# DIFFERENTIAL PERCEPTION OF FILTERED SPEECH BY NATIVE SPEAKERS OF TAMIL AND MALAYALAM

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REG.No.M9317

AN INDEPENDENT PROJECT IN PART FULFILLMENT FOR THE FIRST YEAR M.Sc. (SPEECH AND HEARING) SUBMITTED TO UNIVERSITY OF MYSORE.

ALL INDIA INSTITUTE OF SPEECH AND HEARING: MYSORE - 570 006.

MAY 1994

**DEDICATED To**

**A M M A**

**A P P A**

**&**

**my dearest**

**SIDDHU**

**CERTIFICATE**

This is to certify that the Independent Project entitled; DIFFERENTIAL PERCEPTION OF FILTERED SPEECH BY NATIVE SPEAKERS OF TAMIL AND MALAYALAM is a bonafide work in part fulfillment for M.sc., (Speech and Hearing) of the student with Reg. NO.M9 317.

Mysore
May 1994

Dr. (Miss) S.Nikam
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## C E R T I F I C A T E

This is to certify that the Independent Project entitled: Differential Perception of Filtered Speech by Native Speakers of Tamil and Malayalam has been prepared under my supervision and guidance.

Mysore
May 1994

Dr.(Miss) S.Nikam,
GUIDE

**DECLARATION**

I hereby declare that this Independent Project entitled: Differential Perception of Filtered Speech by Native Speakers of Tamil and Malayalam is the result of my own study under the guidance of Dr.(Miss) S.Nikam, Professor and Head of the Department of Audiology, and Director, All India Institute of Speech and Hearing, Mysore, has not been submitted earlier to any University for any other Diploma or Degree.

Mysore
May 1994

Reg.No.M9317

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# INTRODUCTION

Speech is a multidimentional signal that elicits a linguistic association for it to be an effective communication code, some sort of absolute perceptual categorization must be made of its content. The signal must be broken down into finite number of discrete message elements. The size of the perceptual elements and the manner in which they are processed to yield the percept, are the questions of considerable debate which are processed to yield the percept, and not little speculation. Our present knowledge brings us nowhere near a good understanding of the process. Theorizing about speech perception cloaked in all of its linguistic and over learnt functions, abounds with pit falls.

Although a complete theory of speech perception remains in the future a good deal can be said about auditory discrimination. Some of the classical measurements relate strongly to signal dimensions important to speech, even though the measurements are made outside the linguistic and contextual frames.

The articulation index can be used to compute intelligibility scores from physical measurements on the transmission system. Still ancillary to intelligibility testing, some data are available on the influences of linguistic, contextual and

grammatical constraints. Measures of the prosodic and quality features of speech are not well established.

Speech perception seems more likely an absolute classification of an acoustic signal. Man is highly sensitive to differences in the frequency of sounds under certain conditions the threshold for detecting a difference in the frequencies of two successively presented puretones may be as small as one part in thousand. Rosenblith and Stevens (1965) on the basis of comparative judgements, it has been estimated that the normal listeners are able to accomplish perfect identification among only five different tones (Pollack).

Absolute and differential discriminations yeild substantially different estimates of man's informational capacity. In any speech processing mechanism, fidelity criteria based upon differential discriminations would be expected to be very conservative.

Speech perception is an adaptive process in which the detection process probably is tailored to fit the signal and the listening task. If the listener is able to impose a linguistic organization upon the sounds, he may use information that is temporally dispersed to arrive at a decision,

about a given sound element. If such an association is not made, the decision tends to be made more upon the acoustic factors of the moment and in comparison to whatever standard is available,

A number of studies hare aimed at determining the units in which perception occurs. The experiments arrive at disparate results, probably owing to the large difference in perceptual tasks and due to the fact that there may be no single answer to the question.

Many theorists in speech perception appear to link between production and perception. In producing speech the humans have three kinds of feedback - auditory, tactile and proprioceptive. Blocking of one or more of these channels apparently causes some of its functions to be assumed by one of the other channels.

Pollack (194S) studied the effects of high pass and low pass filtering prior to noise addition. There have been studies that have dealt with the condition of filtering in the presence of noise. Such studies have aided in the enhancing of designs for speech intelligibility when noise is at the listeners end. The filter reduces the information necessary for intelligibility when noise is at the listeners

end by suppressing selected frequency range information. The filtering operation neither increases the s/N ratio nor decreases the S/N ratio at a given frequency filtering done, has been observed to enhance the intelligibility of speech for the case of noise at the listener.

There is evidence that the auditory system is especially tuned for speech, Infants, according to their power of auditory discrimination categorize sounds of speech into groups similar to those used in many languages as distinctive categories or phonemes. The evidence indicates that speech perception is a specialized aspect of general human ability, the ability to speak and recognize patterns. The cues are often redundant. Which permits speech perception, to take place under difficult conditions. A speech sound is often perceived by simultaneously perceiving neighbouring acoustic information. There is evidence that speech perception is somewhat specialized and lateralization function in the brain.

An important aspect of categorical perception is the influence that linguistic knowledge can have on the categories perceived. Bilinguals divide stimuli according to the phonemic contrasts of the particular language. Strange and Jenkins (1967) have reviewed many studies of both

monolingual and bilingual speakers. The studies offer evidence that the language experience of adults can influence their perception.

