Science of Clothing Comfort
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Lecture - 05
Psychology & Comfort

Hello everyone, we will start today, the new topic which is Psychology and Comfort. In last few classes, we have discussed various aspects of clothing and related to comfort. We have also discussed that various factors, which affect clothing comfort and various aspects related to that. In these aspects, like psychological aspects, neuro physiological aspects, thermo physiological aspects transmission related parameters, so all these things now we will discuss in different segments and first segment is that psychological aspects of clothing comfort.
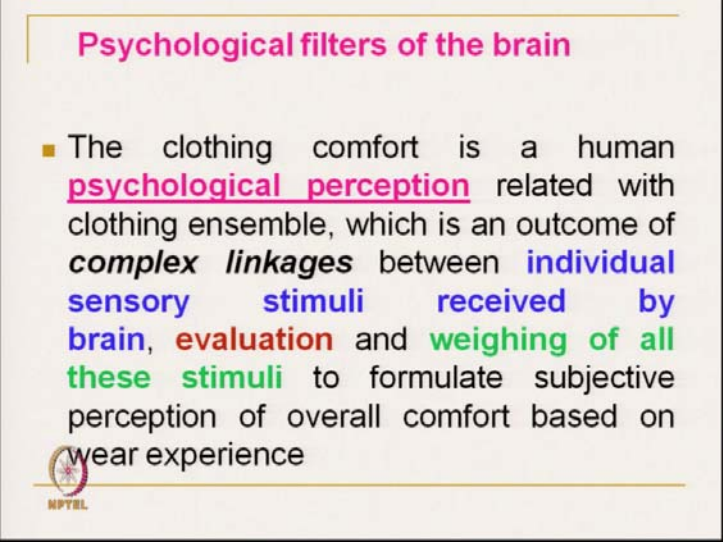
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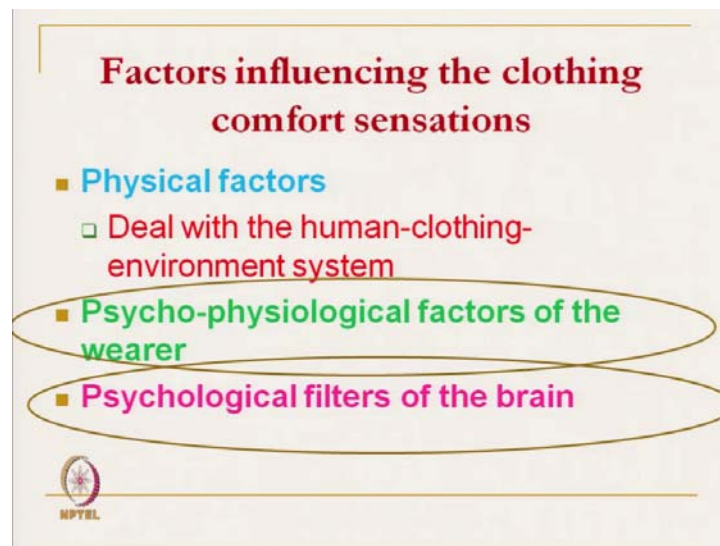
So, if you talk about the psychological aspect, so there are 3 main factors, which influence clothing comfort sensation. First is a physical factors, which deals with the human clothing environment related factor that is a human clothing system and this factor we will not discuss here, we will discuss the factors which are related to the psychological factor and psycho physiological factors of the wearer which actually indirectly affects the clothing comfort sensation.

So, first factor is the physical factors, which deals with human clothing environment

system, second is psycho physiological factors of the wearer and third one is the psychological filter of the brain. So, all these things we will discuss; psychological filter means, how a person after sensation, it sends signal to the filter and brain and how the brain evaluate and filter that sensation and ultimately we get that sensation.
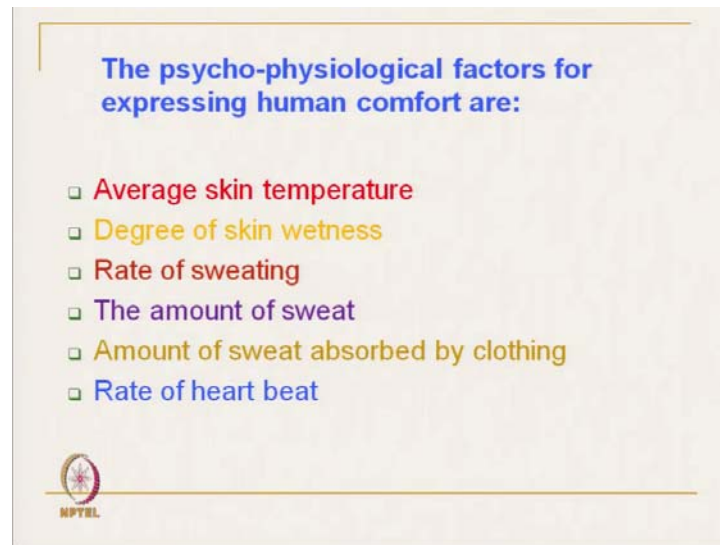
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So, in this segment we will discuss these 2 sections, which is psycho physiological factors of the wearer and psychological filters of the brain. So, which ultimately gives the comfort sensation. So, if we talk about the psycho physiological factors for expressing the human clothing comfort, which are related to average skin temperature. So, if the average skin temperature is high after wearing cloth, so the person will become warm. So, we have to control the average skin temperature.

