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 affects the output as a function of the degree of hearing loss and type of the receiver.

Equipment

Hearing Aids
Phonak Naida V90 SP/UP
Audio Shoes
Phonak Naida D80 SP
Figure 1. The primary equipment used for electroacoustic verification of wireless transmission. Photos from www phonak com and www connavers 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

Independent Variables:
• Easy Gain Settings: from +8 to -8 dB, 2 dB steps
• Severity of Hearing Loss: from a flat 40 dB HL to 10 dB steps
• DM Receiver Type: Phonak Roger X(02) and Roger 18'19' Integrated Receivers

Methods

Tests
• EG Setting: In the test box
• Output from the transmitting microphone from +8 to -8 dB
• DM Receiver Type:
  a) EHA/DM65
  b) EDM/HA65: +8 to -8 dB
  c) HA + DM Receiver
  d) DM Receiver

Signal Type
• Digital Speech Signal
• Digital Modulation

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.

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

Table 3. RMS values for EDM/HA65 and EHA/DM65 when EG set as ± 2 dB for all 6 receivers. NOTE: See Table 1 for abbreviations

Figure 4. 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.

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 in with 2 dB changes in EG settings was 2 dB (±5) when the HA was a flat 40 or 50 dB HL. However, the change was less than 2 dB for HA 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 settings 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


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