

PERFORMANCE CHARACTERISTICS OF INDIAN HEARING AIDS

S. P. C. Pandalay and S. S. Murthy

Introduction

Hearing aid is a miniaturised amplifier circuit, though it takes many forms, is designed specifically for improving human hearing. Reduction in size, improvement in acoustic quality and inconspicuousness to wear, than ever thought possible, have resulted, in greater acceptance of these hearing aids. Hearing Aids are made as glasses, as barrettes, for behind the ear use and for use directly on the ear, as well as in the form of conventional body hearing aid.

The average hearing losses of the hearing aid users ranges from perhaps 25 decibels to as much as 100— decibels. In some instances, hearing shows little change with frequency, in others, it falls strongly with frequency and in a few it rises with frequencies (S. F. Lybarger, 1961). So, accurate information on the performance characteristics of hearing aids is an important prerequisite to properly selecting or fitting them to the large variety of impaired ears. Among the various parameters of the hearing aid, the most important qualities to a hearing aid dealer or the audiologist, according to S. F. Lybarger, 1961, are: the frequency response, the full-on acoustic gain, the saturation sound pressure level and the Harmonic Distortion characteristics.

Problem

As a result, it was decided to study the various characteristics of the Indian-Made hearing aids for many reasons. To mention a few : 1) A study conducted at the Auditory Research Laboratory of the Veterans Administration showed that the average gain of hearing aids in an inventory differed as much as 15 to 20 decibels from the specifications submitted by the manufacturer (Kasten and Revoile, 1965). 2) Inadequate information regarding the performance characteristics of various hearing aids and 3) To check the possible difference that exists between the manufacturer's specifications sheet and the actual performance of the hearing aids.

Method

The study was conducted at the All India Institute of Speech and Hearing, Mysore. All measurements were made, using a Bruel & Kjaer Audio Frequency Analyzer System type 2107, B & K Hearing Aid Test Box type 4217 and B & K

Mr. S. P. C. Pandalay is Lecturer in Audiology, Department of Audiology at the All India Institute of Speech and Hearing, Mysore-6.

Mr. S. S. Murthy is Lecturer in Electronics at the All India Institute of Speech and Hearing.

Precision Sound Level Meter type 2203, housed within a sound treated room. The sound-field and its characteristics were properly measured and maintained.

Results

The results of the study are as follows :

1. *Gain*: is the difference, in decibels, between the free-field in-input sound pressure level to the hearing aid microphone and the output Sound Pressure Level of the hearing aid receiver in a coupler. Gain is specified at the '*Full-on*' level setting of the hearing aid. A 60 decibel input was used as against 50 decibel SPL-suggested by HAIC because Fletcher has pointed out (1953) that this level is exceeded by 40 to 50 per cent of the peak pressures of conversational speech. With the realization that a hearing aid must, of necessity, transduce these peak pressures, and so half of the peak pressure values will not be an overly stringent input setting (Roger N. Kasten, Stephen H. Lotterman, 1967). Average gain, HAIC method, is the average of the '*Full on*' gain values at 500, 1000 and 2000 HZ.

I. The gains of the various Indian Hearing aids are :

1. *Oticonpush pull*: Average gain : 55 decibel and peak gain is 66 decibel at 1600 cycles.
2. *Oticon popular*: Average gain is 55 decibel with a peak gain of 64 decibel at 1250 cycles.
3. *Oticon super 350* : Average gain 55 decibel with a peak gain of 60 decibel at 2500 cycles.
4. *Oticon extra super* : The average gain is 62 decibels with a peak gain of 66 decibels at 1600 cycles.
5. *Danavox economy 647-I*: Average gain is 58 decibels with a peak gain of 66 decibels at 1600 cycles.
6. *Danavox standard without A VC* : The average gain is 56 decibels with a peak gain of 62 decibels at 1200 cycles.
7. *Danavox standard AVC*: The average gain is 57 dB with a peak gain of 66 dB at 1600 cycles.
8. *Danavox Deluxe AVC* : The average gain is 58 decibels with a peak gain of 66 decibels at 1600 cycles.
9. *BEL VH 200* : Average gain is 45 decibels with a peak gain of 56 decibels at 1600 cycles.
10. *Rionet (H 536)* : Average gain is 45 decibels.
11. *L.P.T. Hearing Aid*: Average gain is 47 decibels with a peak gain of 54 dB at 1250 c/s.

