Speech discrimination as a function of Age

by
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A Dissertation
Submitted in Part Fulfilment of The Degree of
Master of Science (Speech and Hearing)
UNIVERSITY OF MYSORE
1983

To Amma, Appa and AKka

C E R T I F I C A T E

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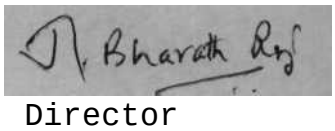

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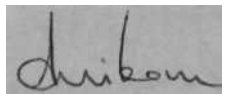

Dr.(Miss) Shailaja Nikam
Guide

D E C L A R A T I O N

This dissertation is the result of my own work done under the guidance of Dr.(Miss) shailaja Nikam, Professor and Head, Department of Audiology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

MYSORE.

Dated:18 May 1983. Reg. No. 8

ACKNOWLEDGEMENT

I wish to acknowledge my gratefulness to my guide Dr. (Miss) Shailaja Nikam, for her flexible and excellent guidance and supervision throughout the study.

I thank Dr. Ratna, for having given me an opportunity to conduct this study.

I I express my sincere thanks to Mr. S.S. Murthy and Mr.N.P. Nataraja for extending all facilities in conducting this study.

My thanks are specially extended to Mrs. Shakunthala Sharma and Dr. Jayaram for their valuable help rendered for statistical and computer analyses of the data.

I specially thank Mr. Satyanarayana, Mr. Tataji and Mr. Bharath kumar for having given full support in recording the speech material.

My thanks are due to Indira, Mrs. Mythili, Arati and Sreelatha for having assisted me in data collection.

My special thanks to Malini, Suma, Asha, Anu and Elizabeth for their support and assistance at all the stages of this work.

I sincerely thank Mrs. shakunthala and Miss Punitha for giving me mental support through out this study.

I personally thank Mrs. pushpa and Mr. Srikanth for their neat type script.

Last but not the least, I thank all my subjects who volunteered for the listening task.

C O N T E N T S

List of Tables

List of Figures

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C H A P T E R - I

I N T R O D U C T I O N

> "The Speech of our children is our interest and the communication of man is our concern? we seek out those who are halting in speech and we offer help to those whose ears have been confused by disease. Life without speech is empty and life devoid of communication is scarcely better than death". - West (1972).

Communication is the sending and receiving of messages both verbal and non-verbal within, between and/or among people. (Oyer and Oyer, 1976). This is a social glue that bind people together and is done mainly through speech. The frequent occurence of the wore speech emphasize the fact that the speech is the source of energy that drives the vehicle of communication.

The vehicle of communication breaks down at two stages of human life cycle. The first level is at the time when we make our first appearance in the world of communication i.e., at our infancy period. The infant does not have adequate speech as a tool to carry out the communication.

The second level of breakdown is at the older age, where the efficiency of the parts of the vehicle are reduced hindering the movement of the vehicle. The efficiency of the part are analogous to the optimal

functioning of the sense organs of the human biological system and the vehicle to the speech communication.

With the advancing age, there is concomitant reduction in the optimal functioning of the senses; The sense of hearing is one which is of utmost importance - as a catalyst for the human speech communication system. Thus the deterioration of hearing as the age advances imposes a heavy tax on the elderly.

The deterioration in hearing as the age advances is termed 'presbycusis' in the audiological term; loss of hearing acuity has been evident in two spheres: 1) pure tone and 2) Speech perceptual/discriminatory ability, various aspects of this are studied which are as follows:

a) Pure tone sensitivity among the aged (Miline, 1975; Miline, 1977; INDRANI, 1981)

b) Speech audiometry (Goeth, 1948; Hayes & Jerger, 1979)

c) Time altered Speech (Bocca & Calearo, 1963; Konkle, Beasley & Bess, 1977)

d) Frequency distorted speech (Kirikae, 1969)

e) Competing message tasks (Carhart & Nicholos, 1971; Mukundan, 1977)

f) Directional hearing ability.

g) Pitch and intensity discriminatory ability.

All these studies agree upon one commonality that there is generally over all reduction in the discriminatory aspects in terms of intensity, frequency and quality of speech as the age advances.

In India two studies have been conducted in this area:

(1) Establishing normative data for different age groups for the pure tone sensitivity.

(2) The performance of the aged on the competing message tasks.

Thus the limited number of studies conducted in India call for the standardization of basic speech discrimination test. This study serves the purpose.

NEED FOR THE STUDY:-

Phonemic regression refers to the discrepancy in the older persons between the hearing level for speech and the discrimination loss - pointing out the rarity of such a finding in the younger age group. This disproportionality is a characteristics of the neural degeneration, if this be the case, one might expect the articulation function for the elderly population to rise with increasing intensity provided the individuals are from a population selected to preclude factors which might account for substantial end-organ lesion; If such a function were established, it could serve as a useful reference against which the

(1) Does the discrimination score vary significantly as a function of age?

(2) Is there an effect of varying sensation level (SL) on the Speech Discrimination scores of the various age groups?

(3) Is there any interaction between Age and sensation Level?

(4) Are the four lists of N.U. Auditory Test No.6 equivalent?

(5) Is the list - level interaction significant?

(6) Is there an age-list-SL interaction?

performance of different age groups could be compared.

Though English tests have been standardized to Indian population (non-native speakers of English), no attempt has been made to find out the speech discrimination score across the various age groups.

Most often, the tests have been standardized on normal hearing adults? Based on these norms, if the elderly people are evaluated, they are prone to diagnosis of handicapped even though it is normal to their age level. Thus each group should be compared with the norms of the corresponding age group to avoid the wrong diagnosis (labelling normal ageing process as abnormal).

This present study thus yields?

(1) data on speech discrimination as a function of age?
(2) identifying the areas of deficiency (Central auditory disorders)?
(3) Gives us an idea in deciding the compensation for the noise induced hearing loss.

SUMMARY AND STATEMENT OF THE PROBLEM

This study was conducted on Seventy five adult male subjects, who were categorized into five groups based on their age. They were in the age range of 19 to 77 years. Their discrimination ability was tested through N.U. Auditory Test No. 6. This study aimed at answering the following questions:

(1) Does the discrimination score vary significantly as a function of age?

(2) Is there an effect of varying sensation level (SL) on the Speech Discrimination scores of the various age groups?

(3) Is there any interaction between Age and sensation Level?

(4) Are the four lists of N.U. Auditory Test No.6 equivalent?

(5) Is the list - level interaction significant?

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C H A P T E R - II

R E V I E W O F L I T E R A T U R E

Gerontologists believe that the aging process begins even before we are born. Though some recent studies (Bergman 1967) indicate that our sensitivity for puretones increases, till puberty and there on there is a slight decline especially around 4KHz. The following paragraphs outlines the hearing sensitivity as a function of age in the normals through various stages of development.

(a) hearing in early years.
(b) hearing in early adult-hood.
(c) hearing in middle and late adult-hood.

(a) Hearing in early years;-

We are well aware of the problems that is encountered in testing the peadiatric group? Because of this obvious difficulties, there are no data for the hearing thresholds of infants soon after birth; This lack of information has been partly cleared by one of recent studies by Eagles (1967) cited by Bergman 1967): The results indicate that from least sensitive hearing level, for children at the age of 5, hearing for puretone improves, reaching a peak at the age of 12 years and then begins to recede at the age of 13 years and 14 years.

(b) Hearing in early adult-hood:-

Despite the many precautions and controls the actual SPL of the thresholds for young adults who are free of history of ear disease have varied considerably in different studies. Wis-cousin state Fair study 1957; Pittsburg study; American audiometric zero. But all these studies agree upon one thing that normal hearing acuity limit is between - 10 to + 26dB HL - Bergman (1962).

(c) Hearing in the middle and late adult-hood:-

Since people in this group are exposed to high intensity noise in the industry, in and around home environment, it is difficult to isolate the acoustic insult from those of aging in the pure sense: To obtain the effects of aging alone on hearing, ideally one should compare the hearing in each succeeding decade of life of persons who were not exposed to noise; both moderate / high intensity noise exposure.

In these aspects, studies done by Glorig (1960), Rosin and Bergman (1962), Corso (1963) and Kapur (1967) indicate the following:

(1) It appears that noise is a contaminanting factor in curves of hearing with aging. The greater the exposure to noise, the more hearing loss in each decade.

(2) Populations in our mechanised society show more hearing loss with the advancing age than the tribal population. This is considered in detail in answering the question "Is presbycusis a combined effect of socio—acusis?"

With this brief introduction as to how the age affects the hearing ability of an individual, now the remaining part of the literature deals with how this middle / late adult-hood group of people perform in various aspects of auditory behaviour.

Effects of aging on Puretone sensitivity:-

Problems of audition frequently are equated with the process of growing older, atleast in the popular view". This general openion is not without substance, since most elderly persons do experience more hearing difficulties than younger individuals. Z Waardemaker (1899) was the first to investigate this diminution of hearing acuity quantitatively in the elderly and he coined the term 'presbycusis' meaning loss of hearing acuity that develops as the result of aging.

Zwaardemaker (1899), further noticed that high frequency thresholds diminished with the increasing age and this process starts as early as the second or third

decade of human life. Supportive evidences come from Benyold (1894), Struy Ben (1913), Cicocoo (1932) and Schober (1952). Hinchcliffe (1959) demonstrated a progressively deteriorating hearing loss through the age of 70 years where as Goetzinger (1961) found significant deterioration of hearing through the age of 89.

Bunch (1926, 1927) made the first description of the hearing acuity of the elderly for the puretones using an electronic audiometer. The common feature depicted by his work was that tonal sensitivity becomes progressively lessened for high frequency stimuli especially for those above lOOOHz. Confirmatous evidence was contributed by Bunch (1931), Glorig and Wheeler (1957), Corso (1963), and Kloty and Kilbanc (1962) (cited in Hill 1979).

With the growing interest in this area, two surveys have been conducted which are as. follows:
Glorig (1954) published the data from the Wisconsin state Fair hearing survey on men and women up to seventy nine years of age. The result of the survey indicate the following:

(1) Hearing loss for puretones become greater with increasing age.

(2) The onset of hearing loss is more gradual among women than among men except in later years the reverse comes true.

(3) with each 10 years increase in age for males, the median hearing loss at 6KHz, increases approximately l0dB as compared with only 3 dB at 1KHz.

Similar findings have been reported in the National health Survey (1962) in USA.

The following are the studies which outlines the differential effect of aging on male vs female:
Corso (1963) investigated the influence of aging on auditory threshold and he reported a progressive deterioration of sensitivity for puretone of high frequency region beyond the age of 60 years;, More over, the rate of deterioration of hearing in women is fairly uniform as a function of age, where a& men exhibited marked changes in hearing on the average about every 15 years.

Miller and Ort (1965) found a high frequency slope in 88% of a group of individuals over the age of 65 years. Generally, the loss is greater for men in frequencies above 4KHz and for the women in the low frequency region. This difference according to them is attributed to the greater noise exposure in men than in women. Corso (1971) also agrees with Miller and Ort (1965) stating that the hearing level for men is higher than that for women, age held constant for 2000HZ and above, at and below 1KHz the hearing level for women tends to be slightly higher than for men.

Traynor & Hull (1974)-cited in Hull 1979) found similar observations as Miller & Ort (1965) and they also said that impact of aging on hearing cannot be appreciated without considering the speech reception and discrimination capabilities.

Miline (1975) measured hearing level for puretones in 215 men and 272 women and results showed that both sexes showed 1. increase in hearing loss in each frequency with increasing age, 2. hearing loss was greater in women for 1KHz and at 2KHz and above for men and 3. the difference in hearing loss between higher and lower frequencies were greater in male aged population.

Two reports regarding the audiometric configuration age given. Burn (1968) reported that in presbycusis, proggressive deterioration of hearing of high tones occured thus yielding a gradually sloping configuration. Dayal and Nussbaum (1971) administered puretone testing on a small selected sample of aging population and their results indicated that 12% of the group demonstrated flat hearing level configuration. Thus, from these studies it is evident that the hearing loss can be evident only at higher frequencies and/or through out the frequency range, viz 250 - 8000HZ. Flat hearing loss can thus stem from the cummulative effect of normal aging process and pathological condition.

Above studies indicate that the hearing loss seem as age advances is of sensory neural type. This finding has been reported by pestalozza and Shores 1957, Glorig et al 1961 and Rosen et al 1965. All these authors have reported of all air borne gap in the aged people and attributed that to the conductive component. This was explained based on the middle ear changes due to aging. Supportive evidence for this finding was given by Miline (1977). In this study, the air-borne gap was computed in an audiometric study of hearing loss in a random sample of older people using sound frequencies of lKHz and 4KHz and omitting persons with abnormal ear drums in 215 men and 272 women. The results indicated the presence of a gap larger than l0dB was greater in both sexes for the higher frequencies and there was no age effect on the air bone gap but the gap increased as the hearing loss in increased.

Glorig (1957) reported the average puretone thresholds of individuals with age range 10 to 79 years of age. The results show that the greatest impairment is in the higher frequencies, beginning with A slight degree at the ages 10 to 19 years. At ages 60 to 69 years, slight degrees of decrement in lower frequency region is noted.

In the similar lines, Feldman and Reger (1967) tested thirty six males between the agess 50 - 86 with pure

tone test, speech tests of simple reaction time to evaluate the relation of auditory sensitivity and reaction time. The results of the study indicated - i. there was a decrease in sensitivity, as the age increased. ii. inspite of the gradual decrease in sensitivity with age, the threshold at frequencies below 2000HZ remain within the normal range through seventh decade, iii. In 50 - 59 year old group a mild high frequency loss was present, iv. In the old 70 year group a moderate to severe loss was seen. v. in the 7th decade and above, a spread of sensitivity decrement to the low frequencies begin to appear and by the eighth decade small but definite sensitivity impairment is present in the low frequency region.

Indian tudies regarding puretone sensitivity as a function of age are few. But recently, Indrani (1981) observed the threshold of hearing by air conduction as a function of age and sex among Indian population. A total of 180 subjects were chosen randomly, the age range of the subject being 10 years 6 months to 87 years. The subjects were categorized into six age groups. The data obtained from tympanometric, reflexo-metric puretone audiometry testing and Blood pressure were compared. The results of the study indicated that there was an increase in hearing thresholds with age in both men and women.

The onset of hearing loss as a function of age occured in the fifth decade of life. The elevation of hearing thresholds was gradual upto fourth decade. But this elevation was marked about 12 dB between fourth and fifth decade in women and between the fifth and sixth decade in men.

All these studies indicate that elderly individuals exhibit high frequency symmetrical hearing loss bilaterally. According to Hinchcliffe. (1962) the two major audiological features in puretone sensitivity as a function of age are-

(i) impairment of auditory sensitivity: It is generally thought that this process is due to the degenerative changes in sensory neuro epithelium of the ear. This is observed only in the later adult life though hearing sensitivity starts deteriorating from the childhood. The cells in the brain also degenerates with age. The cells in the superior temporal gyrus are reduced by half over the period from 20 to 70 years of age.

(ii) Lowering of the upper tone limit is due to the threshold sensitivity for the very high tones becoming much less sensitive with increasing age.

Presbyacusis: a combined effect of socioacusis:

One of the most important factor that obscures the clear understanding of presbycusis is the damage produced by noise-induced hearing lossy thus in the advancing ages,

the human ear is not only subject to the aging effects but also the social stress on the part of the individual. The studies (Glorig, 1960; Rosen, 1962; Corso, 1963; Kapur, 1967; Bergman, 1967;, Spoor, 1969;; Reynand and Canara, 1969) indicated that the aging effects on the hearing acuity should be delineated from that of the acoustic insult to obtain norms on hearing acuity as a function of age:

Glorig et al (1960) conducted a survey on subjects from a relatively quiet environment and concluded that the home environment does influence the amount of presbyacusis experienced. They suggested that the so called presbyacusis is probably is a mixture of aging and socioacusis.

