Usability Engineering

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Module - 06
Lecture - 20
Eye Tracker

Hello everyone. Welcome to this module of lectures. In today's session I would be discussing about the Eye Tracker system and its relation with various commercial and research applications. So, first of all let me tell you the overall outline of this session. So, the first thing that I would be discussing is the evolution of eye tracking device; how the idea initial idea came into being and what is the present status of eye tracker in today's market.

Secondly, I would be introducing various key terminologies associated with this field. This is significant because it will help you to conduct market survey in this domain, as well as it would be supporting the researchers to identify and understand research articles in this field.

Thirdly, I would discuss the different types of eye trackers that are available in today's market. Fourthly, I would be telling you about various psychological experiments and how does psychological experiments can be related with the eye tracking devices. And lastly, the discussions would cover the step by step procedure of using an eye tracking device.

One thing is to be noted here that, I would be discussing the step by step procedure keeping in mind of a particular brand of eye tracking device; however, there are lots of brands of eye movement recorders that are available in the market, but more or less the steps of execution are same for all the devices.

Next, let us start with this session. First of all, what is an eye tracker? An eye tracker to start with the definition, is a sensor-based technology that allows an individual to record the eye positions and capture the eye movements. Next, this kind of device is widely used in commercial applications.

We have seen wide applications of eye tracker in advertising, user experience, point of sale displays, placement of products where we can identify how one product can be placed after the another similar to market service. Secondly we have seen its application in research as well, specially we have seen its application in social and psychological experiments.

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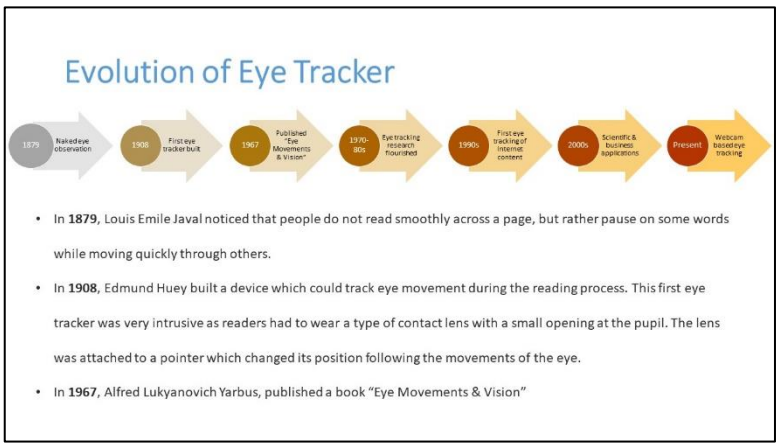

We will start with the evolution of eye tracker. So, the initial phenomena started in 1879, where an individual named Louis Emile Javal noticed that people do not read smoothly any textual content. Sometimes they jump from one part of the text to another; and sometimes they stop at some point of time, sometimes they hurry or sometimes they are very slow, sometimes they ignore some portion of the text.

So, it is not a smooth phenomenon. So, this was first identified during 1879. Later in 1908, a scientist named Edmund Huey, who has built the first ever eye tracking process. This device was little bit intrusive and there was a contact lens associated with the eye. There was a small hole in the contact lens near the pupil.

The lens was attached to a pointer which changed its position following the movements of the eye. Later on in 1967, Alfred Lukyanovich Yarbus published significant an influential book titled" Eye Movements and Vision". This was really influential book during that era, which give a tremendous information about eye movements and its recordings.

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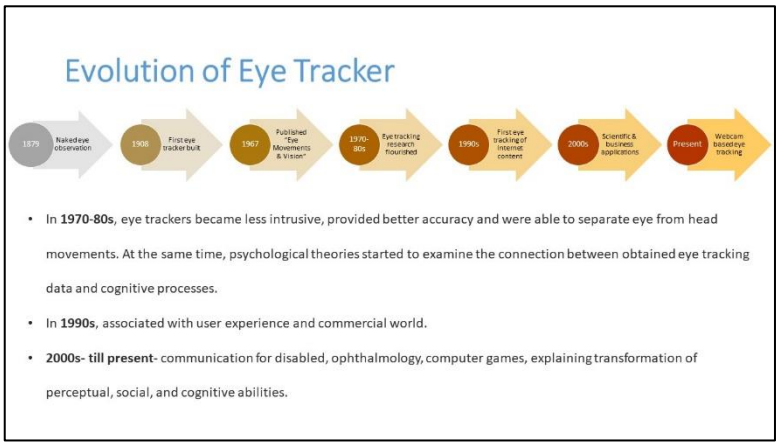

During 1970s and 80s, there was an huge advancement of eye tracking devices. Eye trackers during that time became less intrusive and the they were giving better and accurate measurements and they were able to separate the eye from the head measurements. At the same time, it was seen there was a strong establishment between the eye movement recordings and psychological experiments during this era.

In 1990s it has seen that the eye tracking devices was highly associated with user experience and commercial world of entertainment and advertising. And, then from 2000 till today, eye tracking has been widely used in various applications and research starting from communication with disabled individuals to the usage in ophthalmology. It acted as a input device in computer games. It is able to explain transformation of perceptual, social and cognitive abilities.

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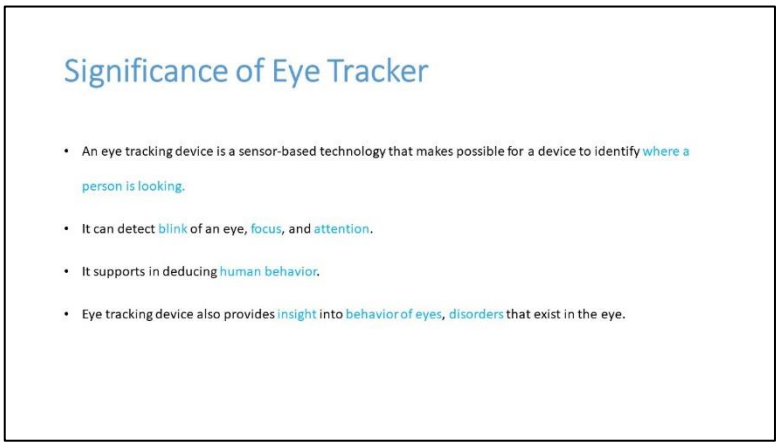

Now, let us identify the significance of eye tracker. Why do we need the eye tracker? First of all, as I mentioned and eye tracker is a sensor-based technology and in a Layman's language it will help you or support you to identify where a person is looking at.

Additionally, it will give you several other information about an individual and his or her eye. It can help you to detect the blink of an individual, it will give you information related to the focus or attention of an individual. Finally, it will help researchers to deduce or derive human behavior. Eye tracking device also provide significant insights in the field of identifying the behavior of eyes and any kind of dysfunctionalities or disorders that are present in our eye.

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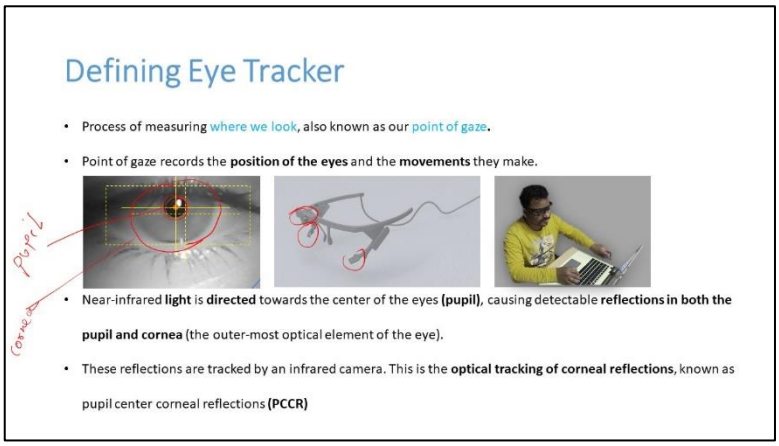

Next, let us see some of the key terminologies associated with the eye tracking device. The first one that is what mentioning is point of gaze. Point of gaze is simply if I say it is where we are looking at; at a in a particular stimuli or in real world. So, it is the process of measuring where we are looking at is called as point of gaze. The point of gaze tells you the position of your eye and the movements they make.