II. *Saturation Sound Pressure Level*: This is the phenomenon of "*over-load*". This is measured with the gain control of the aid at the Full-on setting and the input sound pressure level raised until the output of the aid can no longer increase.

The term output HAIC standard is defined as the average of the 500, 1000, and 2000 cycles values of the saturation sound pressure level. In a good hearing aid, the saturation level should be safely higher than even its peak gain.

1. *Oticon Push-pull*: 120 decibels,
2. *Oticon popular* : Average SPL 125 decibels.
3. *Oticon super* : 128 decibels.
4. *Oticon Extra super* ; 130 decibels.
5. *Danavox economy* : Average SPL is 120 decibels.
6. *Danavox standard*: 118 decibels,
7. *Danavox standard A VC* : Average SPL is 118 decibels.
8. *Danavox Deluxe with AVC*: Average SPL is 120 decibels.
9. *BEL VH 200* : The Average SPL is 119 decibels.
10. *Rionet H 536* : The average SPL is 106 decibels.
11. *L.P.T.*: Average SPL is 125 decibels.

III. *Frequency Response*: The basic frequency Response is obtained, using a 60 dB SPL input. The gain of the aid is set to achieve a 100 dB SPL output at 1000 cycles.

All the above II hearing aids, on this measurement, gave satisfactory response from 200 cycles to 5000 cycles.

IV. *Harmonic distortion*: This results from the non-linearity of the device through which the wave form has passed. According to HAIC, this characteristic is measured with an input to the aid of 75 dB SPL and gain setting for 5 d3 at the frequencies of 500, 700 and 900 cycles because greatest distortion occurs below 1500 cycles. In the present study, the harmonic distortion was measured at 500 c/s, 800 c/s which is close to 700 c/s and at 1000 c/s which is close to 900 c/s because the hearing aid test box available at the Institute did not have provisions to produce 700 and 900 cycles. Five per cent distortion or below is considered to be excellent.

1. *Oticon push pull*: Distortion is 9 per cent.
2. *Oticon popular* : Average distortion is 11 per cent.
3. *Oticon super* : 8 per cent.
4. *Oiicon extra super* : 10 per cent.
5. *Danavox economy*: The distortion was measured with ten decibels gain as it was minimum gain that the hearing aid could be set with. The distortion is 5.2%
6. *Danavox standard*: Average distortion is 8.5 per cent.
7. *Danavox Standard AVC*: Harmonic Distortion Average 10 per cent.
8. *Danavox Deluxe AVC*: Distortion is 8.7 per cent.
9. *BEL VH 200* : Distortion is 8.5 per cent.
10. *Rionet H 536'*. Average distortion is 15 per cent.
11. *L.P.T. Hearing Aid*: Average distortion is 10 per cent.

All characteristics measured at the institute are given here in tabular form in Table 1.

Table 1. Performance Characteristics of various hearing aids

Make of the hearing aid	Dimension	Net weight	Battery	Average Gain	response	Frequency	Average saturated Sound	Harmonic distortion
						Pressure	and	
								1000
1. Oticon push pull (350)	64.5x46x 15.5mm	out cell	40gms with- Eveready E 340E	Mallory	55 decibels 5000	200 c/s to c/s	120 decibels	11%
2. Oticon popular	64.5X46X 15.5mm	"	"	58,,		volt		11%
3. Oticon Super (350)		"		"	128			8%
4. Oticon Extra Super		"		"			55 "	130"
5. Dana vox economy	647 I	62x47x18mm outcell	62	47gms with- Mallory		120	58,, "	5.2%
6. Danavox standard 647 I		"	>>	56	118,, "		118,,	8.5%
7. Danavox standard 647 AVC		"		"			57,, "	10%
8. Danavox Deluxe AVC 647	60x70x16mm	60gms with- out cell	»	Eveready 45,,		200 c/s to 4UW c/s	119,,	8.5%
9. BEL VH 200				No. 915, 1.5 V				
10. Rionet(H536)	58x74x17mm	cell	85gms with No. 915	Eveready 45	20^c/s tO		^ "	15%
11. Low Pressure	Technique		1.5 V _o ltS	60x70X16mm	47 - "		125 "	10%