We know that frequency content of a speech signal is an important factor, capable of affecting speech discrimination performance. French and Steinberg (1947) used high pass and low pass filtering conditions, demonstrated the importance of high frequencies for correct identification of CVC syllables when all frequencies greater than 1000 Hz were passed, 90% of the syllables were recognized correctly. However, when frequencies only below 1000 Hz were presented, correct identification of the items declined to 27%. Similar findings were reported by Hirsh et al. (1954). Clinically, high frequency hearing impairment is a common entity and speech discrimination scores may suffer due to combined effects of filtering and distortion.

In the studies conducted on people with central auditory disorders, the following findings regarding the perception of filtered speech were found. Bocca et al. (1954) took 800 Hz cut-off and found that this particular cut-off was important for fiding the integrative functioning of the cortex. Bocca et al. (1955) with a cut-off at 1000 Hz and in the presence

of a temporal lobe tumor, the contralateral ear shows poor performance. Jerger (1954) also reported the same findings.

There are many studies that are being done and that have been done to show the effects of filtering on the perception of speech. There are no set of values that have been established to show that one set of frequencies is more superior than the other, to enable the perception of filtered speech.

The present study aims at finding out the effect of different filtering conditions on the perception of speech and to find out the effect of knowledge of a particular language affecting the perception of filtered speech.

## REVIEW OF LITERATURE

There have been several studies conducted over the ages to find how changes in parameters of speech would affect the perception of speech. One of the many different types of experiments are the filtered speech experiments. It is well known, that based on the frequencies which are affected, the deaf tend to lose the information that is available in the affected frequency. It is very difficult for a layman or a professional to understand exactly how it feels to be deaf. One of the major drawbacks would be the difficulty in understanding speech, because speech perception would not be normal, if some of the frequencies are cut-off. Most of the studies in speech perception have been done on normals. The best way to simulate a high or low or mid frequency deafness would be by using filters, which can be set at various levels, such that only those frequencies that are specified are passed through and others are not. There have been many studies that have been done by comparing the perception of speech by native speakers of two different languages. There have also been studies, wherein by changing other parameters of filtered speech, perception has been compared.

In one study done by Williamson, Marx, Rebeccalaw (1983) in which filtered speech was presented at various intensities,

it was found that for normal hearing subjects, the type of filtering did not affect speech comprehension until the intensity of the filter signal approached 15 dB SL. Below this, however there was a difference in the perception of speech by a few listeners. Constant and vowel identification were only slightly affected by filtering if the signal is at 15 dB SL.

Another study by Neiderjohn and Mliner (1982) showed that low pass filtering enhanced perception of speech in noise, that is, the S/N ratio by suppressing noise in the frequency range where speech in any case is likely to be masked. The filtering operation reduces the information necessary for intelligibility by suppressing selected frequency range information, in some cases, below the threshold of hearing. Since the filtering operation does not increase the S/N ratio there is no reason to expect an enhanced intelligibility by filtering.

Speaks (1965)Jerger (1965) stated that under conditions of low pass filter where synthetic sentences were given, it Wasseen that performance varied with relative informational content. Testing was done using synthetic sentences and as the amount of information given in the artificial sentences decreased, the subject performance deteriorated. The same results were found when there was periodic interruption of the sentence.

Speaks (1967) studied the effects of frequency filtering on intelligibility of synthetic sentences. Intelligibility of synthetic sentences were found to be quite dependant on low frequency energy. The important frequency of identification of that particular material was 725 Hz.

In a study done by Black (1959) the purpose of the study being the way to determine 20 bands of frequencies which contribute equally to multiple tones. The sounds which were monosyllabic were presented as high pass, band pass and low pass. They found that there were 20 bands of frequencies from 250 Hz to 7000 Hz which were most necessary. They also found that as cut-off frequency increased, the articulation index also increased.

Webster (1964) based on a study, came to the conclusion that speech was deteriorated equally when all frequencies, either above or below 1900 cycle per second were filtered out, or the frequency range above 1900 cycles per second is as important as the range below 1900 cycles per second. Baranek (1964) found the cross over frequency to be 1660 cycles per second. It has been agreed to by many experimentors that the threshold of hearing, at 1000 cycles per second would be the best predictor of hearing loss type and degree.

There was a report by Hanley (1956) on how certain characteristics of speech or puretones are affected by various conditions imposed and how these factors affect the perception of speech. It was seen that the high pass and low pass filtering had the same effect on speech characteristics. Both high and low pass filters had a very strong influence on the frequency distortion. They had a medium influence on the synthesis and a very less amount of loading on the meaningfulness. The low and high pass filters affect synthesis slightly more than meaningfulness and the maximum affected is the frequency distortion.

Kryter (1956) reported that it was the speech signal which was affected by a sharp frequency distortion. Noise is often broad band and regular in spectral shape. Thus a compromise of converting speech from per cycle basis to a broader 20 equal articulation band spectrum and by narrowing the spectrum of noise will be more effective.

Lawrence, Solomon and Webster (1960) various speech phenomena such as tonal detection voice memory, resistance to distortion, resistance to masking, unpleasantness synthesis and a separate factor used for musical talent. They concluded that the ability to understand filtered, reverberant, interrupted, clipped and noise masked speech is a single capability.

