Ergonomics Workplace Analysis
Prof. Urmi R. Salve
Department of Design
Indian Institute of Technology, Guwahati

Lecture - 08
Assessment of Physical and Cognitive Work with Psychophysiological Methods

So, welcome back. Today again we will be talking about various Assessment of Physical and Cognitive Work with Psychophysical Method.

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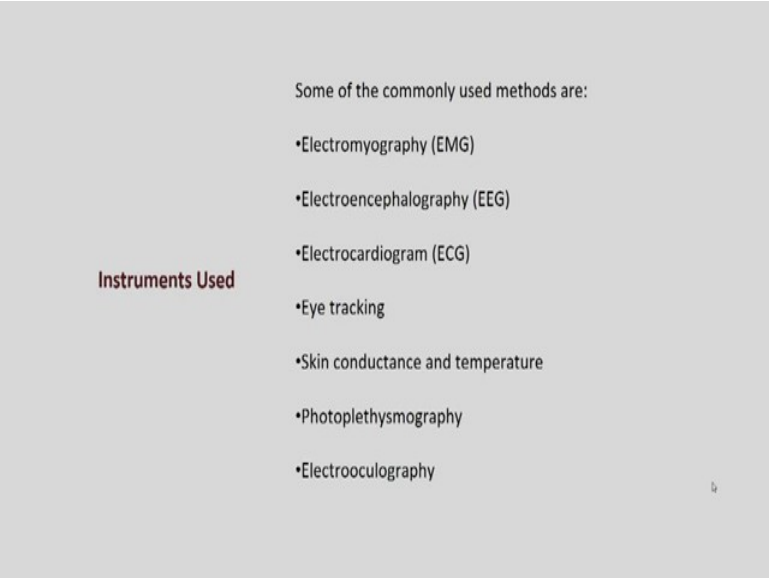

Last class we discussed about what are the varieties available and one of them we discussed that was the EMG. So, in this class we will be talking about EEG, ECG and eye tracking and rest few as we do not have the instrument at our laboratory. So, we will not be able to give it in detail, but of course, if you have queries you can refer back and then we will be able to solve your query. So, let us start about ECG.

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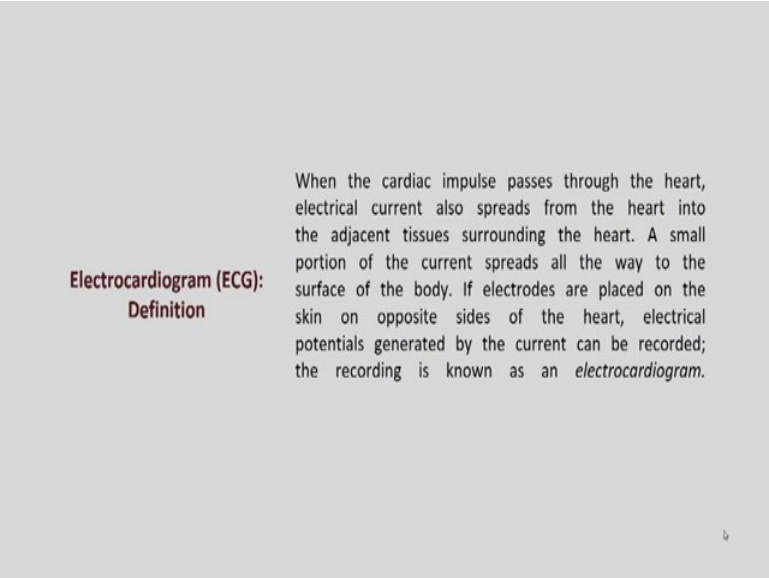

So, what it is? As in last class we understood that EMG is Electromyogram. So, ECG is Electrocardiography or Electrocardiogram right. So, what it is? It is related to the to your heart activity. So, when somebody is working or physically active the heart actually pumps. So, blood comes in and goes out and the whole circulation keeps on going. So, how that activity of heart muscles can be recorded in terms of electrical potential difference and then how we can interpret the physical exertion, mental load and all those things. Today we will be discussing about that.

So, let us understand what it is. So, when any cardiac impulse passes through the heart, electrical current also spreads from heart into the adjacent tissues or surrounding heart. So, a small portion of the current spreads all the way to the surface of the body. If electrodes are placed on the skin on the opposite sides of the heart that electrical potential generated by the current can be recorded and these particular recording will be calling as electrocardiogram.

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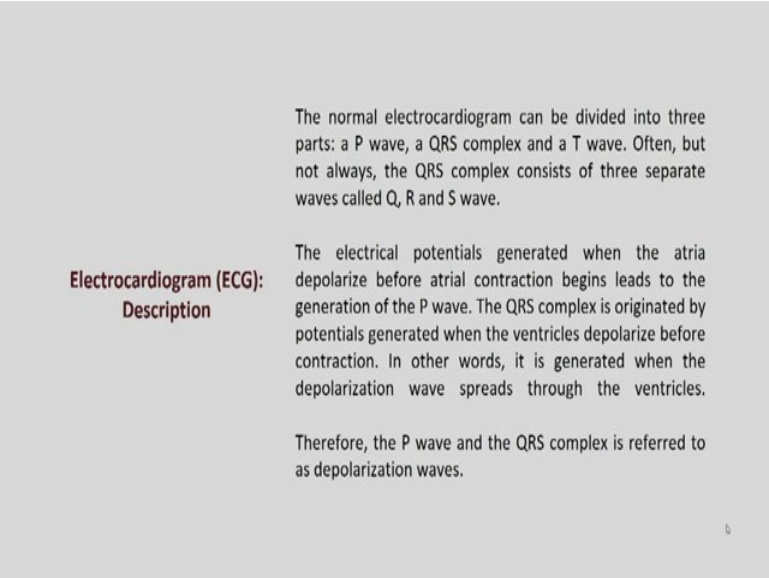

So, let us understand how this electrocardiogram looks like. So, many of our parents or many times we have seen ECG recording, ECG data right, but we never thought of looking at it and let us understand what it says or how the doctor actually interpret this data. So, let us understand few components of it. So, that where you are going to record or when you are going to see that particular recording or that you know printed math copy you may understand or you may analyze or interpret few parts of it.

Of course, medical analysis is different as compared to the kind of analysis or kind of interpretation and ergonomist look for. So, that is very different, but still few components are common. So, let us understand major visible components of ECG and let us understand what does it mean. So, whenever we are talking about ECG recording or Electrocardiogram there are few waves that we are going to see or it is visible in the that particular page; first is P wave then is QRS complex and then third is T wave.

So, the whole one cycle consist of P wave QRS complex and T wave, but many times it happen that this QRS complex consist of three separate that Q, R and S wave sometimes there are changes. So, these changes only we need to identify and we need to interpret our results. So, the electrical potential which generated when the atria depolarize before atrial construction begins that leads to generation of the P wave. So, this particular P wave is a depolarization wave. So, why it happen? Before the atria contracts there is a depolarization. So, when this depolarization happens then this P wave comes. If we are

talking about the QRS complex it's about the ventricle. So, QRS complex is originated by the potential generated when the ventricles are depolarize before contraction.

So, both P waves and QRS complex are because of depolarization. So, we call these all three as depolarization wave, where as T wave is something different.

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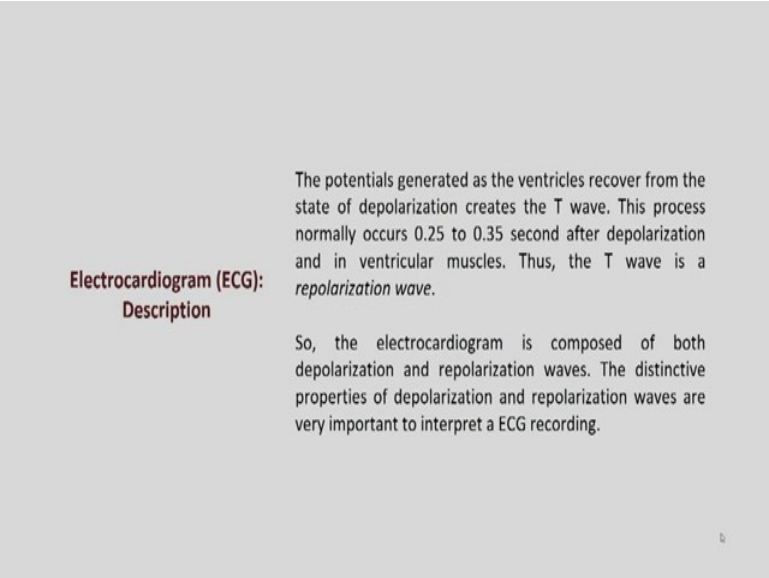

So, when the potential generated as the ventricles recovered from the state of depolarization; so it is repolarization. So, that creates the T wave and this particular T wave process continues for 0.5 to 0.55 seconds. It is because of repolarization we call this T wave as the repolarization wave. So, the electrocardiogram is composed of both depolarization and repolarization wave. The distinctive properties of depolarization and repolarization waves are very important when we are talking or interpreting the ECG recording.

So, if there are changes in these particular processes, that is, the speed, the amount of time taken or the amplitude is expected or the positioning of these depolarization and repolarization. So, P QRS and T components if there are changes then only there is a concerned and we really need to understand that and we need to interpret.

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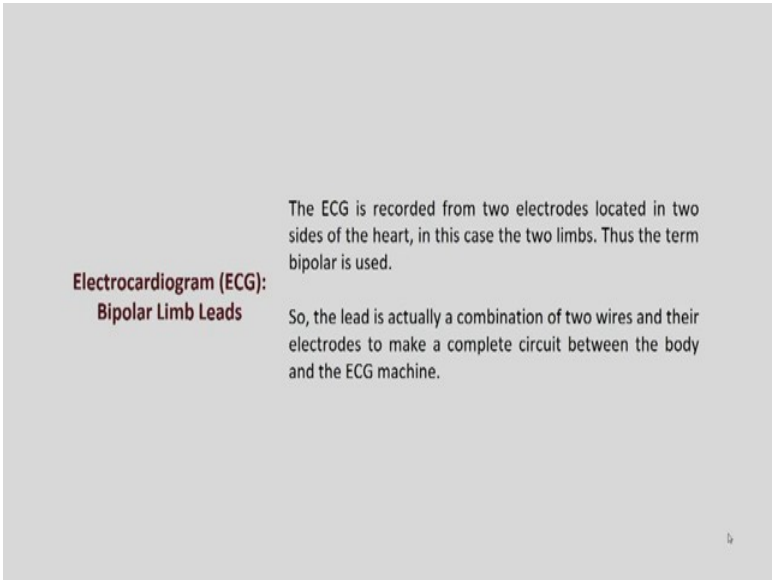

So, before I go for analyzing that data let us understand how we are going to collect the ECG recording ok. So, when we are talking about ECG recording a very important aspect is to understand what bipolar lead is. So, what we do is that ECG we normally record from two particular electrodes which are located two sides of the heart. So, in this case normally two limbs either two hands; two hand or leg like that. So, because it involves two limbs we call bipolar limb leads.

