

The Level Specific CE-Chirp[®]

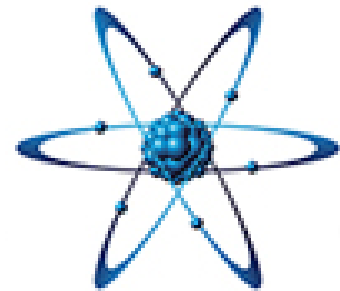
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Introduction:

Cutting edge technological advances are few and far between in the world of Audiology. It's hard to believe that the first introduction of the ASSR or SSEP technology is almost 15 years old! As with this first generation of ASSR, a technological advancement can be a major 'bust' if it doesn't live up to the commercial hype. So when the technology undergoes refinement, the reintroduction can be met with large scale 'skepticism'. Evidence-based research is critically important to support the introduction of new technologies. There is now abundant scientific evidence to support the utilization of this stimulus in traditional ABR threshold applications as well as with an ASSR application.



Background:

It is common knowledge that the auditory evoked response relies on the rapid 'synchronous' firing of the auditory nerve to generate a tiny electrical signal which can be averaged and recorded. When clicks or TB stimuli are presented they produce a 'less than ideal' response because hair cells of the cochlea are stimulated at different absolute times, creating a 'smearing' effect which diminishes the amplitude of the wave V ABR. These detrimental effects to the response are due to a mismatch between the timing of the different frequency components within the stimulus and the travel time for different frequencies within the cochlea.

What if we could alter the stimulus to compensate for cochlear travel times?

Elberling and colleagues (2006) addressed this issue, by engineering an acoustic broad spectrum stimulus with inherent timing functions to simultaneously stimulate the majority of cochlear hair cells. Their new "chirp" maximized the synchronous neural firing of the auditory nerve and produced Wave V amplitudes twice as large as standard clicks but more importantly, test times were substantially reduced when used for threshold assessment.

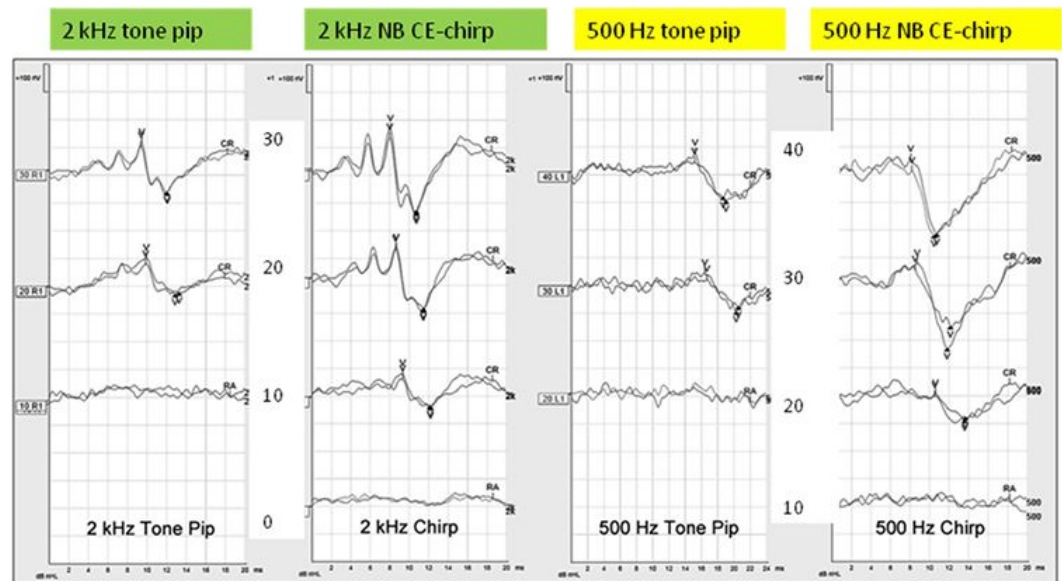
These re-engineered acoustic stimuli (i.e. chirps) have become known as CE-Chirps[®]. Although this may seem like a simple process for acoustical engineers, this stimulus has undergone careful refinement and over a 10 year period an entire family of stimuli called 'Level Specific CE-Chirps[®]' have been developed to produce the most robust Wave V responses regardless of stimulation level.

