# Real Ear Aided Response Differences between Ultrasonic and Conventional Audio Input Signals

John Pumford, Au.D[1] and Brian Taylor, Au.D[2]

[1]Audioscan, Dorchester, ON, Canada. [2]Turtle Beach Hypersound, San Diego, CA, USA.

## INTRODUCTION

The Hypersound Clear ™ directed audio system uses ultrasonic technology to create sound in the air. Unlike conventional audio speakers, which create sound at the surface of a loudspeaker, Hypersound Clear ™ transmits a narrow beam of sound, which focuses the incident sound waves in a direct path to the listener.

Since Hypersound Clear™ can be used by hearing aid wearers, it is important to better understand how ultrasonically transmitted audio interacts with hearing aids, and if it is feasible to verify the aided response of ultrasonically conducted sound.


## OBJECTIVES

1. To evaluate the real ear aided response (REAR) of an ultrasonic signal compared to a conventional air transduced signal produced by the Verifit2.
2. To explore the clinical feasibility of conducting probe microphone measures for Hypersound Clear™

## EQUIPMENT

| Audioscan Verifit2 | Hypersound Clear 500P | Oticon Alta2 Pro TI RITE |
|---|---|---|
| • Software version 4.4.2<br>• Settings:<br>- Fitting formula = NAL-NL2<br>- Age = Adult<br>- RECD = Average<br>- Input = Speech-Std(F) | • Settings:<br>- Equalizer = Standard<br>- Balance = Mid<br>- Voice = N/A<br>- Delay = 0ms<br>- Input = RCA – Back<br>- Volume = 12 | • Receiver = '85'<br>• Coupling = Power dome<br>• Genie Software v. 2.015.2<br>• Settings:<br>- Fitting formula = NAL-NL2<br>- Experienced User<br>- Default settings |

## PROCEDURE

Hearing aids were fitted bilaterally to one subject with occluded (power) domes to minimize the influence of venting effects on the measurements. Devices were programmed for a 40 dB HL flat SNHL, using manufacturer's quick fit settings.

Real-ear aided response (REAR) measures were conducted per the REM manufacturer's specs in a large, quiet room, away from reflective surfaces at 0 degrees azimuth with the subject 3 feet away from the sound source for two conditions:

1. Verifit2 loudspeaker (conventional audio).

2. Hypersound Clear emitters (ultrasonic audio).

The emitters were located on either side of the Verifit2 equipment on the same table (see figure 1) and positioned per the manufacturer's specs (i.e., angled so subject reflection was visible on each emitter).

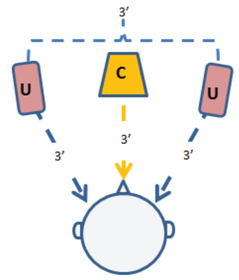


Figure 1. REM setup. C = conventional speaker; U = ultrasonic speaker

To maintain signal consistency for the ultrasonic condition, the Verifit2 signals were routed into the Hypersound RCA input, with the reference microphone active to set the input level across 1/12th octave bands.

## RESULTS

**Input Comparison:**

To evaluate the input level/spectrum delivered to the measurement location by the two signal types, inputs were measured with the probe module held at the measurement location (i.e., 0 degrees azimuth, 3 feet distance from speaker/emitter) without the subject in place and the probe tube in the calibration position (i.e., end of probe tube over the reference mic). As shown in Figures 2 and 3, the long term average speech spectrum (LTASS) input signal level was similar from ~ 750Hz to 12.5 kHz for **soft speech** and from ~ 1 kHz to 12.5 kHz for **average speech**. A relatively larger difference between the input levels was observed for **loud speech** across frequencies. The low to mid frequency roll-off for the ultrasonic system was an expected result based on the manufacturer's specs and reflects the nature of the ultrasonic signal transmission.

**REAR Comparison:**

**Soft Speech:** A relatively close match in REAR measures between conventional and ultrasonic signals was observed for soft speech signal types (see figure 5). There was a notable reduction in the REAR below ~300 Hz for the ultrasonic input, likely attributable to the nature of ultrasonic signal transmission, as noted previously.