Based on a study by Leo-Postman with which a particular item is recognized depends upon the frequency with which this item has been discriminated and used in the past. The more familiar the item, the more redundant the stimulus. Redundancy, in torn facilitates perceptual recognition on the basis of reduced stimulus cues. An improvement in word recognition can be achieved through the strengthening and differentiation of verbal habits* The same principles of learning apply to both linguistic behaviour and the perceptual recognition of words.

Stelmachowiez, Lewis, Kelly, Jesteadt (1990) studied speech perception in low pass filtered noise and reported for normal and hearing impaired listeners. The hearing impaired listeners require a better S/N ratio than the normal listeners at either presentation level for all except the widest bandwidth where their S/N ratios begin to converge with normal values* In aadition, the *S/N* ratios for the hearing impaired listeners plateaved at relatively narrow band widths (0.75 - 2.5 KHz) compared to the normal hearing group. The addition of high frequency component to noise did not alter their performance. These findings suggest that the hearing impaired listeners may have relied upon either low frequency cues or prosodic cues.

Bell, Dirks, Levitt and Dubno(1986) reported from their study that low pass filtering significantly affected error patterns. When categorized by place of articulation, duration or nasality whereas high pass filtering only affected voicing and frication error patterns. Another study by the same authors, revealed that the effect of filtering was dependant upon presentation level and consonant position. In another study by the same authors, - the contribution of certain frequencies to consonant place perception for normal hearing listeners and those with high frequency hearing loss to characterize the different stop consonants recognition and error patterns were examined at various speech presentation levels and under conditions of low pass and high pass filtering. Differential filtering effects on consonant place perception were consistant with spectral composition of acoustic cues. The reduction in audibility for normal hearing provided by fixed frequency, low pass filters, did not appropriately model changes in recognition resulting from high frequency hearing loss.

The effect of combining low pass and high pass bands on consonant recognition in the hearing impaired was done by Barbara Franklin (1975). A comparison was made on consonant recognition. Scores when a low frequency pass band and high frequency pass band were presented to either the same

ear or opposite ear of the hearing impaired. In her study she quoted Miller and Nicely (1955) "low pass filters affect the several linguistic features differently, leaving the phonemes audible but similar in predictable ways, whereas high pass filters remove most of the acoustic power in the consonants, leaving them inaudible and consequently producing quite, random confusion". The results showed that most of the errors were place errors, some manner errors and no voicing errors. The substitution of /s/ for voiced plosives and this was seen even in normals (Franklin, 1969). This means there are acoustic cues for /s/ in low frequencies. In a study done on normal hearing subjects it was seen that there was a total increase in the recognition score when low pass filter was added to high pass and this showed that the low frequency contained information regarding consonants. Rosenthal (1972) reported that some hard of hearing children might improve in the use of residual hearing, if they wore an extended low frequency amplifier on one ear and a standard aid on the other.

## METHODOLOGY

This is a study that was called out on Indian population to find how filter conditions affect the perception of speech.

### Selection of subjects:

18 subjects were taken, age ranging from 17 to 22 years These subjects were divided into three groups based on their native language.

Group-l: Comprised of six native speakers of Malayalam.

Group-2: Comprised of six native speakers of Tamil.

Group-3: Comprised of speakers of both Tamil and Malayalam (bilinguals).

All the speakers knew English as their second language. The bilingual speakers were chosen based on their ability to communicate using either Tamil or Malayalam of the six bilingual speakers 3 of them were Tamil speakers who had learnt Malayalam due to environmental influences and the other three were native speakers of Tamil who had learnt Malayalam due to the influence of the environment.

A passage was read out to the bilinguals and based on their ability to understand the meaning of the passage, and

to express the meaning adequately and effectively, they were chosen for the study. The native speakers of Tamil were made to comprehend a Malayalam passage and the native speakers of Malayalam were made to comprehend a Tamil passage.

All the subjects chosen were volunteers for the study and had normal otological findings and passed the criteria of 0-15 dB HL from 250 Hz to 8 KHz.

**INSTRUMENTATION :**

Stimulus: A set of 50 words were selected from the list prepared by Srilatha (1980). Of the fifty words, 24 words were selected after subjecting the initial list to familiarity rating, was performed by persons who were familial with both the languages. All the words were either bisyllables or trisyllables. The words were audio recorded using the voice of a female speaker.

Instrumentation: The GSI-10 Audiometer was used as the screening device to plot the threshold of the subjects. Those subjects whose thresholds were within 0-15 dB bilaterally in the frequency range 250 Hz to 8 KHz. Goodman's classification modified by Clark (1981) were selected for the study stimulus words were presented through the TDH 50 earphones.

Stimulus words were audio recorded using a meltrack cassette and Philips deck F6112 and the dynamic microphone used was (MD 43).

The recorded word list was filtered using the Hearing Science Lab. The process of filtering was preceeded by measuring the frequency response of the earphones of the Hearing Science Lab, and using Graph Level Recorder (B&K2307 and a signal generator (B&K 10223).

TEST ENVIRONMENT;

The entire procedure was done in a sound treated room where the ambient noise levwl was was dB.

