COMPARISON OF PURE TONE THRESHOLD USING SUPRA AURAL AND CIRCUMAURAL EAR CUSHION

REGISTER NO. M 8701

ASHOK KUMAR

An Independent Project submitted as part fulfilment for first year M.Sc., Speech and Hearing to the University of Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING
MYSORE-570 006

1988

Dr. M. N.Vyasamurthy

"Dada and Dadi"

CERTIFICATE

This is to certify that the Independent Project entitled! "COMPARISON OF PURE TONE THRESHOLD USING SUPRA-AURAL AND CIRCUMAURAL EAHCUSHI0N" is the bonafide work, done in part fulfilment for First Year M.Sc., (Speech and Hearing) of the student with Register Number M8701.

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CERTIFICATE

This is to certify that the Independent Project entitled "COMPARISON Of PURE TONE THRESHOLD USING SUPRA-AURAL AND CIRCUMAURAL EARCUSHION" has been prepared under my supervision and guidance.

Dr.M.J.Vyasamurthy
GUIDE.

DECLARATION

This Independent Project entitled "COMPARISON OF PURE TONE THRESHOLD USING SUPRA-AURAL AND CIRCUMAURAL EARCUSHION" is the result of my own study undertaken under the guidance of Dr.M.N.Vyasamurthy, 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.

Date: April, 1988　　　　Register No.M8701.

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INTRODUCTION

"Audiometry" means the measurement of hearing sensitivity. There are two reasons for measuring hearing acuity. One clear purpose of audiometry is to assist in medical diagnosis and the second purpose is overall assessment of hearing.

Wide range of equipments exist to assist us in measurement of hearing sensitivity. One of them is a pure tone audiometry which provides, as test material, pure tones of selected frequencies and of calibrated sound pressure levels (Davis, 1947).

Pure tone tests are the basic tests to find hearing sensitivity and are also the basic clinical tools for initiating differential diagnosis. These tests also suggest the site of lesion.

Pure tone audiometry consists of Air conduction (AC) and Bone conduction (BC) testing. For AC testing, pure tone signals are presented through the earphone with the frequency ranging from 250Hz to 8000Hz at octave intervals.

BC testing consists of presenting pure tones ranging from 250Hz to 4000Hz by means of a bone vibrator placed on the mastoid, behind the ear or on the forehead.

For each specific frequency, the tones are varied in intensity by means of an attenuator dial on the audiometer to find out the lowest level at which the individual could barely detect the presence of the signal 50% of the time. This particular level of hearing is termed as threshold level of the individual.

There are several factors which could influence obtained threshold level. Threshold variability is often due to non-auditory processes. Those influencing extrinsic variability can be reasonably controlled under laboratory conditions. Such factors like temperature, humidity, light, ambient noise level, calibration of equipments etcy type of ear cushion used may affect the threshold level of individual. Intrinsic variables affecting auditory sensitivity include (1) Neuro-physiologic factors governing organic sensation and (2) subjective considerations, such as motivation, intelligence, attention, familiarity with the listening task and variations in how listeners interpret the same test instructions.

It is apparent that many of these factors may interact so that, for example, the comfort and conditions of the test room together with the attitude of the tester will influence the motivation of the subject which in turns affects the threshold of the subject. Like wise the personality of the subject may influence his response criteria and the variability of the detection threshold (Stephens, 1969, 1971).

Of the factors mentioned above (which affect the threshold sensitivity); one of the factor is type of ear-cushion used for pure tone audiometry.

The ear cushions ace enclosures of the external type earphones. Thus used to fix earphones on the ar. They are made out of rubber and have specific shape and size. Two types of ear cushions are generally recognized. They are:

1. supra—aural ear cushion.
2. circumaural ear cushion.

Supra-aural cushion covers only the outer past of the pinna and seal against the skull. The circumaural cushion occupies a larger volume than supra-aural cushion. The latter is approximately 6cc which is equivalent to the volume of NBS-9A Standard coupler. The specific volume of circum-aural cushions are not known as there is no standard coupler developed to measure the same.

The supra-aural cushion MX-41/AR (as specified by ANSI-1969) are most commonly used for hearing testing. It is a two piece foam cushion made out of Buna rubber (base) and sponge neoprene (Cap).

Performance of different MX-41/AR cushion may differ due to material compound, molding processes effectiveness of the cement connecting the two pieces and aging characteristics of the sponge materials. To overcome this problem. Telephonics developed one piece model 51 ear cushion, comparison were made between MX-41/AR and model 51 and they found no significant difference in their performance. But there was strong indication of Model-51 giving more consistent result with improvement of comfort also (Michael and Bienvenue, 1980).

Earphones and earcushions are available as specific assembly. Moat earphones can be mounted in either supra-aural or circumaural cushion. Sometimes they are available as single unit eg; sharpe HA-10.

Specific combination either supra-aural or circumaural has its own advantages and disadvantages. Some of them are mentioned below;

Earphone—supra-aural cushion combination;

Advantages:

It can be easily calibrated by using the standard coupler NBS-9A, thus approved by various 3tandard such as ANSI, SI:6-1962.

Disadvantages:

1. They become uncomfortable after wearing for longer time which may affect the performance.
2. They do not attenuate ambient noise as effectively as circumaural ear cushion. Hence difficult to use in school screening and industrial screening.

3. This type of cushion defornts the flesh around the canal entrance and constricts the opening. It results in lowering of the resoaant frequency of the system which varies with pressure applied to the cushion which is in contact with the pinna (Villchus. 1969).

Earphone-circumaural cushion combination:

Advantages:

1. It provides greater attenuation of ambient noise and is therefore advantages for testing in noisy situation.
2. It improves the comfort of the wearer.
3. There is less likelihood of energy leakage.
4. They have low impedance in lower frequency region. Thus at this frequency range output measured on a flat plate coupler goes well with the real ear measurements made by supra-aural earphones investigated (Shaw, 1966b).

