# MEASUREMENT OF ELECTROACOUSTIC CHARACTERISTIC AT "T" & "MT" POSITIONS OF BODY LEVEL HEARING AIDS IN DIFFERENT CATEGORIES OF HEARING AIDS

**Reg. No. M. 9107**

*An Independent project submitted as part fulfilment for the first year*

*M.Sc. (Speech and Hearing) to the University of Mysore*

**All India Institute of Speech and Hearing**
**MYSORE - 570 006**
**MAY 1992**

## DEDICATED TO:

***My Beloved DHODDAPPA***

***My Beloved APPA,AMMA***

***My everloving Sisters, Cousin Brothers and Sisters***

***My everloving FRIENDS,***
***RAGHU, GOKUL, BALA, BHUVANA.C.S. SOW MYA.S***

# CERTIFICATE

*This is to certify that this Independent Project entitled* **"MEASUREMENT OF ELECTROACOUSTIC CHARACTERISTIC AT "T" & "MT" POSITIONS OF BODY LEVEL HEARING AIDS IN DIFFERENT CATEGORIES OF HEARING AIDS"** *has teen prepared under my supervision and guidance.*

**MYSORE** **Dr.(MISS).S.NIKAM**
**MAY 1992** **GUIDE**

# CERTIFICATE

*This is to certify that the Project entitled* **"MEASUREMENT OF ELECTROACOUSTIC CHARACTERISTIC AT "T" & "MT" POSITIONS OF BODY LEVEL HEARING AIDS IN DIFFERENT CATEGORIES OF HEARING AIDS"** *is a honafide work, done in part fulfilment for the First year Degree of Master of Science (Speech and Hearing), of the student with* **Reg.No. M 9107.**

**MYSORE**
**MAY 1992**

**DIRECTOR**
**All India Institute of**
**Speech and Hearing**
**MYSORE - 6**

# DECLARATION

*I hereby declare that this Independent Project entitled* **"MEASUREMENT OF ELECTROACOUSTIC CHARACTERISTIC AT "T" & "MT" POSITIONS OF BODY LEVEL HEARING AIDS IN DIFFERENT CATEGORIES OF HEARING AIDS"** *is the result of my own study under the guidance of* **Dr. (MISS).S.NIKAM,** *Professor and Head of the Department of Audiology, All India Institute of Speech and Hearing, Mysore, has not been submitted earlier at any University for any other Diploma or Degree.*

**MYSORE** **Reg No. M. 9107**
**MAY 1992**

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# INTRODUCTION

Hearing is a complex process wherein we first perceive the heard sound and later attribute meaning to the heard sound. Hearing is an important aspect of communication which forms the basis of human activity.

Impairment of hearing not only renders a persons unable to appreciate the different sounds present in his environment, it slowly but surely reduces his capacity to understand the speech of others as in the post lingually deaf. In a prelingually deaf child, hearing loss impedes the acquisition of normal speech and language.

The problem can be mitigated by providing for amplification of the signal reaching the ear. The advent of the hearing aid has helped in the amplification of sounds for the hearing impaired.

A hearing aid is an electroacoustic device which increases the intensity of sound energy and delivers to the ear with as little distortion as possible.

A hearing aid contains 4 basic components: Mic, amplifier, receiver and power supply. Additionally, it may also have a tone control, output controls and telephone pick up coils.

Many hearing aids are equipped with a special circuit to enhance use with a telephone. The circuit consists of a magnetic induction pick-up coil mounted inside the ease. The telephone earphone is a magnetic receiver, which, through magnetic leakage, generates a magnetic field. If placed next to a telephone receive, the induction coil picks up the magnetic field and converts it into an electric signal. It is then amplified and again transduced, this time into an acoustic signal. In other words, the telecoil takes the place of a hearing aid microphone as the input component of the aid.

The telecoil may be used alone as in "T" position or in conjunction with the mic as in "MT" position. If the "T" position is chosen, the mic is cut off of the circuit. The advantage of this is the ability to use the aid with a telephone without interference from sounds in the environment when used in the "MT" position, the environmental sounds are also picked up but it permits communication between people in the surrounding vicinity.

The telecoil may not only be used for telephonic conversation but also in classrooms which have an induction loop system. Presence of the "T" or "MT" position on the aid, enables the child to have a good and constant speech output from the teacher. However when used in the "T" position, though the environment sounds are reduced or lost, child to child interaction/communication is hampered.

Electroacoustic measurements of the hearing aid help us determine the gain of the aid, its frequency response, compare the performance of different hearing aids, and whether or not the aid is in keeping with the specified standards. It also helps in fitting the hearing aid.

