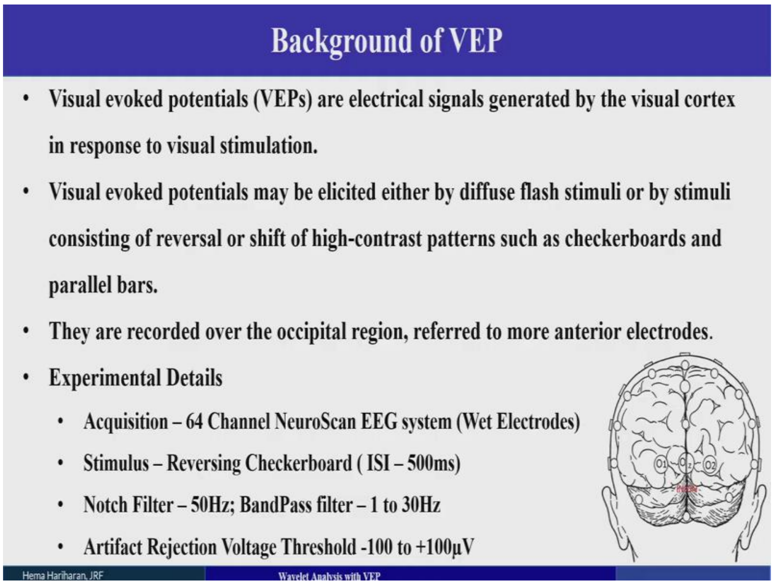
Introductory Neuroscience and Neuro-Instrumentation
Professor Hema Hariharan
Indian Institute of Science, Bengaluru
Lecture 44
Wavelet Analysis with VEP (1)

Hello everyone. So, as a part of this Introductory Neuroscience and Neuro-Instrumentation course, I will be next giving a short update about the wavelet analysis along with the VEPs. So, what is this wavelet analysis about and what are the VEPs, a small background I will be covering in these particular slides, in this presentation. Followed by how to do the analysis and the wavelet analysis and everything.

(Refer Slide Time: 0:52)



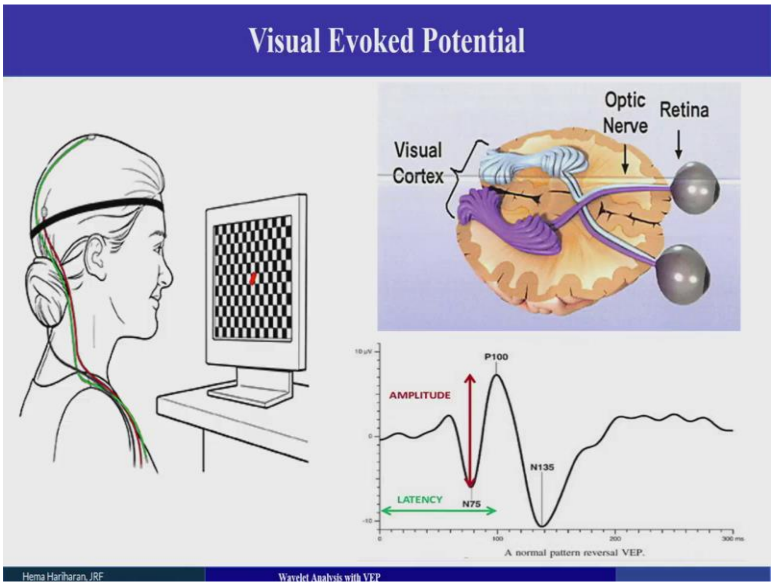
So, firstly I will just you a background about what is this VEP. VEP is nothing but the visual evoke potential. So, we had the as I told you what is an ERP, EPR is a event-related potential with a particular event how the brain is going to respond to that particular event is what is called as this event-related potential. So, here in this visual evoke potential obviously, there will be some visual stimulus. For example, in that P300 as I mentioned before, there was P300 for them the 4 centimeter ball or 6 centimetre ball was been used.