Disadvantages:

1. It cannot be calibrated to NBS-9A, standard coupler. No standard coupler has been developed to calibrate the circumaural earphone as yet. Thus its use is not justified in routine audiometric testing. Its use is limited to laboratory investigations where careful calibration can be performed.
2. At frequencies above 2000Hz, circumaural earphone response varied depending upon the type of earphone and cushion, applied force and placements of earphone on coupler (Shaw and Thiesson, 1962).

Need for the study;

All studies on comparison of pure tone thresholds using supra-aural and circum-aural earcushions have been done in the Western countries. We, most often rely on the data available from those studies. There is racial difference and other differences like, environment, testing conditions, temperature.

Hence, present study was Mainly aimed to compare pure tone thresholds using supra-aural and circum-aural ear cushions on Indian population which would be suitable for our clinical condition.

The present study was aimed at answering the following question:

1. Do the pure tone thresholds differ with the type of ear cushions?
2. If yes, is the difference; frequency specific?

Implication of present study:

The results of this study would indicate,if the two types of ear cushions can be used intereh angeably in clinical practice.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

One of the basic requirements for pure tone audiometry or threshold audiometry is a well controlled test environment? the level of the ambient noise must be low enough to ensure that extraneous masking noise will not affect test results. The most acceptable procedure for controlling ambient noise is use of prefabricated sound rooms. There are situations, however that preclude use of sound treated booths, both from a practical and economic point of view.

As an alternative to the prefabricated sound room, several manufactures offer audiometers equipped with noise attenuating earphone cushions. These cushions are referred to as circumaural enclosures, because they contain a resilient cushion that completely surrounds the pinna. The primary advantage of circumaural enclosure is the noise attenuating property (Copeland and Mowry, 1970; Martin et al. 1971). Increased portability, low relative cost and comfort are additional features.

Several studies have shown differences in pure tone thresholds when circumaural enclosures are used, as compared to a supra–aural cushion (Cozad and Goetzinger, 1970; Harris, 1971; Lankford and Zachman, 1971).

The next few pages encompasses, in a nutshell, some of the relevant literature, under four sub topics. They are

1. Studies related to the acoustic performances of the two ear cushions.
2. Studies baaed on pure tones and noise.
3. Studies baaed on pure tones alone.
4. Miscellaneous information.

1. Studies related to the acoustic performance of the two ear cushions:

The ear cushion opening Should be ¾ of an inch in diameter as recommended by ANSI in 1962. Violation of which may result in alteration of its output at certain frequencies even if the audiometer and the earphones are in good condition. But commercially available car cushions are found to vary from 1/32 of an inch to 1/8 of an inch less than recommended value (Dirk and Wilson, 1976).

Michael and Bienvenue (1976) prescribed a calibration data for the circumaural headset designed for the testing of hearing acuity. Two seta of TDH-39 and TDH-50 earphones were used. One set mounted on a Telephonies circumaural headset, and the other on a supra-aural MX-41/AR ear cushion. 10 subjects were taken and compared, using threshold loudness balance method. Their results revealed that the circumaural earcup offers significantly more attenuation to background noise than does the conventional MX-41/AR supra-aural cushion at all frequencies. In addition, subjective comfort evaluation.

strongly favours the circumaural ear cup over the MX-41/AR cushion. Also, it provides significantly more consistent thresholds than the MX-41/AR headset. Circumaural earphone assembly can be calibrated on a flat-plate for audiometry.

Charan, tax and Neomoeller in 1965 tested the responses of the two types of ear cushions coupled! with 3 types of ear phones. They found that the responses of these earphone earcushion combinations varied considerably above 2KHz due to variations in -

1. the type of earphone used
2. the type of cushion used
3. applied force on the earphone
4. placement of the earphone on the coupler.

Shaw (1966) used a probe-tube microphone to measure ear canal sound pressure levels (SPL's) of 10 subjects each with three different circumaural earphones and two different against - the - earphones, So also measured relative responses between a Sharpe HA-10 circumaural earphone on the flat plate coupler and a Telephonies TDH-39 against - the - ear earphone with MX-41/AR cushion on NBS-9A coupler. Each of them was excited with the voltages which were required to produce identical SPL's in average real ears. In a separate experiment , he showed that the SPL in the ear canal, at the average threshold of hearing of the listeners, was substantially independent of the earphone used.

In view of the work described by Charan et al.(1965) and by shaw (1966), and in view of the evident lack of knowledge of the critical factors which affect the coupling between earphone and ear, the committee (Members of the United States of American Standards Institute writing group S3-1 - W-37) feels that it cannot justifiably write a standard for the coupler calibration of circumaural earphones. In the absence of an acceptable coupler method of calibration, pressures corresponding to the normal threshold of hearing for circumaural earphones cannot be determined. Use of these earphones in pure tone audiometry must therefore be limited to laboratory situations in which special knowledge and calibration facilities are available.

The utility value of these circumaural earphones cannot be assured Whenever sound pressure levels of pure tones at eardrum must be defined accurately.

Unless of course,the calibration of the system consisting of the particular earphones and ears (artificial or real) is thoroughly investigated (2) and the calibration procedure is reliable.

Therefore, the routine use of circumaural earphones in clinical and industrial audiometry cannot be justified, but should be restricted to laboratory practices where investigation of calibration procedure in relation to the specific earphones can be carried out.

Continuing problems with the consistency of the MX-41/AR earphone cushion's physical and acoustical characteristics have led to the development of a one-pience cushion (Model 51) by the Telephonies Company. Michael and Bienvenue (1981) measured the attenuation characteristics of this one-pience cushion; according to ASA standard 1-1975 (ANSI S3.19-1974). The attenuation characteristics provided for the wearer by the model 51 cushions tend to be slightly greater than those of the MX-41/AR cushion but the differences are not gen rally significant with $\alpha = 0.05$. The average attenuation data for the two cushions were relatively uniform: about 8dB at and below 3KHz, and about 29dB at and above 3000HZ. A gradual transition in attenuation levels from 8 to 29 dB was found at the test bands centered at 1000Hz and 2000Hz.