Next, there are several types of eye tracking devices. The one is here with me this is a head mounted eye tracking device which can be used in laboratory experiments. The eye tracking device consists of several cameras. One is a camera in the front which sees or captures the computer screen; and at the bottom there are two cameras that remains or that remains in front of your eye. These are not normal cameras, these are infrared cameras.

So, internally there can be one or more than one infrared camera's attached with this. You can see the image over here. This is the same eye tracking device that I have shown. These

are the camera's that is present over here, and this is the world view camera. So, a respondent is wearing this camera and doing the experiments.

In the left part of the slide, you can see the image of an eye it shows the parts of the eye. So, as you know this portion is called as the pupil and the outer part is referred as the cornea. Now, let me explain how does the eye tracking device or the eye movement recorder works.

First of all, the near infrared light is directed towards the center of the eye that is the pupil causing detectable reflections in both the pupil and the cornea, that is the outer part of the eye. These reflections that is the vector between the pupil and the cornea is tracked by the infrared camera this is called as the optical tracking of corneal reflections and which is known as Pupil Center Corneal Reflections termed as PCCR.

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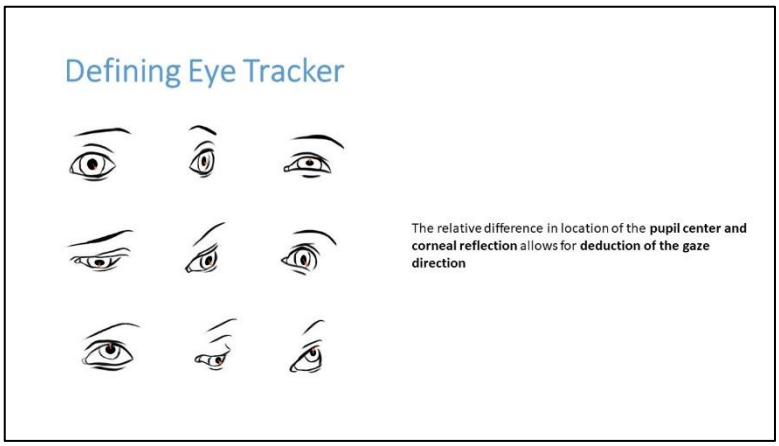

Next, the relative difference in location of the pupil center and corneal reflection allows derivation of the gaze directions.

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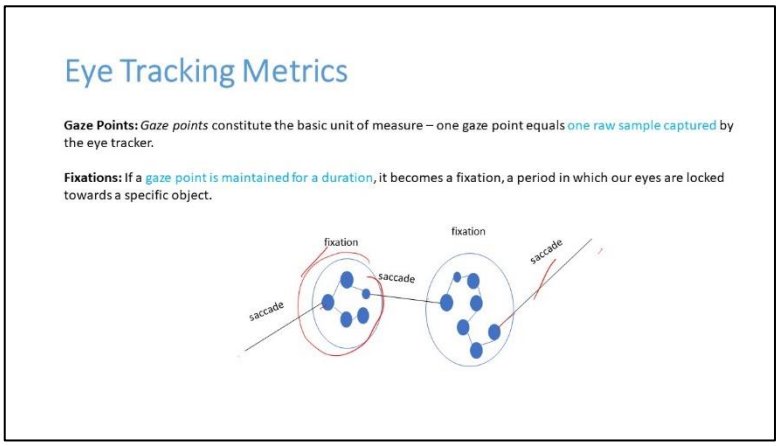

Now, let us focus on some of the key terminologies that are used in this domain. The first of all, as I already mentioned is the gaze or the gaze point. It tells you or it allows one to capture raw data.

So, whenever you looking at any stimuli or anything in the real world, it is considered as gaze. So, the gaze point constitutes the basic unit of measure. One gaze equals one raw sample captured by the eye movement recorder. The second definition is fixation - whenever you lock your gaze or you lock your sight at a particular point in any stimulus or in real world it is called as fixation.

So, a gaze maintained for any particular time stand or a duration is called as fixation. So, you can see in the image. So, if you consider these as gaze; if you maintain the gaze for certain duration it becomes fixation. Now, whenever you look from one point in an in the stimulus and change or moves your eyes from one point to another it is called as saccade. So, movement of eye describes the saccade.

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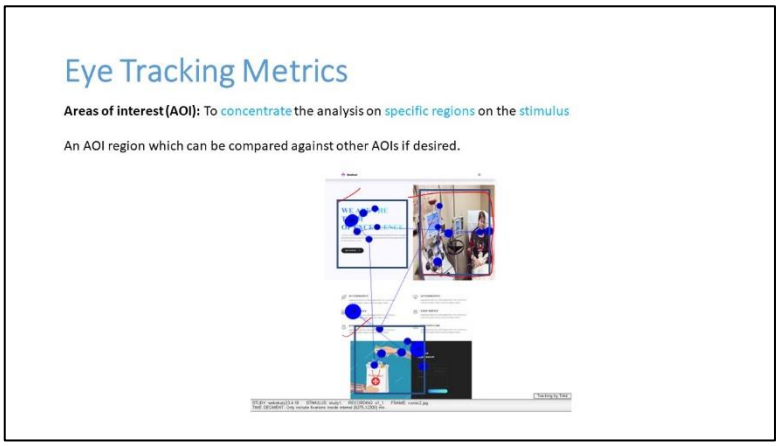

Next is AOI which is abbreviated as Area of Interest. Suppose, you are interested in analysis of a particular region in your stimulus ok, then you can identify that particular region with some kind of markers that are available along with your eye tracking device.

So, it can be a physical marker or a virtual marker. So, the coordinates that you require if you place the markers then that particular area becomes your area of interest. So, it helps in concentrating the analysis on a specific region on the stimulus. Let us see in the diagram. So, this is one stimuli and I have identified various AOI, this is one AOI area of interest where I am interested to analyze this portion of my stimulus.

Then this is another AOI, this is another AOI. So, within this AOI's, I am interested to find various gaze points, fixation, saccades, etcetera. The significance of AOI is that you can compare several AOIs within a stimuli; that is you can compare one AOI with another AOI within a stimuli or you can compare AOIs among multiple stimulus.

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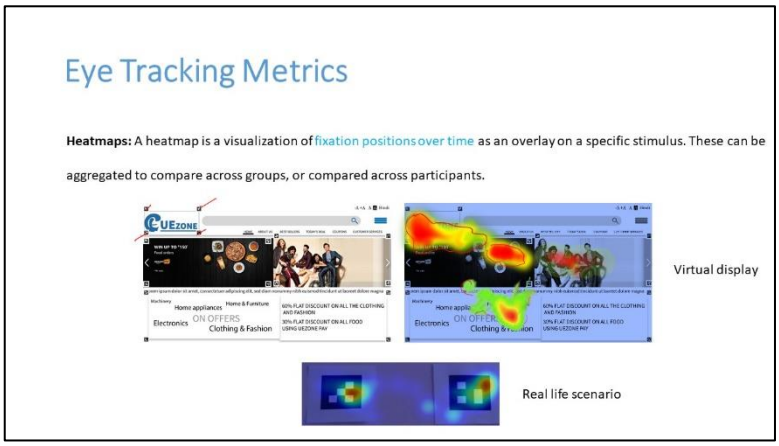

Next is Heat map. A heat map is a visualization of fixations. The fixations can be visualized with some intensity of colors which is referred to as heat map there can be an aggregated to compare these heat maps among groups or several groups. If you see in the image, so, the first image tells you the AOIs, these are the coordinates that are marked and the second image within the AOI, there are certain colors.