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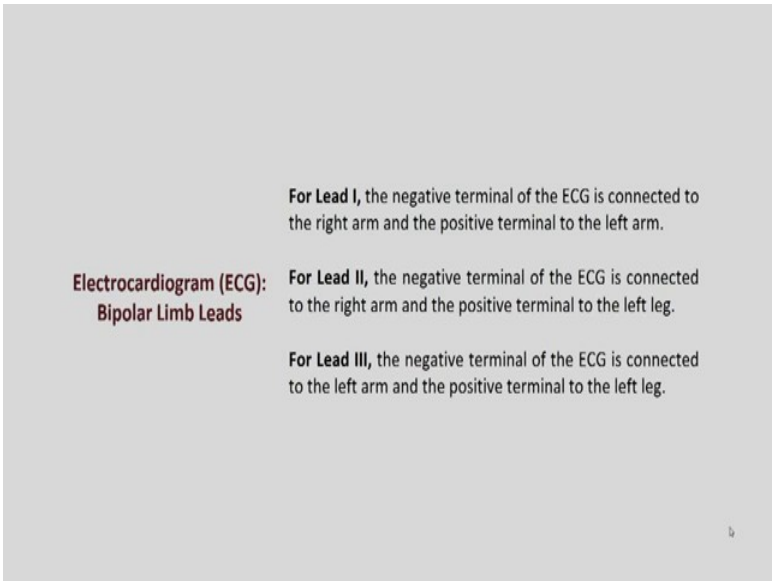

So, there are three types of leads we have lead I, lead II and lead III. So, what this lead one says? It is a negative terminal of ECG which is connected to the right arm and the positive terminal of the left arm, lead III is the negative terminal of ECG is connected with the right arm and positive term of the left leg not left arm left leg. Whereas, lead three is the negative terminal of ECG is connected to the left arm and the positive terminal of the left leg. So, this way or this three leads are connected and we place our leads.

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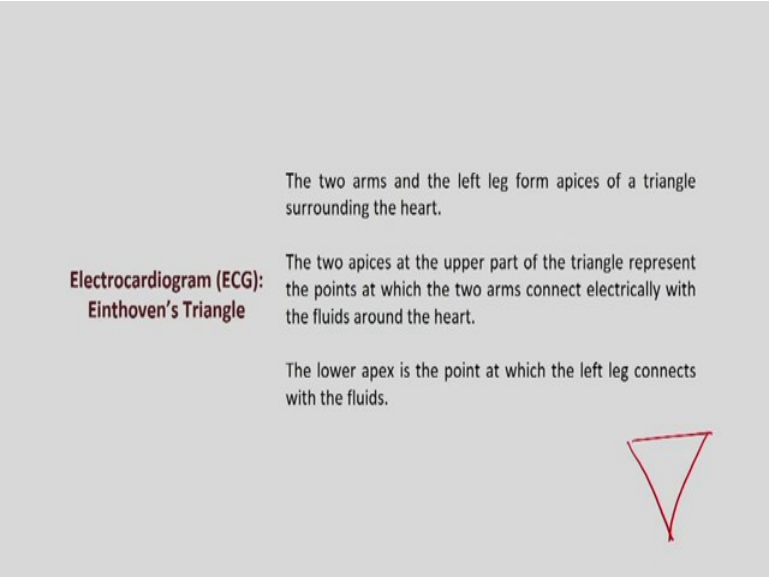

So, once we place these three leads what happens? There is a triangle formation. So, kind of this type of triangles actually forms. What it means? It has a particular terminology we calls Einthoven's triangle. So, two arms and the left leg form particular triangle which surrounds the heart. So, heart is here, it is located like this and there is a triangle.

So, this particular triangle we call it is Einthoven's a triangle and it has a very specific nature. So, we will understand that. So, the two apex of the upper part of the triangle represents the points at which the two arms connect electrically with the fluids surrounding the heart and the lower apex is the point at which the left leg connects with the particular fluid.

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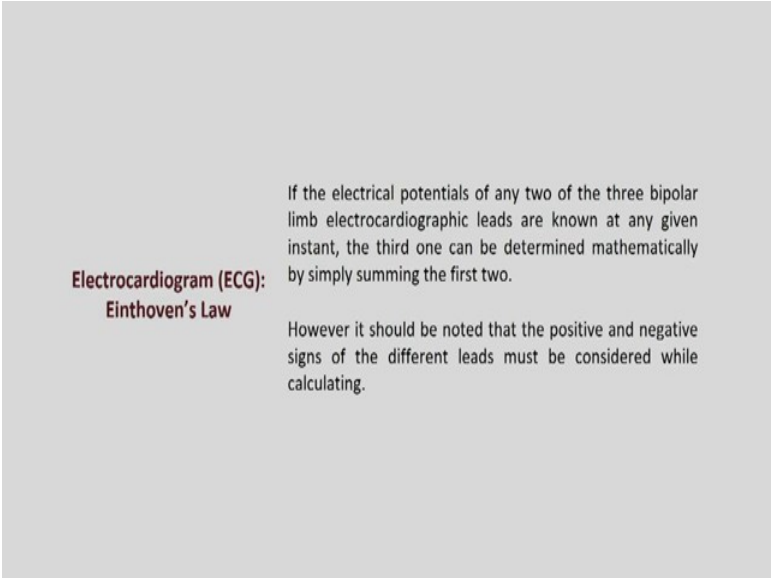

So, what it says? It has a particular law. So, each these limb has positive and negative values right. So, if the electrical potential of any two of these three bipolar limb electrocardiographic leads are known at any given instant, the third one can be determined mathematically only by summing up these other two. Here consideration of sign like positive and negative is very important when we consider not only the mode value with sign like plus this wave volt minus this volt. If we simply plus then like add them then we will get the third one. So, that is the rule we have in this Einthoven's triangle. So, this is the law we follow we are talking about the ECG recording.

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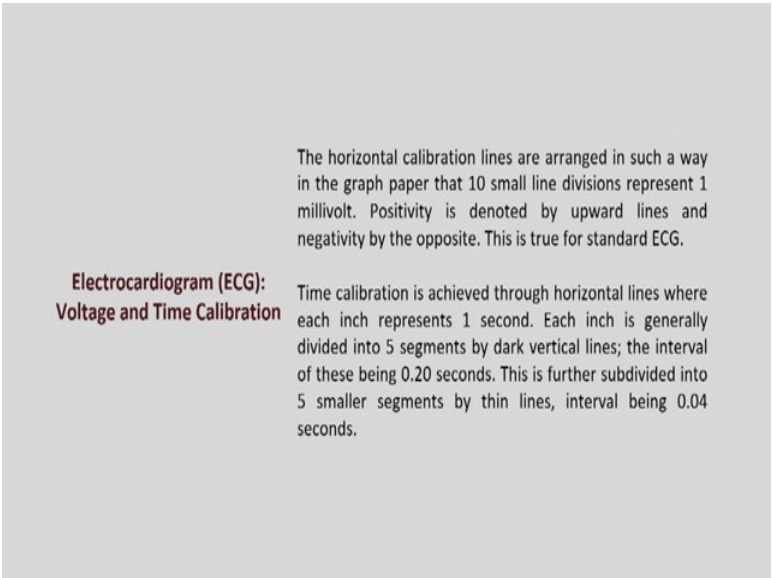

So, when we are doing the ECG recording it is very important first to calibrate the whole system and to understand when the recording is happening, how the voltage is getting measured. The horizontal calibrations line what we have in the graph are arranged in such a way that graph paper in that particular graph paper 10 small line division represents 1 millivolt ok. There are small-small graph, I will show you in the next this particular figure how to calculate it.

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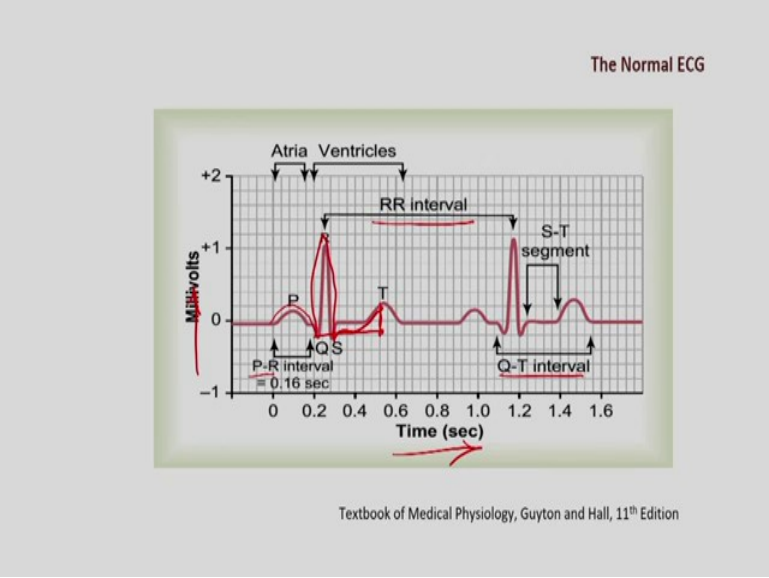

So, 10 small line divisions represent 1 millivolt. So, positivity it denotes upward movement, if it is negative then downward movement. So, time calibration is achieved through horizontal lines where each inch represents 1 second. So, each inch is generally divided into 5 segments by dark vertical lines, the interval of these are actually being 0.20 second. This is further subdivided into 5 smaller segments by thin lines and interval is 0.04 second. So, what you can do as soon as you finish this class? You go and pick up any ECG recording plate like whatever is available with you and try to understand how these lines means and how you can identify these values. So, then only you will be able to you will start interpreting your own data.

So, this is normally a common ECG graph looks like. So, this is like P, Q, R and then comes down S and then it goes here as T; so, this PQRS component. So, here if you see this is the time and here is the millivolt. So, this is here you can see the kind of electrical potential is generated in the times law. So, here you can see I have mentioned P R

interval, then R R interval, P R interval, Q T interval what does it mean and what it actually depicts and how we are going to understand that and what is the meaning of these. So, that I am going to tell you in next few slides.