The frequency response of the hearing aid is the relative amount of gain as a function of frequency for specified input according to the standard. The frequency response is usually determined with the switch in the mic position. It may also be assessed in the "T" and "MT" position. There are very limited studies on "T" and "M" position and no study compares the performance of hearing aid on "T" and "MT" position. Studies which compared "T" and "M" position reveal that the frequency response vary from one to another. The following studies show the performance of hearing aid at "T" position and comparison of that with mic output.

Ling (1966) and Borrild (1968) reported that hearing aids operating on telecoil provided better low frequency response than when on "M" output in loop induction system (ILA).

Sung and Hodgson (1974) found that the "T" positioning tend to provide a better low frequency response than that of the mic. They also found that sensitivity and frequency response at "T" position is different from that of "M" position response range.

Matkin and Olson (1970) reported that undesirable changes in acoustic output and frequency response occur when hearing aids were switched from "M" to "T" setting in ILA systems. They also noted that the average gain of hearing aids set on "T" never exceeded the gain used in mic when used in ILA systems.

Rodrigenz, Holmes and Gardhardt (1985) found that gain characteristic of hearing aids are significantly greater for acoustic coupling than for telecoil coupling regardless of output setting and found that mic coupling achieves more gain for both higher and lower frequency.

Gladstone (1985) found that maximum output of hearing aid is got for telecoil when it was in FOG. He also found that the output at FOG in "T" position equals that of output at "M" position when the volume control is set at 1/3 or 1/2 volume setting.

Since the hearing aid provides again across the different frequency, speech intelligibility using the aid is fairly good. It provides near equal gain across the specified frequencies.

Studies reveal that when the hearing aid is placed in the "T" position, there is a better low frequency response. In other words, the "T" position provides greater or better information about those sounds in the low frequency region.

Hodgson and Sung (1971 & 1974) assumed that because of the better low frequency response at "T" position when compared to the "M" setting resulted in a better speech intelligibility for connected discourse. However, the intelligibility of monosyllabic words lie between the frequency range of 1.5 to 2.5 KHz. Since hearing aids at "T" position does not provide sufficient amplification above 1.5 KHz the intelligibility of monosyllabic words will be affected.

The aims of the present study was:

1) To study if there is a significant difference in the output of the hearing aid between the "T" and "MT" position.

2) To study if there is a significant difference in the output as a function of the frequency when the position is changed from "T" and "MT" in other words, is there an interaction effect between frequency and the "T" and "MT" positions.

3) To study the interaction in between the category of hearing aid and the "T" and "MT" position.

# METHODOLOGY

**Selection of hearing aids: A** total of 45 body level hearing aids were taken up for the study. These 45 hearing aids is the sum of 15 aids from mild, moderate and strong categories. Al these are newly received from the manufacturers. The hearing aids were selected such that they had the provision for "T" and "MT" settings and all these belonged to a single manufacturing company.

Hearing aids were classified into mild, moderate and strong categories (acc. to IS: 10775 - 1984) as per the manufacturers claim.

**TEST ENVIRONMENT:** Test was carried out in an sound treated room. The ambient noise levels inside the room were within permissible levels (IS: 10776-1984).

**INSTRUMENTATION:** The instruments used for the study were as follows:

1) A hearing aid analyzer (Fonix 6500)
2) Standard 2cc coupler.
3) Microphone (M 1550)

**CALIBRATION:** The electronic module is turned on along with the video monitor. Any sound is going to have frequency response regularities. To compensate for these irregularities, the microprocessor "levels" the chamber for each frequency measured. Leveling was performed each time the instrument is turned on (See Appendix-I for standard testing procedure).

The induction coil sensitivity of the hearing aid is measured as follows:

The mic is inserted into 2cc coupler the receiver of the body aid is snapped on to the 1/4" recessed end of the coupler. The aid is placed in the sd. chamber and the controls are set for the operating mode. The gain control is turned full on and the hearing aid is placed in the magnetic field developed by a l000Hz l0MA/m rms current and is oriented to produce greatest coupler output level and this SPL is recorded (See Appendix-II).

The frequency response characteristics for the following frequencies were measured - 200Hz, 500Hz, l000Hz, 1500Hz, 2000Hz, 2500Hz and 4KHz. The steps involved in this are mentioned in the above paragraph.

The values were recorded at different frequencies and the values are given in the Table-I.

The hearing aid control setting were then shifted to MT position and the same procedure was repeated for the same hearing aid.

Similarly, 45 hearing aids were tested and the induction coil sensitivity was measured and the frequency response characteristics were noted.