So, these colors represent the heat maps. Heat maps as in the fixations over a period of time is represented by using some intensity of colors. And the third image represents the use of markers in real life scenario.

Suppose, you want to capture anything within in a real time environment, so you can place these physical markers that you can take a print that is available for a particular eye tracking device and paste it and you can create the area of interest and do analysis within that region.

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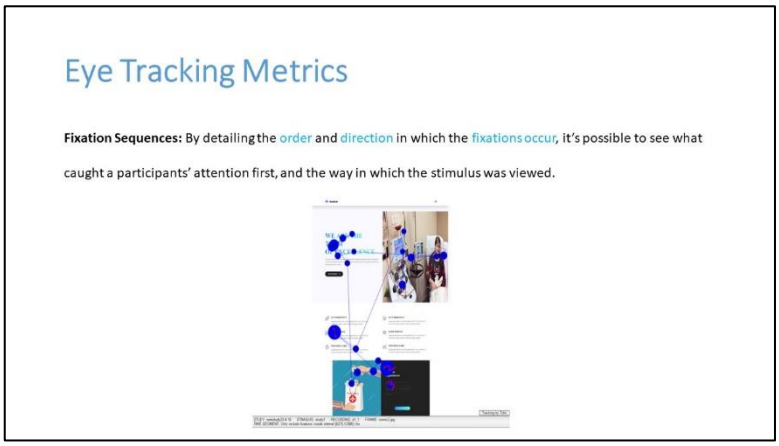

The next definition is fixation sequence - it tells us the detailing or the order and direction in which the fixation occurs. It is possible to see what caught a participant's attention first and the way in which the stimulus was viewed. So, let us consider one example. In a webpage, if there is a logo and then some textual content and again there is an image.

So, where the respondent looked at first for example, the respondent looked at the logo then the textual content and later on the image. So, it will tell the sequence or the order of fixation. So, let us see in the image. So, this is the stimuli. So, you can see several fixations marked with blue color. So, it can be ordered which is called as fixation sequence. For example, the this fixation occurred first, this is second, this is third and so on.

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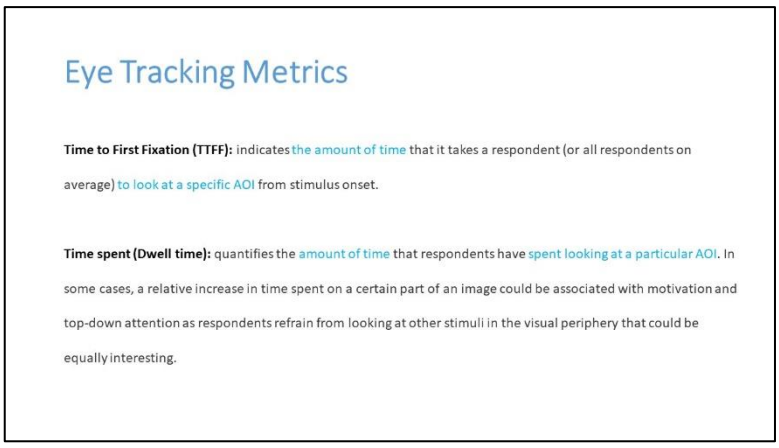

Next, time to first decision TTFF, it indicates the amount of time it takes a respondent or all respondents on an average to look at a specific AOI from stimulus onset. So, whenever

the stimulus starts the time taken by the respondent to look at a particular area is termed as the time to first fixation.

Next is, what is time spent or what is dual time? Both are same, dual time and time spent both are same. It quantifies the amount of time that one respondent spent on a particular AOI; that means, how much time he was spending to look on a particular area of interest. In some cases, it may be certain that part of an image could be associated with motivation or it might be frustration.

So, one disadvantage of eye tracking device or recorder is that it can tell you where you are looking at, but it cannot derive due to what intention or what kind of feeling you are looking on a particular area.

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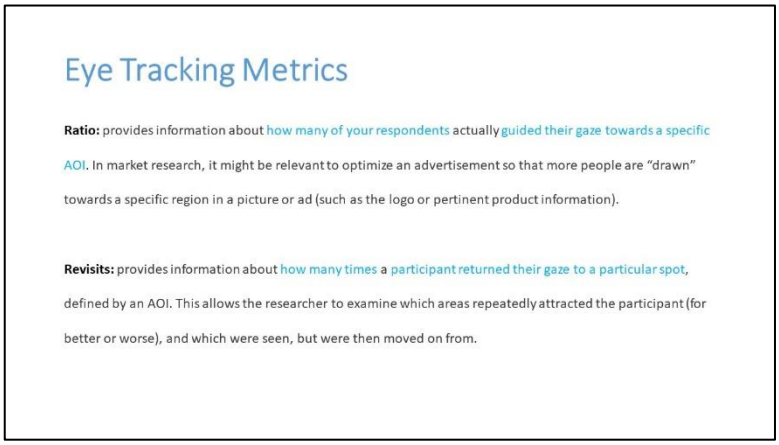

Next, what is ratio? Ratio provides information about how many respondents or subjects actually guided their gaze towards a specific AOI. For example, you have placed a logo in your website and how many respondents gaze is directed towards that logo that is called a ratio.

And this is significantly useful in the in advertising or entertainment where it helps us or it helps them to decide what kind of imagery or what kind of textual content they can keep on their sides so that they can get the maximum attention. Then, significant terminology is revisits it tells you or provides information how many times a participant returned their gaze at a particular point.

So, if you are looking at some visual content in a website and then you have moved your gaze at some other point, and again you are revisiting or coming back to that particular point. So, this gives the measure of revisiting. So, again it is hard to derive any conclusion from this. It is going to give you the quantitative measure, but it is hard to define whether it is due to irritation or it is due to frustration or one is surprised to look at it.

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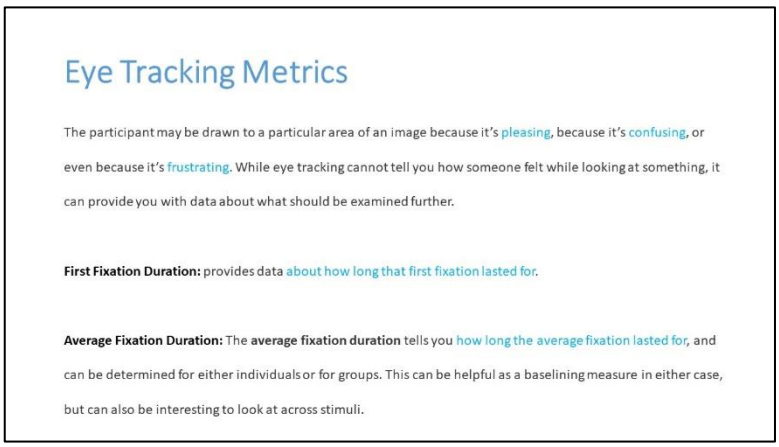

So, the all the quantitative measures are a value by which you can do the analysis, but based on certain psychological test you can derive whether it is due to the pleasing nature of an individual that a person is looking at a particular area of interest or it is due to confusing nature or is it frustrating. While, eye tracking cannot tell you that why someone is looking at something or with what feelings they are looking at something.

Next is, first fixation duration - it provides data about how long the fixation lasted for. Then, you have something called as average fixation duration - the average fixation duration tells you how long the average fixation lasted for. And, it can be determined for either individual or for groups this can be really helpful in baseline measurements in either case, but can be interesting to look at across several stimuli.

