Introductory Neuroscience & Neuro-Instrumentation
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Lecture 62
Basics on EEGs, ERPs and its Acquisition

Hello everyone. So, as a part of the Introductory Neuroscience and the Neuro-Instrumentation course, I will be giving a small, basic an overview about what are this EEG's, ERP's and how is being acquired and other requirements for doing an EEG recording and everything.

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So, first of all, what is an EEG, it is it is called as an Electroencephalography. So, what happens is when our brain we have different parts of where there are various lobes that are there, so for they will show a different electrical activity in our brain. So, how do we acquire the process of acquiring that electrical activity is called as this EEG. So, it can be there are various methods for acquiring this EEG there are like this we using our invasive method or non-invasive method is also there.

So, here there are the there will be a lot of voltage fluctuation. So, in our brain there is a lot of electrons that a electrons and the basically the ionic moments that is taking place in our brain due to the sodium and the potassium pump. So, based on that there will be an ionic current that will be produced and that will produce a voltage fluctuations that is been detected from the electrodes from the scalp of the head.

So, before this measurements the EEG measurements we find that it can be bipolar as well as it can be unipolar also. So, in bipolar measurements or in that method, what happens is the potential difference we measure is between the pair of electrodes, whereas, in the unipolar polar method of EEG measurements, we will be finding or we will be measuring the electrode potential compared between the reference.

So, any of the EEG recording to be specific, they will be having an active electrode a ground and a reference. So, because, there will be because there is a potential difference which we have to be which we have to calculate that requires a grounds so that there will be no it will not affect our body like with an electric current or there will be otherwise there will be some mishap happening.

So, for that purpose there will be a ground given as well as there will be a reference as well as active electrode. So, based on those electrodes only based on the comparison or the difference potential difference between those electrodes, we are measuring the EEG electro the channels. So, what happens is there an a EEG channels that may not be just a single or a bipolar there will be just one electrode or two electrodes nothing like that, it can have even 8 electrode channels or 8 channels or 64 channel recordings which will be placed along the all over the scalp.

So, why we are doing all this EEG recording is that we have to study how the brain is actually acting based on a stimulus. Now, a brain if you say it is having all the there are various functions it is doing in the motor function motor functions as sensory functions and there is cognition. So, there are various parts of the brain which was activated. So, for motor as well as the sensory the touch or any of the work that we do the daily work that we do the walking or the daily activities that is due to the motor cortex or the motor response of the brain.

Whereas, there are some other activities which is taking place in the cognition of the brain also that is done by with a particular events. So, whenever there is as for that is the cognitive brain which we find out is due to the ERP's that is how we give a particular event like a flash of light or a sound or tone or clicks anything any of the auditory or the visual stimuli which we give externally and in order to according to that how the brain is going to respond to the stimulus is what we do in a ERP study.

So, person who is having a problem like if a person is having Parkinson disease, so he will have a lot of tremors and there will be a lot so we can find out with this particular so many artefact or based on those how the brain responds we can find how the person is what is the abnormality that a person is having in the in with a cognition.

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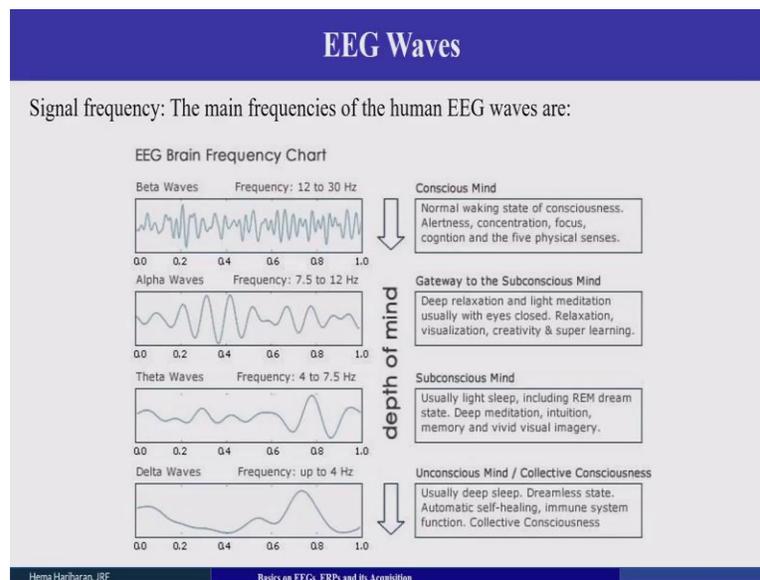
So, there are various kinds of EEG waves that are there. So, we have as mentioned as Doctor Mahesh mentioned about the various bands. So, we have this beta, alpha, gamma, theta and all. So, the beta bands are actually the maximum which is having of 12 to 30 hertz of frequency. So, it is a conscious mind the person in the conscious mind will have that particular waves. The alpha band it will be in the subconscious memory in the mind like when you close your eyes or when you are relaxing or when you have a light meditation.

So, this kind of waves will be opening just if you close your eyes itself this particular alpha waves will be obtained it was in the frequency range of 7.5 to 12 hertz and the theta waves you find that they are actually even more subconscious like in a light sleep as you go deeper and deeper the waves and all it gets lesser and lesser.

So, in the subconscious mind again when you are in a deep meditation or if you are in a very light sleep for just closing eyes, we have the alpha if you have a light sleep then you will have this theta waves. So, it is in a frequency range of about 4 to 7.5 hertz followed by there is a delta wave which is due to the unconscious mind where you find that we will be in a very deep sleep.

So, in that conditions we will have the delta waves which is up to 4 hertz. So, these are the different kinds of EEG waves that are present in humans based on the different frequencies.

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Variables used in the classification of EEG activity

1. **Frequency** refers to rhythmic repetitive activity (in Hz). Voltage refers to the average voltage or peak voltage of EEG activity. Values are dependent, in part, on the recording technique.

2. **Periodicity** refers to the distribution of EEG patterns or components in time .The activity may be generalized, focal or lateralized.

3. **Synchrony** refers to the simultaneous appearance of rhythmic or morphologically distinct patterns over different regions of the head, either on the same side (unilateral) or both sides (bilateral).

4. **Morphology** refers to the shape of the waveform. The shape of a wave or an EEG pattern is determined by the frequencies that combine to make up the waveform and by their phase and voltage relationships.

5. **Impedance -** A measure of the impediment to the flow of alternating current, measured in Ω at a given frequency. Larger numbers mean higher resistance to current flow. The higher the impedance of the electrode, the smaller the amplitude of the EEG signal. In EEG studies, should be at less $2k\Omega$ or less and no more than 5 $k\Omega$.

