

P300 and MMN Acquisition

using SmartEP

Why acquire P300/MMN?

P300 and Mismatched Negativity responses may be used to diagnose certain auditory conditions. This type of testing may provide a medical professional with very useful information about neuro-degenerative and neuro-pathological changes, especially in the language and information processing areas of the brain. These techniques are especially helpful to test patients with aphasia, dyslexia, Parkinson's disease, Alzheimer's disease and other attention problems.

What are P300 and MMN?

P300 and Mismatched Negativity Responses are potential differences generated when a patient is stimulated with a stimulus train containing a frequently occurring stimuli and an infrequent deviant stimuli. The potential difference originates in the auditory cortex and can be recorded by averaging the acquired signal over a specified period of time.

An ideal MMN recording will contain a difference between the response to standard stimulus and the response to the deviant stimulus, which can be observed in the 100 to 200 millisecond region.

An ideal P300 recording will contain one large peak at around 300 milliseconds, in response to stimulation. The amplitude of the peak is inversely related to the level of expectation for the odd stimulus, and the latency is related to the ratio of standard to deviant stimuli.

Patient Preparation

The patient must be placed in a comfortable and quiet environment, preferably a sound booth where the patient sits on a comfortable bed or chair.

Since the P300 recordings require conscious attention, the patient must be instructed to remain alert during testing. The patient must also be instructed to count the deviant stimulus and to report that number at the end of the test when performing P300 testing, compelling the patient to keep up the attention level. It may also be helpful to have the patients either lightly tap their foot or their fingers every time they hear the odd

(deviant) stimulus. For P300 it may be helpful to break down the sweeps into multiple acquisitions with periods of rest in between; this will help prevent patient fatigue.

Since the MMN response looks for innate brain discrimination abilities, the patient may relax and close their eyes as their attention is not required. Unlike in P300, the sweeps can all be acquired in a single block since patient attention is not required.

Electrode Placement

- **Right Inverting (-):** right ear mastoid (M2) or ear lobe (A2).
- **Left Inverting (-):** left ear mastoid (M1) or ear lobe (A1).
- **Joint Non-Inverting (+):** High Forehead (Fpz) or vertex (Cz).
- **Ground:** low forehead.

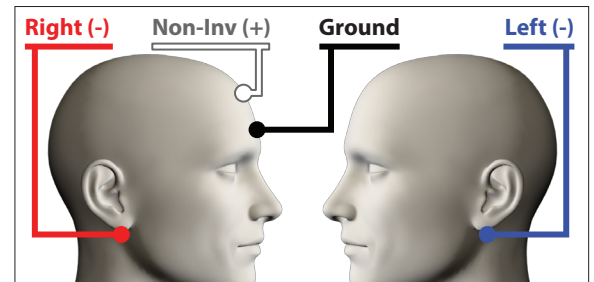


Fig.1 - Suggested placement for Duet

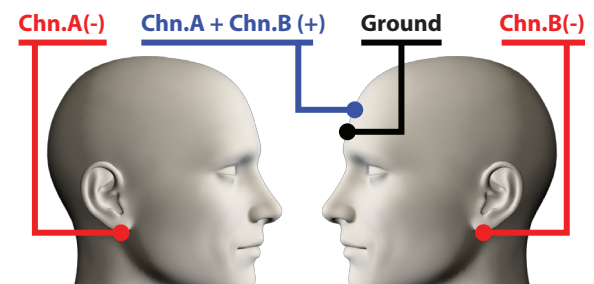


Fig.2 - Suggested placement for USB and USBjr.

When testing using a single channel amplifier, connect the **Red** electrode socket to the Right mastoid, the **Blue** electrode socket to the Left mastoid, and the **Black** electrode socket to the vertex. Remember to flip the amplifier switch to the correct position before starting acquisition.

Keep in mind that using different electrode locations will yield recordings with slightly different wave morphology.

Electrode Usage

Use of gold cup electrodes is recommended when using the Cz non-inverting position. Other wise, surface electrodes are sufficient.