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The psycho-physiological factors for
expressing human comfort are:

- Average skin temperature
- Degree of skin wetness
- Rate of sweating
- The amount of sweat
- Amount of sweat absorbed by clothing
- Rate of heart beat

So, degree of skin wetness, so to keep our body temperature constant, our body physiology keeps releasing the sweat and our clothing has to actually act, there to maintain the skin dry. So, if the skin is wet, then we will feel uncomfortable due to wetness, so that is also psycho physiological factor.

Rate of sweating also depends on the physiology of a person, but as we have already mentioned depending on clothing type, so, rate of sweating, we can control and if type of activity controls the rate of sweating and amount of sweat generated. So, if the amount of sweat is high our clothing's function is to absorb this sweat. Amount of sweat absorbed by the clothing and last one, is the rate of heartbeat. So, all these things are actually related to the psycho physiological factor which is expressed by the human comfort. So, then comes the psychological filter of the brain.

Now, what happened when we wear cloth, so we get different type of best stimulation like thermal stimulation, skin related stimulation, so the clothing comfort is a human psychological perception related to the clothing ensemble and which is the outcome of complex linkage between individual sensations. Like it is sensation of warm sensation or touch sensation or different types of sensation, even smell or may be sound, different types of sensations, we receive after wearing the clothing and it sends individual signal to the brain and brain evaluates and weigh every sensation and ultimately it gives the combined sensation of whether it is a comfortable or not.

I will give you one example, suppose a fabric, it is totally comfortable in all, the sweat, like touch may be it is creating warmth or may be moisture vapour transmission, and sweat absorption is all right. But suppose it is making sound, it is making sound continuous sound, so we may not feel comfortable or else a fabric is very comfortable in touch tactile sensation, it sends signal as a very good touch but it is warm.

So, ultimately so our brain actually tries to evaluate all the sensation, finally it is a combined sensation we get and ultimately it get signals, it is comfortable or not. So, if we see it is a very complex linkage between all the sensations.

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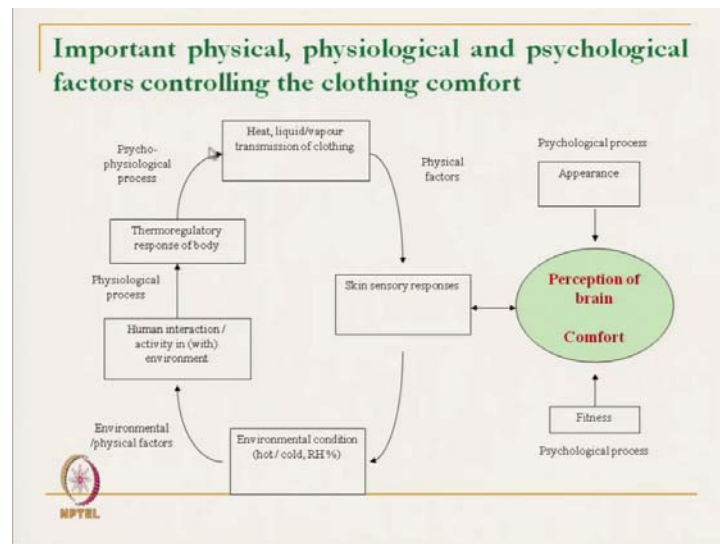
So, the important physical physiological and psychological factors which controls the clothing comfort are all these as we have discussed all these aspects. Like we start with environmental condition directly or indirectly affects our sensation. If the environment is warm ultimately, we will get warmth feeling, whatever clothing we are getting, we are wearing. So, ultimately, we will get that feel, if it is humid, so relativity humidity hot or cold, so finally, we get one particular sensation of our comfort sensation.

Then it comes the physical factors or environmental factors that what is like human interaction or activity. So, clothing comfort as we know depending on the activity level human activity, if he is active so or if he is sitting idle. So, comfort sensation depends on our activity level, so our clothing's function is to compensate heat and moisture mass transmission equation.