Rosen et al (1962) conducted a study on the isolated tribe - the Mabaans in a remote area of Sudan. One hundred subjects were included in each decade from 10 to 70 yearas of age; The testing was conducted in a rest house where the ambient noise level was 40 dB and the testing was done upto 24000 Hz; The results showed a slight decrement in hearing among Mabaans to physiological aging and thus the author concluded that so called presbycusis in modern society is really noise induced socioacusis.

Corso (1963) working with subjects from a nonindustrial relatively noise free environment found there was a seemingly

pure presbycusis of agine, deteriorating in hearing of men and women. The average hearing loss exhibited by the group in this study was considerably less than the general survey normative datar.

The studies done by Kapur (1967) on the Todas of Nilgiris and Jarvis (1967) on the Bushman of south African showed little deterioration as a function of age. Thus these studies indicate that hearing ability is dependent upon the way of life and the environment.

Spoor (1969) gave the median hearing level for non-noise exposed males and females of 25 to 85 years at various test frequencies – the values were based on the data of the 5 different studies where the upper (QU) and lower Quartile (QL) limits and mean are computed. The results indicated the following-

(1) M - OU and QL - M are linearly rising functions of age at all frequencies and is almost identical for both sexes.

(2) For a 25 year old group M – OU and QL - M increases from 4 dB at 250HZ - 6 dB at 8000Hz.

(3) For a 65 year old group M - QU increases with the frequency from 4 to 12 dB and AL - M from 5 to 12 dB.

The above studies clearly depicts the effects of noise exposure on aging. This belief has been disproved by the two following studies.

Vander Sandt and Glorig (1969) estimated the hearing acuity at various age levels in a group of 90 subjects from the Kalahari Bushman. The results of their study indicated that-

(1) no significant difference between the people in modern society and tribes.

(2) A high incidence of middle ear pathology in this population caused a distinct drop in the air conduction at an early age.

Raynand and Cannara 1969 - study on Africans from rural and nomadic environments aging 40 - 70 years showed that audiometric curve do not show exception degree of conservation of hearing in the high frequencies.

These two studies go against the belief that the tribes possess 'supra natural hearing'. This contra-indication can be explained on the following lines.

(i) Many of the inhabitants of tribes were afflicted by the middle ear infections due to unhygenity and also higher incidence of impacted wax was very common among them. Thus this caused a distinct drop in their hearing acuity. The earlier investigations (Spoor, 1969, Kapur, 1967, etc) again cannot be taken for granted, because i. the concept of 'age' was not very clear among the tribal

population. Thus in these studies age factor was considered based upon their physical status, marital status, pubic hairs, etc. Thus the estimates were conservative because the physical appearances are too deceptive to be reliable. ii. More over a Bushman of the wild type over 45 years were relatively rare. Thus the study done on a very small population around the subjects cannot be taken to be very significant to provide the norms for that age group.

Based on these comments on both the group of studies investigation in deeper aspects are warranted.

Speech audiometry in the Geriatric population:-

In addition to the progressive deterioration in the sensitivity for puretones generally attributed to presbycusis the geriatric patient also typically demonstrates a reduced ability to understand the spoken language. This problem seems to be in-compatible with the amount of puretone hearing loss.

One of the measures of listeners hearing ability is the threshold of speech reception on intelligibility. This ability has been investigated by Reger and Feldman (1967) among the elderly population. He found the effect of aging on the speech reception threshold and the results indicated fairly systematic increase with age. This increase, is approximately 9dB (decade after the age of 50 years. More over, as the age advances not only the

SRT increases but also the variance increases, on the similar line, Corso (1977) tested the speech reception ability for 2 groups; one group of young adults and the other group consisting of geriatric population using CID Wl spondee list. The results of his study indicated higher SRT for the geriatric group with mean value 42 dB as compared to 18.5dB for the younger population. Thus these two studies clearly indicated the deterioration in the speech reception ability as the age advances.

It has been a repeated observation that the speech discrimination ability and hence the intelligibility function of the elderly persons cannot be predicted reliably from the objective puretone audiogram or speech reception threshold. This is because, i. puretones are not encountered in every day life situation and ii. it is most often the discrimination of the speech sounds that is affected rather than the speech reception ability.

The credit goes to Gaeth(1948 cited in katz 1982) who for the first time conducted the study on the speech discriminatory ability of the elderly individuals. The result of this study made him coin the term 'Phonemic Regression' which means the reduced ability to hear and to repeat the common words at the supra threshold levels. (This is a characteristic of some elderly people).

Williford (1971) added some more features to Gaeth's observations. They are - 1. phonemic perception difficulties; does not parallel a general delay in mental capacities, ii. this phenomenon occurs more frequently beyond the age of 50 years but a substantial number of older individuals with hearing loss do not display any difficulty. There fores age alone cannot be asole factor for reduced SRT.

Jerger (1973) conducted a study to analyze the phone menic regression phenomenon. He tested 162 patients in the age range of 6 to 89 years of age. The PB list material were NDRC (National Defence Research Council) lists of 1 to 6 recorded on magnetic tape. With the average puretone threshold 500 - 2000HZ held constant, the average PB maxi-mum as a function of age was plotted, the effect of aging on speech intelligibility was apparent. At virtually any level of puretone average there was a systematic decrement in performance with advancing age.

various authours have contributed to the development of speech test material (Harvard PB lists by Egan 1948, CID W22 by Hirsh et al 1952; Rhyme test by Fairbanks 1958) using different types of speech material, thus many studies exist in finding the relationship between the age and the speech discriminatory capacity.

Goetzinger (1961) tested trained thirty six males between the ages of 50 and 89 years for their speech

discrimination ability using the CID w-22 word lists. The control group included twenty males between the ages of 20 to 28 years. The results of the study indicated the following- The increasing difficulty in understanding speech by the aged, is reflected in the systematic decrease in the discrimination score for those above age 50 years. The increase in impairment and understanding is systematic from decade to decade in the experimental group and amounted to 5% / decade. The speech understanding ability is relatively stable over a period of approximately 30 years. After age 50, then there is a gradual progressive decline in discrimination. At the age of 80 there is approximately a 25% loss in discrimination ability. Similar findings have been reported by Reger and Feldman (1967).

It is interesting to note when Goetzinger (1961) used an more difficult discrimination task (Rush Hughes recording of Harvard PB lists), the absolute value of the discrimination score was poorer than for W-22 lists but the difference between scores as a function of age remained approximately 10% per decade upto the eighth decade when it increased to 18 - 20%.

Blumen Field, Bergman, Millner (1969) aimed at studying the relationship between speech discrimination scores and the aging in 55 subjects with age range 27 to 82 years on the Rhyme test. The SDS was found under noisy and quiet

conditions. Speech discrimination on the Rhyme test tended to decrease as the age advanced. The elderly individuals performed similarly under both conditions. All these preceding studies do indicate the differential effect of material on speech discrimination and consequently upon aging.

Attempts have been made to find out whether hearing loss consequent to normal aging process and the hearing loss aa a result of pathological condition have an effect on speech discrimination. The following studies throw some light on such dimension. The first and the fore most attempt was made by Punch Mc Connel (1969). The articulation function of a sample group of elderly adults exhibiting minimal hearing loss (Group I) and that of a second group of elderly persons of comparable age having mild to moderate presbycusic hearing impairment (Group II). Two groups of 12 adults each age 65 and over served as the subjects. Speech discrimination functions were obtained at SL's of 10, 20, 30 and 40dB using disc recordings of CID W22 word lists. Results of the study showed that, i. both the groups generally improved in speech discrimination performance with increasing intensity and ii. Group I had significantly better discrimination ability than group II at each of the four sensation levels.

Kasden (1970) made a comparative study of presbycusic ears with young sensori-neural ears haveing a comparable

puretone hearing on speech discrimination ability. The first group consisted of twenty subjects between 60 - 69 years and the second group consisted of 10 subjects between 20 - 40 years; The performance of both these were compared with the control group of normal hearing subjects between 20 - 28 years. Discrimination scores on CID w-22 word lists at 5 SL's l0dB - 5dB SL were found. The results of the study indicated that the presbycusic patients performed worse than the young SN hearing loss group. The performance of these two groups were very poor as compared with the control group. This shows aging brings more discriminatory problem than hearing loss alone which results from pathology.

Gang (1976) investigated the effect of age on the roll over effect. The thirty-two male veterans aged 60 years and above served as the subjects. Any possibility of retrocochlear involvement is ruled out using carhart's tone decay test. The articulation function on CID W22 Lists were computed for this group. The results of this study were i. the mean function of elderly individuals has a slope of 1.4%/dB against 6%/dB norm. ii. the normal articulation approximates the PB max at 25dBSL where as PB max is achieved at 50dBSL for the elderly group, iii. The slower raising function and reduced PB max- an indicative of the poorer performance on discrimination task is generally exhibited by elderly listeners.

Explanation for the reduced speech discrimination ability among the aged:-

Various authours have put forward their view to explain the reduced speech discrimination abilities among the aged. According to Gaeth (1949) and Hinchcliffe (1962) the phenomenon of phonemic regression can be due to i. reduction in pitch discrimination ability and ii. retro neural lesion or consequent to digenerative changes in the brain.

Reger and Feldman (1967) gives the following reasons for this reduced speech discriminatory ability as a) the high frequency hearing loss which is most often of the cochlear type produce some discrimination loss. More over this high frequency hearing loss produces a filtering effect along with distortion due to impaired cochlear structure themselves, (b) Changes in the elasticity of the cochlear membrane and an increase in stiffness of the basilar membrane causes reduction of sensitivity at low frequencies. This adds to the problem of speech discriminatory abilities, (c) Tactile and auditory reaction time is essential in predicting the speech discrimination. The reduction in the reaction time as the age advances accounts for the poor speech discrimination ability.

In the same line, Raymond and Prathur (1971) based on the neuro anatomy and neuro physiological studies explains the poor speech discrimination, as sequalae of blurring effect.

ie. the peripheral fibres conduct faster compared to the slow conduction rate of the central fibres. This difference in the relative rate of conduction shows even greater differences with the increasing age. This produces a blurring effect which causes a series of measage impulses to be spread out in time as they reach the cortical centres where perception takes place. This explains as to why the elderly show more disturbances in the discrimination of speech rather than simple stimulus such as puretone. Thus the problem lies more in central rather than at peripheral level as explained by Reger and Feldman (1967). Further more willeford (1965, 1971) stated two more reasons as to support Raymond et al (1971) findings, i. There is lowered resistance to noise interference with increasing age. This is attributed to the increased loss of central cells and increased random neural noise. ii. Older persons experience longer after effects of neural activity, persistent central activity following stimulation certainly tend to obscure or confuse subsequent stimulus expecially if those signals are continously varying and following one after another, as in production of speech sounds. Discontinous tasks such as puretones do not change rapidly and might be less, affected. This clearly indicated why the older people have difficulty in understanding speech rather than perceiving the puretone signals which do not require the central integration ability.

The preceeding review on causation of the reduced discrimination ability among the aged is more of a central auditory disorders rather than mere periphery disorder. The diagnosis of the central auditory disorders is more clear cut by increasing the difficulty of speech task by altering parameters such as frequency, time and / or intensity of the speech stimuli. The Geriatric population manifested poorer discrimination on such difficult speech speech situation, in the following pages, we shall consider how the elderly perform in the central auditory tests.

Time altered Speech tests:-

The performance of the elderly on the time altered speech can be considered under two conditions ie. time compressed speech and time expanded speech.

Gray and Sticht (1969) were pioneers to find out the intelligibility of time compressed speech as a function of age and hearing loss. They tested four experimental groups: (i) young, (ii) elderly adults with hearing acuity within the norms of that group, (iii) young SN hearing loss group and (iv) older age group with SN hearing loss. The CID W22 list of words were time compressed at 4 levels of compression ie. 0%, 36%, 46% and 59% was used as the test material. The results of the study indicated that there were no differential effect of age on the perception of time compressed stimuli due to two types of hearing ability.

with the increased age, the ability to discriminate time compressed speech diminished as the amount of compression was increased. This shows that higher the compression level, the more the elderly individuals were taxed in understanding speech.

Konkle and Beasley (1977) studied the effect time compression and sensation level as a function of age. The NU auditory test No.6 was time compressed and presented to four age groups ranging from 54 - 84 years of age at their SL of 24, 32, and 40 dB (ref. SRT). The results indicated that intelligibility decreased as a function of increasing time compression and decreasing sensation levels. Thus there was 20% reduction in scores between the ages of 57 and 70 years. More over, the elderly can perform better at higher SL ie. 40 dBSL as compared to the lower sensation levels.

The effect of time compression and expansion on normal, hard of hearing and aged males been observed by Schon (1970). The subjects of this study were young normal hearing adults, young males with SN hearing loss, aged with average hearing for their age and aged males with SN hearing loss. The results of the study indicated that the intelligibility scores for all the groups were depressed as compared to 0% compression and expansion.

Young men with normal hearing performed better than the young adults with SN hearing loss and both groups of aged males, in the time expanded speech condition, the older group performed better than the compression condition suggesting that older people can discriminate speech sounds, when altered in a slower fashion. Thusaccording to Luterman (1966), the discrimination of time expanded speech was affected by the degree of hearing loss and not age.

Korabic, Freeman and Gerald (1978) studied the effect of time expanded speech on normally hearing and elderly subjects. 18 normal hearing subjects with mean age of 22 years and twenty elderly subjects with mean age of 70 years were the subjects of the study. All subjects had speech discrimination score of 90% for undistorted NU auditory test No.6. Speech discrimination score for the experimental stimuli ie. NU auditory test No.6 processed at 0, 30, 6O and 100% time expansion presented at 4 SL's of 8, 16, 24 and 32 dB. Results of this study indicated that for normally hearing subjects, auditory discrimination performance at all ratios of time expansion was equal to the 0% condition. Among the elderly individuals, there existed direct relationship between the time expansion and discrimination scores, in other words, higher the percentage of expansion, better was the speech discrimination scores. The performance at 1OO% expansion was better

than at 30% and 60%. Thus these findings suggested that when the rate of speech is slowed down, the elderly can process the speech fairly well.

Distorted Speech:-

Callaro and Layaroni (1957) studied two groups of subjects. One group had patients with cerebral tumours and the other group consisted of older individuals between 70 to 85 years. The meaningful sentences delivered at speech of 140, 250 and 350 words/minute formed the test material. The difference in threshold between accelerated and normal speech was computed for each group. The results indicated that threshold shifts were larger in the older age group than the patients who had intra cranial tumours. This gives evidence for the fact that the older individuals can not cope with the accelerated speech. The reason for this can be deduced from the study by Harris (1960). According to him, the subjects with normal hearing at 4KHz had normal intelligibility for sentences altered at a& rate from 280 - 345 words/minute, but when there was hearing loss at 3KHz, even mild, a decrement in intelligibility resulted. Most often the elderly experience loss hearing acuity at and above 3KHz. This explains their reduced score with the accelerated speech tests.

Apart from the peripheral loss, changes, in the higher centres have been reported. Decrease in cell count of the

temporal lobe with advancing age reduces the ability to perceive distorted speech (Hinchcliffe, 1969). The decreased efficiency in the time sampling which is mediated; by the central auditory disorders is also a causative factor Bergman (1971).

Filtered Speech :-

Very few studies have been done in this area; Pioneer in this aspect of study was palva and Jobimen (1970) who investigated the effects of age on discrimination of filtered speech with two different frequency bands using the monoaural tests and Matzker's binaural teats. They tested 149 subjects with the age range 20 — 89 years. The results indicated that in filtered speech test, discrimination falls very early as a function of age; Even the group 30 - 39 years showed a significant deterioration of discrimination in binaural hearing as compared with the youngest group. This change in discrimination of filtered speech occur much more, than changes appear in the puretone thresholds. After 60 years a significant asymmetry appeared in discrimination of filtered speech.

Staggered Spondaic word test (SSW):-

To provide a discription of SSW performance for the older groups, Amerman and parnell (1980) administered SSW to 4l subjects (60 - 79 years). Average word discrimination scores were within normal limits. The older individuals

showed a decrease in response accuracy and increase in the variability relative to the younger subjects. Non significant correlation between age and SSW scores suggest minimal changes in central auditory functions.

