ELECTROACOUSTICAL AND REAL-EAR COMPARISONS OF ASSISTIVE LISTENING DEVICES

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Purpose

To compare electroacoustical characteristics and real-ear insertion gain levels of commercially available personal assistive listening devices (ALDs), equipped with supra-aural headphones and earbud-type transducers.

Methodology

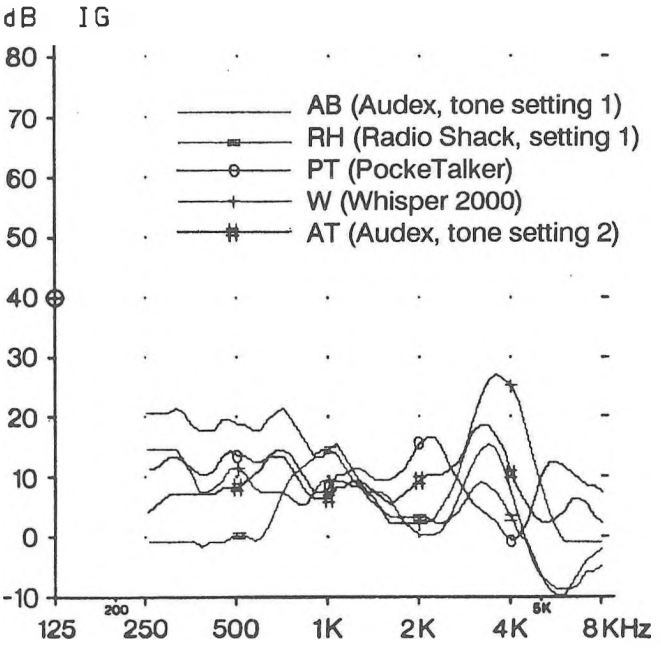
Four ALDs (Radio Shack Stereo Amplified Listener, Williams PockeTalker II, Whisper 2000, Audex Soundirector), two of which had tone adjustments as well as volume controls, were analyzed electro-acoustically and in-situ. Electroacoustical analyses were carried out on a Fonix 5500-Z Hearing Aid Analyzer, under conditions adapted from ANSI (1976) standards for linear output hearing aids. With the ALDs fitted to their supplied or recommended supra-aural headphones, the cushion from the left headphone was removed and the remaining transducer affixed to an HA-1 2 cc coupler with Blu-Tack. For each device, the saturation output (90 dB SPL input), full-on gain (60 dB SPL input), and frequency response were determined, along with second harmonic distortion levels at 500, 800, and 1600 Hz.

In-situ (real-ear) measurements were performed on a Madsen IGO 1500 Insertion Gain Optimizer. Maximum available insertion gain (i.e., volume control set just below the point of feedback) was determined for each device with ten adult listeners, using left pocket ALD/microphone placement, left ear probe placement, and a sweep stimulus level of 50 dB SPL. These measures were repeated, without changing volume control settings, with all ALDs coupled to a pair of earbud-type transducers (Radio Shack #33-8104) in place of their headphones. Where possible, additional available earbud insertion gain at higher volume control settings was also determined.

Results

In the 2 cc coupler, all ALDs had saturation output levels comparable to powerful ear-level hearing aids. Peak saturation levels all exceeded 135 dB SPL at 1000 Hz. All devices also exhibited peak gain levels of at least 50 dB, broad-band frequency responses, and negligible distortion levels. At 1000 Hz, input-output linearity was observed up to an input level of 90 dB SPL.

Except for one device with four listeners, maximum real-ear insertion gain with headphones never exceeded 20 dB at or below 2000 Hz. Peak insertion gain, typically observed in the 3 - 4 kHz region, was consistently less than 30 dB. Means and typical findings (five of six curves) from a single listener are shown in Figure 1.



MEAN MAX. HEADPHONE I.G.(dB)

ALD	AT 1000 HZ	PEAK I.G.
AB	12.8	20.2
AT	8.2	20.5
PT	10.6	23.6
RH	12.7	13.5
RS	10.9	11.7
W	2.8	21.9

Figure 1

Typical single-listener findings (graph) and overall means (table) of maximum ALD insertion gain with headphones.

