A COMPARATIVE STUDY OF THE SUBJECTS PERFORMANCE WITH FM SYSTEM AND THEIR PERSONAL BODY LEVEL HEARING AIDS

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REG. NO. M9215

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

ALL INDIA INSTITUTE OF SPEECH AND HEARING

MYSORE - 570 006

1993

DEDICATED TO

ALL MY TEACHERS

AND

"THE BHARADWAJ'S"

- ALL OF MY DEAREST PEOPLE.

CERTIFICATE

This is to certify that this Independent project entitled **"A comparative study of the subjects performance with FM system and their personal body level hearing aids"** is the bonafide work in part fulfilment for the degree of Master of Science (Speech & Hearing) of the student with Reg. No. M9215.

Mysore
1993

Director
All India Institute of
Speech and Hearing
Mysore

CERTIFICATE

This is to certify that this Independent project entitled **"A comparative study of the subjects performance with FM system and their personal body level hearing aids"** has been prepared under my supervision and guidance.

Mysore
1993

Dr. (Ms.) S. **Nikam**
Guide

DECLARATION

I hereby declare that this Independent project entitled **"A comparative study of the subjects performance with FM system and their personal body level hearing aids"** is the result of my own study under the guidance of Dr. (Ms.) S. Nikam, Prof. & HOD, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any University for any other Diploma or Degree.

Mysore
1993

Reg. No. M9215

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INTRODUCTION

Hearing is the primary sensory system through which we all learn speech and language. No other sensory system can substitute for its functions.

1. Then, what are the consequences of this primary sensory system is damaged.
2. How then does a child learn speech and language?

The consequences are; reduced hearing capabilities and thus poor speech and language ability and this deficit can be minimized through the use of hearing instruments.

The hearing instruments deliver an amplified versions of sounds picked up by their microphone. Just as how the sounds are heard most effectively when the sound source and the listener are nearby just in the same way sounds are most effectively delivered by the hearing instrument to the listeners ear, when their microphones and the sound source are nearby.

The hearing instruments like hearing aids, auditory trainees etc do not differentiate between the speech and the noise. They pick up both.

If the sound source is nearer to the listener than the noise, then speech is heard better. Hence it is important to maintain an appropriate signal-to-noise ratio. Some of the assistive listening devices help in maintaining a good signal -to-noise ratio i.e., they deliver signals effectively even in the presence of noise.

The various assistive listening devices are; the loop induction system, hardwire system, sound field amplification frequency modulation system and infra red system.

Of relevance to this study is the frequency modulation system (the FM system)

The FM system

The FM system is among the most flexible for the transmission of auditory signals to the listeners. FM stands for frequency modulation because the audio signal is frequency modulated into a carrier wave that is sent from the transmitter to the receiver where it is demodulated and delivered directly to the listener's ear.

The system consists of a transmitter worn by the speaker or placed near the sound source and a receiver worn by the listener. It uses either a mic input or a direct plug in connection from the radio, TV or other sound source such as P.A. system. It can be attached to earphones, ear buds coupled inductively by a neck loop or silhouette or coupled

electrically via direct audio input to the hearing instrument.

The F.C.G. has allocated 72-76 MHz as the band of frequencies for auditory assistance. Within this band, two types of band width operate. Narrow band transmission permits operation on 32 separate narrow channels that are spaced 50 KHz apart, wide band transmission divides the band into 8 wide channels spaced 200 KHz apart.

Applications of F.M. system

Davis (1991) has suggested the applications of FM system. They are as follows:

1. The FM system is a versatile system to use, because FM operates on different channels as many as 32 different frequencies can be used in one school building. Adjacent classroom each can have their own system without interference from their neighbour. In addition children can hear their teacher clearly over the background disturbances.

2. With FM system mainstreaming be accomplished easily.

3. Although FM system does not eliminate need for interpreters when necessary, they do provide the child with the sense of independence and increased ability to take charge of their hearing.

4. Children with Central Auditory Disorders/processing difficulties and certain learning disabilities have difficulty in listening/comprehending in presence of background noise or understanding the total auditory message.

5. The child with mild hearing loss may have difficulty hearing and understanding the teacher in difficult situations.

a. When teacher is writing on black board and her back is to the class.

b. When the student next to him is draging his chair on the floor or making other noises with his foot..

c. When the teacher is giving direction and a truck or other noisy vehicles roar by etc. In such cases FM system brings teachers voice directly to the child's ear making the child less frustrated and anxious.

6. FM systems allow direct coupling to a hearing instrument via direct audio expect or by a neck loop.

7. Audiovisual devices such as T.V.'s, V.C.R.'s and tape players can be directly connected to the FM system.

8. FM systems can be purchased as a part of the large area system or individual system. Large area systems can be used in auditoriums and gymnasium. Individual systems can also be used in large areas. The transmitter mic can

be placed on a podium or on the speaker and the individual will be able to hear no matter where he is seated.

9. For young children it can be beneficial to amplify other children's voices in play situations. Special conference type adaptors can be utilized which will allow sound to be picked up in a 20 feet radius and sent to child's ears. Also important in high school class where discussion is an important part of the class.