Richards, Frank and Prout (1979); studied the influence of earphone — cushion center-hole diameter on the acoustics output of audiometric earphones. A psychoacoustic experiment was carried out to evaluate the influence of MX-41/AR cushions having different centerhole diameters. The threshold of 10 trained listeners were measured with a Bekesy audiometer (Grason-Stadler, 8-800) equipped with an MX-41/AR cushion having 9/16 of an inch and a 3/4 of an inch center hole diameter.

Thresholds were obtained wtth a pulsed tone at 1, 2, 3, 4, 6 and 8KHz with the Bekesy set at a slow attenuation rate

(2.5 dB/s). The test frequencies were randomized ?nd the test cushions were counter balanced. Each listener tracked his threshold for 1.5 minute for each test frequency cushion condition.

Results revealed that the thresholds at 1, 2 and 3KHz were not affected by interchanging the 9/16 of an inch center hole diameter cushion and 3/4 of an inch; Center hole diameter. However, at 4 and 8KHz thresholds were 1.5 and 3dB lower with the 9/16 of an inch than with the 3/4 inch, center hole diameter cushion and at 6KHz the thresholds were 1.5dB higher.

Thus it can be said that psychoacoustic as well as acoustical differences exist between cushions having different center holes diameters specially at higher audiometric frequencies.

2. <u>Studies based on pure tones and noise:</u>

Ross and Glorig (1975) compared pure tone thresholds using the Auraldome enclosure and a standard cushion (supra—auxal MX-41/AR). Thresholds were recorded in quiet and in the presence of three levels of sound field noise using conventional audiometric procedure. They found that there were differences in pure tone thresholds between the Auraldome and the Supra-aural cushions. Specifically the data revealed that the differences were statistically significant only when testing was performed in well controlled sound environment without competing noise. In quiet conditions thresholds were higher (poorer) with Auraldome than the MX-41/AR cushion with an exception at 6KHz. Another finding was that significant differences were not found in presence of sound field noise at 50, 60 and 70d8 SPL.

Stark and Borton (1975) studied the differences between pure tone threshold measured with the standard earphone (MX-41/AR) and those obtained with the Audiocups using conventional pure tone audiometry. 30 normal hearing adults age ranging from 20 to 29 years were tested in quiet and noisy environment.

The results revealed that pure tone thresholds obtained with audiocups are almost identical to those measure with supra-aural earphones. Audiocups reduce the masking influence of white noise more effectively. They conclude that audiocups may be used for screening and for threshold audiometry in less than ideal testing environments without fear of invalidating the results.

Martin et al. (1971) studied the attenuating properties of threetypes of noise-attenuating enclosures for audiometric earphones. A supra-aural ear defender (RAF MKB) and on MX-41/AR earcap were used as controls. Measurements were done to assess the degree of attenuation of ambient air borne noise and variation in threshold of hearing as compared with earphones in their normal head band; in a group of adults and a small group of 10 year old children.

Two pairs of noise excluding enclosures HAL HEN and safety supply Company; TDH-39 earphones with MX-41/AR ear-caps and RAF MR3. ear defender were tested on adults. And a further noise excluding enclosure AMPLIVOX AUDIOCUPS and the RAF MK3 ear defenders were tested on the adults and children both. Results showed that there was no significant difference between threshold obtained with three types of fitting i.e. HAL-HEN, Safety Supply Company and MX-41/AR. and the difference in attenuating properties between the noise excluding enclosures and the MX-41/AR earcap were overall statistically significant but in practical terms small.

In view of the wide-spread use of noise excluding enclosures for audiometric earphones used in screening school children, it was decided to repeat the tests on a group of 10 year old children. The results showed a considerably smaller degree of attenuation for both the RAF MK3 ear defender and the AMPLIVOX AUDIOCUPS (Audiometric earmuff).

Tillis and Wall (1974) compared AC thresholds using supra—aural audiometric unit consisting of Telephonics Company. TPH-39 earphone mounted in an MX-41/AR cushion VS. a matching unit encased inan Amplivox company, in an actual school screening situation. 30 males and 30 females aged 6 to 12 years were screened. Using conventional AC thresholds measurement procedure (Carhart and Jerger, 1959) each unit at .5, 1, 2, and 4KHz from each subject (120 audiograms)were taken.

The supra—aural audiotnetric earphone cushion was used either alone or encased in an Amplivox Company "Audiocup" while the Audiocup data were clearly masked thresholds at 500Hz and 1KHz, they were 12 and 8dB closer to audiometric "zero" respectively; than the comparable data. Therefore for school screening the use of the Audiocup does not atte-nuate ambient noise sufficiently to examine thresholds at audiometric "zero". But does allow a screening criterion of hearing lass less than = 15dB "pass" event at 500Hz where the supra-aural unit (MX-41/AR) does not.

Musket and Roeser (1977); obtained pure tone thresholds at frequencies between 250Hz and 8KHz at octave intervals including 6KHz, from 24 children between the ages of 8 and 13 years using a supra-aural cushion (MX—41/AR) and four circumaural enclosure (Auraldame, AR-100R; Otocups; RA-125; Audiocups; Amplivox and Telephonic Audiometric Headset-Model 556). The audiometric Headset and Auraldome use a rigid plate to couple to the driver to the pinna.

Testing was performed in quiet and inthe presence of wide band noise presented at 60dB SPL for three conditions. condition (1) used a TDH-39 driver mounted in the MX-41/AR cushions; (2) used the same TDH-39 driver mounted in one of the circumaural cushions and (3) which was the same as condition (1).