Minimizing Eye Blink Artifacts

Since P300 acquisition requires patient participation, it is better if patients keep their eyes open; however, this may lead to eye blink artifacts. To avoid artifacts, connect an unused acquisition channel placing the electrodes above and below one of the eyes. In this case, the polarity of the electrodes is not important, as the blink will register either way.

Once the electrodes are in place, with the EEG & amplifier window open, look that channel's EEG while the patient blinks repeatedly, then close down the rejection level so that all blinks are rejected.

It is also helpful to ask the patient to fix their vision on a particular location, this usually leads to reductions in the number of blinks.

Setting up SmartEP

The system may be setup with a few clicks of the mouse. Complete the following steps in the order outlined, use the test setting that best fit your requirements or use the recommended settings shown on the next section:

1. Under **[PROTOCOL > MODALITY]** in the main menu, click the appropriate option, P300 or MMN, under **[AUDITORY P300/MMN]**.
2. Set the stimulus, click on **[STIM]** from the control panel and set the stimulus transducer.
3. Click on the **[SETUP P300]** button on the control panel and set the intensity and percent of presentation for the standard and deviant stimuli for either test. Load the stimulus files to be used by clicking on the **[FILE]** button corresponding to each of the buffers being used.
4. Click on the **[AMPLIFIER]** button on the side panel and set the filters, notch filter, artifact rejection ratio and region and desired amplification for each channel.
5. On the control panel, set rate, polarity, intensity and the number of sweeps.
6. Press the **[ACQUIRE]** button to start. Repeat the acquisition with rest periods in between to avoid patient fatigue.

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

You may create your own stimulus files by using the Stimulus Conversion Utility. Refer to the Stimulus Conversion Smart Note for a detailed description of the stimulus conversion and calibration procedure.

Recommended Test Settings

This table shows the recommended settings for P300 and MMN acquisition:

- **Stimulus:** for P300, 1000 Hz in Buffer0 (frequent tone) and 4000 Hz in Buffer1 (deviant tone); use speech files for MMN.
- **% Presentations:** 80% Buffer 0 (frequent), 20% Buffer 1 (deviant).
- **Intensity:** 70 - 90 dB HL, You may also present an intensity disparity between the frequent and deviant stimuli to help patients that are having trouble telling the difference.
- **Rate:** 1.1 per second. (0.3 per second if a longer ISI is needed).
- **Jitter:** None
- **Polarity:** alternating.
- **Transducers:** insert earphones.
- **Filters:** 1 – 30 Hz.
- **Notch Filter:** OFF; ON if there is excessive electrical line noise present.
- **Amplification:** 100k.
- **Analysis Time Window:** 0 to 500 milliseconds; for both MMN and P300.
- **Sweeps:** 25 sweeps in 4 separate acquisition blocks for a total of 100.
- **Montage:** ipsilateral array.

Special Cases

Activating the **Special Two Buffer 50-50 Mode** will result in a 50-50 sequential presentation of two stimuli, where the buffer 1 stimulus always follows the buffer 0 stimulus. If this option is not active, the presentation will be random instead of sequential, where multiple buffer 1 stimuli may occur consecutively.

Activating the **Reject Common After Odd** option will insert an additional Buffer 0 stimulus that will be rejected (not be included in the acquired sweeps). When using it in combination with the special 50-50 mode, the presented buffer sequence will be 0-0-1-0-0-1; if deactivated the 50-50 buffer sequence will be 0-1-0-1.

Creating a grand average

After acquisition, add together all the separate waveforms that correspond to the same stimuli to obtain a grand average. To recognize the source of each waveform, look at the recording identifier at the start of the plot. In parenthesis, the waveforms belonging to the first stimulus will be designated by the channel and buffer; E.g.

(A1) signifies a waveform from channel A using stimulus in buffer 1. To add them:

1. Select the first waveform by clicking on its handle.
2. While holding the **[CTRL]** key on the keyboard, select all other recordings with the same channel and buffer combination.
3. From the SmartEP main menu, click on **[PROCESS > ADD SELECTED RECORDINGS]**.
4. Repeat for all other channel buffer combinations.