Physiological process, so thermoregulation response of the body like we start sweating. So, we may feel uncomfortable if our skin remains wet. So, our clothing's function is to make it dry or to evaporate sweat. So, that is the thermoregulatory systems of the body (Refer Time: 09:06). Next is the psycho physiological process, like different sensations we get and heat and moisture transmission then physical factors. So, different physical factors like heat moisture transmission or air transmission. So, all this characteristics directly or indirectly affect our comfort sensation.
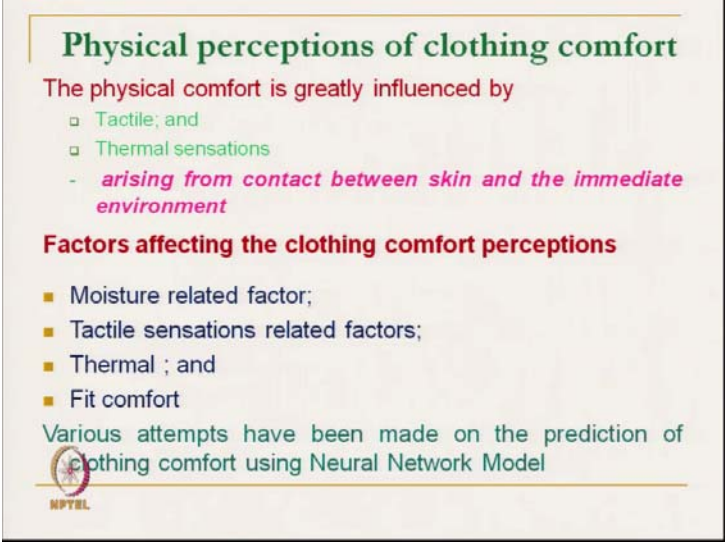
Another important factor is that skin sensory **research** as whether it is a touch that adds hard feeling or soft feeling. So, all this sensation, so if you talk about all this skin sensation and environmental or physical sensation and or physiological process, different sensor of in our body receive the sensation.

Ultimately it sends the signal to the brain and brain perceive and actually evaluate all this level whether it is warm, how much it is warm. So, that actually it evaluates the sensation and it is warm or cold sensation, harsh sensation, harsh feeling or even sound even it is a smell. So, suppose a clothing, it is highly comfortable, but it is does not smell nice so you may feel uncomfortable.

So, all these sensations send along with this the aesthetic sensation, whether it looks good. So, psychological sensation also goes to the brain and another is fit, whether cloth fits nice. So, that is again aesthetic sensation, so brain takes sensation from all the sources and it takes weight age and then evaluates.

So, suppose clothing thermal sensation, it is a temperature differences little bit it is not too high say 27 degree, is comfortable it has become say 29 degree Celsius. So, brain will weigh that what is the difference and similarly if it is a pressure, pressure is high then normal or very high. So, it will take the weightage and ultimately it will give a combined sensation, we cannot tell that it is warm and ultimately, brain gives a particular sensation, whether it is comfortable or not. So, in this segment, we will discuss all these aspects, how to evaluate all these psychological sensations.

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Now, physical perception of clothing comfort, t is generally influenced by tactile touch related physical perception, touch related clothing comfort and thermal sensation. These are arising from the contact with the clothing, when our body in contact with the fabric we get 2 types of physical sensation one is the touch related sensation, another is thermal related sensation or that is related to whether it is a warm or cool.

So, the overall, factors which affect the clothing comfort sensation is the moisture related factor, whether it transmits moisture, tactile sensation related thermal factor and fit related comfort. So, these are the physical factors which sends signal along with some aesthetic factors which is not measureable. This, we can simply measure. So, there are various attempts made to actually measure the perceived comfort. So, there are statistical attempt or technique or neural network technique to measure the clothing perception.

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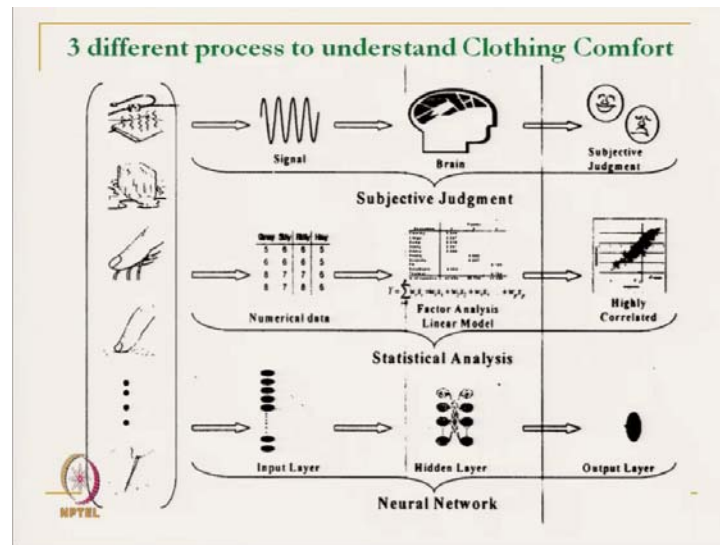
Here it gives 3 different one is subjective judgement. What happened, we will discuss basically wear trial technique. It is a subjective judgement of clothing given to different thermo people or expert and they have been given, they have been asked to judge whether it is comfortable or not. What type of signal you are getting whether it is warm or cold; whether it is harsh or soft or it is a stiff or flexible?