**PROCEDURE:**

A list containing fifty words were subjected to familiarity rating, by speakers who knew both the languages. The rating was done on a 3 point scale in which O-unfamiliar, 1 - familiar and 2 - most familiar. They were given two days time. 24 words were then chosen which were rated to be most familiar. The words were then recorded using a Philips Deck F6112. There were seven lists made of the 24 words based on the process of random sampling.


Fig (a) Shows the set up for the recording the word lists.

The next step was to obtain the frequency response of the Hearing Science Lab.

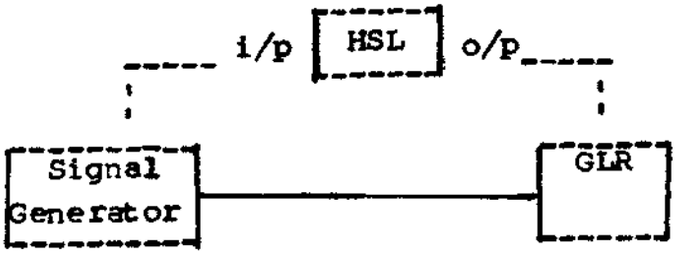



Fig. (b) Schematic representation for the frequency analysis of HSL.

The filtering of the word list was then done.

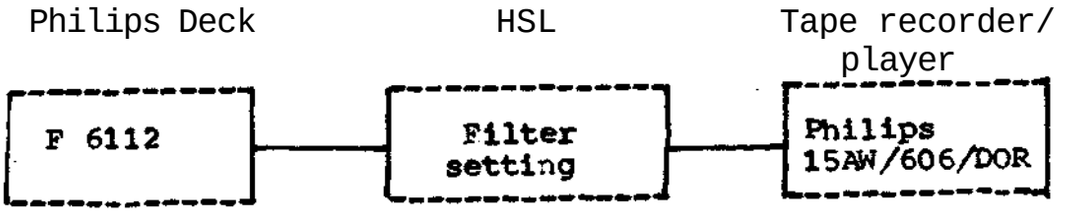



Fig.(c) The instrument set-up for the filtering process.

The filter conditions used were as follows:

There were six filtered conditions and the 7th was the unfiltered word list. The frequencies taken were as follows:

$T1_i$ - 250 Hz high pass

T2 - 250 Hz low pass

$T_3$ - 1 KHz high pass

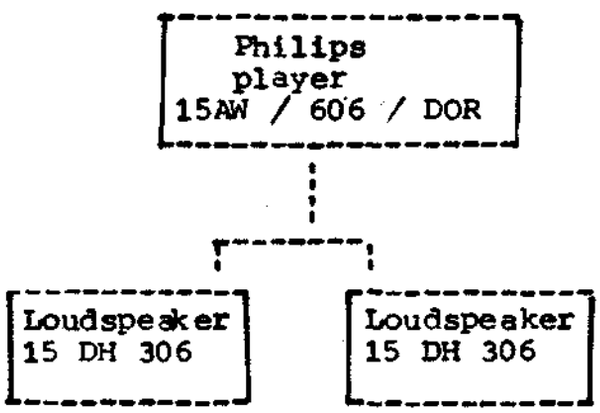
$T_4$ - 1 KHz low pass

$T_5$ - 4 KHz high pass

T6 - 4 KHz low pass

T7 - Unfiltered condition

The filtered words were then presented to each of the subjects.




Pig. (d) Shematic representation for the presentation of the word lists to the subjects

The subjects were asked to write down whatever sound they heard through the loudspeaker, may it be meaningful or non-meaningful.

The written down responses were then given numerical values and then were subjected to a statistical analysis.

## RESULTS AND DISCUSSION

The main aim of the study was

1. To see if the performance of a particular group of subjects was significantly different over the different filter conditions,
2, To test if the knowledge of a language affected the performance in the filtered speech task.

The mean values of performance are shown in the following tables*

| | |
|---|---|
| **1** | **21** |
| **2** | **22** |
| **3** | **20** |
| **4** | **21** |
| **5** | **16** |
| **6** | **19** |

(i) The mean of Malayalam speakers on list T1

| | |
|---|---|
| **1** | **17** |
| **2** | **19** |
| **3** | **16** |
| **4** | **17** |
| **5** | **10** |
| **6** | **7** |

(ii) The mean of Malayalam speakers on list $T_2$

| | |
|---|---|
| 1 | 24 |
| 2 | 22 |
| 3 | 20 |
| 4 | 21 |
| 5 | 15 |
| 6 | 19 |

(iii) Mean of Malayalam speakers on list $T_3$

| | |
|---|---|
| 1 | 23 |
| 2 | 23 |
| 3 | 19 |
| 4 | 21 |
| 5 | 21 |
| 6 | 22 |

(iv) Mean of Malayalam speakers on list $T_4$

| | | | | | |
|---|---|---|---|---|---|
| 1 | 20 | 1 | 24 | 1 | 24 |
| 2 | 17 | 2 | 22 | 2 | 24 |
| 3 | 13 | 3 | 22 | 3 | 24 |
| 4 | 18 | 4 | 23 | 4 | 24 |
| 5 | 10 | 5 | 23 | 5 | 24 |
| 6 | 17 | 6 | 22 | 6 | 24 |

