Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Basic Cognitive Processes

Lecture: 6
Foundations of Cognitive Psychology

by
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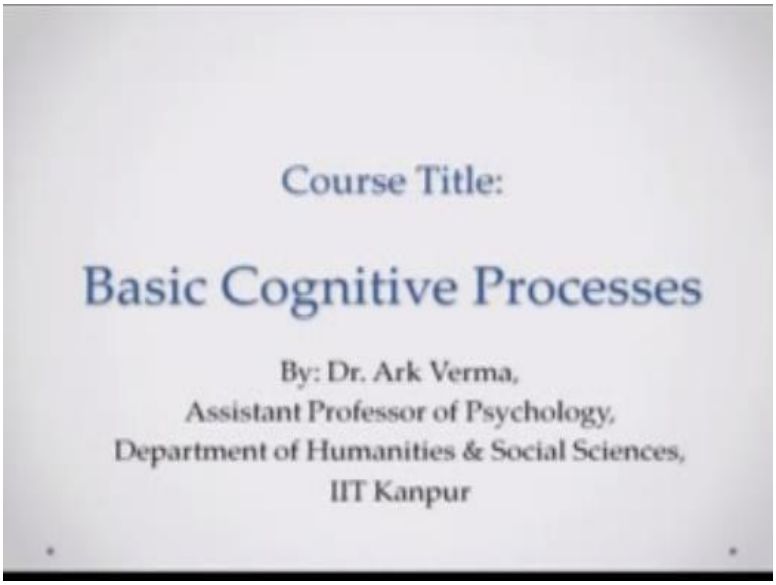

Hello and welcome to the sixth lecture of the serious basic cognitive processes. I am Dr. Ark Verma from IIT Kanpur.

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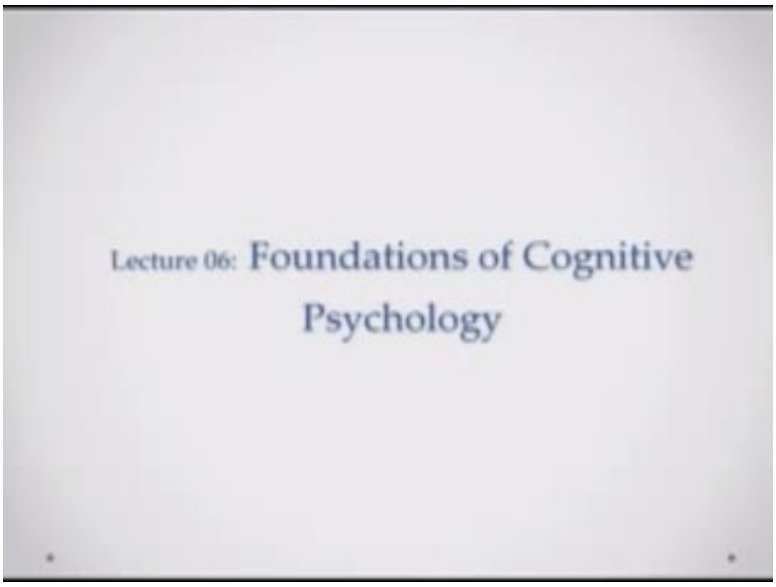

We are still talking about the foundation assumptions in cognitive psychology today.

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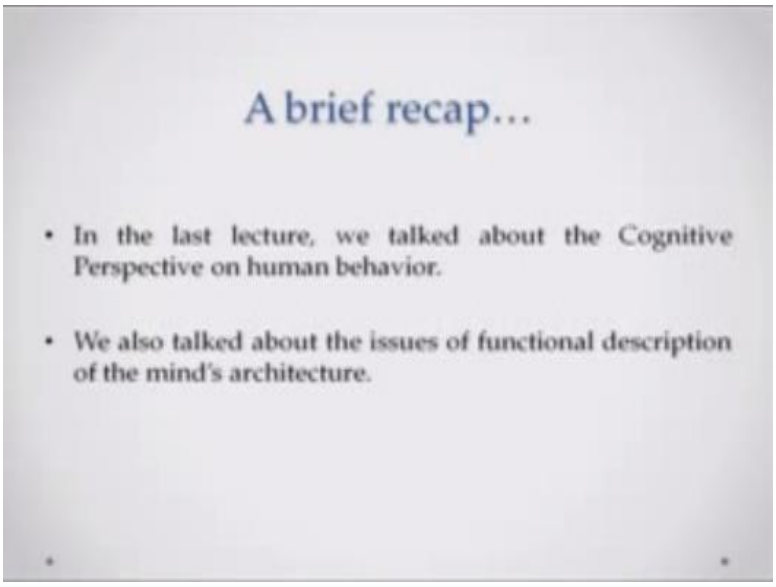

If you remember in the last two lectures, we talked about the behaviours is assumptions in the most recent lecture we talked about the cognitive as perspective on the human behaviour. We also talked about how a functional description of mental events is actually taken as the main point in cognitive psychology.

