Event Related Potentials

In this experiment, you will use the same technique as an electroencephalogram (EEG), to record an event related potential (ERP) for visual stimuli with different emotional valences (positive, negative, neutral). These different visual evoked potential waveforms will be compared to determine which one elicits a greater response in the classroom setting.

Written by staff of ADInstruments and modified by Dr. David Nichols.

Background

The visual system is the part of the nervous system that allows us to see. Signals from the eyes pass through the anterior visual pathways, optic chiasm, and posterior visual pathways to the occipital lobe in the cerebral cortex (Figure 1; see also p 214, fig 7.29). The occipital lobe is the part of the brain responsible for processing visual information.

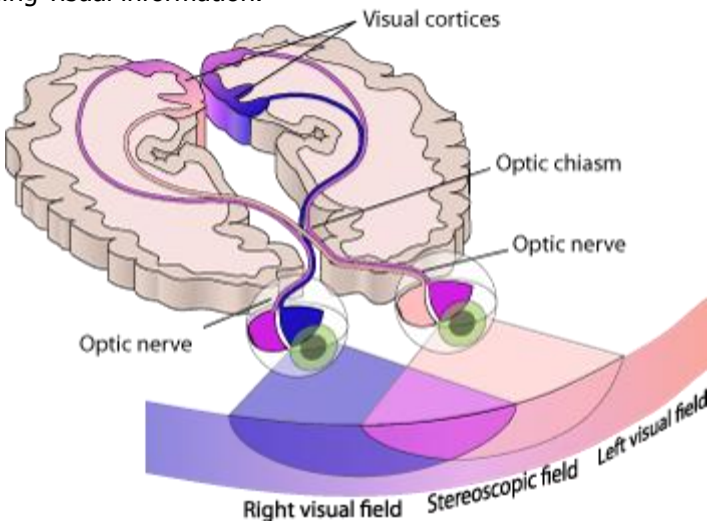


Figure 1. Anatomy of the Visual System

Experimentally, it is possible to examine sensory nervous system behavior by giving repetitive stimuli at fixed time intervals and recording from nerves in the brain itself. Electrical responses of the nervous system that are thus time-locked to a sensory stimulus, an electrical excitation, a movement, or other identifiable events are referred to as "event-related" potentials. The term "evoked potential" is used more specifically to designate the responses of the sensory pathways to sensory or electrical stimuli that are recorded from the central nervous system.

An evoked potential is an electrical potential recorded in response to a stimulus; therefore, it is different from the spontaneous potentials normally recorded in electroencephalograms. The amplitudes of evoked potentials are relatively tiny, sometimes less than a microvolt. In comparison, EEGs are usually tens of microvolts. Because these ongoing physiological signals, as well as noise, are so much greater in amplitude than the evoked potentials, signal averaging needs to be used to extract the evoked potentials from the background. For this reason, reactions to a number of stimulus presentations need to be recorded. As the evoked potential is time-locked to the stimulus, whereas the EEG and noise are not, these and other signals are cancelled out by the averaging, and the evoked potential emerges as averaging progresses, i.e. more trials are included. Most of the electrical activity seen is from the

movement of action potentials down axons; the final tracing is the summed action potentials from many axons which were activated synchronously by the stimulus. The result is a characteristic fluctuation of the potential after the stimulus with negative and positive peaks.

Specific ERPs are expected for particular stimuli. For example, with a checkerboard pattern reversal, you should expect to see peak latencies around 75 ms, 100 ms, and 145 ms for normal patients. These peaks are referred to as N75, P100, and N145, where N refers to a negative peak and P refers to a positive one. This is the most common way to describe peak latencies. P100 is in the normal range if the peak occurs between 90 ms and 117 ms. You may observe different peaks in the current study because of differences in the stimuli used. One possible peak to expect is the P300, which is a positive deflection that normally occurs between 250 and 350 msec after stimulus onset in response to emotional stimuli. However, there are also visual ERPs in the same time range, but centered on a different part of the brain.

The P300 emotional response may be considered a byproduct of ongoing emotional processing across multiple areas in the brain. The Papez Circuit theory of limbic system functioning and interaction of brain areas (Figure 2) labels neocortical responses as the emotional coding that results from activity in the Cingulate cortex. It would only be the activity of the Neocortex on the top of the head that was possibly being picked up in the ERP signal. However, notice in the figure that there is not direct emotional activity in the back of the brain, i.e. the occipital lobe, which is why ERPs in that region would be signaling a different aspect of brain processing of the stimuli, namely visual response.

