956) in their discussion of several circumstances under which stuttering is reduced, devoted considerable time to results obtained by using masking noise. They reported virtually complete elemination of stuttering under conditions of bilateral masking with a tone of intensity that approached pain level and achieved complete masking of the subjects awareness of sound of his own speech. They interpreted these findings and observations within a feedback frame work and presented this data as supporting a conception of stuttering as a perceptual defect.

Malaist & Hutton (1957) studied the change in stutter's fluency, occasioned by auditory masking at levels of 30, 50, 70 and 90 dB. They found a progressive decrease in stuttering as the intensity of masking noise increased. It would seem particularly significant that "sizable decrease in the several measures of severety of stuttering were found to result from masking noise of 50 dB and above. They believed that their findings supported the view point that hearing mechanism may be a factor in the etiology of stuttering.

Shane (1946) studied the effect on stuttering of masking noise delivered at 25 dB and 90 dB bilaterally. The subjects evidenced a significant decrease in stuttering in the condition employing the 90 dB masking but no difference at the 25 dB level. Shane interpreted these findings in terms of an altered self evaluative reaction, namely when the stutterer is unable to hear himself speak, he is in turn relatively free from the anxiety producing cues involved in hearing himself stutterer.

Ham and Steel (1967) in their study, returned stutterers speech signal at 30, 45, 60 and 75 dB above individuals speech reception threshold levels. They found that only the 60 dB and 75 dB increases were accompanied by a statistically significant reduction in stuttering. They also found that masking noise filtered to eliminate frequencies below 800 + 12 resulted in a significantly reduced stuttering whereas filtering out frequencies above 600 + 12 or below 600 and 1200 Hz did not have effect on stuttering.

Cherry and Sayers (1956) reported that masking of low frequency (below 500 Hz) is essential and that masking of bone conducted transmission is most important.

Stromsta (1957) as reported by Soderberg (1968) subjected stammerer to a 1OO dB masking noise while they read with a fundamental frequency of 500, 300 and 100 + 12. A reduction in stammering was observed as the fundamental frequency of the noise was reduced.

Stutton and Chase (1961) compared the effects of continuous masking noise with effects produced under 2 conditions of contingent masking. Using voice actuated relay, masking noise was presented in one of these conditions. Only during phonation and only during silence, it was found that fluency improved under all conditions of masking and further that the condition in which noise occured during silence was just as effective as other two masking conditions.

Murray (1967) has reported results consistent with those of Stutton and Chase. He compared the effects of continuous white noise masking with several conditions of intermittent masking. In the latter condition, brief periods of masking noise were delivered (1) randomly with from 0-9 secs intervening; (2) contingent upon stuttering.

Murray found that continuous masking to be more effective although even random masking resulted in a notable decrease in stuttering. The contingent condition however did not have significant influence. In effect, then masking introduced only after onset of a stutterer was not beneficial. The overall results thus suggest that masking must be ongoing prior to initiation of a word attempt, to be effective.

Adams and Hutchenson (1974) designed a study to test the hypothesis that the growth function of the masking effect in stuttering behaviour is promoted by systemic increase in vocal intensity. 16 normal hearing stutterers read aloud in 4 conditions (quiet, 10 dB, 50 dB and 90 dB sensation levels of continuous white noise). The oral readings were tape recorded. The results showed that under various levels of masking there is an inverse relationship between vocal intensity and stuttering frequency. Results further revealed that vocal intensity was significantly greater in each masking condition than in quiet. Reading time was usually shorter in any experimental condition than in quiet.

Wingate (1971) argued that the effect of masking noise on stuttering is primarily because of the concomitant increase in vocal intensity.

Gerber and Martin (1977) have tried to assess the effects of increased vocal level on stuttering in the presence and absence of masking noise, and the effects of noise on stuttering with and without concomitant increase in vocal level. Stutterers were asked to read a standardized passage under 4 conditions (1) in quiet with normal vocal level; (2) in quiet with increased vocal level; (3) in noise with normal vocal level; and (4) in noise with increased vocal level. Results showed that stuttering reduced in noise in compared to quiet. They opined that reduction in stuttering were related to decrease in auditory feedback rather than increase in vocal level. Largest decrease in auditory feedback, i.e., speaking in noise with normal level resulted in largest decrease in stuttering.

Yairi (1976) observed the influence of binaural and monaural high level white noise (90 dB SL) on stuttering, frequency, vocal level and speaking rate of 6 normal hearing adult stutterers. Binaural noise caused significant decrement in stuttering associated with increased vocal level and a faster speaking rate.

Closs (1976) gave 3 types of auditory feedbacks when his stutterers were reading. The 3 conditions were false increasing feedback, false decreasing feedback and true feedback. Stuttering reduced when either true feedback or false increasing feedback was given.

In recent years there have been several attempts at acoustic analysis of stuttered speech.

Stromsta's (1965) spectrographic findings showed that children who became stutterers had anomalies in formant transitions in their earlier dysfluencies, whereas the children who grew out of these nonfluencies had normal transitional movements.

Agnello (1966) indicated that the acoustic characteristics of the stuttering dysfluencies of stutterers were different from their normal speech dysfluencies. It is interesting that some of the acoustic differences were undetectable by ears and were demonstrated only by spectrographic analysis. Specially the shifts of the 2nd formal which reflects normal forward and backward coarticulatory dynamics were not characteristic of the stuttering movement.

Van Riper (1971) feels that it is essential to determine whether young children employ the schwa vowel in the syllabic repetitions. If they do so, he feels it indicates the probability of developing stuttering on a more permanent basis. Because the proper formant transitions are not present and the required coarticulation cannot be achieved.