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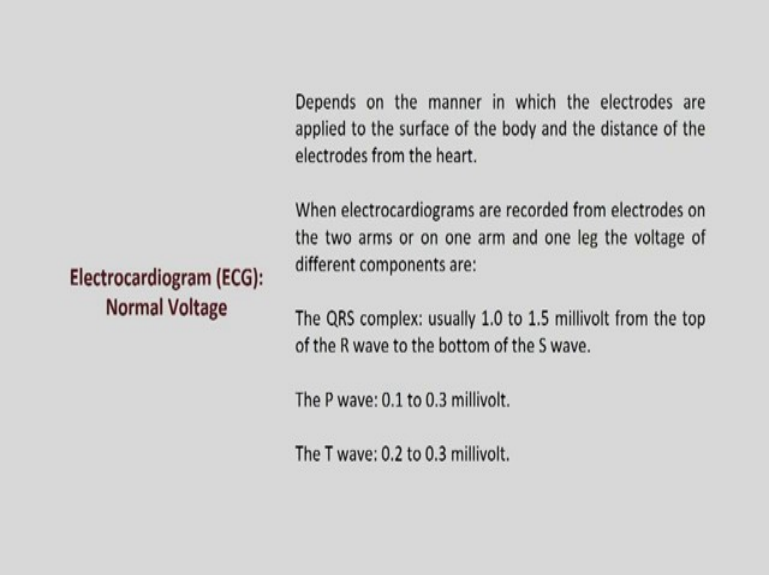

So, let us understand first the normal voltage and then how the other when there is a discrepancy, how we are going to understand it. So, depends on the manner in which the electrodes are applied to the surface of the body and the distance of the electrodes from the heart we have different recording. So, each QRS complex usually has 1 to 1.5 millivolt from the top of the R wave to the bottom of the S wave.

So, this is the recording if it is normal, your heart function if it is normal then we will get this recording. For P recording P wave it is 0.1 to 0.3 millivolt where as for T it is 0.2 to 0.3 millivolt; so this is the normal range. So, if there is any changes then we have a concern that what is the problem and where the problem is, why this changes are happening and then we will enquire it back.

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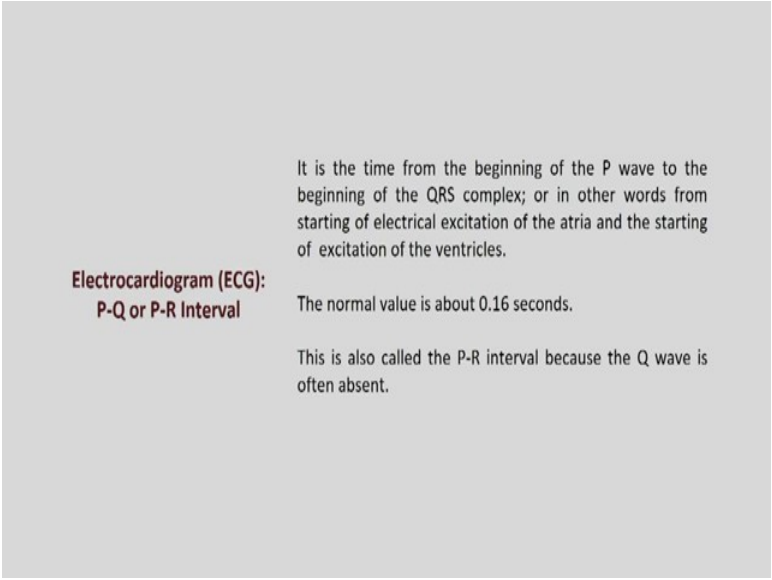

So, what is P Q or P R interval means? So, it is a time from the beginning of the P wave to the beginning of the QRS complex. So, many times it happens Q wave is missing. So, sometimes we call it P Q interval or sometimes we call it P R interval because any times Q is absent. So, normally this particular value stands for 0.16 second. So, if there is change please look at why this change is some as I mentioned as Q is absent many times we call it P R interval as well, now Q T interval.

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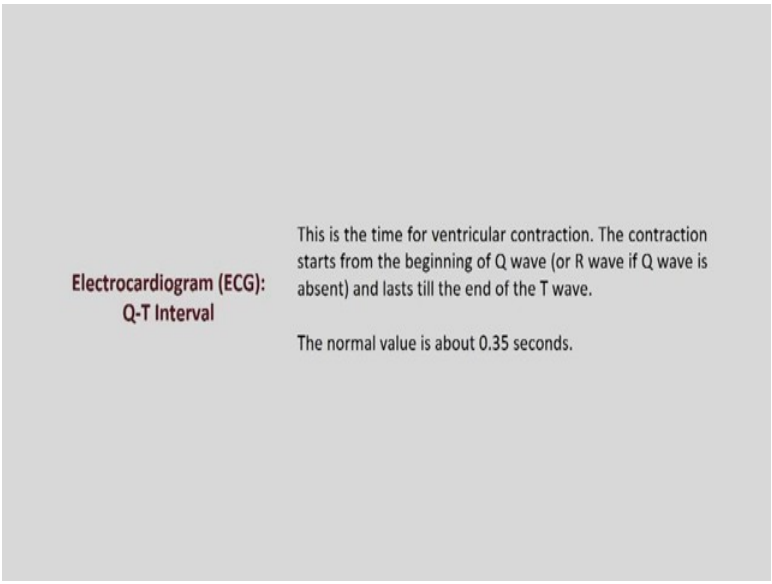

So, this is the time of ventricular contraction. So, when ventricle contract? So, that is the time after depolarization that repolarization happens. So, the contraction starts from the beginning of the Q wave and last till the end of the T wave. So, ventricle contracts and then finally, it relaxes. So, the normal value of this total range like from here to here, so this peak ok; this peak. So, we call it as Q T interval and this is approximately around 0.3 35 seconds.

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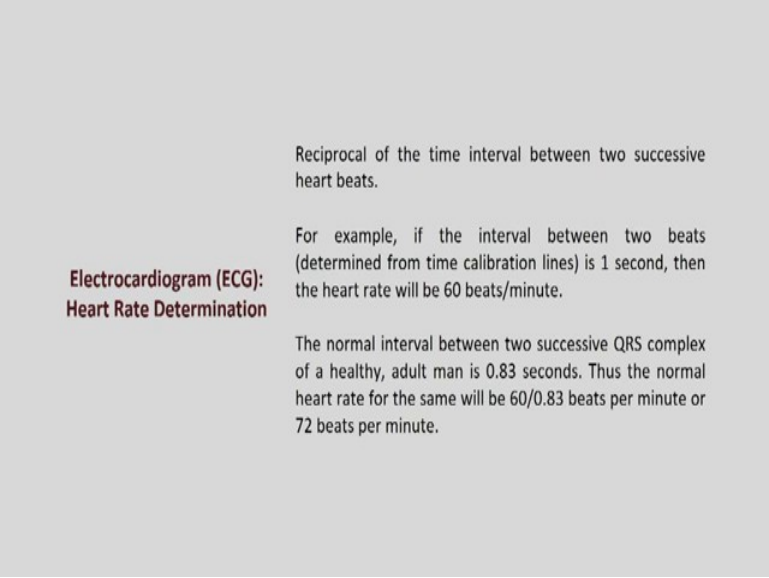

Now, from the ECG recording how we are going to determine the working heart rate or if the patient is in resting condition, how we are going to determine the resting heart rate? It's basically the one cycle distance between one cycle to another cycle. Take an example if the whole complex like you know the whole cycle completes in 1 second, then your heart beat will be 60 beats per minute because each second 1 beat, 1 PQRST complex the whole thing right. But if that changes like QRS the two successive QRS has the interval around 0.83 seconds, then that is your normal heart beat that is 72 beats per minute.

So, 60 divided by 0.83 it comes around 27; so 72 beats per minute is normal heart rate. So, when you are reading any ECG recording or ECG graph you measure the distance between the one QRS to another QRS, QRS that particular state, then you see what is the amount of time taken for that. If it is 0.83, then it is your heart beat is 72 beats per minute

if it is more or less accordingly you can calculate it 60 divided by that amount. So, then you will get the heart rate.

So, if you are an athlete or you are physically very active, your cardiac capacity is very good then may be your heart rate can be little on the lower side. But if you are in a panic condition, if you have done some physical activity then this particular distance of successive 2 QRS will reduce and your heart rate will go high. So, that is the kind of interpretation you can do from by reading the ECG recording.

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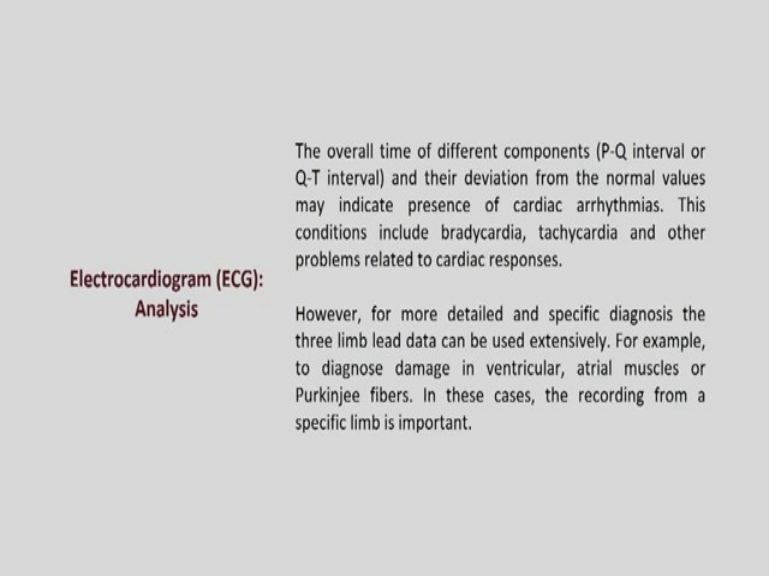

So, that the overall time of different component that it P Q interval or Q T interval and the deviation from the normal values what I mentioned earlier indicates the presence of cardiac arrhythmia. It can be bradycardia, it can be tachycardia or any cardiac any other cardiac problem.

However, for more detailed and specific diagnosis the three lead data like lead I, lead II, lead III we should read separately and each data each lead data can give different aspect of your ECG recording. So, if you get some problem or some discrepancy in the normal one you will read it separately and then you will find out what the problem actually is.