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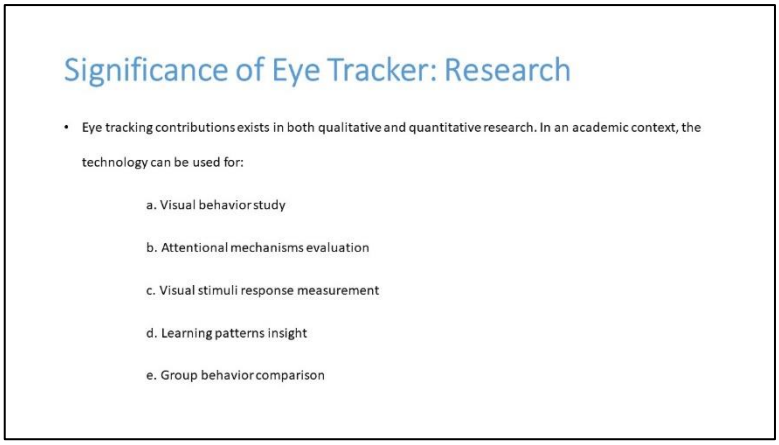

Now, let us focus on the significance of eye tracker in research. Eye tracker is widely used in several research approaches such as quantitative approaches, qualitative approaches or mixed method research approach. There has been wide application of eye tracking research in visual behavior study where one can identify the behavior of an individuals with the visual data that is generated from the eye tracking device.

Next, it can support in identifying attention mechanism evaluation. One can identify the or evaluate the attention or the focus of an individual or respondent. Thirdly, visual stimuli response measurement it might help you in identifying response to a stimulus. Fourthly, it will help you in generating learning pattern insights.

Suppose, you have developed a new application and you can provide the application to your respondents or subjects. And from eye from this kind of device you can identify the learning pattern of your respondents whether they are learning the new application at a very fast pace or they are learning at a medium pace or they have expertise in learning.

So, all these derivations can be done by using the eye movement recorder. And finally, you can do group behavior comparison in between group studies can be identified using this kind of device.

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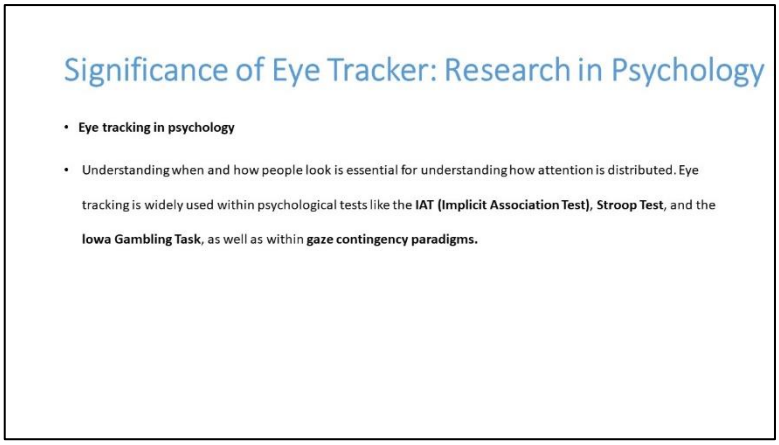

Next, how eye tracking is related with various psychological researches will be shown in the following slides. So, it has been seen that eye tracking is widely used for identifying and understanding how the attention of individuals are distributed.

Eye tracking is widely used in psychological researches. For example, Implicit Association Test IAT, Stroop Test, IOWA Gambling Task and gaze contingency paradigm. So, in this type of test eye tracking devices are explicitly can be explicitly used. Traditionally, psychological experiments were highly associated with questionnaire-based study.

Where the researcher use to interview or give questions to the respondents in order to identify their personality or behavior, but from the past 30 or 40 years, the experiments have highly advanced and the experiments that I mentioned is has been used in this field which is also associated with the eye tracking devices.

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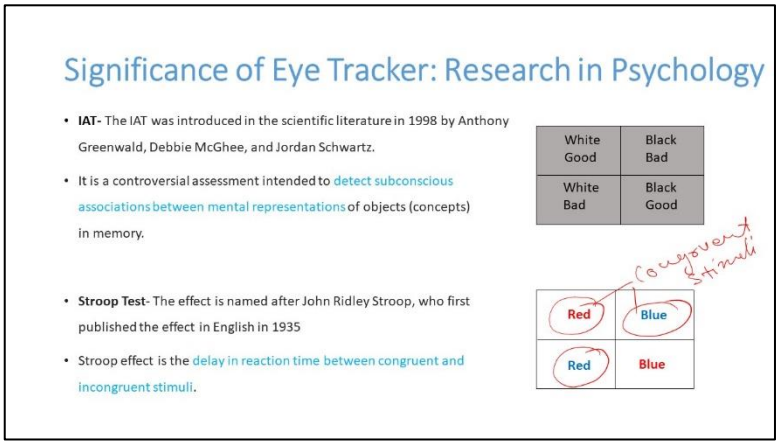

Now, let us see what is an IAT. An IAT is a psychological test that was introduced in the scientific literature in 1998 by Anthony Greenwald, Debbie McGhee and Jordan Schwartz. So, it is a controversial assessment intended to detect subconscious association between mental representation of objects or concepts in memory.

So, it tells you the strength to detect subconscious association among mental representations. So, let us understand this with an example. Consider hypothetically two types of human faces; one is a black face and another one is a white face. So, instructive respondents or subjects whenever they encounter a black face they should click the right key of the computer; and whenever they encounter a white face they should click the left key of the computer.

Now, this is the very simple task, is not it? So, it can be done very easily and you when you identify the performance using the eye movement recorder, it seems to be decent. Now, in the second round of experiments add some constraints to it. How? Let us say for example, consider some positive words. Positive words in the sense like light, flower, wisdom, etcetera and again consider some negative words.

Negative words in as in war, fight, quarrel, etcetera. Now, instruct your respondents in this round of experiment that whenever they encounter a black face in mentally black is represented with negativity. So, whenever they encounter a black face and negative words ask them to press the right key of the computer and whenever the respondents will encounter white face and positive words ask them to press the left key of the computer. This is also simple, is not it?

So, you can identify the performance by using the eye tracking device is you can check that the results may turn out to be decent. Now, in the third round of experiments, just ask your respondents to do vice versa.

For example, if they encounter a black face and if they see a positive word that is light, flower and wisdom ask them to press the right key of the computer. And if they see a white face and negative words such as war quarrel fight ask them to press the left key of the computer.

Now, this is quite difficult for me as well. Now, check the performance using the eye tracking device. Now the performance will degrade you can find the number of mistakes,

the number of eye blinks. And all these kinds of measurements such as blink, the number of mistakes, the time to decide simulating the real-world decisions.

So, all these things can be measured and provide significant insights to psychological experiments the second one type of psychological test is called as stroop test the effect is named after the psychologist John Ridley Stroop who first published the effect of Stroop in English in 1935. The strooped effect is the delay in the reaction time between congruent and incongruent stimuli.

Now, what is a congruent stimulus? Whenever you write a word of a color and you use the same ink of the color then it is called the congruent stimuli. Let us see in the diagram. The first word red is written with a red color, the second word blue is written with a blue color. So, these are congruent stimuli and on contrary if a word of a color is written with some other color other than the color itself.

For example, red is written with something other than red that is it might be blue, it might be green or it might be any other color, then it is called as incongruent stimuli. And if the color blue is written with any color other than blue, then it is called as incongruent stimuli.

So, the difference in response time between congruent and incongruent stimuli can be identified by the eye tracker and may provide you significant insights in this type of psychological experiments.