**ANALYSIS METHOD:** The recorded values were then subjected to 2x3 factorial analysis in order to find out the significant difference among the conditions. The model of 2x3 design is given below:

| | | | "B" condition | | |
|---|---|---|---|---|---|
| | | | Mild | Moderate | Strong |
| "A" Condition | MT | A1 | A1 B1 | Al B2 | Al B3 |
| | T | A2 | A2 B1 | A2 B2 | A2 B3 |

Then the average output (mean) value for each frequency at both "MT" and "T" operations were found. It is done for all categories of hearing aid. Later these values were graphically represented and compared (values are given in the Table-II).

**TABLE-I**: Showing the total output values obtained at "T" and "MT" positions.

| Frequency | Mild | | Moderate | | Strong | |
|---|---|---|---|---|---|---|
| | MT | T | MT | T | MT | T |
| 200 Hz | 1515 | 1544 | 1837 | 1696 | 1996 | 1784 |
| 500Hz | 1547 | 1562 | 1887 | 1684 | 1987 | 1780 |
| 1KHz | 1637 | 1568 | 1906 | 1724 | 2009 | 1818 |
| 1.5KHZ | 1676 | 1557 | 1898 | 1692 | 2027 | 1834 |
| 2KHZ | 1628 | 1558 | 1881 | 1695 | 1994 | 1792 |
| 2.5KHz | 1615 | 1574 | 1879 | 1714 | 1985 | 1807 |
| 4KHz | 1573 | 1540 | 1832 | 1675 | 1925 | 1775 |

**TABLE-II**: Showing the average output (mean) at seven different frequencies for all the categories for "T" and "MT" operations.

| Frequency | Mild | | Moderate | | Strong | |
|---|---|---|---|---|---|---|
| | MT | T | MT | T | MT | T |
| 200 Hz | 101 | 103 | 122.5 | 113 | 133 | 119 |
| 500Hz | 103 | 104 | 127 | 112 | 133.5 | 119 |
| 1KHz | 109 | 105 | 128 | 115 | 134 | 121 |
| 1.5KHz | 112 | 104 | 128 | 113 | 135 | 122 |
| 2KHz | 109 | 104 | 126 | 113 | 133 | 119.5 |
| 2.5KHz | 107 | 105 | 126 | 114 | 132 | 120.5 |
| 4KHz | 105 | 103 | 122 | 112 | 128 | 118 |

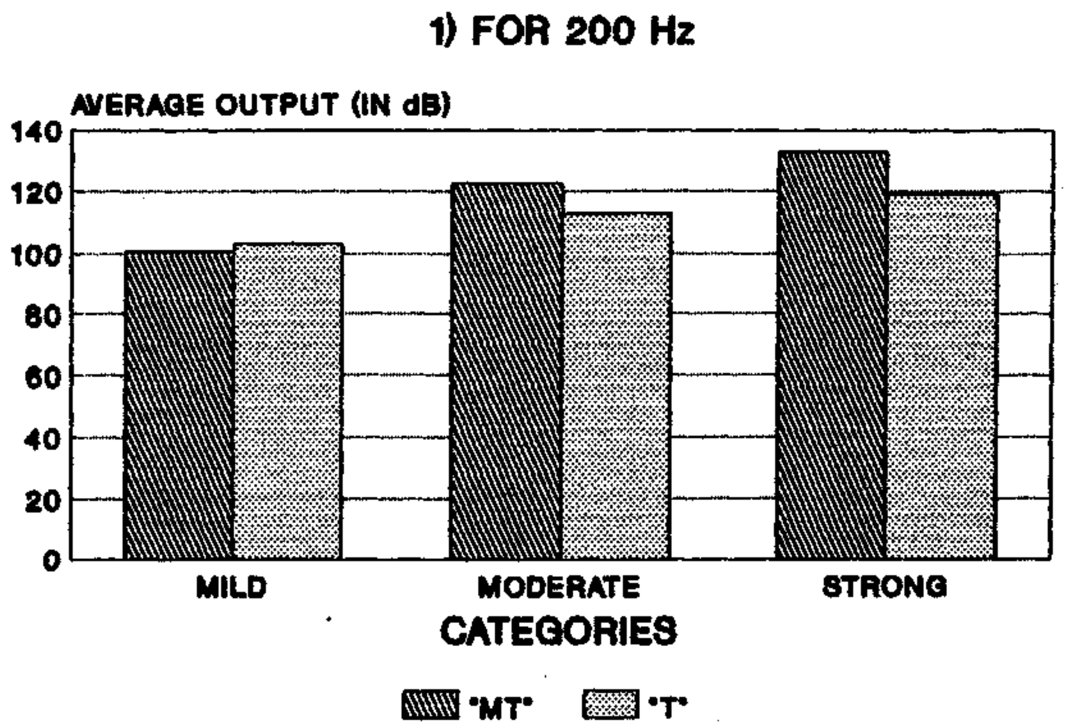
**Table-III**: Showing the "F" ratios for different conditions

