Electroacoustic Verification of the Easy Gain Settings in the Remote Microphone System

Shuang Qi, M.S. and Linda Thibodeau, Ph.D.

The University of Texas at Dallas, Callier Center for Communication Disorders

UT DALLAS School of Behavioral and Brain Sciences

Introduction

- Individuals with hearing loss (HL) typically require a higher signal-to-noise ratio (SNR) to achieve maximum word recognition than their peers with normal hearing. Remote microphone (RM) systems are designed to increase the SNR using a transmitter and a receiver by effectively reducing the effects of competing noise (Boothroyd, 2004).
- Rapid advances in assistive listening devices are occurring in the signal processing of remote microphone systems from frequency-modulated (FM) to digital-modulated (DM) systems (Thibodeau, 2020).
- In the FM system, a technology named “FM Advantage” (FMA) can provide an extra benefit in the SNR for both cochlear implant (Wolfe et al., 2009) and hearing aid (HA) users (Bondurant et al., 2011). In the DM system, a similar technology named “Easy Gain” can also adjust the output from the transmitting microphone from +8 to -8 dB, which might provide an equal benefit similar to that with FMA.

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 Aids	Receivers (2 of each)	Transmitter
 Phonak Naida V90 SP/UP	 Two Phonak Roger 18 and two 19 Integrated Receivers	 Phonak Roger Touchscreen
Audio Shoes		
 Phonak DAI AS 18	 Two Phonak Roger X (02) Receivers	

Figure 1. The primary equipment used for electroacoustic verification of wireless transmission. Photos from www.phonak.com and www.connevans.co.uk.

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
- HA set to Roger only so the local microphone was deactivated

Methods

Independent Variables:

- **Easy Gain Settings:** from +8 to -8 dB, 2 dB steps
- **Severity of Hearing Loss:** from a flat 40 to a flat 80 dB HL, 10 dB steps
- **DM Receiver Type:** Phonak Roger X(02) and Roger 18/19 Integrated receivers

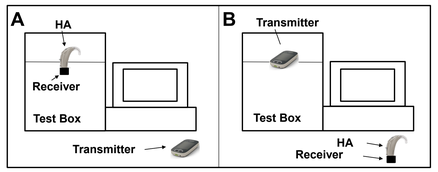

Figure 2. The test setup with Fonix 8000 for electroacoustic evaluation of different hearing settings. A. EHA/DM65SPL evaluation; B. EDM/HA65SPL evaluation. Note: HA = hearing aid

Tests	EG Setting	In the test box	Out of the test box	Signal Type	Signal level
a) EHA/DM65	0 dB	HA + DM receiver	DM Transmitter	Digital Speech Signal	65 dB SPL
b) EDM/HA65	+8 to -8 dB	DM Transmitter	HA + DM Receiver	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. Note: EG = easy gain, HA = hearing aid; DM = digital modulation; E = electroacoustic evaluation

Results

The output for the Easy Gain Settings from +8 to -8 dB in 2 dB steps is shown in Figure 3 for one representative receiver. For EG setting 0, the RMS output for each of the 6 receivers is shown for each hearing loss in Table 2. The average change in RMS output as EG changed in 2 dB increments is shown in Figure 4.

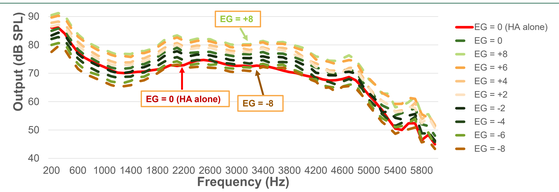

Figure 3. Example of output for Roger 18 receiver as Easy Gain changed from -8 to +8 dB for a flat 60-dB HL with Naida SP HA. NOTE: EG=Easy Gain, HA=Hearing Aid