10. Other applications include sport activities whereby coaches can talk to their players during the games and be heard.

Advantages and disadvantages of FM system

According to Davis (1991) the following are the advantages and disadvantages.

1. Portability of the instrument.
2. Battery operated and easy to carry between classroom.
3. Can be used indoors and outdoors and are not dependent upon weather conditions.
4. Can be used with hearing losses ranging from mild to profound.
5. Installation is easy.
6. Transmission is constant from 100-300 feet and is consistent throughout the area.

7. Obstructions do not interfere with how the person hears the sound.

Disadvantages and limitations of FM system

1. Although 72-76 MHz was allotted as the auditory frequency band, there is a potential for outside interference. Certain paging system and fire call boxes use these frequencies or ones close to them.

2. If two transmitters on the same frequency are used in close proximity, receivers will seek strongest signal. This is capture effect.

Need for this study

Keeping in mind the above stated advantages of FM system, and its nature, and also the results of various studies on FM system in the past, the present study is aimed at corroborating the past research with an indigenously made FM system. The aim of the study is to compare the subjects performance on various auditory tasks with their personal body level hearing aid and indigenously developed FM system.

REVIEW OF LITERATURE

1. Selection of frequency modulated system.
2. Comparison of FM system and other hearing instruments.
3. Evaluation of effectiveness of FM system in different situations viz. classroom, home etc.
4. Evaluation of FM systems with modifications.
5. Characteristics of FM systems.

1. Selection of FM systems

According to **Ross Brackett and Maxon** (1982) all the hard of hearing children enrolled in regular schools are potential candidates for an FM auditory training system. According to them the urgency of recommendation and the degree to which the child can benefit depends upon the educational practices in the school and how school day is organised. If school follows the classical tradition - the teacher lecturing from up front, the children neatly lined up in rows and few questions or discussions encouraged - an FM system can be very effective. FM system can be recommended if speakers output is directed towards the hearing impaired child, whether as a part of the group or individually. Most of the hard of hearing children regardless of degree of hearing loss will receive benefit from proper use of FM system and the key to success is flexibility on part of classroom teacher and other personal working with the child.

2. Comparison of FM system and other hearing instruments

a. **Ross, Giolas and Carver** (1973) found out speech discrimination score in eleven children with different degree of hearing loss in ordinary classroom conditions at a distance of 8-14 feet from talker with their usual amplification condition and with an FM auditory trainer. The differences ranged from 12-76%. None of these children had been tested in a similar study 3 years previously with similar results (Ross & Grolon 1971).

b. **Sung et al.**, (1976) did a study to investigate the intelligibility of speech transduced through a FM system installed in class room and a conventional induction loop amplification (ILS) system and to examine the applicability of an FM adaptor when used with commercially available hearing aids. Prerecorded monosyllables were presented at 40 dBSL with S/N ratio of 8, to thirty six normal hearing subjects.

1. Results indicated that speech transduced through FM system was significantly better than that of the conventional ILA system. Irregularities in the high frequency response of the conventional ILA system were apparently contributory factors to the differences observed.

2. When FM adaptor was used in conjunction with body type hearing aids, the frequency response depends on the positioning of the adaptor to the aid because of

directionality of the telecoil. In this experiment authors found that the attachment of FM adaptor to the mid position of hearing aid provided the highest output.

3. **Carol Flexer, Denise Wray *et* al.**, (1987) used word and sentence recognition scores to compare the effectiveness of a typical FM system, an inexpensive hard-wire unit and the personal hearing aids of ten moderately hearing impaired college students. They were tested in a quiet university classroom setting. Students wore only their own hearing aids and were reluctant to use ALD's that have been shown to provide a superior signals to that of personal hearing aids. Results indicated that FM unit performed significantly better than both the hardwire and personal hearing aids.

3. Evaluation of effectiveness of FM systems different situations viz. classrooms home etc.

a. Benoit (1989) studied the efficacy of home use of FM amplification systems with toddlers and preschool age, hearing impaired children. Information necessary was obtained through the parents. Three issues were addressed.

1. How well do hearing impaired children ages one through four years adjust to using FM receiver.
2. How well do parents adjust to using an FM - Mic -transmitter.

3. What changes in parent child interaction result from the use of an FM system.

The FM system were loaned to parents for a period of 12 months and were asked to fill a questionnaire after 3, 6 and 12 months of home use of FM system. 4 out of 10 subjects dropped out of study for various reasons.

Results

At three or six months into study parents reported that wearing a mic was not a major source of nuisance or source of self consciousness. At the end of 12 months most of the parents said their children was more apt to imitate sound or words when using FM system while a few parents said use of FM appeared to encourage their child to watch for speech reading cues. Parents also found that with use of FM system the amount of language stimulation for child increased as compared to use of conventional amplification. Thus the author concludes by saying that by simply wearing a mic-transtnitter can remind the parents to provide their child with much needed verbal stimuli.

b. Made11 (1992) has tried to justify for the amplification with FM system for hearing impaired children. He says preschool years fall in critical time for development of language and auditory skill. Most hearing impaired children are at home during these critical years, with their parents or other care giver providing the majority of child's

language input. For this input to be useful, speech must be audible throughout the range of speech spectrum at a sufficiently, loud level to be heard, but not so loud as to over drive the amplification system and cause distortion.

