Making ABR fast, accurate and clear!

Response amplitudes typically 50% larger than tone burst responses, with the potential to halve the test time.

CE-Chirp® Stimulus Family
The Gold standard for threshold assessment

"Our work has shown that narrow-band CE-Chirps® offer frequency-specific testing in typically half the time taken by tone pips. Given that a sleeping baby is a ticking time bomb waiting to go off, that's an advantage you can't afford to pass up. It's frustrating that not all ABR systems offer this stimulus." 

Guy Lightfoot PhD 2013
The Challenge:
Identifying wave V close to threshold

**Difficult and time consuming testing**
Correctly diagnosing the type and degree of hearing loss so that rehabilitation can occur, is one of the most important roles of an audiologist or physician.

Click and tone burst ABR have been successfully used for many years, but despite their common clinical use these stimuli are associated with long test times and small wave V amplitudes. This results in ABR traces which are difficult to interpret, leading clinicians to have less confidence in what they see on screen.

**The solution**
Large ABR waveforms are dependent on synchronous neural firing. Unfortunately, click and tone burst stimuli are not designed to stimulate the cochlea optimally. As the cochlea is tonotopically organised, the different frequency components of the click and tone bursts reach their point of stimulation on the basilar membranes at different times. This leads to temporal smearing of the ABR result shown on screen. The solution to this problem is to design a stimulus which stimulates all the desired frequencies of the basilar membrane at the same time.

**A preview of the benefits of the CE-Chirp® stimulus family**
- Response amplitudes typically 50% larger than tone burst responses, with the potential to halve the test time
- Easier interpretation
- Reduced test time
- Increased confidence

**The CE-Chirp® stimulus family**
- Traditional CE-Chirp® & NB CE-Chirp® from 2007 & current CE-Chirp® LS Family
- NB CE-Chirp® LS family (2014)
- All with normative data included
Compensating for the cochlear delay

The CE-Chirp® stimulus family was developed following many years of extensive human studies by numerous researchers including Claus Elberling, the researcher who the CE-Chirp® has been named in honor of.

These studies determined the delay model that had the best match for the average human cochlea, the outcome being the innovative CE-Chirp®. For the clinician this means larger amplitude waveform responses allowing for easier threshold identification. In 2007, Interacoustics was the first company to introduce the revolutionary CE-Chirp® into a diagnostic evoked potentials platform leading to markedly reduced test time and easier interpretation for the clinician. Response amplitudes up to twice the size when compared with traditional clicks or tone bursts can be achieved with both the broadband CE-Chirp® and frequency specific narrow band CE-Chirps®. The CE-Chirp® LS stimulus family is an overall improvement to the original CE-Chirp® stimulus family.

While the original broadband CE-Chirp® was designed for optimal response amplitudes at medium stimulation intensities, the level specific (LS) broadband CE-Chirp® provides clearer waveform morphology at high and low intensities.

For an easier visual evaluation of the Narrow Band (NB) CE-Chirp® responses, each of the NB CE-Chirp® stimuli have been time-shifted to provide latencies similar to the Click and the CE-Chirp® LS stimulus. The time-shifted NB CE-Chirp® are named NB CE-Chirp® LS, as the placements are level specific.

The similarities between the CE-Chirp® LS and the Click lie in the spectrum and calibration of the stimuli, while the difference lies in the presentation timing of the low, mid and high frequency components of the stimulus in order to provide greater neural synchronization.

Click versus CE-Chirp® Stimulus

Comparison of click and broadband CE-Chirp® LS stimulus amplitudes and latencies. The wave V amplitudes are larger with the broadband CE-Chirp® LS.

The Proof: Is in the waveforms

Learn more about the clinical advantages of the CE-Chirp® family at www.interacoustics.com

CE-Chirp® Stimulus Family
The Gold standard for threshold assessment

UK NHSP approved*

ABR threshold with NB CE-Chirps®

NB CE-Chirps® ABR is a fast, accurate tool for estimating the hearing threshold. These results are essential for the diagnostic evaluation.

Comparison of ABR response amplitude, test time, and estimation of hearing threshold using frequency specific chirp and tone pip stimuli in newborns.
(Ferm, Lightfoot & Stevens, 2013)

Results & Conclusion:
Overall, NB CE-Chirp® responses were 64% larger than the tone pip responses. Fmp was significantly higher for NB CE-Chirps®.