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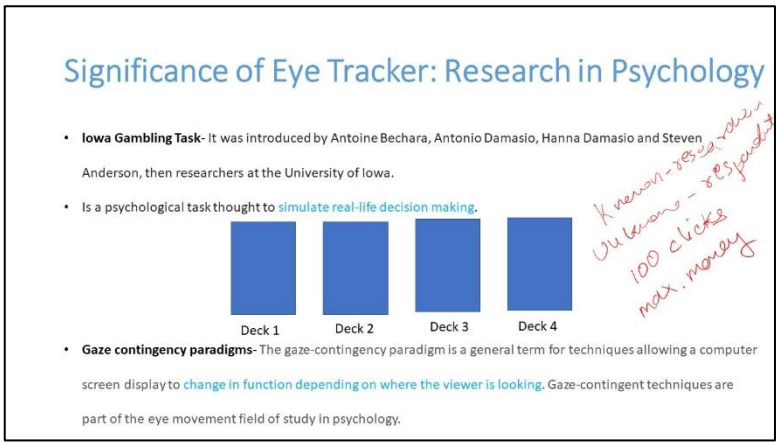

Next one is the IOWA Gambling Task - it was introduced by the psychologist and scientist. Antoine Bechara, Antonio Damasio, Hanna Damasio and Steven Anderson. They were the

researchers of the university of IOWA. It tells it as a psychological task that is designed to simulate the real time decision making. They had seen the figure consider four deck of cards; 1, 2, 3, 4 and you ask your respondent to click on these cards randomly.

Now, the constraint over here is that with stipulated number of clicks let us say 100 clicks they have to gain maximum money with stipulated number of clicks they have to gain the maximum money. Now, the trick over here is that if you click on deck 1, it might make you gain some money if you click on deck 2, it might make you lose some money again if you click on deck 1 it might make you gain some money and again if you click deck 4 it might make you lose some money.

But the pattern by which they can gain or lose money is known to researcher; however, it is unknown to respondent. So, the whenever the respondents start clicking on the deck of cards, they click the cards randomly and sometimes they lose money and sometimes they make money. Until they figure out the patterns they randomly lose and make money.

So, till they find out the exact pattern that helps in amount of time that can be measured by the eye tracking devices. The time they identify the way by which they can gain the money would be identified by the eye tracking devices.

Next is gaze contingency paradigm - the gaze contingency paradigm is a general term for techniques a computer screen display to change function depending on where the viewer is looking at. Gaze contingent techniques are part of the eye movement and highly associated with the psychological studies.

Now, in this kind of technique study is designed where the respondent needs to look at a stimuli and wherever they look at any point of interest the functionality of the screen changes. So, the eye tracking device is highly supported in this kind of psychological test.

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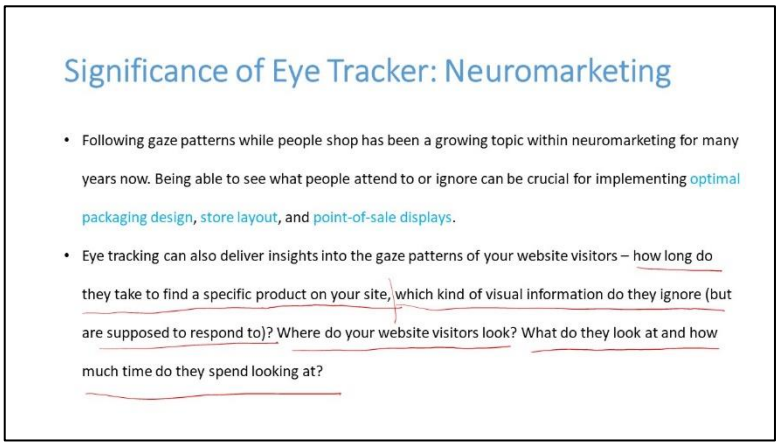

Next, eye tracking is also widely seen in neuromarketing. Following gaze patterns while people shop has been a growing topic within neuromarketing for many years now. Using this eye tracking device, one would be able to find the optical packaging design the it is highly significant in advertising and then the store layout and point of sale displays. It will help you to identify where to place which product so, that it leads to buying intentions of a user.

Next eye tracking device also has been widely used with the development of websites; while using it with the websites you can ask the following questions. So, the first question that you can ask is how long do they find to they take to find a specific product on your site, which kind of visual information do they ignore, but are supposed to respond to?

So, the first question is how long do they take to find a specific product on your site? Suppose you have placed a useful information suppose your intention is to sell something in your website and you have placed this important information on any part of your website. Now how long do the respondent take to find out this significant information can be identified using the eye movement recorder?

The next question is which kind of visual information do they ignore, but are supposed to respond to? For example, let us say for buying a product they have to click on a button. So, they have to respond to this particular button in order to buy something on your website, but whether they are looking at that particular significant information or whether the respondents are ignoring that information can be identified by the eye tracking device.

The next question is where do the website visitors look? So, using the eye tracking device you can tell the respondents or you can identify as a researcher where are your respondents looking at. Are they looking at a particular visual information or are they looking at textual information or you can identify their interest in a particular site? And then you can identify what do they look at and how much time do they look at.

So, you can find out what are they looking at in your website, are they looking at a logo, are they looking at any particular information or are they looking at any visual content etcetera ok. So, that can be identified using the gaze that I have mentioned earlier. And for how much time, what is the fixation for that particular website or a particular area of interest can also be derived by using the eye movement recorder.

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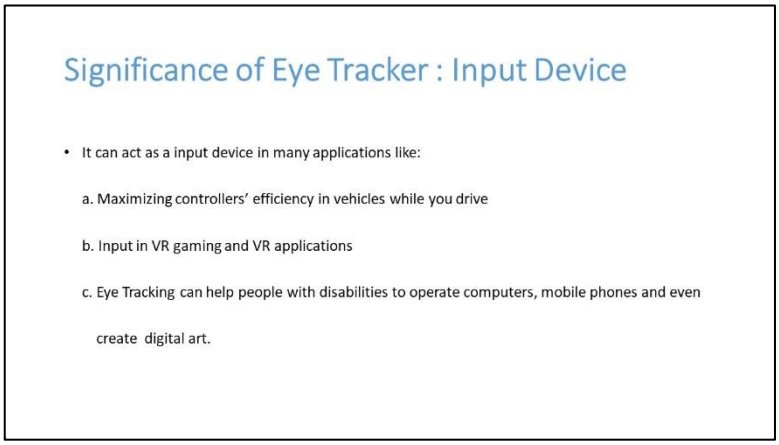

Next, eye tracking device also act as a input in various applications. So, it can be used in maximizing controllers efficiency in vehicles while you drive this is one of the applications of eye tracking device. Next, it can act as an input in virtual reality applications and virtual reality gaming.

Thirdly, eye tracking can help people to operate computers with those who are having disabilities and it can help in tracking people's eye movements in mobile phones and even it is able to create digital art with the help of eye movements.

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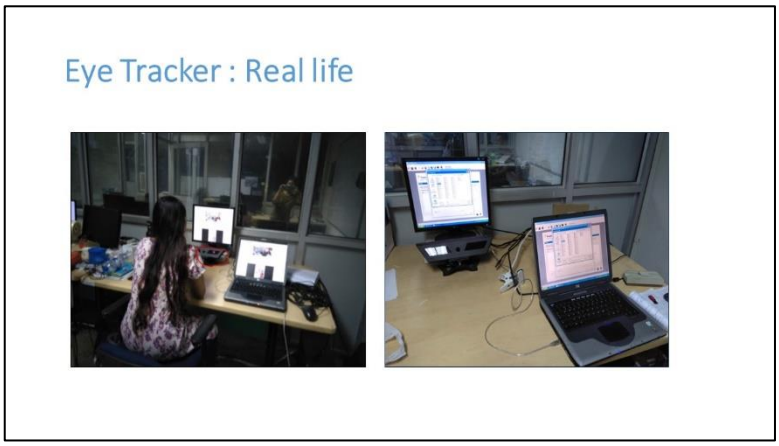

Next these are some of the images that we captured during an experiment in a laboratory using eye tracking devices. Now, as I said there are various types of eye tracking devices. This is a stationery or a remote or desktop eye tracking device which is usually located at the bottom of a screen.