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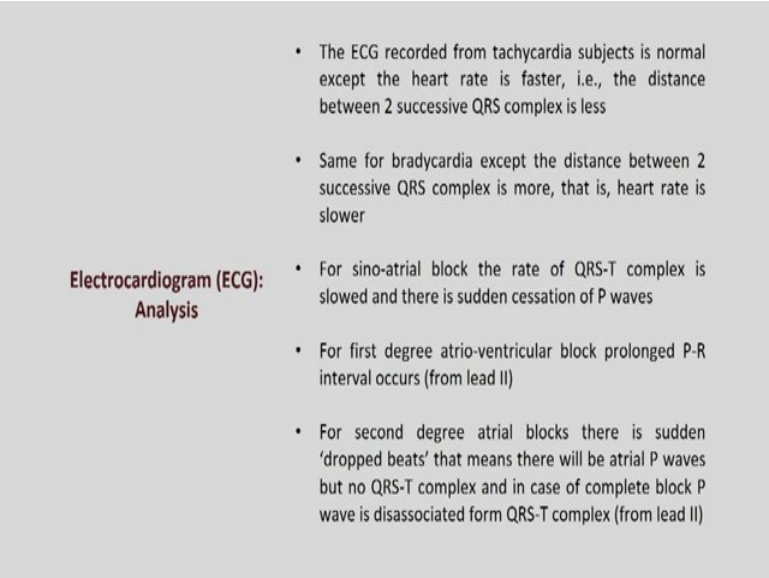

Some very specific commonly identified features that I try to bring down here I will tell you. So, if the ECG what you recorded have some the recorded forms any tachycardia patient. So, what will happen? The two successive QRS complex the distance will be little less, where as for the bradycardia it will be little more means your heart rate is less. For sino-atrial block the rate of QRST complex is slowed down and there is a sudden cessation of P wave; so that also is can be seen.

For first degree atrio-ventricular block prolonged P-R interval that may you find specifically from lead II. For second degree atrial blocks there is a sudden drop beats; that means, there will be atrial P waves, but no QRST complex. So, if that kind of phenomena you see from the lead III, then you can say it's a second degree of atrial blocks.

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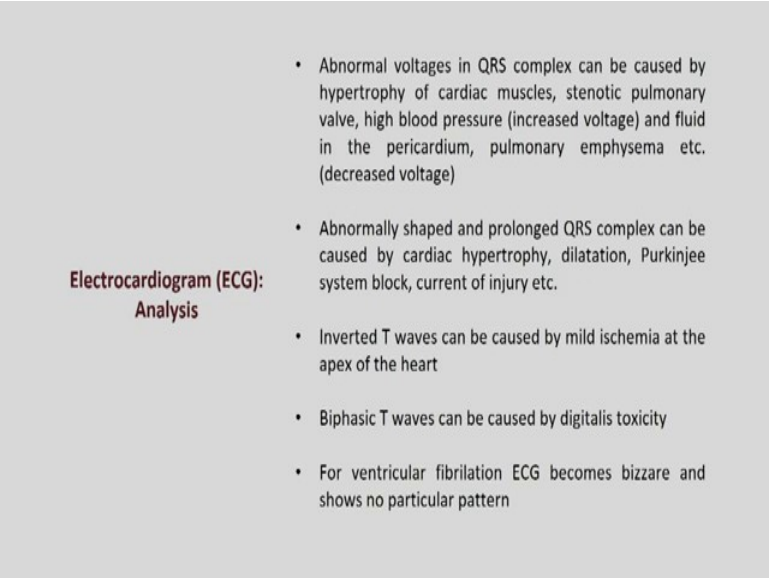

So, these are the indications also if you find some abnormal voltage in QRS complex, you can identify there is hypertrophy of the muscles, stenotic pulmonary valve, high blood pressure etc if the power voltage is increased. If it is decreased, then you can say pericardium, pulmonary emphysema or any similar type of disorders. So, abnormally shaped and prolonged QRS complex can be caused by cardiac hypertrophy, dilatation etcetera.

Here one important thing is how T wave looks, T wave is on the positive side, but if some how you find an inverted T wave like it is on the opposite direction, then you can expect a mild ischemia at the apex the of the heart. Biphasic T wave also some times is visible and it can be caused by digitalis toxicity, so that is also possible. For ventricular fibrilation ECG becomes bizarre and it shows no particular pattern. So, that is an indication when specially you are doing lot of cardiac test right stress test. So, if you have such kind of indication you really need to go for medical intervention; so that is important.

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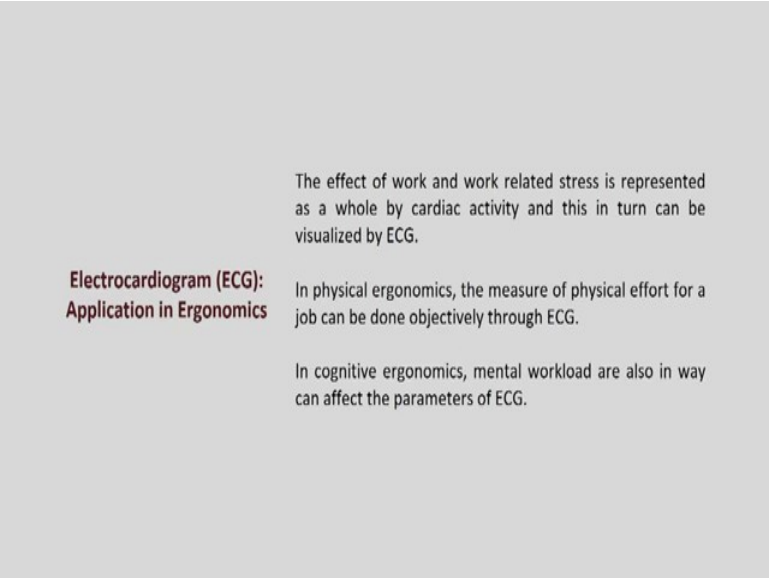

So, whatever we spoke till now is lot of medical aspect or medical understanding of your ECG, but how these things are important for an ergonomic assessment or ergonomic work place analysis system that we need to understand. So, when we are talking about work or work related stress, it is very much related to your physical stress right.

This is directly depended or can be reflected on the heart rate or heart activity or cardiac activity. So, if the person is physically active. So, you can really directly monitor that one through the ECG recording. So, that is objectively you can measure and you can find it out. Where as if there is mental work load where the person is in sedentary position, but lot of mental stress is there that also sometimes can be reflected from the heart rate recording or not ECG recording not heart rate recording ECG recording.

So, these are the major application of ECG when we are talking about implementation of ECG recording or ECG data or including the ECG analysis for your ergonomic studies. So, here what I would like to say is whenever you are planning something related to identifying the physical work load specially physical ergonomics consists of lot of manual activity, lot of mental stress there you may plan for this type of study and you can record ECG and you can analysis it.

So, today's task will be you just pickup one single ECG recorded paper with is available nearby and then you really count them in millivolts and along with the time and try to interpret how the data is and what is the condition of that particular heart ok. So, if you

have any difficulties please contact back and so, that we also we can also assist you for your better understanding.

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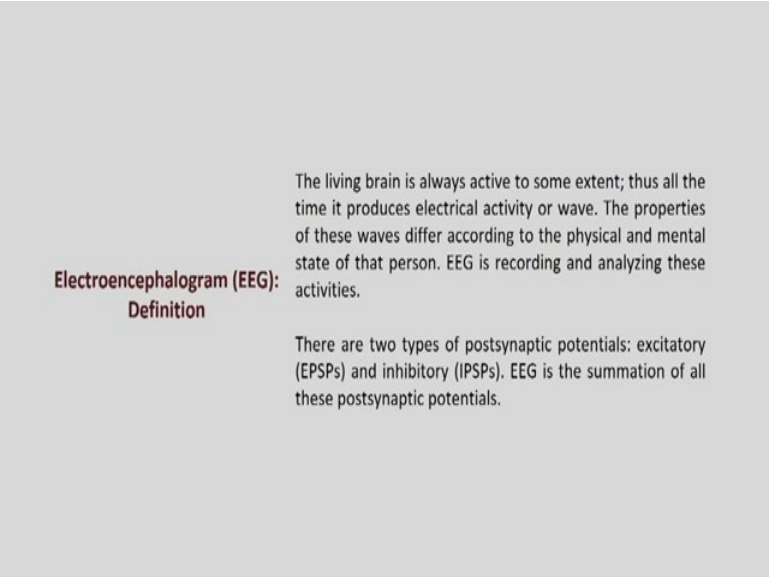

So, once ECG is done I will take you for another important kind of psychophysical analysis that is the Electroencephalogram or we call it EEG. By nomenlecture itself we understand is related to your brain. So, when there is a brain and if it is in living condition always there is some electrical action potential is getting generated and it has a very specific pattern.

So, always it is available and some kind of electrical activities is there and once we record that activity we call it EEG recording or Electroencephalogram. So, there are two very specific postsynaptic potentials; one is excitatory another is inhibitory. So, once we record these excitatory and inhibitory postsynaptic potentials we sum them up and we get the EEG recording.

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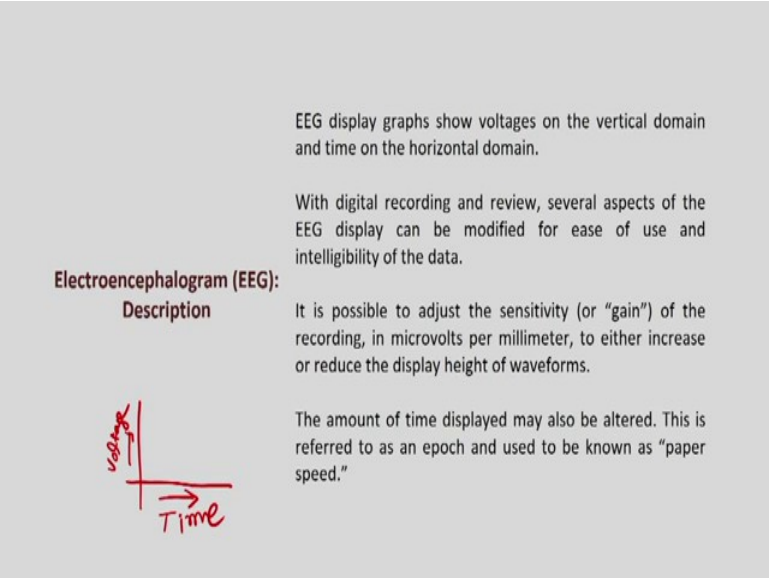

So, how this EEG recording is and what the meaning of all these let us understand. So, EEG display the graphs, it shows in voltage on the vertical domain same as your ECG and time on the horizontal. So, here if our graph is there, so in this case it is voltage and here it will be the time.