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The next is there these are few of the variables which we can be used to classify the EEG activity. So, based on the frequency we have various frequency it actually refers to this rhythmic repetitive activity of the EEG like there will be a repetition sometimes taking place so, it can be rhythmic or it can be arrhythmic also.

So, in the rhythmic activity what happens is there will be a constantly the changing constant frequency that will be changing the EEG activity in arrhythmic what happens is there will be no stable rhythms will be present. So, it will be like all scattered kind of. So, that is the frequency there based on frequency that is how we can classify the EEG activity.

So, here in this the voltage it refers as to the average voltage or the peak voltage of the EEG activity. The next we have is actually the periodicity. So, in periodicity what happens is there will be it refer it actually refers to the distribution of the EEG patterns or the components with time.

So, the activity it can be either a particular focal or it can be lateralized. So, that is about the periodicity then we then comes the synchrony. In synchrony, it is actually the simultaneous appearance of this rhythmic as well as the morphologically distinct patterns over different regions of the head either on the same side or both sides.

So, it can be either in one side of the brain or in both sides, we have this synchrony. For example, now, in case of in my previous recordings in the tutorials, I had mentioned that as you move from here from the front to the onion side what happens is there will be a dipole reversal that is taking place.

So, that is called that is the synchronisation like that is because of the dipole that is there in the brain. So, here if it is one side, the other side the in the back, it will be the opposite. So, that is the synchrony that is taking place between the two places. So, that is a simultaneous appearance itself, but it will be in a reversal patterns.

Next is actually about the morphology. So, morphology it refers to the shape of the waveform. So, here the shape of the wave or EEG pattern it is determined by the frequencies that combined to make up the waveform and their face and voltage relationships. So, based on this wave patterns, we can have the monomorphic, polymorphic or sinusoidal and transient et cetera. So, those are about the morphology.

Next I have to discuss I wanted to discuss in detail is about the impedance. So, what is this impedance actually? Impedance is nothing but it is actually the opposition to the alternating current flow and it has various components. So, in impedance itself you will have the resistance as well as the reactance. So, what is this resistance? Resistance it is as you know it is a opposition to the direct current and the and in context of this impedance what happens is it is actually a frequency independent of opposition to the AC current flow.

So, this is about the resistance, and what is reactance? Reactance is nothing but it is a combination of both the capacitance as well as the inductance and it opposes the AC current. So, together along because EEG actually what happens is it contains a strong AC signal that is why we have the EEG usually the EEG researchers or the ERP researchers and all they mostly measure the impedance rather than the resistance of that particular electrode.

So, what is this thing that causes this impedance is that, impedance is actually highly measured, it is usually few kilo ohms sets usually that much kilo ohms it should be there. So, in context with EEG recordings the impedance is typically measured as we will be passing a small current of current to this electrodes to one or more electrodes and based on that, we will measure how the electrode or the electrode is supposing the flow of current.

So, how we the main goal of this impedance check is that we have to check the impedance between the electrode and conductive gel. Now, what happens is when in our brain, we will not have just we cannot just directly record the signal it should make contact with the scalp. So, it can be either a dry electrode or it can be a wet electrode. So, if it is a wet electrode, what happens is we need a conductive gel that has to be provided along with it. So, there the impedance check will be between the electrode and that conductive gel or the tissues or the that overlays over the skull.

So, any living skin you find that they will have this dead layer of skin cells also. So, this dead skin cells will provide a high impedance between the electrode and the living skin tissue. The most important impact that happens in the signal to noise ratio is due to the common mode rejection that is happening. So, what happens in this common mode rejection is that it is a, what is this common mode rejection? it is nothing but it is the ability of the recording system to reject the noise that is common in the active and the reference electrode.

So, that is any noisy sources that is identical in the active and reference recording what happens is it will get attenuated within the differential amplifier because the output of the amplifier subtracts the voltage measured at the reference electrode from the voltage measured at the active electrode.

So, this is why the common mode rejection ratio is very much important and it actually helps in finding out the signal to noise ratio. So, when if the common mode rejection of the amplifier is increasing the what happens is the contribution of the noise signals it decreases and which will increase the signal to noise ratio.

So, how do we do the how do we manage this common mode rejection ratio is that we will keep a high impedance in the recording system usually a traditional method of EEG in a traditional EEG recording what happens is we will use a low impedance EEG recordings. The problem is typically solved by cleansing and abrading the skin. So, before doing any EEG recording we will clean the scalp we will just abrade it with a electrode gel.

So, what happens by that is we create aberrations in the skin and that is how we are in reducing the impedance by disrupting the external layer of the dead skin cells there by providing a more direct contact with the underlying living skin tissues. So, this is why we use that is why we

usually clean the electrode we using electrode gel or any other we will prepare the scalp accordingly for this purpose only.

So, that the impedance is properly done, along with that we have some skin potentials also to be checked before doing that. So, any of the impedance so it is always recommended to have a minimum impedance of about 5 to 10 kilo ohms. So, the greater the impedance it leads to a voltage drop and attenuation of the bio signal.

So, the lower impedance would not allow the transduction of the bio signal. So, low impedance in the electrode your during the bio potential recording such as EEG, EMG it requires, so these are the points which is to be noted in order to check the impedance. So, lower the impedance that is how we will get a proper EEG recording. So, it will be fit is lower the impedance there will be a lesser voltage drop and the even the signal will be conditioned in such a manner that we will get a proper signal. So, that is the that is about the impedance.

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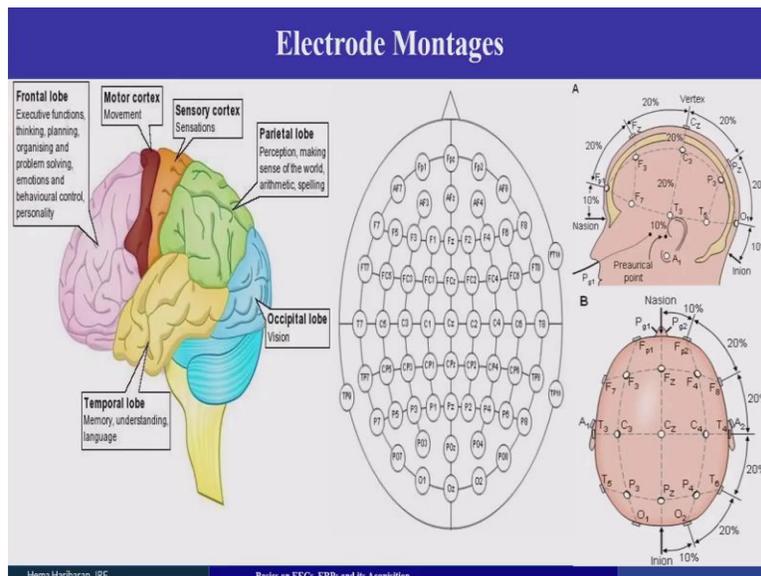
These are the usual electrode montages that has been used and brain for collecting the EEG signal. So, here this part of the brain, the front frontal lobe here in this place only we have all the functions of thinking, planning, organising, emotions, behavioural control and all takes place in this pink part of the brain.