The use of SSW test for measurement of central auditory ability in adults beyond the age of 60 years is presently limited by the lack of an adequate normative data basically by which to differentiate typical and the atypical response patterns obtained from the elderly (Brunt 1972 cited in Maurer and Rupp 1979).

Competing Speech Test:

Phoneme Discrimination in older persons under varying S/N conditions:-

An old individual can fairly communicate in the environment with minimum disturbances. This communication is challenged when back ground noise is more which adds to his perceptual problems, reducing the efficiency of communication. Wylie (1973) explained this phenomenon. He suggested that at ages from 30 to 80 years the statistically average persons will lose about 15% of nerve conduction speed. As a result, the older person must receive more intense signals or longer signals with less back ground noise to develop the same level of recognitionas the young adult. Bearing this in mind we shall proceed to the studies conducted in this line.

Grower (1969) attempted to measure speech discrimination ability in the presence of noise among the ability elderly. His subjects were 40 patients with presbycusiss with their ages between 62 and 81. The phonemic scores for the S/N of α, + 10, Q and - 5dB were obtained in older to attain the goal. The results of the study showed that for the average patient with presbycusis, his social handicap is clearly expressed in his rapidly diclining phoneme score if the ambient noise reaches speech level and surpass it.

Smith and Prathur (1971) studied the phoneme discrimination in older persons under varying S/N ratio; Two groups of subjects, 10 subjects older than 60 years of age and 10 between the ages of 18 - 30 (puretone- normal hearing at speech frequencies) identified 16 consonants in a CV context which were presented at 6 sensation levels of noise over 4 S/N ratio. The results show that the older group performed significantly more poorly than the younger group over all listening conditions. However there was no difference in the relative performance between the two groups as either the SL of noise increased or S/N ratio became poorer;; In addition, even in quiet condition the similar results were obtained as in noise.

In 1971, Carhart and Nicholas reported their findings on a related task where they studied masking for spondees

in complex listening situation for young and elderly women with good hearing. The older population had difficulty in identifying the words in simple competing situation and were more affected than the young in more complex backgrounds.

Bergman (1971) tested 282 adults from 20 to 89 years of age and the results indicated-

(i) the ability to interpret good listening conditions declined only slightly until the age of 80 years. For the 8O - 89 year group only a small decline in the performance was noted.

(ii) interpretation of sentences at various levels of distortion revealed clear decrease in performance at the higher age; Sharp decline in these tasks were noted in the beginning of 4th decade.

(iii) In the interpretation of interrupted speech, the drop in performance was particularly striking, starting from no deficit at ages 20 - 29 and increasing learity to a 65% deficit at 8th decade of life (cited from Layton).

Indian Study in this area:

Mukundan (1977) used competing message in Telegu and English with subjects ranging from 29 - 75 years at S/N ratios ranging from -12, 6, 0, +6 and +12dB were employed. The presentation level of the primary message was maintained at 40 dB HTL. Discrimination in quite was also obtained.

The subjects in the present study were found to obtain significantly higher scores in the absence of competing background. This implies that when the listening situation are relatively simple, the discrimination ability for the elderly subjects is not excessively taxed. Mukundan (1977) concluded that the older subjects performed significantly poorer than younger subjects on a competing message tasks.

Bonding's study in 1979 attempted to study the critical band width in presbycusis, 20 patients (61 - 82 years) with flat audiometric patterns were the subjects, critical band width estimation was performed by the method of loudness summation using noise centered around 1KHz, the results indicated a normal critical band width in these subjects.

Plomp and Mimpur (1979) investigated the speech reception threshold for sentences as a function of age and noise level: For 140 male subjects (20/ decade between 20 - 89) and 72 females (20/ decade between 60 - 89) and 12 for the age interval 90 - 96; the monoaural SRT for sentences was found in quiet and noise at 4 levels (22.5, 37.5, 52.5 and 67.5). The results of this study indicated (1) Hearing loss for speech at high noise level increases progressively above the age of 50, (2) Acceptable noise levels in rooms used by the aged must be 5 or 10 dB lower than those used by normal hearing subjects.

Duquesnory and Plomp (1980) studied the effects of reverberation and noise on intelligibility of sentences: in cases of presbycusis. The subjects were 1. 50 males between 60 - 67 years and 30 males-69 - 90 years and 30 females from home for the aged. 2. A control group of 20 young subjects between 18 - 35. The SRT was measured under five reverberant conditions between RT of O and 2.3 at a constant noise level 52.5 dBA. The results of their study indicated that the elders performed poorly at the high reverberation condition.

Margolis and Goldberg (1980) cited in Marshall (1981) measured the critical ratio in 5 presbycusic listeners for a lOOOHz tone at 50dB SPL varying the spectrum level of broad band noise to obtain 60% detection of tone, 415 presbycusic listeners showed abnormal critical ratio ie. they needed an improved S/N ratio in order to detect the tone.

Kaplan and pickett (1982) studied the differences in speech discrimination in the elderly as a function of type of competing noise, ie. speech babble Vs. cafeteria noise. The subjects were 26 elderly individuals with bilaterally mild to moderate SN hearing loss with the age range 61 - 91 years. To measure SD in quiet a performance intensity function using CID W22 list (Hirsh 1955) and discrimination in competition using SSI at 0 to 90 dBHL.

The stimulus was given under 1. monotic, 2. low frequency attenuated, 3. dichotic and 4. diotic. The results of the study indicated 1) S/N ratios needed to maintain monotic discrimination between 50 - 75% were higher for the cafeteria noise than for the speech babble. Thus listening in speech sample an easier task for elderly than listening in cafteria noise.
2) Although dichotic - monotic and dicotic monotic superiority can be seen with both types of noise, the effect was more pronounced with babble, (speech babble).

These data confirm that the hearing handicap of many elderly subjects manifests itself primarily in an noisy environment. Thus the exact measurement of their handicap index should be obtained in presence of competing noise.

The performance of the aged on the various audiological tests is given in Table I. The performance on the following tests like I, II, III, IV son on are as follows:-

Table I summarizes the findings on the following tests, used with the aged:

I. (1) impedence audiometry,
(2) Bekesy audiometry.

II. Special tests.
(1) SISI.
(2) Adaptation.

III. Binaural hearing ability.
(1) Directional hearing, localization Vs lateralization.

IV. Tests of Brainstem lesions.
(1) Brainstem response audiometry.
(2) Masking Level Difference.

Investigator	Sample & Methodology	Findings	Explanation
1. Impedence Audiometry			
Beathi and Leany(1975) (cited in Marshall, 1982)	admittance value in two groups of individuals elderly group (60-78 years) and young(17-29 years)	admittance value was higher in the elderly group as compared to the young adults.	
Blood and Greenberg (1976)	Dynamic compliance of the middle ear system among the aged.	a significant increase in impedence in population aged 50 and above.	
Nerbome Bliss and Ronald (1978)	Mean static compliance as a function of age and sex in 3 groups 20-29; 60-69 and 70-79 years of age.	Slight but not significant tendency for the static compliance value to decrease with age; the acoustic impedence value increases with age particularly above 70 years. This is due to increased stiffness of the conductive mechanism as the age advances.	
Hall (1979)	The effects of age on static compliance in 336 subjects in age range 6-91.	Both in men and women static compliance value are maximum between 31-40 years and then decreases systematically with increasing age.	

Investigator	Sample and Methodology	Findings	Explanation
Jerger (1972)	Evaluated the age variation of the reflex thresholds among children less than 6 years and adults above 65 years.	The intensity of the sound to elicit reflex diminishes with increasing age.	
Habenuar and Snyder(1974)	64 normal persons from 3 to 68 years of age.	Poorer reflex thresholds in the younger age groups.	
Seaverton & Lennor(1976)	The subjects of the study formed 3 age range groups 20-30; 40-50; 60-70.	While the reflexes in 3 age groups were elicited at equivalent SL, the supra-acoustic reflex amplitude were reduced.	
Jerger(1978) (cited in osterhantmel, 1979)	compared thresholds for puretones, and noise as a function of age.	Decrease in acoustic reflex threshold for puretone while no change in acoustic reflex threshold for white noise with increasing age.	
Oster hammel and oster Hammel(1979)	268 persons in the ages 10-80 years. Tested the effect of age/sex on compliance and stapedial reflex.	The absolute compliance has no dependences on sex or age. The stapedius reflex threshold expressed in dB SPL decrease systematically at a rate of 3.5 dB/decade.	

Investigator	Sample & Methodology	Findings	Explanation
Quaranto and Cassaro(1980)	relation between crossed and uncrossed acoustic reflexthreshold in presbycusis subjects.		
Thompson and Sills (1980)	studied the growth of the acoustic reflex to filtered noise and tone of 500 Hz, 1 KHz, and 2 KHz in 30 persons between 20-70 years	The rate of growth in amplitude decreased linearly with increase in age. The size of this decrease in growth of amplitude for tone ranges from 2 - 5 between the youngest and oldest. The monotonic decrease in conductance and susceptance with increase in stimulus level seen mainly in the 60-70 years.	
Hall (1982)	92 subjects grouped according to age as 20-30, 6O-69 and 70-80 years. The crossed and uncrossed reflex amplitude was measured.	uncrossed reflex amplitude decreases with increasing age. Decrease in the amplitude of reflex with age is apparent only at the maximum signal intensity level (110 dB SPL). Over the range of 20-80 years, maximum reflex amplitude on the average decreased by 56%.	
II. BEKESY AUDIOMETHY			
Jokinen and Kaiya (1970)	60 presbycusic ears were studied with forward and backward sweep frequency.	The sweeps with the continuous tone gave slightly better threshold values in forward than in reverse direction at middle and high frequency and the situation being opposite at low frequency.	

Investigation	Sample & Methodology	Findings	Explanation
III. Loudness Function			
(a) SISI Tests			
Pestalossa and Showe(1955)	Reger's technique of mono-aural bifrequencies loudness balancing was used to assess recruitment in 20 elderly individuals.	They found that 20% of the patients had complete recruitment, 30% had partial recruitment and 50% had none.	Since the presence of recruitment is indicative of cochlear pathology, absence of it in majority of the elderly suggest the higher centres.
Goetzinger (1961)	He tested 80 males and 40 females in a population of the aged subjects.	Among male population 34% showed complete recruitment; 51% incomplete recruitment and 15% no recruitment. Among females they found that 25% complete recruitment; 40% incomplete recruitment and 35% no recruitment.	
Jerger(1973)	Two groups of elderly individuals, one group exhibiting recruitment and other with no recruitment and one	The effect of loudness recruitment on auditory discrimination ability among the elderly. The results	

Investigation	Sample & Methodology	Findings	Explanation
	control group 12 normal young persons	of the study indicated no difference between the 3 groups. Thus the disproportionate loss in speech understanding in aging is not strongly related to the loudness recruitment phenomenon.	
Traywpr(1975)	Subjects ranging from 78 to 92 years using the impedence audio-metry to detect recruitment.	60% of the subjects did not show acoustic reflexes that would be indicative of recruitment while 40% demonstrated reflexes at normal or near normal intensities.	
Marshall(1981)		Since the SISI test would be greatly affected by a conservative criterion, this test may be especially inappropriate for the elderly.	
(b) Adaptation			
Goetzinger (1961)	Tested subjects with age range 60-79 and 80-89.	No correlation between the presence of presbycusis and tone decay. None of them exhibited significant decay at 1KHz, 2KHz and 500 Hz.	

Investigator	Sample & Methodology	Findings	Explanation
Milden and Peterson(1972) (Cited in Mainer and Rupp, 1979).	Studied the normal and SN hearing loss ears among the elderly and compared with the normal young adults.	They found that the tone decay pattern for their older population werex not different from those of their young population.	
IV. FREQUENCY DISCRIMINATION AUDIOMETRY			
Mermauram (1955). Cited in Marshall (1982).	DLF at 20 dB SL across the frequency 125 - 4OOO Hz.	DLF at this frequency range larger than normal but lesser than pathological condition such as M.D.	Impaired auditory discrimination due to the degenerative changes that occurs in the brain with age.
Konig(1957)	DLF for pulsed sinu-soidal at 40 dB SL for 125 - 4000 Hz, 10 listeners per decade through 20-89 years.	Poor discrimination as a function of age.	Degeneration of sensory cells in the vicinity of the helico trama and in the first coil of the cochlea.
Rose(1965)		At the age of 70, the DL for frequency is 2 to 3 times the value at the age of 25.	

Investigation	Sample & Methodology	Findings	Explanation
Zwicker & Schon (1978).(Cited in Marshall, 1982).	72 hearing impaired sub-impaired subjects, 10 of whom had presbycusis	This group showed greatly reduced freq-uency selectivity results compared with normal young groups.	
V. DIRECTIONAL HEARING AND LOCOLIZATTON VS LATERALIZATION AMONG AGED			
Matyker(1958) and Springborn (1959).	Localization of phantom source.	This ability decreased steadily after the age of 30 years.	This implied a defect in integration of the stimuli received from the two ears; integra-tion being the process that takes place at the brain stem, the defect indicates a degenera-tion that occurs in brain stem.
Kirikae (1969)	Two groups of subjects (1) subjects between 50-75 and (2) younger groups between 20-30 years. Tests used were (i) directional hearing (ii) Time Vs intensi-ties trade.	Minimal interaural time differences necessary to latera-lize the sound image (TDL). TDL for the aged was 0.082 where-as for the young it was 0.05 thus greater for the aged. The young people perceive the lateralization even with a slight difference in time.	Changes in pinna size affect the sound directionality as age advances.

Investigator	Sample & Methodology	Findings	Explanation
Bostaro and Russolo(1982)	Used three central tonal lists like auditory lateralization; temporal order and auditory pattern among 50-88 aging 60-80. This result was compared with the sensitized speech.	Results shows a considerable reduction of the performance intensity function with age whereas tonal test remains within the value of younger subjects.	This can be explained based on the fact that central tonal tests are of low frequency dominated which usually are affected little by presbycusis.
VI. BRAIN STEM RESPONSE AUDIOMETRY			
Corti and Arpini(1978)	Studied late potentials in 60 subjects of different age groups, Children with mean age 6.2 and adults with mean age 76.8.	No CNV is recorded in children under the age of 5 years. 36% of the elderly exhibited the CNV.	
Spink and Johannson and Pinsig (1979)	Slow components of the acoustically evoked potentials for 1000 Hz tone was compared between 2 groups; one group with mean age of 22 and the other with mean age of 63.	F_3 latencies of the older group was significantly shorter at 60, 75 and 90 dB HL than those of the younger group. This is due to a decreased efferent inhibition of several nucleoli of the auditory pathway as the age advances. No significant differences in the latencies of P_1 and N_1 among the two groups.	

Investigator	Sample & Methodology	Findings	Explanation
Hall and Jerger(1980)	Studied the amplitude and latencies of the ABR as a function of age in 182 males and 137 females.	The age had a slight effect on both latencies and amplitude of the wave V. Latencies increased about 0.2 msec over the age range from 25 - 55 but the amplitude of wave V decreased about 10%.	
Fujikawa & Weber(1980) Cited in Hall et. al (1980).	Tested 3 groups of 8 subjects each infants, young adults and geriatric population using 4 rates of click presentation (0.13/sec; 0.33/sec; 0.50/sec and 0.67/sec).	Greater shifts for infants and geriatrics than were present for the young adults.	
Tillman, Carhart, Nicholas (1973) Quararta & Cervellera (1974)	Measured MLD for Speech under 27, binaural conditions in presence of 1 - 3 competing maskers for 2 groups (1) 10 normal young adults (2) 55 elderly adults (63 - 88).	The older group exhibited a smaller MLD of 1.8 dB during antiphasic as compared to 8 dB for the young adults in the same condition.	This difference, probably indicates the reduced hearing efficiencies in the complex listening situation as the age advances.

