Introductory Neuroscience & Neuro-Instrumentation
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Lecture 33
Introduction to EEGLab/ERPLab, AEP demo

Hello, hello everyone, so as a part of the Introductory Neuroscience and Neuro-Instrumentation course, I would be explaining how to do the EEG and ERP Lab analysis. So, there is various ERPs present, so for each ERPs how to do the data processing using MATLAB and the plugins like the EEG Lab and ERP Lab is what I will be explaining in this demonstration. So first I will just give an overview of what is these ERPs.

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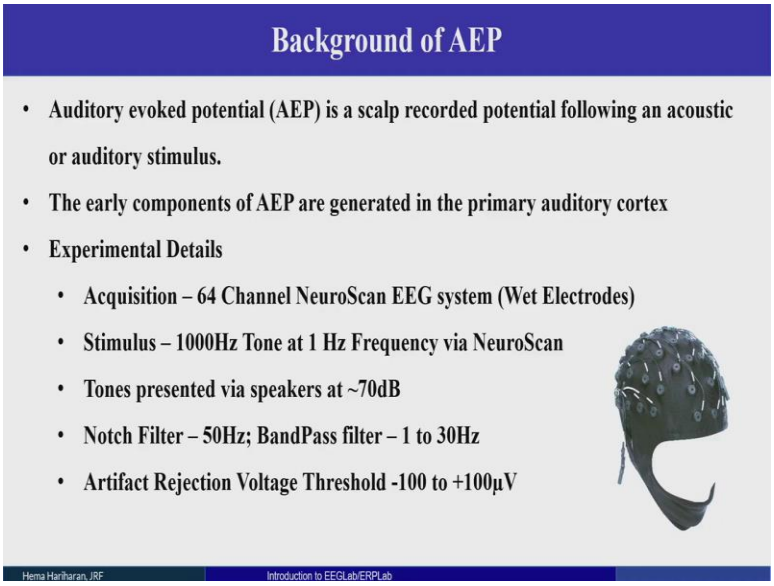

So what are the ERPs? ERPs are nothing but they are the event related potential. So, our brain are having various electrodes, various points are present over the electrodes. So the brain, it stimulates due to an event, there will be a stimulus that has been given to the brain which, based on which the response is been obtained from the scalp. So that is called as the event related potential. So, based on an event we are evoking a potential to be obtained, a biopotential has been obtained from that. That is called as the event related potential.

So what are these kinds of events? It can be any kind of events. It can be a flash of light or it can be a difference in the size of a ball or color, different colors of balls or it can be an auditory stimulus, it can be a tone or it can be clicked. So, these are the different kinds of events that can be presented.

So what is this AEP? AEP is the Auditory Evoked Potential. So, when we are giving a particular auditory stimulus like it can be a tone, 1000 Hertz or 500 Hertz tone, so based on that tone, we will be getting, the scalp records the potential based on the stimulus given. That is called auditory evoked potential.

The brain has various parts like the frontal, occipital, parietal etc. So, here the auditory, the auditory stimulus is first recognized or it is first generated in the auditory cortex which is exactly above the ears over the temporal lobe. So, over there only we will be getting the proper auditory stimulus, the response for their auditory stimulus.

So here we are using an experiment. In this experiment which I have been working, we were using the NeuroScan 64 channel EEG system wherein this, the cap as I have shown over here, this the, here the electrodes have been placed over the head and these electrodes, these points over here, these are the, they are the electrode which creates contact with the scalp of the head and that is how the EEG is been acquired.

So, first, for any step before the data processing, we have to acquire the data which has been obtained from this NeuroScan EEG system and the stimulus is been given through software called system software. So, where we can create whatever kind of stimulus which we want.

For example in this case of auditory evoked potential, we require an auditory stimulus or an audio signal which is 1000 Hertz tone which we have used in a Hertz, in a frequency of 1 Hertz which means for a second there will be one signal that has been, one trigger will be given by the system to the Acquisition NeuroScan system.