(v) Mean of the Malayalam speakers on list $T_5$

(vi) Mean of Malayalam speakers on list $T_6$

(vii) Mean performance of Malayalam speakers on List T7

The mean values of the scores obtained by the Tamil speakers is shown below:

| | | | | | |
|---|---|---|---|---|---|
| 1 | 23 | 1 | 9 | 1 | 20 |
| 2 | 21 | 2 | 20 | 2 | 19 |
| 3 | 15 | 3 | 8 | 3 | 17 |
| 4 | 22 | 4 | 11 | 4 | 23 |
| 5 | 17 | 5 | 2 | 5 | 19 |
| 6 | 22 | 6 | 4 | 6 | 22 |

Mean of the Tamil speakers on list T1

Mean value of Tamil speakers in list $T_2$

Mean value of Tamil speakers in list $T_3$

| | | | | | |
|---|---|---|---|---|---|
| 1 | 24 | 1 | 18 | 1 | 22 |
| 2 | 20 | 2 | 19 | 2 | 23 |
| 3 | 20 | 3 | 11 | 3 | 20 |
| 4 | 24 | 4 | 20 | 4 | 22 |
| 5 | 22 | 5 | 16 | 5 | 22 |
| 6 | 23 | 6 | 19 | 6 | 22 |

Mean of the Tamil speakers list $T_4$

Mean of the Tamil Speakers on list $T_5$

Mean of Tamil Speakers on list T6

| | |
|---|---|
| 1 | 24 |
| 2 | 24 |
| 3 | 24 |
| 4 | 24 |
| 5 | 24 |
| 6 | 24 |

Mean of Tamil speakers on list $T_7$

The mean performance of the bilinguals is shown on the following tables.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 22 | 1 | 17 | 1 | 22 |
| 2 | 21 | 2 | 17 | 2 | 21 |
| 3 | 23 | 3 | 17 | 3 | 22 |
| 4 | 23 | 4 | 17 | 4 | 20 |
| 5 | 22 | 5 | 15 | 5 | 17 |
| 6 | 18 | 6 | 12 | 6 | 19 |

Mean score of bilinguals on T1 | Mean score of bilinguals on $T_2$ | Mean score of bilinguals on $T_3$

| | | | | | |
|---|---|---|---|---|---|
| 1 | 23 | 1 | 21 | 1 | 23 |
| 2 | 24 | 2 | 20 | 2 | 24 |
| 3 | 24 | 3 | 21 | 3 | 23 |
| 4 | 24 | 4 | 12 | 4 | 222 |
| 5 | 24 | 5 | 16 | 5 | 24 |
| 6 | 20 | 6 | 17 | 6 | 23 |

Mean values of the bilinguals on list $T_4$ | Mean values of bilinguals on list $T_5$ | Mean values of bilinguals on list T6

| | |
|---|---|
| 1 | 24 |
| 2 | 24 |
| 3 | 24 |
| 4 | 24 |
| 5 | 24 |
| 6 | 24 |

Mean Of the bilinguals on list T7

Based on the mean values of each list a common mean was obtained for each of the three groups and the values -are given below:

