

Electroneuronography in SmartEP

using the Universal Smart Box

What are ENoGs?

Electroneuronography testing is performed by stimulating the stylomastoid foramen with electrical stimuli. This procedure will cause a reaction at the nasio-labial fold, which can be recorded with the use of electrodes. The process is used to evaluate and measure the integrity of the facial nerve. By comparing the responses from each side of the face, it is possible to determine the amount of degeneration and the best course of action for treatment. Patients with facial nerve disorders will experience difficulty performing simple actions such as eating, blinking or smiling; some patients will need to take additional steps for eye protection while the problem persists.

An ENoG recording will contain a small peak corresponding to the Masseter muscle, followed by negative peak N1 that usually occurs before 6ms, then positive peak P1 and negative peak N2.

Why use ENoGs?

ENoG testing for normal facial nerve integrity, when combined with the right battery of tests, can provide valuable diagnostic information about the following conditions:

- Bell's Palsy,
- Otitis Media,
- Multiple Sclerosis,
- Facial nerve neuromas,
- Central nervous system disorders,
- Surgically induced injuries,
- Trauma to the temporal bone
- Mastoiditis.

All of these conditions may cause facial nerve palsy, and will cause the ENoG response to reduce significantly in amplitude or to appear unidentifiable in the recording.

Patient Preparation

The patient must be placed in a comfortable environment, where the patient sits upright on a comfortable chair. It is recommended to advise the patient about the stimulation being presented in a sensitive manner.

Keep in mind that the perceived sensitivity of the stimulus by the patient is highly correlated with the location of stimulation and ensuring the correct nerve location on the face is being stimulated.

If you use the probe for direct stimulation then the amount of pressure that is applied from hand holding the stimulator probe to skin by the clinician during the test can also affect what is felt by the patient and the twitching response. The twitching response should be observed to be the same on both sides.

It is very important that before responses are acquired that some time is taken in the setup process to identify location of stimulation and twitching response on both sides. If using the probe tips for stimulation you must make sure to apply conductive gel to the probe tips each and every time you move between sides.

The electrical stimulation delivered to the patient is also affected by skin impedance and facial tissue.

Electrode Setup

Electrodes and stimulators may be placed in the following configuration:

- **Cathode (-):** Behind earlobe.
- **Anode (+):** Ahead of earlobe.
- **Inverting (-) and Non-Inverting:** nasio-labial fold ipsilaterally.
- **Ground:** Forehead.

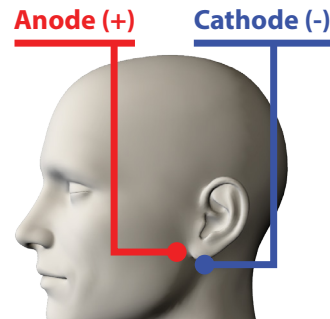


Fig.1 - Suggested stimulating electrode placement

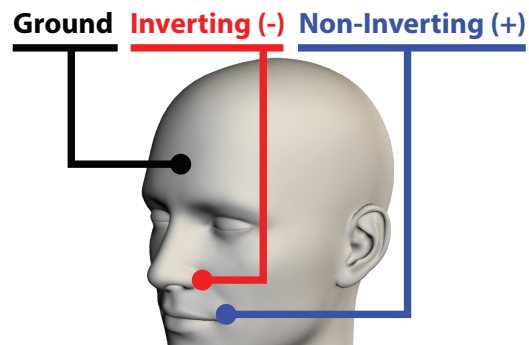


Fig.2 - Suggested recording electrode placement

If the response is 'triphasic' or the mandible starts moving along with the stimulus, then the electrodes will need to be repositioned to

minimize Masseter response. Recording electrodes may also be placed across the top of the ipsilateral eyebrow; also used for intra-operative monitoring.



WARNING: Electricity

When using the somatosensory equipment, The **SUBJECT MUST BE DISCONNECTED FROM THE STIMULATOR WHILE POWERING UP**. Electrical shock may occur. Maintain the Dial on the stimulator to the lowest position when the equipment is not in use.