Here in the motor and sensory together we find that it forms a central lobe of the brain. Then the green, the green part of the green shade over here it shows the parietal lobe here in this place

only we have the thinking, the memory working memory of the brain and all it works in this parietal lobe and over in the occipital lobe that is the blue shaded area here in this place only you will have the vision.

So, all the visual stimuli which we get we will perceive it in this occipital lobe. Then the yellow region over here it is called as the temporal lobe. So, in this place, we have all the auditory stimulus, auditory or the MMN and auditory evoked potential et cetera and all is obtained in the temporal lobe.

So, here in the next figure as I shown over here, these are the different 64 channel montage over here it is called as the 64 channel montage. So, over here this is the nose and this is the nasion and this the inion part of the brain. So what happen here in this these are the frontal lobes over here, these are the frontal lobes and then front the inion side.

So, all the frontal lobes are given as F and all the all the electrodes that are towards your left are odd numbers and the ones towards the right are all even numbers. So, there that is the how the electrode numbering is been done and the distance between of between these electrodes it is like a 10 20 system. So, it we will take the total of the total area that 10 percent like that we will take. Usually in any of the usually how we actually take the, we select this electrode position as first we will fix the we will fix how far we have to take.

So, this two side this here in the ear lobe in this part and this side from here we will take a measure and we will take and from this point this point till the behind in this occipital behind here we will take a we will tape it and find out what is the length and from here we will take 10 percent, 20 percent like that we will measure and we have to fix all the electrodes.

This is the actual actually we used to the traditional method of fixing the electrodes were like this. So, we will manually we have to measure how much the 10 percent, 20 percent everything we will mark everything and then we will do the electrode we will place the electrode along if it is a gel electrode we have to add the gels the conductive gel is to be added, if it is a dry electrode then we have to mark in such a manner that it makes contact with the scalp. So, like that we have to manually do all this.

But now a days now these days we have all these equipment's as in the form of a cap is it available. So, that is why we have the previous in the demonstration which I was the subject so

we had the cap that was having all the electrode positions were all placed like that itself so we can just put and that with all the signal processing unit and all the Wi-Fi, router and everything we can just directly do a recording.

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So, in a electrode channel another one important thing that you have to note is that of reference and the ground as I told in the previous in the previous slides, I have been mentioned that this the actual electrode channels are the active electrodes, then along with that we have the reference as well as the ground channels or electrodes are also important.

So, the volt here first we what we do is that, we will measure the voltage between the active and the ground then the voltage between the reference as well as the ground. So, when we differentiate when we find the potential difference between the active and the reference is when we get the EEG recording.

So, that is what here usually the reference or the ground would be the ear lopes. So, here in this part, we will have the we will put the clamp we will use this as the reference or the ground and even the mastoid also can be used as the ground some of the capes and all they will have its own ground and references, so we have to just connect with along with the circuit.

So, that the electrodes will get the EEG channel EEG recordings. So, here this blue the blue over here indicates the blue electrode over here is active electrode and here we have the reference electrode and any amplifier will have its own ground also. So, when we were the differential

difference between the active electrode and the reference electrode is what we get as the EEG that is how we measure the EEG recording.

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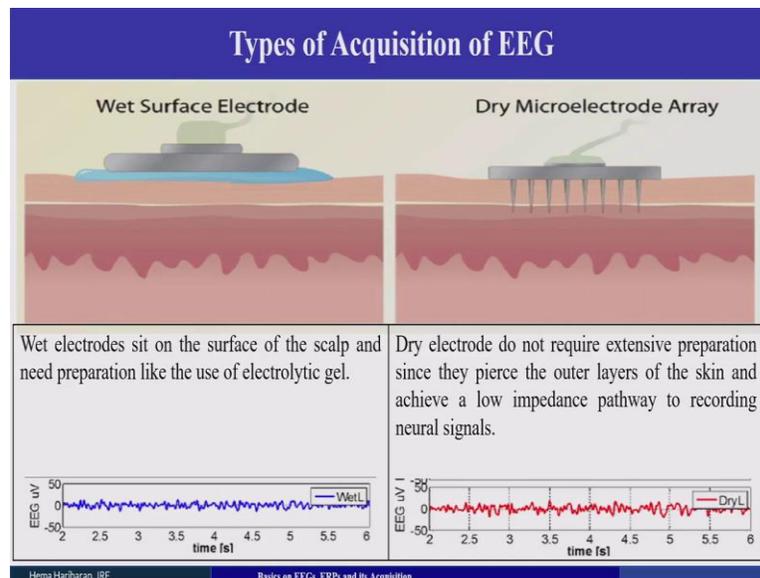
So, the next one is about the how the different types of acquisition of EEG. So, we have the wet surface electrode as well as the dry electrode also in this picture, it is pierce inside the layers of the skin but even we can have electrode wherein just it touches the surface of the scalp of the head.

So, that is there are these are the two different in the difference between the wet and the dry electrode is that we will have a conductive gel between that there is an electrode and there is a skin in between that we there should be some conduction that should take place between those two in order to acquire the EEG.

So, that is given by the wet electrode and in wet electrode the impedances would be comparatively better than that of the dry electrodes. So, that is why whenever when we compare the EEG recording for wet electrode and for a dry electrode you will find that the wet electrodes will have a smoother waves rather than in dry electrodes you will have find a lot of noise and all in between that is because of this impedance problem that is there between the wet and the dry electrode.

The dry electrode will it is just creating the contact we will just make even we can do we will not do any kind of skin aberrations or anything will not be done. So, because of that skin aberration

only that impedance is being properly checked and that is how we are getting the proper reading. So, if that is step itself is not there, then the impedance will there will be a low impedance in that recording system. So, that is why they will be comparatively more noisy waveforms will be obtained in case of the dry micro in the dry electrode system. So, these are the different dry electrodes that has been used.