Evidence Based Benefits:

Multiple studies have documented the superiority of the CE-Chirps[®] as compared to traditional stimuli. Ferm & Lightfoot's (2015) used data gathered from the United Kingdom's universal newborn screening program and demonstrated NB CE-Chirp

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responses were 1.6 times larger than standard TB counterparts and the ability to achieve responses closer to threshold was improved significantly with the added benefit of reduced test times. As a result, the official UK NHSP recommendations for threshold estimation were modified to reflect the documented improvements from NB CE-Chirps[®].



Venail, Artaud, Blanchet, Uziel and Mondain (2014) evaluated the Interacoustics Eclipse ASSR using NB CE-Chirp[®] stimuli. Comparisons were made between traditional TB ABRs, NB CE-Chirp[®] ASSR and behavioral thresholds. The authors' reported ASSRs were highly and significantly correlated to the behavioral thresholds for normal and hearing impaired children at 0.5, 1, 2 and 4kHz. Venail and colleagues reported while using multiple narrow-band CE-Chirps[®], the ASSR total test time was 22 minutes, similar to what others have previously reported (Rodriguez et al, 2014 reported 21 minutes, Mühler et al, 2012 reported 19 minutes, Seidel et al, 2013 reported 33 minutes).

Stimulus Timing Onset

In an ABR application, the LS NB CE-Chirps[®] are positioned earlier on the time line than Tone Bursts, and therefore provide shorter response latencies. Of note, the broad band CE-Chirp[®] Wave V latency corresponded quite closely to the traditional click. This phenomenon is not to be confused with the effect played out in the cochlea! It is solely related to an 'engineering' decision on stimulus onset timing alone.

One might think of these earlier "stimuli start times" as analogous (although opposite) to the 0.9 msec acoustic timing delay (and compensation) all manufactures use to accommodate the tubing length of insert earphones. Likewise, in the most current Eclipse EP25 software (4.4.2), stimulus start times have been 'normalized' for the newest Level Specific NB CE-Chirps[®] to produce Wave V latencies which are identical

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to each other and also similar to the Broad Band LS CE-Chirp® Wave V latency which approximates the traditional click.

dBnHL	Click	CE-Chirp LS				
		Broad-band	NB 4kHz	NB 2kHz	NB 1kHz	NB .5kHz
90dB	5.23	5.33	4.95	4.95	4.95	4.95
80dB	5.36	5.35	5.27	5.27	5.27	5.27
70dB	5.57	5.51	5.60	5.60	5.60	5.60
60dB	5.84	5.80	5.96	5.96	5.96	5.96
50dB	6.20	6.20	6.36	6.36	6.36	6.36
40dB	6.64	6.71	6.82	6.82	6.82	6.82
30dB	7.13	7.32	7.35	7.35	7.35	7.35
20dB	7.70	8.02	7.97	7.97	7.97	7.97
10dB	8.35	8.80	8.70	8.70	8.70	8.70

Adult Wave V Latency Tables for the Interacoustics Eclipse EP25

For NB CE-Chirps® correction factors for electrophysiologic ABR thresholds to estimated audiogram can be 'decreased' by 5 dB. For example, if a 20dB correction factor for 500Hz TB was previously used, clinicians using the new software would modify this to 15 dB. The same applies to bone conducted thresholds. A complete list of age and transducer dependent correction factors can be found on the UK NHSP website.

AC - INSERTS	Tone pip/click ABR					Chirp			
	0.5k	1k	2k	4k	Click	0.5k	1k	2k	4k
Corrected age									
≤12 weeks (≤84 days)	-15	-10	-5	0	5	-10	-5	0	5
13 to 24 weeks (85–168 days)	-20	-15	-10	-5	0	-15	-10	-5	0
> 24 wk (>168 days)	-20	-15	-10	-10	-5	-15	-10	-5	-5

Guidelines for the early audiological assessment and management of babies referred from the Newborn Hearing Screening Programme - 2013.

Official nHL to estimated audiogram correction factors for level specific NB CE-Chirps® as used by the UK NHSP program.

Summary:

A common objection by Audiologists for staying clear of ASSR is “It is only reliable in the moderate to severe hearing cases and test times are still too long”. **Current research indicates that this statement is no longer valid** as it relates to some of the new technologies. Now there is substantial independent scientific evidence to support the use of the LS CE-Chirps® for threshold estimation in lieu of click and tone burst stimuli. In fact, approximately 50% of newborns being screened in California are being tested with the CE-Chirp® using an ASSR application. Ask your local office for reference materials, educational documents, videos and tutorials on the CE-Chirp®.

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