So, same as we have in ECG and even in EMG; so, with digital recording and we have lot of know instruments technology, what we get is the EEG display which can be modified for ease of our use and lot of interpretation. So, it is possible sometimes. So, adjust the sensitivity of the recording in microvolts per millimeter to either increase or reduce the display height of the waveform whatever the waves we are getting we can adjust that. So, this amount of time displayed may also be altered can possible. So, this is referred as an epoch potential we call it and use to be known as paper speed.

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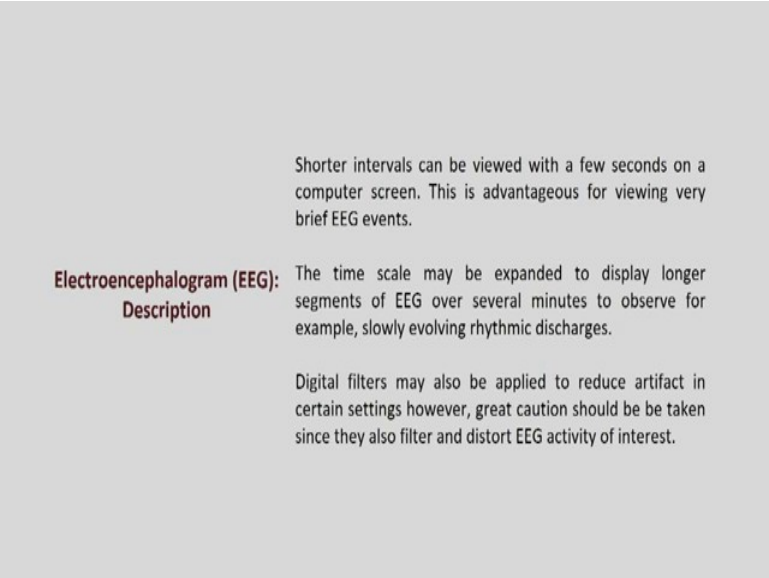

So, shorter the intervals can be viewed with a few second on a computer screen and this is the advantageous for viewing very brief EEG events. So, if it is very brief then we really can capture that one in computer and we can really see it. The time scale may be expanded to display the larger segment of EEG over several minutes to observe for those phenomena.

So, digital filter also we can use and we can reduce the artifact for certain settings and when ever actually you are going to use EEG or you are going to record EEG then you will understand how to do these small-small adjustment. Now, here again I would like to mention as I mentioned in my previous class that EMG recording preparation of the skin or placing up the placing the electrodes all are very much skill based.

So, as many times you will be experimenting you will have more confidence and you will be cleaner to do this particular job. So, it is very important you keep on practicing this type of data collection and instrument handling same as for your ECG here also for EEG recording. And, it is very dependent very important its very much experience dependence, the first time when you are going to record you may fail to understand or fail to gather a proper data, but if you continue it for several experiments you will be master of it. So, that is very important for all these type of recording.

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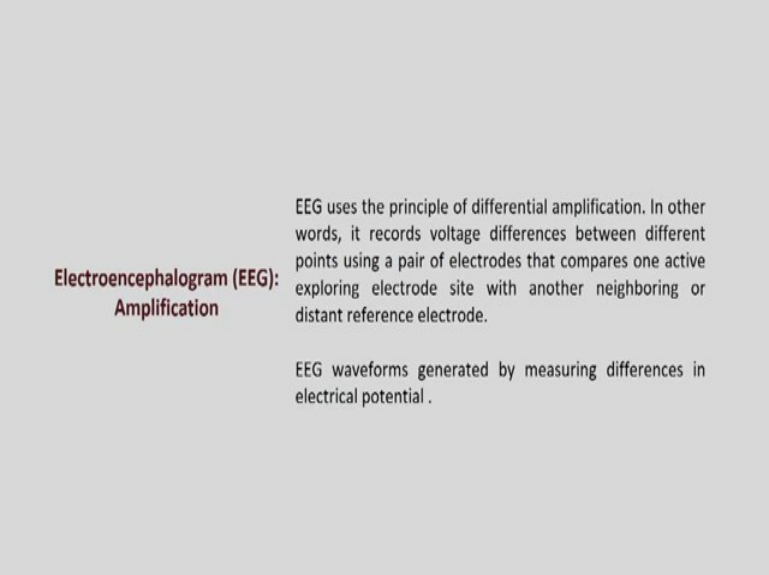

So, as we are talking about the action potential and know its differential potential, it is very important to amplify it. So, same as for EMG the nature is same, but the instrument used is little different we actually what we does it the same principle that differential amplification. So, that only we use for the EEG signal processing.

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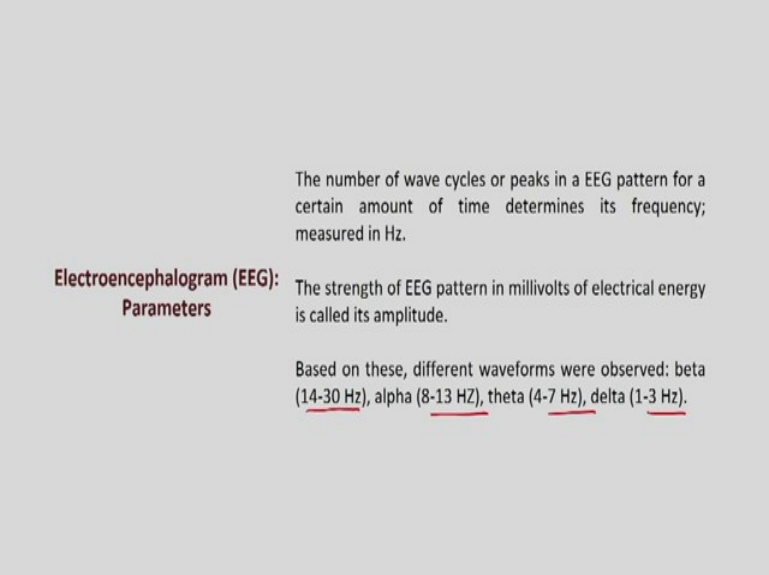

When we record any EEG signal we have some very specific type of waves that actually helps us to understand that what the status of our brain is. We have beta, alpha, theta and delta. These are the major four types of waves we see from the EEG recording. So, these are the Hertz that represents these specific types of wave. Now, let us understand what this wave represents.

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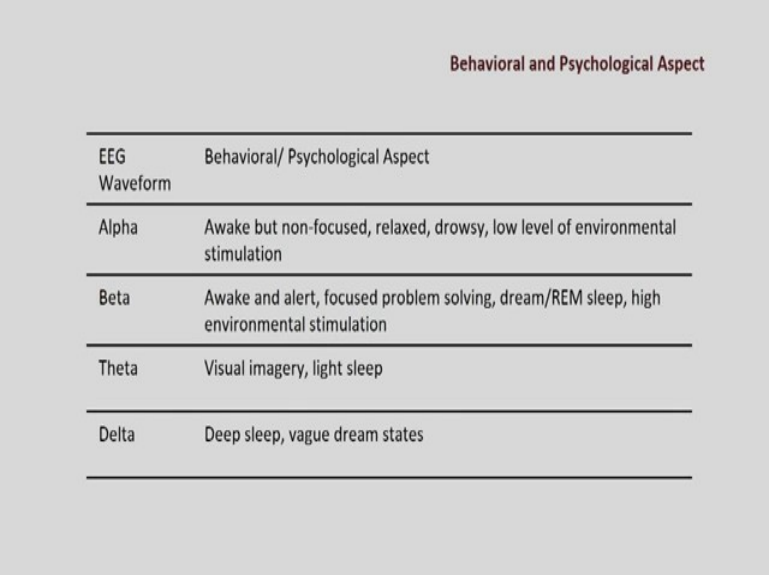

So, alpha says when you are in an awake condition, but even not focused you are little relaxed, you are drowsy your eyes are open, but you are not really looking at something then it is alpha. Where as beta is very much alert awake condition. So, you are doing some focused problem solving you are in dream, but in rem sleep high environmental stimulation. So, in these cases you will get beta wave. In theta if you have some visual imagery light sleep then you will get theta wave from your EEG recording and delta when it is in deep sleep and vague dream states, then you will get this wave.

So, normally when the person is like working somewhere either alpha or beta there are probability is there to gather this type of these two types of waves. So, when somebody is working what is the type of concentration we need based on these value or these type of wave recording we can understand that.

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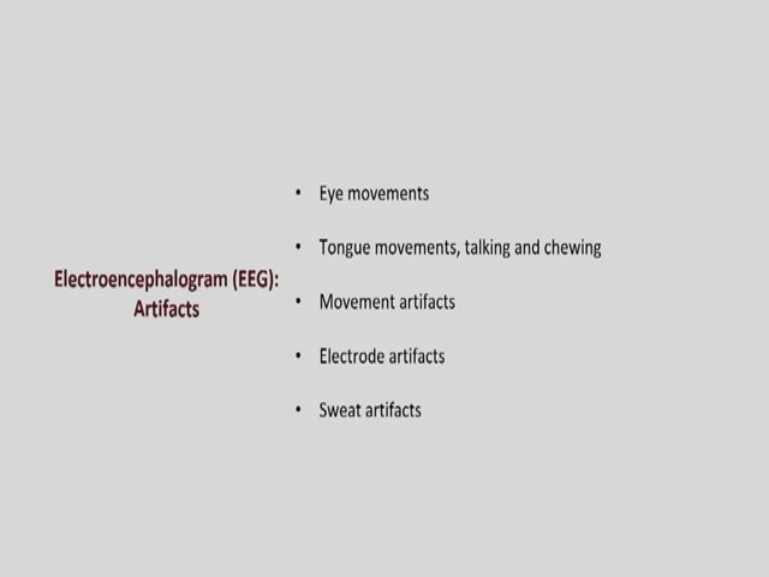

As in EMG also we had. So, many varieties of artifacts same here in EEG we have artifacts like eye movements, tongue movement, talking chewing, movement artifacts, electrode artifacts, sweat artifacts all these are there So, you really need to bothered or you really need to understand how to eliminate them and how to get a correct data.

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Electroencephalogram (EEG): Method

In conventional scalp EEG, electrodes are placed on the scalp with a conductive gel or paste.

Before that the scalp is prepared by light abrasion to reduce impedance due to dead skin cells.

In some systems each electrode is attached to an individual wire.

In other systems electrodes are embedded through caps or net which is particularly common when high-density arrays of electrodes are needed.