Montgomery and Cooke (1976) have attempted to study the perceptual and acoustic characteristics of a carefully selected set of part word repetitions from the speech of adult stutterers. The results revealed that Schwa vowel was perceived in only 25% of repetitions. Spectrographic analysis showed that although abnormal consonant duration and CV formant transition characterized the central segment of the stuttered word, the remainder of the word is identical to its fluently produced counter part. The results were interpreted to mean that for the type of dysfluency selected the articulatory breakdown is confined to the initial consonant and it is likely that abnormal formant transitions from initial consonant to vowel, when present are due to deviant formation of the consonant rather than to faulty transition dynamics.

With the increasing belief that larynx is the culprit for stuttering, and that faulty phonatory function in stutterers is reflected in VOT, the voice onset studies have been widely used in the area of stuttering.

There are several reports that stutterers have longer VOT than normals. Adams and Hayden (1974) have found that stutterers performed significantly poorer than normals both in terms of prompt starting and stopping of voicing.

Starkweather et al (1976) measured the latency of vocalization onset for stutterers and non stutterers. The results showed that stutterers are slower in initiating vocalization across a wide variety of syllables. They further concluded that ". . . . . . . either vocal dysfunction or lack of cerebral dominance may be responsible for these differences".

Adam and Reis (1971) found that stutterers experience more difficulty in reading a passage which is filled with voiced and voiceless consonants than that of one with all voiced consonants.

Basu (1979) indicated that stutterers showed a longer VOT for voiceless and voiced stop consonants both in reading and in isolation, when compared to non stutterers.

Agnello and Wingate (1972) have also found that even when the stutterers spoke fluently their VOTs were longer than normals. Using the spectrograms they concluded that stuttering interruptions generally appear at the transitional boundaries.

Hillman and Gilbert (1977) have studied VOT values of fluent contextual speech of stutterers and compared with VOT values of non stutterers. Ten stutterers and ten non stutterers were asked to read the rainbow passage. Intervocalic voiceless stop consonant segments were selected and displayed on wide-band spectrograms. Results Indicated that (a) stutterers displayed longer VOT values than the non stutterers; (b) VOT values increased in duration as the place of articulation moved back in the oral cavity.

Lisker and Abramson (1964, 1974) have opined that VOT is the critical acoustic cue underlying voicing distructions in all languages of the world, whereas Winitz (1975) opines aspiration as the primary perceptual cue in detection of voicing and VOT being an unimportant secondary cue.

VOT has been found to differ from each voiceless stop sound and its voiced counterpart. VOT has also been found to increase consistently with respect to the position of articulation, i.e., as it moves backward in the oral cavity (Lisker and Abramson, 1964, Zlatin and Koenigshiecht, 1976, Basu 1979).

Language has been found to be a variable in VOT measurement. Lisker and Abramson (1964) have studied VOT for a number of languages including Tamil, Hindi, Marathi and English for the stop sounds in word initial positions. The VOT values obtained were found to vary from language to language. They have also reported that VOT values are lesser in running speech than in non-sense syllables. Hence, type of speech sample is another variable for VOT measurement.

Speakers age has been found to be yet another variable influencing the VOT. Ravishankar (1981) found that the VOT values show a gradual change with increasing age. 7-8 year period can be considered as the time at which stabilization of VOT is seen in males.

Summerfield and Haggard (1972) have observed VOT values to be decreasing with increase in speaking rate.

Summerfield (1974), Klatt (1975) have indicated that the VOT for a given stop depends upon several features of phonetic context.

Thus a number of variables have been found to affect VOT. But the effect of noise on VOT hag not been studied. Most of the speech samples were limited to reading a passage or sounds in isolation. Spontaneous speech has been given little consideration.

Review of literature reveals that there is a deficiency in studies attempting to spectrographically analyze the effects of masking noise on stutterer's speech.

The only relevant study in this regard is that of Bryton and Conture (1978). They have investigated the effects of noise and rhythmic stimulation on stutterers vocal fundamental frequency, vowel duration and vocal level and the relation these variables have to one another and to stuttering during noise and rhythmic stimulation. Measurements of speech variables were obtained from audio and graphic level recordings and from narrow and broad band spectrograms. Results indicated that stuttering was significantly reduced during noise and rhythmic stimulation with the reduction during rhythmic stimulation being significantly greater than the reduction during noise. Decreases in stuttering were correlated with increases in vowel duration during both conditions for 7 of 9 subjects. They have interpreted the findings to suggest that temporal changes in speech production are related to decrease in stuttering that occurs during noise and rhythmic stimulation.

Thus, the Review of Literature leaves an impression that there is considerable need for spectrographically investigating the effects of masking noise on stutterers speech.

CHAPTER III

METHODOLOGY

The purpose of the study was to find out the effects of masking noise on rate of speech, fluency, fundamental frequency, voice onset time, vowel duration and vocal level in stutterers and normals.

Selection of subjects:- Four stutterers ntatohod for -age, 3ax+-4:eeuJiii<9 proi-lnnncy iind tnteil^yeneo^and with no other speech and hearing problems, except stuttering, were selected for this experiment.

Four non stutterers matched for age, sex, intelligence and reading proficiency were selected as control group. They had no speech and hearing problems.

The stutterers were selected on the following criterion:

1) Having Kannada as mother-tongue
2) Registered at All India Institute of Speech and Hearing, Mysore, for their speech impediment and were diagnosed and confirmed by competent Speech Pathologist, as stutterers
3) The stuttering was marked as moderate to severe in nature
4) Willing to participate in this study.

The stutterers and non-stutterers (all males) were in the age range of 18 years to 28 years, with a mean age of 23 years.

All speech recordings were done using a unidirectional microphone in a quiet room of the Speech Pathology Department of All India Institute of Speech and Hearing, where ambient noise levels ranged from 45 dB SPL to 60 dB SPL.