In case of where there were visual evoke potential, we will be flashing light or it can be either reversing checkerboard or some visual potential is been given. So, how the brain perceives this visual? It is in the visual cortex and the visual cortex is mainly present in the occipital region of the brain. Occipital that is in the O1OZ, O1O2 in that particular place it will be present. So, here the visual potentials it will give you, it is same like the auditory evoke potential only, it will be like having the N1 P1 P2 complex everything.

So, here the experiment it is reversing checkerboard, the stimulus is given and it is in the frequency of about 2 hertz like for which means for every 500 millisecond, there will be a reversing of the checkerboard happening over here. Similar to the other, here also we have obtained acquired the data using the 64 channel neural scan system. So, here we have to give the stimulus accordingly, the reversing checkerboard is being given. And the artifact rejection, all the filters, the notch filter, the bandpass filter everything is been performed in this case.

So, basically, when there is that, when there is a high contract patterns is being observed, the brain it will respond to that particular as a visual as a response to that visual stimulus in the visual cortex region of the brain.

(Refer Slide Time: 3:20)

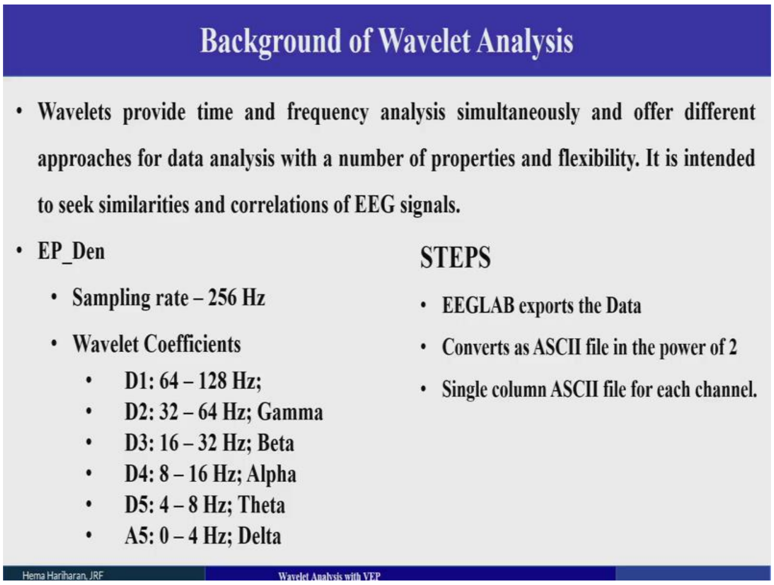


So, how does it look like is, this is how the experiment is being done. Here the reversing checkerboard is being presented over here and the subject is made to sit in such a manner that they are in the angle is been kept to a constant and the line of sight and all should be properly measured and everything. And then we will be, the experiment is being recorded. So, what happens over here is, the retina, from the retina through the optical nerves, the signal is being given to the visual cortex that is present in the behind, exactly behind the brain. So, it is like above the thalamus or above the cerebrum like that. So, it is at the back.

And the visual, the visual potential, it is obtained, the visual evoked potential that is obtained is in this fashion. Like always in any of the ERPs the amplitude and the latency, these two are the parameters that we have to check in everything. So, for example in MMN also we check this P1 N1 P2 response that is the one which we check. Similarly, in for the P300 means we will check that at that 300 millisecond in that or a more than that, we will be getting the response. For MMN means it should be in that latency range from minus 50, sorry 150 to 300 millisecond.

So, for any ERPs any ERP analysis this amplitude and latency is the one which we have to check in details. So, that is the one which we have to focus on in any of the ERPs. Next, I will just give you how this, what is this wavelet about and how does that change the wavelet, I mean the EEG analysis.

(Refer Slide Time: 5:11)



So, this wavelets and all they are they actually give a time and frequency analysis. So, frequency analysis of the EEG. Now EEG is having a huge dataset and there will be a lot of waveforms that is being obtained. So, we cannot doing, there are various methods wherein we can do the analysis of the EEG, but using the Fourier transform or it can be short-time Fourier transform or like that there are various methods and all are there for doing the wavelet, the EEG analysis.