So, different judgements we will discuss, different techniques we have followed and ultimately it gets signal sensory signal and brain gives some output value and we get subjective judgment whether comfortable or not.

Similarly, next is the statistical analysis, we get large number of data, it is a softness, hardness or large number of data and see subjective judgment it gives a single. This is harsh, this is subjective judgment, but this statistical technique, we actually measure the different value; softness, hardness and all this is objectively measured and ultimately large number of data and then analyse the data with the may be with subjective judgement. We analyse the data and finally get the relationship, correlation. Last one, it is a neural network.

A neural network, we get the different sensation and with a different input layer, hidden layer and output layer, a different layer we get. The output value, if you see it is a back propagation technique.

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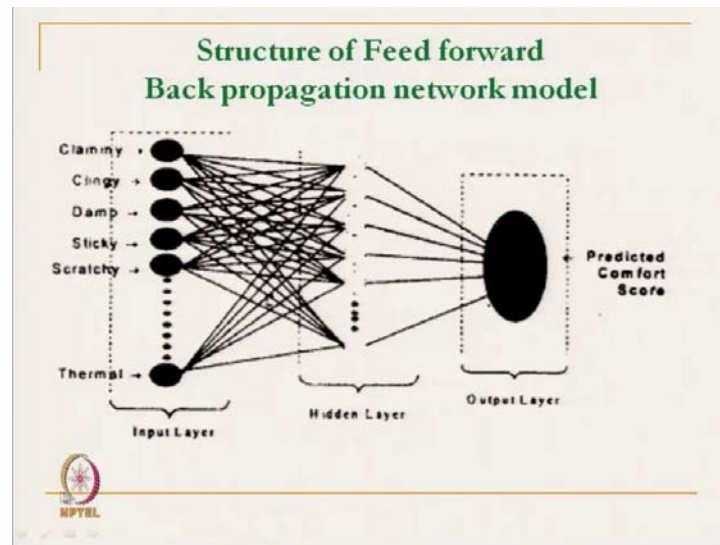
So here, so different comfort related sensation we give as input, it is input layer it is like a clammy phase clingy, damp, sticky, scratchy, thermal; so different sensation we get and then ultimately through hidden layer we get some predicted comfort value. So, this is one of the techniques, we can use this neural network technique to get the psychological perception of clothing.

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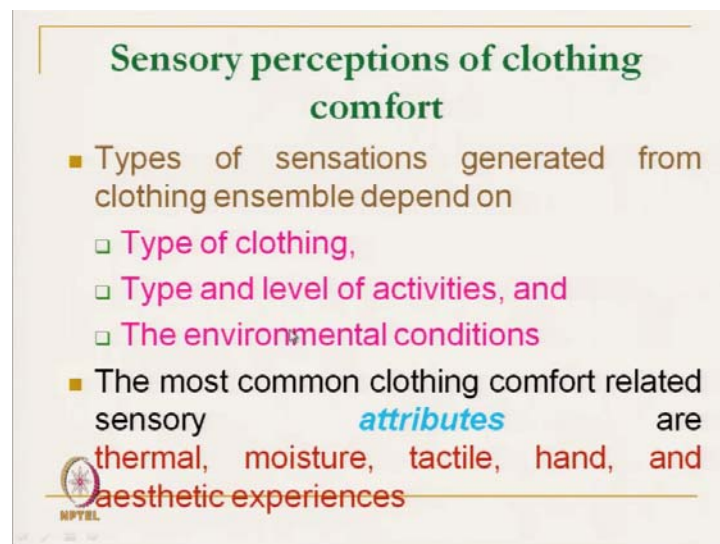
Now, the sensory perception of clothing comfort is generated type of sensation from clothing ensemble, it depends on type of clothing, type and level of activities and the

environmental condition. So, the ultimately, we get all these sensation depending on all these activities. So, suppose, a particular clothing if we change the activity, our sensation will be different.

So, clothing is not the only factor, all these 3 factors has to come together, then we get the final sensation for a particular clothing. If we change the activity, we will get different sensation or we keep the activity same, if we change the environment, so we will get all these defects. So, it is an interrelationship between all these parameters. The most common clothing comfort related sensory attributes are the thermal, moisture, tactile hand and aesthetics.

So, we are not taking here the sound related activity or smell, so these are not common but if we want to incorporate, we can incorporate here. But for clothing comfort related activity so these are attributes; thermal related sensation, we have to get moisture related sensation, tactile or hand whether it is a harsh or something or aesthetic look wise. If we want to incorporate as I have said, all these parameters, they are correct, they are perfect, but if the cloths smells awkward, so we will feel uncomfortable. So, if we want to incorporate the smell and also sound so that sometime it may be irritating. So, we will actually stick here and confine our self with all these activities.