So, these triggers are given and the tones which can be, these tones can be presented in whichever manner it can be, through the headphones or by speakers. So, in this experiment we had given the AEP through the speakers and followed by the, in the NeuroScan Acquisition System itself, we can give, we can assign various parameters.

For example, we can give whichever, if we want 64 channel that accordingly that configuration we can give or it can be a 32 channel configuration or even if we want only the frontal electrodes we can give just the 3 electrodes for the forehead, just forehead bands. So, like that we can give the configuration can be given in that manner.

So then, we have various other, like during the acquisition itself while giving the stimulus or by giving, while giving the triggers what happens sometimes, our, we cannot be in a stable position for a long time. So it can, we can change our, there will be a muscle movement or we just blink our eyes or there can be different kinds of artifacts that can be produced during the experiments.

So, those artifacts can be rejected using the, using a voltage threshold from minus 100 to 100 micro Volts because mostly all these blinking of the eyes or any other muscle contraction or the EMG artifacts whatever, whichever artifacts that is been produced, it cannot go more than 1000, 100 micro Volts. It will be in that range only. Because our EEG signal is like it comes in very few micro Volts and over that any artifacts will not go beyond minus 100 to 100 micro Volts.

So, for that reason we keep the voltage rejection volt threshold and reject these, in this range we will reject the signals, and then we can, there will be various other noise artifacts or there is EMG artifacts and all of which can be removed using the filter. So, we can have a notch filter or a bandpass filter and a bandpass filter both together if you use you will get a proper ERP.

Now the whole of this EEG, it is like continuous data, it will take about maybe 2 minutes or 3 minutes of the experiment or it can be even more. For AEP specifically, it will take about 2 minutes at most, so after that, but we want, our interest is just to get a particular time period, just from a few, few milliseconds like the first initially some 500 or 300 milliseconds along that range only we require any ERPs. So, we can just cut down or cut down that particular part of, that particular process where we cut short the time period according to our interest that is called epoching.

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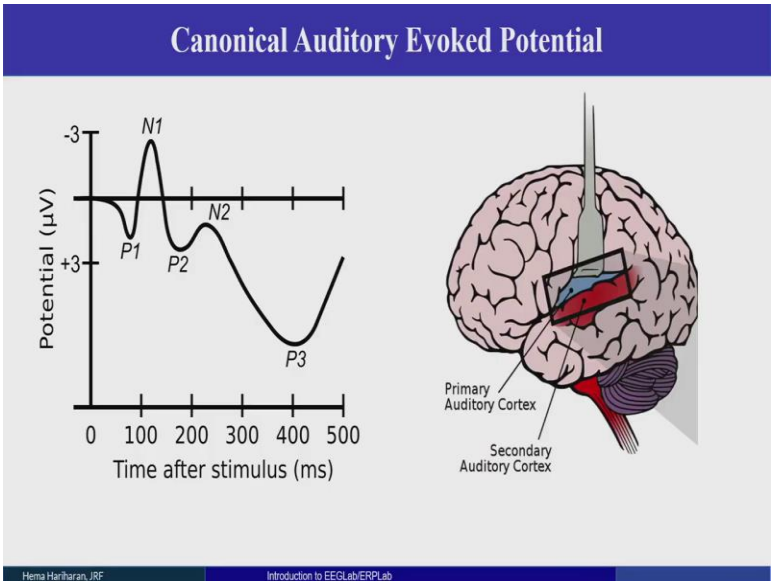

So, I will just give you how does this AEP looks like? So this is the, how the AEP actually looks like. Here this particular, this P1 N1 P2 complex that is the, that will be present in any auditory or visual evoked potential, in all the evoked potential this particular complex, this N1 P1 P2 this complex is called as the late, late complex, so LPC complex we say that as, Late Positive Complex.