The use of FM mic can improve S/N ratio by 10-15 dB, provide more of the less intense high frequency information that is critical for speech recognition and significantly reduce the negative effects of distance and background noise on speech signal. The author says selection of appropriate FM system and appropriate coupling is critical. For children with very profound hearing loss body worm FM system with button transducer may be useful, while for children with less profound loss may be best fit with FM system with BTE transducer or with BTE hearing aids coupled to FM system. FM can also be successfully fitted on infants as young as 2-3 months but trial period has to be considered before any final amplification.

c. **Worner** (1988) describes an inexpensive group FM amplification that was developed at the Utah school for deaf. This system, according to the author was developed to enhance auditory learning in classroom. The purpose of the system was to equalize the SPL/distance ratio between the speaker and the listener.

The equipment consisted of 2 piece wireless FM mic system, a 25 watt stereo amplifier, a pair of stereo

speakers, two patch cords, 50' of speaker cable and an optional AM/FM stereo cassette player. It costs 342.75. The equipment amplified across normal speech range and did not distort stops, fricative's, affricates or resonantsi The FM receiver was connected to the amplifier and this amplifier was connected to FM cassette recorder.

Two classroom at the Utah School for deaf were tested for sound levels with a SLM using an 'A' scale setting. As a word list was read, first with and then without the system, SPL readings were taken at various locations in the room. Results indicated that the system equalizes SPL through out the room with the increase in SPL falling in the range of 70-73 dB.

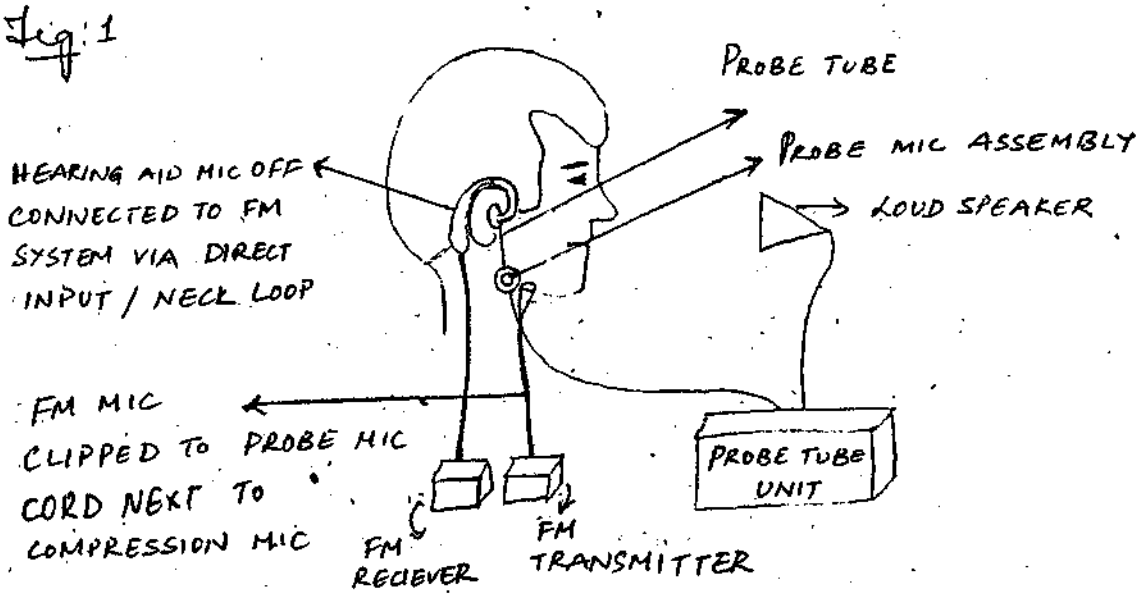
4. Evaluation of FM systems with modifications

a. Hawkins and Schum (1985) measured a variety of electro acoustic characteristics on four hearing aids and then repeated with hearing aids connected to two different FM system via. three coupling methods.; (a) Direct input (b) Neck loop (c) Silhoutte indicator. The measurements included frequency response, harmonic distortion, noise levels, input-output functions and FM receiver volume control wheel taper curves. Omnidirectional and directional FM mic were compared in classroom environment. Minor changes in hearing aid-silhoutte coupling were also investigated. Results indicated that there was large

difference in some frequency response comparison with no single coupling method providing consistently better agreement with the hearing aid alone response. With the exception of silhoutte-inductor, distortion and noise levels were similar for the hearing aids and FM hearing and combinations. Differences in the input-output function between hearing aids and the FM system were observed. Some FM hearing aid combination produced very non linear FM receiver volume control wheel taper curves. The output level of the broad band noise in a classroom was reduced when a directional FM mic was compared with omnidirectional version. The result indicated that it cannot be assume that E.A.C. of a personal hearing aid are preserved when it is connected to FM system.