| Frequency | A condition (Main Effect) | B Condition (Main effect) | AB condition (Interaction effect) |
|---|---|---|---|
| 200 Hz | 20* | 76.5* | 8.74* |
| 500Hz | 33.9* | 77.64* | 10.60* |
| 1KHz | 76.42* | 120.20* | 5.51* |
| 1.5KHz | 132.21* | 145.54* | 4.31+ |
| 2KHz | 74.36* | 98.62* | 5.52* |
| 2.5KHz | 85.9* | 165.60* | 9.94* |
| 4KHz | 90.67* | 210.66* | 11.44* |

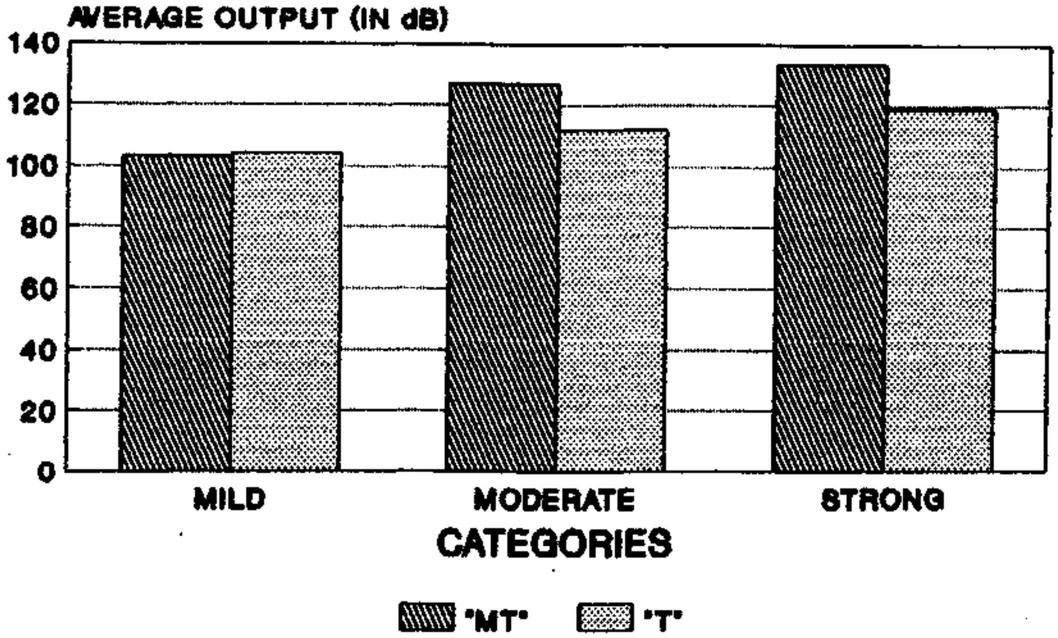
Degrees of freedom (df): for A - 1, for B = 2, for AB = 2,for Within cell - 30

Note: "*" indicates significant difference at 0.01 level
"+" indicates significant difference at 0.05 level

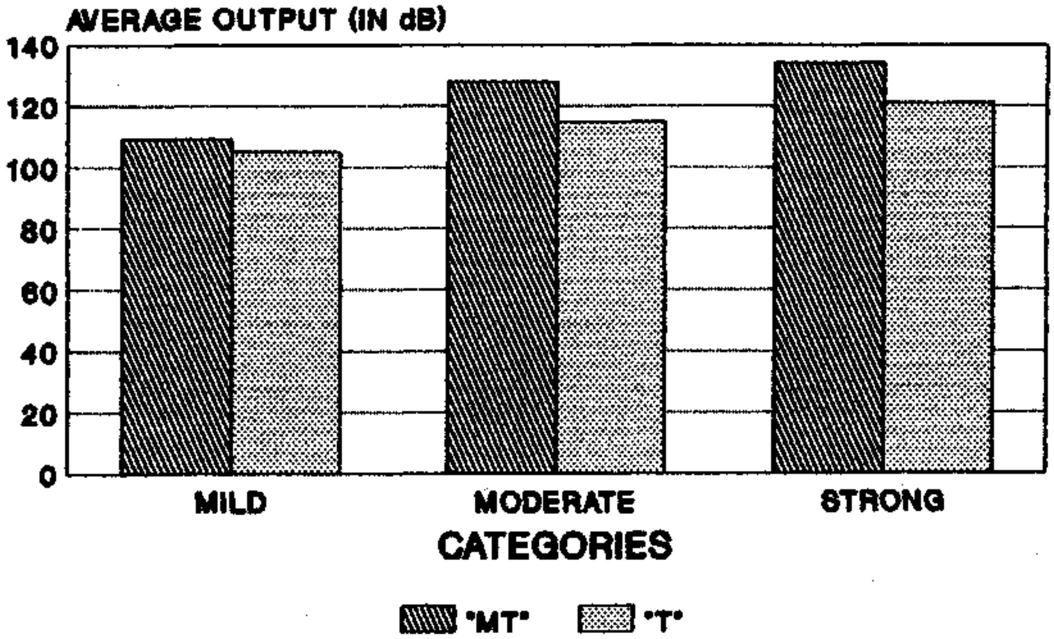
# GRAPHICAL REPRESENTATION OF THE MEAN VALUES FOR ALL CATEGORIES OF HEARING AIDS AT "T" & "MT" POSITIONS