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So, here these are the 10 prongs that has actually been used which just creates a contact on the scalp that is all that is why that is what there is no any gel or any conductive gel nothing has been use. So, it is just a dry electrode which creates contact with the scalp, that is it. So, here this that the next pic is a cap which have where in we here insert these prongs onto it and then we connect all those wires together and then we have a signal processing unit signal processing unit which will record which will capture the signal and it will do the further signal processing and everything and we will get the data the in EEG data accordingly. So, this is about the dry channel. So, the sorry with dry electrodes.
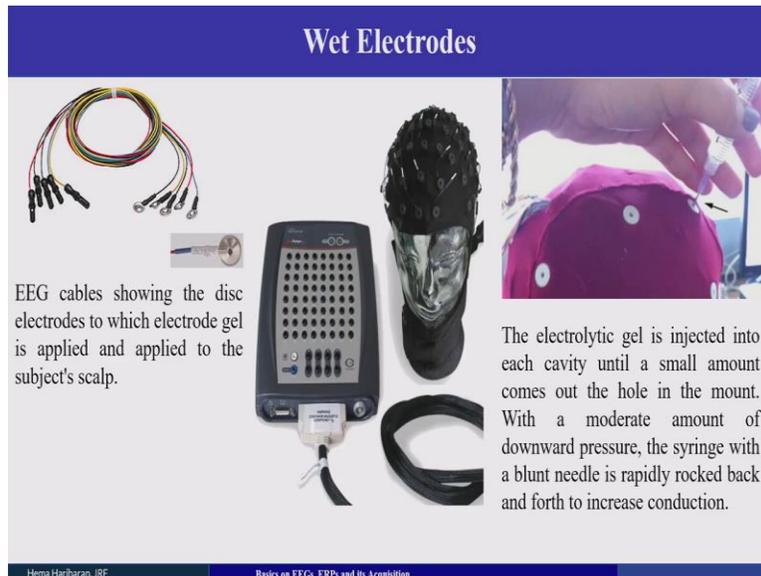
So, next is about the wet electrode. So, in this wet electrodes what happens is that we will be using any these are the first pic over here as it actually mentions that these are the electrode which can be given if you like the bipolar recording , if you do not want all the 64 channels you know we just want only a few recordings from the from the frontal electrodes or from any part of the brain just that much you want you do not want the whole 64 channel or 32 or 8 channel nothing I just want only two three electrodes to be done.

So, we can just take these gold plated electrodes, we can put into this, this particular pic this box kind of thing, which is called as the head stage, so where we can put all these gold electrodes and all and we can just put a conductive paste. So, this is one kind of a conductive gel that has been used. So, this is actually being used for the enobio cap. So, for example, now, this is actually one just one electrode for a wet channel electrode. So, it has be it will be like this hollow.

So, what happens is we will just put it in one part of the brain and then what I mean one part of the head and then we will take the gel in this and we will just put inserted So, what happens is this is hollow inside, so it will create the contact with the scalp wherever it is, if it is here we can just keep it over here and put the electrode like that. So, this is how we inject the electrolytic gel is been injected into the cavity like that, then only it to creates a contact with the brain. So, basically any EEG recording it should have a contact, so that is to should not be compromised at all.

So, when an a dry electrode means there will be no gel in wet electrode means we will have a gel in this is the this is actually a cap that has been used in neuro scan the neuro scan dry electrode cap it is that is this is the cap how it looks like. So, here in this here like this, we have to insert there will be a sponge or a electrode or a gel we have to insert into the electrode and that is how it actually creates the contact.

So, it will give it is not a sharp needle and all it is just a bland needle or it is like a syringe kind of thing. So, it will just put over and we can just increase the conduction between the conduction between the signal processing I mean the querying system and the scalp. So, that is about the wet electrode.

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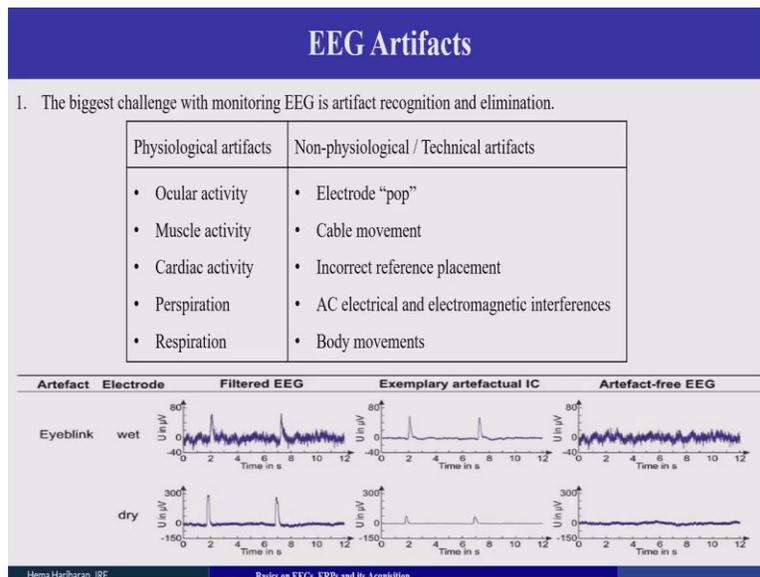
Then, the next I will be discussing is about the EEG artefacts. So, it is very difficult to sit like without making any artefacts it is very difficult. Because if it is in the case of dry electrodes and all even if there is a small moment also they will it will show full all the artefacts will be clearly shown.

So, here I will just discuss what are the different types of artefacts and how does it look like. So, here the some of the artefacts are because of the subjects alone. So, they will be they will do some ocular activity for example, the blink blinking of the eye or just moving the eyeball movement like that or something like that some of the ocular activity that is it takes place the

next is actually the muscular activity for example, if you move your head or if you clench your teeth or some of those are called as the muscular activity.

Sometimes even the cardiac activity for example, the ECG of the person is also for example in the head also even in the head also there will be the blood moment or so. So, their cardiac activity can be sensed even along with EEG. So, the ECG is the is another one artefact that is. Perspiration is the view to the, sweat sweating or even sometimes you find that the scalp is having a lot of sweats or sweat, if it is sweating, then that will that also acts as an artefact.

The next is the respiration when we are in the when we are sitting for a recording we will have some the respiration activity. So, some small movement also will be acquired by the acquisition system EEG acquisition systems. Then the other one is the technical artefacts that is happening because sometimes what happens the electrodes will just come out of the position so it will not be we will it will not create a proper contact between the scalp and the electrode this that will be loss of lost of contact that will be happening that is why that artefact occur. Sometimes the reference we will place it in a in proper place.

So, for example if reference has to be here if it should be here it sometimes we will keep in some other place and that is why there will be a artefact occurring because of that and sometimes there will be AC interference also. So, what happens is usually any of the EEG acquisition it takes place in a Faraday or it should be in a place where there is highly insulated without any AC currents or interference and all so that is another one artefact that has caused.