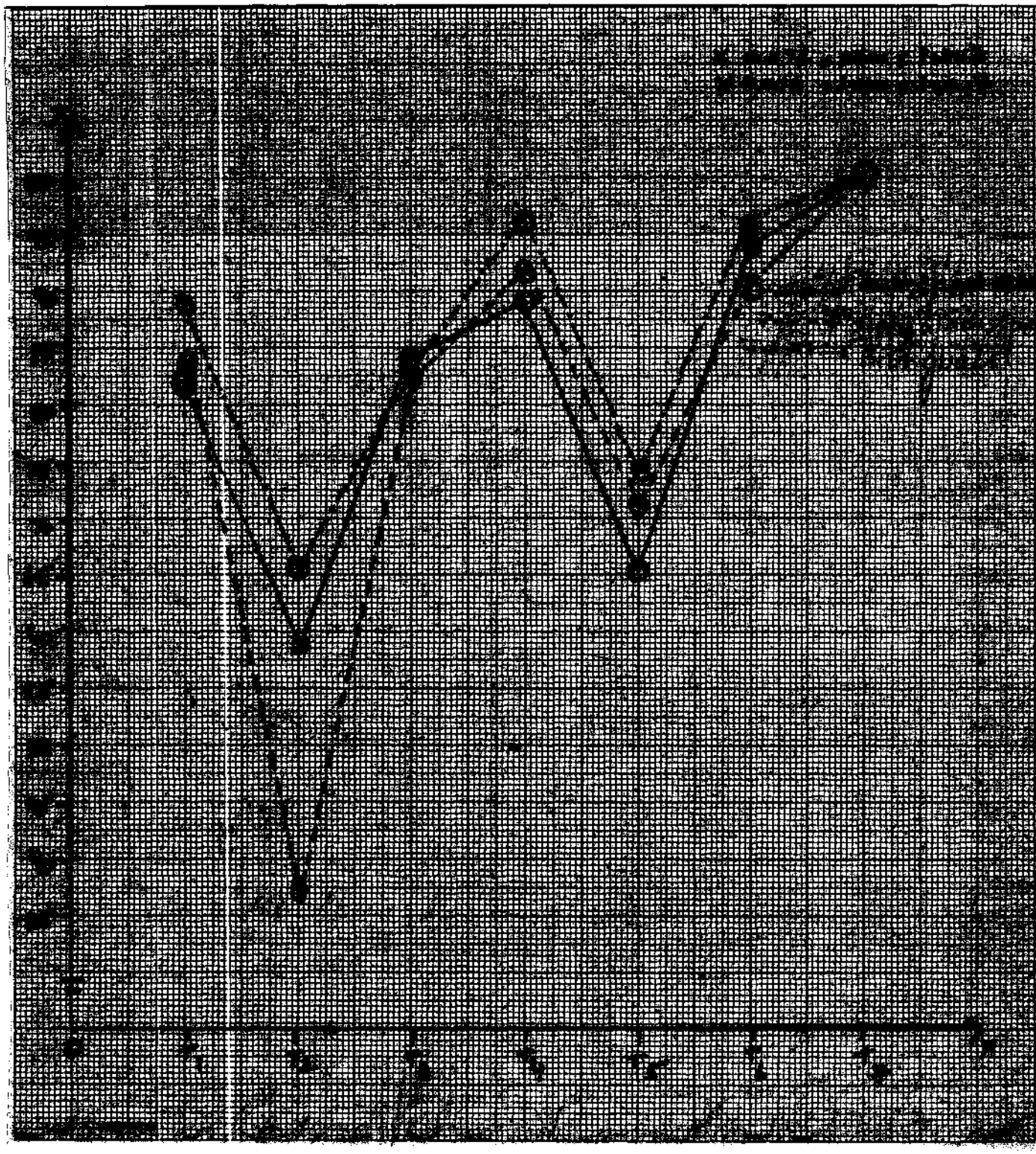
| List Number | Malayalam speakers | Tamil Speakers | Bilinguals |
|---|---|---|---|
| $T_1$ | 19.8 | 20 | 21.5 |
| $T_2$ | 14.33 | 9 | 15.83 |
| $T_3$ | 20.16 | 20. 16 | 22.16 |
| $T_4$ | 21.5 | 23. 6 | 22.16 |
| $T_5$ | 15.83 | 17 .16 | 17.83 |
| $T_6$ | 22.6 | 21. 8 | 23.16 |
| $T_7$ | 24 | 24 | 24 |

Table (b) Showing the common meaN of the performance of each of the groups onthe word lists.

Based on the common means obtained,, a percentage graph was made.

| List number | Malayalam speakers | Tamil Speakers | Bilinguals |
|---|---|---|---|
| $T_1$ | 82.5% | 83.3% | 89.5% |
| $T_2$ | 59.7% | 37.5% | 65.95% |
| $T_3$ | 84% | 83.3% | 84% |
| $T_4$ | 89.5% | 92.3% | 96.5% |
| $T_5$ | 65.95% | 71.5% | 74.29% |
| $T_6$ | 94.16% | 90.8% | 96.5% |
| $T_7$ | 100% | 100% | 100% |

Table (c) Showing the values of the mean performance of each of the groups when converted into percentages.



A graphical representation of the percentage scores obtained on the performance of the three groups.

From this, it can be seen that the three groups shoved poor performance in the lists $T_2$ and $T_5$, that is 250 Hz low pass and 4 KHz high pass respectively.

Within and between group comparisons were made to see the performance within a group and between languages.

Table (d) showing the within group comparison of the speakers of Malayalam. It was seen that when each list was compared against the other, there was significant difference between all the groups except T1 against T6 and T3 against $T_7$ at the 0.01 level. The significance value was obtained using the oaired ' t' test-

Table (d) : Malayalam Speakers

| Lists compared | Significance | |
|---|---|---|
| | 0.01 | 0.05 |
| $T_1$and $T_2$ | / | / |
| $T_1$ and $T_3$ | / | / |
| $T_1$ and T4 | / | / |
| $T_1$ arid $T_5$ | / | / |
| $T_1$ and $T_6$ | | / |
| $T_1$ and $T_7$ | / | / |
| $T_2$ and $T_3$ | / | / |
| $T_2$ and $T_4$ | / | / |
| $T_2$ and $T_5$ | / | / |
| $T_2$ and $T_g$ | / | / |
| $T_2$ and $T_7$ | / | / |
| $T_3$ and $T_4$ | / | / |
| T3 and T5 | / | / |
| T3 and T6 | / | / |
| $T_3$ and T7 | - | / |

/ = Significant.

not significant.

