The Nature of Psychology
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Lecture - 03
Sensory Processes

Hello friends. Welcome back to this lecture number 3 on course on Human Behavior. Now, in this course as I promised what we will be doing is we will be studying Human Behavior; how human beings react and what is the way to study human beings; what is the way to study how human reacts to certain situations? This is an important thing and it is difficult also. The reason being that most natural sciences have lost theorems which govern or which direct how to predict the behavior of elements, but with human beings the problem lies in the fact that human beings are studying human beings. And so, it is difficult to study something which it is.

On the other hand the problem also lies with the fact that human beings are unpredictable. The behavior of human beings the reaction of human beings so stimulus are unpredictable and so, once the behavior or the reaction is unpredictable, we need a way to measure this behavior. I will give you an example. Take any person. Now this person will respond to different different stimuluses, differently in different environments.

So, how do we make a prediction? The science of psychology gives us methods and tools to actually make predictions about human behavior. Now the question lies in the fact that why should we study human behavior; what is the reason of using psychology or why should we study psychology? Important aspect human beings from timing memorial wanted to control other people.

One of the best things to do is to control other people and how do we do that only if we can predict the behavior other people and that is why the science of psychology is important. Because psychology is the only science which studies humans; all other natural sciences studies inanimate objects; objects which follow certain theorems. Human beings do not follow certain theorems and that is why psychology is a probabilistic science. It works in terms of probabilities; that is one of the reasons why psychologists are the highest paid jobs in the West.

Now, what we did in the first two lecture, since this is a third lecture and in continuation with the first two lectures on the course on Human Behavior, I will just recap what we did in the first two lectures. So, in the first two lectures what I did was, I introduced the Science of Psychology. So, we started off by understanding the definition of what psychology is; what does it do and why should we study psychology? And in that we outline that psychology is the study of why human beings do; what they do; how they do and how to measure them that is the science of psychology.

It is a study of human behavior and mental processes. Mental process is the reason why humans behave in certain way. Then we looked at the history of psychology where it starts from and as I explained there psychology started from philosophy. So, the old philosophers like Socrates, Aristotle, John Locke, Descartes all these people came up with theories, came up with ideas about how to study humans and from there branched the science of psychology.

So, psychology has 2 fathers; looking at how it progressed. One father is philosophy and the other father is physiology because psychology is the study of not only the thought processes, but also how the brain creates or the mind creates the thought process..

And so one of the most primitive subject matter of psychology was the study of the soul, which is the study of the mind, which is the study of the behavior. Because soul manifests itself in to the mind and mind manifests itself into the behavior and this behavior is actually produced by the brain. So, the study of the brain should how be the study of psychology?

So, that is what we established in the first lecture. We also looked at some schools of psychologies early schools before World War I, for example we have structuralism where everything was in terms of structure, studying psychology in terms of structure; then we looked at functionalism which said that if you want to study a human behavior, you have to actually see the behavior in process because behavior is adaptive.

Then, we moved on to studying the school of behaviourism which basically said that psychology or it could be studied in terms of stimulus response reactions. So, if there is a stimulus. So, there is a behavior and the stimulus and behavior are related together. For example, if a person does the same reaction to the same stimulus every time, it is basically his reaction to it and this is what is behaviourism. And then we looked at the

idea of psychoanalysis and cognitive psychology. So, these are these are the basic schools or positive psychology.

These are the basic schools which we did. Further on, we moved on to the newer schools of psychology for example, cognitive neuroscience psycholinguistics and so on and forth. in lecture number 2, we did a review of all this and looked at the newer sciences of psychology and the various perspectives of how to look at psychological problems and we discussed 3 or 4 if I remember correctly perspectives. Those perspectives where Psychoanalytical Perspective, the Behavioral Perspective, the Cognitive Perspective, the Subjective Perspective and so on and so forth.

So, basically why a particular event in psychology happens can be looked on from different different viewpoints that we discussed in the last lecture. Other than that what we focused on was looking at the various methods of doing psychology and so, there we discussed the Experimental method; we discussed the Correlational method; we discussed something called the Survey method, Literature review method and so on and so forth and towards the end of the lecture in the last class what we did was we looked at Ethics in research.

So, what kind of ethics should be followed in research since psychology is a science which does experiments on human beings. So, what are the kind of ethics that should be followed and some of the ethics is that you should be treating people humanely something called inform consent and so on and so forth. The several other things that that is in terms of ethics; so, what is the things? It is basically how you should deal with human beings and that was what the subject matter of the last lecture was.

Now, from today onwards we look into certain aspects of psychology or certain components of psychology and we will see how these components actually build up in understanding human behavior in understanding human psychology and one of the first primitive things to understand is something called Sensory Processes. Now what is Sensory Processes? Sensory Processes are those processes which actually help you understand or help you perceive the way the world around us.

Now as you know that you have 5 sense organs; most people have 5 sense organs and why is the sense organs there? These sense organs does a wonderful work, it encodes the physical word or it interacts with the physical world and actually gives you the

interpretation, are actually codes the physical world with you. So, you are human beings interaction with the world outside them goes through something called sensory process or sensory systems.

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So, what will do here is very briefly since this is not a detailed course on psychophysics or sensory systems; what will do is, we will give you a touch and go kind of a thing about. What is sensory processes; why they are necessary and how it becomes part of psychology?

So, before starting let us actually create a scenario to give you what sensory process means. Imagine that it is a wonderful starry night and you are sitting on a park bench. The night is wonderful wind is blowing and at that point of time when you are sitting in this night on the park bench there are several things that you hear or several kind of stimuli which is impinging on you several kind of signals from the environment which is in impinging on you.

For example, the rustling of the trees which is impinging on your ears; the light which is coming from the lamppost opposite to you; the scratching which you feel in your leg; the weight of the flowers or the back that you have on your shoulders; the bird that is chirping some further away; the rustling of the wind and so many other things which are there which are exactly being impinging on you.

So, your different sense organs; for example, eyes are seeing something, ears are looking something and so, there is a whole lot of information which you are collecting, which is impinging on you, which is falling on you. These are the ones which you can read; these are the ones which you can hear; these are the ones which you can encode or pay attention too, but these are not the only information which is infringing on you.

There are several information which is which is basically coming to you, but you cannot encode. For example, the microwave transmitter there that is somewhere down the hill is also sending microwave signals of cell phones which is exactly impinging on you, but you cannot hear it because it is outside the range of hearing. The infrared light which is coming from some tower somewhere a microwave tower or some some kind of a cell phone tower which is also impinging, but you cannot actually see it.

The whistle that your neighbour is blowing which is the ultrasonic range or subsonic range to alert the dog, but you are not able to encode it and several other electromagnetic and other kind of patterns and waves are there which you cannot see. So, part of the part of the visible spectrum or part of the stimulus you can hear for which you are tuned to and part of the spectra you cannot hear. So, just sitting on the bench you are not alone, there are so many things; there are so much stimulus which is falling on you and some of you hear and some of you do not hear.

This particular section, we will tell you how you encode or how you notice this signals and not only notice this signals, from these signals create the world for you. In the external world what you hear when you when you see something when you see a tree, what do you actually see? If there is a window and out of that window if I ask you to see there is there is an object of a certain nature, a cylindrical object which is brown in the base and green on the other side on the top side, what do you see? What your eyes actually see is the reflected photons from this structure.

So, the eye actually sees photons, light particles and these light particles which fall on the eye are then carried out to a certain region of the brain which organizes them, compares them to some structure, compares them to some organization, compares them to something representation which you have been encoded before and says that, this is a tree.