Investigator	Sample & Methodology	Findings	Explanation
Findlay and Schuman(1976)	MLD for speech was compared under two conditions sm Nm and S N for three groups of subjects. (1) Twenty normal children 5-6 years. (2) 40 normal young adults and (3) 20 aged adults between 60 - 76 years.	No inter aural difference appeared for children. Mean MLD for right ear exceeded than for left ear in Sm Nm condition - more significantly for the young adults.	The mechanism for MLD recedes in CMS Thus the reduced MLD suggest that the elderly subjects has undergone some subtle - if not detectable deterio-ration in CMS which interferes with binaural processing.

C H A P T E R - III

M E T H O D O L O G Y

The purpose of the present study was to provide normative data on speech discrimination as a function of age.

TEST MATERIAL

This study utilized two types of materials which are as follows;

(a) Test of English ability: This was developed at the Central institute of English and Foreign languages. This test waa administered as a screening procedure to select those who are proficient in English. The test items were valued for 100 points. A cut off level of 50 points was chosen and thus the subjects with the minimum score of 50 points were included in the study (Appendix - I).

(b) Speech material: Two kinds of Speech material were used:

(i) CID w-1 (list A) - Spondee word list developed by Hirsh et. al(1952) was used for the estimation of the Speech Reception Threshold(SRT)(Appendix II).

(ii) The CNC syllables were used to test the Speech Discrimination. The four lists of the Form A of the N.U. auditory test No.6 were used (Appendix

RECORDING PROCEDURE

The test stimuli were recorded in an anechoic chamber using the tape recorder (Grundig TK 745) with a microphone (GO SM 331). The recordings were done at a tape speed of 7½ inches per second.

The recording was made by an young adult male talker aged 24 years.

The spondees were recorded with a carrier phrase "You will say . . . . . ". The level of the carrier phrase was maintained to peak at 0, while the spondees was allowed to follow in a natural manner. Between successive spondes, a 5 seconds silent interval was given to allow the subject to give an oral response.

similarly, the mono-syllabic words were also recorded. Between successive words, a silent interval of 8 seconds was given which allowed the subject to give written responses.

The recorded material were then fed to the Graphic Level Recorder through audiometric tape input. The level of all the words of all lists were recorded on the level recorder. Peak average was found individually for each list. A lOOOHz tone was recorded from a standard audiometer (Beltone 200 c) prior to the onset of stimuli for each list. The intensity of this l000Hz tone is such adjusted that it is equivalent to the average peak amplitude.

INSTRUMENTATION

The data was collected using a two channel audiometer (Madsen OB 70) and a Stereo tape recorder (Uher SG 631). The output of the tape recorder formed the input of the audiometer, from where, the speech stimuli is delivered to the ears through TDH-39 earphones with MX 41-AR cushions.

The audiometer was periodically calibrated to ANSI (1971) specifications. The calibration procedure is given in Appendix IV.

The frequency response characteristics of the earphones used in the investigations is represented in Appendix V.

TEST ENVIRONMENT

The testing was carried out in a sound treated two room situation. Ambient noise level was measured and it was found to be within the standard specified levels (Appendix VI).

SUBJECTS

Seventy five male subjects who were non-native speakers of English were randomly selected for this study. The age range of the subjects was from 19 years to 77 years. The subjects were categorized into five age groups with fifteen in each group.

		Mean Age in Years	Median Age in Years
I Group	19-29 Years	23.4	23
II Group	3O-39 Years	34.1	33
III Group	40-49 Years	44.96	44
IV Group	50-60 Years	55.5	56
V Group	60 and above	64.6	63

CRITERIA FOR SELECTION OF SUBJECTS

(a) The subjects under the study were non-native speakers of English residing in India.

(b) All the subjects were required to pass the test of English ability.

(c) The subjects should have had a normal hearing acuity bilaterally in all frequencies 250 Hz through 8000 Hz and the exhibited Air-Bone gap should be less than 10 dB(ANSl 1969). The normative data on pure tone thresholdsdndrani, 1981) was utilized in meeting the normal hearing acuity criteria as a function of age (Appendix VII).

TEST PROCEDURE

This involved three steps:

(i) Pure tone threshold testing and establishing pure-tone average?

(ii) Speech Reception Threshold testing; and

(iii) Speech Discrimination testing.

(i) Pure-tone threshold testing:

All the subjects were subjected to pure-tone testing via both air conduction and bone conduction. The thresholds were obtained using modified Hughson-Westlake procedure (Carhart and Jerger, 1959).

(ii) Speech Reception Threshold test procedure:

Following the pure tone audiometry, the Speech Reception Threshold of the test ear was determined with CID Wl list. The better ear was selected as the test ear for all the subjects irrespective of their age groups.

The subject was first familiarized with the entire list by reading the list to the subject in a face to face situation. The instruction for this task was given as:

"You will hear recorded words like ..... arm chair, airplane, base ball....(in an alphabetical order).. All these words will be preceded by the phrase 'You will say...' You have to repeat the word that follows this phrase. If you are not sure of the word try to guess".

To determine Speech Reception Threshold, two spondees were presented initially at 30 dB HL. If both the words were repeated correctly, the intensity was decreased by 10 dB steps. At each level two spondees were presented.

This intensity was reduced in 10 dB steps until the subject failed to repeat both the spondees; At this level the intensity was increased by 8 dB and two spondees were given at this level. The level was decreased in 2 dB steps with two spondees at each level. The descent continued till the subject missed five out of six words. The lowest level at which the subject repeated both words correctly minus 1 dB for those words repeated correctly from then on, was taken as the Speech Reception Threshold (SRT).

(iii) Speech Discrimination test procedure:

Speech discrimination ability was determined using the four CNC word lists of N.U. auditory test No.6 Form A at five presentation levels viz., 8, 16, 24, 32, 40 dB SL above SRT. All the four lists were heard by all the subjects but at different sensations levels. This was made possible using list level combinations for the fifteen subjects in each group based on random number table (Mc Call 1970).

The criteria used for assigning the levels to different subjects were

(1) no list would be presented more than once to any subject;
(2) no level will be repeated for any subject.

The subject was given four response sheets on which he was required to write down the response.

The subject was instructed as follows:

"You will hear four lists of words having fifty words in each list. Some lists will be louder than the others. Write down the word that follows the phrase 'You will say.....' if you do not understand, try to guess; If you fail to guess, leave the blank against that serial number and go on to the next".

The lists were presented at the previously assigned levels; All the four lists were presented in a single session.

SCORING

The data will be scored based on the written response of the subject. Each correct response will be given a weightage of 2%. Total percentage of correct responses at each level was computed for each list; The scores were computed similarly for all the age groups. The scores obtained were subjected to appropriate statistical treatment.

C H A P T E R -IV

R E S U L T S

The data collected was subjected to various statistical analysis. The various measures obtained were measures of central tendency, measures of variability and Two-way analysis of variance.

Two measures of central tendency viz mean and median were calculated for all the four lists at five sensation levels and for each group separately. The dispersion of the scores were also determined by computing standard deviation. The values of mean, median and standard deviation are given in Table II.

Mean values were used for plotting the articulation function for the five sensation levels. This is depicted in the Figure - 1.

Effect of level:-

From Table II, it may be observed that in general, discrimination scores increased with increase in sensation level. This is seen for all the five age groups, variability in the scores is not systematic across the sensation level with exception for group III (40 - 49 years).

Articulation function for the five age groups are shown in Figure-1. It may be noted that the speech dis-

Age	19 - 29 Years	30 - 39 Years	40 - 49 Years	50 - 59 Years	60 and above
Sensation Level					
8 dB Mean	40.33	35.92	32.50	26.17	19.00
Median	37.0	37.50	28.00	21.00	17.00
SD	18.50	14.81	19.11	20.04	12.48
16 dB Mean	62.83	63.83	55.17	51.67	41.67
Median	65.00	64.00	56.00	58.00	48.00
SD	9.94	14.97	17.78	19.40	19.46
24 dB Mean	77.33	77.33	71.50	71.50	54.00
Median	77.00	84.00	74.00	74.00	59.00
SD	12.36	11.82	11.38	9.03	13.32
32 dB Mean	78.00	82.50	80.66	83.00	68.83
Median	82.5	86.00	80.00	84.00	66.00
SD	11.67	11.12	10.62	8.50	16.37
40 dB Mean	82.00	84.33	86.17	82.67	74.00
Median	87.00	87.00	84.00	80.00	74.00
SD	8.05	9.21	7.31	10.10	15.23

Table 11 : Mean, Median, standard devatkion scores : Sensation level Vs age range.

crimination scores increased with increase in sensation level. None of the age groups showed a plateau in their function, indicating that the scores may improve at higher sensation levels.

The slopes of the articulation function was computed between 8 dB - 16 dBSL for each group.

In addition to the above measures, the dispersion of the scores with respect to age was plotted against five sensation level to check for the necessity for ANOVA. These regression curves are given in the Figures. 2 to 6. Based en these regression curves, the following are evident:-

i. There is reduction of speech discrimination ability for all the age group especially at the lowest sensation level ie. 8dBSL.

ii. The speech discrimination scores improve with increase in sensation level for all age groups;

These indicated the need for ANOVA to be computed. This was carried out to check the main effects of lists and levels and the interaction between the two. The findings are given in Table III to VII. Differences among the sensation level was significant at 0.01% level.

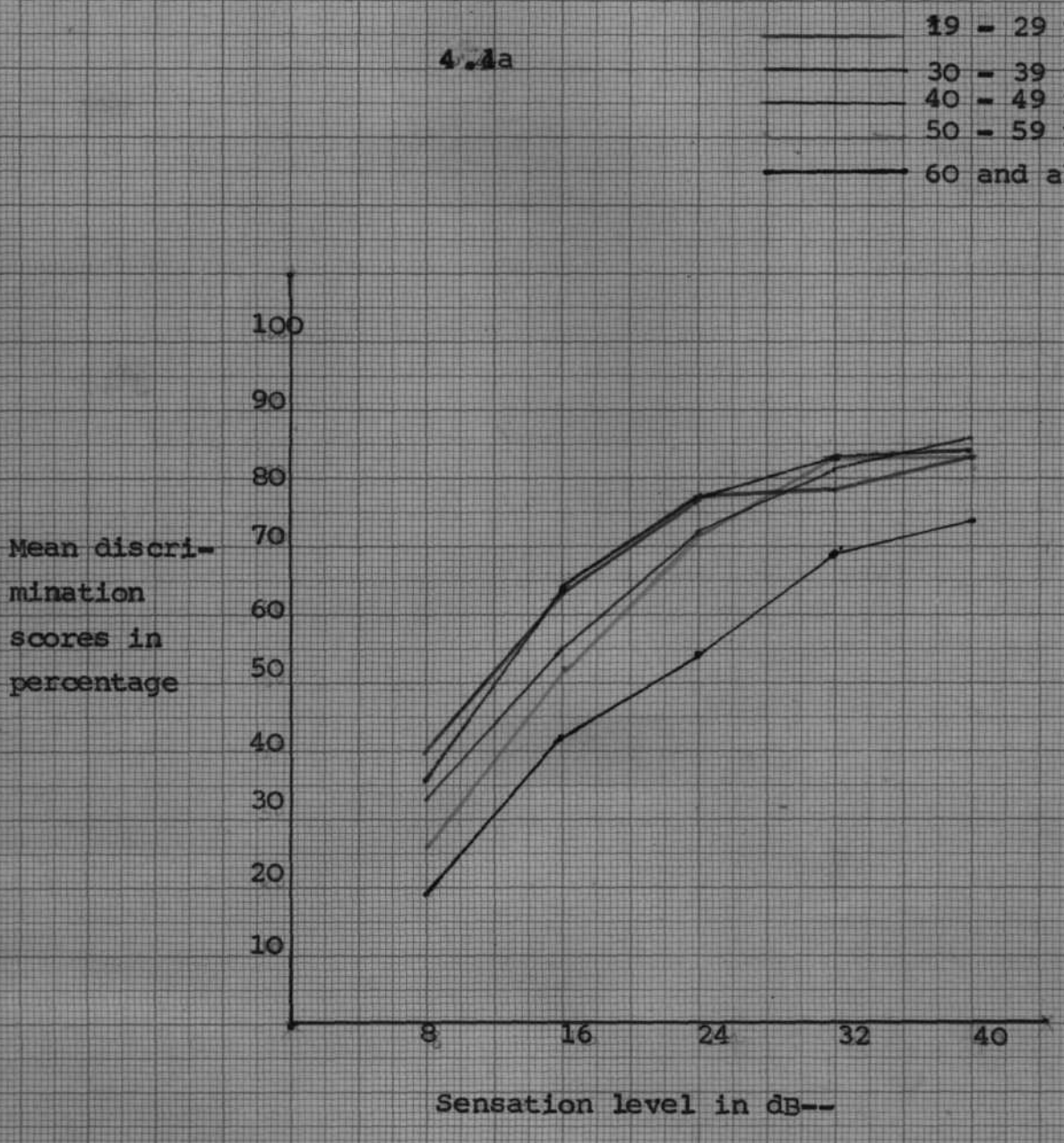
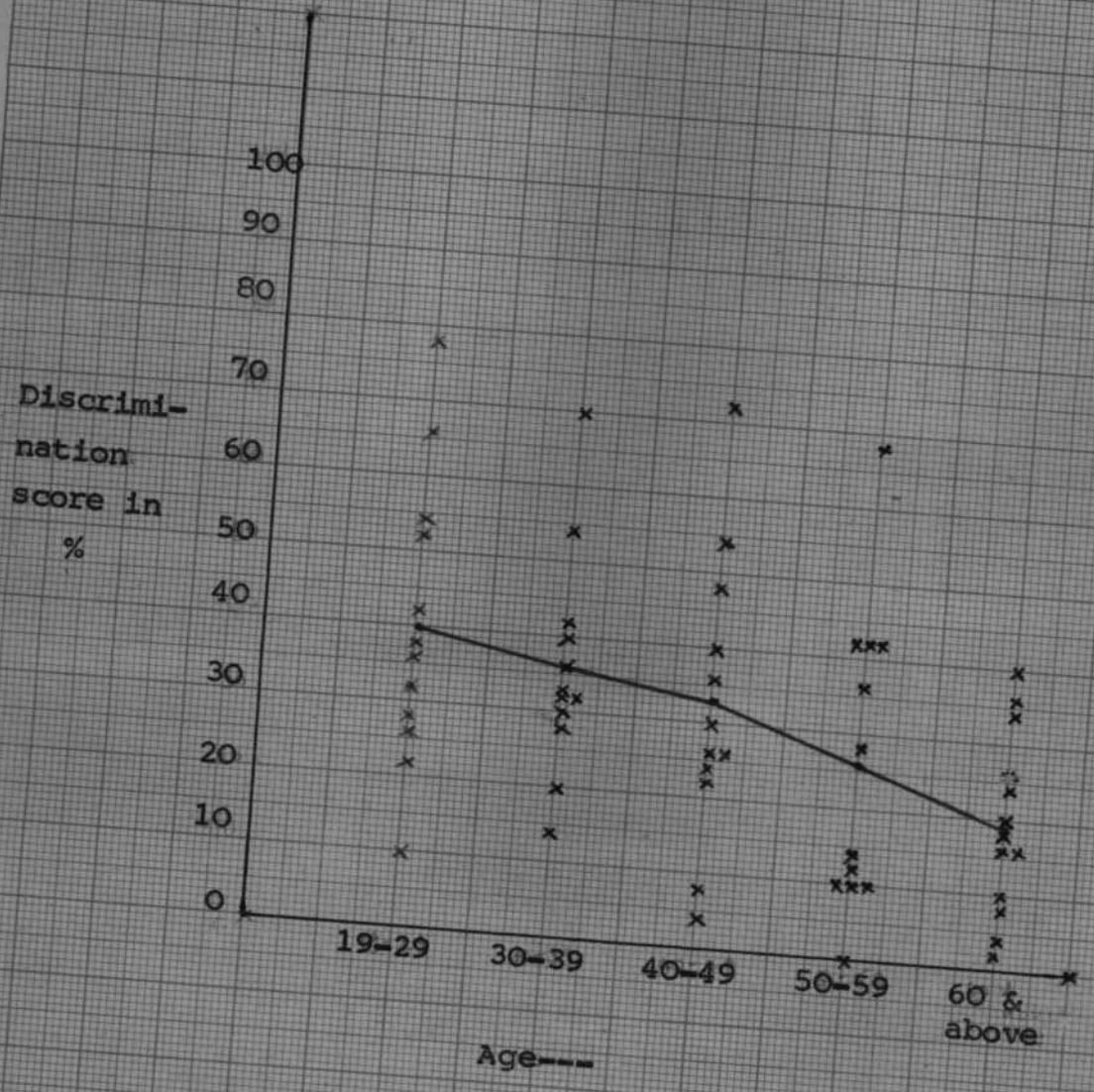