Recommended Settings

It is recommended to run this test two to four times, using the following settings:

- **Stimulus Duration:** 200 microseconds pulse.
- **Stimulus Amplitude:** 100%
- **Phase:** Positive.
- **Rate:** 1.1 per second
- **Transducers:** Somatosensory stimulator probe with pair of electrodes. If using the stimulator probe prongs directly, conductive gel such as Spectragel must be used on the tips; Stimuli will only be present on the tips while pressing the ON button on the probe.
- **Intensity:** 15 to 25 mA (or enough to produce supramaximal response, additional stimulation will not produce better results)
- **Artifact rejection level:** 100%
- **Artifact rejection region:** Start at 2.5 ms, assuming a 200 us stimulus. Otherwise, set to 0.5 ms after the end of your defined stimulus.
- **Gain:** 5K.
- **Filters:** 1 – 5000 Hz .
- **Notch Filter:** ON.
- **Analysis Time Window:** 0 to 20 milliseconds. A pre stimulus baseline can be added to the view using the **[SET PAGE]** menu options.
- **Scale:** 1000 uV
- **Sweeps:** 1 - 20. If using the stimulator probe prongs, keep in mind that the stimulus will only be present on the tips while pressing the ON button on the probe; otherwise, if the stimulus is not present during any of the sweeps, the results will not be accurate.
- **Electrode Montage:** for the recording electrodes, along the nasolabial fold or near the forehead above the eyebrows, ground to the forehead for the recording electrodes. For the stimulation electrodes at the stylomastoid foramen region with the cathode behind the earlobe.

Setting up SmartEP

Complete the following steps to set up SmartEP for ENoG acquisition:

1. On the SmartEP main menu, select **[PROTOCOL > MODALITY > SOMATOSENSORY > STANDARD]**.
2. Click on the **[AMPLIFIER]** button in the side panel and set the following
 - a. Filters: 1 - 5000 Hz,
 - b. Line filter to ON,
 - c. Artifact rejection level set to 100%
 - d. Artifact rejection region to start 0.5 ms after the end of the stimulus (i.e., 2.5 to 20 ms)
 - e. Set gain to 5k
 - f. Verify the channel designations based on your version of SmartEP.
 - For SmartEP version 5.55 and up, typically channel A will be set to Right and channel B will be set to Left.
 - For SmartEP versions below 5.55, turn OFF channels that will not be used, e.g., when testing the right channel A should be set to Right and channel B should be set to OFF; when testing the left, channel A should be set to OFF and channel B should be set to Left.
3. Click on **[STIMULUS > SELECT STIMULUS]** to edit the stimulus settings. If an eNoG stimulus already exists, you may load it using the **[LOAD]** button; otherwise, you can create one as follows:
 - a. Set the stimulus length to 200 us
 - b. Set the amplitude to 100%
 - c. Set the phase to positive.
 - d. After changing the values, click on **[GENERATE NEW STIMULUS]** to update the stimulus.
 - e. Click **[SAVE]** and name it "ENOG.STM" to keep a copy of it for future use, the reload it.
4. Choose your presentation settings:
 - a. Set **[INTENSITY]** to 25 mA
 - b. Set **[RATE]** to 1.1/s
 - c. Set **[SWEEPS]** anywhere between 1 and 20
 - d. Set **[LIMIT]** to 40 mA, or any value above the Intensity level.
5. Click on **[SET PAGE]** at the right side of the screen and under **[SCALE]** select "Other", enter a value of 1000 uV.
6. Click **[STIM ON]** to activate the stimulator. Note that the stimulus will stop automatically after an acquisition is completed, if you wish to override this behavior, click on **[STIMULUS > STIMULATION OFF AT THE END OF ACQUISITION]** to deactivate this feature.
7. Click **[ACQUIRE]** to start testing.

Carefully select your filter settings in the EEG and Amplifier window. Lack of filtering may result in excessive artifact, excessive filtering may result in waveforms that are too smooth to assess correctly.

EEG and Amplifier settings may need to be adjusted more than once.