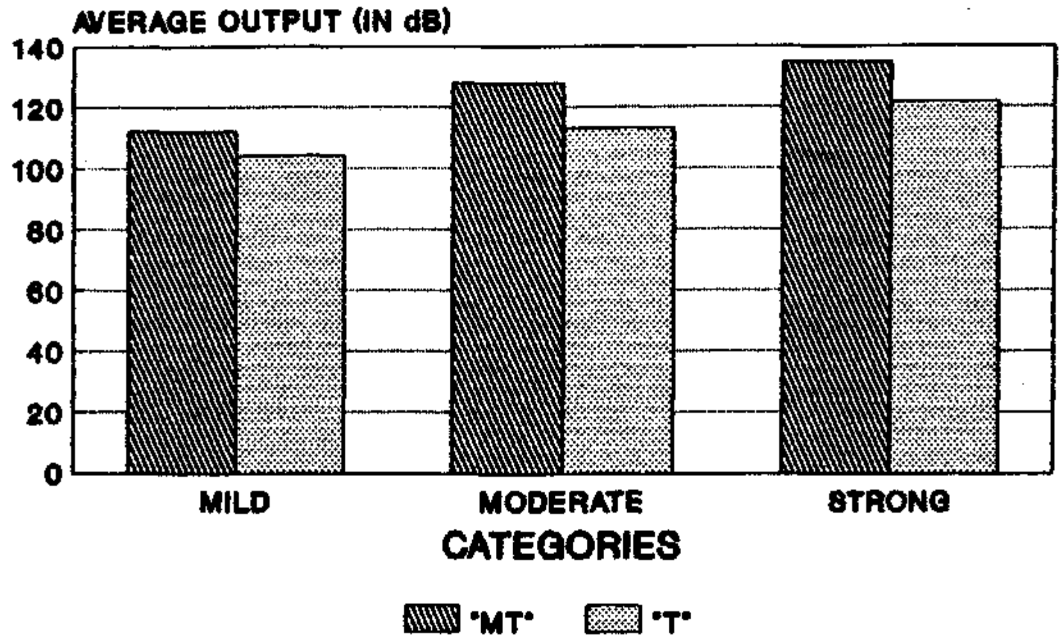
1) FOR 500 Hz



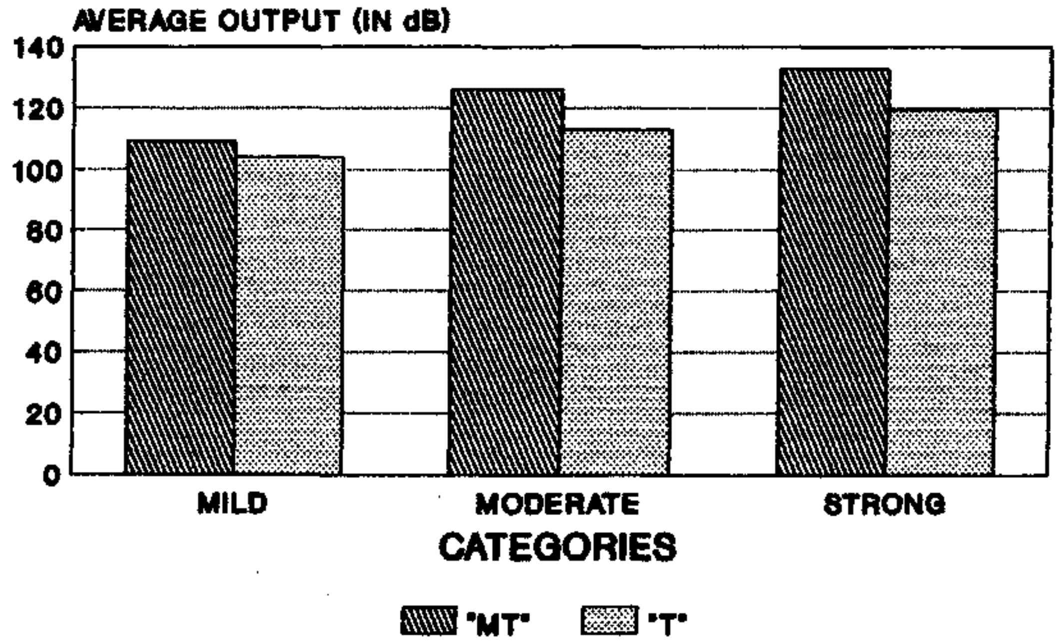

3) FOR 1 KHz



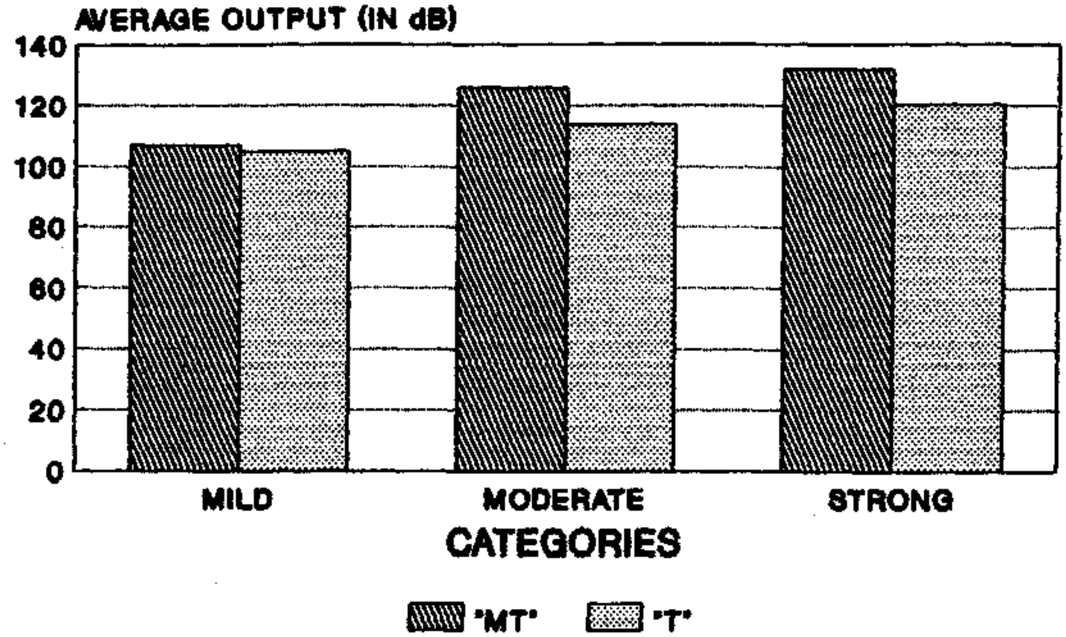
4) FOR 1.5 KHz



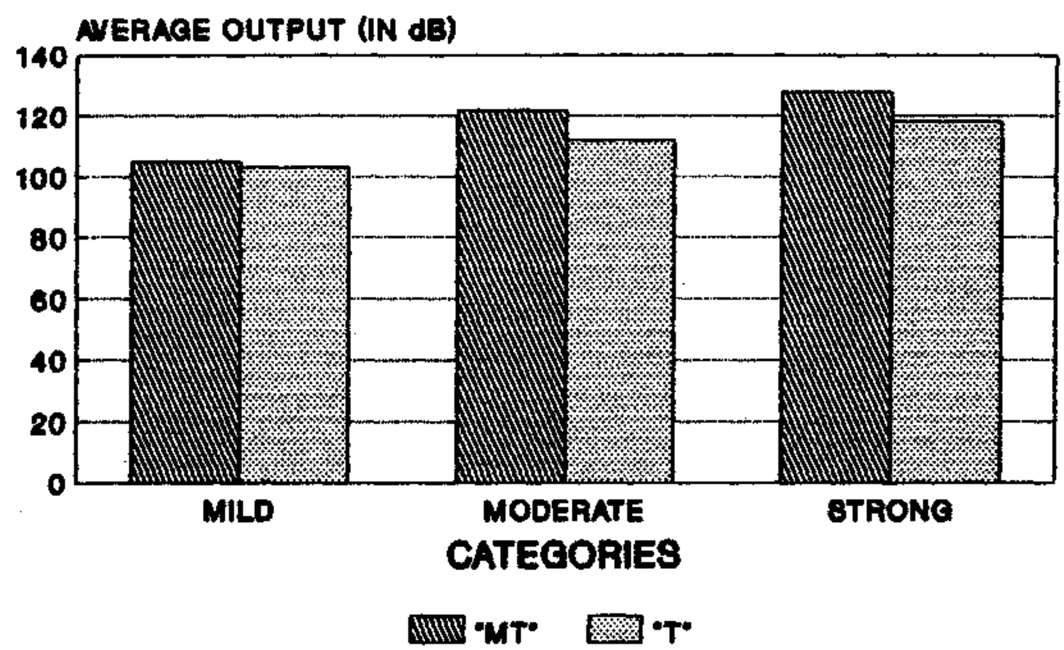

5) FOR 2 KHz



## 6) FOR 2.5 KHz




## 7) FOR 4 KHz



# RESULTS AND DISCUSSION

The purpose of this study was to measure the outputs at different frequencies for the "T" and "MT" operations.

The outputs obtained for the hearing aids in "T" position and "MT" positions have been depicted in Table-I. And these data have been subjected to 2x3 factorial design and the following results were obtained (The F ratios values are given in Table-Ill).

1) There is a significant difference between the outputs at "T" and "MT" positions for all the frequencies.

2) There is a significant difference between the different categories of hearing aid for all the frequencies in terms of output.

3) a) There is a significant difference between the output of different categories of hearing aid at "T" position.

b) And significant difference between the outputs of different categories of hearing aid at "MT" position.

This statistical analysis revealed significant differences at 0.01 level for all the conditions.

The mean outputs for "T" and "MT" operations for different categories of hearing aids at different frequencies have been calculated and tabulated in Table-II. The same data was made use of for drawing "multiple bar diagram" (Shown graphically).