All ALDs provided more low-frequency gain with earbuds. Peak insertion gain was typically found at 355 Hz, where 14 - 34 dB more gain was observed than with headphones. For those devices that could not be worn at full-on with headphones, additional gain of up to 14 dB was available at higher volume control settings with earbuds. However, gain in the 3 - 4 kHz region still tended to be lower than that available with headphones (see Figure 2). This may be due to the greater canal occlusion created by earbuds, or possibly to a limitation of the earbuds used in this study.

Discussion

Examination of the single-listener curves in Figures 1 and 2 shows that the insertion gain available from an ALD depends primarily on the output transducer employed. While one device consistently provided the most gain for all listeners (with earbuds), there was no consistent rank order among the others. Between-subject variability was also observed, suggesting that external ear differences also influence ALD efficacy.

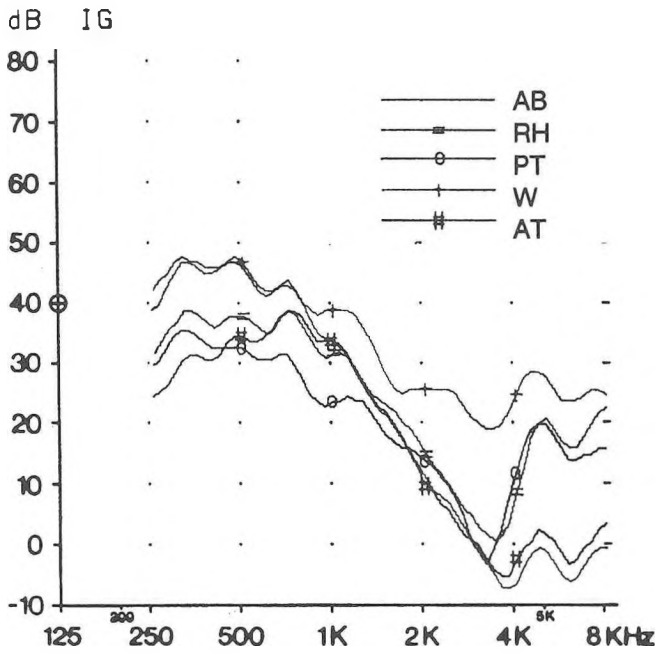
For various reasons, ALDs may be considered as potential substitutes for conventional hearing aids. However, one ALD will not be equally suitable for all wearers with hearing losses. It is suggested that an ALD should be selected and/or modified for an individual according to some fitting criteria, even if it cannot meet such criteria closely because of limited flexibility. Research into further output modifications of ALDs, whether by electronic or non-electronic means, is also warranted. Finally, the input-output linearity of these devices is of particular concern, since their output levels may potentially exceed listeners' tolerance levels and/or levels considered hazardous by health and safety standards.

Bibliography

Bebout, J.M. Non-hearing aid amplification devices: Competition or complement for hearing aids? The Hearing Journal, 1988, 41, No. 5, 7-12.

Brooks, W.S., & Grimes, A.M. Real-ear assessment of personal communication devices. Poster presented at 1989 ASHA Convention, St. Louis, MO.

Pruitt, J.B. Assistive listening device versus conventional hearing aid in an elderly patient: Case report. Journal of the American Academy of Audiology, 1990, 1, 41-43.



MAXIMUM AVAILABLE EARBUD I.G.(dB)

ALD	≃355 Hz	1 kHz	≃3 kHz	8 kHz
AB	41.3	22.4	–4.6	8.3
AT	28.2	24.4	–4.5	11.1
PT	32.7	14.1	0.8	26.1
RH	33.4	23.8	6.0	12.3
RS	33.5	22.1	0.7	16.9
W	42.2	29.0	17.8	18.8

Figure 2

Typical single-listener findings (graph) and overall means (table) of maximum ALD insertion gain with earbuds.

≃ using maximum and minimum gain values in these respective frequency regions.