



## INTRODUCTION

- In daily communication situations, reverberation and background noise make it challenging to understand a talker, especially for those with hearing loss (HL). Assistive listening devices are designed to address such listening dilemmas by increasing the signal-to-noise ratio (SNR) (Boothroyd, 2004).
- In the frequency-modulated (FM) system, a technology named "FM Advantage" (FMA) can provide an extra 0-18 dB benefit in the SNR. Benefits with FMA processing have been reported for the cochlear implant (Wolfe et al., 2009) and hearing aid (HA) users (Bondurant et al., 2011).
- In the digital-modulated (DM) system, a similar technology named "Easy Gain" (EG) can be used to adjust the output from +8 to -8 dB. Based on the research with FMA adjustments, changing EG settings on the DM receiver may be necessary to improve the audibility of the signal from the transmitter.

## PURPOSE

The purpose of this study was to evaluate how the Easy Gain setting on the receiver would affect the output as a function of the degree of hearing loss and type of the receiver.

## EQUIPMENT

Hearing Aid	Receivers	Transmitter
Phonak V90 SP Audio Shoe	Phonak Roger 18 Integrated Receiver	Phonak Roger Inspiro
Phonak DAI AS 18	Phonak Roger X (O2) Receiver	

Figure 1. The primary equipment used for electroacoustic verification of wireless transmission

### Hearing Aid Setting:

- HA was programmed using Adaptive Phonak Digital for a 60-year-old, experienced HA user
- Gain level set to 100% target gain
- Frequency lowering and volume control functions turned off, while other features were set to default

## MEASUREMENT

### Independent Variables:

- Easy Gain Settings: from +8 to -8 dB, 2 dB steps
- Severity of HL: from a flat 40 to a flat 80 dB HL, 10 dB steps
- DM Receiver Type: two Phonak Roger X(O2) and two Phonak Roger 18 Integrated receivers

Tests	EG Setting	In the test box	Out of the test box	Signal Type	Signal level
a) EHA/DM65	0 dB	HA + DM receiver	Transmitter	Digital Speech Signal	65 dB SPL
b) EDM/HA65	+8 to -8 dB	DM Microphone	HA + DM Receiver + Transmitter	Digital Speech Signal	65 dB SPL

Table 1. Electroacoustic procedures for Easy Gain settings from +8 to -8 dB in 2 dB steps. Tests were completed according to AAA guidelines (2008) for remote microphone technologies for two conditions, a) when the HA was placed in the test box, and b) when the DM microphone was placed in the test box. Note: EG = easy gain, HA = hearing aid; DM = digital modulation; E = electroacoustic evaluation

### Testing Procedures:

- Tests completed in a calibrated Fonix 8000 HA test system
- For each HL condition:
  - HA verification performed based on ANSI S3.22 (2003)
  - Each of the four receivers tested with the nine EG settings