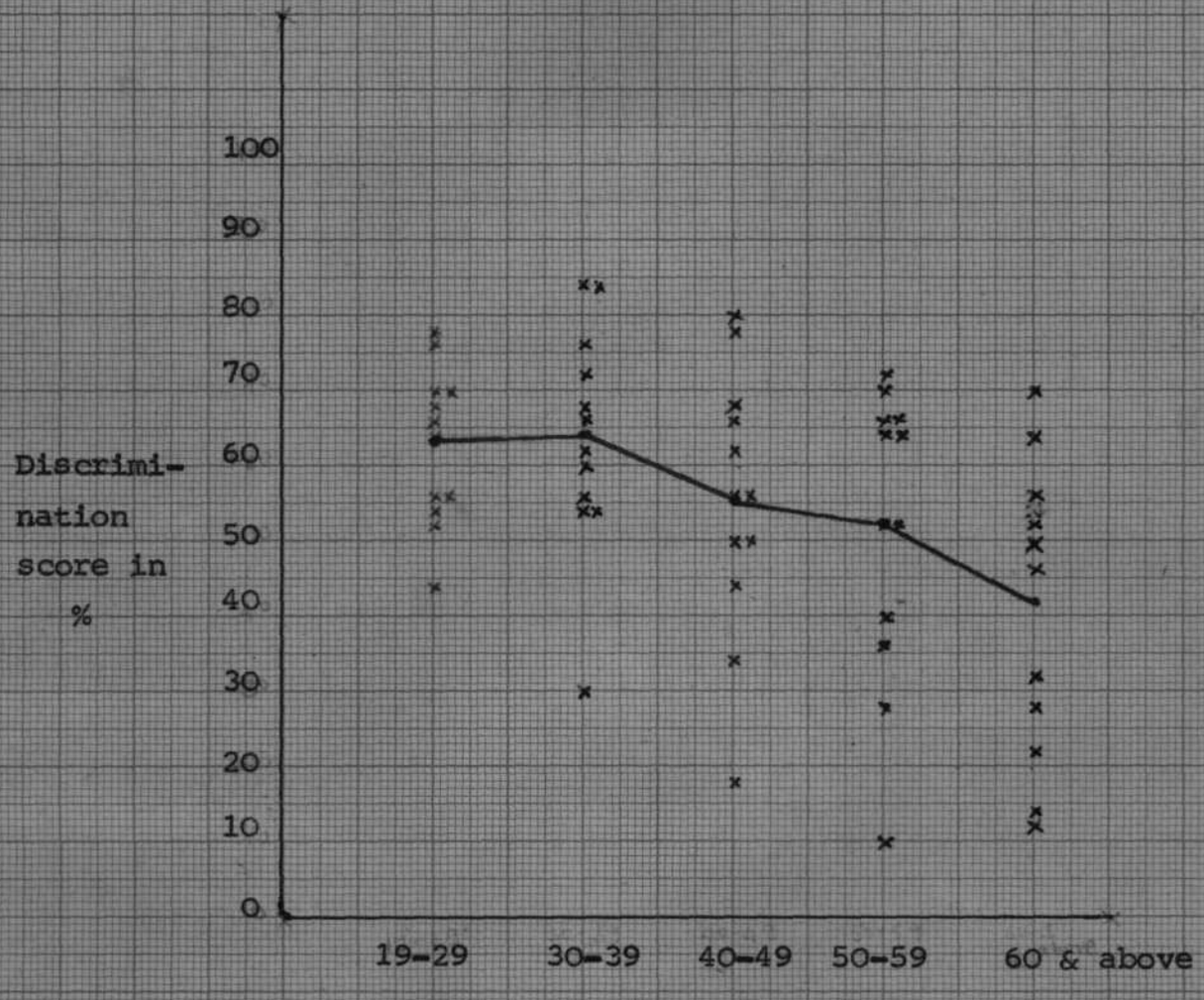
Figure 1- Articulation function for various age groups.

Figure - 2



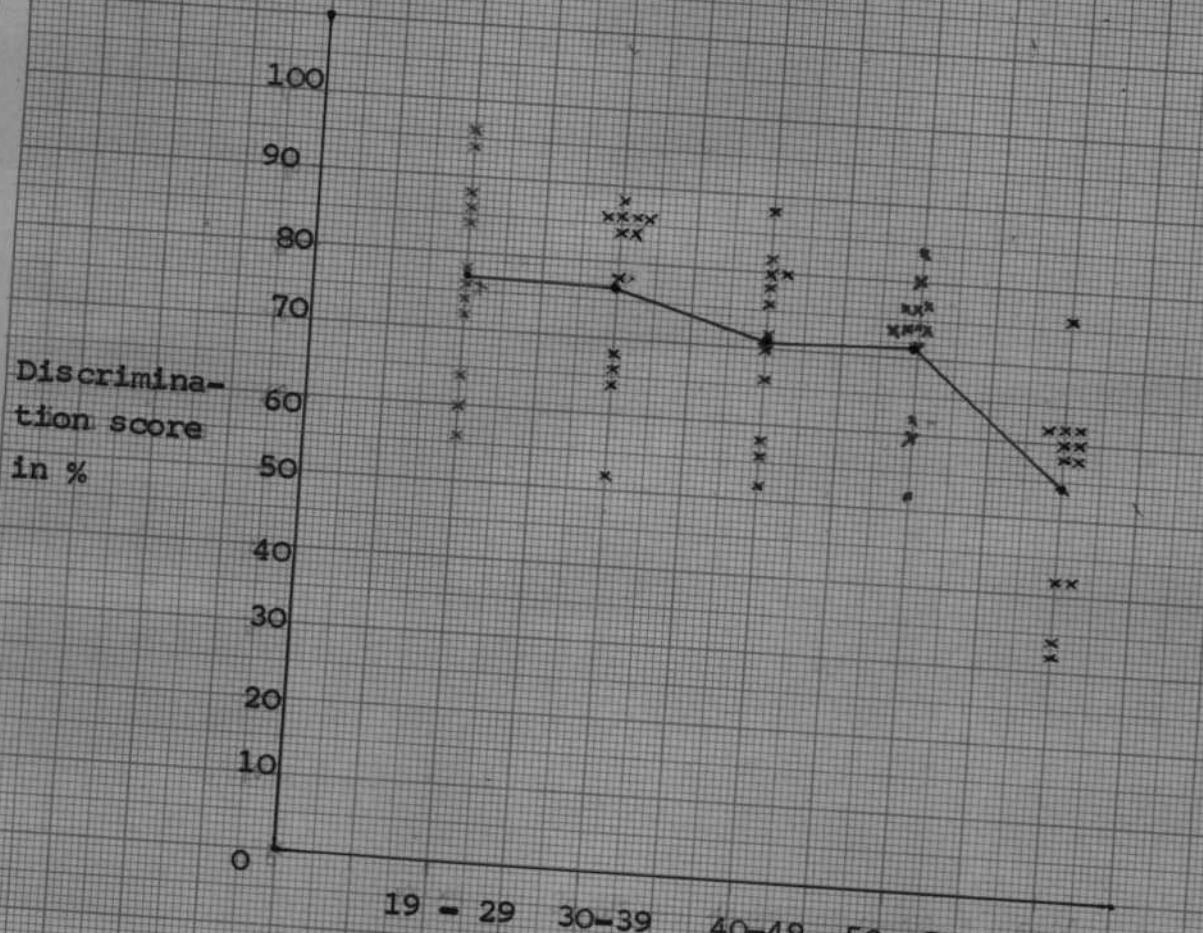
Regression Curve At 8 dBSL

Figure - 3



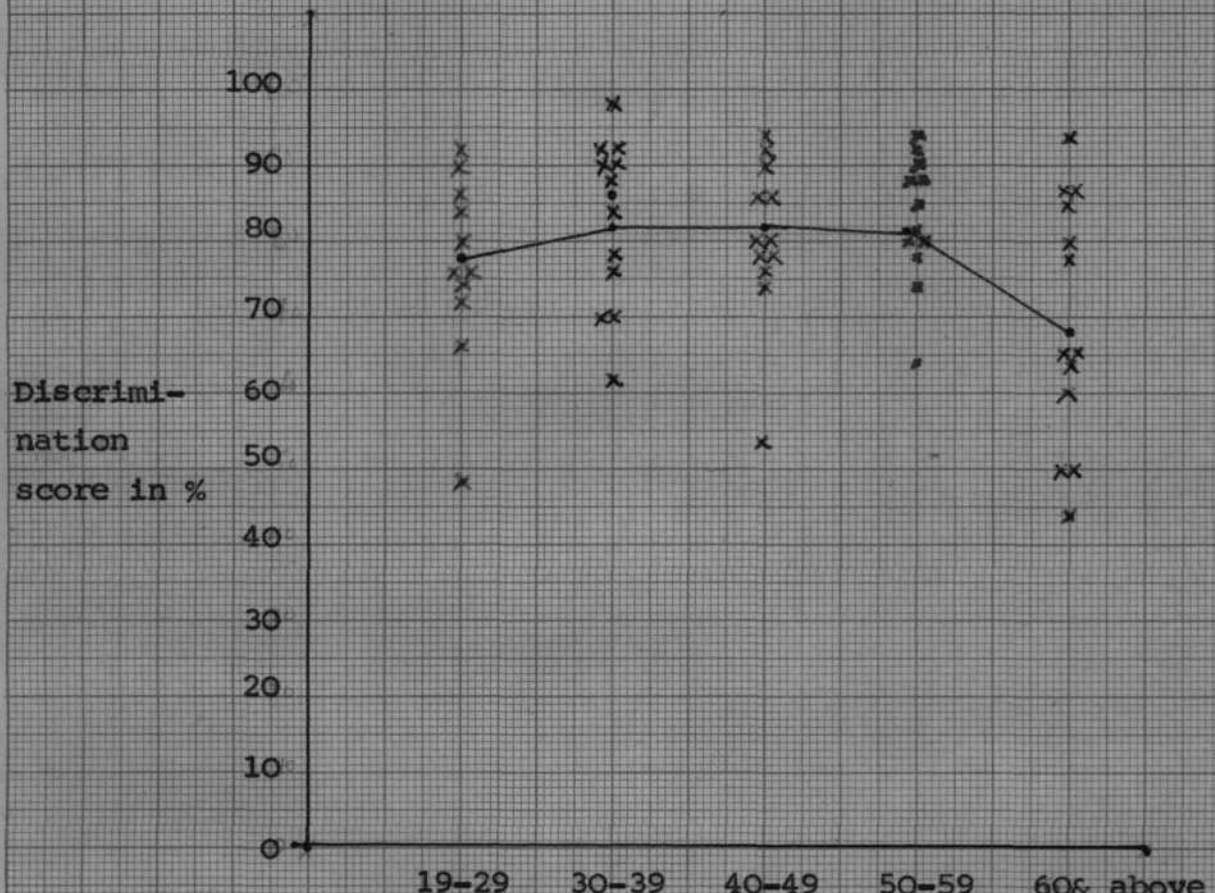
Regression curve at 16 dBSL

Figure - 4



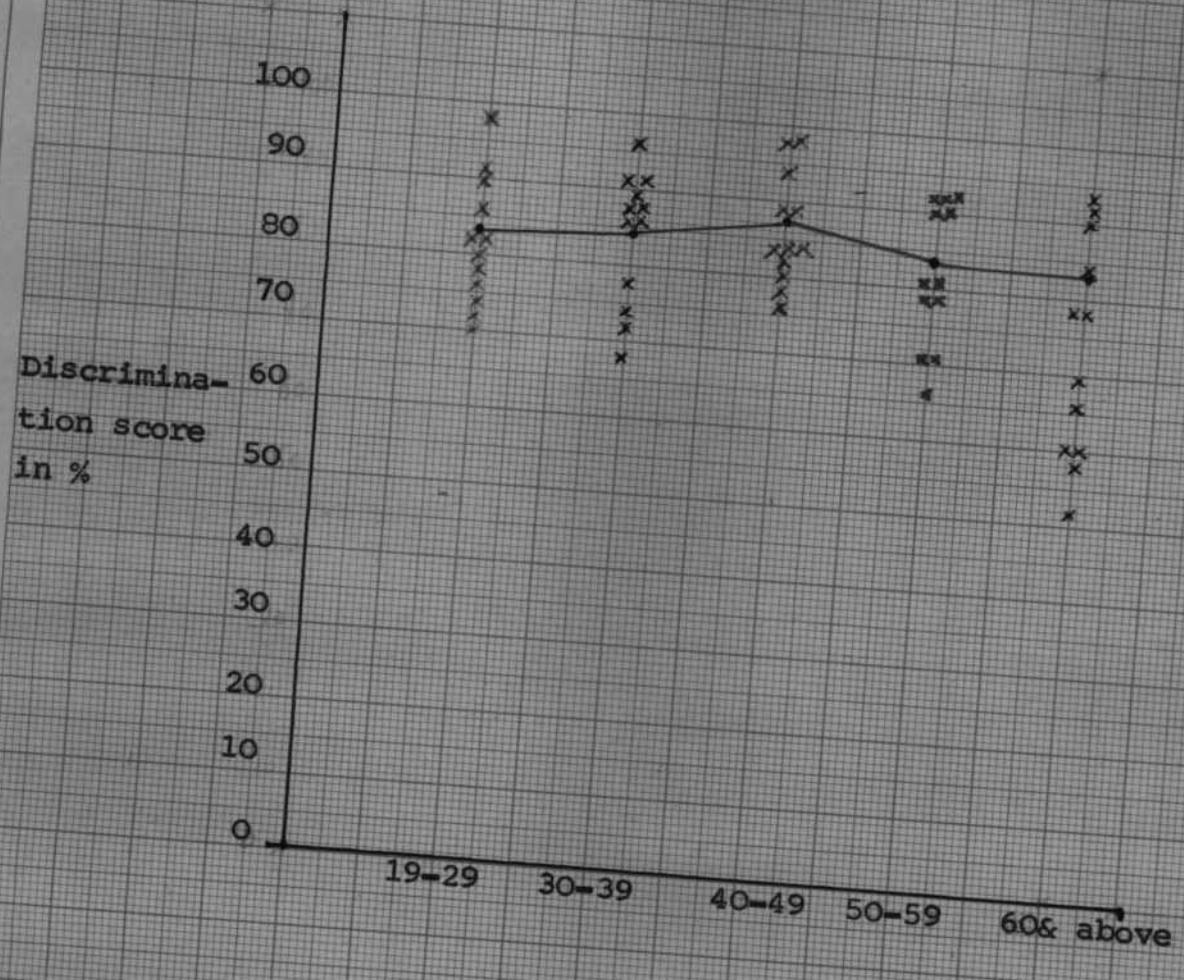
Regression curve at 24 dBSL.

Figure - 5



Regression curve at 32 dBSL

Figure - 6



Regression curve at 40 dBSL

Source of Variation	df	Sum of square	mean sum of squares	F ration
Lists	3	577.918	192.64	1.05
Sensation Level	4	14175.273	3543.82	19.29*
SL X list	12	1618.324	134.86	0.73
Sub total	19			
Within group	40			
Total	59			

*Significant at both 0.01% level.

Table III - Results of Two way analysis of variance for the effect of sensation level vs lists for 19 - 29 age group.

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Source of Variation	df	Sum of square	mean of squares	F ratio
Lists	3	754.988	251.66	1.71
Sensation Level	4	19293.273	4823.32	32.85*
SL X Lists	12	2085.926	173.83	1.18
Sub total	19	22134.188		
Within group	40	5873.996	146.85	
Total	59			

*Significant at 0.01% level.