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So, the established attributes of the sensory perception of human is that these are the attributes, whether cloth is loose or tight, it is a fit related, heavy or light, stiff or pliable.

So, these are all tactile related sensation; sticky or non sticky, some time the cloth if sticks to a body, you may feel uncomfortable.
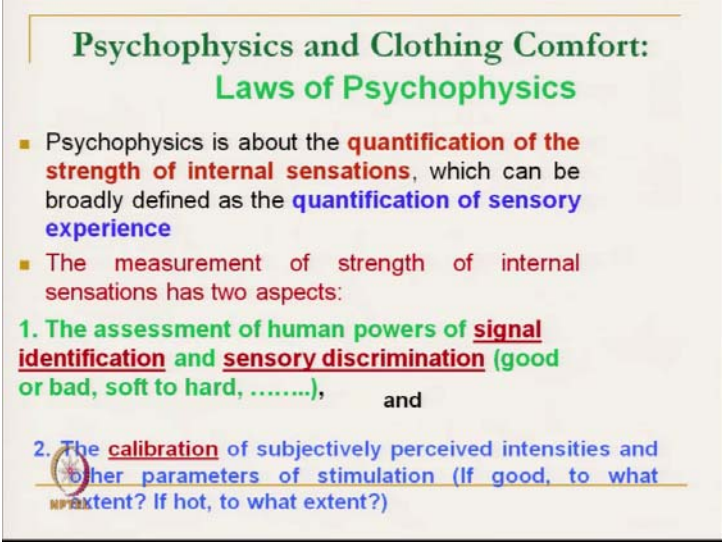
Like one example if you start sweating, we are wearing cotton cloth, if we start sweating then our same cloth which was comfortable, it will start sticking with our skin so we will feel uncomfortable like absorbent or non absorbent. So, if it is absorbent, so we may feel comfortable; sometime cold or warm, so that directly gives the thermal rated sensation.

So, all these type of pricky or non-pricky, it is a tactile layer sensation rough smooth. So, there are various attributes we can define, but we should be very careful, some of the parameters, some of the attributes may be confusing. So, we cannot take all the attributes, so sometime it may get we may get confused. So, that is why it is actually the standard attributes we use normally most important attributes coarse or fine that is one attribute. We can take whether fabric is coarse feel or fine feel that is a one tactile attributes, rough or smooth, stiff or pliable hard soft cold or warm, rustle or quiet, so this are the attributes we normally use.

So, this attributes what the attributes, this attributes is the physical sensation what we get the physical intensity we will get and sensory perception means this attributes is external one, we get the attributes like your touch warm, cold. These are the external attributes we get from the clothing or environment or sensory perception means; what our brain perceive that value. So, these are the 2 factors which are very important in psychology psychological perception.

So, relations between the attributes, physical attributes or external attributes with the sensory perception which is actually known as psychophysics. Laws of psychophysics deals with the relationship between attributes and sensory perception. So, there are different laws of psychophysics here we will deal with, I will discuss 3 important laws of the psychophysics.

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So that means, this laws of psychophysics, a psychophysics is about the quantification of the strength of internal sensation, it is you have to quantify the strength of the internal sensation which can be broadly divided defined as the quantification of sensory experience. The measurement of strength of internal sensation has 2 aspects, so if you want to measure the internal strength of sensation, we have to measure 2 steps one is signal identification.
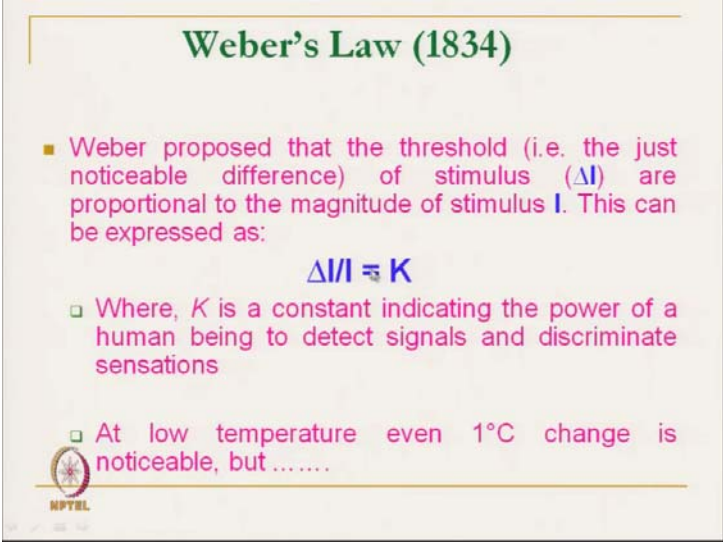
So, the assessment of human power of signal identification and sensory discrimination, like if whether it is a warm or cold, I am touching here whether I am feeling warm or cold that is a identify I can identify that is the first power of brain, you have to identify it is soft or hard. So, I am touching here this is giving hard feeling, but when I am touching it is a soft feeling. So, our sensor should be able to discriminate whether it is a cold or hot, soft or hard or else good or bad, so these are sensory discrimination we have to do and next is calibration.

