A comparison of ABR & Cortical ERA as threshold estimation tests

Since both the auditory brainstem response (ABR) and Cortical ERA (CAEP) can be used for threshold estimation, it is worth briefly highlighting the pros and cons of the two techniques.

ABR responses are generally less variable, more robust and essentially immune from the patient's mental state and can conveniently be recorded in sleep, under general anaesthesia or with the patient physically relaxed. However, the presence of excess myogenic (muscle) activity makes accurate threshold estimation unlikely in awake patients. Cortical ERA tests are much less sensitive to muscle activity but are affected by mental arousal level, making them most suitable for alert adults and passively co-operative older children. ABR tests require short duration stimuli which carry restricted frequency-specific information and makes low frequency tests especially difficult whereas cortical tests can use longer, highly frequency-specific stimuli of any frequency, allowing an audiogram to be constructed, assuming one has the time and inclination to do so.

The following table summarises the main pros & cons of the two tests as implemented on a standard ERA system when testing adults or older children (manual collection, replication & manipulation of data):

Issue	**ABR**	CAEP
Age of patient	All ages	Adults & children >8 years
Requirements of patient	Low muscle activity	Reasonably alert
Patient Conditioning	Lying down, eyes closed, relaxed	Sitting, reading or watching a video
Frequency Specificity	Using clicks: almost none Using tone pips: about 30dB per octave maximum audiogram slope	Almost ideal, capable of resolving audiometric notches
Frequency range	1 - 8 kHz; 500 Hz with difficulty	250 - 8000 Hz
Accuracy of threshold in individuals	Clicks: typically ±10dB Pips: depends on frequency: 10-15dB at 2 - 4 kHz; increasingly worse at lower frequencies	Typically ±10dB Accuracy is poorer in a small (~5%) percentage of cases
Typical test duration (assuming 3-5 levels)	8-10 minutes per threshold	8-12 minutes per threshold
Calibration of Stimuli	ISO 389-6 (2007) but no official bone tone reference values yet	Uses ISO / ANSI audiometric pure tone calibration standards
Equipment Requirements	Standard ERA system Better & quicker with specialised software	Standard ERA system Better & quicker with specialised software

Both techniques require waveform replication at each intensity, creation of grand averages, sorting of waveforms into intensity order, cursor placement, and should ideally include objective waveform scoring (response evaluation). Such software is becoming available for ABR-based tests, driven primarily by the time constraints inherent in the testing of neonates. The "optimized" Cortical ERA test described on this site in an example of similar software, but which has yet to be implemented on a standard ERA platform.

Summary of ABR -v- CAEP comparison

The two techniques are similar in many respects (test time and accuracy of threshold prediction) yet offer different advantages and limitations. ABR can used in neonates and young children; Cortical ERA is highly frequency specific, allows testing down to low frequencies, accesses a greater portion of the auditory pathway and uses the same calibration reference data as used for conventional audiometry. Perhaps the situation is best summarised by Stapells (2002): Cortical ERA is "the (threshold estimation) measure of choice for most older children and adults". "It is unfortunate that especially in the United States, the P1-N1-P2 slow cortical response is underused, having been replaced by the ABR".

Just a very brief note here on the use of Steady-State techniques: the pros & cons appear very similar to those of the ABR but with (possibly) better frequency specificity and better developed objective assessment tools. BSA has produced (2020) guidance on ASSR testing, including the 40Hz ASSR test which is a worthy alternative to CAEP in adults.