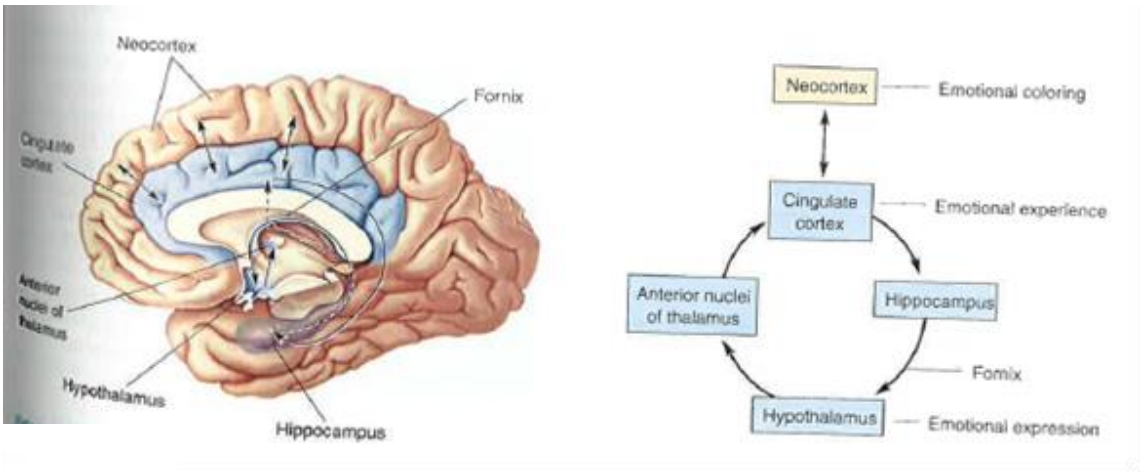


Figure 2. The Papez circuit, from p 569, fig 18.5

Required Equipment

- Cedrus StimTracker Device
- PowerLab Data Acquisition Unit
- 5 Lead Shielded Bio Amp Cable & Shielded Lead Wires
- Pillow and stack of books
- Abrasive Gel, Alcohol Swabs, Gauze Pad, Q-tips
- 2 Elastic bandages

Software Programs

- LabChart – for recording the brain responses and analyzing the data
- Superlab – for presenting the stimuli

⚠ **This experiment requires looking at visual stimuli being turned on and off for a long period of time. Students with epilepsy should not volunteer to participate in this experiment.**

⚠ **The volunteer needs to have normal or corrected-to-normal vision and a healthy visual system. Students taking medications which may affect pupil size should not volunteer for this experiment.**

Procedure

Equipment Setup and Electrode Attachment (caps option – steps

1. Turn on the computer and monitor.

2. Make sure the StimTracker is turned off and the USB is connected to the computer, and the parallel port is connected to the PowerLab. Now turn on the StimTracker (look for the light on the front).

3. Make sure the PowerLab is turned off and the USB cable is connected to the computer. Now turn on the PowerLab (look for the light on the front).

4. Launch LabChart 7 and open the settings file "EEG2_with_comments" from the Lab 10 folder.

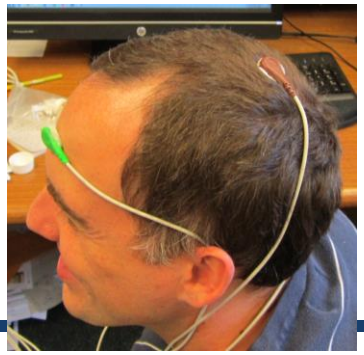
5. Position the LabChart window to be on the external monitor. This will allow the experimenter to view the window without the participant seeing it once it is turned away from the participant (you can wait to turn the monitor until right before you collect the data).

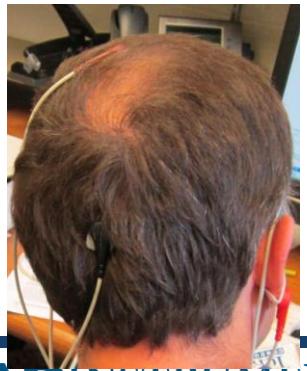
6. Launch SuperLab. Open the file "Emotionality_ERP_File". Ask your instructor if you do not see it in the files list and you are not sure of its location on the computer.