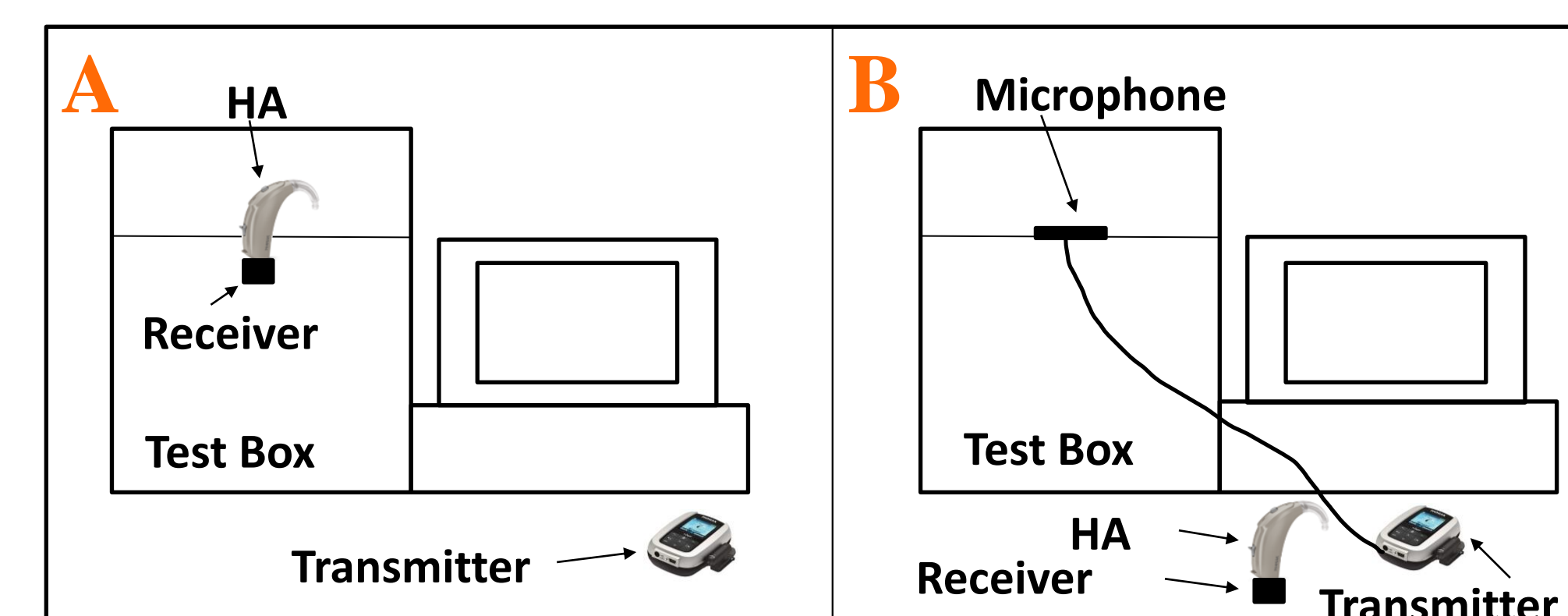


Figure 2. The test setup for electroacoustic evaluation of different hearing settings (Figure Adapted From ANSI S3.47-2014). A. EHA/DM65SPL evaluation; B. EDM/HA65SPL evaluation. Note: HA = hearing aid

## RESULTS

Condition	EG	Receiver	Degree of Hearing loss (dB HL)				
			40	50	60	70	80
EHA/DM65	0	-	82.75	86.18	92.25	100.65	112.65
EDM/HA65	0	Roger 18 Integrated	84.65	90.40	96.75	104.25	114.25
EDM/HA65	0	Roger X (O2)	82.30	86.45	92.85	101.55	112.15

Table 2. Comparison of root-mean-square (RMS) values for EHA/DM65 and EDM/HA65 when EG set as 0 dB. NOTE: See Table 1 for abbreviations