It is anticipated that there could be significant reductions in test time for the same signal to noise ratio by using NB CE-Chirps® when testing newborns.

*Tone bursts are also referred to as tone pips.
Further comparisons of ABR response amplitudes, test time, and estimation of hearing threshold using frequency-specific chirp and tone pip stimuli in newborns: Findings at 0.5 and 2 kHz.
(Ferm & Lightfoot, 2015)

Conclusion:
The advantages of NB CE-Chirps® over tone pips® we previously identified at 4 and 1 kHz extends to 0.5 and 2 kHz, which supports the use of NB CE-Chirps® when testing newborns. We propose that ABR nHL threshold to eHL corrections for NB CE-Chirps® should be approximately 5 dB less than corrections for tone pips at 0.5 and 2 kHz, mirroring our recommendation at 4 and 1 kHz.

Guidelines for the early audiological assessment and management of babies referred from the Newborn Hearing Screening Program.
(Stevens, Sutton & Wood (eds), 2013)

Comparing auditory brainstem responses (ABRs) to toneburst and narrow band CE-chirp® in young infants.
(Rodrigues, Ramos & Lewis, 2013)

Conclusion:
Narrow band CE-chirp® ABRs generate shorter latencies than the toneburst ABRs, especially to low frequencies. Higher amplitudes were found with narrow band CE-chirp® stimuli for all frequencies tested, except to high levels.
The NB CE-Chirp® ASSR was developed by Cebulla, Stürzebecher and Elberling (2006) and has demonstrated up to 50% faster detection and even more accurate hearing thresholds compared to earlier generation ASSR systems.

Furthermore, the results of NB CE-Chirp® ASSR are optimized for hearing aid fitting.

The following articles highlight the benefits and usability of the CE-Chirp® stimulus family in clinical testing.

### Refining the audiological assessment in children using narrow-band CE-Chirp®-evoked auditory steady state responses
(Venail et al., 2014)

**Conclusions:**
Narrow-band CE-Chirps® allow a fast and reliable assessment of auditory thresholds in children, especially in the low-frequency range, by comparison with other stimuli.

### Fast Hearing-Threshold Estimation Using Multiple Auditory Steady-State Responses with Narrow-Band Chirps and Adaptive Stimulus Patterns
(Mühler, Mentzel & Verhey, 2012)

**Conclusions:**
The average differences between the behavioural hearing thresholds and the ASSR threshold estimate were 10, 8, 13, and 15 dB for test frequencies of 500, 1000, 2000, and 4000 Hz, respectively. The average overall test duration of 18.6 minutes for the threshold estimations at the four frequencies and both ears demonstrates the benefit of an adaptive recording algorithm and the efficiency of optimized narrow-band chirp stimuli.

### Auditory Steady-State Evoked Responses for Preterm and Term Neonates
(Ribeiro, Carvallo & Marcoux, 2010)

**Conclusions:**
Significant threshold differences were measured between the groups at 500 and 2000 Hz, while the thresholds at 1000 and 2000 Hz were similar. These results indicate that ASSRs can be effectively measured with a similar signal-to-noise ratio in both groups, but that there is a significant maturational effect occurring during gestation at the level of structures, which participates in the formation of the ASSR at 500 and 4000 Hz.

### Threshold prediction in children with sensorineural hearing loss using the auditory steady-state responses and tone-evoked auditory brain stem response
(Rodrigues & Lewis, 2010)

**Conclusions:**
Multiple ASSRs have strong correlations to tone-evoked ABR and to behavioral thresholds obtained during follow-up in hearing impaired infants and young children. These results might be useful in order to provide further evidence for the use of multiple ASSRs, as an alternative tool to tone-evoked ABR, although further data are still required.
References & Suggested Reading

Articles


Learn more about the CE-Chirp® stimulus family at www.interacoustics.com/eclipse

CE-Chirp® Stimulus Family

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Guy Lightfoot PhD 2013
Where is the CE-Chirp® stimulus family available?

*The CE-Chirp® stimulus family is included in the EP25 and ASSR and is optional for the EP15 software for the Eclipse.

*The original CE-Chirp® and the special HiLo CE-Chirp® are included in the ABRIS440 automated ABR software for the Titan.