7. Connect the 5 Lead Shielded Bio Amp Cable to the Bio Amp Pod Port on the front panel of the PowerLab.

8. Attach the Shielded Lead Wires to the Bio Amp Cable in Channel 1 and 2 and Earth. For Channel 1, the "positive" (black tip) will lead to the inion on the back of the head (the bump above the neck), i.e. "black on back", the "negative" (white tip) will lead to the forehead, i.e. "white on right", and the Earth will lead to the other side of the forehead. For Channel 2, the "positive" (brown/purple) tip will go on the top of the head in the middle, and the "negative" (red) tip will go on the right earlobe, i.e. "red on right".

   Refer to the figures below for proper placement, but do not attach them to the volunteer yet. Follow the color scheme on the Bio Amp Cable. The earlobe location will use a disposable electrode. Fill the remaining electrode ends with electrode conductive paste.





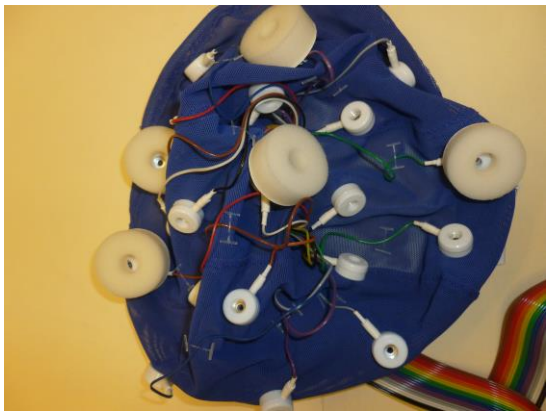
9. Remove any jewelry from the volunteer's head, neck, and ears. Have the volunteer hold their hair out of the way and abrade the skin with Abrasive Gel before sticking the electrodes to the skin. This is necessary to reduce the skin's resistance. After abrasion, clean the area with an alcohol swab to remove the dead skin cells. Let the skin dry and stick the electrodes to the skin or snap them into the disposable electrodes. Position the electrodes on the forehead to allow for wires to wrap over their ears comfortably (so that they can clearly see the stimuli presented on the screen).

10. Immediately wrap the elastic bandages tightly around the volunteer's head and over all the electrodes on the scalp. One will need to go under the chin and then over the head. Make sure the electrodes are pressed firmly against the volunteer's head.

11. Check that all electrodes are properly connected to the volunteer and the Bio Amp Cable before proceeding. Make sure the wire and elastic bandage are not in their line of vision.

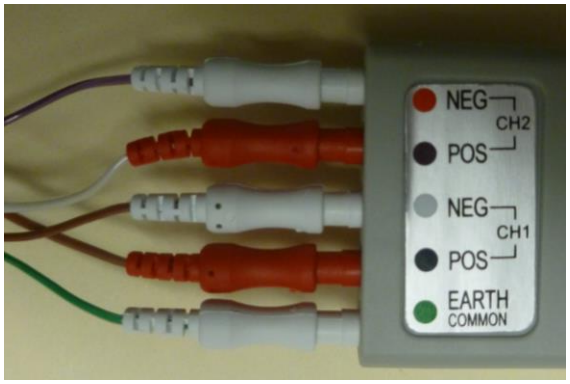
Optional EEG Cap setup:

12. Prepare the electrode caps with the basic initial setup. This includes determining the appropriately sized cap using the measuring tape around the forehead (blue is large, red is medium). Put 5 disposable sponge disks around the inside electrodes at the following locations – 2 in the front with brown wires, the right back (left side of head) with a green wire, the right side (left side of head) with a purple wire, and the middle with a white wire (see Figure to the right).



13. Remove any jewelry from the volunteer's face, ears, and neck. For abrasion and gel filling, you will need to use one of the disposable syringe and needle sets. Put the needle end onto the syringe and get 3-5 ml of gel into the syringe. After putting the cap on the participant and securing it in place with the chest strap, insert the blunt end of the needle and push down with medium pressure while twisting the syringe around in order to abrade the skin, though try not to cause bleeding on the scalp. After abrading the location, use the syringe to insert enough gel in the electrode location to have it start coming out of the top. Wipe excess amounts away with a paper towel.