L ^ -

| Lists compared | Significance | |
|---|---|---|
| | 0.01 | 0.05 |
| $T_4$ and $T_5$ | / | / |
| **$T_4$** and **$T_6$** | / | / |
| $T_4$ and **$T_7$** | / | / |
| **$T_6$** and **$T_6$** | / | / |
| $T_5$ and $T_7$ | / | / |
| **$T_6$** and $T_7$ | / | / |

Table-E: showing the performance of Tamil speakers within the various groups.

| Lists compared | Significance | |
|---|---|---|
| | 0.01 | 0.05 |
| **$T_1$** and **$T_2$** | / | / |
| **$T_1$** and **$T_3$** | / | / |
| $T_1$ and $T_4$ | / | / |
| **$T_1$** and **$T_5$** | - | / |
| **$T_1$** and **$T_6$** | / | / |
| **$T_1$** and $T_7$ | / | / |
| $T_2$ and $T_4$ | / | / |
| **$T_2$** and $T_4$ | / | / |
| $T_2$ and $T_5$ | - | / |
| $T_2$ and **$T_6$** | / | / |
| $T_2$ and **$T_7$** | / | / |
| **$T_3$** and $T_4$ | | |
| **$T_3$** and **$T_5$** | | |
| $T_3$ and $T_7$ | / | / |
| $T_4$ and $T_5$ | / | / |
| $T_4$ and **$T_6$** | / | / |
| $T_4$ and **$T_7$** | / | / |
| $T_5$ and $T_6$ | / | / |
| $T_5$ and **$T_7$** | / | / |
| $T_6$ and **$T_7$** | / | / |

From Table (E) is clear that except between the lists $T_1$ and $T_1$, that is the 250 Hz high pass and the unfiltered list there is no significant difference. Between $T_2$, and $T_5$ that is 250 Hz low pass and 4 KHz high pass there is no significant difference atthe 0.01 level. All the other groups are significant.

Table-F Bilingual speakers:

| Lists compared | Significance | |
|---|---|---|
| | 0.01 | 0.05 |
| $T_1$ and $T_2$ | / | / |
| $T_1$ and $T_3$ | / | / |
| $T_1$ and $T_4$ | / | / |
| $T_1$ and $T_5$ | / | / |
| $T_1$ and $T_6$ | / | / |
| $T_1$ and $T_7$ | - | / |
| $T_2$ and $T_3$ | / | / |
| $T_2$ and $T_4$ | / | / |
| $T_2$ and $T_5$ | / | / |
| $T_2$ and $T_6$ | / | / |
| $T_2$ and $T_7$ | / | / |
| $T_3$ and $T_4$ | - | / |
| $T_3$ and $T_5$ | / | / |
| $T_3$ and $T_6$ | - | / |
| $T_3$ and $T_7$ | / | / |
| $T_4$ and $T_5$ | - | / |
| $T_4$ and $T_6$ | / | / |
| $T_4$ and $T_7$ | | - |
| $T_5$ and $T_6$ | / | / |
| $T_5$ and $T_7$ | / | / |
| $T_6$ and $T_7$ | - | / |

Table-F: Showing the performance score significance of the bilinguals.

Table-(F) showing the difference in the performance across the various lists by the bilinguals. It can be observed from the table that there is no significant difference among the following groups:

(1) $T_1$nd $T_7$: That is 250 Hz high pass and the unfiltered condition.

(2) $T_3$ and $T_4$: 1 KHz high pass and 1 KHz low pass.

(3) $T_3$ and $T_6$ 1 KHz high pass and 4 KHz low pass.

(4) $T_4$ and $T_5$: 1 KHz low pass and 1KHz high pass.

(5) $T_4$ and $T_7$: 1 KHz high pass and the unfiltered condition.

(6) $T_g$ and $T_?$: 4 KHz low pass and no filter condition.

When the comparison is done between groups, then the results obtained were as shown in Table (G),

| List number | Malayalam | Tamil | Bilinguals | Significance 0.05 | 0.01 |
|---|---|---|---|---|---|
| $T_2$ | / | / | | / | / |
| | / | | / | / | / |
| | | - | - | - | / |
| $T_6$ | / | / | | / | / |
| | / | | / | / | / |
| | | - | - | / | |

From Table (G) we can make out that When the list $T_2$ is considered there is no significant difference in the performance

of the Tamil speakers and the bilingual*. When list $T_6$ is considered then, there is no significant difference between speaker of Tamil and the bilinguals. In the remaining lists, the groups were significantly different.

From the levels of significance that were obtained using the ' t' test, it can be said that the differences within the groups are significant, that is to say that the subjects did not perform the same way in the list as they did in another so it can be said that the filter conditions were effective in the perception of speech.

Taking the Malayalam speakers into consideration the following points can be noted,

1) For the Malayalam speakers, there is no difference, whether the speech is 250 Hz high pass or 4 KHz low pass, which means that both the cut-offs have the same value, enabling the perception of speech.
2) There is no difference in the performance when the condition is unfiltered or when it is a 1KHz high pass, indicating that the frequencies above 1 KHz are not very important for the perception of speech.

Taking the Tamil speakers into consideration the following points can be noted.

1) There is no difference in the performance when the words are 250 Hz high pass or when they are 4 KHz low pass, indicating that the frequency difference between 1 KHa and 4 KHz are the most important for the perception of speech.
2) Another finding is that there is no difference in the performance at the 250 Hz high pass and the 4 KHz low pass condition, indicating that this range is important for the perception of speech.