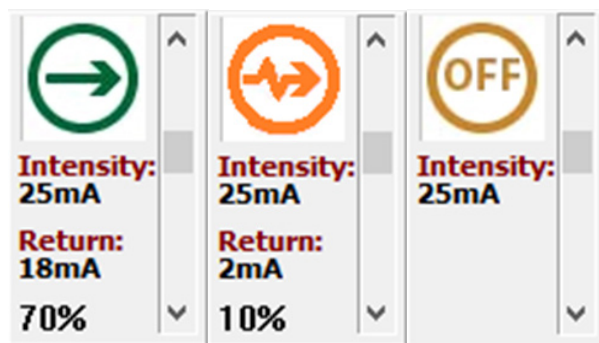
For SmartEP version 5.55 and up, you may save your setup to a single Settings file. In SmartEP versions below 5.55, it is recommended to save your settings as two separate files, one for the Right side and one for the Left side, ENoG-Right.SET and ENoG-Left.SET.

While Acquiring

To ensure proper data acquisition, make sure the **[STIM]** button is set to ON while acquiring (see image below). In addition, if using the metal prongs on the Electrical Stimulator Probe to stimulate, make sure to keep the ON button pressed while sweeps are being acquired.

Intensity: 25mA	Stim: ON
Acquire	Continue

It is important to keep a good current return, and to maintain current return parity between the left and right sides. The current return indicator can be seen to the right side of the screen, under the **[AMPLIFIER]** button. The following images show a good current return, an unsatisfactory current return, and the indicator when the electrical stimulation is OFF



Marking Peaks

For an accurate diagnosis, you may need to place the applicable labels on the recently acquired recording. P1 and N1 may be marked when recognizable follow these steps for each of the labels:

1. Click on the peak label you wish to mark (N1, P1, N2, etc...) from the tool bar, it will turn red when active.
2. Click the location on the waveform where the label should be placed. Alternatively, right click at the location, then select "Mark Peak" from the context menu.
3. Once the peak marker is placed, drag the top marker of the labels to the top of the peak, if needed.
4. To obtain waveform amplitudes, drag the bottom marker P1 to the valley following the peak (location of N2).

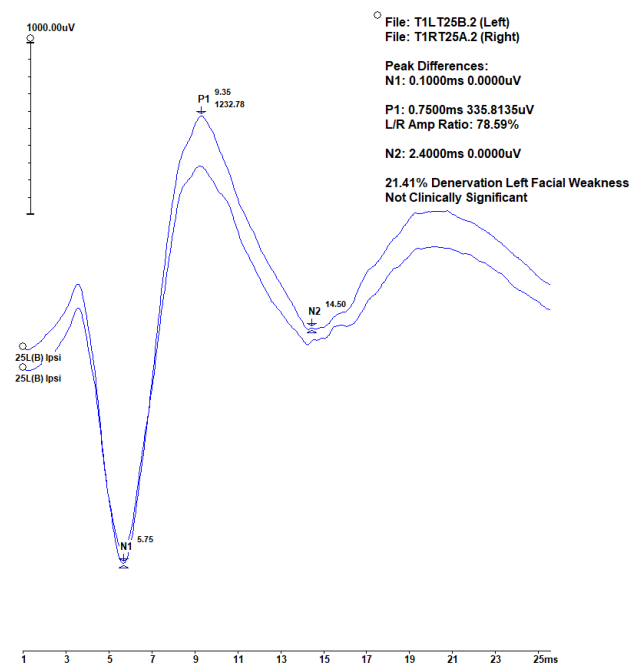


Fig.3 - Suggested label placement

The graph shows suggested label placing for an acquired eNOG. Additional markers are available from the recording right-click menu. Since label placement is subjective, all results must be evaluated by an audiologist or medical professional trained in eNOG techniques.

Comparing Sides

After the peaks on the recordings for the right and left sides are both marked, you may compare the sides by doing the following:

1. Select one waveform by clicking on it.
2. Select the second waveform by holding the **[CTRL]** key on the keyboard, then clicking on it.
3. Open the recording information panel by clicking on **[REC INFO]** on the right hand side of the screen.
4. Open the **[COMP]** tab to view the comparison.
5. To add the comparison results to the page, just click on the **[ADD TO PAGE]** button.
6. To add additional information to the comparison, such as a self-calculated denervation percentage, select the text item, then right click and choose **[EDIT]**. Once editing is complete, click **[OK]** to close.

Printing

Select **[PRINT REPORT]** or **[PRINT PAGE]** from the SmartEP main menu to print a report of the currently displayed waveforms. You may also save page or report to PDF for an electronic version. See the SmartEP manual or the device Instructions for Use manual for additional report generation options.