Equipment used

1) A portable Audiometer (Arphi - Calibrated to ISO 1964 standards)

2) UHER Tape Recorder (SG 631 LOGIC professional tape recorder)

3) SPECTROGRAPH (Voice Identification, INC - 700 Series)
4) Audio Frequency Analyzer (B&K 2107)
5) Digipitels (An accessory of Spedtrograph)
6) Stop Watch

Preparation of reading material

For the purpose of reading, a non-emotional and meaningful passage (about coconut) was selected. This passage had two parts. The number of words were equal in both the parts, and words which were to be analyzed spectrographically had occured in both parts. Care was taken in preparing passage so that four vowels (/a/; /e/, /u/, /i/) in initial position and three consonants(/Q/, /p/, /k/) in different words would occur so that it would become easy for measurement after spectrographic analysis.

To determine the time taken to read each passage, five normal subjects were requested to read each passage and it was found that time taken to read each passage was same. Mean time taken to read each passage was 28 seconds.

Procedure

A portable audiometer (Arphi-portable, calibrated to ISO standards) was used to deliver the masking noise binaurally. The noise output was fixed at 90 dB HTL for all subjects.

The following instructions were given in Kannada to all subjects (stutterers and non-stutterers):

"ನಾನು ಈಗ ಇದನ್ನು ನಿಮ್ಮ ಕಿವಿಯ ಮೇಲೆ ಇಡುತ್ತೇನೆ. ನೀವು ಈ ವಾಕ್ಯಗಳನ್ನು, ಸಾಮಾನ್ಯವಾಗಿ ಓದುವ ತೆರದ ಓದಿ"

"Now I am going to put the earphones on your ears and please read this passage as you usually do".

The passage I and the passage II were alternately presented to encounter the order effect.

Subject No. 1 read the passge I in the absence of masking noise and this reading was recorded on professional tape recorder (UHER SG 631 LOGIC).

In part 2 of the experiment, the earphones were placed again on the ears after giving same instructions and read the passage II in the presence of masking noise and the reading was recorded using the tape recorder (UHER SG 631 LOGIC).

The same procedure was used for both stutterers and non-stutterers but masking noise was presented alternately as shown in the table below:

TABLE 4..

Subjects	Reading without noise	Reading with noise
1	Passage I	Passage II
2	Passage II	Passage I
3	Passage I	Passage II
4	Passage II	Passage I

Thus the readings of all subjects with and without masking were collected for the purpose of further analysis.

Analysis of speech samples

The collected speech samples were subjected to the following analysis:

1. Measurement of stuttering blocks - both in the absence and in the presence of masking noise.

2. Measurement of mean values of rate of speech - both in the absence and in the presence of masking noise.

3. Measurement of mean values of fundamental frequency - both in the absence and in the presence of masking noise.

4. Measurement of mean values of vocal level - both in the absence and in the presence of masking noise.

5. Measurement of mean values of voice onset time - both in the absence and in the presence of masking noise.

6. Measurement of mean values of vowel duration - both in the absence and in the presence of masking noise.

1. Measurement of stuttering blocks

For the purpose of measuring the number of stuttering blocks, the definition of stuttering (defined elsewhere) given by Wingate (1964) was adopted. Here number of stuttering blocks per passage was recorded, both in the absence and in the presence of masking noise. This was done by the investigator and a senior post-graduate student of Speech Pathology and Audiology.

No blocks, however, were observed in samples of non-stutterers in both the conditions.

2. Measurement of mean values of rate of speech

The rate of speech for both stutterers and non-stutterers both in the absence and in the presence of masking noise was measured using a stop watch and mean rate of speech was determined.

3. Measurement of mean values of fundamental frequency

To measure the fundamental frequency, the output from the professional tape recorder was given the "DIGIPITCH", which is an accessory of spectrograph (Voice Identification INC - 700 series). This equipment gives a direct digital display of fundamental frequency variations of the running speech (reading material). The whole passage was fed to the "Digipitch" to note the variations in fundamental frequency and thus fundamental frequency variations were noted.

The same procedure was used to find out fundamental frequency variations in each passage of all subjects both in the absence and in the presence of masking noise.

4. Measurement of mean values of vocal level

Measurement of mean values of vocal level (intensity) were computed in the following way by obtaining values for each subject.

A B&K Audio Frequency Analyzer No. was used to measure the vocal intensity after making necessary adjustments. For this purpose, five sentences in each passage (which have been underlined in appended passages used for the study) were selected and fed to the audio-frequency analyzer from the professional tape recorder and the intensity range for each sentence was noted. Thus, this procedure was carried out for all subjects readings - both in the absence and in the presence of masking noise and mean values were obtained.

5. Measurement of mean values of voice onset time and
6. vowel duration of predetermined vowels and consonants, both in the absence and in the presence of masking noise was done from the spectrograms of predetermined words which were analyzed using spectrograph (Voice Identification, INC, 700 series).

The following procedure was used to obtain spectrograms.

Eight words (i.e., predetermined words) consisting of four vowels (/a/, /e/, /u/ and /i/) in initial position and four consonants(/k/, / /p /, /a/ in initial position in each passage, were transferred to the tape recorder of the spectrograph from the professional tape recorder, on which it was originally recorded, using internal line recording technique.

Both Wideband and Narrowband spectrograms were obtained to measure voice onset time and vowel duration.

Voice onset time for stop consonants and vowel duration were measured using a time scale.

Thus the analysis of speech samples was done.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to verify the hypotheses 1, 2, 3, 4, 5 and 6. Results are discussed only on the basis of mean deviation obtained for experimental and control group for different variables as no statistical treatment could be given to the results obtained as the population studied was too small.

1. The effect of noise on rate of speech

The number of syllables read per second in the absence and in the presence of binaural masking noise were calculated for normal speakers and stutterers. The results have been tabulated in Tables 2 and 3.

