Electroacoustic Evaluation of Pediatric-Focused Hearing Assistive Devices/Systems in Different Digital Signal Transmission Arrangements

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INTRODUCTION

• Hearing assistive devices/systems (HADS) are intended to facilitate hearing by providing amplification of an acoustic signal and/or improving signal-to-noise ratio (SNR).
• Digital modulated (DM) signal transmission systems operate on a 2.4 GHz bandwidth and transmit signals directly from a transmitter or remote microphone (RM) on the talker to a receiver worn by the listener.
• ANSI S3.47-2014 provides recommended measurements for performance verification.
• American Academy of Audiology Clinical Practice Guidelines (AAA-2011 Guidelines) state electroacoustic transparency occurs when equal inputs to the HADS and hearing aid (HA) microphone produce equal outputs from the HA.

PURPOSE

• Part 1: The primary goal of this study was to compare and verify the electroacoustic analysis (EAA) of HADS in different DM transmission arrangements per ANSI S3.47-2014 standard.
• Part 2: The secondary goal was to evaluate the transparency of HADS based on AAA-2011 Guidelines.

METHOD

HAs with undamped ear hooks
• Oticon Opn Play 2 BTE PP
• Oticon Opn 3 BTE PP

HA programming
• Part 1 (EAA measurement): Flat 100 dBHL sensorineural hearing loss (SNHL) with maximum power output
• Part 2 (Transparency measurement): Flat 50dBHL & 100dBHL SNHL

Desired Sensation Level (DSL v5.0) fitting formula with junior fitting mode and average real-ear-to-coupler difference values (Seewald et al. 2005) for a 10-year-old listener

Adaptive features such as noise reduction and directionality disabled

Electroacoustic analysis procedure
• HA attached to a 2cc coupler and output measured in a calibrated Fonix 8000 hearing aid test system-Frye Electronics, Inc.
• All measurement values were obtained with five measurements when variables were held constant.

RESULTS

Table 1: Equipment and test setups of three transmission arrangements. Notes: BTE - behind-the-ear; RM - remote microphone; HA - hearing aid; DM - digital microphone.

Table 2: Electroacoustic measurement values in the two hearing aid models coupled with three DM transmission arrangements. No asterisks indicate values obtained with the first one showed inconsistent transparency.

Table 3: Electroacoustic transparency measurement values for each hearing aid coupled with noisy digital transmission arrangements. Notes: BTE - behind-the-ear; SNHL = sensorineural hearing loss; DM = direct audio input; IL = induction loop; DDS = direct digital streaming.

Figure 1: Electroacoustic measurement values of the two hearing aid models coupled with three DM transmission arrangements. Notes: See text for abbreviations.

Figure 2: Electroacoustic transparency measurement values for each hearing aid coupled with noisy digital transmission arrangements. Notes: BTE - behind-the-ear; SNHL = sensorineural hearing loss; DM = direct audio input; IL = induction loop; DDS = direct digital streaming.

Figure 2A: A second Roger X receiver was required because measurements obtained with the first one showed inconsistent transparency.

Figure 2B: Transparency was met when the difference between three-frequency (75, 1, 2 kHz) average outputs of the HA and HADS with 65 dB SPL inputs was within 2 dB.

Part 3 (Transparency measurement):

• Transparency was still achieved based on the three-frequency average (Figure 2B).
• Direct digital streaming: Increased outputs were noted above 2 kHz. Transparency was still achieved based on the three-frequency average (Figure 2C).

IMPLICATIONS

• EAA findings suggest the need for specification sheets for HADS across manufacturers to determine if the devices are meeting specifications.
• Evaluation across HADS in different digital signal transmission arrangements revealed desirable transparency per AAA-2011 Guidelines.
• Frequency output curves may not be closely matched even when transparency was achieved. This supports the critical need of electroacoustic evaluation for HADS.

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REFERENCES