So, if somebody wears a brown colour pant in a green colour shirt on the top he is not a tree. But then if something has a brown bark and a green colour leaf, leaf on top of it is a tree. So, how do you distinguish between them, that is the interesting thing. So, what the eyes actually see is the physical stimulus which is basically the photons, but what the humans perceive out of it what the human see out of it is tree and things like that. Now sensation is the part where you actually encode these photons. If it is light or pressure of pressure waves if it is sound or tactile waves if it is touch and so on and so forth.

So, how do you encode a temperature pressure, this kind of physical stimuluses; how the human system or how the human sensory system takes in these informations and from them creates a psychological world that is what sensation is all about.

So, let us then start our journey and then understand what are sensory processes and how this sensation or the act of sensory processes the fact of sensory systems actually work. So, in a very simple way, if I have to tell you the sensory processes are the processes so looking at in this way this is my external environment and this external environment has things like photons, air pressure and temperature and so on and so forth. So, these are the physical qualities; things which physics measure, but then these things when they fall into the human system, this is the human system. So, this is the physical system I would say and this is the psychological system.

So, in the psychological system, these photons from the light air, pressure in terms of sound, temperature in terms of feeling and so on and so forth; then these impinge or this fall on the human being sensory organs, these are the sensory organs if it falls on the sensory organs; how these sensory organs translate this these photons and air pressure and temperature into light or basically the act of seeing air pressure in terms of sound and temperature in terms of things like cold and hot. How do they translate that is what sensory process all about that is what the study of sensory processes all about. So, at this interface where the physical world converts into the psychological world lies the sensory system. So, this is called a sensory system.

So, what is a sensory system sensory system is a detection mechanism. It actually encodes the physical world into the psychological world. In the physical world you have temperatures. For example 2 degree, 3 degree, 4 degree, 18 degree, 20 degree, 40 degree.

On the psychological world you call these numbers as hot, cold, being hot, being cold and things like that.

On the physical world you have photons; 4 photons, 8 photons, bunch of photons, high number 1 billion photons that kind of a thing. On the psychological world you have too bright, less bright, higher brightness, great hue, lesser hue; were colour, non colour and things like that. On the physical world you have tones like 1 hertz, 5 hertz, 10 hertz, 50 hertz, 20 hertz, 200 hertz, 1000 hertz. On the psychological world you have dimension likes loud, high pitch, low pitch, low tone, high tone things like that.

So, how these physical stimuluses is gets converted into the psychological stimulus and how does this matching happens is what sensation is all about. So, sensation is a process which encodes the physical stimuluses and mix and encode and throws it back or basically converts it into a form so that the brain can understand and make meaning out of it that is what sensation is all about. So, let us start this section on what is Sensation?

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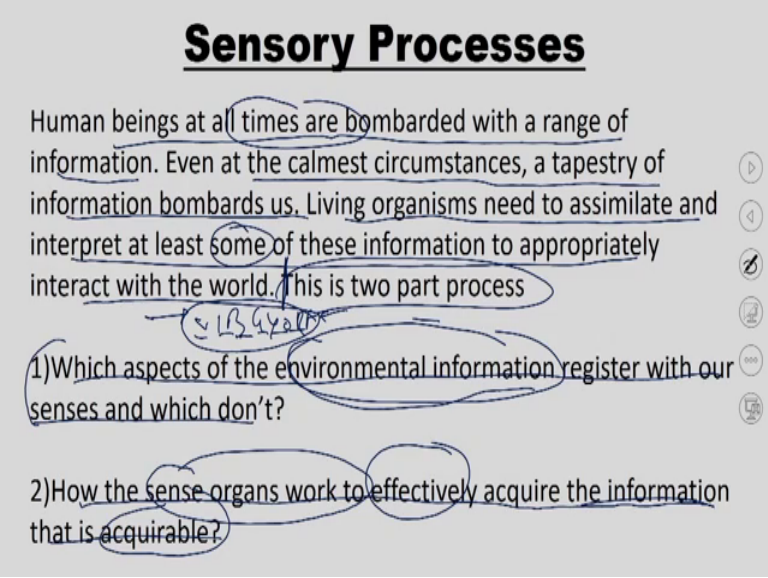

So, Sensory Processes; what our Sensory Processes? Human beings at all times are bombarded with a range of information. As I said in my example also and what happens is that at all point of time you have a number of information impinging on you. So, the person is sitting on this particular chair has a lot of information which is impinging on you.

So, human beings at all times get these kind of information. Even at the common circumstances or tapestry of information bombards us. So, even when you are sitting calmly on a bench on a wonderful night, what really happens is a lot of information gets on to you; a lot of information is impinging on to you. Now living organisms need to assimilate and interpret at least some of this information to appropriately interacting with the world. This is a two part process. Now this whole thing of how you convert the physical stimulus into the psychological stimulus is basically the act of sensation.

Now, how does the sensation really work? Now the process of how this information from the environment is basically encoded in a form that the brain can read and make interpretation sort of it is a two part process; number one which aspects of the environmental information register with our senses and which does not?

So, one problem with sensation is that what aspects of the sensory processes or the sensory stimulus do we actually read and it is very difficult to answer here this question with the present knowledge, the reason being that it is beyond the scope of this particular lecture. Since, this is a very introductory lecture on psychology. It is very difficult to tell you what aspects of the environmental information register with our senses and which don't? But I will definitely give you outlook of how this happens of how this problem is solved. For example, look at bats.

Now bats can hear only high pitch sound, but they cannot see and so, there is their sensory systems or the hearing systems are tuned in that way. What happens is when they fly? They get a re-vibration from any material which is in their path and from that they actually select the path of flying. Look at dogs they have very poor vision, but they are very sense strong sense of smell and so what part of the stimulus get impinges or what part of the stimulus aspects of the stimulus from the environment information register with the senses is dependent on these kind of things.

So, people and the answer to this basically the quick answer to this is, that it is coming from adaptation, it is coming from so a long lineage of adaptation. Now the interesting questions is this question cannot be handled here or as I said it is basically why can human beings only see the visible range spectra. If that is the question it cannot be answered here, but then here the answer is that human beings can only see from ultraviolet to infrared and after that they cannot see. So, this between this is the visual

spectra and so that is the colours the VIBGYOR that the human being can see now VIBGYOR.

V I B G Y O R; the Violet, Indigo, Blue, Green, Yellow, Orange, Red is what the human beings can see. Outside this range of the spectra, the human beings cannot see. Now you can ask me the question why does this happen? It can be answered in some other higher level course, but for now I can say that this happens because human eyes are trained in that way, they can see that way. And if you look at the dogs, they can see infrared; similarly the ultraviolet some animals can see ultraviolet and so on and so forth. So, that kind of a thing; so, this question we will leave it here. The second question is of interest to us.

Now, what is the second question? Second question is how is the sense organs work to effectively acquire the information that is acquirable. So, what characteristic of the sense organs or how does the sense organs actually collect this information and not only collect this information, they effectively acquire this information and make meaning out of it. So, that is what is of importance to us in the present lecture.

So, what we are going to do in this in the present lecture is look at how the sense organs work to effectively acquire the information which is acquirable from the environment. Now how this in information which the sense organs is acquiring how meaning is made of it will come in lecture number 5 and 6 when we discuss Perception. Here will only look at the mechanism through which external information from the environment is encoded in our brains; how they are encoded that is what is of interest to us in our present lecture.