This is the laboratory set up where a respondent is sitting in front of a eye tracking device and looking at a stimuli. And in the second image, we were capturing the data that were generated by the eye movement recorders.

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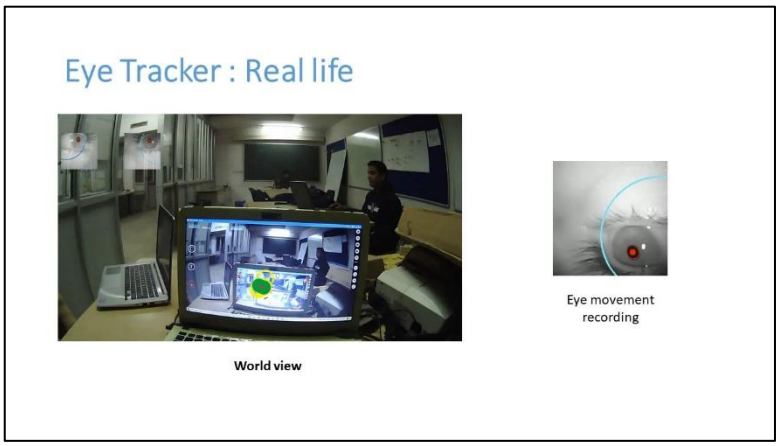

Next, I am going to show you a video when you initialize your eye tracking device then you can identify three types of windows. The first one is the world view window that I am going to show you. And in this, you can view your entire stimuli and apart from that you can view the movement of both of your eyes.

So, in this video you have observed the gaze points, the fixation, where a particular vision was locked on a stimuli and you have found out the saccades. So, all these kind of data can be generated. This experiment was conducted on head mounted eye tracking device and in the top left corner, you can see both windows of the eye that is the left eye and the right eye.

More zoomed vision of your eye movement recording can be seen now. So, this video showed you the reflections at the pupil and cornea that was moved from the infrared cameras of the head mounted eye tracking device.

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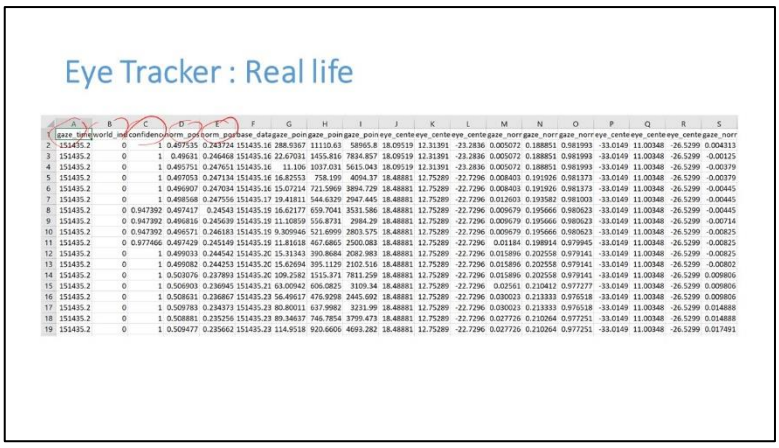

So, once we have finished our experiment we can generate several excel sheets. The excel sheets for gaze points, fixations, saccades; then you can also generate heat maps. So, all these kinds of information can be generated after you are done with your experiment. This is one such excel sheet that I have shown.

It is a gaze plot excel sheet where you can find out the gaze time world index, confidence, normal position x; that is x and y coordinates and so many more. This we are the explanation of this we are going to see in the next lecture where we are going to get a demonstration of eye tracking device and its analysis.

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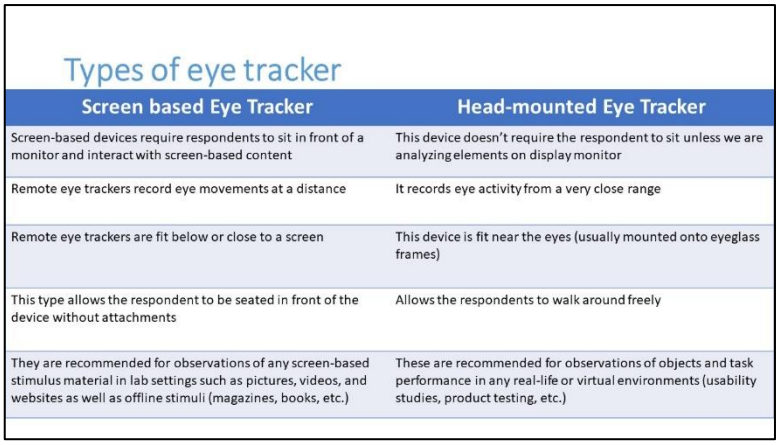

Types of eye tracker

Screen based Eye Tracker	Head-mounted Eye Tracker
Screen-based devices require respondents to sit in front of a monitor and interact with screen-based content	This device doesn't require the respondent to sit unless we are analyzing elements on display monitor
Remote eye trackers record eye movements at a distance	It records eye activity from a very close range
Remote eye trackers are fit below or close to a screen	This device is fit near the eyes (usually mounted onto eyeglass frames)
This type allows the respondent to be seated in front of the device without attachments	Allows the respondents to walk around freely
They are recommended for observations of any screen-based stimulus material in lab settings such as pictures, videos, and websites as well as offline stimuli (magazines, books, etc.)	These are recommended for observations of objects and task performance in any real-life or virtual environments (usability studies, product testing, etc.)

Next, let us discuss the third outline that I have told you the types of eye tracking device. So, we identified two types of eye tracking device. One is generally screen based eye tracker which is also called as remote, stationary or desktop eye tracker; and the other one is head mounted eye tracker which is also called as eye tracking glasses.

So, screen-based eye tracker requires respondents to sit in front of the screen and they can do experiments with any screen-based content. On contrary head mounted eye tracker do not required its respondents to sit in front of the system and they can move around freely. The second difference is remote or screen-based eye tracker keeps a record of the eye movements at a distance maybe 400 centimeter.

Whereas head mounted eye tracker keeps the recording or records from a very close range. Thirdly, remote eye trackers are fit below the screen as I have shown in the image that was a remote eye tracker which was which is usually fit below the screen and attached to the computer screen; whereas, the head mounted eye tracker is generally fit near your eyes. It is like a spectacle that I have shown and you can wear it like a spectacle and do your experiment.

Next, screen-based eye tracker allow the respondent to be seated in front of the device without any attachment. And, on the other hand head mounted eye tracker allows the respondent to walk around freely and another significant difference is that screen-based eye tracker are recommended for observations of any screen based stimulus material in lab settings.

Such as picture videos and websites magazines, books etcetera. Whereas, on the other hand, head mounted eye trackers are recommended for observations or of objects or task

on sight that is you can do usability testing, product testing, by moving around and going to any particular sight.

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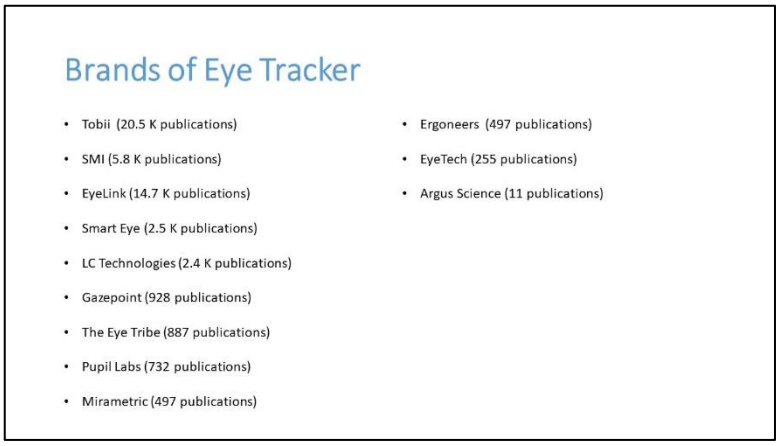

Now, there are various brands of eye trackers that are available in the market. Some of the list of eye trackers are to be SMI, Eye Link; and they have huge range of publications Smart Eye, LC Technologies, Gaze points, Eye Tribe, Pupil Labs; the one that I showed you is from Pupil Labs, Mirametric, Ergoneers, EyeTech, Argus Science these are relatively newer ones. So, there are various brands that are available in eye tracking devices. Now, you have to identify what is significant for you in your commercial application or for research use.