Results revealed no signifiant difference for any of the factors (test frequency, type of earphone enclosure or age) for the thresholds obtained in quiet using the Audiocups, Audiometric headsets and otocups. For the Auraldome, the type of earphone enclosure was found to be significant. Multiple - t-testa revealed the differences between the MX-41/AR and the Auraldome to be statistically significant at 500Hz, 1000Hz and 6000Hz.

Across frequency, thresholds obtained in noise with the Audiocups, Audiometric headset and otocups were found to be significantly different. However the thresholds obtained using a Auraldomes were not significantly different from the MX-41/AR cushion.

3. Studies based on pure tones alone:

Sergeant and Harris (1970) conducted a study to determine differences in audiometric threshold using the usual audiomettic earphone cushion, the MX-41/AR, and the willson "Sound Barrier" supra-aural muff. Differences in median audiometric thresholds for 20 subjects resulting from embedding earphones in the supra-aural MX-41/AR muff and in the Wilson "sound Barrier" supra-aural muff was obtained. Applying these corrections to the Wilson muff with its much superior sound-attenuation properties makes passible threshold audiometry in much noisier work spaces than heretofore.

Cozad and Goetzinger (1970), compared audiometric and acoustic coupler measurements on the supra-aural unit vs. each of these Auraldome and Pedersen unit. Audiograms of 54 normal hearing young adult (Mean age of 30 years) and acoustic coupler measurements w?re compared for a supra-aural earcushion (MX-41/AR) and two circumaural earphone cushion units at 0.5, 1, 2, and 4KHz. Mean audiograms were reasonably comparable between the supra-aural and Auraldome units (Maximum of 3.5dB discrepancy, at 0.5 KHz); substantial differences, upto 13.1dB, existed between the supra-aural and Pedersen unit. Acoustic coupler differences between the supra-aural and the Auraldome unit were not comparable with the mean audiometric differences (discrepancies at 1 to 4 KHz ranged from 6.5 to 8.1dB). However such discrepancies did not exist for the supra-aural vs. the Pedersen unit. At 4KHz the Auraldome can simply replace the supra-aural unit if desired, but coupler data do not validate this transfer.

Lankford and zachman (1971) obtained thresholds from the right ears of 14 male and 14 females with normal hearing (Threshold better than 20dB ANSI at each of the test frequencies). The subject's age ranged from 20 to 30 years. Thresholds were measured using the supra-aural earcushion and the Auraldome unit at all frequencies from 0.125 to 8KHz at octave intervals. Thresholds at each frequency was obtained directly from subject's Bekesy tracing for the pulsed tone the mid point was calculated from 5 high and 5 low - intensity peaks of the tracing.

Results revealed that there was no overall significant difference due to the earphone condition ($P>0.05$). A significant difference was obtained for the frequency condition ($P< 0.05$) and for the earphone - by - frequency interaction ($P<0.05$). The mean differences in dB between the earphones revealed that Auraldome gives higher (poorer) thresholds with respect to the supra-aural earphone at 9 of the 11 frequencies. At 4 and 8KHz, thresholds were lower (better than those obtained with the supra-aural earcushion).

It was desired to know whether a circumaural earphone could, perhaps with some acoustic correction, simply replace the American Supra-aural Earphone/Cushion in audiometry, and if so how to standardize a transfer function for threshold sound pressure level. Harris (1971) compared three circumaural earphones incorporating in turn the identical pamoflux PDR-8 driver with the same driver in MX-41/AR supra-aural earcushion. Bekeay thresholds were collected on 26 ears, SPL out-puts on a flat-plate coupler were traced on a graphic level recorder with the identical voltage to all earphones and SPL outputs at the entrance to the human meatus of 10 young men were recorded by probe tube microphony, also with the identical voltage pattern.

Results of the above study revealed the following:-

a. All frequencies yielded about the same (±5dB). Bekesy mean thresholds through 0.5 to 8KHz, but the standard deviation of individual differences between any circum-aural unit re the supra-aural device was 5 to 10dB at 4KHz and up; thus for an appreciable number of subjects circumaural earphones are not in fact interchangeable with the supra-aural unit in audiometry in the octave 4 to 8 KHz.

b. Attempts to specify the SPL's produced by each device by probe microphony at the entrance to the meatus were only partially successfull. Mean data were stable through 0.5 to 8KHz, but again, individual variances at 4KHz and up indicate that equal loudness does not yeild exactly equal SPL at the probe tip.

c. A flat-plate coupler can well store mean threshold SPL for any circumaural device; acoustic interaction however between device and coupler render specific comparisons among devices of little use at 4KHz and up without psychoacoustic corroboration.

d. The circumaural devices tested, with their greatly superior noise attenuation, can with certain precautions be used in screening audiometry where the noise levels cannot be reduced to acceptable levels.

e. Using probe tone microphones and loudness balancing procedures, it was found that some commercial muffs could be used in audiometry at 500Hz to 3KHz; but at frequencies above 3KHz they were acceptable as screening devices only.

Wood and Fagundas (1972) studied 10 normal hearing subjects in a sound-treated booth, conventional fixed frequency pulsed tone Bekesy thresholds were collected (attenuation rate: 2-5dB/sec) at 8 frequencies from each eary twice with the supra-aural unit and twice with the identical unit inserted inthe Audiocup.

Results revealed that mean threshold differences were negligible between the two devices, amounting at the most to a correctable 4 and 5dB at 6 and 8KHz respectively. Individual differences between thresholds for the two devices showed standard deviation of a maximum 3.8dB (Mean-2.8dB) between 5 to 6KHz. The data also revealed that there was an agreement between the supra-aural and circumaural units being best at lKHz that is also in agreement with the previous study by Harris (1968).