b. Hawkins (1987) described a technique to measure the real ear performance of an FM system using an ear canal probe tube mic device. The method involves placement of FM mic next to the monitoring (compression) mic of the probe tube assembly to produce a constant SPL input to the FM system. With the probe tube in the ear canal, a hearing aid alone is measured. With a 60 dB SPL input and the FM system attached to the hearing aid (personal FM system) is assessed with an 80 dB SPL input to account for higher input levels that occur due to six inch distance between the speakers mouth and FM mic. This technique permits a rapid comparison of the real ear response of hearing aid and the FM system. (Fig 1)

Fig: 1


PROBE TUBE
PROBE MIC ASSEMBLY
LOUD SPEAKER
HEARING AID MIC OFF
CONNECTED TO FM
SYSTEM VIA DIRECT
INPUT / NECK LOOP
FM MIC
CLIPPED TO PROBE MIC
CORD NEXT TO
COMPRESSION MIC
FM
RECIEVER
FM
TRANSMITTER
PROBE TUBE
UNIT

The drawback of using this procedure is that if a swept pure tone or warble tone is used and FM system utilizes a compression unit, the shape of frequency response in low frequency may not be accurate. Secondly, there may be presence of acoustic feedback with a high gain hearing aid due to close proximity of FM mic to the ear mold where sound is leaking out.

5. Characteristics of FM systems

a. Electroacoustic characteristics of various personal FM system configuration were performed and reported by **Hawkins and Van Taselle** in 1982.

These characteristics were obtained through the use of Zwislocki ear stimulator and KEMAR SSPL-9O and frequency response curves have obtained with different hearing aids coupled to a FM increase via neck loops and direct input and then compared to response obtained with different hearing aids in mic mode. In addition hearing aid orientation to and distance from the loop, clothing effects, internal noise levels, for receiver volume control taper and the effect of different for receivers were investigated. The results indicated that:

1. The spectrum delivered to the hearing aid user when aid is switched from mic to telecoil and coupled to an FM teleloop system is not same. Concept of constant

amplification with teleloop does not appear valid, at least for hearing aids.

2. Frequency response with and without clothing covering the neck loop were within ±2 dB across the entire frequency range indicating no effect of the type of clothing employed.

3. Changes in gain can vary in direction in different portions of frequency response.

i. Frequency response was best when the normal aid orientation was maintained (behind and above the ear) than it being parallel to shoulders.

ii. Also gain across different frequency improved when the loop was next to the aid than it being on the shoulder or half way between shoulder and aid.

4. Significant increases in internal noises were observed with both tele loop and direct input system when compared to microphone condition.

5. Effect of different FM receivers: Results indicate that even with the same hearing aid different responses may be observed when different FM systems are used.

6. Direct input response: It was found that with hearing aid and FM system the wearer would receive the same spectrally

shaped signal with both the hearing aid alone and the hearing aid connected to the FM system via a direct input coupling method. The FM system then would offer the same signal but at a better S/N ratio.

7. FM receiver volume control taper: FM receiver volume control taper curves could pose serious problems for a child. If the child is capable of adjusting the volume control wheels, minor movements of receiver wheel would cause large changes in output and make fine adjustment difference of a professional who is setting the volume control wheel for the child is unaware of such a taper curve and sets the volume control wheel to some arbitrary point, the hearing aid may well be in saturation, producing very high output and increased distortion. Speech could be less intelligible, higher output levels might increase the possibility of additional hearing loss from over amplification.

METHODOLOGY

1. Subjects
2. Instruments
3. Test Environment
4. Calibration
5. Electro Acoustic Measurement
6. Test Materials
7. Procedure

1. Subjects

The total number of cases tested were two females and three males age range was 5-12 years (five to twelve years with a mean of 7.3 years. Pure tone audiometry was done for all these cases and the degree of hearing loss ranged from moderate to severe. Most of these subjects used a moderate gain hearing aid except for two of them, who used strong gain hearing aid. All the subjects had a vocabulary of 150-200 words and they conversed in simple sentences.

2. Instruments

The instruments used were as follows:

a. Audiometer : Madssen OB-822.
b. Microphone : MD 402-K.
c. Amplifier : Cosmic CD 100 Delux MK II
d. Loudspeaker : Cosmic COVOX 4500.