Condition	Receiver	Degree of Hearing loss (dB HL) 40	50	60	70	80
EHA/DM65	-	81.2	86.1	92.3	101.1	112.7
EDM/HA65	Roger X(02)-#1	81.2	86.4	92.0	101.3	112.0
	Roger X(02)-#2	81.1	86.5	92.1	101.5	112.0
	Roger 18-#1	83.9	88.6	94.8	102.3	114.0
	Roger 18-#2	84.0	89.3	94.8	102.5	114.1
	Roger 19-#1	85.2	89.5	95.6	104.0	114.6
	Roger 19-#2	84.8	89.8	96.2	104.2	114.8

Table 2. RMS values for EHA/DM65 and EDM/HA65 when EG set as 0 dB for all 6 receivers. NOTE: See Table 1 for abbreviations.

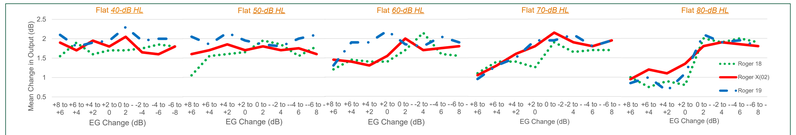

Figure 4. Average difference in RMS output of Two Receivers for each of the Three Receiver Types when Easy Gain Setting changed by 2 dB steps for the five degrees of hearing loss. NOTE: RMS = root mean square, EG = easy gain, HL = hearing loss.

Summary

- **Easy Gain Settings:** As EG changed by 2 dB, the RMS output changed 2 dB (±.5) only for the 40 dB HL condition. However, the output spectrum (Figure 3) showed nonlinear increases after 1000 Hz such that even negative EG settings resulted in increases in output. This occurred for all receiver types.
- **Severity of Hearing Loss:** As HL increased, the change in output was typically less than 2 dB for EG settings > 0 dB. With a greater degree of HL, HA compression would have greater effects on the output for EG settings > 0 dB.
- **DM Receiver Type:** The mean output of integrated receivers (both Roger 18 and Roger 19) was generally greater than that of Roger X (02) receiver, with mean = 2.03 dB and 3.14 dB, respectively.

a) For the Roger X (02) and Roger 19 receiver, the increase in output with 2 dB changes in EG settings was 2 dB (±.5) when the HL was a flat 40 or 50 dB HL. However, the change was less than 2 dB for HL conditions 60, 70 or 80 dB HL.

b) For the Roger 18 receiver, the increase in output was similar to Roger X (02) 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.

Conclusion

The three factors, including EG settings, degree of HL, and DM receiver-type, interact with each other such that electroacoustic verification of Roger Remote Microphone Systems is necessary to determine appropriate settings.

References

- American Academy of Audiology (2008). AAA clinical practice guidelines: remote microphone technologies for children and youth from birth to 21 years. Available at: http://www.audiology.org/resources/documentlibrary/documents/hatguideline.pdf. Accessed April 28, 2014
- American National Standards Institute. (2003). American National Standard Specification of Hearing Aid Characteristics (ANSI S3.22-2003). New York: American National Standards Institute, Inc.
- Boothroyd, A. (2004). Hearing Aid Accessories for Adults: The Remote FM Microphone. *Ear and Hearing, 25(1),* 22–33. https://doi.org/10.1097/01.AUD.0000111260.46595.EC
- Bondurant LM, Thibodeau L. (2011). Behavioral verification of FM advantage settings. *Journal of Educational Audiology,17,* 11–22.
- Thibodeau, L. M. (2020). Between the listener and the talker: connectivity options. *Seminars in Hearing, 41(4),* 247–253. https://doi.org/10.1055/s-0040-1718710
- Wolfe, J., Schafer, E. C., Heldner, B., Mülder, H., Ward, E., & Vincent, B. (2009). Evaluation of speech recognition in noise with cochlear implants and dynamic FM. *Journal of the American Academy of Audiology, 20(7),* 409–421. https://doi.org/10.3766/jaaa.20.7.3

Acknowledgement

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