After creating the grand average, you may clear the original recordings from the page, or move them to another report page for future reference. Don't forget to save the grand average waveforms, using the options in the Recordings menu, or by saving a Report.

Additional steps for MMN

Once the recordings are acquired, the MMN response is found by obtaining the difference between the waveforms resulting from the deviant and common stimuli. To obtain the resulting response do the following:

1. Select the deviant response waveform, usually buffer 1, by clicking on the recording handle.
2. While holding down the **[CTRL]** key on the keyboard, select the common response waveform by clicking on the recording handle.
3. From the SmartEP main menu, choose **[PROCESS > ADDITION/SUBTRACTION MODE > uV WEIGHTED]**
4. From the same menu, choose **[PROCESS > SUBTRACT TWO SELECTED RECORDINGS]**.

The resulting waveform will show a dip at around 100 to 200 milliseconds. If the result shows a hump instead you may have inadvertently reversed the subtraction operation. To fix, select the resulting waveform and then use the **[PROCESS > INVERT ACTIVE RECORDING]** option from the SmartEP main menu.

Marking Peaks

To help you diagnose a condition accurately, you should first place the applicable labels on the recently acquired recording in one of the following ways. Select the recording and then, either:

- Click on the button corresponding to the label you wish to place from the SmartEP tool bar. The label button will turn red. Click again on the general area where the label is to be placed.
- Right click at the point of the recording where the label is to be placed. From the pop-up

menu, mouse over the **[MARK PEAK]** option.

Then, select label to be placed (P1, N1, P2, N2, P3, N3, MMN).

Once the label is on the waveform, drag the top marker of the labels to the appropriate place if needed. To obtain an amplitude, move the bottom marker to its appropriate location, usually the next peak or valley. You may also use the left and right arrow keys on the keyboard to move the position on the top marker; hold the **[ALT]** key while using the arrows to move the position of the bottom marker.

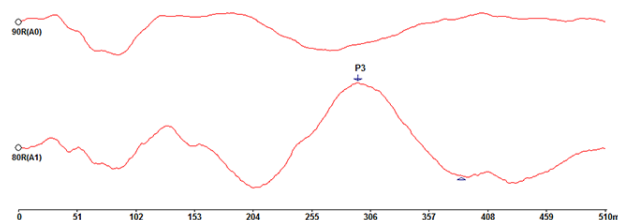


Fig.3 - Sample P300 recording.

The graph above shows the differences between responses to the common stimulus (top), and the deviant stimulus (bottom).

In the case of MMN, the area under the curve will be calculated when the bottom marker is dragged to the end of the valley as shown on Fig.4.

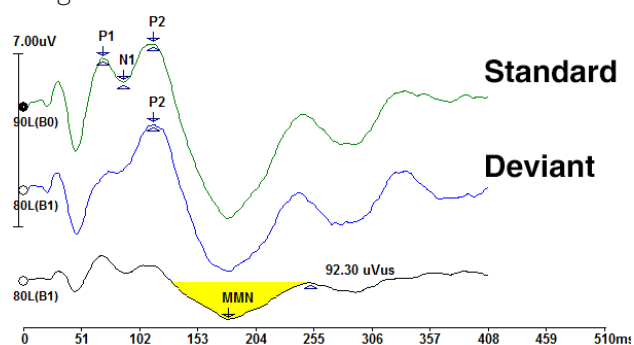


Fig.4 - Sample MMN recording.

The graph above shows suggested label placement for acquired MMN response. Recordings labeled (X0) are for the common buffer and (X1) for the deviant buffer, where X represents the channel from which the recording was acquired. The same nomenclature applies to P300 recordings.

Since label placement is subjective, all results must be evaluated by an audiologist or medical professional trained in P300/MMN techniques.

Printing

Select **[PRINT ALL PAGES]** or **[PRINT PAGE]** from the SmartEP main menu to print a report of the currently displayed signals. Reports can also be printed to PDF using additional options on the main menu.