4. Miscellaneous information:

Speaks (1969) investigated differences in performances between circumaural cushion (CZU-6) and supra-aural cushion (MX-41/AR) on threshold sensitivity for speech. The results revealed that supra-aural cushion shows slight superiority of performance but at supra threshold level hearing 80dB, performance were the same. Thus speech discrimination was unaffected by the choice of cushion.

Chaiklin and McClellan (1971); investigated the audiometric management of collapsible ear canals by performing pure tone audiometry under six conditions with 12 subjects having normal hearing and normal ear canals and 12 subjects with collapsible ear canals.

Sound field audiometry provided valid and reliable threshold estimates. With appropriate calibration, a circumaural earphone assembly provided valid and reliable results between 125 and 3000Hz but produced large intersubject differences above 3000HZ. A hand held supraaural earphone was effective above l000Hz but grossly unreliable below 1.5KHz. A small war insert was relatively ineffective ia neutralizing the effects of collapsible ear canals. Thus it can be said that sound-field audiometry or a circumaural ear phone are useful for assessing patient's collapsible ear canals and that earmolds, ear inserts or polyethylene tubing are inappropriate solutions to the problem.

Ears that collapse from audiometer ear cushion pressure may show elevated stapedial reflex thresholds. In such cases, erroneous judgements about the status of a patient's hearing are possible.

Erwin et al.(1976); studied 15 normal ears and suggested that the use of a circumaural ear cushion on the impedance audiometer headset is an effective method of dominating outer ear closure and the resulting spurious thresholds, when the proper correction values by frequency are applied to the audiometer dial reading. For reflex thresholds taken with impedance bridge; it has been found that similar shifts (poorer thresholds) occur when the same ears are tested first with the supra-aural and then with the circumaural (NAF-48490-1) cushion the earphone.

Erwin (1980); reported the use of NAF-48490-1 circumaural ear cushions on audiometer earphones to prevent pinna or ear canal collapse and to ensure patent ear canals during audiometry.

When a financial compensation for hearing loss is to be calculated from the results of audiological evaluation, some agencies require pure-tone air conduction thresholds to be determined at 3000Hz. should a patient who has entered a hearing loss compensation claim have collapsing pinnae or ear canals. Circumaural ear cushions are used on the audiometer earphones to avoid spurious elevation of thresholds, a dial correction for 3000Hz may be necessary.

Ten adult patient aged 25 to 60 years served as the subjects. Pure tone average for these subjects ranged from 5 to 65dBHL. Hearing loss were considered to be sensorineural. The ears of each subjects were examined by palpatron and otoscopic examination was done to rule out collapsing ears or other occluding conditions. A pure tone airconduction threshold was determined at 3000Hz for one ear of each patient. After threshold determination with the supra-aural ear cushion, the cushion was replaced with an NAP-48490—a circumaural ear cushion, and threshold at 3000Hz was taken again.

Results showed that listener threshold taken with the circumaural ear cushion averaged 6.25dB poorer than did thresholds taken with the same earphone and supra-aural cushion. The t-test for significance of differences between means of two correlated samples was significant (t=4.79) at the 0.002 level (P<0.002). These results suggests that a dial correction of 5dB should be applied when taking a pure tone threshold at 3000Hz using an audiometer earphone fitted with an MAP 48490-a circumaural earcushion.

METHODOLOGY

METHODOLOGY

Subjects:

Twenty subjects (10 males and 10 females) in the age range of 17 to 25 years, with a median age of 20 years took part in this study. The selection of subjects was done on a random basis and met the following criteria:

1. They should not have any history of ear discharge, tinnitus, ear ache, headache, giddiness exposure to loud noise or any other otologic compliants.
2. Hearing sensitivity within 20dBHL (ANSI 1969) at frequencies from 250Hz to 8000Hz at octave intervals.

Instrument used:

A Madsen TBN 85 Audiometer, TDH-39 earphone with a supra–aural earcushion and a circumaural earcushion within ME 70 headset were used. The audiometer was calibrated according to the specifications given by ANSI 1969, ISO-1975.

Test Environment:

The study was carried out in a sound treated one room condition. The ambient noise level, present in the test room were below the permissible (ISO-1964) maximum allowable noise level.

Procedure:

The subject was seated on an arm chair so that the control panel of the audiometer was out of his line of vision.

Testing was conducted on only one ear of each subject with the choice being right ear. One pair of TDH-39 earphone was used in the present study. During testing procedures. Circumaural earcushion and supra-aural earcushion were interchanged for threshold determination respectively for each subject.

Thresholds were obtained for pure tone at the test frequencies (250Hz to 8000Hz) at octave frequency including 6000Hz) using both the circumaural as well as supra—aural earphone-cushion in an acoustically sound treated room. The order of testing was randomized so that half of the subjects were tested using circumaural ear cushion first and supra-aural later. And for the remaining half the order was reversed. Pure tone thresholds were established using the Modified Hughson-Westlake procedure.

The following instructions were given:

"You will hear a tone in your right ear. Raise your index finger when you hear the tone. Even if you hear a soft signal, raise your finger and hold it up as long as you hear the tone. when you no longer hear it, bring your finger down".

The thresholds were recorded manually (for both circum-aural and supra—aural earcushion) and were tabulated for statistical analysis.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The present study was aimed to compare the pure tone air-conduction thresholds at 250Hz to 8KHz at octave intervals including 6KHz using supra-aural and circumaural ear cushion among normals.

The study was performed on 20 normal subjects in an age range of 17 to 25 years. Pure tone air-conduction thresholds were determined using Modified Hughson-Westlake Procedure.

The data collected was statistically analyzed. The Mean and Standard Deviation of pure tone thresholds, obtained using supra-aural and circumaural earcushion at different frequencies are presented in Table-I. The mean thresholds are also graphically represented in Fig.I.