So this particular, this particular N1 that is there, that is the most prominent peak that will be obtained in the 100th millisecond of a recording. So this particular, if this is there we can confirm that our auditory, the auditory cortex that is there, it is properly functioning in our brain. So this particular, here this red and blue zone, this blue color area that is called as the primary auditory cortex where the evoked potential will get activate or it will generate, the AEP, the AEPs are generated in that region specifically.

So, after this data acquisition from the NeuroScan, we will get continuous data like as I told you it will be from, it will range from, for about 200 milli, 200 seconds or it can be more than that also. So, that particular we have to further process it using this EEG Lab and the ERP Lab. So, I will just give you a small overview of what is this EEG Lab and this ERP Lab.

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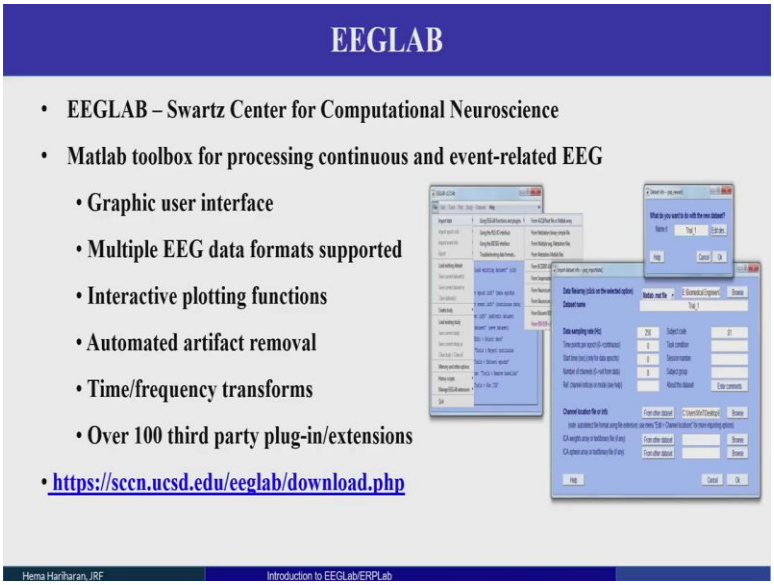

So, this EEG Lab is nothing but, it is a MATLAB toolbox that is given by the Swartz Center of Computational Neuroscience. So these particular, they have given a plugin, plugin to, to just process the EEG and the ERPs. So, EEG Lab is like to import, basically EEG and ERP Lab, there are two different things but they work under the same user interface. So this, this gives, instead of scripting some people will have difficulty in scripting for, at least for one data we can give graphical user interfaced method rather than scripting.

So, using these EEG Lab itself we can have a, we can make the scripts according to the function we do using itself. So, this MATLAB toolbox, helps, it is having these graphical user interface approaches and then we can have various EEG Lab data formats.

Now EEG Acquisition, it can, it need not be just in form of pdf or cnt or various formats are there and this EEG Lab, it is having different plugins also with which we can import all those different kinds of EEG data formats and then we can have various plotting methods and we can have the artifact been removed and then we can have a different time, topographic analysis can be done and various other, various advantages are being there, being user-friendly also, it is being very useful for, it is like a very basic step for EEG analysis.

And then there are various other plugins available like, in order. For example, if you want to do some other preprocessing steps or if you want to do some other artifact rejections or various other formats in which we can import, export the preprocessing steps so like that various other

extension is available which I will show in the, in the demonstrations like how to get all these plugins installed and how to go about this working with this toolbox. So this is just the primary like, for importing alone this particular data toolbox is being used.