The cable moment sometimes what happens the electrodes it should be intact in one place, but sometimes what happens there will be some cable movement taking place so due to that there will be in artefact occurring then other one artefact is due to the body movement. So, when we move our body like we are we just make our movement or we feel laugh or something some movement in our body itself will that technical artefacts will occur.

So, the next time showing is about the how the blinks look like. So, here if you see the wet here the blinks first figure it shows the filtered EEG so here we have a proper artefact that pointed peak is called due to the blinking. So, next the next figure over that it is it shows just the we just removed the artefact alone. So, that is the then we remove that artefact from the filter signal that

is how we get the EEG signals. So, the last column indicates the artefact without any artefact artefact free EEG signal. So, this is actually due to an eye blink.

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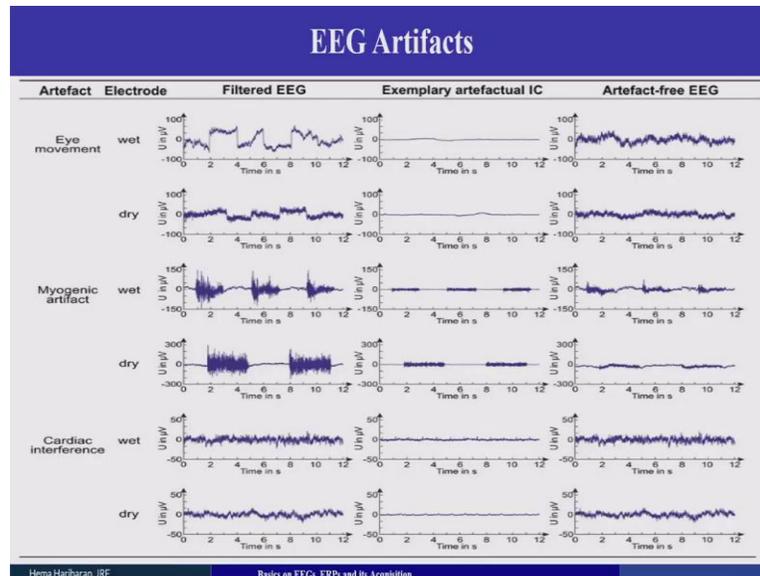
Similarly, we have due to the eye movement also so when there is an eye movement, this type of artefacts we will be obtaining. So, that can be eliminated and we can get the proper artefact free signals. So, I when I mention so, there are various ways to remove this artefacts and all for a basically we can, we cannot avoid making such moments. So, like eye blink and all we cannot avoid it. So, how do we avoid this artefact during the EEG acquisition or EEG analysis is that we can have the high pass filters, low pass filters, the notch filters like that, those filters and all can remove.

There are in some there are softwares like this EEG lab, ERP lab et cetera which as having a proper artefact detection module itself where in with it will remove we can just select that or it should be the like usually all this artefacts will be from 10 minus 10 100 to 100 microvolts. So, in this particular range only. So, we can just window it in that particular range and just remove the artefacts in that particular voltage threshold. So, that is how we can remove the EEG artefacts. So, this is about the, so first I showed about the eye blinks this is eye moment.
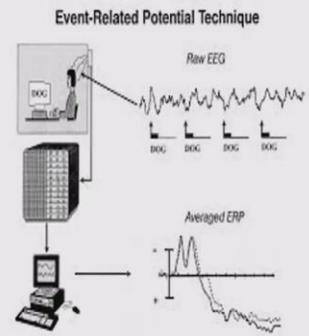
The next is the, so the muscular activity so when you are clenching your teeth or when you are moving around or if there is any any this external stimuli or anything like that, this is how we remove the muscle muscular movement and then we have the ECG activity also can be removed

along with that. Actually there are electrodes where we can keep over here in this region itself like between the eye HEOG, VOG we call those channels. So, it will it will detect the eye blinks and eye movement and also that is how we can we can remove those EEG artefacts.

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So, the next is actually about the ERP's. So, event related potential. So, as I told you, we are in this this particular potential which we are recording is basically for the cognitive brain as I said. So, how the brain perceives a particular stimulus? How it responds to a particular stimulus, that is how that is why it is called as an event related potential a bio potential that is being created when we flash a particular event from the scalp that is why it is called as the event related potential of the brain.

So, what are the different so here in this picture over here as I mentioned, first we will get a proper raw signal is been obtained, we will have a stimulus been given so according to that the raw EEG is been obtained, and then we can further we can take the continuous data do further analysis and EEG ERP analysis and finally we can get the averaged ERP. So, for a we cannot just get a for one stimuli we cannot get any EEG signal and all, so what we have to do is we have to continuously do about for 120 or 1000 recordings like that and totally we average together to obtain the ERP's as such.

So, just for one the whole experiment which we get is a total continuous EEG file. So, in that EEG file we will get we will remove the we will take the particular triggers or the events and

then we average together and that is how we obtain the averaged ERP's. So, any other stimulus over here it actually is for visual evoked potential. So, event for a visual evoked potential it is a flash of light or a reversing checkerboard and if for P300 we have to give up oddball stimulus is to be given that is 3 triggers to be given so, I will just I will just mention how the P300 triggers look like. Then the auditory stimulus like the tones been used for AEP and MMN ERP's and for clicks basically for the ABR experiment.

So, what is this ABR? ABR is the auditory brainstem response. So, the now till now, the previous tutorials I have mentioned that there are the potential that are obtained in the 100 millisecond as the AEP. So, before this 100 milliseconds also there are a lot of processing that has taken place that is called as the auditory brainstem response.

So, how that is from the here tell the auditory cortex there will it will move through various cochlea the there will be a lot of the sound travels from the ear lobe to the brainstem, sorry the auditory cortex through various stages. So, that is been recorded in the first 10 to 10 to 15 milliseconds in that range. So, that is called as the ABR and we give here is the clicks and that to in a fast it will be a totally fast response actually and here even in the in case of ABR the recording, sorry the therefore ABR we have a different parameters of filters that is being given for ABR.

So, that is about the different auditory stimulus and auditory responses that has been obtain, then we have is actually the N400. N400 is actually a negative negative peak that has been obtained in the 400 millisecond. So, how what is the stimulus that has been given as that we will have a sentence we will give a sentence will be given and in that the last word of the sentence will be funny or it will it will be weird or it will not be it will not it will be incongruent to the to the meaning of the sentence.