**Average Speech:** A relatively close match in output between the conventional and ultrasonic input signals was observed for average speech with a trend for relatively higher output for the conventional input signal type below ~500 Hz. There was some variability in the 2-4 kHz region between the two input types for average speech inputs (see figure 6).

**Loud speech:** A reduction in low to mid frequency energy for the ultrasonic audio signal compared to the conventional audio signal was noted below approximately 1000 Hz (see figure 7). A tendency for the ultrasonic input signal to generate a higher output above approximately 3000 Hz under these measurement conditions was also observed.


Figure 2. Soft speech input: Green = conventional; Purple = ultrasonic


Figure 5. REAR Soft speech: Green = conventional ; Purple = ultrasonic

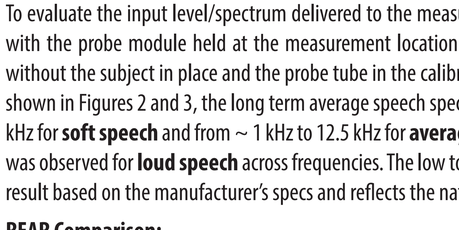


Figure 3. Average speech input: Blue = conventional; Yellow = ultrasonic

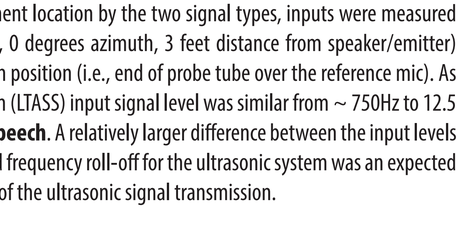


Figure 6. REAR Average speech: Blue = conventional ; Yellow = ultrasonic

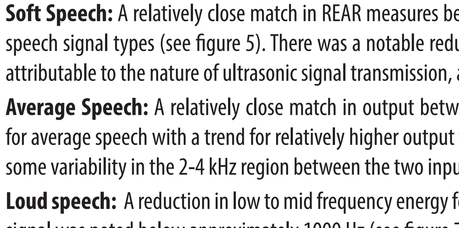


Figure 4. Loud speech input: Green = conventional; Purple = ultrasonic

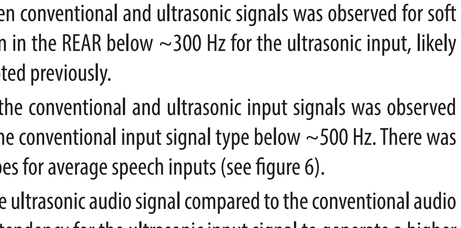


Figure 7. REAR Loud speech. Green = conventional ; Purple = ultrasonic

## CONCLUSIONS AND CLINICAL IMPACT

This case study confirmed it is possible to conduct real-ear aided response (REAR) measurements with both conventional and ultrasonic audio input signals. Testing revealed a relatively close match in REARs for soft and average speech signals above ~ 300Hz for one manufacturer's hearing aids under the conditions of this evaluation. Some variability was observed in the 2-4 kHz region for these input levels. Larger REAR differences were observed for louder input signals in both the low and high frequency regions.

Observed mismatches in the low frequency region are likely due to differences in input level. Given the reduction in low frequency REARs for the ultrasonic audio relative to the conventional audio, clinicians who dispense Hypersound Clear may consider the use of a woofer or sound bar to boost the audio signal for low and mid frequency sounds. This is especially apparent for patients with moderate to severe hearing loss between 250 and 1000 Hz.

Reasons for the observed differences in the REAR match for the high frequencies will require further investigation to determine whether they are attributable to the nature of the concurrent calibration routine used with the Hypersound device during this study or a function of the nature of the ultrasonic signal itself. Future studies could also investigate additional instruments and/or other hearing losses with or without the addition of an optional woofer or sound bar to determine their impact on the relative audibility of ultrasonic and conventional audio input signals.

## REFERENCES

References available upon request.

Contact Brian Taylor at brian.taylor@turtlebeach.com.

HYPERSOUND hearing solutions

audioscan Hearing Instrument Fitting Systems