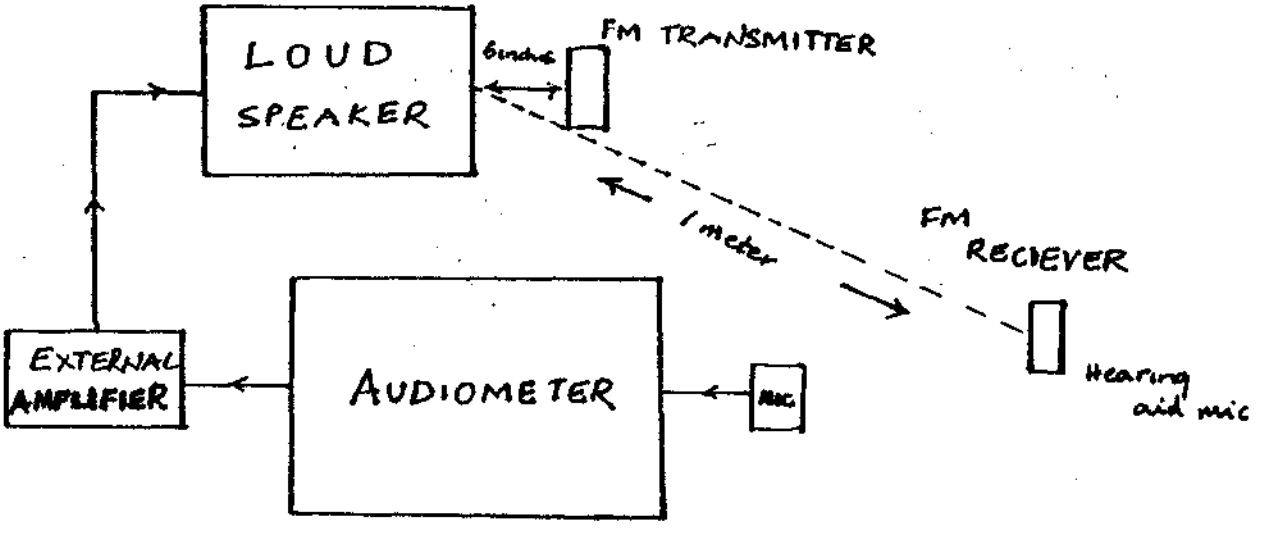
e. FM system : The FM system employed was the one developed by I.T.I. Ltd., Bangalore, I.T.I. Manual with the specification of FM system is given in the appendix (Table 1).

f. Hearing aids : The following were subjects personal hearing aids

1) Alps Easy (mod)
2) Arphi super - N
3) Arphi Push Pull 650 V.T.

Instrumentation

Fig 2



3. Test environment

Testing was carried out in a sound treated two room situation-Ambient noise was calculated and the noise levels each of the frequencies are given in the Appendix (Table II) (External amplifier was connected to the audiometer and it was on when the levels of noise were measured. Level of noise at different frequencies were measured. Levels of noise at different frequencies were measured when left loudspeaker was on and then when right speaker was on).

4. Calibration

The loudspeakers were calibrated for warble tones and speech using sound level meter (B&K 2203) and mic (B and K 4145). The procedure used is given below:

1. First the loudspeaker was switched on.
2. Reverse and ldB were selected.
3. Hearing level was set to correct value for calibration (70 dB).
4. Calibration key on display board was activated.
5. The output level for each frequency was adjusted by turning the hearing level control.
6. When calibration was complete, calibration key was released.

For speech calibration, the procedure was same, but instead of the loudspeaker, the microphone was switched on.

5. Electro Acoustic Measurement

Electro acoustic measurements were done with FM system using Fonix 6500 system.

The measurement details are included in the Appendix in Table III.

6. Test materials

Test materials consisted of

a. Picturized paired words.
b. Picturized common words.

The paired words were; /Kitaki-ba;gilu/, /Appa-Amma/, /na:ji-bjekku/, /Ka:ru-bassu/, /tatte-lo:ta/. These paired words were checked out with 10 profoundly deaf children attending therapy at A.I.I.S.H. and it was found that these words existed in their vocabulary and that the pictures represented the paired words. Hence these five pictures were used with all the subjects. These paired words were used to estimate the speech reception threshold).

Fifteen common objects were picturized. These common words were chosen keeping in mind.

1. Vocabulary of the subjects.
2. That these words consists of phonemes representing different frequency components.

These pictures were screened on the same profoundly deaf children and finally 5 picture cards were selected. These five pictures were used for estimating the speech discrimination score. These words were /ti:vi/ /angi/ /ili/ /ungura/ /sebu/.

7. Procedure

The subjects were seated in the test room in a comfortable chair at a distance of 1 meter from the loudspeaker, fine loudspeaker was made use of for presentation of signal. The azimuth of sound source was 45°.

Thresholds for warble tones and speech audiometry was done with:

1) FM system in FM mode;
2) FM system in mic mode and with
3) The the subjects personal hearing aid.

Depending on the task, different instructions were given.

When subjects were tested with their hearing aid, new batteries and cords were provided to ensure proper transmission of signals. An informal check of the subjects hearing and was done before testing in case of any distortion it was refered for repair. The controls of the hearing aid was kept in the use position only.

When the FM system was made use of it was made sure that the system was recharged for 14-15 hrs. During testing, receiver unit of the system was pinned on to the subjects clothes and a 'V' cord with 2 AP180 receivers were connected to the receiver unit. The transmitter unit was placed on top of the loudspeaker with its microphone being placed at a distance of 6 inches from the centre (normally recommended distance between sound source and microphone). Care was taken such that every subject was seated in the same place at the same distance from the loudspeaker.

Audiometry

1. Threshold for warble tones.
2. Speech audiometry.
   a) Speech reception threshold.
   b) Speech discrimination score.

1. Threshold for warble tones

The children were instructed verbally as well as by using gestures regarding the response mode. Younger children were instructed to pick up a block and keep it near their ear and when they heard the tone had to put the block into a basket. Older children were instructed to raise their index finger whenever they heard a tone and lower it when they did not. The threshold for 250 Hz, 500 Hz, 1 KHz, 2 KHz and & KHz were found for all subjects with hearing aid and FM system.

