

The HEARLab[®] System

Cortical Evoked Potential Analyzer

What are Cortical Measurements?

Cortical Auditory Evoked Potential (CAEP) measurements are used to detect whether particular sounds produce an electrical response in a patient's brain. HEARLab provides the hearing health professional with an easy-to-use method of performing this measurement.

A transducer such as an insert earphone, bone vibrator, or sound field speaker is used to deliver the test signal to the patient who is passively alert. Electrodes placed on the patient's head measure the cortical response. A statistical analysis of each response (a "p-value") is automatically calculated to determine the probability that a CAEP signal was present. The clinician can verify this analysis with a visual examination of the measured cortical response.

CAEP can be tested on patients who are unable or unwilling to communicate to the clinician about whether they can hear a signal. This could include infants and small children who have not yet developed language skills, and adults who are disabled or uncooperative. Cortical measurements are performed when the patient is alert and awake. The patient can be entertained during the test with reading material or a silent DVD. Small children can be tested while being held in their parent's arms and playing with a quiet toy.

Previous to HEARLab, cortical measurements have largely only been made in research laboratories. HEARLab has been developed over the last several years by the staff at the National Acoustics Laboratories of Australia (NAL) with the idea that advanced auditory testing needs to be available at the clinical level at an affordable price. HEARLab is also designed to allow the addition of significant additional measurements in the future as advances are made in the field.

The widespread use of infant hearing screening has identified hearing loss in children at much younger ages than ever before. While greatly improving the hearing health care of these children, this practice has also brought new challenges to pediatric audiologists providing amplification for patients who do not have the ability to directly tell us what they are hearing.

After a child has been diagnosed with a hearing loss using otoacoustic auditory emissions (OAE) and auditory brainstem response (ABR) tests, the child may be fitted with hearing aids. This creates a challenge for pediatric audiologists: real-ear (and simulated real-ear) measurements can be used to measure the amplification provided by the hearing aid, but it is



difficult to determine if that amplification is providing a benefit to the patient. One possible solution would be to perform an aided ABR test on the child. However, ABR testing has some fundamental drawbacks when performed with hearing aids.

Most digital hearing aids have a digital processing delay of at least 3 milliseconds (ms), and some digital hearing aids have a delay of more than 10 ms. Since the neural signal in the ABR test is received a few milliseconds after the reception of the auditory test stimulus, the delay of the digital hearing aid can interfere with the certainty of the ABR result. The ABR test also uses a short impulse stimulus type that is not speech-like and may not be processed properly with a hearing aid. In fact, the energy of the ABR impulse signal can actually momentarily saturate the hearing aid circuitry. Together, these issues mean that ABR is not a suitable method for assessing the impact of amplification on speech sounds.

Cortical testing, however, can show the neural response of the patient to speech sounds after they have been amplified by a hearing aid. The primary cortical waveforms arise around 100 to 300 ms after a signal is presented to the patient. Auditory stimulus durations of up to 100ms may be used in cortical testing. This is over an order of magnitude longer than the very brief stimulus durations that are used in an ABR test as the ABR waveform durations are less than 10 milliseconds and the response starts almost immediately upon stimulus onset. This much longer stimulus duration gives even the slowest digital hearing aid plenty of time to process the signal, making it unlikely that the digital processing delay will affect the cortical test results. And unlike ABR, cortical testing can use a variety of test stimuli, including speech-like signals that are easily processed by hearing aids and should not saturate their circuitry.

Aided Cortical Assessment Module

The Aided Cortical Assessment (ACA) module is used to evaluate whether speech tokens produce a CAEP response to the wearer of a hearing aid. This test can be used on both children and adults. Three speech stimuli with low (/m/), medium (/g/), and high (/t/) frequency emphasis are presented to the patient in the free-field at input levels of 55, 65 and 75 dB SPL which are typical of soft, medium and loud conversations respectively. These signals have a presentation time long enough to activate the compression circuits of most hearing aids. Voltages measured on the scalp synchronous with the speech sounds indicate that amplification of these conversational level sounds has been sufficient to activate activity in the auditory cortex. The unaided response of the patient can also be measured, allowing the clinician to compare the unaided and the aided cortical responses.

Cortical Tone Evaluation Module

The Cortical Tone Evaluation (CTE) module provides clinicians with a tool to evaluate the audibility of highly frequency-specific tones in adults who are unable or unwilling to participate in regular pure tone audiometry assessments. Air and bone audiometric test tones are presented to the patient from 500 to 4000 Hz, 0-110 dB HL (air), and 0-70 dB HL (bone). Masking may be applied to the non-test ear as appropriate.

The CTE Module will not replace standard audiometric tests produced by a clinical audiometer, but it will provide a great tool that can be used when the standard testing methods are not possible or practical.



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