The table indicates that the supra-aural earphones yielded better thresholds at four of the seven frequencies but the differences between Mean thresholds are very small. Threshold differences for individual subjects were never greater than ±10dB at any frequency. The difference was not statistically significant. It appears therefore that those thresholds obtained using the circumaural enclosure are no different than those obtained using supra-aural earphone arrangement (supported by Stark and Borton 1975).

The mean threshold obtained using circumaural and supra-aural ear cushions are compared in Fig.2. The mean differences in dB between the circumaural and supra-aural earphones revealed that circumaural gives poorer (i.e. higher) thresholds when compared to the supra-aural earphone threshold at six of the seven frequencies tested. The only exception being at 4KHz where the mean differences between the two thresholds was O.5dB i.e. both types of earphone-cushion combination yielded almost same threshold.

Contradictory to the findings by Harris in 1968, the data showed an agreement in thresholds between the two set ups. This was particularly true for the 4KHz pure tone.

The mean standard deviation computed across all the frequencies was 6.092 dB for circumaural and 6.095 dB for supra-aural earcushion. The suggest that the S.D. for the two earcushion is almost the same.

This signifies that the variability in threshold is the same irrespective of the type of ear cushion used, at all frequencies except at 500 and 8000Hz. This is in agreement with the finding of Wood and Pagundas, 1972.

Table-II shows significance level at different frequencies obtained from "The Wilcoxon Matched-Pairs Signed Rank Test".

A further statistical analysis was done to examine the significant difference between the air conduction threshold. obtained by supra-aural MX-41/AR and circumaural earcushion.

"The Wileoxon Matched Pairs Signed-Ranks Tests* was used to find out the significant difference between the two set-ups.

Analysis of the data revealed that the differences between supra-aural and circumaural were significant at 250Hz and 6KHz at all levels of significance (0.05, 0.02 and 0.01 level of significance). At 500Hz, 1KHz and 2KHz significant difference was found at 0.05 and 0.02 level of significance.

The most important finding was that there was no significant difference between the two units (supra-aural and circumaural) at 4KHz and 3KHz.

Table-1 shewing Mean and Standard Deviation (SD) of Circuraural and Supra-Aural Ear Cushion.

Type of ear cushion used	250Hz		500Hz		1KHz		2KHz		4KHz		6 KHz		9KHz	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D..	Mean	S.D.	Mean	S.D.	Mean	S.D.
Circumaural Ear cushion	11.5	±6.1	11.5	±5.5	6.75	±5.35	8.23	±3.06	8.0	±4.85	14.75	+ 6.178	12.0	± 7.65
Supra-aural Ear cushion	7.25	+5.8	7.5	+5.02	6.25	+ 5.21	4.75	+4.60	7.5	±4.60	9.5	+7.73	9.25	± 8.70

Table-II Showing level of significance obtained from "wilcoxon Matched-Pairs signed—ranks test* between the two earcushions supra-aural and circumaural.

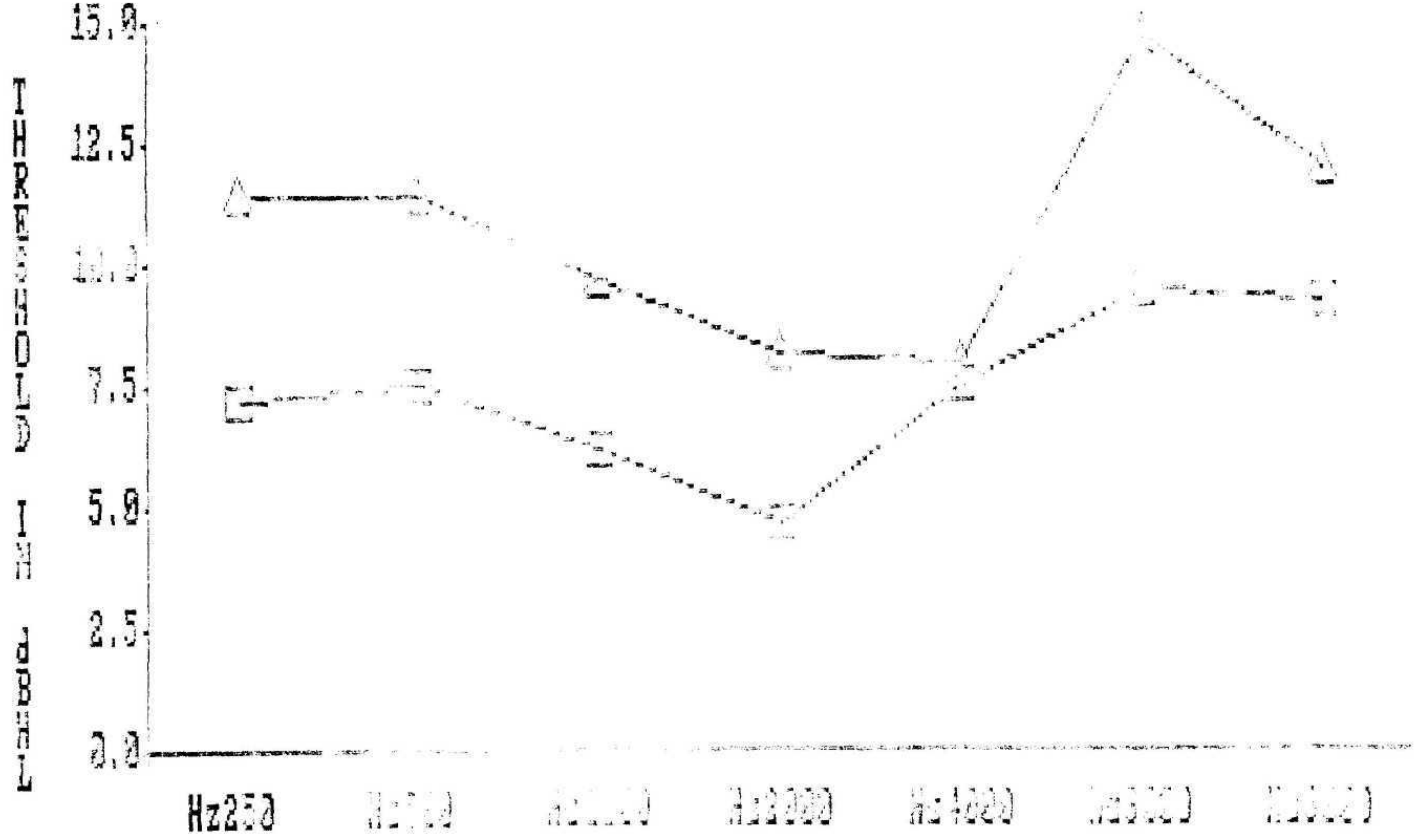
Frequency	Leve/of significance
250HZ	***
500HZ	**
iOOOHz	**
2000HZ	**
4000HZ	Not significant
6000HZ	***
8000Hz	Not significant