Table 2: Showing the number of syllables read per second in the absence of and in the presence of binaural masking noise by non-stutterers (normal speakers)

Subject No.	Absence of binaural masking noise	Presence of binaural masking noise
1	5.80	6.20
2	7.45	7.24
3	6.70	7.09
4	5.13	4.76
Mean	6.27	6.32

Table 3 showing the number of syllables read per second in the absence and in the presence of binaural masking noise by stutterers

Subject No.	Absence of binaural masking noise	Presence of binaural masking noise
1	4.30	3.72
2	1.86	1.70
3	3.31	4.11
4	2.52	2.86
Mean	3.01	3.10

Among stutterers, subject No. 1 and subject No. 2 showed a reduction in the number of syllables read per second in the presence of binaural masking noise whereas, subjects No. 3 and 4 showed an increase in the presence of binaural masking noise. The mean number of syllables read per second for the group in the absence of binaural masking noise was 3.01 and the mean number of syllables read per second in the presence of binaural masking noise was 3.10. The rate of speech was almost same. The rate of speech was same during reading in the presence of binaural masking noise when compared to reading in the absence of binaural masking noise in this group. Thus the hypothesis No. l(a) "that there will be no significant difference in the mean rate of speech values of stutterers in reading in the absence and in the presence of binaural masking noise" is accepted.

In the control group (non-stutterers), subjects No. 1 and 3 showed an increase in the number of syllables read per second in the absence of noise to the presence of noise whereas subjects 2 and 4 showed a reduction in the number of syllables read per second in the absence of noise to the presence of noise. The mean number of syllables read per second in the absence of noise was 6.27 and the mean number of syllables read per second in the presence of noise was 6.32. Thus the hypothesis No. l(b) "that there is no significant difference in the rate of speech of normals under reading in the absence and in the presence of binaural masking noise is accepted. Thus it can be concluded that binaural masking noise has no effect on rate of speech, both in case of stutterers and non-stutterers. However, the effect may vary with individual subjects, as shown in this experiment, i.e., the rate of speech may increase in some and may decrease in some others.

Further, it can be concluded from this experiment that the stutterers have taken more time to read the passages when compared to non-stutterers, i.e., the mean time taken by the stutterers to read the passage in the absence of binaural masking noise was 52.33 seconds, whereas, non-stutterers have taken 28 seconds to read the same passage under similar conditions. Similarly, non-stutterers have taken less time to read the passages under binaural masking noise condition (28.5 seconds) compared to stutterers who have taken more time to read the same passages (41 seconds). This may be because of the presence of stuttering in the stuttering group. Therefore, it can be concluded that stutterers rate of reading is low compared to normals.

2. The effect of noise on stuttering blocks

The number of stuttering blocks occured per passage, in each subject, in the absence and in the presence of binaural masking noise were calculated for non-stutterers and stutterers. The results have been tabulated in Table 4.

Table 4 shows the frequency of stuttering blocks in the absence and in the presence of binaural masking noise for stutterers.

Subject No.	Absence of binaural masking noise	Presence of binaural masking noise
1	13	11
2	38	35
3	12	8
4	22	17
Mean	21.25	17.75

The introduction of binaural masking noise in non-stutterers did not affect the fluency, hence no stuttering like blocks were observed. Thus the hypothesis 2(b) "that there will be no significant difference in the blocks of normals under reading in the absence and in the presence of binaural masking noise" is accepted.

On the contrary, all stutterers shewed an increase in fluency, i.e., reduction of stuttering blocks in the presence of binaural masking noise, when compared to the absence of binaural masking noise condition. The mean number of stuttering blocks in the absence of binaural masking noise was 21.25 per passage and mean number of stuttering blocks in the presence of binaural masking noise was 17.75. Thus in stutterers, the number of stuttering blocks reduced in the presence of binaural masking noise. Therefore, the hypothesis No. 2(a) stating that "there will be no significant difference in mean value of stuttering blocks of stutterers under reading in the absence and in the presence of binaural masking noise" is rejected. Therefore, it may be concluded that binaural masking noise has effect on stuttering, i.e., in stutterers, stuttering would be reduced under binaural masking condition.

3. Effect of noise on fundamental frequency of voice

The fundamental frequency was observed in reading a passage, in each subject, in the absence and in the presence of binaural masking noise for stutterers and non-stutterers.

The results have been given in Tables 5 and 6.

Table 5 shows the mean fundamental frequency values under reading in the absence and in the presence of binaural masking noise for stutterers

Subject No.	Fundamental frequency under reading in the absence of binaural masking noise	Fundamental frequency under reading in the presence of binaural masking noise
1	112.5 Hz	125 Hz
2	137.5 Hz	165 Hz
3	125 Hz	147 Hz
4	117 Hz	130 Hz
Mean	123.12 Hz	141.87 Hz

All stutterers showed an increased fundamental frequency in the presence of binaural masking noise than in the absence of binaural masking noise condition. The mean value of fundamental frequency in the absence of binaural masking noise was 123.12 Hz and the mean value of fundamental frequency in the presence of masking noise was 141.87 Hz. Thus the hypothesis 3(a) stating that "there will be no significant difference in the mean fundamental frequency values of stutterers in the absence of binaural masking noise" is rejected.

Similarly, even non-stutterers exhibited an increased fundamental frequency in the presence of binaural masking noise than in the absence of binaural masking noise condition.

Further, the comparison of difference of mean fundamental frequency in two different conditions between non-stutterers and stutterers shows that the increase in fundamental frequency is greater in case of stutterers than non-stutterers.

4. The effect of binaural masking noise on vocal level

The mean values of the vocal level (intensity), while reading a passage, of each subject, in the absence and in the presence of binaural masking noise for stutterers and non-stutterers were determined and given in Tables 7 and 8.