Multiple bar diagram shows that the output at "T" positions is 2 to 3 dB greater than "MT" operation at 200 and 500Hz for mild category hearing aids alone. And the output at "MT" position is 10 to 12 dB greater than the output at "T" position for mid and high frequencies for mild, moderate and strong category hearing aids.

## DISCUSSION

Results of this study indicated that the output characteristics of hearing aids, were significantly greater for "MT" operations than for telecoil operation except for that of low frequencies (200Hz and 2500Ha) in mild category hearing aids alone. This finding partly support Sung et.al., (1974), who reported better low frequency output under telecoil coupling condition for moderate and strong category hearing aids than microphone coupling. But in this present study better low frequency responses were got only for mild category hearing aids.

This difference may be attributed to (1) procedural variations. Sung et.al., (1974) in their study used 20MA/m as input whereas in this study the input was l0MA/m as specified by ANSI standards.

2) may be due to the comparison of output values between "T" and "M" operations in his study whereas in the present study "T" and "MT" operations were compared.

In actual classroom use, the response of the aid operating on telecoil will be affected by the fidelity of the loop itself. According to the present study, when operating on "MT" input the overall performance is better than "T" operation mode in loop induction (IL) systems even though in "T" operation mode there was better low frequency response.

The IS: (10776: part 2) has specified the gain outputs in different categories hearing aid. This has been modified in the amendment, No.2 of IS (10776) in 1989, March. This has been depicted in the following table.