But what happens is that in those type of channels, for those analysis like the FFTs of the STFTs and everything, what happens is there will be a loss of data or sometime there will be, it does not, it should simultaneously it has to measure or it has to work on time as well as the frequency domain of the EEG analysis. That is not been done in other options or either what happens is there will be a loss of data or sometimes the even this time, for time-domain analysis is been done, the frequency would not be done.

If the frequency analysis being done, that time the analysis would not be done. So, vice versa it should be completely, simultaneously it has to be done. So, only wavelet analysis that particular option is possible wherein, we can do the analysis simultaneously and the correlation studies and everything can be done together. So, what is wavelet is all about? Wavelets are nothing but the whole of this our EEG data we have to decompose it into small wavelet packages.

So, first of all based on this, this particular step it always takes place based on the sampling rate alone. So, with the sampling rate only we can do the wavelet analysis properly. Based on that only the different wavelet coefficients are being created. So, here in this analysis we have in we have been working with the wavelet analysis that is being done by Quiroga. This Quiroga's paper they have made a software or there is something called as the EP_Den software which is being given in the University of Leicester.

So, in that in that particular, if you just put EP_Den wavelet denoising Quiroga, if you put in this way you will get in Google we can get over their page and how to download and everything. So it is like there is a they have their Matlab code itself. So, it just we have to run it and we have to give the data according to that. So, another one important thing about this wavelet is that it always takes the sample number or sampling rate or anything in the powers of 2 that is one of the most important thing.

Because that is like a standard, it should have always, always this sample size it should be in the powers of 2 alone. So, the sampling rate over here which we take, it is 256 hertz that is the normal, that is like they have used for their tutorial purposes their analysis they have took 256. So, according to our data, according to our this thing, our CNT files, we can give this particular sampling rate according to that.

So, for example, now in all this neuro scan data file, the sampling rate is being taken as 1000 hertz. So, what we do is that we actually will resample those data in 1024 which is again the power of 2. So, that is the important step we have to consider. Now in case of you know BO or the open BSI datas and all, they take a sampling rate of 500 hertz. So, in that case we have to do a closest 2 to the power powers of 2 means that will be 512. So, we have to do the resampling in that 512 range.

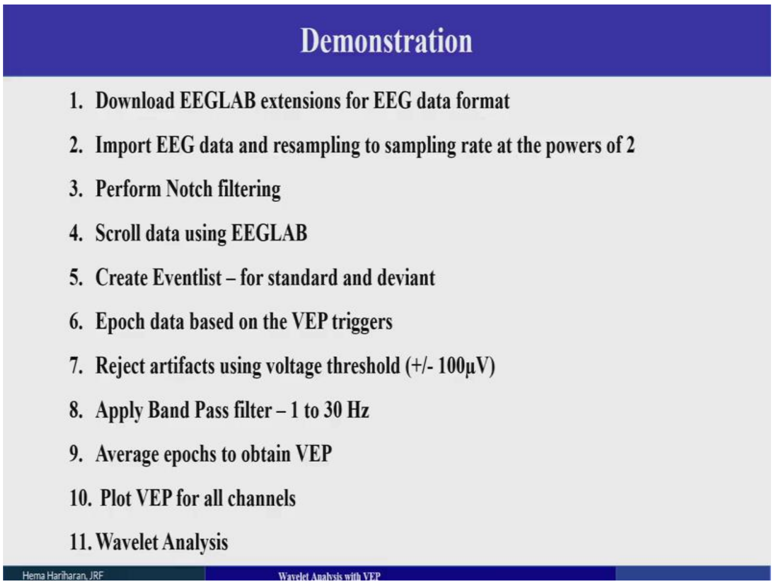
So, based on this sampling rate the wavelet coefficients will be decomposed. So, basically what we are doing is that the whole dataset first we do the whole dataset is first run by this data wavelet coefficients. Then we reconstruct the data and they we get the wavelet analysed after denoising with various algorithms and all. So, in this particular Quiroga paper, they have mentioned that, where they have used something called as the B spline orthogonal, they have used that particular wavelet.