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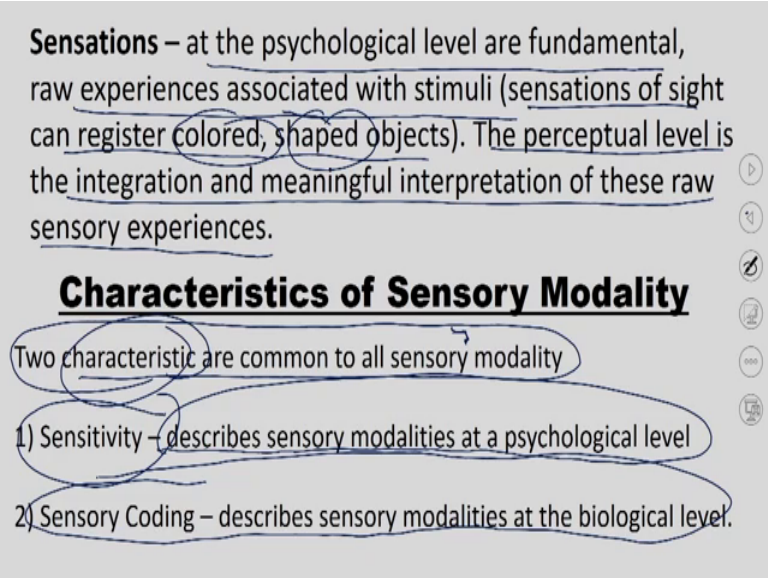

So, then let us now defined what is Sensations? So, what are sensations at the psychological level they are fundamental raw experiences associated with stimuli. And I have discussed before what really happens is that sensations are interpretations of physical stimulus. Now physical stimuluses like temperature, pressure, light intensity, number of photons, air pressure and that kind of a thing or all these air waves are what are sensations.

Now sensations of sight can register coloured, shaped, objects. Now, if we look at photons, the same number of photons has several variables or several parameters to it. The same level of number of photons can actually also describe psychological facts like intensity; psychological facts like hue; psychological facts like colour; psychological facts like saturation.

So, all these things can be defined from the same. Also this side sensation can register not only colour, but also shape of objects. So, when the eye perceives something it only not only perceives what kind of the object it is; what kind of shape of the object it is, it also perceives what is the form of the object; what is the shape of the object.

And as we have discussed in the Gestalt theory, what really happens is that, when the eye looks at something it breaks the figure or breaks any object into foreground and background and based on that it looks at the form of how the figure is of how the object the from which the light has been reflected on to our eye how it is. So, the eye has

special cells which actually recognizes angles, lines, curves and that kind of a thing. So, sensations can tell you how this object is or what is the nature of this object?

Now, the perceptual level is the integration and meaning interpretation of these raw sensory experiences and that is what I have discussed. So, external in information or external stimuli when they impinge on our sensory systems, the sensory systems embed or basically take this information and make it in a form or compile it in a form so that the brain is able to read it and make meaning out of it.

So, the making meaning out of or raw experiences, it what is called perception. The process through which stimuli from the external environment is encoded into the brain or into our sensory systems or into our mind is what is sensation. So, that is what the difference between sensation and perception. Sensation is a system which encodes physical information into the brain. Perception is a system which takes these in raw experiences, raw information and then makes meaning out of it. So, that is one primary definition.

Now, for any sensory system to work there should be some quality of the sensory system more sensory systems are some characteristics. So, how do we discuss sensory systems. Very good example of sensory system is the multi meter. Now if you are aware of what a multi meter is; a multi meter is basically a device which can actually test the current output of any plug that you have in your house.

Now how does this when you buy a multi meter; what are you looking at? One of the primary things so if you want a good multi meter which can detect any amount of current if you are aware of what a multi meter is, what it can do is it can look at current how much current is passing, what is the voltage. So, you should know the difference between voltage and current and what is the resistivity; how much resistance is there and these are some of the things that the multi meter can actually measure.

Now, when you want to buy a multi meter to actually look at if you are working if you are one of those people who are working with currents and circuits, you should be able to buy a good multi meter. Now when you are buying a good multi meter what are the things that you want in a multi meter? One of the primary things, one of the foremost things that you want in a multi meter is it should be accurate and how do you measure

accuracy? The measurement of accuracy is in terms of sensitivity. How sensitive your multi meter is?

Similarly, how sensitive or how accurate your sensory system is measured in terms of sensitivity and so some of the characteristics or the sensory system or some of the ways or some of the qualities of sensory system is one of the quality is sensitivity. Sensitivity is how easily or how correctly the sensory system can actually understand or can actually perceive or collect information from the environment.

So, some of the characteristics of the sensory modality is there are two characteristics that are common to all sensory modalities. As I said these are the two characteristics or these are the two main parameters of any sensory organs; be it the ear, be it the eye, be it the skin or be it any of the 5 senses. These 5 senses have a quality right that that tells you how accurate they are and they can these qualities are measured in terms of sensitivity.

So, what is sensitivity? As I said in terms of the multi meter when you are buying a multi meter the first thing you want to know it, how accurate this is; how sensitive it is which basically means that if you are wearing if you are measuring low currents and low voltages and if you are measuring high voltages, can it resist; can it accurately measure both high voltages and low voltages and that will depend upon the sensitivity of the multi meter.

Similarly, in this case the sensitivity of the sensory system will tell whether it can perceive stimuluses of very high intensity and stimuluses of very low intensity. So, what is sensitivity then? Sensitivity describes the sensory modality at the psychological level. It says how quality or the quality of information; how much quality of the information can the sensory system actually embed right. So, how if a sensory system is there what kind of quality of information it is collecting? So, that is what is sensitivity and then, there is Sensory Coding which is describes a sensory modalities at the biological level.

Now, even Sensory Coding in terms of the multi meter is that how is the circuit actually passing the current; what is the way in which the circuits are aligned so that the sensitivity; so that the multi meter is actually working. Now in terms of the sensory systems in terms of humans and sense organ the sensitivity is basically how accurate a sensory system is which basically means that at the psychological level what is the quality of information that the sensory system is giving you. Can it give it colour; can it

give you hue; can it give you the saturation; can it give you figure and background and so that kind of a thing; so, how accurate the sensory systems is. In terms of sensory coding, it means that how is this information being encoded into the brain.

So, once a light particle is falling into the eye, a particle of photon is falling into the eye; how is this photon being interpreted in terms of colour, in terms of form, in terms of any other thing for that matter right. So, what is the process behind interpreting it? So, sensitivity is how much information it can give and sensory coding is how it is happening. Now in terms of the multi meter sensitivity is how accurate it is as sensory coding is in terms of what are the circuits and how is the circuits actually behaving; how is the circuits actually taking the information and that is what the two differences are.

So, Sensitivity.

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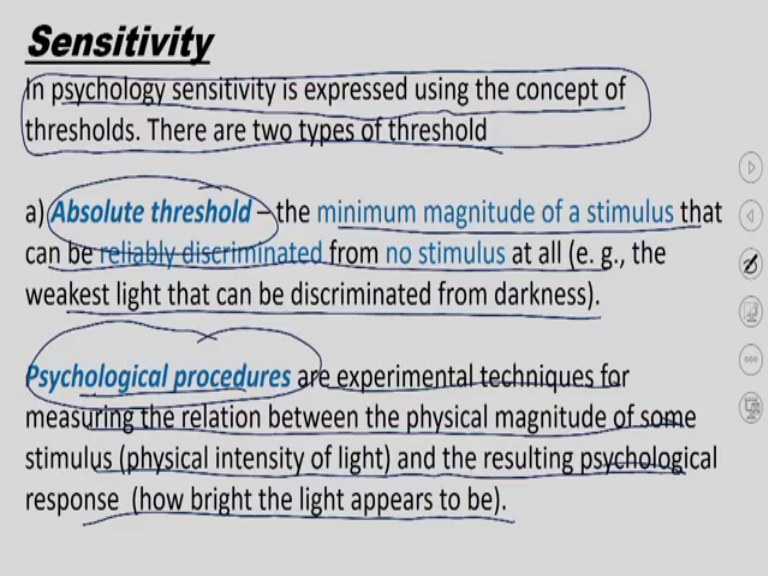

So, how do we define this sensitivity? Now in psychology sensitivity is expressed using the concept of thresholds. Now there are two types of thresholds. So, any system has which has sensitivity or which tells you the accuracy of a signal can be actually expressed in terms of a threshold right.