| Standards | Mild | Moderate | Strong |
|---|---|---|---|
| (IS: 10776, 1984) | 100dB | 110dB | 120dB |
| IS: 1989 Amendment | 75dB | 85dB | 95dB |

The values of gain outputs obtained in the present study are in agreement with IS (10776; part 2), 1984 but differ from the specification of IS, 1989 amendment. So, this necessiates the development of comprehensive standard.

The orientation and the placement of the hearing aid mic inside the chamber altered the maximum output. So, when this is applied to class room situation the distance between the induction loop and the placement of the children's hearing aid should be taken into consideration for better performance.

Based on the findings the use of "MT" position for hearing impaired children in classroom settings is emphasised. This is because the overall performance of the hearing aid operating on "MT" position was better. Also, unlike hearing aids in "T" position the hearing aids operating on "MT" positions facilitate interspeaker communication.

## SUMMARY

A total of 45 hearing aids were taken up for the study. Fifteen hearing aids from each category (mild, moderate and strong) were included. All the hearing aids were newly received from manufacturers.

Hearing aid output characteristics at different frequencies (200Hz, 500Hz, 1KHz, 1.5KHz, 2KHz, 2.5KHz and 4KHz) were measured according to ANSI standards using Fonix 6500. These measured values were then recorded and subjected to 2x3 factorial analysis.

Using this statistical procedure significant difference among 3 categories of hearing aid, between "T" and "MT" position were found.