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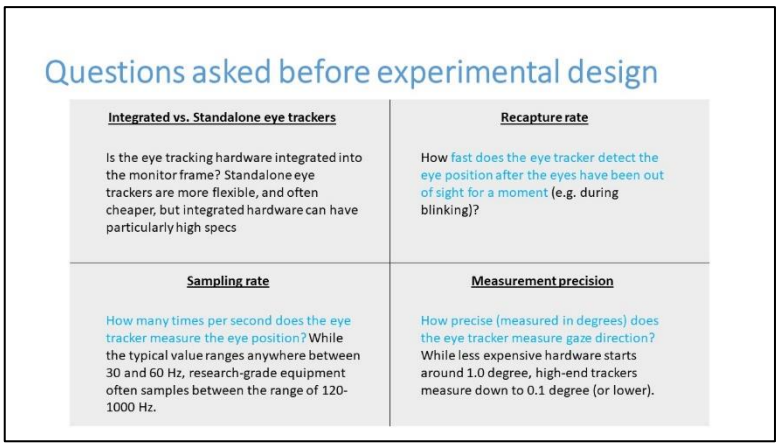

So, before you plan your experimental design or you have to buy a eye tracking device for your individual or laboratory purpose. The questions that you must ask are first of all whether you require an integrated device or a standalone device.

Next, you have to ensure the recapture rate of the device. Thirdly you must identify the sampling rate of the device and finally, the measurement precision. So, first of all let us focus on the first question that is whether it is an integrated or a standalone device? Now, you have to identify is the eye tracking hardware integrated with some kind of screen base system or it is a standalone one.

The standalone ones are flexible and it is dedicatedly used for the eye tracking recording experiments. The second one is the recapture rate - it tells you how fast does the eye tracker detect the eye position after the eye has been out of sight for a moment right. Suppose, you have looked somewhere out of your area of interest or you have blinked for some time.

So, how fast that after blinking how fast does it cap recaptures your gaze. So, that can be measured by the recapture rate. Next, sampling rate - how many times per second does the eye tracker measure the eye position; while the less cost devices which are used for commercial use they can use 30 to 60 hertz of sampling rate whereas, if you are explicitly use using the eye movement recorder for your experimental use then you have to go for high end devices which can be starting from 120 hertz to 1000 hertz.

And finally, the fourth question that is measurement precision - how precise it is usually measured in degrees does the eye tracker measure the eye detection. For the low even for this the low cost device which is usually measured in degrees starts from one degree and if it is really high end system then it can be 0.1 degree or even lower.

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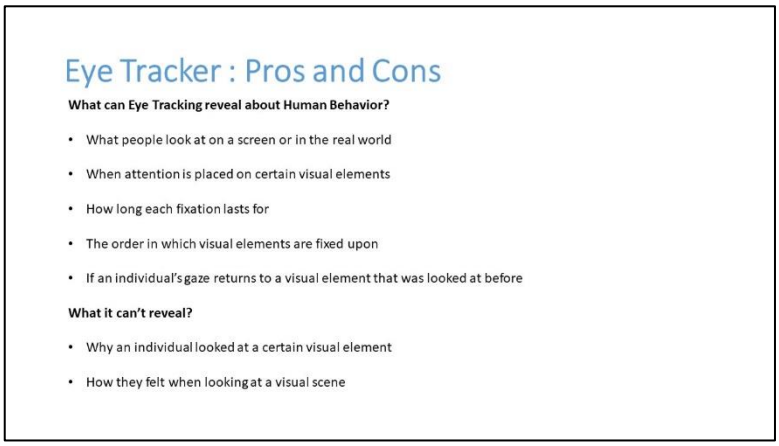

Now, let us come to the pros and cons of eye tracking devices. Now, the eye tracking device as I mentioned can give you quantitative data, but some kind of crucial derivations are not, significant or not or cannot be done in the using this kind of devices for example, let us first focus on what can a eye tracking device reveal about a human behavior.

The first one is what people look at on a screen or the real world that can be identified using an eye tracking device; that is the gaze positions you can identify the gaze positions using this eye tracking device. The second question that it can answer is, where your attention is? That is it can identify the fixation.

Third is how long does the fixation lasted for the time of fixation and then the order in the in which the visual element was viewed that is the sequence of fixation which part of area of interest was viewed first and then which part is viewed later. And finally, if an individual has returned its gaze to a particular area of interest; that is whether they have revisited or not.

And there are some things that the eye tracker cannot reveal. The first of all it cannot tell you why an individual looked at a certain visual point what is the intention, and while looking at a particular object or a particular point in your area of interest, what are their feelings? Are they happy? Are they surprised? Are they confusing? So, it is hard to determine and requires future investigations to conclude on these questions.

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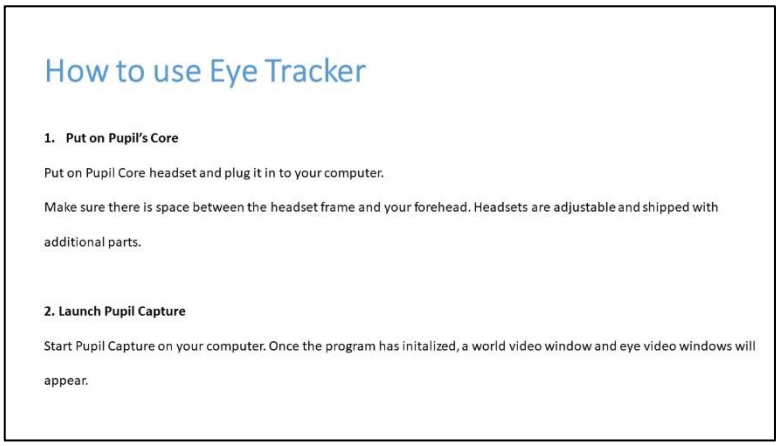

And we have come to the last part of the lecture where I am going to tell you how to use a eye tracker. As you note noted earlier that I am going to explain the steps from the point of view of a particular brand of eye tracking device, but the steps of execution are more or less same for other brands as well that are available in the market.

The first is you have to put on your pupil core the one that I have showed you head mounted glass that you can put on as like a spectacle. And ensure that, there is a space between the head frame set and the forehead and the headsets and the camera are adjustable along with your eye.

Next, launch the Pupil Capture - Pupil Capture is a software that allows you to capture the stimulus. So, this software is available on the pupil side and you can download and install in your system. And, once you initialize this software you can see three windows as was earlier shown in the video. In one window that is the world view you can find your stimulus and in the two other windows you can find the reflection of your left and right eye.