So, most since the quality of a sensory or system or a sensory organ or the quality of any detecting organ is or instrument the if it depends upon sensitive the sensitivity can be expressed in terms of certain thresholds. What are thresholds? There is something called

an Absolute threshold and there is some and there is something called Differential thresholds. So, let us start first with first of all with what is an Absolute threshold and what is the Differential threshold. Let us go back a little bit and understand the concept of thresholds.

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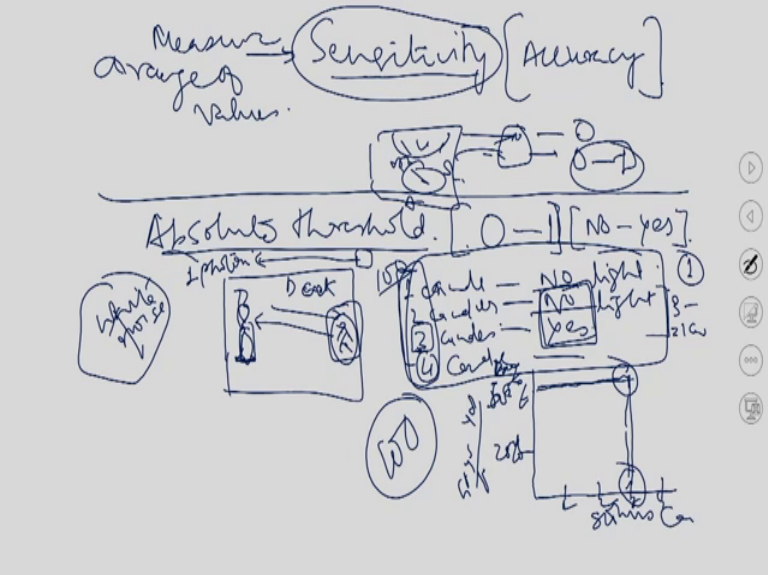

So, sensitivity is basically the accuracy. So, where a sensitive when a system is sent to be sensitive sensitive it means that it can measure a range of values right. So, if this is my multi meter, this is how the thing is and these are the two lids which is at. It is the selector which can measure volts and ohms and ampere and so on and so forth and these are the two lists which are there if am looking at the sensitivity of the system with what I want to know is how sensitive the system; how it is measured; can it detect 0; can the system detects 0 and the second thing is if it can detect 0, can it distinguish between 0 and 1; can it make a difference between 0 and 1?

Now, to measure sensitivity the first thing that you should know is Absolute threshold. What is absolute threshold? Absolute threshold is known as the threshold or the limit at which a person just start seeing. So, at the point from which 0 becomes 1 or a person's response from no be becomes yes is what is absolute threshold right.

So, absolute threshold is defined as the minimal amount of physical stimulus that should be presented so that any human beings start saying yes from no; what is the meaning of this? Let us try and understand let us take a simple experiment. Now in this simple

experiment, let us say that I take a person and I put this person into a room which is dark. So, this is dark room and then, I light a candle. This is the candle which I have flame and this person has to see this candle and tell me whether he is able to see light or not.

Now if it is a physical system, one assuming that 1 candle produces just 1 photon of light and if I have a system physical system which detects 1 photon, the movement that this candle is on and it emits 1 photon the physical system will say yes. It can see 1 photon and this is called the Absolute threshold for this physical system or this physical toolbox. So, if I take you into a dark room and in that dark room, there is no light and suddenly I put up 1 candle and I ask someone to actually look at this candle and tell me when he sees light, the moment when he sees light is called the absolute threshold.

Now, assuming that it is a very dark room and it is a very small candle and it is at the distance that I am burning this candle, the possibility is that when I have 1 candle lit the person says he still does not see light he does not see light. So, 1 candle is not actually giving the sensation of light to this person. Now I increase. So, 1 candle lit the person says no light.

Now, I increase my candle to 2. The person still says no light and then my increase my candles to 3 and the person says yes. This is absolute threshold. The absolute threshold is the point at which the person that I have who is witnessing the candle in the dark room says from no light to yes light and so, the absolute threshold is 3 candles minus 2 candles which is 1 candle.

So, the absolute threshold is here. This is what my absolute threshold is all about right. So, absolute threshold is at that point the point at which any system, any sensory system starts registering the presence of a stimulus from no presence of a stimulus. From 0 stimulus to 1 stimulus; the point at which this happens is what is called absolute threshold and for any sensory systems this absolute threshold is necessary because absolute thresholds will select the baseline will make the baseline.

Now, as I said with physical systems it is very easy to mark a 0 because physical systems can have 0 values right. Human beings do not have a 0 value. Now you would ask me the question that why is this human being not able to see 1 candle light; whereas, 1 candle light will have certain amount of photons. It will have more than let us assume 100

photons right. So, why is this person not able to see 100 photon, but if I have a photon detector with me which is a physical stimulus, it can see it can just see 1 photon.

The reason why human beings cannot see this one candle and then even with 2 candles they cannot see it is because the human brain has a number of white noise. So, if you look at how the brain is designed, this human brain has a lot of noise on it is own and this is called white noise. The human brain has a number of neurons which keeps on firing at all points of time and that creates a noise in itself.

I will give you an example. Try closing your eyes and try to be still, the moment you do that it is not possible the reason being that there are so many neurons in your in your head in your brain which keeps on firing at all points of time and it is very difficult to actually get silent that is the neural noise and against this neural noise, this person has actually to witness this candle. So, chances are that he will miss because there is already noise; a lot of activity already happening in the brain, the chances are that he will not notice 1 candle.

So, when we are 2 candle the intensity increases and still do not notices, but when there is 3 candle the intensity of light is a little bit high and so against the background noise this person is able to now see the candle and that is called the absolute threshold. But what happens these my physical stimuluses. My physical stimulus does not has any noise to start with it; does not have a background noise and since it does not has a boy background noise, it can read 0 photon and 1 photon right and so, that is the difference why human beings take more number of times. So, well discuss this in something called the Theory of Signal Detection as we progress into this lecture.

So, for now what our interest is what is called absolute threshold. So, the absolute threshold is the point at which human beings are start telling or any system start telling from no to yes. There from no presence of the stimulus to presence of the stimulus. Now how do I measure this absolute threshold?

Now what will happen is if you look into it what will happen is if I do this experiment with this person and assuming that this person has a brain which of course, most people have and there will be a lot of neural noises. The chances are that this person will vary in his responses of when he sees the light. It might so happen that if I do a 100 trials; 100 trials what will happen is that at some point of time, the person for with 3 candles will

say that he is seeing light at some times at the 4th candle, he will say that he is seeing light and at some times what will happen is that the 2 candle he will say that he is having seeing light and so how do we decide absolute threshold?

So, absolute threshold generally is measured in terms of. So, if this is my stimulus intensity or I would say the number of candles. So, this is 1; this is 2; this is 3; this is 4 and this is my percentage of saying yes. So, percentage of saying yes to candles right. So, this is 25 percent times I say yes; this is 50 percent of times that I say yes; this is 75 percent of times that I say the light from no light. The point at which 50 percent of the time; this is 50 percent I say yes.