Table 7 shows mean values of vocal level in dB SPL produced by each stutterer for given sentence in the absence and in the presence of binaural masking noise under reading

Subject Mo.		Sentence I	Sentence II	Sentence III	Sentence IV	Sentence V
1	AMS	85 dB	85 dB	85 dB	85 dB	85 dB
	PMS	100 dB	100 dB	100 dB	100 dB	100 dB
2	AMS	95 dB	95 dB	95 dB	95 dB	95 dB
	PMS	107.5 dB	107.5 dB	107.5 dB	107.5 dB	107.5 dB
3	AMS	95	95	95	95	95
	PMS	102.5	102.5	102.5	102.5	102.5
4	AMS	100	100	100	100	100
	PMS	107.5	107.5	107.5	107.5	107.5

AMS = Absence of Masking Noise; PMS - Presence of Masking Nois e

Grand mean value of vocal level in the) 93.12 dB
absence of binaural masking noise)

Grand mean value of vocal level in the)
presence of binaural masking noise) 106dB

In general, both stutterers and non-stutterers showed an increased vocal level in the presence of binaural masking noise than to absence of binaural masking noise while reading a passage, as expected.

That is, there was an increase in the vocal intensity in the presence of masking noise.

For stutterers, the mean value of vocal intensity in the absence of masking noise was 93.12 dB s L and in the presence of masking noise was 106 dB. Therefore, the hypothesis 5(a) stating that "there will be no significant difference in mean vocal intensity values of stutterers', under reading in the absence and in the presence of binaural masking noise" is rejected.

The hypothesis 5(b) stating that "there will be no significant difference in mean vocal level values of non-stutterers, under reading, in the absence and in the presence of binaural masking noise" is also rejected as evident from the Table No. 8.

Table 8 shows the mean values of vocal level in dB SPL produced by each non-stutterer for given sentence in the absence and in the presence of binaural masking noise un3er reading

Subject No.		Sentence I	Sentence II	Sentence III	Sentence IV	Sentence V
1	AMS	97.5	97.5	97.5	97.5	97.5
	PMS	102.5	102.5	102.5	1O2.5	102.5
2	AMS	87.5	87.5	87.5	87.5	87.5
	FMS	92.5	92.5	92.5	92.5	92.5
3	AMS	92.5	92.5	92.5	92.5	92.5
	PMS	97.5	97.5	97.5	97.5	97.5
4	AMS	87.5	87.5	87.5	87.5	87.5
	FMS	92.5	92.5	92.5	92.5	92.5

AMS = Absence of Masking Noise
PMS = Presence of Masking Noise

Grand mean value of vocal level in the absence of binaural masking noise of non-stutterers) 92.51 dB

Grand mean value of vocal level in the presence of binaural masking noise of non-stutterers) 97.5 dB

The hypothesis 5(c) stating that there will be no significant difference in mean vocal level values of stutterers and non-stutterers, in reading, in the absence of binaural masking noise" is accepted, as the mean difference is only .61 dB.

The hypothesis 5(d) stating that there will be no significant difference in mean vocal level value of stutterers and non-stutterers, in reading, in the presence of binaural masking noise" is rejected as the mean difference is 8.5 dB.

Results also show that there was greater increment in vocal intensities of stutterers compared to non-stutterers, in reading, under binaural masking noise. Stutterers increased their vocal level by 12.88 dB whereas non-stutterers increased their vocal level by only 4.49 dB only.

5. The effect of masking noise on voice onset time (VOT)

The effect of binaural masking noise on voice onset time, in each subject, under reading, in the absence and in the presence of masking noise in stutterers and non-stutterers have been presented in Table No. 9.

Table 9 shows the mean VOT values in seconds for /k/, /p/ and /θ/ - all voiceless stop sounds produced by stutterers and non-stutterers in the absence and presence of binaural masking noise, while reading

Sound	Stutterers		Non-stutterers	
	Absence of Noise	Presence of Noise	Absence of Noise	Presence of Noise
/k/	0.022	0.022	0.023	0.025
/P/	0.020	0.020	0.020	0.017
/e/	0.017	0.020	0.017	0.022

Inspection of Table 9 reveals that there is no significant difference in VOT values in case of stutterers in the absence and in the presence of binaural masking noise. Therefore, the hypothesis 4(a) stating that "there is no significant difference in mean VOT values of stutterers in the absence and in the presence of binaural masking noise" is accepted.

Similarly, the hypotheses 5(b) stating that "there is no significant difference in mean VOT values of non-stutterers in the absence and in the presence of binaural masking noise" is also accepted on the basis of results obtained.

Further, the table also reveals that there is no significant difference between VOTs of stutterers and non-stutterers in the absence and in the presence of binaural masking. Thus the hypotheses 5(c) and (d) are accepted.

Thus, the binaural masking noise seems to have no effect on VOT in stutterers and non-stutterers. In the absence and in the presence of binaural masking, stutterers and non-stutterers produced similar VOTs.

6. The effect of masking noise on vowel duration

The hypothesis No. 6(a) stating that there will be no significant difference in mean vowel duration values of stutterers under reading in the absence and in the presence of binaural masking noise is rejected, as the table no. 10 shows that there is significant difference between the mean values of vowel duration under the two conditions.

Table 10 shows the mean vowel duration on values in seconds for four vowels /a/, /i/, /u/ and /e/ produced by stutterers and non-stutterers in the absence and in the presence of binaural masking noise

Vowel	Stutterers		Non-stutterers	
	Absence of Noise	Presence of Noise	Absence of Noise	Presence of Noise
/a/	0.13	0.16	0.17	0.17
/i/	0.13	0.15	0.12	0.14
/u/	0.10	0.12	0.07	0.11
/e/	0.09	0.13	0.12	0.16

Similarly the table 10 reveals a significant difference between the mean vowel duration values in the readings of non-stutterers in the absence and in the presence of binaural masking noise. Thus the hypothesis 6(b) stating that "there will be no significant difference in mean vowel duration values of non-stutterers, under reading, in the absence and in the presence of binaural masking noise" is rejected.