2. Speech Audiometry

a. Speech Reception Threshold (SRT)

Is defined as the hearing level at which the patient can repeat 50% of the words correctly.

The subjects were familiarized with the paired words, by asking them to point to the pictures on naming them. This was done informally before the testing. Five pictures were laid on the table and the subjects were asked to point to the pictures when they were named. Five lists of these paired words were prepared and they were written in different order. This was to rule out the order effect. The presentation level was 20 dB above the average warble tone threshold at 500 Kz, 1 KHz and 2 KHz. The level of presentation was reduced until the subject responded at least 50% of the time correctly. Responses were recorded in terms of the number of pictures identified correctly.

b. Speech discrimination score

It is a percentage score of a person's ability to discriminate speech stimuli among the others.

Instruction: The subjects were instructed to listen carefully and point to the picture corresponding to the word read out. Five lists of words were prepared consisting of five words each written in different order.

i. Initially these five lists were presented at 55 dBHL (normal conservational level). As in case of S.R.T, scoring, here also responses were recorded in terms of the number of correct responses.

ii. Speech discrimination score was also calculated in presence of noise. For this speech stimuli was presented through the right loudspeaker and speech noise through the left loudspeaker at 20 dB, 25 dB and 30 dB above the speech signal i.e., at -30 S/N ratio, -25 S/N ratio and - 20 S/N ratio. Again here the responses were recorded in terms of the number of correct responses. The scores were recorded in a tabulation sheet, which was as follows.

	Thresholds for W. tone					SRT	SDS at	SDS in
	250	500	IK	2K	4K		55 dB	Noise
FM SYS (FM mode)								-30 S/NR -25 S/NR -20 S/NR -15 S/NR
FM SYS (mic mode)								
EG AID								

RESULTS AND DISCUSSION

The analysis of 1the data indicated the following results.

Subjs.	Group representa-tion	Average for warble tones	S.R.T.	S.D.S. at 55 dB	S.D.S. at -30 S/N ratio
5	Hearing aid	43.28	48.00	84%	8%
5	FM SYS (MIC)	39.32	38.00	92%	8%
5	FM SYS (FM)	39.62	37.00	96%	96%
5	Totally average	40.74	41.00	90.67%	37.33%

THRESHOLDS FOR WARBLE TONES

FM system (FM Mode)

Subject	250 Hz	500 Hz	1 K	2 K	4K
I	20	30	40	55	85(NR)
II	25	20	45	35	80
III	10	55	50	50	80
IV	20	20	25	25	65
V	50	40	50	55	85(NR)

FM system (Mic Mode)

Subject	250 Hz	500 Hz	1 K	2 K	4K
I	20	30	40	60	85(NR)
II	25	25	45	35	85(NR)
III	20	75	50	55	85(NR)
IV	35	20	25	35	60
V	20	35	40	60	85(NR)

Hearing Aid

Subject	250 Hz	500 Hz	1 K	2 K	4K
I	35	45	50	65	85(NR)
II	35	40	50	55	85(NR)
III	25	55	45	55	85
IV	50	55	65	70	65
V	25	30	45	35	85(NR)

The data presented above indicated the following:

The thresholds for the subjects for warble tones were better on using FM system in FM mode. There was an average of 4 dB improvement at 500 Hz, 1 KHz and 2 KHz on using FM system; in comparison to their personal hearing aids. This was seen for subject I, II and IV. The average thresholds for subjects III was 1-2 dB higher than the thresholds obtained with the use of FM system in mic mode and their hearing aids. For subject V the thresholds for warble tones using FM (FM) mode reduced by almost 3.5 dB in comparison to thresholds obtained using FM system in mic mode. Also the thresholds for warble tones were lower by an average of 12 dB at (500 Hz, 1 KHz, 2 Kz) on using FM system (FM mode) in comparison to the thresholds obtained using their personal hearing aid.

Also it was found that the subjects thresholds improved by 12 dB at 250 Hz and 500 Hz (low frequencies) on using the FM system in comparison to their personal hearing aid and 9-10 dB of improvement at higher frequencies (i.e., 1 kz and 2 KHz).

The discrepancies seen in the cases III and V for the task of detection of warble tones could be because the cases were straight away tested with the FM system than their hearing aids, or because, they were inattentive when tested

with FM system, or because the FM system did not suit their requirements. The reasons, however have to be ascertained, and the study has to be extended taking more number of subjects.

II

SPEECH RECEPTION THRESHOLD

Subject	^{FM}(FM)	^{FM}(Mic)	HG AID
I	50 dB	50 dB	60 dB
II	20	20	45
III	75	75	75
IV	20	20	20
V	20	20	40
Average	37 dB	38 dB	48 dB

The data indicated that all the 5 subjects performance the best with FM system (both mic mode and FM mode) for speech reception task. In comparison to their scores on using FM system, the subjects scored 9-10 dfi more on using their personal hearing aid for the speech reception task.

It is noted that, with, use, the hearing aid performance does not remain constant. There can be an increase in distortion and internal noise, this can be a possible reason why the subjects performed poorer with their personal hearing aid on speech reception task. The subjects under this study had used their hearing aid for more than 1.5 years to 2 years and it is possible that the internal noise of the hearing aid interfered with the intelligibility of speech.