So, the number of candles at which assuming that you have taken 100 trials of this experiment and the number of trials at which 50 percent of the time, people say that the they see light from no light is what is called the absolute threshold. So, for detaining determining absolute threshold, I have to run this experiment. Now how is this experiment running first; I lit 1 candle the person says no; I lit second candle, the person says no; I lit third candle, the person says no; I lit the 4 candle, the person says yes I can see light. And so this is comprised of one trial. This is called 1 set or 1 trial and this way I will keep on doing for 100 times.

The only change that I will make is in sometimes I will start with 1 candle, 2 candle, 3 candle, 4 candle and in sometimes I will start with 6 candle, 5 candle, 4 candle, 3 candles, 2 candles so on and so forth. So, in one case the person has to see say from no light to light and the other case they have to say from light to no light and then what I will do is I will merge the results together, take an average and come to the point where 50 percent of the time this person is saying that they see the light and this is what is called the absolute threshold.

And that determines the sensitivity of any sensory system or any sensory mechanism any sensory instrument for that matter. So, what is the absolute threshold? It is the minimum magnitude of a stimulus that can be reliably discriminated from no stimulus at all. Example, the weakest light that can be discriminated from the darkness.

So, as I said this is the procedure of doing it. This is how you actually decide from the absolute threshold or find out the absolute threshold. The way of finding an absolute threshold is that the point at which a person starts seeing a stimulus from no stimulus and

how do you do it? You do it through multiple number of trials; 1 trial is starting with no stimulus and increasing the stimulus in a systematic manner till the point of time that the human being says yes I can see the stimulus.

The other way is from a very high value decreasing it in a manner so that it all trials he says I see it, and the trial at which he says I do not see it; look at that trial and then block those trials, take an average and you get the at the point the point at which the human being says that 50 percent at times he sees the stimulus is what is called the absolute threshold right.

And Psychological Procedure; now, these are experimental techniques for measuring the relation between physical magnitude of some stimulus physical intensity of light and the resulting psychological response of how bright the light appears to be. Now the process that I described to you of how to measure the light or how to measure the absolute threshold is what is called the psychological procedure for measuring absolute threshold and this is called the method of limits.

Now there are several other techniques of measuring absolute threshold and I discussed the most easiest technique which is out there. So, one of the features of measuring sensitivity of a system is measuring the absolute threshold. The point at which no stimulus to stimulus is discriminated, but is that all is that the only thing which we require in terms of measuring sensitivity. As I said sensitivity is the accuracy of a system or accuracy of a detection system.

Now, in case of humans the detection system is the eye and so on and so forth. So, if the eye gets wrong, if the eye cannot detect something then the brain cannot make meaning out of it and you will not understand what the physical world is all about. And so, the accuracy system depends on sensitivity and sensitivity of system depends on how quickly or with how much accuracy, the system can detect no stimulus to one stimulus no stimulus just from stimulus absent to stimulus present and that is called the absolute threshold.

What else do we require; is that enough? That is not enough. We now need to measure there something called the Differential threshold; the point at which people say that they can see a change. Why? Because with the absolute threshold they can just say that yes I

can now see. But I can now see is not enough. Any change in intensity any change in the stimulus should also be measured.

The absolute threshold will tell you from no stimulus to yes stimulus, but then if within the stimulus something changes, I should also be able to make a change. From no money to yes money. So, if you have 0 money this is can 0 and so if I say in terms of money if I in India if you look into it if I give you let us say 1 rupees; then you will say I have money right.

So, 1 rupees is the amount of money that most and I do this experiment with number of people and for most people 1 rupees is money and 25 paisa or 50 paisa is not money. So, basically if 1 rupees is what most people say that now I have money. So, from 0 money to 1 money is 1 rupees that is the absolute threshold, but that is not enough. I should also be tell able to tell how can you mind the difference.

So, if I give you 2 rupees; whether 2 rupees is equivalent to a change in money; whether 2 rupees can be see the difference? So, if I give you 2 rupees and you say it is the same as 1 rupees, but if I give you 5 rupees now you say that yes the difference is there. Now I can see the difference. Now there is a change in the money value, then this is called the Differential threshold. So, Differential threshold is the amount of the stimulus change that should be made so that people are able to notice a difference and that is called the just noticeable difference. So, let us come back to that idea.

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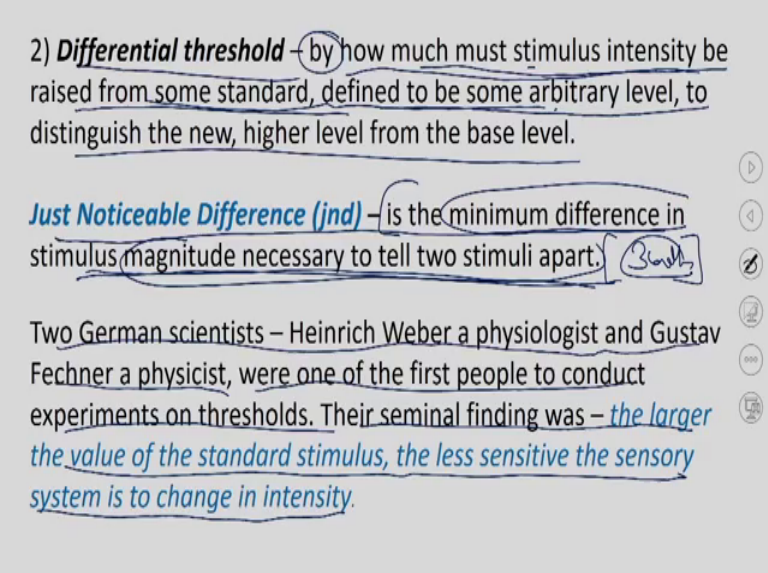

So, then we have something called the differential threshold; what is the differential threshold? Differential threshold by how much must the stimulus intensity be raised from some standard defined to be some arbitrary level to distinguish the new higher level from the base level and that is called the Just Noticeable Difference is the minimum difference in stimulus magnitude necessary to tell two stimuluses apart.

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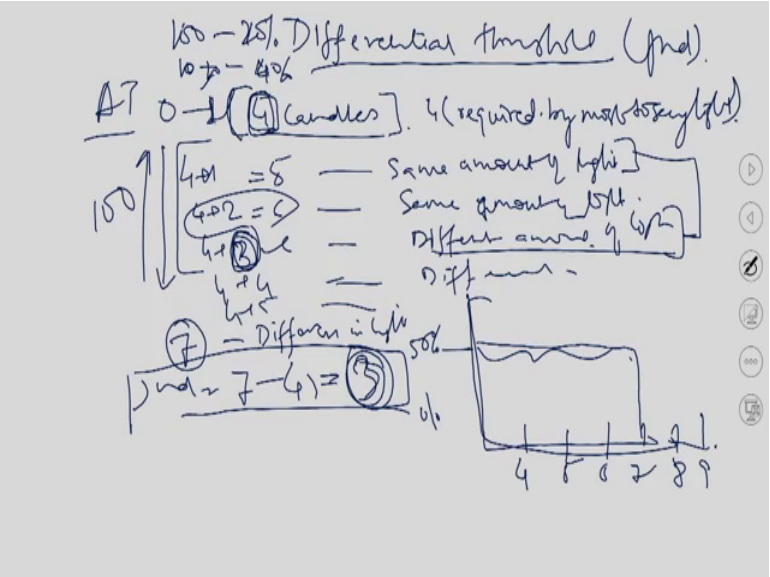

So, Differential threshold or the Just Noticeable Difference. So, let us say we have established the absolute threshold 0 to 1 and that is 4 candles. So, basically 4 candles is what is required by most people to say that there is light. If you use 3 candles if you use three and half candles, most people will not see light and so, 4 candles are required by most people.