Calibration means if it is good, how much, if it is not, how much. So, our brain has to measure in 2 aspects; one is we have to identify the sensory discrimination or we have to identify the signal and then it is a calibration. Our brain has to calibrate. So, if it is hot, how much, these 2 aspects are there in any a measurement.

So, GT Fechner who actually originated the mathematical relationship between these 2, what are these 2 aspects; one is the stimulus external stimulus and sensory perception

first actually formulate the interrelationship between these two. first law which is actually proposed by Weber.

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Weber's law proposed threshold that is just noticeable difference of the external stimulus is proportional to magnitude of the external stimulus I, this can be expressed

$$\frac{\Delta I}{I} = K$$

What does it mean it is where this k constant which indicates the power of human being to detect signal and discriminate the sensation; that means, it has to that k depends on the power of the humans brain.

Now, here I is the magnitude of sensation at a low temperature, we can differentiate even 1 degree Celsius temperature difference. At low magnitude of stimulus, we can perceive the change, if the temperature change from say 5 to 6 degree Celsius or 5 to 7 degree Celsius, we can clearly differentiate; it is warmer today. But if it is say 45 to 46, 45 to 47 it will be little bit difficult.

So, basically, change of sensation is proportional to the magnitude of external stimulus. Here the main problem with the Weber's law, it does not deal about the internal sensation, it talks about the external stimulus, it does not talk about the internal sensation

of the body. How do we fill relationship, he has not actually proposed?

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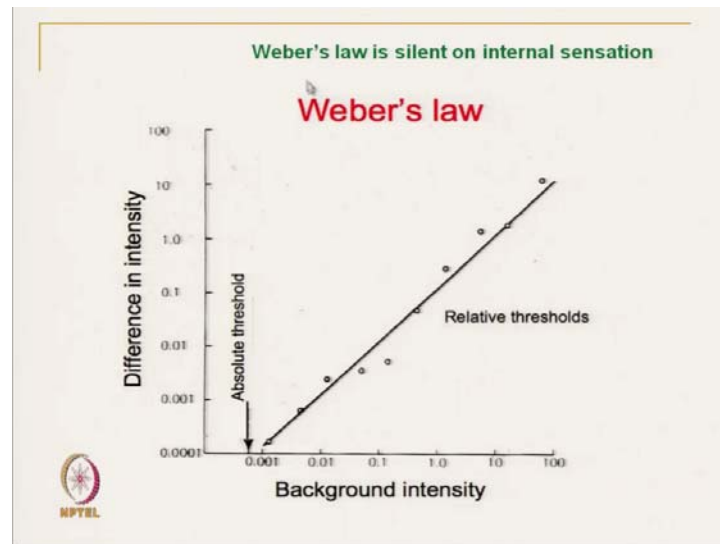
Now, Weber's law is silent on internal sensation, it does not talk about the internal sensation, only the intensity is proportional to the difference in intensity. So, at different level of intensity, you can make out difference and there is absolute threshold, when we start getting signal. What is absolute threshold? So, after certain pressure only, our sensor will start receiving the signal, so absolute threshold at minimum change is the Weber's law.

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Next is the Fechner's law, so in 1860 he has proposed first relationship between the physical stimulus and internal sensation which is a logarithmic relationship.

$$S = K \log I$$

So, if it is a physical stimulus, suppose it is temperature or brightness or brightness of colour. So, internal stimulus is the physical stimulus and S is the internal sensation, we can sense.

So, what he has proposed k is the constant determined by stimulus threshold which represent the lowest physical value evoking the sensation that we have discussed; a threshold and the differential threshold providing the subjective unit of sensory intensity and here it says he assumed that sensation changes arithmetically, whereas, as the intensity of physical stimulus changes increases logarithmic step so that was his assumption.