III S.D.S. IN THE ABSENCE OF NOISE

Subject	FM (FM)	FM (Mic)	HG AID
I	80%	80%	80%
II	100%	100%	100%
III	100%	80%	40%
IV	100%	100%	100%
V	100%	100%	100%
Average	96%	92%	84%

The scores on speech discrimination task was good in all the 3 conditions. The subjects scored 96% on using the FM system in FM mode. However, they scored a) 4% less than this on using the FM system mic mode and b) 12% less than the scores on FM system in FM mode on using their personal hearing aid.

The discrepancy of 12% on using the hearing aid, can be possibly be due to the internal noise and distortion of the hearing aid that resulted from prolonged use. However, the FM system that was used in this study was a new piece.

IV

S.D.S. IN THE PRESENCE OF NOISE

Subject	^{FM}(FM)	^{FM}(Mic)	*EG* AID
I	80%	0%	0%
II[4]	100%	40%	40%
III	100%	0%	0%
IV	100%	0%	0%
V	100%	0%	0%
Average	37 dB	38 dB	48 dB

The major difference in performance on using the 3 systems were seen on speech discrimination task in presence of noise.

While the subjects score lowered dramatically on using their personal hearing. (i.e., 84% to 8%) and on using FM system in Mic position (i.e., 92%-8%), the presence of noise did not alter than performance on speech discrimination task with FM system in FM mode and hence the score remained at 96% (i.e., in the absence and presence of noise the scores did not vary).

For the task of discrimination of speech in noise, the subjects performed poorly with FM system in mic mode and hearing aid because, the noise, their mic had picked up, interfered with the intelligibility of speech. For the FM

system in FM mode since the microphone of the transmitter was close to the sound source, the subjects performance was not hindered even on increasing the signal-to-noise ratio upto -30. Thus their scores on speech discrimination remained the same in the absence and presence of noise.

SUMMARY AND CONCLUSION

Review of literature indicates that the FM systems are highly advantageous over hearing aids in that they offer a constant output of sound pressure level and a very good signal-to-noise ratio.

A study was hence conducted to verify it experimentally using a prototype that was developed indigenously. Five subjects were tested for their performance in the following three conditions.

1. Hearing aid.
2. FM system in FM mode.
3. FM system in Mic mode.

They were tested for detection of warble tone, speech reception threshold and speech discrimination (a) at 55 dB (absence of noise) and at (b)—30 S/N ratio (presence of noise).

Results indicated that subjects performed better in all the task on using FM system in FM mode, especially speech discrimination at -30 signal-to-noise ratio.

Thus the results suggested that use of FM system in FM mode should be considered critical for a hearing impaired, listening in noisy environment.

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Ongoing developments in FMAS

Single channel simplex system
Multi channel simplex system
Duplex system
FMAS routed through the direct signal in put hearing aids.

Specifications

Noise free operting range of transmitter/receiver	: 50mts.
Peak out put sound pressure level	: 136 dB Spl.
Frequency response	: 250 to 3400 Hz.
Audio distortion at peak output	: Less than 7%
Type of battery.	: 3.6V, 250mAh, NiCad. Rechargable.
Batter/ current drain	: 15 mA.

FM Transmitter

Crerating Frequency	: 74.625 MHz.
Transmitter Power	: 10 mW.
Tvpe of modulation	: FM
Maximum Deviation	: 4 KHz.
Distortion for 1 KHz tone	: Less than *5%*

FM Receiver

Receive Frequency	: 74.625 MHz.
Receiver sensitivity 12dB SIXAD	: -118 dBm.
Distortion for iKHz tone	: Less than 5%
Maximum AF Electrical output	: 2.2 V rms.

FM AUDITORY SYSTEM

INDIAN TELEPHONE INDUSTRIES LIMITED
DOORAVANINAGAR BANGALORE - 560 016

FM AUDITORY SYSTEM (FMAS)

FMAS is a personal wireless radio transmitter/receiver system, which provides enhanced listening conditions to the hearing impaired, under various situations such as classrooms, auditoriums, board meetings and even out of doors.

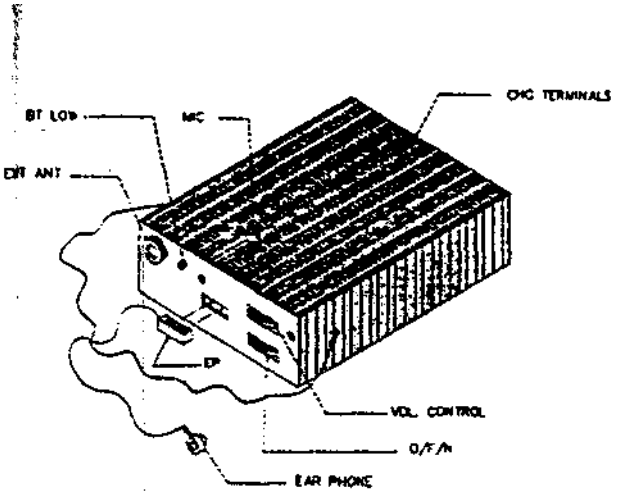
The "RECEIVER" of FMAS operates as a normal hearing aid in the "N" mode. While in F mode, it receives the speech from a distant "TRANS-MITTER" located close to the source.