Table IV : Results of Two-way analysis of variance for the effect of sensation level Us. lists for 30 - 39 age group.

Source of variation	df	Sum of square	Mean of sum square	r ratio
Lists	3	966.934	322.31	1.57
Sensation Level	4	22661.600	5665.40	27.63*
SL X Lists	12	1578.398	131.53	0.64
Sub total	19	25206.932		
Within group	40	8202.668	205.07	
Total	59	33409.600		

*Significant at O.Ol% level.

Table V: Results of Two-way ANOVA for the effect of sensation level Vs lists for 40 - 49 age group.

Source of variation	df	Sum of squares	Mean of sum squares	F ratio
Lists	3	1629.078	543.02	2.81
Sensation level	4	28130.000	7032.50	36.35*
SL X Lists	12	2010.262	167.52	0.87
Sub total	19	31769.332		
Within groups	40	7738.668	193.47	
Total	59	39508.000		

*Significant at 0.01% level.

Table VI: Results of Two-way ANOVA for the effect of sensation level Vs lists for 50 - 59 age group.

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Source of variance	df	Sum of square	Mean of sum squares	F ratio
Lists	3	642.867	214.29	0.96
sensation Level	4	23590.666	5897.67	26.43*
SL X Lists	12	3766.133	313.84	1.41
Sub group	19	27999.666		
Within group	40	8925.334	223.13	
Total	59	36925.000		

*Significant at 0.01% level.

Table VII: Results of Two-way ANOVA for the effect of sensation level Vs lists for 60 and above age group.

Inter Test Differences-

Differences among the lists were not significant at 0.01.

Interaction Effects:-

Interaction between lists and sensation level was not significant at both the levels, since the four lists are equivalent, the ANOVA was computed to find out the effects of age and sensation level and the interaction between them. Here again, the interaction effect of sensation level vs age was not significant.

Effect of age:-

The Two - ways ANOVA of this factor is given in Table VIII. Differences among the five age group was; significant across five sensation levels at 0.01% level. It is evident that speech discrimination scores decreases as a function of age.

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Source of variance	df	Sum of squares	Mean of Sum squares	F-ratio
Sensation level	4	11772.328	2943.082	15.07*
Age groups	4	105233.140	26308.285	134.68*
SL X Age	16	2617.672	163.604	0.84
Sub total	24	119623.140		
Within group	275	53720.141	195.35	
Total	299	173343.280		

*significant at 0.01% level.

Table VIII: Results of Two-way analysis of Variance for the effect of sensation level vs age group and their interaction effect.

CHAPTER – V

DISCUSSION

The results of the present study are discussed along the following lines.

Effect of sensation level:

The effect of sensation level on the mean performance across various age group is depicted in the articulation function curve (Fig. 1).

The articulation function for the five age groups show that the scores increase with increase in sensation level, in none of the age groups was a plateau exhibited, indicating that the scores may improve further at higher sensation levels.

The slope of the articulation function was computed between 8 and 16 dBSL for the five age groups which are as follows:-

2.87% / dB for 19 - 29 age group, 3.5% / dB for 30-39 years, 2.75% /dB for 40 - 49 group, 3.13% / dB for 50-59 years and finally 2.87% /dB for 60 years and above.

Similar findings have been reported by Hirsh et al (1959) where the normal young listeners achieved an intelligibility improvement of 5% / dB from 0 - lOdBSL. This implies that articulation function of the present study

has a more gradual slope than that obtained by Hirsh et al (1959).

It may also be noted from Table I that the discrimination scores improve with an increase in the sensation level. This consistently found across all five age groups. But the variability is not systematic across the five sensation levels especially for the young and the older age group. Variability seems to be fairly systematic across sensation levelsfor other three groups. These findings are in variance with Punch and Mc Connel (1969), Rintelmann, Schumaier and Jetty (1974) , Malini, (1981), where the variability decreased with increase in sensation levels. This difference between the studies can be attributed to the recording procedure in the present study. The speech materials were recorded in an anechoic chamber. Thus the speech is devoid of the normal communication environmental characteristics.

However the mean scores obtained at any sensation level in the present study is consistently lower than those obtained by Punch & Mc Connell (1969), Blumen, Bergh (1969) and Kasden (1970).

This difference in the scores can be attributed to the type of speech stimuli used. Both the studies by Punch and Mc Connell (1969) and Kasden (1970) used CID W22 and Blumen et al (1969) used Rhyme tests of Fairbank's (1958)

The present study utilized NU auditory test No.6. CID W22 has been found to be easier than any other tests like Harvard PB lists or NU auditory test No. 6 (Carhart 1965). More over, CID W22 gave high scores at a sensation level of 25 dB while high scores are obtained only at 40 dBSL in the present study. This can be attributed to the greater familiarity of the words and speaker intelligibility especially at lower sensation levels(owens 1962; Goetzinger 1972).

Inter test difference:-

The ANOVA of lists vs level and their interaction indicated that there were no significant differences among the lists. Hence it proves the hypothesis that all the four lists of form A of NU auditory test No.6 are equivalent. The results of the present study corresponds to the earlier investigations by Rintelmann, Schumaier and Burchfield 1974; Schumaier, penley and Rintelmann 1974; This finding does not agree with the Indian study by Malini (1981) where there is difference between the lists. This disagreement among the two Indian studies may be due to the talker difference.

Interaction effect:-

The interaction effect between the lists and the sensation levels was not significant at 0.0l level.

Similarly, there is no significant interaction between age and sensation levels.

Age effect:-

The results obtained in the present study revealed a decrease in speech discriminatory ability with age. Mean discrimination scores decreased consistently as the age advances. From this it is also evident that

(1) group II (people in the third decade) performed better than group I (people in the second decade).
(2) group II did better than any other age group.
(3) Similar performances have been observed in the group III and IV (between the 4th and 5th decade).
(4) group V had poor discrimination compared to all other groups. At higher sensation level very slight differences existed between the successive age groups.

The results of the present study agree with the findings of Gaeth (1948), Goetzinger (1961), Feldman and Reger (1969), Punch and Mc Connell (1969), Blumenfeld, Bergman and Miller (1969), Kasden (1970) and Gang (1976) that the speech discrimination scores decrease as the age advances.

The performance of the older group in the present study was consistently lower than that of subjects by Kasden's (1970), or punch and Mc Connell's (1969) study.

and Bergman, Blumenfeld and Miller (1969). However these studies cannot be compared directly for the following reasons:-

(1) Difference in material: The present study used NU auditory test No.6 and the other studies except for Blumen et al (1969) who used CID W22. As discussed earlier CID W22 is reported to be an easier test than NU auditory test No.6. Blumenfeld et al (1969) used Rhyme test in their study. This test involved a closed set response (Fairbanks, 1958). Thus the listener in this tests is given a multiple choice from which he/she is able to pick up a response. This is comparatively easier than open set tests which involves more guessing without any clues.

(2) Difference in recording procedure: in addition to the above mentioned factors, the recording were made in an anechoic chamber in the present study while recordings were made in the sound treated room in the other three studies.

(3) The presentation levels used: This varied in all the four studies. The present study utilized five sensation levels viz 8dBSL, 16dBSL, 24dBSL, 32dBSL and 40dBSL while Kasden (1970) used l0dBSL, 20dBSL, 30dBSL, 40dBSL and 50dBSL. Punch and Mc Connell (1969) used only four levels viz- 10, 20, 30 and 40 dB, and Bergaman et al (1969) used only at 35dBSL. Hence the comparison can be

made only between the closer sensation levels ie 30/32: and 40 dBSL. This difference could be attributed to the fact that:- (in the discrimination scores between studies)

i. NU auditory test No.6 is a more difficult test of speech discrimination.

ii. According to Linden (1965 cited in Geffner and Danovan 1974) reported that in a case with slowly progressive hearing loss, with normal hearing at frequencies below 2000HZ, discrimination score obtained using W22 was not affected. This may be the reason as to why older subjects did not perform equally poorly on the two tests.

iii. The subjects in the present study were non native speakers of English which the other studies included relatively younger subjects of native speakers of English. This has been supported by the cross language studies, Moreover, according to Singh (1966) the subjects native language influences their perception of speech sounds. The present study included subjects who had different native language. This may account for the poorer scores by the non native speaker of English.

To conclude despite the difference in speech material, recording and sensation levels used in these studies, they all support that 1. speech discrimination increases, with the increase in sensation levels and 2. the older groups perform poorer than the younger individual at all sensation levels.

CHAPTER - VI

SUMMARY AND CONCLUSION

The present investigation was undertaken to study the effect of aging on the speech discrimination ability - among a group of subjects of Indian nationality. A sample of seventy five male subjects were selected. The sample was categorized into five age groups baaed on the age factor: 19 - 29 years, 30 - 39 years, 40 - 49 yeara, 50 - 59 years and 60 and above, each age group consisting of fifteen subjects.

The subjects had to have normal hearing in both ears, at frequency from 250 Hz - 8KHz at Octave intervals even at 6KHZ. Normal hearing for the each group was decided based on the norms given by Indrani (1981). in addition the subjects have to give a negative history of any kind of ear abnormalities, structural and functional prior to as well as at the time of testing, etc. More over, they had to obtain a score of atleast 50% an the test of English ability (CIEFL 1980).

Speech reception testing was done for each subjects using the CID Wl test material. Following this the four lists of Form A of NU- auditory test No.6 were presented to evaluate the speech discrimination ability. The speech stimuli were tape recorded and presented through the tape input of a clinical audiometer (Madsen OB 70) at five

levels viz 8, 16, 24, 32 and 40 dB SL re SRT. The list level combinations were computed based on the random number table and also the order of presentation was chosen randomly.

The scores obtained were subjected to the measures of central tendency and the measure of variability, in addition Two - Way analysis of variance was also computed.

Based on the results of the analysis, the following conclusions may be drawn:-

i. Speech discrimination scores increase with the increase in sensation levels.

ii. This increment with raise in sensation level is observed across all the five age groups.

iii. There is decrease in the speech discrimination ability as the age advances. The individuals in the second decade and third decade age group performed almost similarly. Similar performance is also noted between 40 - 50 years age group and 50 - 60 years age group. Beyond 40 years of age the speech discrimination ability is poorer compared to the younger populations. This decrement in this ability is the most for the older group (60 and above age group thus reflecting the speech perceptual problem among the aged.

iv. All the four lists of Form A of NU auditory test No.6 were equivalent.

Suggestions for further research:-

1. To assess the clinical atility of NU auditory test No. 6 using the Indian population.

2. To evaluate the speech discrimination ability among the female subjects as a function of age and to see if there is any effect of sex on such ability.

3. To administer this test to the population in the age range of a years to 18 years, to see if this test can be utilized for the children and adolescent subjects.

4. To analyze and compare the errors in discrimination made by the subjects in the different age groups.

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R E F E R E N C E S

Alpines, J. "Diagnostic and Rehabilitative aspects of Geriatric audiology". ASHA, 7: 455 - 459 (1965).

Amerman and Pamell M.M., "The Staggered spondaic word test - a normative investigation of older adults". Ear and hearing, 1(1). 1980. 42 - 45.

Antonelli, A. Sensitized speech tests in aged people. Rojskjaer, C. (ed. Speech audiometry) second Danovax symposium, 1970. 66 - 79,

Antonelli, A.R. Auditory processing disorders and problems with hearing aid fitting in old age. Audiology, 17(1). 1978. 27-31.

Beagley, H.A, Sheldrake, J.D., Difference on brainstem response latency with age and sex. Brit. Journal of Audiology, 12, 69-77. 1978.

Bergman. Effects of aging on hearing. Maico, 2(6). 21-24. 1967.

Bergman, M. Hearing and Aging. Audiology, 10, 161-171 1971.

Blood, I and Greenberg, M.J. Acoustic limitance of the ear in the geriatric person. Jour, of Ann. Aud. Society, 2, 185-187, 1977.

Blumenfeld, Bergman and Millner, E. Speech discrimination in an aging population. JSHR, 12, 210-217. 1969.

Bocca and Calearo, C. Central hearing processes in J. Jerger(ed) Modern developments in audiology. New York. Academic Press (1963).

Bonding, P. Critical band width in presbycusis. Scand. Audiol., 8, No.l, 1979. 43-50.

Boothroyd, A. Developmental factors in Speech recognition, international Audiology, 9, 3O-38. 1970.

Bosatra, A and Pussolo, M. Comparison between central tonal tests and central speech tests in elderly subjects. Audiol. 21(4), 334-341. 1982.

Calearo, C. and Layzaroni, A. Speech intelligibility in relation to the speed of the message. Laryngoscope, 67, 410-419. 1957.

carhart, R. Problems in the measurement of Speech discrimination. Jour. Speech. Hear. Res., 9, 461-465. (1966).

Carhart and Nicholos, s. perceptual masking in elderly persons, paper presented at the annual convention of ASHA (American Speech and Hearing Association). Chicago (1971).

Carhart and Tillman, T.w. interaction of competing speech signals with hearing loss. Arch, Otolaryng., 91, 273-279. (1970).

Corso. Age and sex differences in pure-tone - Survey of hearing levels from 18 - 65. Arch. oto. Laryng., 77, 385 (1963).

Corso, J.F. Sensory processes and age effects. Journal Gerontology, 26, 90-105 (1971).

Corso, J.F. presbycusis, hearing aids and aging. Audiol. 16, No.2, 146-163 (1977).

Corso, J. Age and sex differences in pure tone thresholds. Arch, of Otolaryng., 77, 385-405 (1963).

Corso J.F. Age correction factor in noise induced hearing loss: A Quantitative model. Audiol., 19(3), 221-232 (1980).

Davis Abnormal hearing and deafness, in Davis and Silverman (ed) Hearing and Deafness. 3rd edition, New York, Holdt, Reinhart and Winston, 110-114 (1970).

De Quiros, J.B. Accelerated speech audiometry, an estimation of test results. Beltone translation, 17 (1964).

Duanesneey, A.J. and plomep, R. Effect of reverberation and noise on intelligibility of sentences in cases of presbycusis. JASA, 68(2), 537-544 (1980).

Feldman, R.M. and Roger, S.N. Relation among hearing-reaction time and age. JSHR, 10, 479-495 (1967)^

Findlay and Schurchman. MLD for Speech: effects of ear dominance and age. Audiol. 15, 232-241 (1976).

Fijikawa and Weber, A.B. Effects of increased stimulus rate on brainstem electric response (BER) audiometry as a function of age. JAAS, 3(3), 147-150 (1977).

Gang, R.P. The effects of age on diagnostic utility of of the roll over phenomenon. JSHD, 41, 63-69 (1976).

Geffner and Danovan. intelligibility functions of normal and sensorineural loss subjects on the W-22 tests. JAR, 14, 82-86 (1974).

Gersdorff, Mc.H. Impedacemetric study of the variations of the auditory reflex in man as a function of age. Audiol. 17(3), 260-270 (1978).

Glorig, R.D., Wheeler, R., oniggle, W., Gring, S., and Summer Field, A. Wisconsin state fair hearing Survey. Monograph of American Academy of opthalmology and Otolaryngology (1957).

Glorigy High, w., and Nixon. Changes in air and bone conduction threshold as a function of age. Annals of oto. Rhno. and Laryngol. 74, 288-298 (1962).

Goetzinger, C.P. Word discrimination testing. Chapter in J. Katz (ed) Hand book of clinical audiology, Baltimore (1972).

Goetzinger, C.P., Proud, G.O., Dirks and Embry, J. A study of hearing in advanced age. Arch, oto-Laryngol. 73, 662-674 (1961).

Groen, J.J., Social hearing handicap: Its measurement by Speech audiometry in noise, international Audy 8, 182-183 (1969).

Hall, J.N. Effects of age and sex on static compliance. Arch. Otolaryngol. 105, 153-156 (1973).

Hall, J.W. Acoustic Reflex amplitude: Effect of age and Sex. Audiol. 21(4), 294 (1982).