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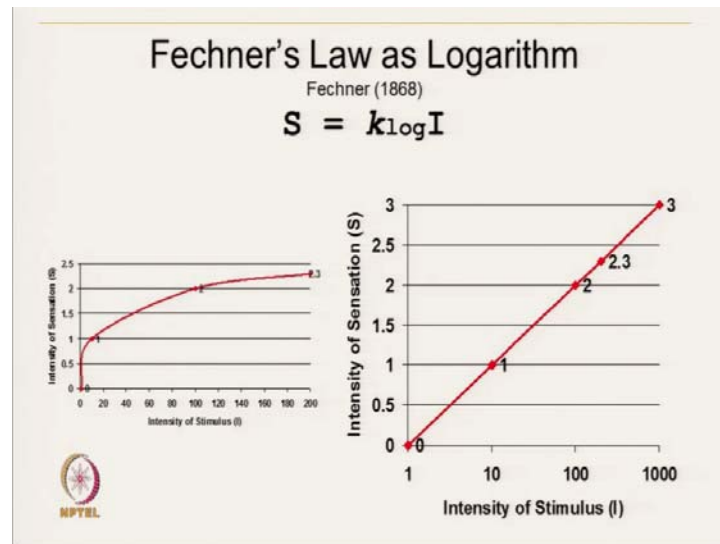
So, I is the stimulus in the graph, this is the intensity of the stimulus. x axis and y axis it is the intensity of sensation and if we convert it to a logarithmic scale. So, it is log I and which is directly proportional to the intensity of sensation, so this is arithmetic change and S changes arithmetically, sensation changes arithmetically and intensity of stimulus changes with logarithmic, what does it mean.

Suppose, we take warm sensation. So, initially, we are changing from 0 to 10 degree

Celsius, sensation increases by 1.

But similar increase in sensation if we want to have another one up to 2 sensation, if we want to have increase, our temperature has to increase from 10 to 100. So, another 90 degree increase if we can have then the similar change in sensation will be there. So, this is the first one which gives the relationship between the intensity of stimulus and intensity of sensation.

But he failed to quantify the value, he could give the some relationship, but he failed to quantify the amount of sensation and third one, latest one it is 1950 around 1953- 54.

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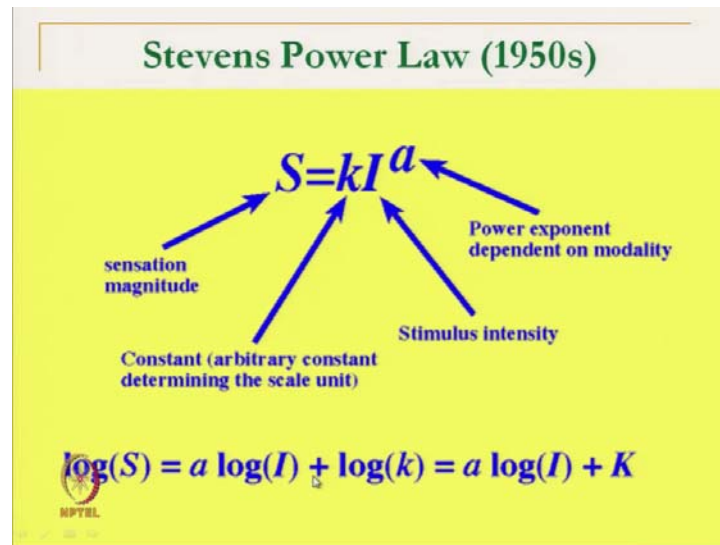

Stevens proposed power law, which says that method of estimation of relationship is subjective. It is internal sensation and physical stimulus

$$S=k\ I^a$$

where k is the scale factor and a is an exponent characteristics of physical stimulus .

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So, by these 2 what he has made he just tried to see S equal to k multiplied to the power a, S is sensation magnitude. Internal sensation depends on k is an arbitrary constant of determining the scale factor, I is the stimulus intensity as we have discussed earlier also and a is the power exponent dependent on the modality which is extremely made, who he could quantify Steven could quantify a value depending on the type of stimulus.

So, depend on the modality what it type is of, so if it is say heat or cold we will get one a particular value of if it is electric shock we will get a particular value if it is pressure we will get. So, he could quantify the value so if you just rearrange this equation. So, log S equal to a log I plus log k which is constant this in this form we can get.

So, finally, if you see so this is the relationship Stevens power law which says S is the magnitude of estimation, that is estimation means estimation of internal sensation, k is the constant, I is a physical intensity of physical attributes outside which may be like brightness may be apparent length may be electric shock ,n is exponent.

So, typically if you see this power law is different relation for electric shock, for brightness this is relationship and for apparent length this is the relationship. Where the value of n exponent has been defined, so some known exponent for Stevens's power law for brightness is 0.33, n will be 0.33, k can be any arbitrary value.

Similarly, electric shock, n is 3.5 power is 3.5. So what does it show? So, you can see for 3 different types of sensations, ultimately with increase of stimulus, the physical sensation increases, but rate of increase is different. Like for brightness, it initially increases then slows down, that means with the increase of intensity stimulus magnitude we get increased signal sensation. But at higher level, the increase of sensation is reduced, rate of increase is reduced, which mean initially if it is too dull, very dull to certain increase.

Arbitrary unit increase in brightness, it will give you sudden jump in sensation. You will feel, this is very nice, it is very bright, our sensation will tell it is bright. But from say 70 to 90 if brightness increases, we feel some increase in sensation, but it won't give you the actual rate of increase which we got in initial stage; that means, it depends on the value of the power n.