14. Plug the end of the electrode cap cables into the attachment with individual red and white female connector ends on them. Attach the connectors to it on the sticker side, with white/purple in Ch 2 neg, red/white in Ch 2 pos, white/green in Ch 1 neg (white circle), red/brown in Ch 1 pos (black circle), and white/brown in earth (green circle). (See Figure to the right)



Exercise 1: Event Related Potentials

In this exercise, you will examine event related potentials (ERPs) that are responses to simple visual stimuli shown on the monitor. Keep noise to a minimum as distractions will affect your results.

1. You should still have the settings file "EEG2_with_comments" open in LabChart. If not, re-open it now. Save the data file with the name of the lab and the initials of your group members.

2. Have the volunteer sit in a relaxed position about 2 ft from the laptop monitor. Have the participant sit in front of a table or desk and move the cart up to the other side of the table or desk.

   Use a desk and a stack of books with a pillow on top to keep the participants head at a fixed distance from the screen. Make sure they are comfortable and there are no distractions nearby. Make sure the lighting conditions are the same on each side of the volunteer (i.e. shut the blinds if necessary and turn off the lights). Make sure the reflections are not visible on the computer monitor.

3. Look at the Bioamp settings in the "EEG" channel. Confirm they are: Range=>200μV, low pass=>50 Hz, high pass=>0.5 Hz. Also confirm that the EEG signal is consistently in the range between -50 and 50 μV when the participant keeps their head still and is not blinking. If not, you will need to adjust the electrodes to make better contact with the skin. Also have the participant blink a few times to make sure that sharp negative deflections are clearly seen to ensure proper connection.

4. Have the volunteer fixate on the middle of the laptop screen. Remind them to stay focused on this point at all times; tell them to ***try not to blink except when houses are shown*** (please blink when houses are shown!!!) and to keep their head still whenever stimuli are presented.

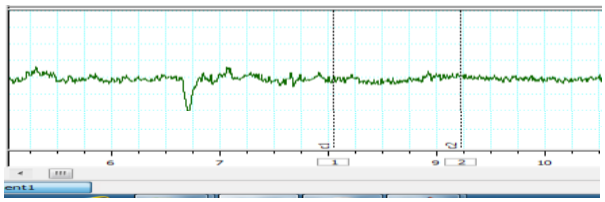
5. Make sure that the "Emotionality_ERP_File" is open in SuperLab. You will be presenting the experimental stimuli in 4 separate blocks to the participant. It is required that you start and stop the recording in LabChart before each presentation. Make sure you do not touch the mouse or cart at all when the stimuli are being shown.

   Turn the external monitor away from the participant and have the other group members sit back away from the participant to avoid distracting them.

6. In order to collect data, you need to get LabChart going first and then start the stimulus presentation in SuperLab. It is extremely important ***not to move the mouse or the cart once you have started showing the stimuli*** or it is quite likely that the SuperLab program will crash and you will have to repeat that part of collecting data.

   When the volunteer is ready, select **Start** in LabChart to begin recording. Now press the **green arrow key** in SuperLab to start the stimulus presentation. Deselect the "save collected data" box. Do not enter a participant name (leave it blank). Hit "run". The stimuli take about 2.5 minutes.

7. Note that comment lines should be appearing in the LabChart window whenever a stimulus is presented on the screen (see example on the right). If this is not happening, stop the recording and notify the instructor. You will need to press **Stop** after the stimuli are finished. Save your data, but do not close the LabChart window.



8. Repeat steps 6 and 7, including **saving the data after each set of stimuli are presented**, 3 more times. You will have presented the stimuli a total of 4 times.

9. Make sure that you have saved the data file. While keeping open the LabChart software, you can shut down the SuperLab software.

10. After all of the data is collected, the participant can remove the electrodes and everyone can help clean the electrode tips using paper towels, q-tips, and alcohol swabs. You can turn off the power for the StimTracker and the PowerLab. Please wait until the end of class to put away all equipment.

Analysis

The Scope window allows you to compare the waveforms easily for the different conditions. You can use this to determine the magnitude of the brain response to the different conditions.