From the results of data of the bilinguals the following conclusions can be drawn:

1) There is no difference in the performance between 250 Hz high pass and unfiltered conditions, which means that the frequencies below 250 Hz are not very essential for the perception of speech.
2) There is no difference in the performance of the 250 Hz low pass and 4 KHz high pass condition, showing that above 250 Hz and below 4 KHz lie the most important range for speech perception.
3) There was no difference in performance between 1 KHz high pass and 1 KHz low pass. This may indicate that most of the frequencies which enable the correct perception of speech should be around 1 KHz.
4) There is no difference in the performance between 1 KHz high pass and 4 KHz low pass. This shows that this

frequency range could be the most important for the perception of speech by bilinguals.

5) There was no difference in the performance between the 1KHz low pass and 4 KHz high pass condition. This means to say that the frequencies below 1 KHz and the frequencies above 4 KHz are both equal in importance for the perception of speech.
6) There is no difference between the unfiltered condition and the 1 KHz low pass showing that frequencies below 1 KHz enable the complete perception of speech.
7) There was no difference in the performance of the bilinguals in the unfiltered condition and 4 KHz low pass condition, indicating that the frequencies below 4 KHz are the ones that enable the best perception of speech.

Taking into consideration the between group comparison: The following results can be drawn:

It can be said that filtering does not affect the performance between groups, that is knowing a particular language does not affect the perception of speech.

## SUMMARY AND CONCLUSION

Review of literature shows that the filtering of speech at various frequency levels adversely affects the perception of speech.

This study was an experimental study done on Indian population to see how filtering would affect speech perception.

Two languages, Tamil and Malayalam were taken and a common word list was made. The words were then filtered at various cut-off frequencies and three groups of listeners were made to perceive these words, one group of Tamil speakers, one group of Malayalam speakers and a group of bilinguals.

The results obtained indicated that there was significant difference in the performance among the various Malayalam speakers showing that the filtering does affect the performance.

Based on the performance of the Tamil speakers, it was seen that there was a significant difference between the Tamil speakers, indicating that filtering does affect the perception of speech.

The performance of bilinguals also indicates that there is a significant difference between the performance of each of the bilinguals on the various lists.

But when the performance is compared across the different languages, it was seen that there was no significant difference between the Tamil, Malayalam and the bilingual speakers. This indicates that filtering does not effect the performance on different languages, indirectly we can say that knowledge of a language does not effect the performance.

**LIMITATIONS OF THE STUDY:**

This study has been done on a common word list and so the groups exposed, knew the words. The lists $T_2$ and $T_5$ were a little less in intensity when compared to the other lists.

**IMPLICATIONS AND RECOMMENDATIONS:**

In future there should be a study that compares across two groups, out of which one group knows the language and the other group does not. The stimuli can be presented through the earphone of an audiometer so that the intensity can be increased when necessary.

## BIBLIOGRAPHY

Barbara, F. (1975). The effect of combining low and high frequency pass bands on consonant recognition in hearing impaired. JSHR (18).

Charles* S., and Jerger, J. (1965). Method of speech identification. JSHR (8).

Charles, S. (1967). Intelligibility of filtered synthetic sentences. JSHR (10).

Dirks, D.D., and Bell, T.S. (1986). Log linear models of consonant confusion data. JASA (85).

Dubno, J.R., Donald, D.W., and Ellison, D.E. (1989). Stop consonant recognition for normal hearing listeners and those with high frequency hearing loss. JASA.

Dirks, D.D., Bell, T.S., and Caratette, C. (1989). Interactive factors in consonant confusion. JASA (85).

French and Steinberg (1947). Cited in Katz, J. (1985). Handbook of Clinical Audlology. Buffalo University, Waverly Press, USA.

Fletcher (1953). Cited in Katz, J. (1985). Hand book of Clinical Audiology. Buffalo University, Waverly Press, USA.

Hanley, N.C. (1956). Factorial analysis of speech perception. JSHD (21).

Hirsh (1954). Cited in Katz, J. (1965). Handbook of Clinical Audiology. Buffalo University, Waverly Press, USA.

John, W.B. (1959). Equally contributing frequency bands in intelligibility testing. JSHR (2).

James, F.C. (1960). A factorial study of speech perception. JSHR (3).

Kryter, K. (1963). Hearing impairment for speech. Archives of Otolaryngology, (77).

Kryter, K.D. (1956). Predicting the intelligibility of speech from acoustic measures. JSHD (21).

Neiderjohn, R.J., and Mliner, D.G. (1982). The effects of high pass and low pass filtering upon the intelligibility of speech in White noise. JAR (22).

Pollack, M.c. (1975). Amplification for the hearing impaired. Harcourt Brace Jovanovich Publishers, New York.

Ramachandran, R.P., and Peter, K. (199 3). Frequency domain adaptive post filtering for enhancement of noisy speech. JSHD.

Rosenwig, R.M., and Leo, P. (1957). Perceptual recognition of words. JSHD (22).

Speaks, D.W., and Grant,K.W, (1985). The contribution of fundamental frequency, amplitude envelope and voicing duration cues to speechreading in normal hearing. JASA (77).

Stelmachowicz, P.G., and Lewis, D.E. (1990). Speech perception in low pass filtered speech for normal and hearing impaired listeners. JSHR (2) 33.

Webster, J.C. (1964). Important frequencies in noise masked speech. Archives of Otolaryngology (80).

Williamson, D.G., and Marx, J.A. (1983). The effects of high pass filtered speech on speech discrimination. BJA (17).