For example, the pizza was too hot that is a ordinary sentence, but we will replace that hot the pizza was to purple. So, it will be a difference there will be we will think that okay this word is not appropriate for this particular sentence. So, that particular peak or that particular stimulus or that particular response that has been obtained is called as the N400. There similarly, there are various other many other event related potentials are there like contingent negative variation, Bereitschaftspotential.

So, those all are a different did all it is all for the different cognitive part of the brain for its functioning and everything. This recognition potential is that we where we can recognise a particular thing. For example, if we are given a alphabets were English or Hindi alphabets and along with that we give any Chinese alphabet you will not know what is the difference between the English and the Chinese.

So, we will recognise the English alphabets, but we cannot recognise what are these Chinese alphabets. So, with a difference between that the that deviant and the standard is what we get as the recognition potential. So, that is also a negative peak that will be obtained like the like the mismatch negativity. So, this is how the this is about the generally about the event related potentials.

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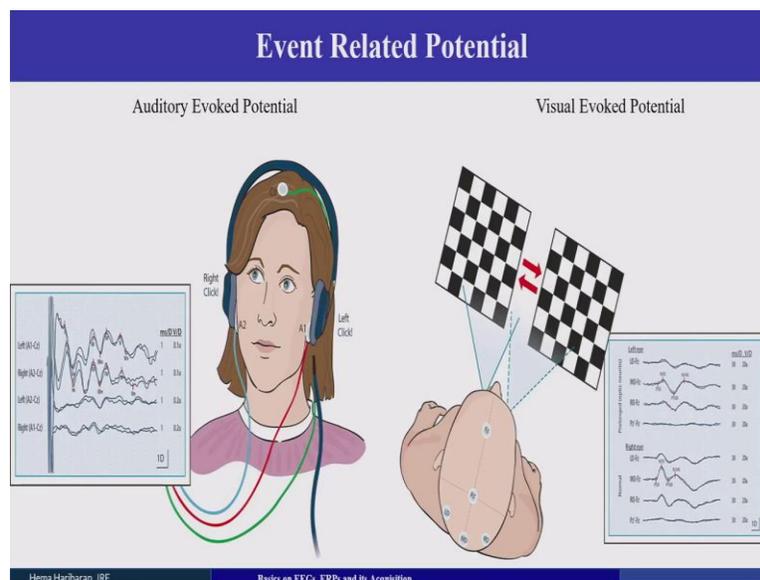
The next we will discuss is about this is how the auditory evoked potential is been given. So, we will this is either you find this auditory tones are given through the headphones or earphones or it can be given it can be generated by other speakers as well. So, that is how the evoked potential has been obtained.

So, based on we will have the electrodes and all connected and the headphones and all connected everything. So, there continuous electrodes channels continuous data has been obtained along with this trigger is also been obtained. So, we can just average all the trigger channels together

and finally, we can get the ERP's of the auditory evoked potential and this is the picture in the next the next is the visual evoked potential.

So, we usually we have a reversing checkerboard that has been obtained. So, here also we were get a negative, sorry there will be the late positive complex and N1 P1 N2 complex that is the most common complex that will be obtained and which will evoked potential as well as in the auditory evoked potential.

So, I will just show you how the VP actually looks like, in the presentation which Doctor Mahesh had mentioned we saw the how the auditory evoked potential was being generated from the presentation software. So, I will just show you how the visual actually due to some other issues and all we could not project the we evoked visual evoked potential to be shown. So, that is why I will just show you how it is actually been seen. So this is how it looks like.

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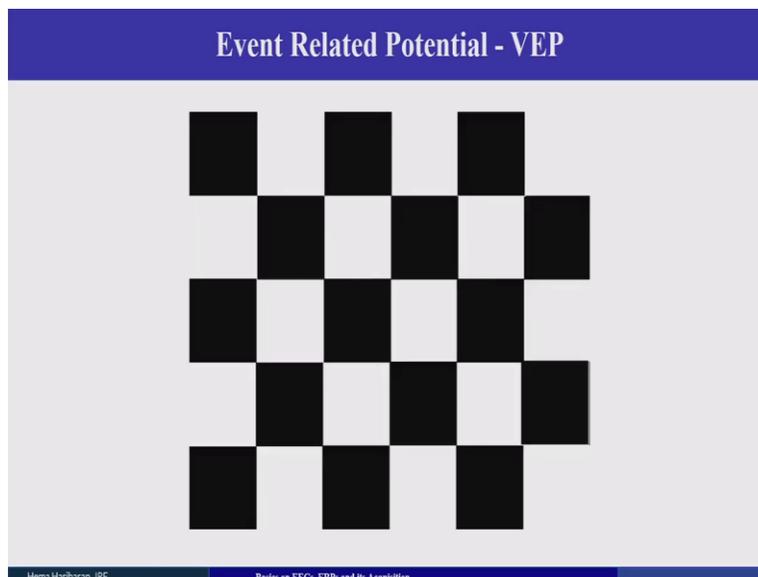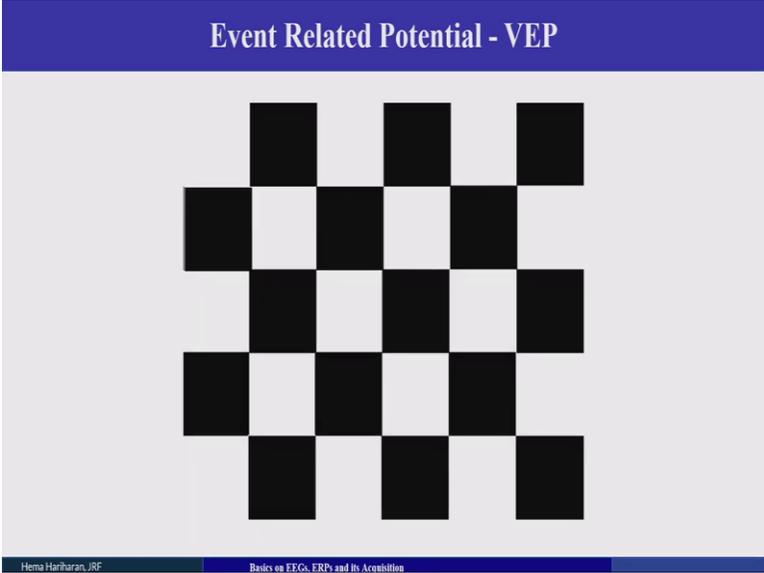
So, this is how the VP this is how this type of movement this, it keeps moving for so long like it will keep reversing the checkerboard keeps reversing this is this this is how we get the we pay recording has been obtained in this particular this the stimulus given for that particular for the VP's. So, I will just discuss about MMN and P300 also.