NB: * P<0.05

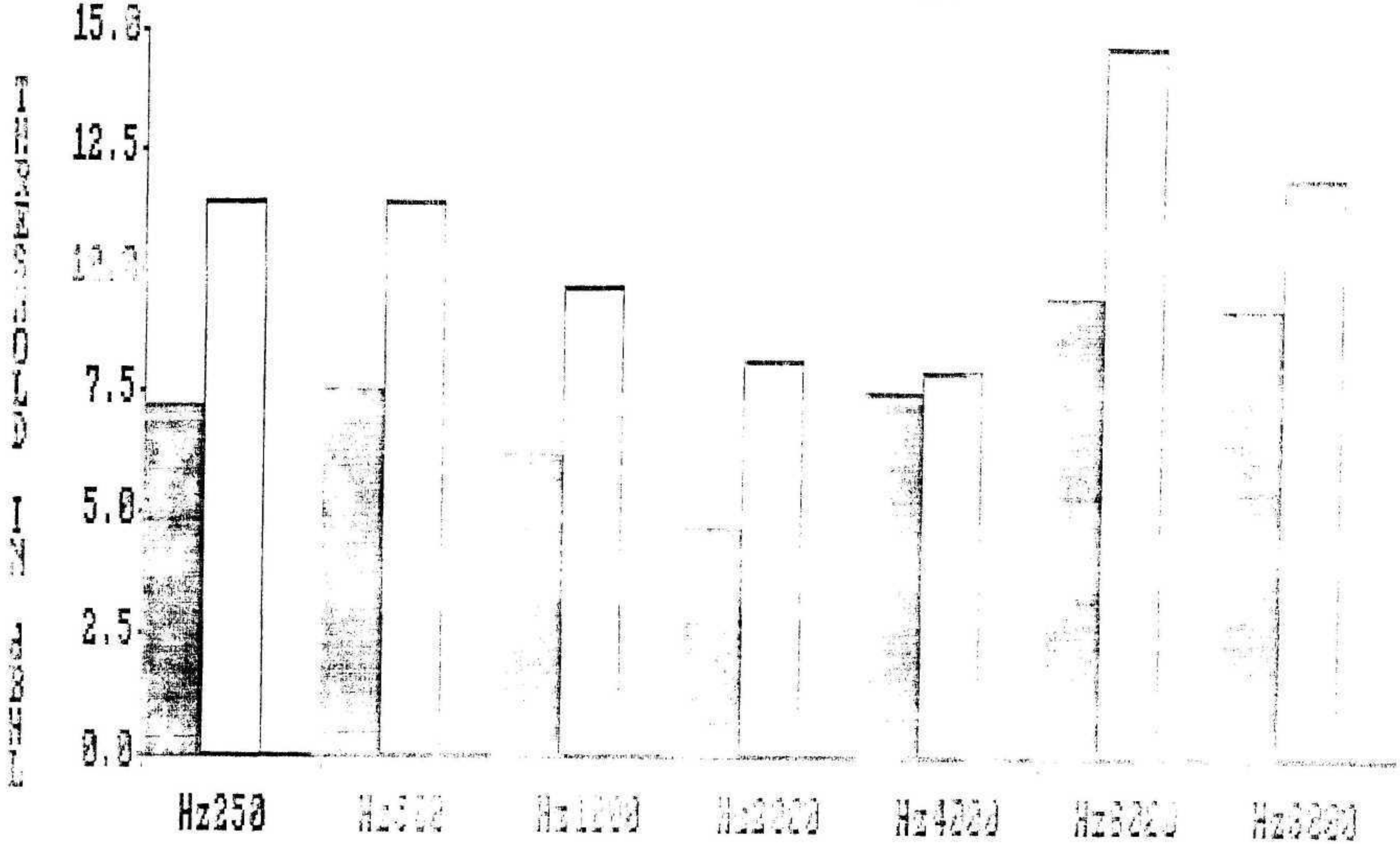
** P<:0.02

*** P^O.01

Mean Threshold As A Function Of Frequency, Obtained Using The Two Types Of Ear-Cushion.



COMPARISON OF PURE TONE THRESHOLDS AT VARIOUS FREQUENCIES USING THE TWO EAR CUSHIONS



SUMMARY AND CONCLUSION

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The present study was aimed at answering the following questions.

1. Do the pure tone thresholds differ with the type of ear cushions?
2. If yes, is the difference; frequency specific?

A sample comprising of 20 subjects (10 males and 10 females) with normal hearing and with median age of 20 years were tested.

Pure tone thresholds at 250Hz, 500Hz, 1KHz, 2KHz, 4KHz 6KHz and 8KHz were established using Modified Hughson Westlake Procedure. The right ear of each subject was tested separately with circumaural (within ME-70 headset) and supra–aural earcushion (MX-41/AR).

