

The influence of earphone characteristics on chirp ABRs

Claus Elberling, WDH and Sinnet G.B. Kristensen, SDU

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Background

- Many experiments with Chirps are described in the literature
- Most experiments use either the ER-3A or the ER-2 insert earphone
- However, significant acoustical differences exist between the earphones
 - both in the amplitude response and in the phase response
- A comparative study are therefore carried out



Overview

- Insert earphones ER-3A and ER-2
- Acoustical details
- ABR-comparisons
 - Amplitude, latency and waveforms
- Additional experiment
- Summary and conclusion

Insert earphone (ER-3A)





Insert earphones



ER-3A

Sound velocity = 343 m/s ER-3A delay = 278*10⁻³/343 = 0.81 ms



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Ear canal extensions

Different connections for the 711-coupler ear canal extensions

DB 2012

DB 0370







Sensitivity



this is the STANDARD

Click calibration

ISO 389-6

Acoustics — Reference zero for the calibration of audiometric equipment —

1. 200 million

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Frequency responses



Group Delay

Group Delay = the negative slope of the phase response



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Conclusions (Acoustics)

- The Ear canal extension influences the frequency response for both earphones
- Differences in:
 - Sensitivity (≈ 28 dB at 1000 Hz)
 - Max output
 - ER-3A: 1000 Hz ≈ 120 dB HL; Click ≈ 95 dB nHL
 - ER-2 : 1000 Hz \approx 100 dB HL; Click \approx 65 dB nHL
 - Frequency response
 - Amplitude, Phase (Group Delay)
 - At identical Click levels (dB nHL) the two earphones deliver the same amount of acoustic energy in the 1500 3500 Hz range.

ABR experiment

- 11 young, normal hearing subjects
 - Both ears are tested (N = 22)
- Three stimuli
 - Click, CE-Chirp, LS-Chirp
- Two earphones
 - ER-3A: 20, 40, 60, and 80 dB nHL
 - ER-2 : 20, 40, and 60 dB nHL
- ABR-comparisons
 - Amplitude, latency and waveforms



Amplitude and latency



Main Experiment, N = 22

Grand Averages



Number of peaks



Conclusion (ABR)

Differences:

- ABR amplitudes at lower levels
 - Especially for the chirps
- Waveforms
- Response definition (number of peaks)

What is the reason

- Amplitude response ?
- Rippled Group Delay ?
- Additional experiment



Additional experiment

Five young, normal hearing subjects

- Subgroup from main experiment
- Both ears are tested (N = 10)
- Two stimuli
 - LS-Chirp
 - Simulated LS-Chirp
 - With the ER-2, the amplitude response of the ER-3A is simulated, but the Group Delay of the ER-2 is maintained
- One earphone
 - ER-2 : 20, 40, and 60 dB nHL
- ABR-comparisons
 - Amplitude, latency and waveforms



Amplitude





Additional Experiment, N = 10



Grand Averages

Conclusion

- There are significant differences between the ABRs generated by the two earphones
 - Especially in the amplitude generated by the Chirps at lower levels
- It appears to be the extended frequency range of the ER-2 that is causing this difference and not the rippled Group Delay of the ER-3A
- At lower levels, the Chirp from the ER-2 generates
 2.25 times larger ABRs than the Click from the ER-3A