Harbert, F, Young, I., and Menduke. Audiological findings in presbycusis. JAR, 6, 297-312 (1966).

Hayes and Jerger, J. Low frequency hearing loss in presbycusis - a central interpretation. Arch. Otolaryngol. 105, 9-12 (1979).

Hayes, D and Jerger, J. Aging and the use of hearing aids. Scand. Audiol. 8, 35-40 (1979).

Hinche Cliffe. The threshold of hearing as a function of age. Acoustica, 9, 303-308 (1959).

Hinchecliffe, R. The anatomical locus of the presbycusis. JSHD, 27, 301-310 (1962).

Heldson. Communication problem of the geriatric patient. JSHR, 25, 238-247 (1960).

Hull., "Hearing evaluation of the elderly". Chapter in Handbook of Clinical Audiology edited by Katz(1979) Chap. 35., The Williams and Wilkins CO., Baltimore.

Indrani, R., Normal hearing by air conduction as a function of age and sex in Indians. Unpublished Masters Dissertation, Mysore University (1981).

Janet Jaffers., The social adequacy of two selected samples of Geriatric - presbycusis with significant hearing loss, international audiology, 8, 317-327 (1969).

Javis, J.F. The acuity of hearing in Kalahoni Bushmen. Journal Laryngol. 81, 1-63 (1973).

Jerger, J. Audiological findings in aging. Ann. oto. Rhino Layngol. 82, 115-124 (1973).

Jerger, J. comments on the effect of aging on the stapedius reflex thresholds. JASA, 66, 908 (1979).

Jerger, J., and Hall, J.w. Effect of age and sex on the auditory brainstem response. Arch. Otol. 106, 387-391 (1980).

Jokinen and Kaija. Presbyacusis - Forward vs Backward frequency sweep audiometry. Acta, 70, 227-231 (1976).

Kaplan, H. and Pickett, J.M., Effects of dichotic/ diotic Vs monotonic presentation on speech understanding in noise in elderly hearing impaired listeners. Ear,and hearing, (1981).

Kaplan, H., and Pickett, J.M. Differences in Speech discrimination in the elderly as a function of type of competing noise: Speech, Babble or Cafteria. Audiol. 21(4), 325-333 (1982).

Kapur, Y.P and Patt, A.J. Hearing in Todas of South India, Arch. otoAaryngol. 85, 400-4O4 (1967).

Kasden, S.D. Speech discrimination in two age groups matched for hearing loss. J. Aud. Res. 10(3), 210-212 (1970).

Kirikae, K. Auditory function in advancing age with reference to histological changes in central auditory system. Audiol. 8, 221-230 (1969).

Konig, E. Pitch discrimination and age. Acta otolaryngol, 48, (1957).

Konig, E. and Basel. Audiological Tests in Presbycusie. International audiology, 8, 240-255.

Konkle, D., Beasley, D and Bess, F., Intelligibility of time altered speech in relation to chronological aging. JSHR, 20, 108-115 (1977).

Korabic E.W., Freeman, B.A., and Clunch, G.t. Intelligibility of time expanded speech with normally hearing and elderly subjects. Audiol. 17(2), 150-164 (1978).

Kurt Jatho. population surveys and norms, international Audiology, 8, 231-239 (1969).

Layton, B. Perceptual noise and aging, Psycho. Bull., 6, 875-883 (1975).

Luterman, D.M., Welsh, O.C and Melsose, J. "Response of aged males to time altered speech stimuli". JSHR, 9, 226-230 (1966).

Malini, M.S. Standardization of Nu auditory test No.6 on an English speaking Indian population. No.85. Unpublished Masters thesis submitted to Mysore University (1981).

Margolis, H.R and Goldberg, S.M. Auditory frequency selectivity in normal and presbycusic subjects. JSHR, 23(3), 603-613 (198O).

Marston, L.E and Goetzinger. A comparison of sensitized words and sentences for distinguishing non peripheral auditory changes as a function of aging. Cortex, 8, 213-223 (1972).

Marshall, L. Auditory processing in aging listeners. JSHD, 46(3), 226-240 (1981).

Maurer and Rupp. Chapter 2. Hearing impairment in the elderly people. Chapter 4: Audiological assessment of old age deafness, in Maurer and Rupp (ed) Hearing and Aging, New York, Grunne and Stratton (1979).

Mc Call, B.R., Fundamental statistics for psychology. Harcourt, Brace and World Inc., (1970).

Miller, M and Ort, R. Hearing problems in a home for the aged. Acta Otolaryngol. 59, 33-44 (1965).

Miller, M. Audiological rehabilitation of the geriatric patient. Maico Audio. 2(1), (1969).

Miline, J.S. Pure tone audiometry in older people. Brit. Jour, of Audiol. 9(2), 50-57 (1975).

Miline, J.S. A longitudinal study of hearing loss in older people. BJA, 11(1), 7-14 (1977).

Milne., The ABG in older people. Brit. Jour, of Audiol. 11(1), 1-6 (1977).

Mukundan, G. An experimental study of age and language variables in a competing message task. An unpublished masters dissertation to University of Mysore. (1977).

Ner Bonne, M.A., Bliss, A.T and Schow. Acoustic impedence values in the elderly. Jour, of Amer. Audiol. Society, 4, 57-59 (1978).

Orchik, D.J and Burgess, J. Synthetic sentences identification as a function of the age of the listener. Jour, of Amar. Aud. Society, 3, 42-46 (1977).

Oster hammel and Oster hammel, P. Age and sex variation for the normal stapedial reflex thresholds and tympanometric compliance values. Scand. Audiol., 8, 153-158 (1979).

Owens, E. Intelligibility of words varying in familiarity. JSHR, 4, 113-129 (1961).

Palva and Jokinen, K. Presbyacusis vs Filtered speech test. Acta Otolaryngol. 70, 232-241 (197O).

Pestolozya, G and Shore, K. Clinical evaluation of presbycusis on the basis of different tests of auditory function. Laryngoscope, 65, 1136-1163 (1955).

Plomp, R. and Minpen, A.M. SRT for sentences as a function of age and noise level. JASA, 66, 1333-1342 (1979).

Power, J.K and Powers, E.A. Hearing problems of elderly persons; Social consequences and prevalences. ASHA, 20, 79-83 (1978).

Punch, J.L and Mc Connel, F. The Speech discrimination function of elderly adults. JAR, 9, 159-166 (1969).

Quaranta, Cassaro and Cervellera. MLD in normal and pathological loss. Audiol. 13, 428 (1974).

Quaranta, A.P, Cassarro, et.al., Acoustic reflexometry in presbycusis. Audiol. 19(4), 310-315 (1980).

Raymond, A.s and William, F.P. Phoneme discrimination in older persons under varying s/N conditions. JSHR, 14(3), 630-638.

Raymond, J.C and Bateris, L. An investigation into presbycusis in Africans from sureel and nomadic environments, int. Audiol. 8, 294-303 (1969).

Rintelmann, Schumaier and Burchfield. influence of test form on speech discrimination scores in normal listeners of Nu auditory test No.6. JAR, Suupl.2, (1974).

Robinson, D.W and Sulton, G.J. Age effect in hearing - a comparative analysis of the published data. Audiol. 18, 320-334 (1979).

Rosen, S., Plester and Rosen, V. High frequency audiometry in presbycusis. Arch, otolaryngol. 79, 18-32 (1964).

Reinsche, L., Lawson, G, Beasley, D.S and Smith. Age and sex differences on preferred listening rate for speech. JAR, 19(2), 91-94 (1979).

Rupp, R.R. The community challenge - hearing loss in the elderly - a charge to the rest of us. Hearing instruments, 30, 16 (1979).

Schon, T. The effects of Speech intelligibility on time compression and expansion on normal hearing/ hard of hearing and the aged males. JAR, 10, 263-268 (1970).

Snoop, C and Benni, C.A. The effects of age upon the visual perception of speech. Scand. Audiol. 8, 3-8 (1979).

Seliman, S. The effects of aging on the stapedial reflex thresholds. JASA, 66, 735-738 (1979).

Smith, R.A. and Pratin, W.F. Phonemic discrimination in older persons under varying S/n condition. JSHR, 14, 630-638 (1971).

Spink, U., Johannsen, H.S. and Pikig. Acoustically evoked potential dependence upon age. Scand. Audiol. 8(1), 11-14 (1979).

Spoor, A and Passchier, V.W. Spread in hearing levels of non noise exposed people at various ages, international Audiol. 8, 328-335 (1969).

Sticht, T.G and Gray, B.B. The intelligibility of time compressed words as a function of age and hearing loss. JSHR, 12(2), 443-448 (1969).

Thompson, D.J., Sils, J.A. Recke, K.s. Acoustic admittance and the aging ears. JSHR, 22, 29-36 (1979).

Thompson, et.al. Acoustic reflex growth in the aging adults. JSHR, 23, 405-418 (1980).

Tillman, J.W and Olsen, W.O. Speech audiometry in Jerger (ed) Modern developments in audiology. 2nd edition, New York, Academic Press. (1973).

Tillman, T.W., Carhart, R and Nicholla, s. Release from multiple maskers in elderly persons. JSHR, 16, 152-160 (1973).

Vander Sandt, Aram Glorig and R. Dickson. A survey of the acuity of hearing in Kalahan Bush men. interna-tional Audiol. 8, 290-297 (1967).

Venkatesh, C.S. Geriatric Audiology - an independant project submitted to the Mysore University (1982).

Williford. The Geriatric patient. Chapter 9 in the Rose, E.D (Ed) "Audiological assessment". 2nd edition. Englewood Cliffs, prentice Hall inc., New Jersey (1978).

Zwaardemaker, H. Range of hearing at various ages. Jour, of psychol. 7, 10-28 (1894).

Appendix I

A TEST OF ENGLISH ABILITY
(CIEFL DB 2B 1980)

SECTION A

(I) Write suitable articles in the blanks in the following sentence

(1) This is_____worst thing that could have happened

(2) Mr. Shankar is_____honest man.

(II) Write suitable prepositions in the blanks in the following sentences

1. He was born_____the summer_____1969.

2. She fell unconscious_____hearing the shocking news.

(III) Write suitable pronouns in the blanks in the followipg sentences

1. The children have gone for a holiday with _____ parents.

2. is this cycle_____? I've seen you using it.

(IV) Write suitable articles, prepositions or pronouns in hhe blanks in the following sentences.

1. The children are scared of him because_____shouts at

2. The doctor has advised_____to live_____fruits alone as he found that she had_____very bad liver.

3. There are_____number of good films in Hyderabad now. I want to see them all. To do that, I must see them at____ rate of one a day. Even them, I am afraid I may miss some them.

Appendix I continued...

(V) Insert suitable articles, prepositions or pronouns wherever necessary in the following sentences.

Example: Mt. Everest is the highest peak in the world.

1. As there is lot of money in bank thieves are attracted by it.
2. I asked the teacher to explain me the new topic in Science.
3. The Principal wants you to inform as soon as you arrive.
4. Talking about the accident, she said she had seen with own eyes.
5. If you are in need of anything ask it.

SECTION B

(I) insert the right form of the verb given in brackets into each of the following sentences.

1. He (go) there yesterday.
2. She_____(go) to school by bus everyday.
3. I must_____(meet) the Principal tomorrow.
4. He_____(have) his tea when I_____(telephone) him yesterday.
5. He_____(live) here since 1934.

Appendix iContinued

(II) Put a mark against all the sentences which are grammatically correct and an (X) mark against those not grammatically correct.

1. Last year I walk to school everyday. /____/
2. Last year I have walked to school everyday. /____/
3. Last year I walked to school everyday. /____/
4. Last year I was walk to school every day. /____/
5. Hari did not came to class. /____/
6. Hari has not come to class. /____/
7. Hari has not came to class. /____/
8. Hari does not come to class. ^____/
9. Kamal was been swimming since sunrise. /____/
10. Kamal swimming since sunrise. ^____/
11. Kamal swims since sunrise. /____/
12. Kamal has been swimming since sunrise. /____/

(III) Make questions whose answers will be the following statements, use the words given in brackets to begin the questions.

1. The students like science fiction. (What)

2. Hari has broken my glasses. (Whose)

3. The children go to school by bus. (How)

Appendix I Continued

SECTION C

(I) Read each sentence and decide if there is an error in any underlined part, write the letter of the wrong part in the box. If there is no error write D. (NE stands for 'NO ERROR')

1. An object normally becomes hot when place it in the sun. (NE)
   A B C D

2. Ranjit and his sister are studying in same school.(NE) /___/
   A B C d

3. Balu and brother came to my house last night. (NE) /__/
   A B C D

4. She does not know anyone who works in that office.(NE) /___/
   A B C D

5. Why did you gave him my book? (NE) /____/
   A B C D

6. I did not been able to pay my fees yet. (NE) /___/
   A BC D

7. It was difficult for me to hearing the speaker. (NE) //
   A B C D

8. The police complain that cyclists seldom observe traffic
   A B C
   rules. (NE) /___/

9. Mother asked to my friends why they were leaving so
   A B
   soon. (NE) /_____/
   c D

10. I still do not understand that how a steam engine works.
    A B C
    (NE) /_/
    D

11. You will lose your purse unless you are not careful.
    A B C
    (NE) /_____/
    D

Appendix I continued

12. We searched (A) everywhere but could not anywhere find the (B) (C)
watch. (NE) (D) / /

13. A friend of her told me (A) that she has passed (B) (C). (NE) (D) /

14. The Principal himself must sign (A) (B) both the copies
of the application (C). (NE) (D) /____/

15. I was sure he would join (A) this college although he did (B) (C)
not do so. (NE) (D)

SECTION D

(I) select words from the list given to fill in the blanks in the sentences:

List of words:

is	what	who	although
are	when	whom	because
was	where	whose	However
were	which	that	therefore
am	while	so that	but

1. He left the place early he could reach ho
before sunrise.
2. I thought he would join the college_____he did not
do so.
3. When I telephoned him yesterday he told me _____ he
_____returning only next week.

Appendix i continued

4. _____ are the candidates _____ are to be interviewed today?

5. He does not have the needed qualifications. ___ he has been given a temporary appointment.

6. ---------- the rains came late, farmers are hopeful of a good crop.

(II) Rewrite the following sentences correcting the mistakes in them.

1. He used to laughing at others.

_____

2. How you open this gate?

_____

3. He has left the college in 1978.

_____

4. can you tell how does it work?

_____

5. Having booking the ticket much in advance, we enjoyed a comfortable journey.

_____

6. The man whom I met him yesterday is the new warden

_____

SECTION E

Read each passage and the statements that follow it. Decide whether each statement is true or false, according to the passage, and put a / / or a / X / in the box.

(I) Rani asked Raju if he wished to own a scooter. He said he did not mind spending seven thousand rupees on buying one. But he could not spend two hundred rupees a month just for maintaining it.

Appendix I continued

1. Rani wants to sell a scooter for Rs. 7000/- / /

2. Raju cannot imagine spending so much money on a scooter./ /

3. Raju can afford to pay Rs. 7000/- for a scooter. / /

4. Raju thinks that maintaining a scooter is expensive. / /

(II) "Not" said Julie's father, "it's not right to keep a dog in a flat in the middle of a big town. Wait for a few weeks. Then we will have our own house with a garden".

5. Julie had asked her father to get a pet dog. / /

6. Julie's father does not like pet dogs. / /

7. Julie's family were about to move to a new house. /____/

(III) When my aunt was young there was no electricity or running water in the house. She used to walk half a mile everyday to fetch water from the village well.

8. My aunt walks half a mile everyday. / /

9. She does not go to the village well now. /_____/

10. She usually fetches water from the well. /____/

(IV) We lived in Hyderabad many years ago. We were there for four years. Thep my family moved to Madras, we haven't been to Hyderabad since then.