Thus, it can be concluded that the binaural masking noise has increased the vowel duration - both in the case of stutterers and non-stutterers.

Results of the present study indicate that the stuttering is reduced with increase in vocal intensity level and fundamental frequency and no change in the rate of speech under binaural masking noise. Further, no changes were observed in VOT values in cases of stutterers under binaural masking noise. Similarly in case of non-stutterers no change in the rate of speech, increase in fundamental frequency and increase in vocal intensity levels were observed under binaural masking condition. However, no change in VOT was observed in these subjects also.

There are several reports indicating effects of masking noise on stuttering. However, no report was available to the investigation regarding the analysis of speech of stutterers and non-stutterers under binaural masking noise, under reading, using spectrograph.

The increase in rate of speech under masking noise has been reported by Yaire (1978). This is in contradiction to the findings of the present study. However, in the present study, 2 non-stutterers and 2 stutterers have shown a decrease in the rate of speech or syllable output per second whereas 2 stutterers and 2 non-stutterers showed an increase in the rate of speech or syllable output per second.

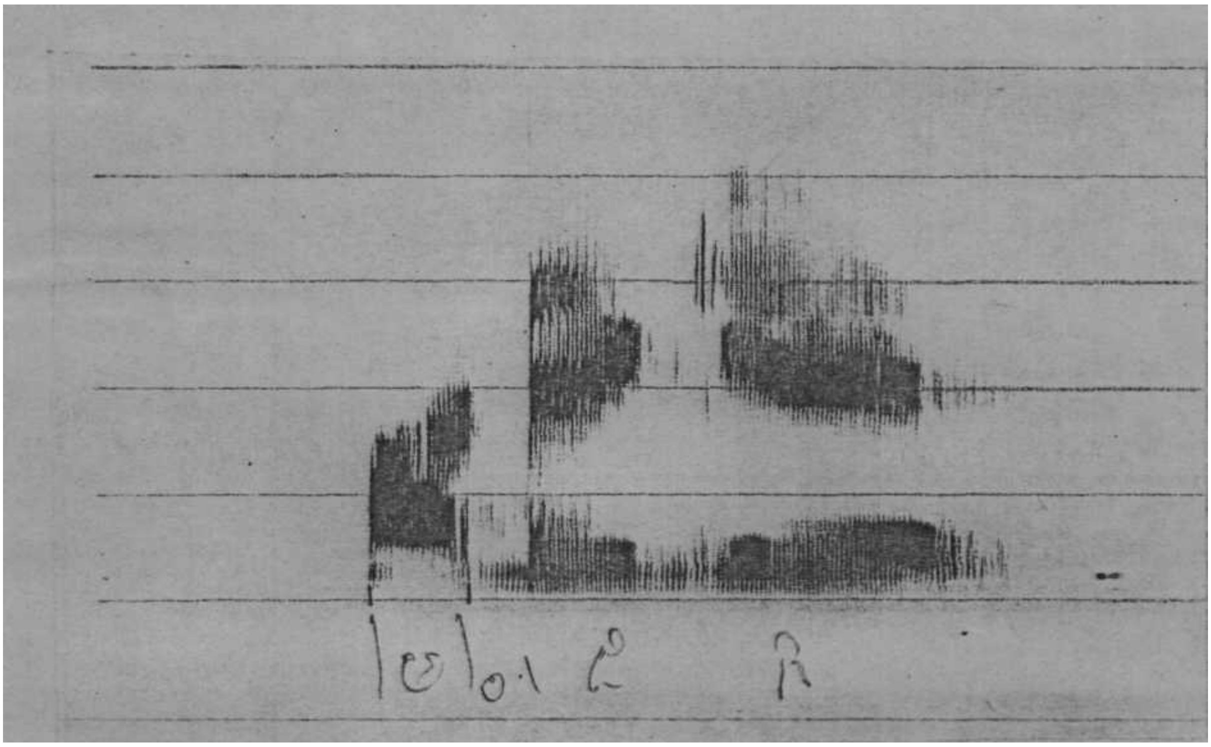
Thus the rate of speech may be varied, i.e., increased or decreased by using binaural masking noise. The individual responses to binaural masking noise in terms of rate of speech may vary, as seen in this experiment.

It is interesting to note that all subjects in the present study have shown an increase in vowel duration under binaural masking noise. Inspite of this, 2 subjects in each group showed a decrease in the rate of speech. This indicates that there is a need for more studies in this regard.