Table 2. Showing the manufacturer's claim and our findings

Make of the He.rin. AiH	AS Per the specification sheet			Results of the Measurements		
	NA, N.A., N.A.	Max. P_{out}	Distortion	Gain	Max. output	Distortion
1. Uticon push pull	N.A.	N.A.	55 decibels	120	decibels	9 %
2. Uticon popular	N.A.	N.A.	-	58	"	125 " 11%
3. Uticon super	Peak Gain 76 dB	Peak Power 134 dB	- 55	128	"	8%
4. Oticon Extra Super	Peak Gain 82 dB	Peak Power 139 dB	- 62	130	"	10
5. Danavox Economy	60dB	119 decibels	-	58	120 "	5.2%
6. Danavox Standard 647 I				Jt "	118	" 8.5%
7. Danavox Standard AVC 647 I	56 dB	121	-	<?7 "	118	" 10%
8. Danavox Deluxe AVC 647 I	57 dB	121	<> "	120	" 8.7%	
9. BEL VH 200	N.A	N.A	N.A.	45	199	8.5%
10. Rion et (H 536)	80 dB	Not specified	---	45	106	15%
11. L.P.T. 50	dB	10%	47	"	125	10%

Note : N.A.=Not Available.

Discussion

In terms of gain the Danavox hearing aids showed no significant difference from the manufacturers specification sheet. For Oticon hearing aids, as the manufacturer has given the peak gain values, no comparison could be made in terms of average gain. But wide difference in the peak gain values for Oticon Super and Extra Super was noticed. In Danavox Deluxe AVC and Standard AVC the gain was calculated with their setting for maximum gain. The improvement that could be achieved from the minimum gain setting to the maximum setting in Danavox Standard AVC was 11 dB and in Danavox Deluxe only 5 dB.

All the hearing aids give very good frequency response from 315 to 4000 c/s in the total range of 203 c/s to 5000 c/s. The maximum output of these hearing aids approximates with the specification of the manufacturers.

The distortion of all these hearing aids was comparately high. No one hearing aid gives less than 5 per cent distortion.

All the measurements were performed with Mallory 14 volt battery except for BEL and Rionet hearing aids where Eveready 15 volt battery was used.

The measurements of Oticon hearing aids were carried out with type D₄ receiver which offers comparatively very low impedance and a flat frequency response characteristic as per the company. Danavox hearing aids were tested with star type receiver (*) supplied by the company along with the hearing aids.

The difference between the manufacture's specification sheet and the values obtained in the study is given in Table 2.

REFERENCES

1. HAIC Conference on Hearing Aid evaluation procedures. Sept. 1967. ASHA Reports No. 2.
2. James Jerger, Charles Speaks and Corolyn Malmquist. 1966. "Hearing Aid Performance and Hearing Aid Selection". JSHR Vol. 9. No. 1.
3. S. F. Lybarger 1961. "A new standard for measuring hearing aid performance" ASHA Vol. 3 No. 4.
4. Roger N. Kasten and Stephen H. Lotherman. 1967. "A Longitudinal examination of Harmonic distortion in Hearing Aids" JSHR Vol. 10. No. 2.
5. Roger N. Kasten, Stephen H. Lotherman and Sally G, Revoile 1967. "Variability of Gain Vs Frequency Characteristics in Hearing Aids" JSHR. Vol. 10. No. 2.