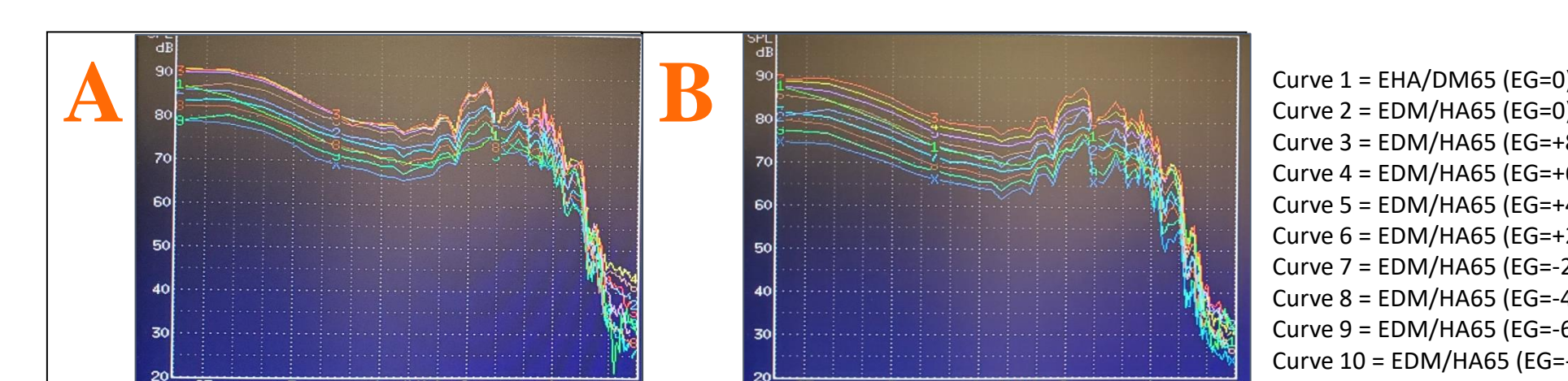


Figure 3. Examples of changes in Easy Gain for EHA/DM65 (curve 1) and EDM/HA65 (curves 2 to 10) for a flat 60-dB HL for two receivers: A. Roger 18 Integrated; B. Roger X (O2)

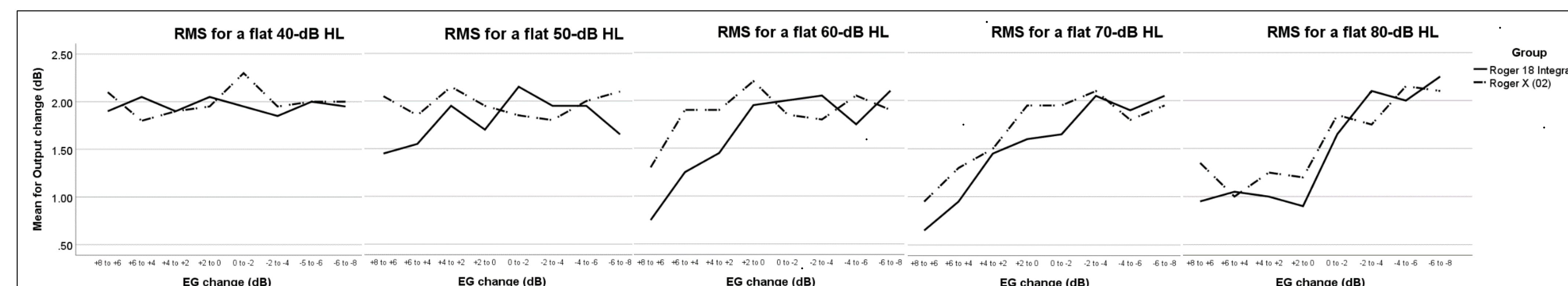


Figure 4. Output Comparison for the Two Receivers. RMS = root mean square, EG = easy gain, HL = hearing loss

## SUMMARY

- Easy Gain Settings: The change in output as EG was changed is shown in Figure 4. As EG changed by 2 dB, the output changed 2 dB ( $\pm .5$  dB) only for the 40 dB HL condition.

- Degree of HL: As HL increased, the change in output was typically less than 2 dB for EG changes > 0 dB. With greater degree of HL, there would be greater effects of HA compression on the output for EG settings > 0 dB.
- Receiver Type: The RMS output of Roger 18 integrated receivers was generally greater (mean=2.77 dB) than that of Roger X (O2) receivers.
  - a) For the Roger X (O2) receiver, the increase in output with 2 dB changes in EG settings was 2 dB when the hearing loss was a flat 40 or 50 dB HL. However, the change was less than 2 dB for hearing loss conditions 60, 70 or 80 dB HL when EG setting changes > 0 dB.
  - b) For the Roger 18 Integrated receiver, the increase in output was similar to Roger X (O2) for flat 40 dB HL. Similarly, for greater HL conditions, the dB change in output was less than 2 dB for EG setting changes > 0 dB.

## CONCLUSIONS

The three independent factors including EG settings, degree of hearing loss and type of receiver interact such that electroacoustic verification is necessary to determine appropriate settings.

## REFERENCES

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## ACKNOWLEDGEMENTS

Special thanks to Phonak for providing the hearing aids and wireless technology.