The present study has revealed that in no instance did a subject's (individual threshold) threshold using a circumaural differ from those obtained with supra–aural by more than ±10dB in quiet condition, i.e. the difference was not statistically significant. It appears therefore that these thresholds obtained using the circumaural enclosure are no different than those obtained using supra–aural earphone arrangement.

Based on the above results it may be inferred that the two types of ear cushions may be used interchangeably.

This observation however, is restricted to threshold measurement in a sound treated room. Further studies need to be carried out before generalizing these results to supra threshold tests and for tests in noisy environments.

Recommendations for future research;

1. Similar experiments can be carried out by testing both the ears (Right and Left).
2. This study can be done on larger population.
3. Different stimuli or testing conditions can be used to assess the utility of a particular earcushion.

BIBLIOGRAPHY

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Beagley, H.A., (1981): "Audiology and Audiological Medicine" Vol.I, Oxford University Press. New York.

Season, R.W., et al., (1967); "Limitations on the use of Circumaural Earphones", J.Acoust.Soc.Amer. 14, 713-714.

Bruel, P.A., et al., (1976)! "Investigation of A New Insert Earphone Coupler", Hear.Instrum. 27, 22.

Bryant, H.w., (1972): "Comparable Coupler and real ear measurements on Supra—aural and insert type earphones", J.Acoust.Soc. Amer. 52, 1599—1606.

Carhart, R., and Jerger, J., (1959): "Preferred method for Clinical determination of Pure tone thresholds", J.Speech.Hear.Disord. 24, 330-345.

Chaiklin, J., and McClellan, Max., (1971): "Audiometric Management of Collapsible Ear Cannals", Arch. Otolaryngol. 93, 397-407.

Coles, R., (1967): "E.A.M. Enclosure by audiometer earphone", J.Speech.Hear.Disord. 32, 296-297.

Cozad, R.L., and Goetzinger,C. (1970s "Audiometric and Acoustic Coupler Comparison between two Circumaural Earphone and Ear-Cushion Combination Vs. A Standard Unit", J.Aud.Res. 10, 62-64.

Harris, J.D., (1970): "Efficient Monaural Procedure for the Psychoacoustic Calibration of Earphones", J.Acoust. Soc.Amer. 47, 1048-1054.

Harris, J.D., (1971); "The Use of Circumaural Earphones in Audiometry", J.Speech.Hear.Res. 14, 53-70.

Katz, J., (1978); "Hand Book of Clinical Audiology", Williams and Wilkins, Baltimore, Md.

Lankford, J.S., and Zachman, T.A., (1971): "Using Auraldome in Audiometry", J.Aud.Res. 11, 154-159.

Martin, M.C., Williams, V., and Lodge, J.J., (1971): "An Evaluation of Noise Excluding Enclosures for Audiometric Earphones", sound. 5, 90-93.

Michael, P.L., and Bienvenue, G.R., (1976): "Calibration data for a Circumaural headset designed for hearing testing", J.Acoust.Soc.Amer. 60, 944-950.

Michael, P.L., and Bienvenue, G.R., (1980) : "A Comparison of acoustical performance between a new one piece earphone cushion and the conventional two-piece MX-41/AR Cushion", J.Acoust.Soc.Amer. 67, 693-698.

Michael, P.L., and Bienvenue, G.R., (1981): "Noise attenuation characteristics for supra-aural audiometric headsets using the models MX-41/AR and 51 earphone cushion", J.Acoust.Soc.Amer. 70, 1235-1238.

Musket, C.H., and Roeaer, R.J., (1977): "Using Circumaural Earphones with children", J.Speech.Hear.Res. 20, 325-333.

Newby, H., "Audiology" 4th Edn. Englewood Cliffs, N.J., Prentice Hall, 1979.

Richards, et al., (1979): "Influence of Earphone Cushion Centre hole diameter on the acoustic output of audiometric earphones", J.Acoust.Soc.Amer. 65, 257-259.

Riender, E.D., (1980): "Collapsing ears and the Use of Circumaural ear cushions at 3000Hz", Ear and Hear. 1, 117-118.

Riender, E.D., and Shimizu, H., (1976); "Collapsing ears and acoustic Reflex measurements with Circumaural ear Cushions*, Arch.Otolaryngol. 102, 358-362.

Roeser, R.J., and Glorig, A., (1975): "Pure tone Audiometry in noise with Auraldomes", Audiology, 14, 144-151.

Sargeant, R.L., and Harris, J.D., (1961): "Supra-aural Cushions in Audiometry" Reprint from the J.Acoust.Soc.Amer. 33, 966.

Siegel, S., (1956): "Non-Parametric Statistics For the Behavioral Sciences", McGRAW-HILL KOGAKUSHA, LTD. TOKYO.

Speak, C, (1969): "Effect of Circumaural earphone Cushion on threshold sensitivity for Speech", J.Acoust.Soc. Amer. 46, 1515-1517.

Stark, E.W., and Borton, T.E., (1975): "Noise Excluding Enclosure for Audiometry", Audiology, 14, 232-237.

Tillis, C.H., and Wall, L., (1974): "Use of Audiocup in a Routine school Audiometric Screening Program*, J.Aug.Res. 14, 217-219.

Tillman, T.W., and Gish, K.D., (1964)! "Comments on the Effect of Circumaural earphones on Auditory Threshold", J.Acoust.Soc.Amer. 36, Reprint No.168.

Villchur, E., (1970): "Audiometer-Earphone Mounting to Improve Intersubject and Cushion - Fit reliability", J.Acouat.Soc.Amer. 48, 1387-1396.

Wood, T.J., and Fagundas, K.W., (1972)t "Use of the Amplivox Audiocup in Audiometry", J.Aud.Res. 12, 313-317.