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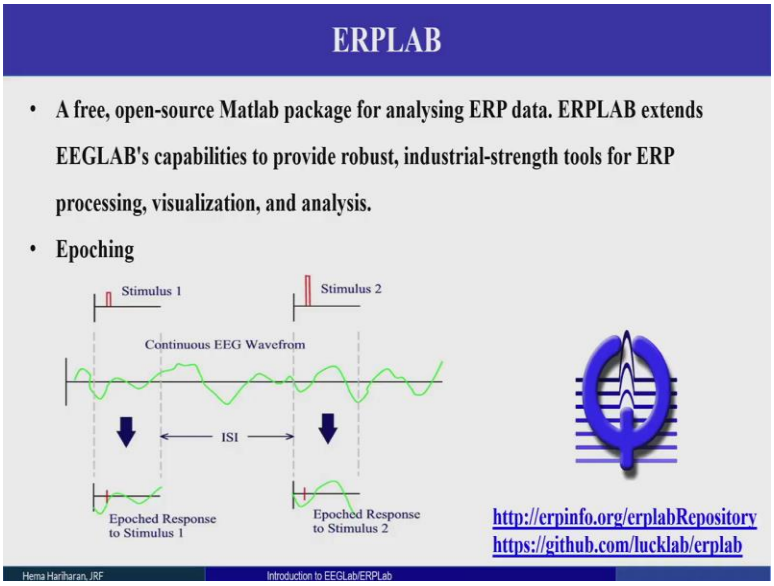

Next, we will have this ERP Lab. This particular ERP Lab, ERP Lab is also a free source MATLAB package itself which helps in analyzing the ERP data. So, the whole of EEG is like a continuous whole data, so here for example, this green color, the green waveform that is being shown over here that is the whole EEG waveform that is being there.

But for this, this red color here, that is called as the stimulus, for that stimulus we want to get how the brain responds. So, at least just a few milli, few seconds or few milliseconds of the data is only required for processing our, for getting the ERPs. So we have, we can do that epoching for a particular time domain alone.

So for example, I just require from minus 50 milliseconds to 200 milliseconds in order to process the EEG, AEP analysis for the auditory evoked potential, we just want that LPC complex to be seen. So, for that reason we just require a maximum of 200 milliseconds or maximum of 300 milliseconds not more than that. So, we will take a small baseline from minus 50, from the trigger we just do not require the EEG or the ERP waveform from the trigger. We just want, just a few microseconds before the trigger starts we wanted the ERPs to be analyzed.

So, that we will get an idea of how the, how the waveform looks prior to the trigger is being given. So, this is this particular step is called as epoching and this is a very basic step for an ERP Lab, ERPs as concerned. So for this, I will again show you how it looks, how to do the various demo, the steps for AEP with this particular EEG Lab and ERP Lab and these sites I have mentioned over here in this place where we can, in these sites we will be obtaining all those EEG and ERP Lab zip files we will get and we can download it and how to import that into out MATLAB that also I will be giving you as a demo.

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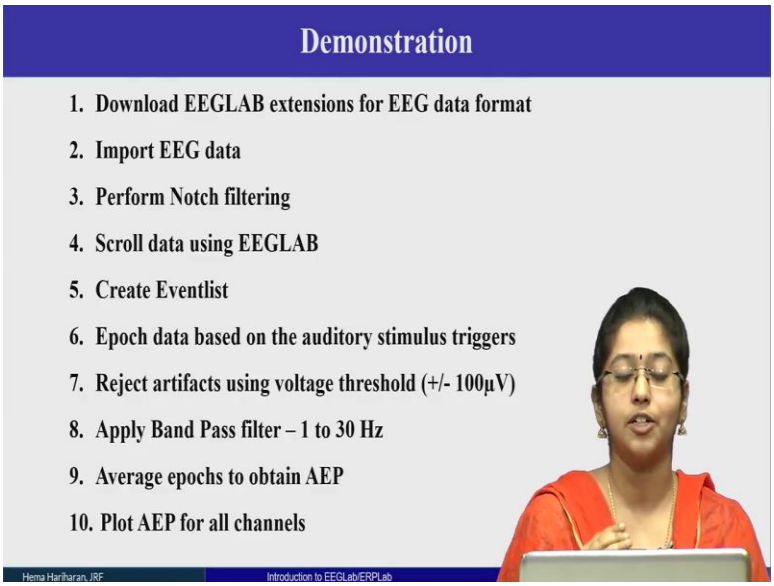