We are assuming this. Most people to say they see light in a dark room. Now how do we disc find out the differential threshold? What is the differential threshold? The number of candles that I should add in this 4 candles so that people say that now they see a change in intensity. Now they see a change in light. Now let us assume that what I do now the person has made a change.

So, I add one more candle into it. So, now, I have 5 candles and the person says I see the same amount of light. So, what I do is I add 2 candles, 6 candles person says same amount of light. I add 3 candles person says different amount of light from the previous one. So, this is different from this right and so, that is what is called the differential

threshold. So, 3 candles if I increase initially I need 4 candles to say yes and if I add 3 more candles, then the person says that this is differential threshold or this is he sees a difference in light right and that is what is called the differential threshold. So, differential threshold is the amount of change that should be done to any standard stimulus.

Now the standard stimulus here is the absolute threshold. 4 candles is when he says sees light. So, if the amount of number of candles that I should add, the number of light candles that I should add so that the person says that now I see a change in light from 4 candles; where 4 candles it just says that I see light and the next time that he sees or next time said he says that now I see a change in the light is what is called the differential threshold.

So, it is the same procedure what I will do is ill add so, 3 candles is when he says he sees the same amount of light and if I do this 100 times it may so happen that with 4 plus 4 candles, we will say I see a difference in light. So, sometimes he uses 4 plus 4 candles sometimes he uses 4 plus 5 candles and so on and so forth. So, what I will do is and again the process is sometimes I will go increasing and sometimes I will go decreasing.

So, sometimes I will increase from 4 candle is the basic, it is called the standard. So, I will increase one more candle he says I do not see light, I increase 2 candles and now some time he says he sees light. So, I will increase 3 candles he still says I am seeing light, 4 candles he says I am seeing light and so on and so forth. In the other time what I will do is ill use 4 plus 6 candles or 4 plus. So, 10 candles in total and I say do you see light he says yes; then, I decrease one more; then I decrease one more and then I decrease one more.

So, I come to 4 plus 4 candles then he says yes, I see a change from what you have shown me before and this is called the differential threshold. So, 4 plus 6 and 4 plus four. So, 10 candles and 8 candles. So, 8 at the 8th candle he says that he is the difference and so, I do this 100 different times. And so the point at which this is the stimulus intensity. So, it will start with 4 because 4 was hue. In our case 4 was the initial stimulus.

So, this is 5 candle, this is 6 candle, 7 candles, 8 candles, 9 candles and so on and so forth and this is the percentage of time that the person says I see light and similarly this is 50 percent. So, the number of candles above 4 that the person requires to say that now

he say sees a change in light is what is called the Differential threshold and this is called the Just Noticeable Difference. So, if seven candles is, what is required for a person to say that he sees differences in light, then what is the JND? The Just Noticeable Difference is 7 candles minus 4, since 4 was 4 was the initial thing and so, 3 candle is what is required.

So, an addition of 3 candles each time will produce a change in light in density. So, 4 candle is what the person requires to start saying that he sees light and if you add 3 candles onto it he says now I see a difference and that is what is called the differential threshold and that is what is required in terms of in terms of measuring the accuracy or sensitivity of system. So, JND is this.

Now, the thing is this JND will tell you how many now units of the stimulus it should be given so that you can see this difference. Now there is a problem the problem is the more higher the standard is the more number of candles you will require or the more number of changes in the initial stimulus you will require. Let us understand this how this concept really works..

Let us say I have a 100 watt bulb and I have a let us say 80 watt bulb in presence of it. So, I have 100 watt bulb and I have 80 watt bulb and I light both of them and I say do you see the difference. You won't. So, from the 80 watt, I will decrease it to 70 watt. I still do not see the way difference then, to 60 watt; then to 50 watt; then to 40 watt; then to 30 and 20. At 20 you say yes I see the difference.

So, starting with 100 watt bulb; you will see the difference at 20 watts. Let us go the reverse. Suppose I have a fight verb 5 watt bulb or 10 watt bulb; how much should I change in the wattage of the second bulb so that you see the difference. So, I have a 10 watt bulb and then I have a again I have a let us say 2 watt bulb.

Do you see the difference yeah no. 3 watt bulb yes; 4 watt or maybe 4 watt bulb yes. So, in my difference from 10 watt when I am comparing two 10 watts bulbs the difference is in terms of 40; 4 times. So, the higher the standard stimulus is, the more the intensity of change is required. So, here it is required. So, here it is required 20 and here it is required 40 and that is what the differences. Let us understand this with. So, what is the differential threshold?

This is the stimulus intensity that should be raised from some standard defined to be some arbitrary level and what is just noticeable difference, it is the minimum difference in the stimulus magnitude necessary to tell the two stimulus apart. So, if there are two stimulus which is present and there is a set in terms of the candle the initial candle is 4 and how much should I increase or decrease my number of candles. So, that you see a difference, the answer here is 3 candles and that is what is called the just noticeable difference.

Another way of experimenting this is I have a standard. So, generally it is called the method of comparison method of standard comparison and in this what happens in the standard weight is given to your hand and then, you are first you are given to a standard weight and then you are given different different weights which is related to the standard. So, sometimes you will see the weight and you will say that it is lesser and sometimes you will get a weight and you will say it is higher.

Now the number of weights or the value of the weight at which you say that it is different from the weight that you have in your hand is what is called the Just Noticeable Difference. So, if you have a 50 watt weight or a 50 gram weight on your hand and then I give you a 51 gram weight and you still are not able to tell whether it is different from the weight that you have seen before the 50 gram weight. Then it is not that standard stimulus or it is not the Just Noticeable Difference.

The weight at which you say that the standard 50 gram weight is different for example, let us say 55 gram is the weight at which you say that now the standard the one you gave before the standard that you gave before is different from the 55gram weight. This is called the differential threshold or the Just Noticeable Difference and this is the minimum difference in stimulus magnitude necessary to tell two stimulus apart. What you are doing is you are able to tell the 50 gram weight and the 55 gram weight apart. What you are able to do is with 7 candles, you are able to tell that 4 candle light is different from 7 candle light and so that is the 3 candle light is what is the difference which is here.

Now, 2 German scientists Heinrich Weber Weber a physiologist and Gustav Fechner who was a physicist, where one of the first people to conduct experiments on thresholds; they were the first people to conduct experiments on the threshold and what did they find the

seminal work finding was that the larger the value of the standard stimulus the less sensitive the sensory system is to change in intensity.

So, if you have a 100 watt bulbs you will require much higher sensitivity for change or you will require a much higher sensitive bulb for measuring the intensity. So, if you are working with 40 watts bulb, the change that you require or the second watt bulb the change that you require for second watt bulb can be differentiated with the 40 watt bulb is lesser. So, even it let us say at 36 watt or let us say at 32 watt you can say that their difference, but if you have 100 watt bulb and if you want to see a difference of how many watt should be added onto it.

So, that people can say they are changing there are different is a 100 watt bulb would require maybe 129 or 140 watt bulb in next to it. So, that now you can see the chain. Let us understand this in terms of a more physical or a more general concept. If you have a; if you are buying a chips which is 5 rupees and if the price of the chips is increased by 1 rupees, you will see the difference; you will find the difference.