Exercise 1: ERP Viewing and Establishing Exclusion

1. Examine the data in the Scope window (button at top with a green squiggly line). Confirm that the "Mode" is on "comment" using the pull down menu.

2. Open the "comment settings" dialog box. This is where you select how to align the data and specify how much time before and after a comment to examine for the ERP. Make sure it essentially matches Figure 3. **Containing 'c6'** refers to the houses condition (supposed to blink). Use from **0.2 s before the comment to 1.0 s after the comment**. A different range of time may be appropriate for other experiments. **Average 20 pages** because that matches the number of trials per condition that were shown to the participant.

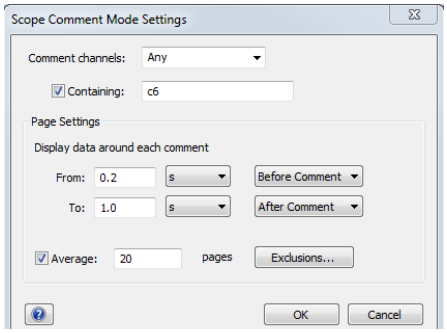


Figure 3. Comment Settings

3. Set the exclusion range by clicking on "Exclusions". Make sure the settings match those in Figure 4. Use the channel as "EEG" because that is where the electrodes on the forehead are that record blinks.

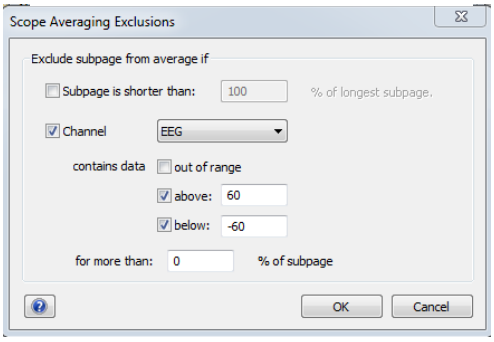
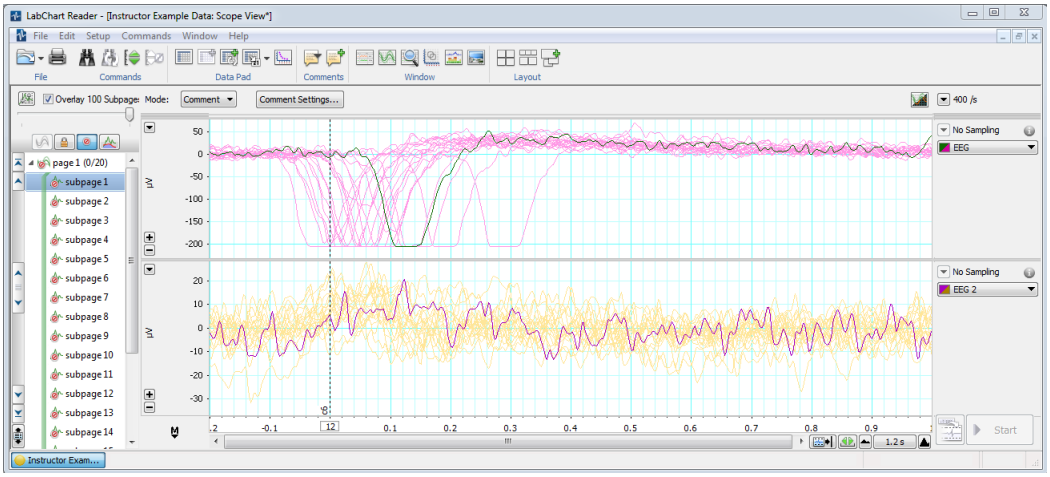


Figure 4. Exclusion Settings

4. Click 'OK' to view the ERPs in scope view.
Click on the 'page 1' arrow on the left to open all of the individual trials and then click 'subpage 1'. You may need to click on auto scale to make them visible, as below. (Double green arrows in the upper left hand corner above Commands.)