11. We are now living in Madras. /____/

12. We used to live in Hyderabad. /_____/

13. we visited Madras from Hyderabad four years ago. /__/

14. We lived in Madras for four years before returning to Hyderabad. /_____/

15. We haven't visited Hyderabad for many years now. /

Appendix I continued

SECTION F

(I) Read the passage carefully and answer the questions that follow:

The frail man wearing a jibba and dark glasses, and carrying a walking stick, was a familiar figure all over India, one day, people returning home from offices in Madras were surprised to find him walking along the road to the central Railway station just like an ordinary man. There were surprised looks and excited inquiries, people asked one another, "Why is he walking in this crowd? It could be dangerous". The man they were talking about was Chakravarthi Rajagopalachari, The Chief Minister of Madras state, when Rajaji, as he was popularly and affectionately known, was asked why he was going to the station on foot, he had a simple answer. He had actually come by car. But the traffic jam near the station had forced the car to stop. He had to reach the station in time, so he had got out of the car and was walking, in any case, he did not see any reason why he should not walk a few steps w e n though he was the Chief Minister of the State.

1. At what time of day did people see Rajaji walking on the road?

   (a) early in the morning (c) at about 10.00 a.m.

   (b) late at night. (d) at about 5.00 p.m. /___/

2. What information supports your answer to question 1?

   a) He was carrying a walking stick.
   b) He was wearing dark glasses.
   c) The road near the station was crowded.
   d) People were returning home from offices.

3. There were surprised looks and excited enquiries because

   a) it was dangerous for a minister to walk in a crowd.
   b) Rajaji's train might have been delayed.
   c) the Chief Minister was walking along the road.
   d) the crowd had forced the chief Minister's car to stop but he was facing the situation bravely. /_____/

4. Rajaji's reason for walking to the station was that

   a) he believed in simple Gandhian principles.
   b) he thought walking would be more effective in the traffic jam.
   c) his popularity depended on being close to the common man.
   d) the crowded was hostile and he would be safer in the station. /_____/

Appendix I continued

5. "in any case, he did not see any reason why he should not walk....." This statement indicates that Rajajir felt that ministers should

a) always walk and set an example.
b) be prepared to walk whenever it seemed necessary.
c) walk on the steps of buildings, not on the roads.
d) help prevent traffic jams by not using bigh official

/ /

6. Find the word nearest in meaning to the word in capitals which occurs in the passage.

FRAIL: a) fierce b) weak c) important d) simple / /

INQUIRIES: a) rumours b) slogans c) questions d) notices

/ /

ACTUALLY: a) really b)usually c) earlier d) accidentally

/ /

Appendix II

CID W-l

1. Grey hound
2. School boy
3. Ink well
4. White wash
5+ Pan cake
6. mouse trap
7. Ear drum
8. head light
9. birthday
10. duck pond
11. side walk
12. hot dog
13. padlock
14. mushroom
15. hard ware
16. workshop
17. Horse shoe
18. arm chair
19. base ball
20. Stairway
21. Cowboy
22. Iceberg
23. North west
24. Rail road
25. play ground
26. airplane
27. wood work
28. oat meal
29. tooth brush
30. Fare well
31. grandson
32. drawbridge
33. door mat
34. hot house
35. day break
36. sun set

Appendix III

N.U Auditory test No: 6

	List I	List II	List III	List IV
1.	Land	pick	base	pass
2.	boat	room	mess	doll
3.	pool	nice	cause	back
4.	nag	said	mop	red
5.	limb	fail	good	wash
6.	shout	south	luck	sour
7.	sub	white	walk	bone
8.	vine	keep	youth	get
9.	dime	dead	pain	wheat
10.	goose	loaf	date	thumb
11.	whip	dab	pearl	sad
12.	tough	numb	search	yearn
13.	puff	juice	ditch	wife
14.	keen	chief	talk	such
15.	death	merge	sing	neat
16.	Sell	wag	germ	peg
17.	Take	rain	life	mob
18.	fall	witch	team	gas
19.	raise	soap	lid	check
20.	third	young	pole	join
21.	gap	ton	road	lease
22.	bat	key	shall	long
23.	met	calm	late	chain
24.	jar	tool	cheek	bill
25.	door	pike	beg	hole

Continued...

Appendix III Continued...

	List I	List II	List III	List IV
26.	love	mill	gun	lean
27.	sure	hush	jug	tape
28.	knock	shack	sheep	tire
29.	choice	read	five	dip
30.	hash	rot	rush	rose
31.	lot	hate	rush	rose
32.	raid	live	void	fit
33.	hurl	book	wire	make
34.	moon	voice	half	vote
35.	page	gaze	note	judge
36.	yes	pad	when	food
37.	reach	thought	name	ripe
38.	king	bought	thin	have
39.	home	turn	tell	rough
40.	rag	chair	bar	kick
41.	Which or witch	lose	mouse	lose
42.	week	bite	hire	near
43.	size	haze	cab	perch
44.	mode	match	hit	shirt
45.	bean	learn	chat	bath
46.	tip	shawl	phone	time
47.	chalk	deep	Soup	hall
48.	jail	gin	dodge	mood
49.	burn	goal	size	dog
50.	Kite	far	Cool	should

0*0*0*0*0**0*0

Appendix IV

CALIBRATION PROCEDURE

The procedure adopted for the 1. Cablibration of the Audiometer was aa follows:

1.1. For the calibration of intensity, the test earphone (TDH-39) of the audiometer was coupled with an Artificial Ear(Bruel & Kjaer 4152 with condensor microphone Bruel & Kjaer 4144). This system was then connected to a SPL meter (Bruel & Kjaer 2209). The attenuator dial of the audiometer was set at 70 dB HTL, then the output of the audiometer at each frequency across 250 Hz to 8000 Hz was measured.

Similarly, Bone conduction calibration was done at the audiometric output at 40 dB HL and instead of artificial ear, artificial mastoid(Bruel & Kjaer 4930) was placed in the system.

Whenever the difference between the observed SPL value and the expected value was more than 2.5 dB, internal calibration was done by adjusting the preset in the audiometer. Thus the output levels of the audiometer was well within 2.5 dB with reference to the standards.

1.2. To ensure the accuracy of the test frequencies, the output of the earphone was fed to the frequency counter

(Rodart 203). Maintaining the intensity at a Constant level, the frequencies were swept from 250 Hz through 8OO Hz. The corresponding red out for each frequency were found to be within the permissible limits.

2. <u>calibration of Tape Input:</u>

This was carried out through two different measurements:

2.1. To check if there is any mismatch between the tape out put and the audiometer input, the following procedure was used:

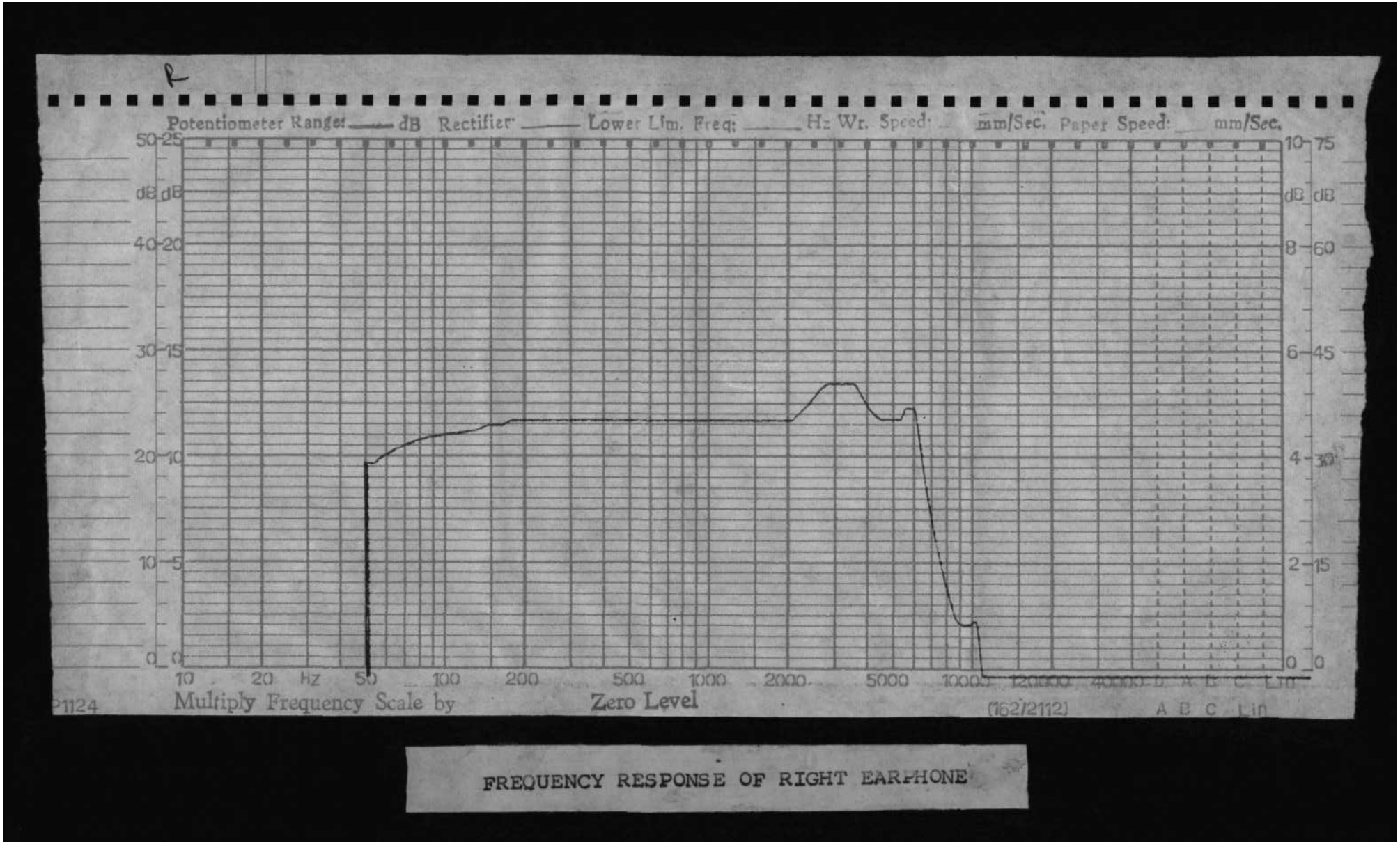
Four puretones of frequencies 250, 500, 1000 and 2000 Hz were recorded on a magnetic tape using the electrical output of a clinical audiometer(Beltone 200 C). The tape recorded output was then given to the tape input of the audiometer(Madsen OB 70). The levels of the 250, 500 and 2000 Hz tone were found to be within +3 dB with reference to the 1000 Hz tone(at 70 dB HL). Thus it was established that there was no mismatch between the tape recorder output and the tape input of the audiometer.

2.2. To check the tape output of the audiometer, a speech spectrum noise was used. The noise was recorded on a magnetic tape, using the same tape recorder. The tape was then played with the output being given to the earphone

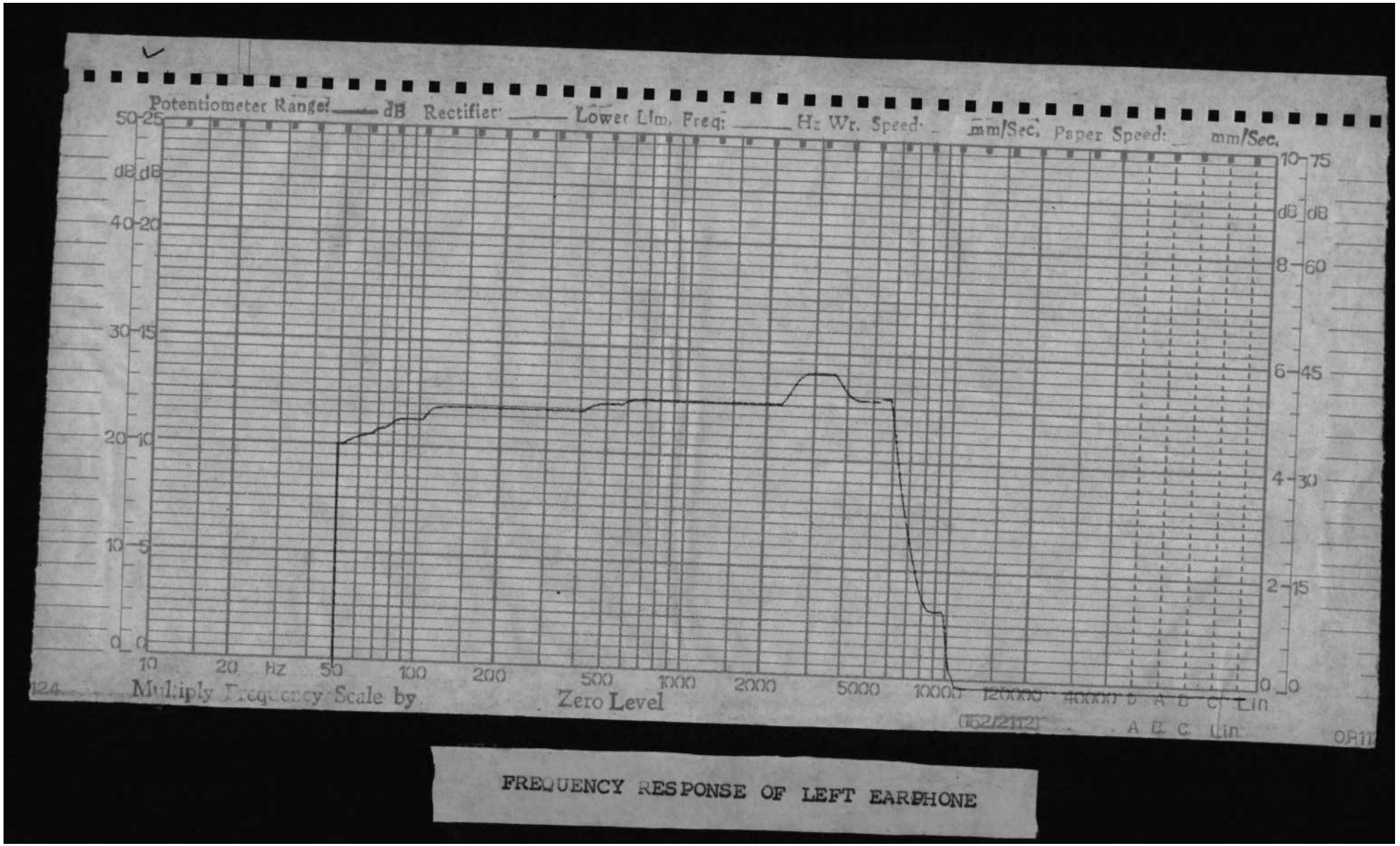
through the audiometer. The intensity dial reading of the audiometer was 70 dB HL. The SPL value obtained was 90dB SPL which is in agreement with the ANSI specifications.

3. Earphone frequency response characteristics

The output from the beat frequency oscillator(Bruel & Kjaer type 1022) was given to the artificial ear(Bruel & Kjaer 4152). The output from the test earphone was given to an audio-frequency analyzer(Bruel & Kjaer 2107). The output from the analyzer was given to a Level recorder(Bruel & Kjaer 2305). As the beat frequency oscillator scanned through the frequency range from 20 Hz to 20 KHz, the graphical recording of the frequency response of the earphone was obtained. The response curve is given in Appendix V.



FREQUENCY RESPONSE OF RIGHT EARPHONE



FREQUENCY RESPONSE OF LEFT EARPHONE

Appendix VI

The Noise levels in the test room were as follows:

125	30
250	21
500	12
1000	12
2000	10
4000	10
8000	10
C-Scale	33

*0*0*0*0**0*0**0*0**

age group		250	500	1K	2K	4K	6K	8K
20 - 29 Years	Right	10	1O	5	5	10	15	10
	Left	5	5	5	5	1O	5	5
30 - 39 Years	Right	10	10	10	10	10	20	20
	Left	5	5	5	5	lo	15	10
40 - 49 Years	Right	10	10	15	15	15	25	2O
	Left	10	10	15	15	15	20	10
50 - 59 Years	Right	15	15	15	15	25	25	25
	Left	15	15	15	15	25	30	20
60 - 69 Years	Right	20	20	20	25	45	60	60
	Left	20	20	20	25	45	55	65

Appendix VII - Normative data on pure tone sensitivity as a function of age:

Air conduction Thresholds