But if you are let us say you are buying or television which is costing 50000 or 60000 and then a change of 1 rupees is negligent in here. So, the if the pressure that you feel the change that you feel when the 5 rupees chips is increased by 1 rupees for that to come in terms of the television it has to be the price has to increase by some 5000 or 10000.

If the price is increased by 5000 or 10000, the same amount of difference you will feel as you are feeling for the chips. So, if the price of the chips from 5 rupees is increased to 1 rupees that the change that you feel for that to happen in terms of the television which is 50000 rupees and in increase in 5 percent has to be done. A 5 percent increase has to be done which is if they increase the price of the television by 5000 or 10000, you will feel the same amount of difference and so the stronger the initial stimulus, stronger the thing that has to be measured, the more number amount of increase in stimulus or the more amount of change has to be gathered and that is what they said.

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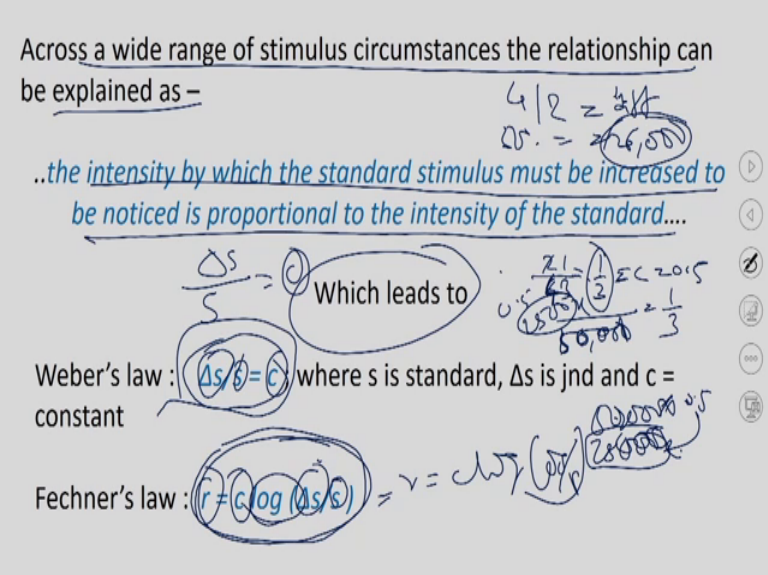

So across a wide range of stimulus circumstances, the relationship can be explained as the intensity by which a standard stimulus must be increased to be noticed is proportional to the intensity of the standard and that is what is called Weber's Law or Weber's Fechner's law. This leads to the equation of Weber's law which says that del s by s equals to c; where del s is the change in standard change in the stimulus second stimulus and the s is the intensity of the initial stimulus and c is to be constant.

So, if I if let us put it this way if 2 rupees, if this is the increase in rupees in the chips that has to be done for you to say that it is changed. So, here the value is 1 by 3. So, or this is the constant. Now if it is a 50000; if it is a 50000 equivalent. So, let us say or let us say it is 4 rupees and so, this becomes 0.5 right and so, if that is what it is if it is a 50000 television you have to buy, the change it has to be 0.5 into 50000. So, which equals to 2500; that is the difference right. So, our increase in.

So, basically 50000 into 0.5 which will be 2500 and so, 2500 is the increase that you should do for chips a 2 rupees increase is basically called different; whereas, for 50000 if 4 rupees chips is there you have to increase the price by 25000 that is how the same amount because the difference is half. So, 4 rupees chips if 2 rupees is increased then you see it is different. In the 50000 television or 25000 increase has to be done. Then, you can say that the price is equivalent.

Now this is very simple and so, what it says is the stronger the stimulus initial stimulus is, the higher is the change which is required because both of them is constant. Now what

factor found out is that the way this law works Weber's law works is not true and it is not a simple function. So, del s by s across stimulus is not same. So, for chips it may work and for clothes it may not work and for different stimulus it was different. And so, what Fechner did was he came up with a new law which is called the Logarithmic Law and in this law this law is valid across different different situations.

And so, what this says is that r is equals to c log of del s by s; where my del s is the change in the in stimulus that has to be compared, s is the standard stimulus and c is the constant and r is the factor which will tell me tell us how much difference should be there and so, this is Fechner's law of how it should work.

So, basically what this law says is that as the comparison stimulus the higher the comparison stimulus is, the more number of stimulus units; you have to increase for somebody to say that they see a change. So, if you have a 100 watt bulb, you will maybe require a 150 watt bulb. So, that the person says that I see the change, but if you have a 40 watt bulb maybe at 36 watt or maybe at 50 watt people will notice the change of people will say it is the change.

So, in terms of a 100 watt bulbs you require 50 more wattage toward the person to say that they see a difference, but when the initial stimulus is 40 watt, the initial bulb is 40 watt even at 10 watts, they can see the change. So, the higher the standard stimulus, the comparison stimulus the more change that is required in the initial stimulus and that is what is Weber's law is. And so, what Fechner did was he says that this law does not work across stimuluses and so, we introduced a logarithmic value or a logarithmic way of seeing this.

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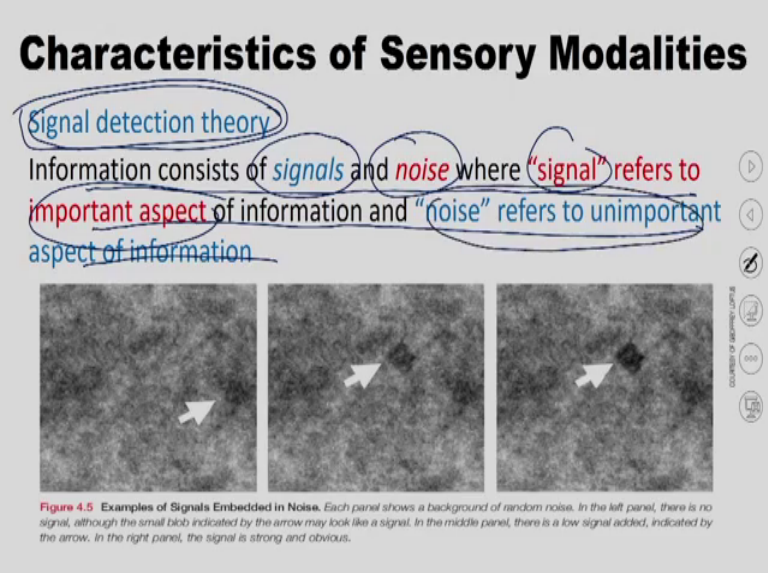

So, this is how this simple absolute and differential threshold really works and that defines the sensitive system. So, the sensitivity of a system or sensory system is dependent on something called the absolute threshold and differential threshold. Next comes the Signal detection theory. The theory of signal detection; what is this theory all about? Let us start understanding this theory a little bit. So, I will do part of the theory in this lecture and part of the theory in the next lecture. What is this theory all about? Now this theory is information consists of signals and noise where signal refers to important aspects of information and noise refers to unimportant aspects of information. Now how does this theory actually start?

Now any signal as I said any signal which is given to any stimulus which is given to you your sensory system, this sensory system is never accurate. The reason why this sensory system is never accurate is that the stimulus which you are hearing the stimulus which is impinging on to you is composed of noise as well, the environmental noise as well as internal noise. Your brain also makes some noise and so, detection of stimuluses becomes difficult because this stimulus that you look at is composed of noise from the external source as well as internal noise.

Now this Signal action theory is a very important theory, the reason being that it is used not only in psychology but in a range of other electrical engineering subjects or n number of other subjects. What is the theory about; how does this theory start? Now this theory in a very important in a very basic way how to understand this theory is that, let us look

at medical professional's right. So, first I will give you an overview of what the theory is and then I will try to explain you how does this theory come about.