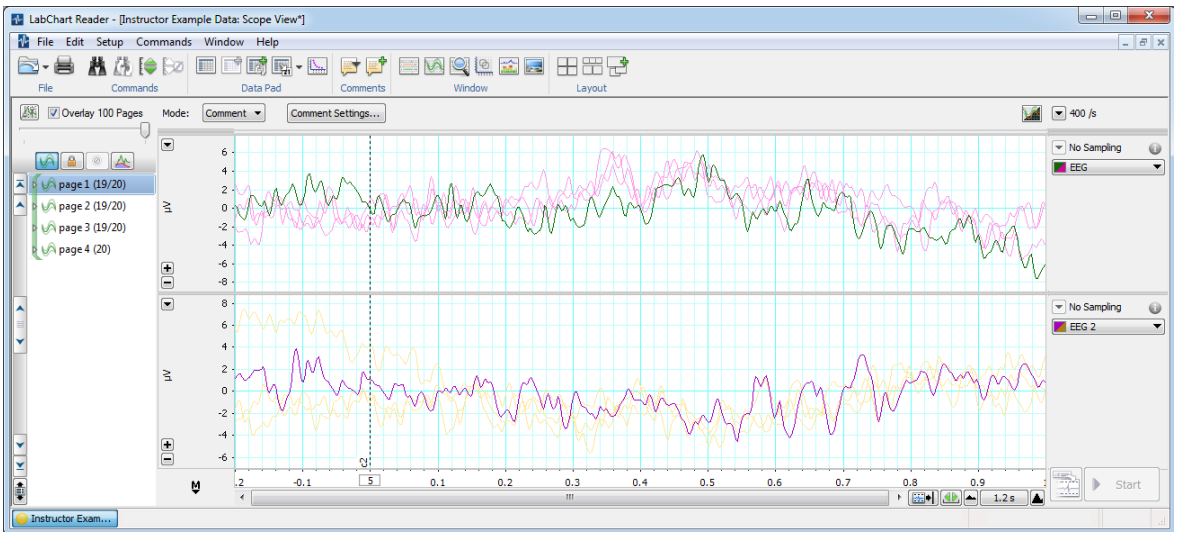


Note here that pretty much every trial ought to be excluded because the task was to blink whenever a house image appeared, but the exact timing of the blink varied from trial to trial.

You can use the up and down arrows to look at individual trials (green on pink in the top, Channel 1 window, and purple on yellow in the bottom, Channel 2 window).

5. Now you will look at the 3 experimental data conditions to determine if there are differences in the ERPs to the different conditions. Reopen the comment settings box and change 'Containing' to c2. Then select 'ok'. You will likely need to autoscale to see all of the data. **Print a PDF of the scope view** (you will repeat this for each of the comment types).

   Make note on your data sheet of how many included trials there are for each of the sets of data (each 'page' is a different set). This is a number stated out of 20. In a moment you will switch to a comment type of 'c3' and then 'c4', which are for the different conditions. For right now, view the voltage fluctuations for individual sets of data to see how the ERPs change. Do this by using the up and down arrows.



Exercise 2: Determining the ERP response in LabChart

You will now be determining the magnitude of the ERP in the P300 range, but scaled in relation to the baseline range in order to put it into context. Note that the dotted line at time 0 is actually inserted about 100 msec before the stimulus is presented because of how the StimTracker hardware and SuperLab program function.

1. Make sure that you have selected Page 1 for the C2 comment condition. Move the cursor back and forth in the top Channel 1 window within the time range of 0 to 0.1 sec and locate the maximum amplitude value (it ought to be a positive number), with the output being shown in µV above the EEG channel title on the right hand side. Mark this under 'baseline' in Table 1.

2. Within the same time range, but this time looking at the bottom Channel 2 window, locate the maximum amplitude value listed above the EEG 2 channel title and mark this in Table 2.

3. Now you will do a similar process but looking in the time range of 0.3 to 0.4 sec to locate the magnitude of the P300, first in Channel 1 (EEG) and then in Channel 2 (EEG 2).

4. Switch to Page 2 by either clicking on it with your mouse or using the down arrow on the keyboard. Repeat steps 1-3.

5. Repeat step 4 for the remaining 2 pages.

6. Repeat steps 1-5 for the 2 remaining comment conditions. In order to do this you will need to switch what comments the program is looking at by altering the Comment Settings (first to c3 and then to c4).

7. Once all of the data has been collected, you can first calculate the contrast for each of the ERPs and then calculate the average across contrasts for each of the comment conditions in each of the channels. Record these values on your data notesheet.

8. The lab is now finished. Please put away the equipment in the storage room.

Please have a wonderful rest of the day.