So, let us come for the recording how we are going to collect this type of EEG recording. As I mentioned in the beginning itself it is a differential potential; so, off course you have to record this particular process through a kind of electrodes you have to place it in throughout your skull and then you have to record the kind of movement is happening.

So, before the skull is ready for data collection or ready for placing the lead you need to really to remove the hair some kind of know light abrasion is required which will actually help to reduce the impedance due to dead skin cells same as for your EMG. Now-a-days a lot of advanced systems are available where electrodes are attached to an individual particular wire and you connect it directly. In some system you have a cap where electrodes are placed before hand and you are just putting that cap on the head of the person and then you start recording. So, these are the modification or very advanced instruments available where you can gather the data.

So, see for EMG we have very specific requirement like which muscle we do not know it's absolutely based on the researcher we need to find out that particular muscle (Refer Time: 33:21) of that particular identified muscle. So, it is very dependent on the researcher, but in case of EEG you have approximately pre identified location because we are going to put on head right. So, these types of caps are available, so you can directly use them.

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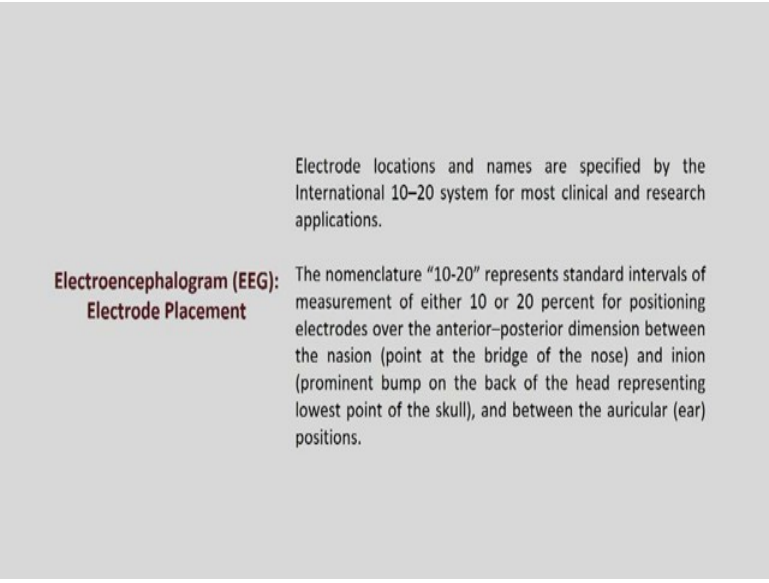

Here one principle or we can say international law we have that is 10-20 system. What does this particular mean? So, it says the intervals the standard intervals of measurement of either 10 or 20 percent of for the positioning electrodes over the anterior posterior dimension between the nasion location. So, point at the bridge of the nose and the inion prominent bump of the back of your head that is the skull and the between the auricular that is the ear position, so here ok. So, this way you need to place your electrodes.

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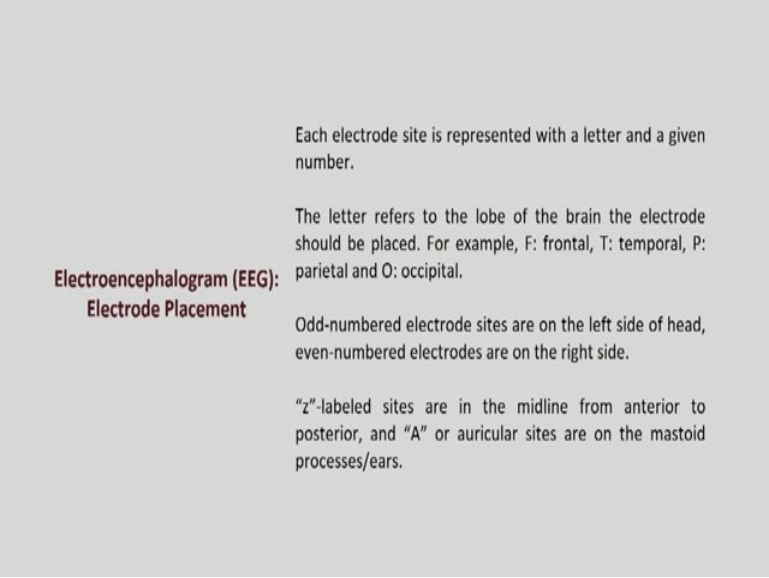

Now, each electrode site is represented with a particular letter which is given a number like if you are putting any electrode that is in the frontal lobe that will be denominated as F, temporal T, parietal P occipital O. So, this way you can give the nomenclature of your electoral. So, its rule that odd numbered electrode sites are on the left side of your head where as even number is on the right side of your head, so that is the rule.

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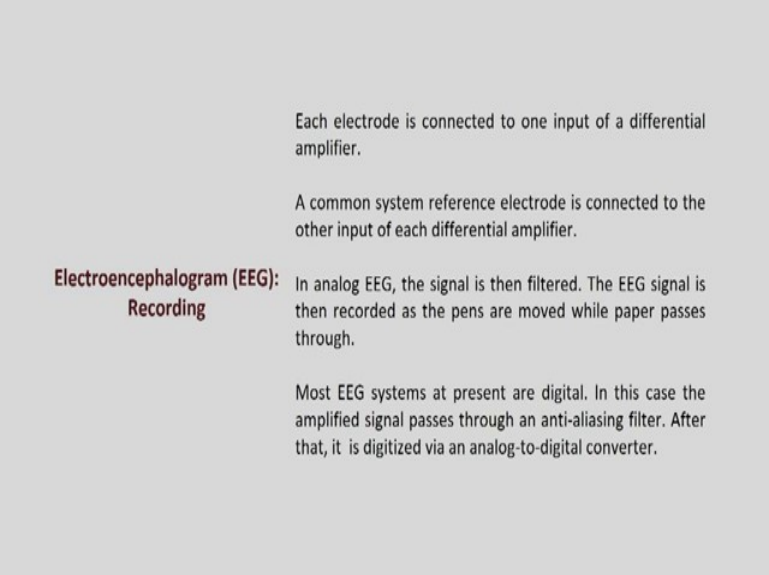

Now, once you start recording this type of like this EEG. So, each electrode is connected to one input of differential amplifier and a particular common system reference electrode is connected to the other output of the differential amplifier; so that is standard. So, in analogue EEG the signal is getting filtered once it get recorded that EEG signal is then recorded as the pens are moved on the on a particular paper like you know it is a kind of rotating valve.

So, paper is moving and there is a pen which is getting recorded. Same we measure we get the cardiogram in a moving paper same smoked paper sometimes in that way similar fashion. So, how brain active brain activity happens needle moves and it keeps on recording; so, that is the way we should record it.

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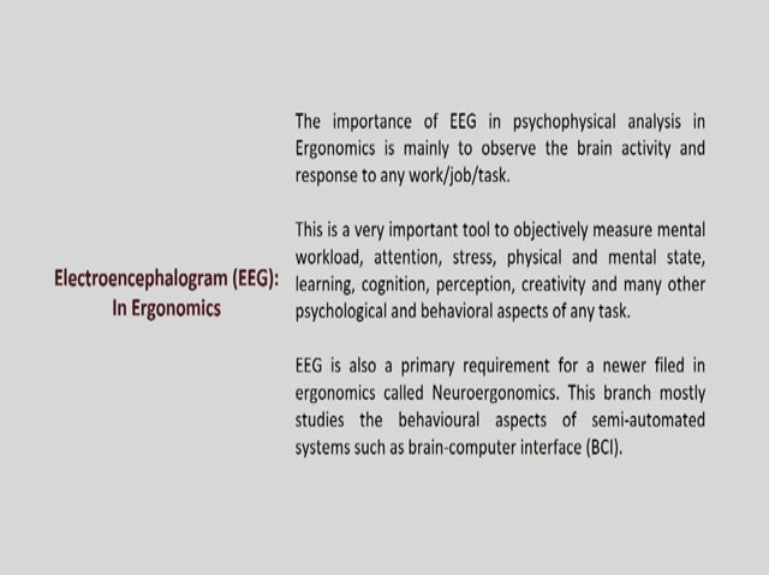

Now, once we record all these EEG value like you know alpha wave we have seen or we see the beta wave or somebody is sleeping we are getting some other wave, what is what we are going to do with this data? We really try to interpret this particular data based on the kind of mental status we have in that particular situation. Suppose a person is working in a particular work station or work place there is some occupational stress in terms of psychological or in terms of know fear understanding or supervisor pressure, how that is getting know activity because see all these stress has an impact on your performance.

So, if you really do not understand the mental status or mental health of that particular worker you will not be able to really interpret. So, questionnaire is a method to understand from the person's perspective, but actually what is happening you do not know. So, being an ergonomist if you interpret these EEG data you will be able to understand the brain activity and their responses at work or job or at particular task, this is also very important when we are talking about design.

Now, let us take example know we have designed a product, how the operation of the product function of that product or aesthetics of, how it is impacting on the human brain, how the human being is interacting with that particular product. Or you are looking at an webpage, how the information is getting focused, how you are trying to understand that all these aspects are very important for the designer to know. So, there we can definitely use EEG recording and UG data for interpreting and further processing or further decision making. So, that is very important.

Here a very new emerging field is that neuroergonomics. What it does? EEG which is primary requirement for this particular field? What it does is it studies the behavioral aspect of a semi automated system which is brain-computer interaction. So, brain computer interface we rather call. So, this neuroergonomics is very challenging filed and EEG is one of the best instrument or best tool we can say for this particular filed and we can utilize it for further recording or interpreting the data So, we completed EMG, ECG and EEG.

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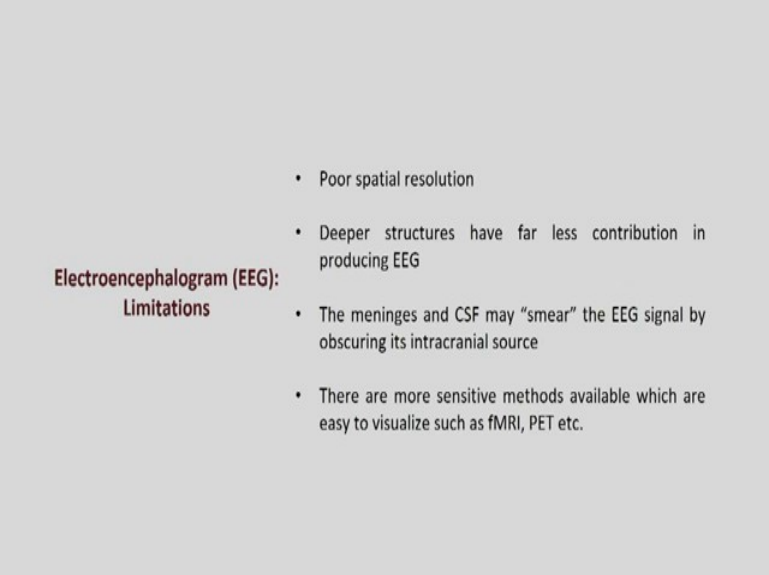

Now, let us go for going further let us understand some limitation of this EEG it is very spatial. So, its spatial solution is very less. You will get more sensitive recording if you do FMRI, PET and all. But of course, these are very expensive. Deeper structure of your brain may not contribute to this particular EEG wave, so you may not get proper understanding of it. So, that is one limitation. And meninges and CSF may smear the EEG signal by obscuring its intracranial source. Those transactions like when these intracranial sources are giving the potential it may not get reflected properly. So, there may be some obstruction.

