

Electrophysiological Thresholds

using SmartEP

What is Hearing Level?

The stimulation provided by all equipment is given in a sound pressure level (SPL) scale; an absolute scale based in true physical measurements. However, normal hearing levels for different populations (including animal subjects) may not be the same across all frequencies; prompting the need for a corrected scale in order to simplify the detection of abnormal hearing subjects. In humans this scale is referred to as HL, where the end of the scale is 0 representing audiometric zero; or normal hearing. Traditionally, this is done by finding behavioral thresholds for the subject and generating a correction table according to the observed behaviors. In cases where the population being tested cannot interactively provide threshold information, such as in mice, it may be necessary to find the normal expected ABR hearing threshold using electrophysiological responses. This procedure follows.

Patient Preparation

The patient must be placed in a quiet and comfortable environment. The patients must be instructed to relax during testing; in the case of lab animals, sedation will be necessary. It is recommended to avoid ingestion of stimulants, such as caffeine, before testing. In humans, electrodes may be placed in the following configuration:

- **Inverting (-) :** Ipsilateral (Testing) Mastoid
- **Non-Inverting (+) :** High Forehead
- **Ground:** Contralateral Mastoid

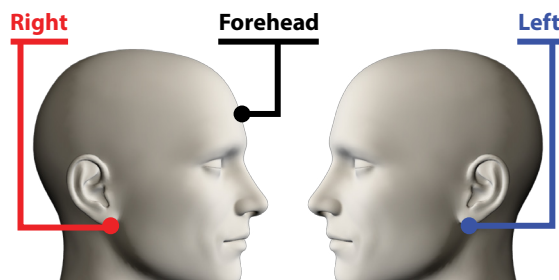


Fig.1 - Suggested electrode placement

Surface electrodes are sufficient for acquiring ABR recordings. Clean and prepare electrode pacing sites in order to reduce the impedance and acquire a clearer recording.

When testing both ears, in a dual channel system, place the corresponding inverting electrodes on the mastoids, place the ground electrode on the lower forehead and place the non-inverting lead, using a Y-adaptor, above the ground electrode. Any other standard electrode placement configurations can be used.

For animal subjects, the electrode configuration may need to be different from the one shown. In this case, the use of sub-dermal needle electrodes is recommended.

Setting up SmartEP

Complete the following steps in the order outlined, use the test setting that best fits your requirements or use the recommended settings shown in the next section:

1. Under **[PROTOCOL > MODALITY]** in the main menu, make sure **[AUDITORY > ABR]** is selected.
2. Click on the **[AMPLIFIER]** button to the right of the main screen and set the filters, notch filter, artifact rejection ratio and region and desired amplification for each channel.
3. On the control panel, set rate, polarity, intensity and the number of sweeps.
4. Set the stimulus, click on **[STIM]** from the control panel and set the stimulus type, duration, frequency, window, masking and transducer, as necessary.
5. Press the **[ACQUIRE]** button to start. Repeat acquisition 2 to 4 times.

SmartEP allows automation of the acquisition process; creating an intensity sweep protocol while keeping the stimulation option as default may help simplify the process. For additional information on how to create a protocol, consult the SmartEP Users Manual.

Make sure to carefully select your filter settings in the EEG and Amplifier dialog box. An unfiltered recording can always be filtered digitally to obtain a smoother waveform; however, hardware filtering cannot be undone.

Recommended Test Settings

The following list shows an example of suggested settings for ABR acquisition; the settings needed for your purposes may vary. Different settings may result in variability. You will need to acquire an intensity sweep for each ear at each of the frequencies contained in the calibration table up to the value you wish to have as your maximum frequency for this particular population.

- **Stimulus:** 0.1 millisecond click; or tone bursts from 125 Hz to 32 kHz.
- **Rate:** 27.1 per second. Slower rates may improve wave I.
- **Polarity:** alternating.
- **Intensity:** 90 dB SPL to 0 dB SPL for threshold search.
- **Filters:** 30 to 3000 Hz as needed. 1500 Hz low pass will yield smoother recordings.
- **Notch Filter:** OFF, turn ON only if power line noise is present.
- **Amplification:** 100K
- **Analysis time window:** 0 to 40 milliseconds for tones of 500 Hz and below, 0 to 25 milliseconds for higher frequency stimuli and clicks.
- **Sweeps:** 1024 or 2048.
- **Electrode montage:** ipsilateral or contralateral array.

Keep in mind that stimulus durations, specially when using tone bursts, may cause lower or higher thresholds. For the most accurate results, the same durations used during this procedure should be used when testing.

Detecting Threshold

Once you finish acquiring, you must find the threshold for each frequency. To mark peaks activate the recording, then right click at the point of the recording where the label is to be placed and select the peak to be marked.

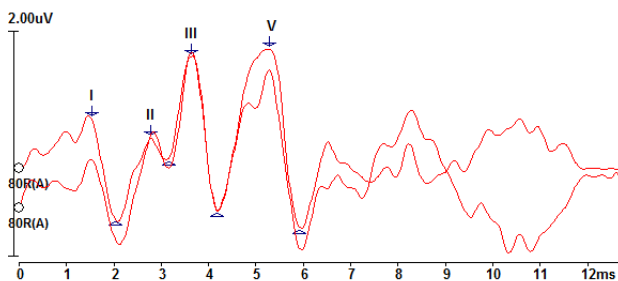


Fig.2 - Sample click ABR

Using the Results

Once all thresholds have been determined for all the ears and at all frequencies, the results must be averaged to find an estimated correction value for the population. For populations where behavioral estimation is not possible, therefore knowledge of existing hearing impairments is not known, it is recommended to discard results which fall too far from observed norm that applies to the rest of the tested population. The following table shows 5 ears tested at 3 different frequencies. Notice that the Left Ear 2 (LE2) has abnormal thresholds at 16 and 18 kHz; therefore they are not taken into consideration in the average. Note that the more ears you test, the more accurate your average values are. Generally, 10 ear pairs should provide sufficient accuracy to establish a good baseline.

FREQ	RE1	LE1	RE2	LE2	RE3	AVG
14kHz	25	25	30	35	30	29
16kHz	35	30	35	60	30	32
18kHz	30	30	30	70	35	31

To use the results in the software:

1. Open the Calibration Utility from the Launchpad program by choosing **[SYSTEM > CALIBRATION]** from the main menu. Enter your name and the system password when prompted; the default password is "ihs".
2. Open the SPL to HL conversion Table by clicking on **[CALIBRATION > EDIT SPL TO HL TABLE]**
3. Select the stimulator you used from the list
4. Enter the average values as your conversion values.
5. Save the table as SEPWIN.S2H if you wish to use the values as your default.

Save the table in a file with a different name if you will be using the system with multiple populations. To use one of these different tables, load them into the Calibration utility and then save them as SEPWIN.S2H for use with the system. In addition, you may create your own Latency-Intensity Norms using the data that you have just acquired; the Latency-Intensity norms table can be accessed thru the Launch Pad by clicking on "Utilities > SmartEP Latency-Intensity Norms."

Remember that for the most accurate results when testing, you should strive to use the same testing parameters and electrode setup as when performing the procedure outlined in this document.