Now, if it is electric shock, so initially if you see electric shocks for lower voltage if we get shock, we may not give get the sensation, but at after certain level, we will start giving getting this sudden sensation. So, we can have n value for different warm, cold or touch or different types of sensation we can derive, so here Stevens actually he could quantify the internal sensation which is his actually real contribution. So, all these laws of psychophysics indicate there is a fundamental difference between physical stimulus I and internal sensation. So, we get sensation from different physical stimulus, but these are totally different.

Weber's and Fechner's as we have discussed; they could actually give some fundamental understanding, but failed to provide basis of measurement of this sensory perception correctly. So, Stevens's power law proposed a power relationship between physical stimulus magnitude and internal sensation which provides direct measurement of sensation in a sensory judgement process. So, now Stevens' power law is extensively used to measure the different level of internal sensation, provided we can get this value of n for different types of stimulus. So, these are the different aspects of psychophysics laws of psychophysics.

Now, we will discuss the different types of psychological scales and rating scales. So, if we get some sensation, brain has got ability to identify the sensation and how to scale whether it is warm, how much warm, so different types of scaling system, we will now

discuss.

Firstly, we will discuss with the psychological scale and rating scale is the most practical scale which is used in market research. These things we will discuss one by one. Psychological scale; scaling is a process of assigning a number to a characteristics of objects or events according to a particular rule, we have to actually assign certain number it may be numerical number, but the number does not always correspond to the numerical value, it does not have value, we have to only give a number. So, in the numbers are used as a symbol to represent certain characteristics, we cannot actually perform any arithmetic function.

The rules specifying how the numbers are assigned to the characteristics to measure may be arbitrary and changes as per the rule. We have to assign number for example, actually scaling is used for market research. So, I will give you an example, we give 0 for male, 1 for female, so this does not mean that 0 is 1 is superior to 0. So, 1 for female, 0 for male we can give arbitrarily. So, it is making the judgement.

So, in research, there are 4 types of psychological scale, one is the nominal scale then is ordinal scale then interval scale and the ratio scale. So, there are 4 different types of psychological scales, so these 4 scales respond to descending sequence of subgroup; that means, nominal scale has got all the subgroup, it is a very simple one.

So, for example, the group of nominal scale containing the group of ordinal scale, so nominal scales contains all the groups of ordinal scale. Similarly ordinal scale, contains the group of interval scale, it contains the group of ratio scale. So, psychological scaling is of 4 different steps and moving from nominal to ratio scale, it becomes complex. So, rules become more and more complex and kind of arithmetic operation we can give, we can actually use more and more arithmetic. So, the kind of arithmetic operation for which number can be used are increased.

So, firstly, we will start with the nominal scale, nominal scale deals about the equality, basically it gives a particular value, gives a group of subject which we do not discriminate. So, the numbers are used to categorize the object, all numbers of a particular class have equal value. We do not change, anything cannot be added or subtracted multiplied or divided , we cannot do it.

It distinguishes the object or event on the scale from things that are not means male or female. So, number all numbers in the class have equal value. So, here if you are someone has got 0; that means, we know he is male. That means, there is no discrimination that means, it determines the equality. If you have 0 that means you are male, if someone is got 1; that means, she is female and between 1 and 0, within 1 or within 0, we actually cannot discriminate this is called nominal which is very simple one.

So, number 1 does not mean that 1, does not mean it is superior to 0, it is not. We cannot compare, like football team A and football team B. So, this need not be always numerical value, it can be alphabet. Team A and team B. So, within team A, all the players are equal, we do not discriminate, within team B all the players are equal, so t we can differentiate by B by word, we can differentiate or even by colour like football player team, we differentiate by jersey.

So, white colour or blue colour jersey, so white colour means all their players for a particular team. But we do not discriminate and number on the jersey of a player does not mean that he is superior. So, number 10 is not superior to number 1. So, that way, he is not superior to number 1; that means, here it is a basically the equality. So, nominal scale talks about the equality of particular group of people, it only differentiate 10 in a group.

So, a scale in which number or letter is assigned to the object serve as a level , that is you can give number or letter or classification and those numbers have no value , A and B they do not have any value. For instance we assigned 0 to wool, 1 to silk; that means, all wool will have 0 and all silk will have 1. So, we cannot tell that 1, silk is superior to wool, here only it separates groups. So, number 1 does not mean the superior position of number 2.

The rule for nominal scale is that all members of a class have the same number and no two classes have same number. Like silk if we give one in study, we cannot give silk as 0. For a particular study, we have to keep it arbitrarily. Tomorrow, we are going to start another study, we can give 0 as silk, 1 as wool that will be totally separate study. We will stop here, so next class, we will start with an ordinal scale.

Thank you.