

## What is LLR?

Late Latency Responses, also known as ALR, are components of the auditory evoked potential response. The LLR response is found between 50 and 250 milliseconds from the time of stimulation, after the ABR and MLR. LLRs appear to reflect the response of the auditory cortex. As with ABRs, LLRs can be acquired with the use of pure tone stimulation (tone-bursts). The LLR response is of very low frequency (under 30Hz) and has a common voltage range between three and ten microvolts.

The recordings acquired will contain certain peaks and valleys. In an LLR recording, the peaks are given by a positive potential difference, which are labeled with a P; the valleys are given by negative potential difference, which are labeled with an N. The first peak, **P1**, is commonly found at 50 to 80ms from stimulation. The next peak, **P2**, may be found 150 to 200 ms from stimulation. The first negative voltage, **N1**, is found between 100 and 150 milliseconds. The second negative voltage, **N2**, is commonly found between 180 and 250 milliseconds. LLR responses are most commonly acquired using surface electrodes in Fz-A1-A2 or Fz-A2-A1 configurations for right and left acquisition respectively.

## Why acquire LLR?

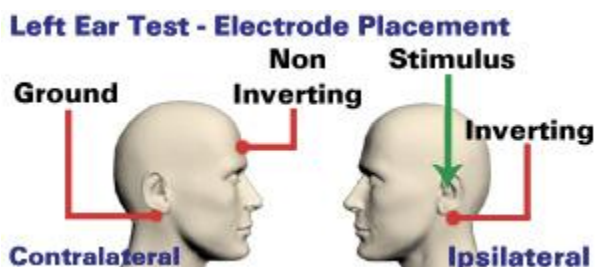
Late Latency Responses may be used to diagnose certain auditory conditions. This type of testing can provide very useful information about hearing loss in a patient.

LLR testing can help determine the amount and type of hearing loss at specific frequencies, (i.e. hearing threshold), in children and adults, depending on the cause of hearing impairment. LLR testing can also provide information about the presence of nervous system abnormalities, particularly referring to levels above the auditory brainstem.

## Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient lies down on a comfortable bed. The patient must be instructed to relax during testing. It is recommended that the patient avoid stimulants, or any kind of drug that may affect the nervous system, before testing. For LLR acquisition, Electrodes may be placed in the following configuration:

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



When testing the Right ear, switch the positions of the inverting and non-inverting electrodes. When testing both ears, in a dual channel system, place one inverting electrodes on each mastoid, a non-inverting on the high forehead (using a Y adapter) and the ground electrode on the low forehead.

## Electrode Usage

Surface electrodes are sufficient for acquiring LLR recordings. Clean and prepare electrode pacing sites in order to reduce the impedance and acquire a clearer recording. You must use pediatric electrodes with infants.

## Acquiring LLRs with SmartEP

LLR acquisition is a built in function of SmartEP. A few clicks of the mouse will allow you to start

# LLR acquisition using SmartEP

LLR acquisition. Complete the following steps to acquire data:

- From the SmartEP main menu, select Stimulus > Modality > Auditory > LLR. This option will apply the necessary settings and scales to start acquisition.
- Click on the **EEG and Amplifier** button from the SmartEP control panel and set the filters, notch filter, desired amplification and artifact rejection ratio and region for each channel, as necessary.
- Click on the **Stim** button on the SmartEP control panel and select the proper stimulus and stimulation options. Click OK to set the stimulus. Save the settings for later use by using the Save button on the Control Panel.
- On the control panel, set the rate, phase, mode and sweeps as needed.
- Click on the Acquire button on the control panel to start acquiring for the selected ear.

Make sure to carefully select your filter settings in the EEG and Amplifier dialog box. Lack of filtering may result in excessive artifact, while excessive filtering may result in waveforms that are too smooth to assess. EEG and Amplifier settings may not need to be adjusted more than once.

## Recommended Test Settings

Use these settings as a guideline for acquisition. It is recommended to run the test 2 to 4 times.

<b>Stimulus</b>	40 milliseconds Tone Burst
<b>Frequent</b>	500 – 8000 Hz, as needed
<b>Rate</b>	1.1/sec
<b>Polarity</b>	Alternating
<b>Transducers</b>	Insert Earphones
<b>Intensity</b>	50dB or Higher
<b>Filters</b>	1-30 Hz
<b>Notch Filter:</b>	OFF
<b>Amplification</b>	50x
<b>Analysis Time</b>	Overall 600 milliseconds
<b>Window</b>	
<b>Sweeps</b>	250

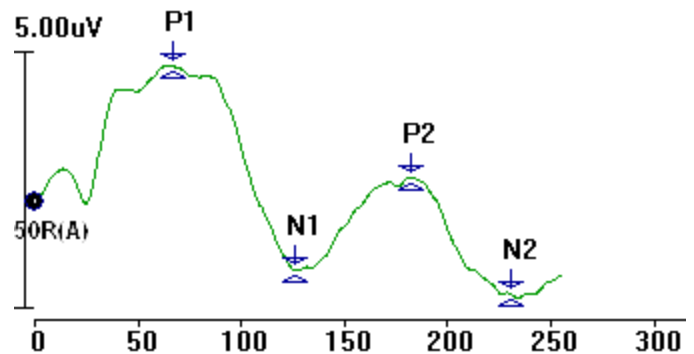
**Electrode Montage**

Ipsilateral or Contralateral Array

## Marking Peaks

To accurately diagnose a condition, you must first place the applicable labels on the recently acquired recording:

- Right click at the point of the recording where the label is to be placed.
- From the popup menu, select the Mark Other Peak option.
- On the dialog box, Select label to be placed (P1, N1, P2 and N2).
- Once placed, drag the top marker of the labels to the appropriate place.
- Move the bottom marker to its appropriate place.



The graph shows suggested label placing for an acquired LLR.

## Analysis

Select **Print Pages** or **Print Page** from the SmartEP main Menu to print a report of the currently displayed signals. See the SmartEP manual for other report generation options.

Since label placement is subjective, all results must be evaluated by an audiologist or medical technician trained in LLR techniques.