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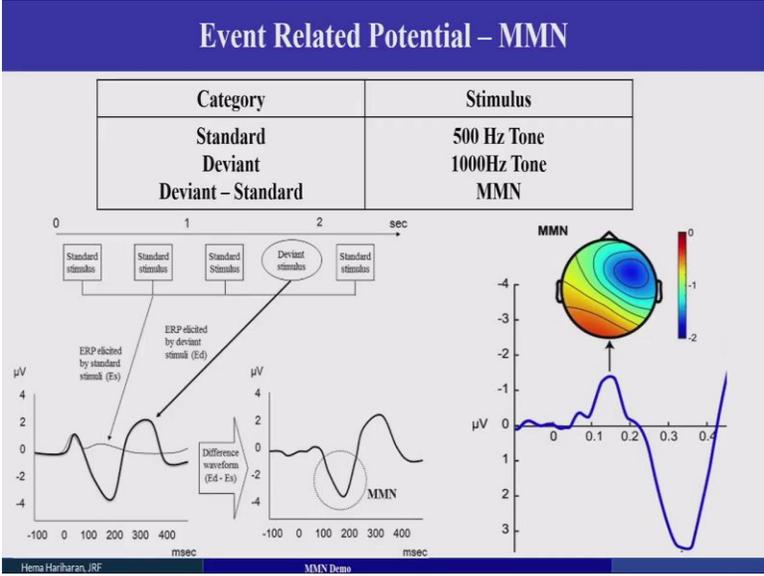
So in MMN what happens is we will have a there are two events over there one is the standard and another one is the deviant. So, it will be given enough this particular way the MMN recording, sorry the MMN stimulus was shown by Doctor Mahesh where I was the subject where we have the we there he shown was the duration MMN wherein there was different deviance one

particular standard and the deviance was 1000, 2000, 3000, 100000 10 like that there are they were different deviance were being used.

But what is the thing is that always this MMN it should be repetitive. So, if we have three standards, then there should be one and one deviant that will be repeating for n number of loops. So, that is how the MMN has been obtained. So, first we have the standards of 500 or any we can design our own experiment according to the tones we can make our own tones accordingly and then we have to record the MMN so we will give the tones are being given in this manner for standard standard standard deviation standard standard standard deviant like that.

So, with this deviant it can be anything it can be 1000, 1000, 100 2000 anything it can be. So, the difference between this deviant and the standard is what we called as the MMN. So, the MMN is nothing but the mismatch negativity so when what happens is that our brain it can remember a particular event for a short-term memory we say so it means that for example if you want a remember a particular number for that particular moment you will might remember that number but then after few minutes or hours you will not be remembering what is that number so that is called as a short-term memory so that is been recorded in this MMN.

So, this MMN it can be the applications if you say it is actually can be used in when in babies also in order to check whether they are auditory function is proper or not, whether they can way they can differentiate the different tones or not that is basically it about the MMN. So, here the standard is been given together and then one deviant then for three standards then a deviant like that.

So, always there will be a MMN, there will be a peak that will be obtained than the 150 to 300 in this range only we will have the MMN response obtained and basically always mostly it will be obtained in the right frontal this part of the brain. It will be in the right frontal part of the brain the response is obtained in case of MMN. So, this this particular demo with presentation software was been given where I was a subject and that was already being done.

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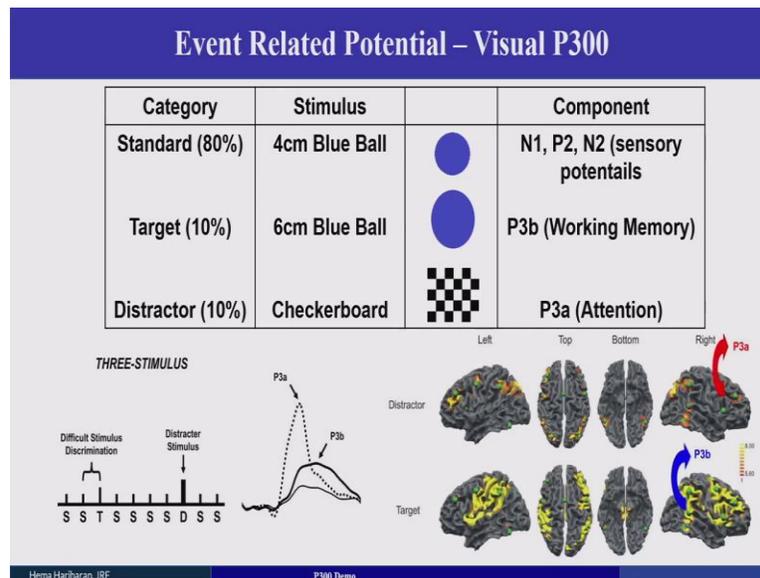
The next I will just give you an overview about how the P300 also looks like. So, P300 there will be three three stimulus will be given one is a 4 centimetre then the 6 centimetre ball again a checkerboard. So, the blue ball the 4 centimetre ball it is just like a flash of light that is coming. So, that will give us it will just give a visual evoked potential regular visual evoked potential. Now, the target and the destructor is the important part.

So in here what happen is that when we are given when the subject is been doing when we are making preparing a subject to do the visual P300 we will instruct the subject to give a response whenever he sees a 6 centimetre blue ball. So, whenever there is a target seen the response button should be.

So in this case what happens is that our working memory we are just telling the brain that okay whenever there is a 6 centimetre ball our working memory should our working memory is been activated in this case, that is why whenever when this target is being shown we are giving a response so which means that we have a brain is remembering that yes, this is how it should this is for this particular bar I have to give a response.

So, we it will it is like we are giving we are giving working we are giving for a memory cortex we are giving a working it is been done with given to that. So, then we have a distractor in this distractor what happens is that we will just sometimes what happens is that there will be a 4 centimetre and 6 centimetre but we will just remember that for a we can just remember but we

have to give some distraction so that we pay attention that again there is the safe 6 centimetre ball again coming.

So, the distractor this particular stimulus is just because we have to pay attention to the targets stimulus for that purpose we have the distractor. So, the when we when we have this and this standard target and the distractor, it is been given in probabilities of 80 percent 80 percent should be of standards. So, out of 1000 of the triggers nearly 800 triggers will be of standards than 100 triggers will be of the targets and 100 of distractor.

So, what happens is that we can directly a just all the targets we can average and get the P3b component and all the destructors can be together averaged and we can get the P3a component. So, with the P3a component we find that it is obtained from the frontal part where we the attention as I told you in the previous slides and all the attention which will be taking part in the frontal part of the brain.