Yeah, so these are the demonstration steps that will be, that I will be covering. So firstly I will, so how to import the data then, how to do the filtering, then how to scroll the data along the, how to see the whole data how it looks and then how to create this Eventlist, the brain as such you find that these triggers, it is given from the NeuroScan system. But then what happens is we wanted, we want just, we cannot just take the triggers as such, we have to assign a different name for that. So how to do that and all is the next step.

So how to epoch the data, like as I said we wanted to be in this particular time frame. So, in that how to take that epoching and how do we reject all the artifacts. As I told you there will be various artifacts of blinking or muscles congestion or when we move ahead or we cannot be still for a while taking data or while acquiring data how, we cannot, we cannot, just for 2 minutes we cannot be steady like that.

So, there will be movement in our head or there will be some muscle movement, eye blinks or anything, so that can be rejected using these artifact rejections in EEG Lab and ERP Lab, and then we have other filterings like bandpass filter. So, this is the sequential order in which we have to do any of the EEG or ERP analysis and then finally we can obtain the data.

And another important thing about these ERPs is that almost always all the ERP, all the evoked potentials it will be in the form of a negative up like always as I have shown in the figure, there will be always, it should be, it will be always in the negative up manner. It will not be, most, some P300 for example, those and all will be in a positive, positive up we can obtain in the positive up manner, but otherwise, almost every other, all potentials will be negative up only. So I will just start up with the demonstration of how it looks in the actual live processing how do we do it. I will just go through that.

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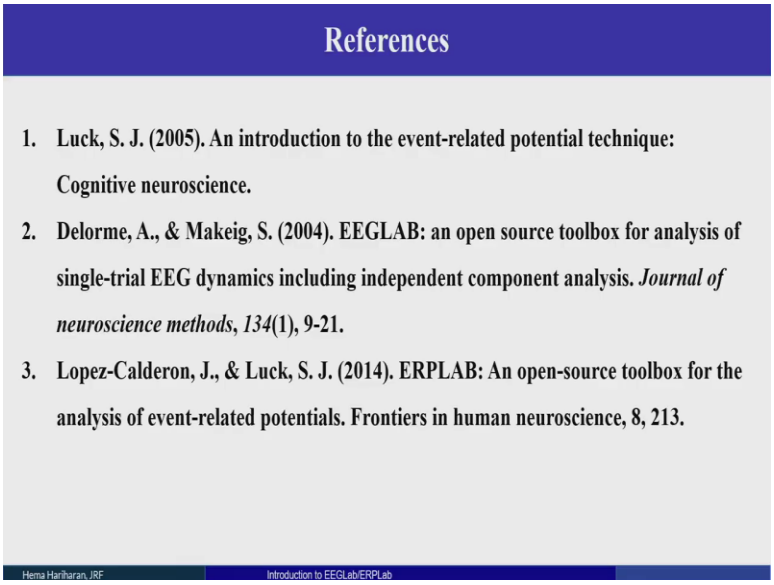

So these are the different references that can be useful for this particular presentation. Like we have the different ERPs and how is its characteristics and how does it look and how it has been started working, how they started working, everything has been explained in this paper, in the first paper and the next two are the, just a base paper about the EEG Lab and the ERP Lab, how the software came into the picture and how they have done all the steps regarding it. So, that has been given in these two papers.

So, the next I will be giving you a short, short demonstration of how to do the AEP analysis and then followed by, I will give the other next, like this AEP some other various ERPs are there, like the P300, MMN VEPs, so along with that I will give their presentations and followed by its demonstrations as well. So, thank you and I will start with the demonstration now.