So, these are the kind of limitations we have when we are using EEG. But any way still we have lot of scope to use EEG and get proper information of it. So, I always encourage to if you have the context to use of EEG you please use it and you have more objective value for interpreting your result. So that is very important.

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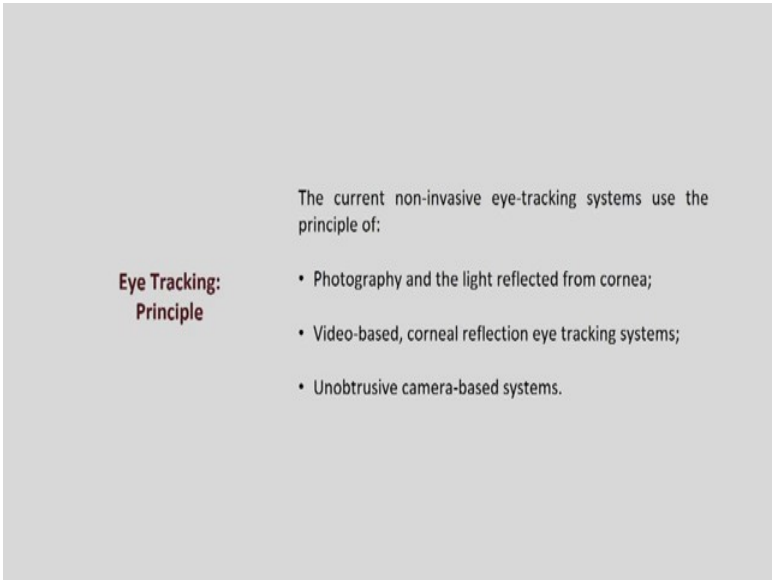

So, once we complete all these electrical potential recording let us try to understand one more important or frequently used method for ergonomic analysis and product design that is eye tracking system. So, tracking the eye movement or tracking how the human being is looking at the object and taking decision or interpreting that particular perception all those things is depending on the you can be evaluated by this particular system.

So, again it's a non-invasive system. It follows mainly three principles: one is photography and the light reflected from the cornea, second is video based corneal reflection eye tracking system and third is unobtrusive camera based system.

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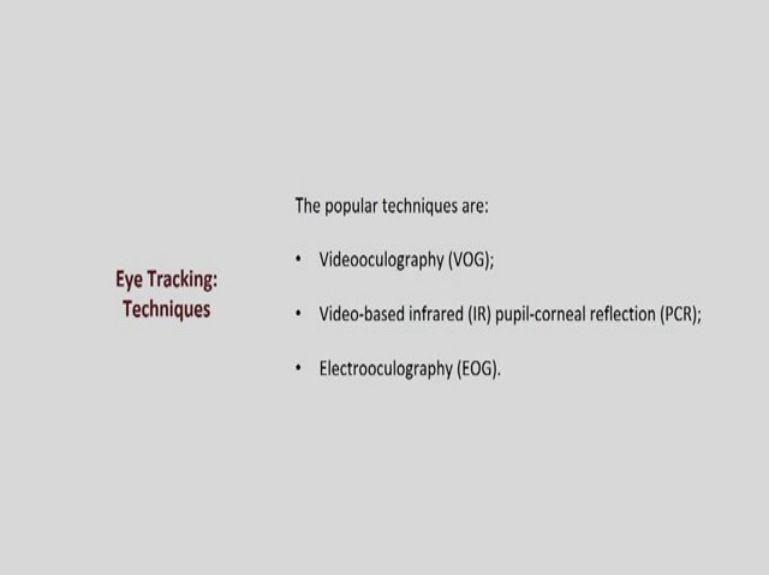

So, these are the principle we use and we have three very specific technique; one is videooculography, video based infrared pupil corneal reflection and electrooculography. So, I will be describing all these separately.

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Eye Tracking: Video-based Tracking

A video-based eye tracking system can be either a remote or head-mounted configuration.

Components of the setup: a video camera that records the movements of the eye(s) and a computer that saves and analyses the gaze data.

In remote systems, the camera is typically based below the computer screen.

In head-mounted systems, the camera is attached either on a frame of eyeglasses or in a separate "helmet". Sometimes it also includes a scene camera. This is to record the user's point of view and can be used to map the user's gaze to the current visual scene.

So, let us take first the video based tracking. So, what it does? So, a video based eye tracking system can be either a remote or head mounted configuration, it can be wireless also. So, components of this particular set up we have a video camera that records the movement of the eye and a computer that saves and analyze the gaze data. So, when you are looking at some particular object that camera is going to record my eye movement and it is going to transfer to the computer and it is going to record it, save it and further analyze it.

In remote system the camera is typically the based at the below of the computer screen some time, but its then become stationary. So, you may not get the data when the person is in dynamic condition where as you have some system which is head mounted. So, that the camera is attached either on an eye glass. You are wearing goggles and the camera is fitted over here or some kind of helmet you have and you are actually recording the eye movements. So, those types of systems are available.

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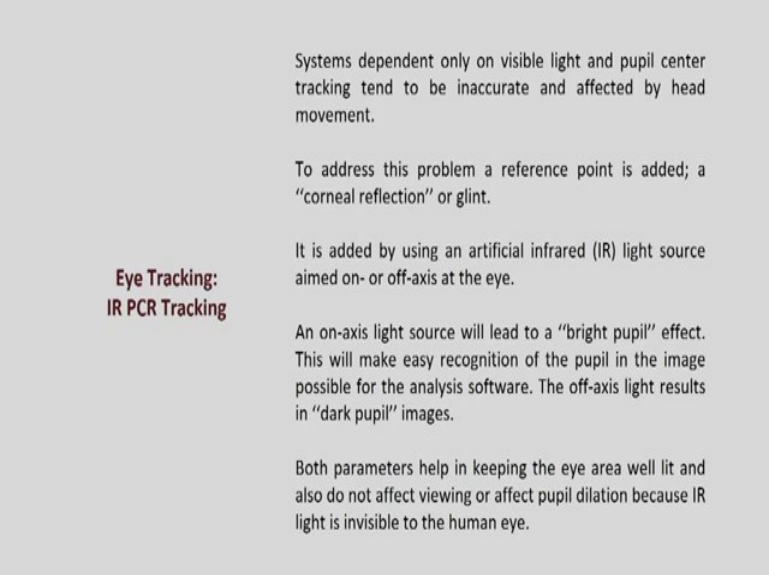

We have one of them I will show in the laboratory how we are doing the experiments with the eye tracking system. In IR, PCR tracking system what we do? System is very much depended on the visible light and pupil center tracking that tend to be inaccurate and affected by the head movement. So, there may be a problem.

So, to address this, a reference point we can add that is the corneal reflection and we call it glint. So, it is added by using an artificial infrared light source and aimed at on or off axis the angle. So, when on axis light source will lead to a bright pupil effect. This will make easy to recognize the pupil in the image wherever it is possible for that particular soft ware to analyze it whereas, off axis light results in the dark pupil.

So, if it is on then it is light bright pupil and if it is off then it is dark pupil. So, both this parameter help in keeping the eye area well lit like the whole eye will be very much in light, but it will not affect the human sight because IR cannot affect the human sight. But again use of IR is a question. So, whenever we are using it we have to be very careful.

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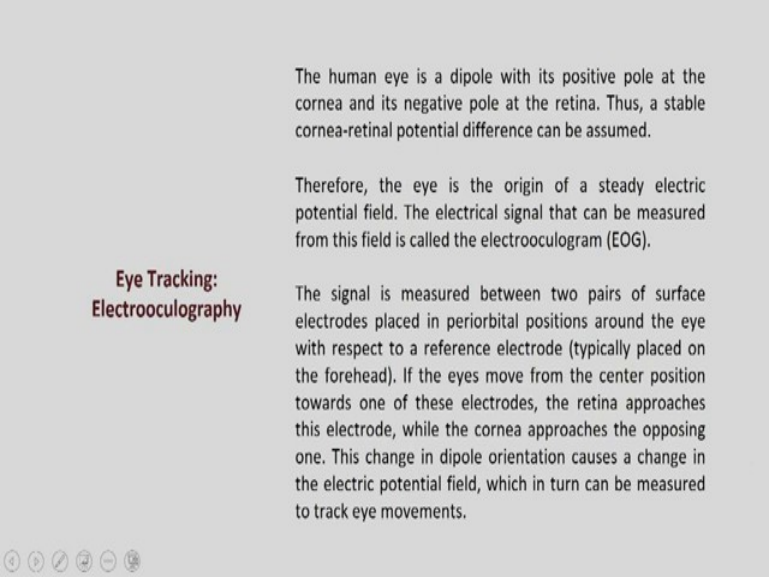

Now, we have electrooculography; we had video oculography here we are talking about electro oculography. It's again the changes in the polarization. In the human eye we have the dipole with positive pole at the cornea and its negative pole in the retina. So, this cornea-retinal potential difference if we can measure, then we will be able to understand how the movement is happening.

So, at the origin of the study electrical field will be there and electrical signal that we can measure from this retinal and corneal dipole, will be calling at the electrooculogram. So, how we are going to measure it? Now, take an example. So, we place two pairs of surface electrode because we really cannot do intravenous thing. So, we are placing surface electrode in peri-orbital position around the eye with respect to a reference electrode. If the eyes move from the center position- suppose I am looking at here. Now, if my eyes are moving on this direction then what will happen? Towards these electrode that retina approaches this electrode, where as cornea approaches to the opposite one.

So, this changes the polarity. This particular difference will be able to record and then further measure and then we will try to understand, how the changes happen, how long that changes happen and from where to where these changes happen. So, this way we actually use electrooculography. In our laboratory we have the first one I will show you during the lab experiment.