So, P3a is obtained from the frontal part of the brain and P3b is from the parietal where we have to think a lot, we have to have the working memory and all working properly so all of them. So, first the P3a component comes up and then the P3b component comes up. So, this is how the three stimulus interval looks like and I will just show you how the P300 stimuli it just looks like.
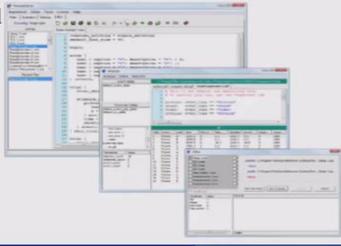
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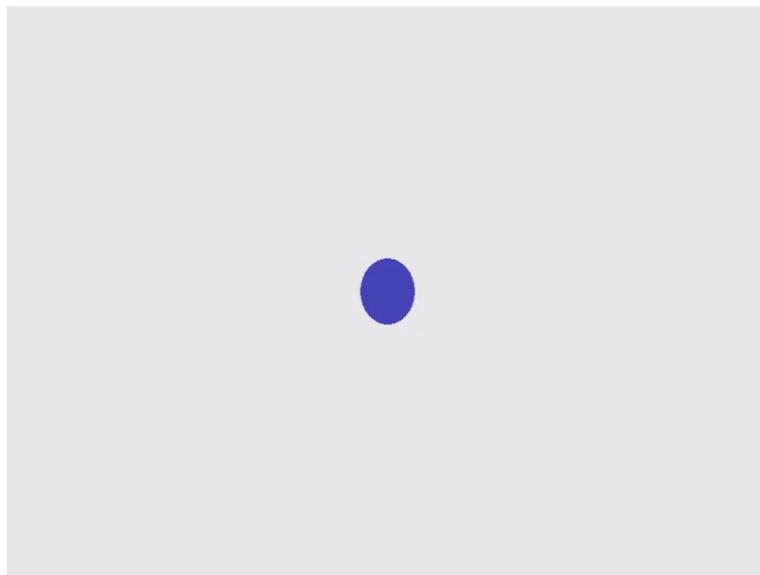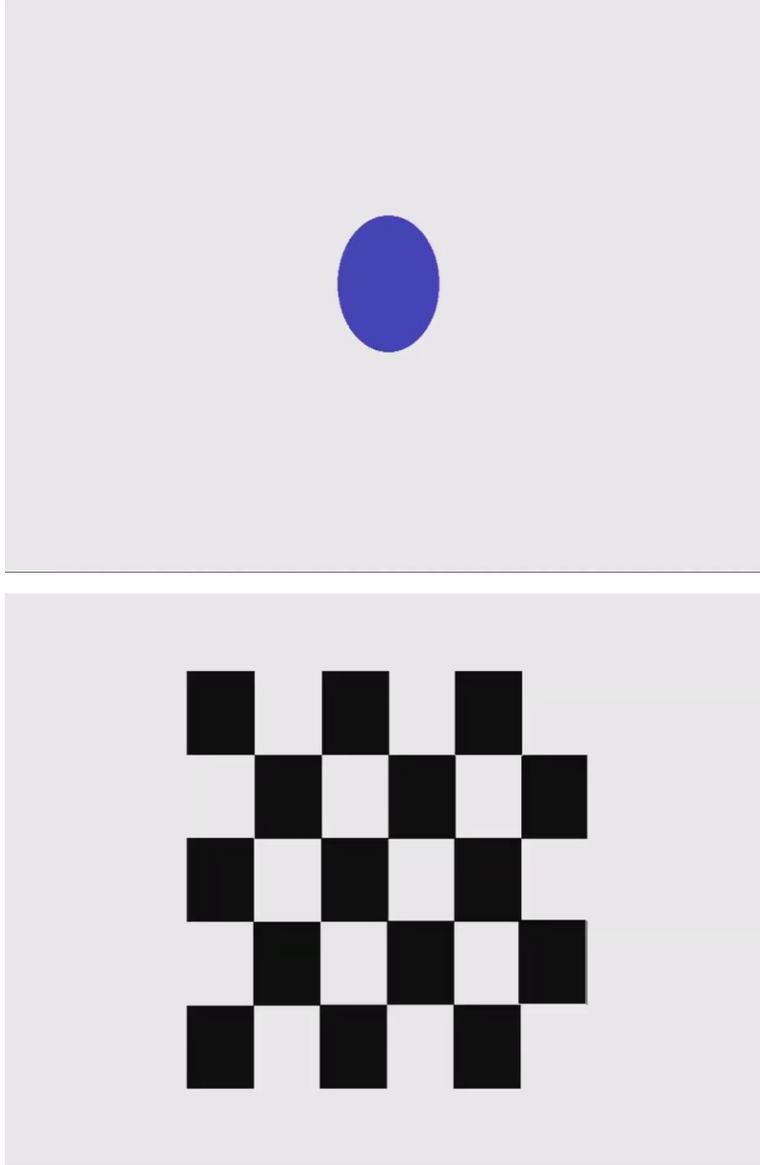
So, this is how the P300 looks like we will be it will be highly randomized. So, this is about the P300.

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The next slide is about the presentation software. So, this is the software which is actually now there are various ways in which we can give the stimulus this auditory visual stimulus and all there are various phase in which we can give. For Enobio specifically we can actually be in we have we can give the stimulus using this presentation software. So, the stimulus with it runs it runs and all the Windows system and it we can have a all the behavioural.

So, if this is particular software was mainly and created by the neurophysiologists so in order to design all these various cognitive brain experiments et cetera memory experiments. So, here we have the behavioural physiological and the physiological parameters like fMRI, ERP, MEG et cetera and all can be measured it also delivers all those are 2D, 3D auditory stimulus everything it being it is can give you know it can monitor a variety of device, it can interfere with external hardware. So, interfere with external hardware, which means that when we can create a stimulus in presentation and it can be given as an input to another software.

For example now in case of enobio the demo as shown the presentation was software was working in one place and the triggers was being given to the enobio NIC software so it can enter that is what their interface it can interface with external hardware and all these ERP's, sorry the auditory and they evoked potential now, it should be in the probability of this range. It should be repetitive some for MMN in case it should be repetitive like three standards and a one deviant like that.

So, that can be programmed with a presentation software. So, based on that we can get the different the stimuli and it also helps it is also extensible also, it can be used in various platforms various other places. It also as built to precise the stimulus and we can if you want the response we have to give the response externally.

Now, if you want a response to that 6 centimetre ball, we have to give that particular we have to externally say to the presentation software that yes, we have to get a response in this particular for this particular stimulus like that. So, all those things are that can be done using the presentation software. So, this is about all the EEG acquisition and ERP recording and how to create the stimulus and everything. Thank you.