Designed using the latest Electronic Techniques, it provides the follow-ing features.

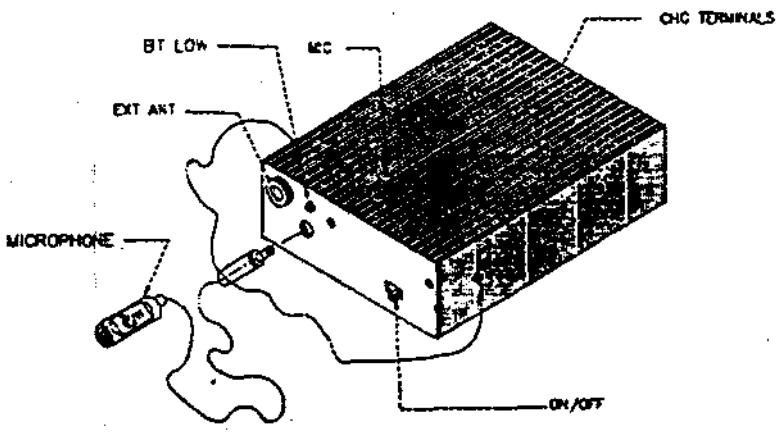
* High Quality speech in both FM(F) mode and NORMAL(N) mode.
* Low noise wireless communication upto 50 metres.
* Improved accoustic performance.
* Automatic squelch operation.
* Compact size.
* Listening level adjustments.
* Rechargable batteries.

Controls and Functions

* BT LOW Indicates the discharged condition of the batter). Initially the set has to be charged forl5Hrs. before use.
* O/F/N Selects the mode of operation should be in OFF mode while not in use. N mode for the normal hearing aid operation. F mode to receive speech from the transmitter.
* MIC Microphone
* REC Earphone outlet
* VOL CON Listening level control.
* CH' Charging terminals.
* EXTANT When connected extends the range of operation.



RECEIVER



TRANSMITTER

APPENDIX
TABLE I

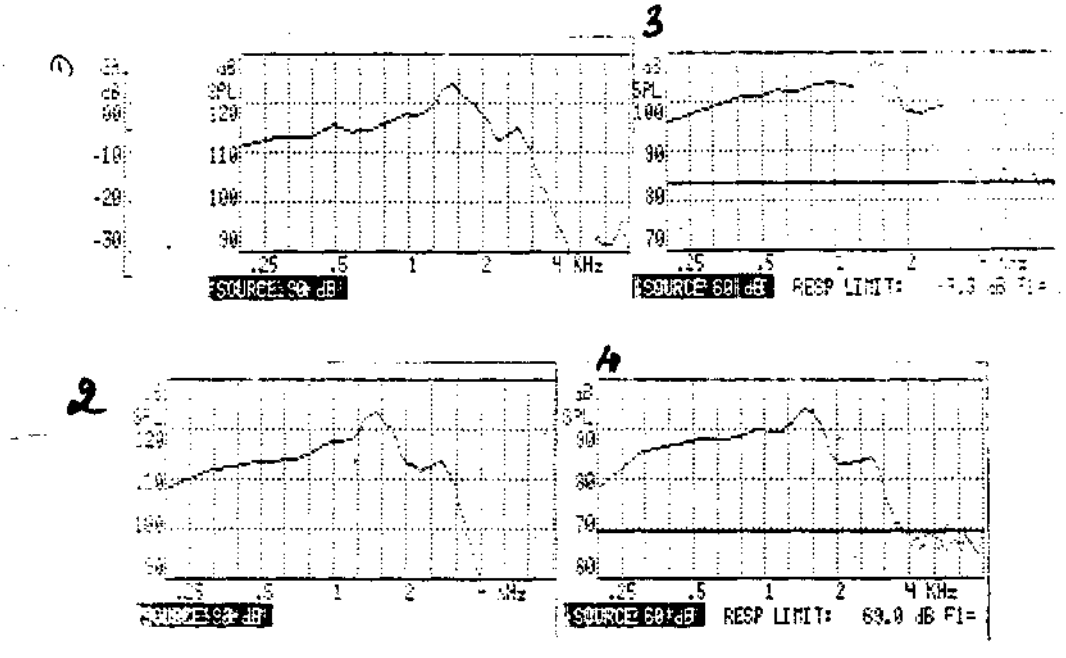
TABLE II

Ambient noise in the test environment

External filter	Left speaker 'on'	Right speaker 'on'
250 Hz	19 dB	23
500 Hz	21 dB	26
1000 Hz	21 dB	26.5
2000 Hz	24.5 dB	24.5
4000 Hz	23.5 dB	24.5
6000 Hz and	25 dB	18
8000 Hz EXT	33.5 dB	38 dB

TABLE III

ELECTRO ACOUSTIC MEASUREMENTS



1. Hearing aid OSPL curve in FM position
2. Hearing aid OSPL curve in Mic position
3. Hearing aid frequency response curve in FM position
4. Hearing aid frequency response curve in Mic position.