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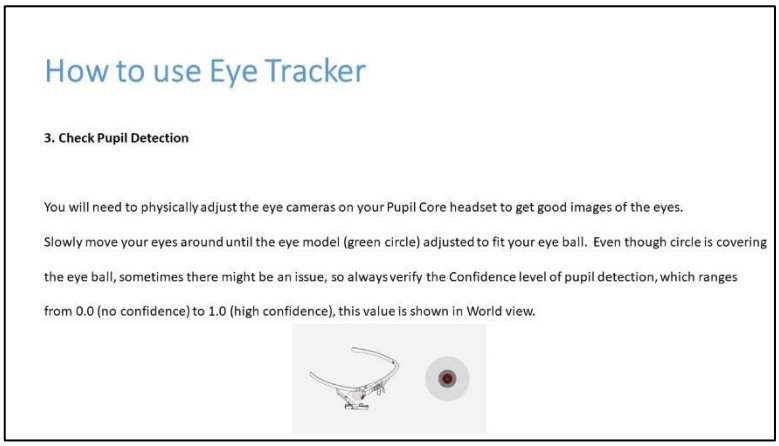

The third step is checking the pupil detection. So, you need to do it physically and adjust the camera along with your eye. And so that you can capture good images. Slowly move your eyes till the eye model that is a green circle adjusted fit your eyeballs even though if you are getting the green circle ensure the confidence. Confidence by which your eye gets captured.

So, the confidence value ranges from 0 to 1.0, 0.0 indicates the confidence is low you cannot capture with this less confidence, you cannot capture. So, you have to capture in the confidence of 1.0.

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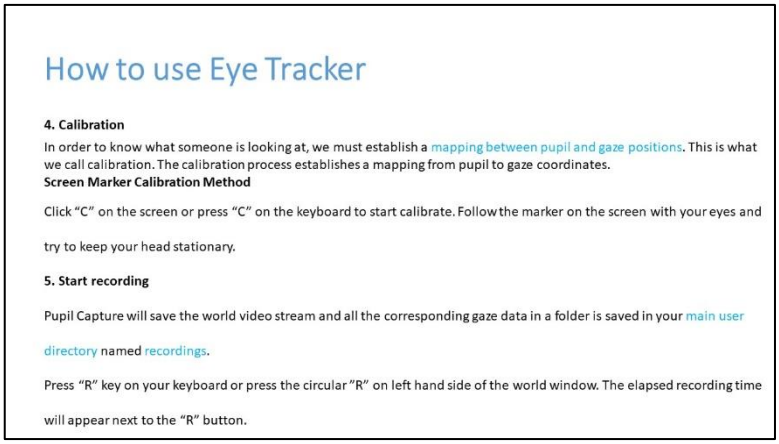

The next step is calibration - in order to know where a person is looking at, you have to calibrate your device. Calibration means it is establishing the mapping between your pupil and the gaze positions that is called as calibration.

That is the establishment or the mapping between the pupil and the gaze coordinates. You can start the calibration by clicking “C” in your keyboard for this kind of a device or there would be a calibrate C button on the world view window in the left-hand side of your screen.

So, you can click the window and your calibration starts. When you start your calibration follow the marker on the screen with your eyes and try to keep your head stationary during calibration.

The next step is start recording - Pupil Capture will save your record data in a folder under your main user directory and the folder name would be recordings. So, when you have to start the recording press “R" on your keyboard or there would be a “R" button on your world view window which you can press. The elapse time of recording will be shown in the worldview window itself.

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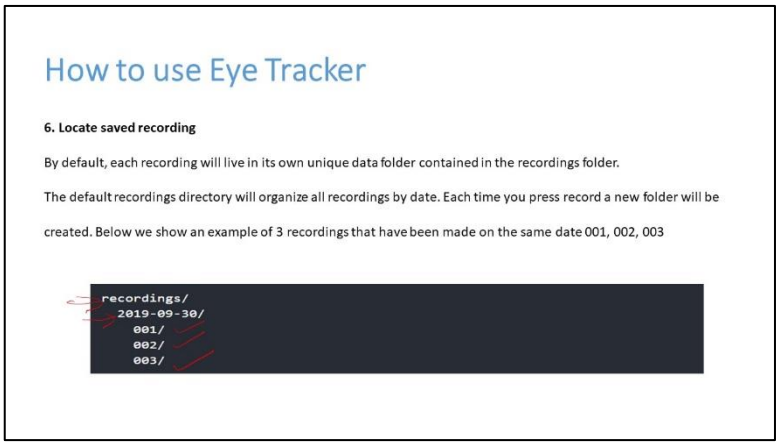

Once you finish with your recording, you have to save or find out your recorded data. So, your recorded data would be in a data folder under your main user directory and which would be named as recordings. And the date you do your recording under recordings folder, you will be getting the next folder with the same date you have done the recording. And under the date folder, you can get the recordings that you have done.

If you have done multiple recordings you can get the folder names as say let us say 001, 002 and so on. Let us see the hierarchy of the files that are generated in the image. So, once you have done the recording. So, this is the hierarchy in the main user directory you will be getting the recordings folder.

And under the recordings folder, the date which you have recorded a folder would be generated and suppose you have clicked 3 times you have done 3 recordings. So, this is the first recording 001, you have done the second recording 002, and then you have done the third recording 003.

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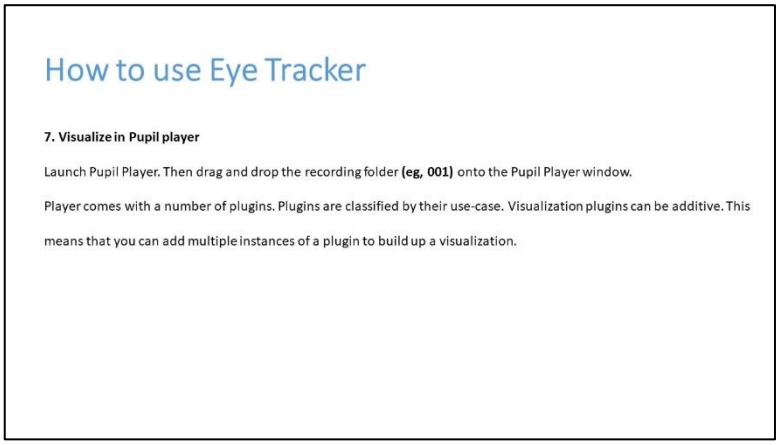

Finally, what you have recorded you can see by using a pupil player. Pupil player is a software and for viewing what you have recorded you can just drag and drop the recorded folder. For example, you have you can drag and drop folder 002 onto the pupil player window.

Pupil player comes with a number of plugins. The plugins are classified by their use cases. Visualization plugins there can be an additive visualization plugin. This means that you can add multiple instances to a plugin to build up a visualization.

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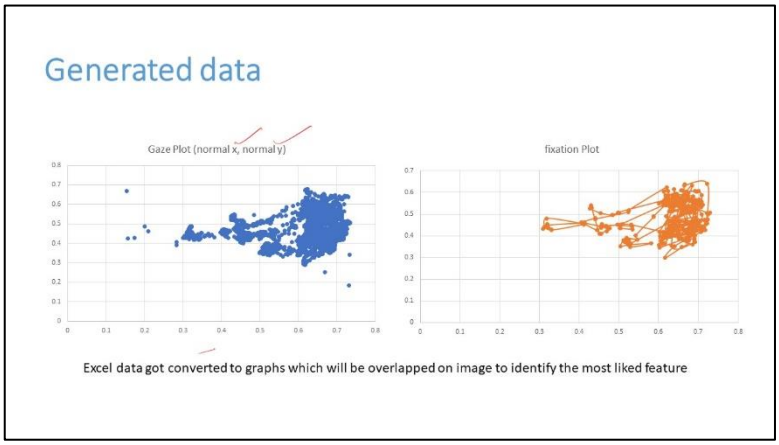

Finally, this is the generated data from the excel sheets that we have generated. So, the graph shows that, first of all it is the gaze plot where it shows the gaze of coordinates x and y since this is the 2-dimensional image. So, there is no depth. So, the first one is the gaze plot where it shows the gazes or where people have watched in the stimuli and the second one is the fixation plot. It is also generated with the coordinates x and y. Finally, happy learning and.

Thank you.