The differences in response between the "T" and "MT" input were also examined. Findings indicate that:

1) Given hearing aids have different performance for "T" and "MT" operations.

2) The telecoil provides better low frequency response in mild category hearing, aids than the MT operations. This relation was not observed for moderate and strong categories (Shown graphically).

3) For mid and high frequencies there was a significant difference in output between all the categories of hearing aids in "MT" and "T" positions. That is, output values were always greater in "MT" operation.

Implication of this study suggest that when recommending a hearing aid, the hearing aid filter roust be aware of possible differences, between "T" and "MT" operations. It, therefore, is necessary to evaluate each aid prior to fitting to ensure that the desired response is available under the conditions.

**FURTHER RECOMMENDATIONS:**

* To study the other electroacoustic characteristics in the "T" and "MT" positions.

* To develop more comprehensive standards based on the study of these electroacoustic characteristics. And such standards undoubtedly would help the hearing aid industry and professional community to better meet the needs of the hearing impaired.

* To study the same parameters in different types (BTR, spectacle type) and models of hearing aid.

* To study the frequencies response at different volume settings (1/2, 3/4 and full on gain) at "T" and "MT" position.

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calibrator. Tighten the lock nut without moving the position of the adjustment screw.

**NOTE:** Allow at least 30 minutes at room temperature before checking the calibration of the test set, especially it is has been exposed to cold temperatures. Open the sound chamber lid during this warm up period.

**LEVELING:** Any sound chamber will have frequency irregularities. To compensate for these irregularity the microprocessor in the FONIX 6500 corrects, or levels", the chamber for each frequency measured. Leveling must be performed each time the instrument is turned on. Following procedure must be made use of:

1) Place the mic on the left side of the sound chamber, with the mic grill over the reference point. Close and latch the sound chamber lid.

2) Press the (Level) button to start the leveling sequence. The system, responds by sending a complex composite signal consisting of low iron that correct the chamber for subsequent tests.

3) After a few seconds, the video monitor will display a graph with a straight line across at 0dB, indicating that the chamber has been leveled. This process will not have to be repeated unless the instrument is turned off.

# APPENDIX-I

## MICROPHONE CALIBRATION CHECK:

Although it is not necessary to check the calibration of the Fonix 6500 every time it is turned on. When doing it for the first time the following procedure must be followed.

1) Insert the M 1550 mic into the 14 mm by 1" adaptor supplied in the standard accessories kit. Insert the microphone/adapter assembly into the output port of the calibrator.

2) Press the RESET button located on the left side of the front panel.

3) After pressing, the instrument will be in COMPOSITE MODE. Press the [SINE/COMPOSITE] button found under SIGNAL. The red LED will turn off indicating that the instrument is in SINE (PURE TONE) mode.

4) Check the SPL input from the M 1550 on the video monitor (under MICROPHONE AMPLIFIER). The figure presented should agree with the stated output of the calibrator.

5) If the output of the test set microphone amplifier does not match the stated output level of the calibrator, adjust the set amplifier with the GAIN adjustment control screw located on the real panel, next to the M 1550 input plug. Loosen the lock nut and turn the screw until the reading on the display matches the specifications of the

# APPENDIX-II

## BUILT-IN TELECOIL SETUP: CHECKING FOR MAGNETIC FIELDS:

To prepare for testing with the built in telecoil, use the following procedure.

1) The video monitor normally emits its own magnetic field. Therefore, locate the test chamber as far as possible from the monitor to avoid interference with telecoil measurements. A distance of 1 1/2 feet will reduce interference from the monitor to a negligible level at 1KHz. A distance of 2 or more feet will be necessary to avoid interference from the monitor across the entire frequency spectrum.

Follow the steps below to check for the influence of magnetic fields, both from the monitor and from other sources, such as fluorescent lights, electrical wiring, etc.

2) Press (MENU) & then (COIL)

3) Select ANSI with the (A) or (V) button.

4) Press (START).

5) Connect a linear hearing aid to the proper coupler and place it in the center of the test area. Set the switch on the aid to "T" and set the gain for maximum.
While watching the dB SPL output reading on the monitor, orient the body of the aid for the maximum possible output.

6) Without changing the aids' orientation, plug in the supplied RCA (phone) dummy plug into the socket directly beneath the multi-pin socket at the bottom right of the

outside of the teat chamber (This breaks the signal to the built-in telecoil). The l000Hz output reading on the monitor must drop by 10dB in order for the reading to be accurate. For an entire sweep to be accurate, the output roust drop by 20dB. Try a different location for the test chamber if these conditions are not met.

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**BLOCKDIAGRAM**