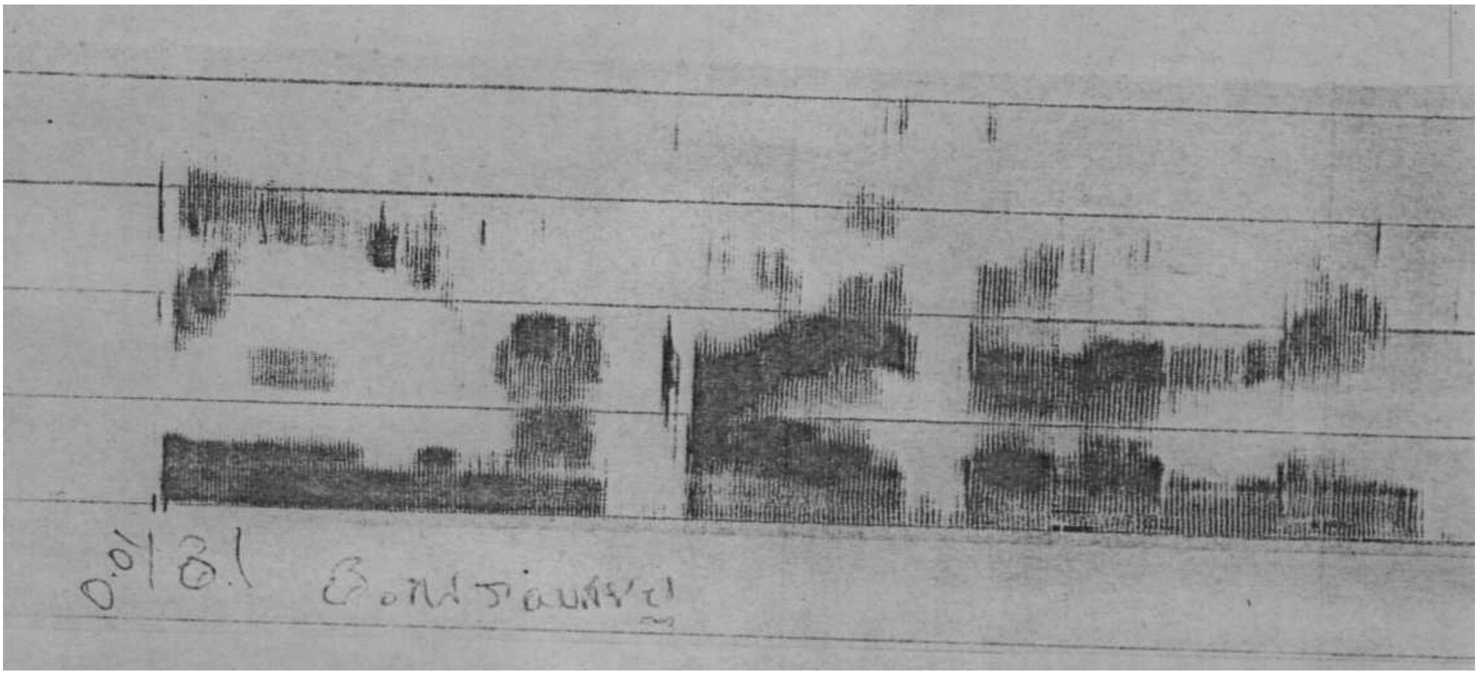
As reported by several investigators Shane (1946), Cherry and Sayers (1956), Maraist and Hutton (1957), Stromsta (1957), Sutton and Chase (1961), Murray (1967) and Ham and Steer (1967), even in the present study, there has been a decrease in the number of stuttering blocks in the case of stutterers under binaural masking noise condition. Some have tried to explain this decrease in stuttering blocks on the basis of decrease in rate of speech (Adams and Hutchinson, 1974; Hanley and Steer, 1949), as slow rate of speech also has shown decrease in the stuttering blocks. However, in the present study it is difficult to offer this explanation, as 2 subjects have shown an increase in rate of speech along with decrease in stuttering blocks. Shane (1946) has attributed reduction of stuttering under high intensity making noise to lack of auditory feedback which will not permit the anxiety producing cues to interfere.

Some investigators have attributed the decrease in stuttering under binaural masking noise to increased vocal intensity levels (Yaire, 1978; Adams and Hutchinson, 1974; Black and Atkinson). In the present study also, there has been a decrease in stuttering blocks under binaural masking along with increase in vocal intensity level. However, Gerber and Martin (1977) have concluded, after assessing the effect of increased vocal levels on stuttering in the presence and in the absence of binaural masking noise, that stuttering reduced in the presence of noise when compared to quiet conditions. Therefore, it is difficult to attribute decrease in stuttering blocks to increased vocal intensity levels. This increase in vocal intensity levels under binaural masking conditions has also been observed in normals, which can be attributed to well known "Lombard effect" and a similar phenomenon was observed in case of stutterers also.

Even though, there are reports attributing decrease in number of stuttering blocks under binaural masking noise to vocal intensity, no report is found attributing decrease in stuttering blocks to increase in fundamental frequency of voice.



Spectrogram of the word



Spectrogram of the word

In the present study an increase in fundamental frequency of voice has been found both in case of stutterers and non-stutterers along with increase in vocal intensity levels under binaural masking condition. It would be appropriate to consider this change in fundamental frequency of voice as a part of "Lombard effect". Even though, these two vocal parameters are affected by masking noise, both in stutterers and non-stutterers, no changes in voice onset time has been observed in the present study. Several investigators (Adams and Reiss, 1971? Agnello and Wingate, 1972; Hillman and Gilbert, 1977; and Babul Basu, 1979) have reported that the stutterers require greater time to initiate phonation (longer VOT) compared to normals. But in present study no such difference was found.

This may be because of speech samples used, i.e., of reading. It has been established by Lisker and Abramson (1964) that reading acts as a variable in the measurement of voice onset time. Further, it was difficult to get clear spectrograms for the speech of stutterers which might have also contributed for this no difference in VOT between the two groups.

Another aspect of speech that would change under binaural masking noise condition, is the vowel duration, as reported by Bryton and Conture (1978). There was an increase in vowel duration in the present study also under binaural masking noise condition. Bryton and Conture (1978) attribute decrease in stuttering blocks under binaural masking noise to increase in vowel duration. They also support this finding by considering the changes in temporal aspects of speech in rhythmic speech. Prolongation of speech as therapy to stuttering, in which vowels are prolonged, i.e., vowel duration is increased, has also been reported to decrease the stuttering blocks. Therefore, it will be interesting to study the effects of this temporal aspect, i.e., increase in vowel duration on stuttering.

It may be concluded that binaural masking noise reduces stuttering along with bringing about changes in vowel duration, vocal intensity and fundamental frequency.

CHAPTER V

SUMMARY AND CONCLUSIONS

Several reports have been made that binaural masking noise has effect on frequency of stuttering and this effect has been attributed to variations in vocal intensity, fundamental frequency of voice, rate of speech and vowel duration.

Bryton and Conture (1978) have analyzed the speech of stutterers under binaural masking and rhythemic speech stimulation using spectrograph. They have attributed the decrease in stuttering under these two conditions to increase in vowel duration. The present study was conducted to find out the effects of binaural masking noise on rate of speech, frequency of stuttering, vocal intensity level, fundamental frequency of voice, voice onset time and vowel duration.