So, most of us have actually been to doctors to do get our X-rays, MRI's and so on and so forth. How does the doctor decide that you have a particular disease; how does he decide when he is looking at your X-ray, when he is looking at your MRI; how does he decide. The way he decides that your disease is what is the basic premise of a signal detection theory right.

So, when he when you look at the X-ray of a doctor what happens is when the doctor looks up an X-ray he looks at something he looks at a photo of yours right it looks at a MRI here have a photo. So, each doctor has a certain characteristics of or has a certain parameter of saying something is wrong. So, let us say you have a cancer or you have a broken bone. Now you take an X-ray of this broken bone while go to a doctor. Now the doctor will look at your X-ray and based on the X-ray, he will decide whether the bone is broken or not.

Now, how does he make that decision whether the bone is broken or not. He looks at the X-ray and then he has certain characteristics, certain parameters based on which he decides whether the bone is broken or not. For example, if you look at this X-ray in the there is or this is an actually an MRI and so, if you look at this MRI what how do you decide whether the bone is broken or not. So, he uses certain parameters that he has learned.

One parameter will be that the place at which the bone is broken it will be more black than white. Then he will also have parameters like it will be more out right and so, the signal will be concentrated there which will use the area or region will be more grade and then, here well have other parameters from different tests. For example, he will take a blood test. So, more blood will be flowing there will be a swelling. So, when swelling is there, the X-ray will have a certain other kind of shading.

So, this based on this shading, based on the blood test, based on some other medical reports, we will actually decide whether you have a particular broken bone or not. Now that if you go with the same X-ray to different different doctors; different different doctors will have different opinions about the broken bone right and so, how does the doctor decide is what is signal detection theory; how does the doctor make this in

understanding or make this idea that you have a broken bone. Some doctors are liberal and some doctors are conservative.

The liberal doctors will just give you an X-ray and based on the X-ray he will actually decide whether the bone is broken or not some other doctors who are conservative, they will give you more number of tests because they do not believe the X-ray. So, the more number of tests you have the more parameters he has, the more number of data he has and based on that more number of data, he wants to be accurate that the bone is broken or not.

So, this is how signal detection theory really works right. So, more data you have or the more info information you have, you actually predict or you actually come up with a solution whether the bone is broken or not. Even within the X-ray what could happen is that it could happen that you look at an X-ray and the doctor decides that it is broken.

Now, if some doctors generally take one or two parameters. For example, how much greying is around a certain area. So, more whiten area is or more greying an area is it is a broken bone. So, he just uses two characteristics. Some other doctors maybe use 5 characteristics not only the greying or the whitening, they will also look at sides how much light differentiation is in the side and they will also look at the neighbouring areas and they will also look at the X-ray from the top in the bottom and they will do some comparisons with X-rays that you seen before and based on 5 or 6 criteria, they will decide whether the bone is broken or not.

So, they will consider 4 or 5 features from the X-ray and based on that they will actually decide whether the bone is broken or not. Now this work of how quickly you decide a bone is broken based on the X-ray and how long do you take how many characteristics that you take for deciding the bone is broken or not is what is the basic of a Signal detection theory.

The more easier the more quickly you decide a bone is broken or not, the chances are that you might be correct and you might also land up with a false alarm. What is a false alarm? The bone is not broken and you have said the bone is broken and in those cases what will happen is the more easily you say by looking at X-ray that the bone is broken, the chances are that you might also fall victim to the fact that it is not broken at all and the bulb that you are seeing the bulge that you are seeing the greying that you are seeing

or the whitening that you are saying is because of the film itself it is not an actually true X-ray.

And so, if you do not do multiple tests, what could happen is the more lenient you are the chances are that you will do more errors. The more number of errors you do and if you say that it is broken it is not broken, the person gets into a plaster and it is uncomfortable for him and so, he may not come back to you. But on the other hand if you take a number of tests and based on that you say a bone is correct, then the chances are that you are very conservative. So, if you take a long time number of parameters and based on that if you say the bone is broken or not, the person might have spend so much money and getting so much data or so much tests that he may not come to you.

He says that if I go to this doctor, he does a number of tests and he does a number of tests and based on that he says is correct. So, he is always correct, but the point is that he does unnecessary a number of tests. On the other hand I have the liberal person who actually looks at the X-ray only and says it is broken bone and in those cases what will happen is this doctor says quickly broken bone. So, there are chances that a person may not have a broken bone, but he goes into a plaster and so he will not come to you.

So, how do you decide when is a broken bone there or the X-ray that you are showing is actually of the broken bone and not an error or not a noise not an error on the film itself that process is called signal detection theory and that is what has been displayed here. So, signal detection theory is basically deciding how to differentiate the signal and noise and where signal is the important aspect and the noise is non important aspects.

So, in our case in the X-ray case what happens is the whiting that you see around, the whiting that you see around is actually the signal and sometimes the greying that you see is not actually because of the X-ray or the person, but it is because the film already had a black colour spot on to it and that is the unimportant noise. So, how do you differentiate between this unimportant aspect and the important aspect is what the signal detection theory actually does.

It makes you understand what is the difference between two these two things and how to make the difference. So, what I will do is since this is going to require a more time some more time into understanding signal detection theory. I will stop here and try to review

what we did in this lecture and maybe next time when we in the next lecture, I will continue with what is signal detection theory.

So, all in all what we did in this present lecture, we looked at what is sensory system; what is the sensory system and what is the requirement of a sensory system. So, we define a sensory system, what is a sensory system and we defined it as a system which takes in external information and inputs into the brain or inputs into the psychological system. So, sensory system is a mechanism which takes in physical stimuluses and then converts it into something which is psychological in nature.

For example, temperature in degrees is converted into cold and hot that is what a sensory system is. Then we looked at how the sensory system really works. We discussed the idea of a sensory system and the two parameters the sensory system of how the sensory system works. Even before that we discussed how the sensory system encodes things. So, what is the way in which it encodes and what is the way in interprets and so, we discussed two important aspects of sensory system which is the sensitivity and the sensory coding. So, we have we are just covering the sensitivity now and sensory coding well try doing it in the next lecture.

So, you during the sensitivity of a system how to measure the sensitivity or how accurate a system is requires you to understand two concepts; the concepts of absolute threshold and differential threshold and that is what we did in this class. We try to understand what is absolute threshold and what is differential threshold. But just understanding absolute threshold and differential threshold is not enough. We would also be able to tell noise from signal and why this noise is there. The noise could be because the signal that you have, the stimulus that you have may consist of inherent noises.

Also the human system the human brain has some noise on it is own white noise on it is own. So, detection as I said as we showed you in the absolute threshold experiment, physical systems will require just 1 candle and they will say ill see a change, but then human system require 4 candles. The reason being that human systems or human brain has a noise on it is own and these noise make them not detect stimulus. And so this detection, the way human beings detect, the way human beings say yes to another stimulus and no to another stimulus is what is signal detection theory.

So, what is the paradigm or what is how does how do human beings detect stimuluses and not detect stimuluses and how these noise and stimuluses, they combines together to human being saying yes and no to a signal present a not present is, what is the idea of a signal detection theory. So, in the upcoming lecture in the next lecture, what will do is we will try and see what is signal detection theory and then when also see how the signals from the external environment is encoded through the biological process.

In addition to that we will just take one sensory system which is the visual system and we will try and see how this visual system works and how does it encode stimuluses and how does it make meaning to the stimulus and sensory systems. So, that is what we will be doing in the next lecture. So, up till the next lecture, it is goodbye from here.

Thank you.