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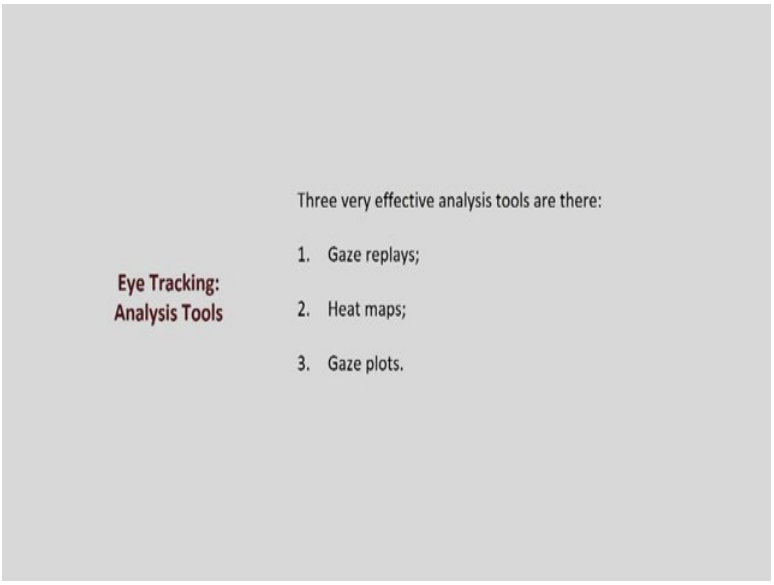

So, when we are talking about eye tracking, we have gaze replays, heat maps and gaze plots these are the three major identified variables that we are going to use or identified nature that we are going to use for interpreting the data.

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Eye Tracking: Gaze Replays

Gaze replays enable watching the test session video with the user's eye motion overlaid over a recording of the changing computer screen image. A blue dot can be seen. This is the user's eye, moving around a page.

Gaze replays are interesting to observe; it can be slowed down and each point of the gaze path can be analyzed and thus the information about all the fixation points.

However, gaze replay is a time consuming process.

So, let us understand what gaze replay is. So, gaze replay enable watching the test succession video with users eye motion overlaid over a recording of the changing computer screen image. So, when the screen image is changing how it is moving, so that you need to see. A particular blue dot will be there which will continuously move on the screen and if the particular person is looking at first here then here then here and then know somewhere in the screen will be able to see that blue dot is moving. So, how long that dot is holding where and all those things we will be able to map it.

So, gaze replays are very interesting to observe because it really shows how my eyes are moving in the screen also it helps to understand my path gaze path like from where to where I am moving I means the subject is moving. So, that is very important. But yes this particular process is time consuming you should be very careful before planning this particular experimental set up or experimental study.

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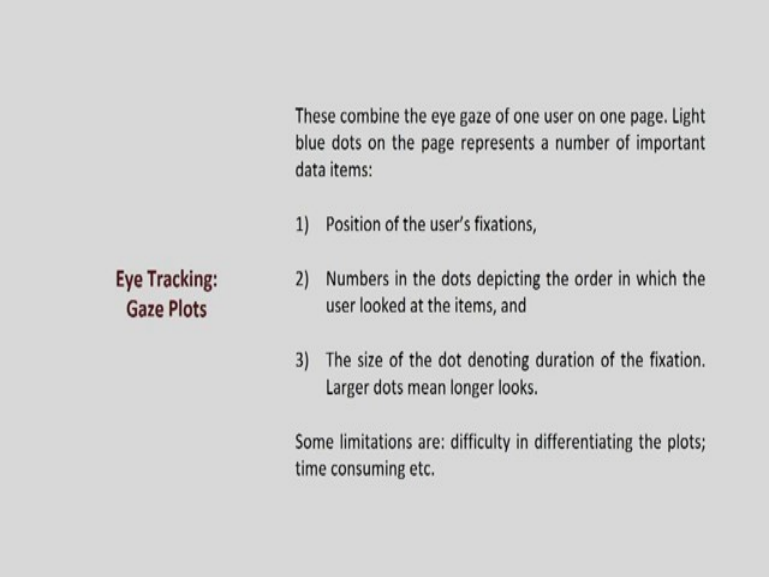

Then gaze plots; so here we have users' fixation, position of the users' fixation: numbers in the dots depicting the order in which users look at the item and the size of the dot demoting the duration of the fixation.

So, if the dot size is larger; that means, you looked at the particular portion for longer duration, if it is less diameter is less you have looked at for less amount of time. So, this way through gazes plot also we can understand how my eye tracking or eye movement is happening.

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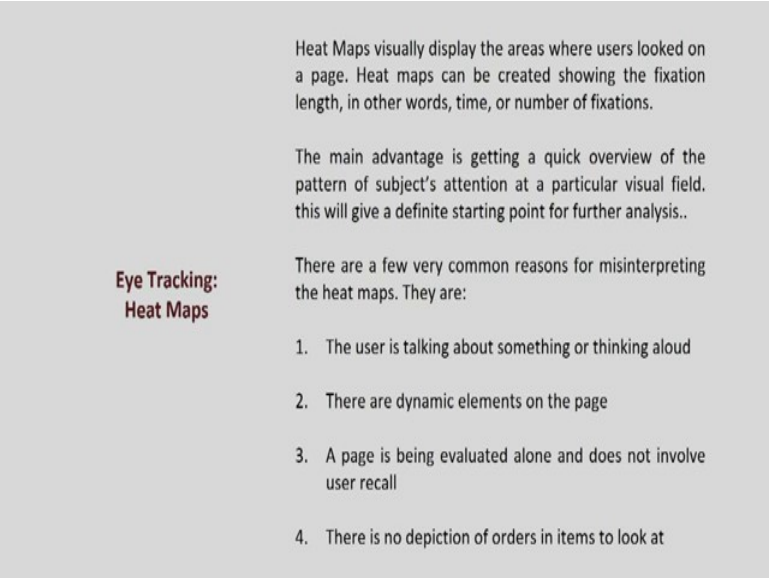

The third one is the heat map. So, here as the nomenclature says heat map, if I am looking at the particular object it will the portion that location will denoted by the red color where as when you are looking at for that particular place for lesser duration, it will be as a blue color; blue means cold, red means hot.

So, that way you can identify in the on the screen or on the product or on the shelf or on the display image where the person is looking how long what is the concentration and all those things. Here it is very important suppose I am looking at particular object and you know thinking something. So, how do I identify that? So, or I am looking at particular object like physically, but really I am not mentally present in that particular place. So, how do I understand that.

So, here integration of different system is very important, especially if you integrate eye tracking and EEG then it will be very good to interpret the whole context properly. So, many times it happens that user is particularly talking about something and thinking something else or there are lot of dynamic elements on the page. So, how to interpret that? Maybe there is a page is being evaluated alone and does not involve the users recalled. How you are going to evaluate these entire things there you may have some misinterpretation of your data and you should be very careful.

So, whenever you are using eye tracking system before collection of the data you first prepare the experimental setup, try to understand what are the clauses are involved for this particular situation, try to understand the context properly and then do some trial and then only start your actual data collection that is the best option if you want to get a proper and nice result out of your experiments. So, this is very important.

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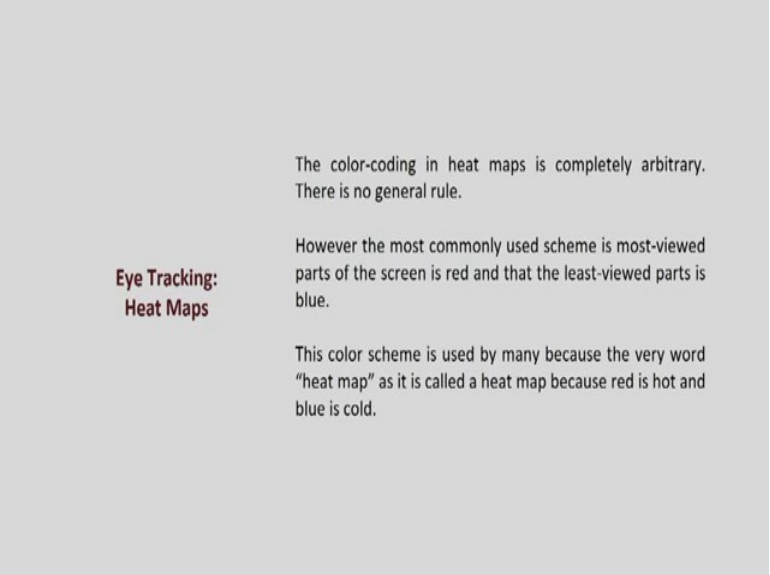

As I mentioned earlier that color coding like know for this hit map that red is hot; that means, you are looking at that particular portion for longer hours very intensive looking whereas, the other one is cold where you are not looking for longer hours or no its not least viewed area.

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Eye Tracking: In Ergonomics

It is a technique for collecting information about human perception, cognition, and behavior.

Eye-tracking is a mean of analyzing aspects of sensory perception in the visual modality—where the subjects are looking.

These locations of visual perception can be used to infer foci and patterns of gaze. These parameters are important to understand human cognition and behavior.

Currently, eye-tracking hardware has been developed to make it mobile, so that data can be collected not only in research laboratories but also in the field.

So, how this particular method is helpful in the field of ergonomics? Suppose you are designing workplace or you are trying to set up an work place how the person is going to interact with those element of the system and how those elements has an influence on the workers performance you can really monitor or really understand or take a pre measure using these eye tracking system.

So, eye tracking system also helps for the cognitive ergonomics because it helps to understand the perception of that particular product, if it is integrated mainly with the EEG system. That helps a lot. Also eye tracking hardware has been evolved. If you see our instrument you can see lot of improvement from the earlier one.

Nowadays all these wireless technology are involved, so if you have those instruments you really can monitor. In case of design off course how that design has an impact on the user you can really measure it. Specially in case of merchandising it is very important. Display design, then in the galleries and all you really need to know how the eye movements and happening how the color, how light has an impact on the gazing and all those things. So, this type of study is very dependent on the eye tracking system.

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So, again I would like to refer these are the books through which you can study all the things whatever we discussed today and if you have any query or any question. Basically these are very technical in nature whatever we studied today and last class So, understanding, detailing is very important.

So, you read it, try to practice it. If you have the facility available or you try to contact your nearby institute where this type of facilities available at least you try at least one experiment and then let us know you your constrain or let us know how you are interpreting your data. So, what you can do, you take example you create your own context and know collect your data accordingly and share those interpreted result with us. So, that we can understand you have understood correctly or not, till then.

Thank you.