The study consisted of four non-stutterers and four stutterers, matched for age, sex, reading proficiency and intelligence. All the subjects read two passages - one in the absence of binaural masking noise and the other in the presence of binaural masking noise of 90 dB HTL. The readings were recorded using a professional tape recorder. The recordings were analyzed using spectrograph, audio-frequency analyzer, and digipitch to obtain vowel duration, voice onset time, vocal intensity level and fundamental frequency of voice. The rate of speech and number of blocks were also determined.

The results have been discussed.

Conclusions

1. There is a significant decrease in number of stuttering blocks under binaural masking noise condition in case of stutterers.

2. Normals showed no stuttering blocks under binaural masking condition.

3. No significant difference in syllable output per second was found in the absence and in the presence of binaural masking noise in both the groups.

4. Both stutterers and non-stutterers showed an increase in vocal intensity level under binaural masking noise. However, stutterers showed greater increase in vocal intensity than non-stutterers.

5. Subjects of both groups showed an increase in fundamental frequency of voice under binaural masking noise. Again stutterers showed greater increase in fundamental frequency of voice compared to non-stutterers.

6. No significant difference in voice onset time (VDT) was observed in stutterers and non-stutterers - both in the absence and in the presence of binaural masking noise.

7. An increase in vowel duration was found in both stutterers and non-stutterers under binaural masking.

Recommendations for future study

1. The study may be tried on large population.

2. Different kinds of masking noises, i.e., narrow band, saw-tooth, may be tried with stutterers and normals, to see their effects on parameters that have been studied in this experiment.

3. Effect of white noise, at different intensities, on speech and reading may be studied.

4. Different sex and age groups of stutterers may be subjected to masking noise to note its effects.

5. Effect of masking noise on VOT in Kannada and other languages may be compared.

6. Spontaneous speech and reading under binaural masking noise may be compared using a spectrograph.

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APPENDIX I

PASSAGE NO. 1

ತೆಂಗಿನಕಾಯಿಗಳಲ್ಲಿ ಬಗೆಗಳುಂಟು. ಕೆಲವು ಗುಂಡಾಗಿರುತ್ತವೆ. ಕೆಲವು ಉದ್ದವಾಗಿ ದಪ್ಪವಾಗಿರುತ್ತವೆ. ಇದರ ಹೊರಗಡೆ ನಾರಾದ ಗುಂಜಿನ ಹೊದಿಕೆಯಿದೆ. ಇದರೊಳಗೆ ಗಟ್ಟಿಯಾದ ಕರಟವಿದೆ. ಚಿಪ್ಪಿನೊಳಗೆ ಕಾಯಿಯೂ, ನೀರೂ ಇರುತ್ತವೆ. ಕೊಬ್ಬರಿಯನ್ನು ಅಡಿಗೆಯಲ್ಲಿ ಉಪಯೋಗಿಸುತ್ತಾರೆ. ಎಳನೀರು ಕುಡಿಯಲು ಬಹಳ ರುಚಿ. ಅದಕ್ಕೆ ವೈದ್ಯಕೀಯ ಗುಣವೂ ಇದೆ. ನಾರನ್ನು ಹಗ್ಗ ನೇಯಲು, ಜಮಖಾನ ತಯಾರಿಸಲು ಉಪಯೋಗಿಸುತ್ತಾರೆ.

PASSAGE NO. 2

ತೆಂಗಿನ ಮರ ಬಹಳ ಉದ್ದವಾದುದು. ತೆಂಗಿನಕಾಯಿಗಳಲ್ಲಿ ಎರಡು ವಿಧಗಳಿವೆ. ಕೆಲವು ಹಸಿರಾಗಿರುತ್ತವೆ. ಕೆಲವು ಹಳದಿ ಬಣ್ಣವಾಗಿರುತ್ತವೆ. ತೆಂಗಿನ ಮರದಿಂದ ಬಹಳ ಉಪಯೋಗಗಳಿವೆ. ಎಳನೀರಿಗೆ ದಣಿವಾರಿಸುವ ಗುಣವಿದೆ. ಕರಟದಿಂದ ಗುಂಡಿ ಮಾಡುತ್ತಾರೆ. ಗುಂಜಿನ ಒಳಗೆ ಚಿಪ್ಪಿದೆ. ಇದು ಗಟ್ಟಿಯಾಗಿದೆ. ಕೊಬ್ಬರಿಯನ್ನು ಅಡಿಗೆ ಮಾಡಲು ಬಳಸುತ್ತಾರೆ. ನಾರಿನಿಂದ ವಿಧವಿಧವಾದ ಬಣ್ಣದ ಹಗ್ಗ ನೇಯುತ್ತಾರೆ.

APPENDIX II

LIST OF PRE-DETERMINED WORDS SUBJECTED TO SPBCTROGRAPHIC ANALYSIS IN EACH PASSAGE.

PASSAGE 1	PASSAGE 2
1. ತೆಂಗಿನ ಕಾಯಿಗಳಲ್ಲಿ	1. ತೆಂಗಿನ ಕಾಯಿಗಳಲ್ಲಿ
2. ಕೆಲವು	2. ಕೆಲವು
3. ನಾರಾದ	3. ಉಪಯೋಗಗಳಿವೆ
4. ಇದರೊಳಗೆ	4. ಎಳನೀರಿಗೆ
5. ಚಿಪ್ಪಿನೊಳಗೆ	5. ಚಿಪ್ಪಿದೆ
6. ಅಡಿಗೆಯಲ್ಲಿ	6. ಇದು
7. ಎಳನೀರು	7. ಅಡಿಗೆ
8. ಉಪಯೋಗಿಸುತ್ತಾರೆ	8. ನಾರಿನಿಂದ