So, that is the that is like that is somewhat similar to how the ERPs look. So, that is why that particular orthogonal B splines are being used. These wavelet coefficients they will be divided or they will be as I told you they will reconstruct I said, so first we have to, they will first reduce it in this DI, D2, D3, D4, D5 so in this ranges the gamma, beta, alpha, theta, delta in this ranges it will be in this particular range it will first get reduced and then from here it is being reconstructed as the next for the next wavelet for the analysis.

So, first what happens is after doing this EEG analysis and everything, the data is then exported. We will I was showing how we export the data. So, after the exporting the data we have to convert those datas in the forms of in the, we have to convert into ASCII files and that too it should be all those sample data also it should be in the powers of 2 I will just go through the wavelet, the wavelet analysis, the software the code and I will show you where the difference and all has to be made.

And a single column mean ASCII file has to be made. So, this these are the 3 additional steps that has to be done apart from the EEG analysis, ERP analysis. So, I will just do this extra step to show how to do the wavelet analysis and how, where the changes and all to be done in the code.

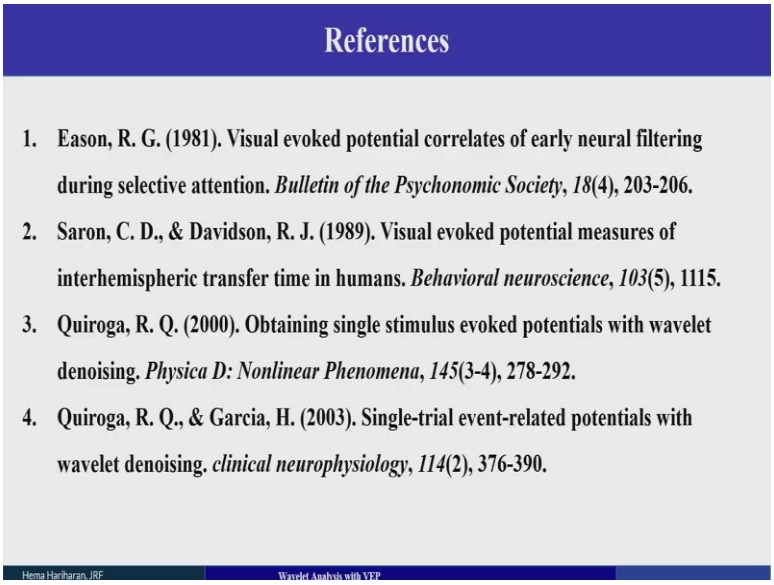
(Refer Slide Time: 11:53)



So, this is just a sequential step of what is the demonstration, what I am going to do. So, as similarly we first do the, since we are working on the VEP data, first we will do the VEP analysis and we have to do, here one important step we have to do is the resampling we have to do because we want to get a the samples, the export the samples in the powers of 2, so for that purpose we have to do the wavelet, so this resampling has to being done.

And then followed by this similar thing, epoching, the creating the event list, then the VEP triggers, then all those VEP analysis everything has to be done and finally we do the wavelet analysis using the software. So, this is how we do the, this is the just demonstration steps that I am going to do. Next I will be showing how to do the thing.

(Refer Slide Time: 12:45)



Before that, just these are the 2 Quiroga papers I have mentioned about the wavelet analysis they have being doing. So, in their website also there will be various tutorials and everything that shows how the, how it looks when the data things happens and the wavelet analysis important thing is that we can also help, it also helps us to understand how the how our brain is getting used to the stimulus.

Now for experience, one experiment it takes for about to 15 to 20 minutes means for initially for some time our brain will be a bit, it will get used to, I mean it will be like first initially we will be concentrating on the triggers or the stimulus everything, but later on we will be getting, our brain will get used to that. So that habituation it will take place in our brain itself. So, that also can be analysed using the wavelet analysis, how the habituation is taking place as the time proceeds in the experiment.

So, based on that we can also tell, this is how the brain should look, the I mean this is, this so much time is required for our for obtaining the P300 analysis or AEP analysis or VEP analysis that we can, that time, the time required for the thing can be understood. And this is, the first two papers are just some VEP related papers wherein they have used the VEPs how and all that is being, when they have started working on it and how it was being developed and everything has been shown in those two papers. Next I will be working, I will show you the demonstration. Thank you.