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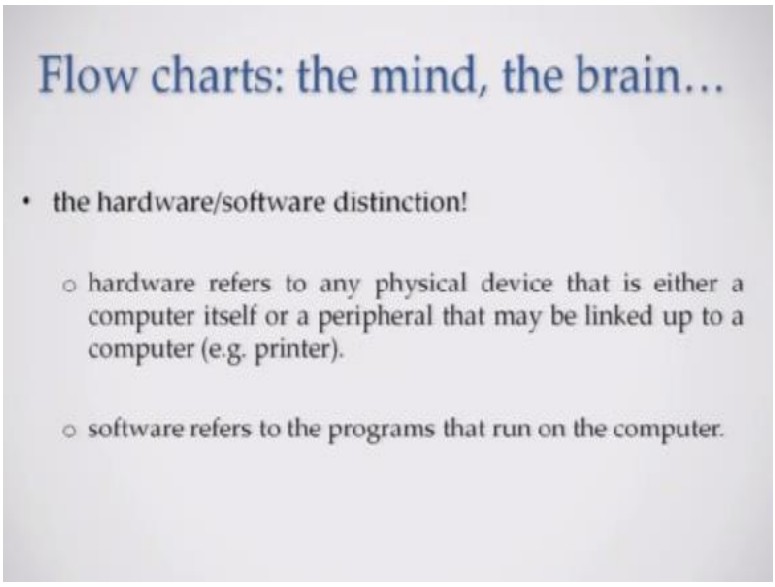

In today's lecture we would actually move towards a different kind of dichotomy something which you might have heard obviously something you might already heard is this hardware and software distinction that we make between the mind and the brain. This is probably one of the most use analogies brought out from computer science, but something which kind of also has its own assumptions.

So let us examine those assumptions and see how they help us in understanding this relationship between mind and behaviour. Now hardware if you see it refers to any physical device that is either a computer itself or it is a peripheral unit like your mouse, your keyboard things like that. Software refers to the programs that run on the computer. So there is this distinction between what a hardware is, and what a software is.

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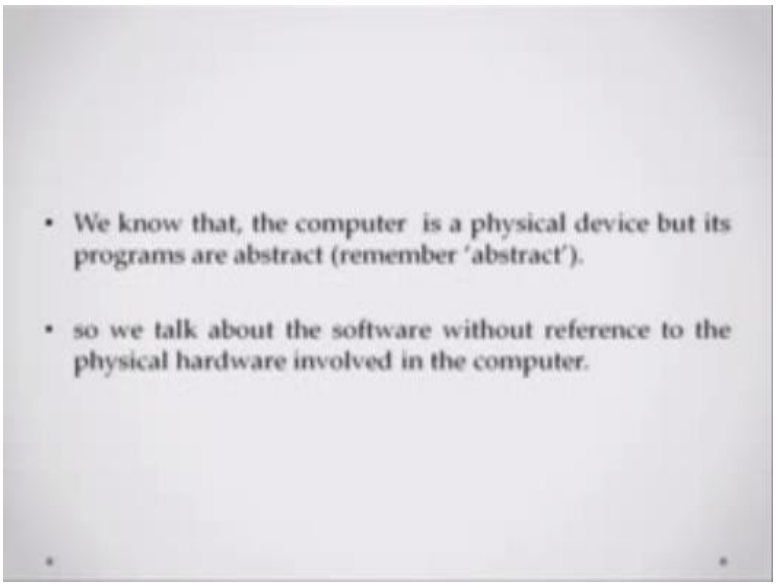

Now we know that because computer is a physical device but it is programs are abstracts. So whatever the computer does is actually abstract that is what a software part is. So we talk about the software generally without reference to the physical hardware of the computer. So whenever you say for sample, I saw this movie on the computer. Okay we do not really talk about the driver disk going round and round in the DVD player of the computer which led me to watch the movie.

We generally just say we saw the movie on the computer. So we generally talking about just the software part not really referring to the hardware part all the time. This is pretty much what we can actually do about the human behaviour or human mind as well. We can very well and comfortably talk about the different mental functions without always referring to the, what is happening in the hardware of the neural part, that is your brain.

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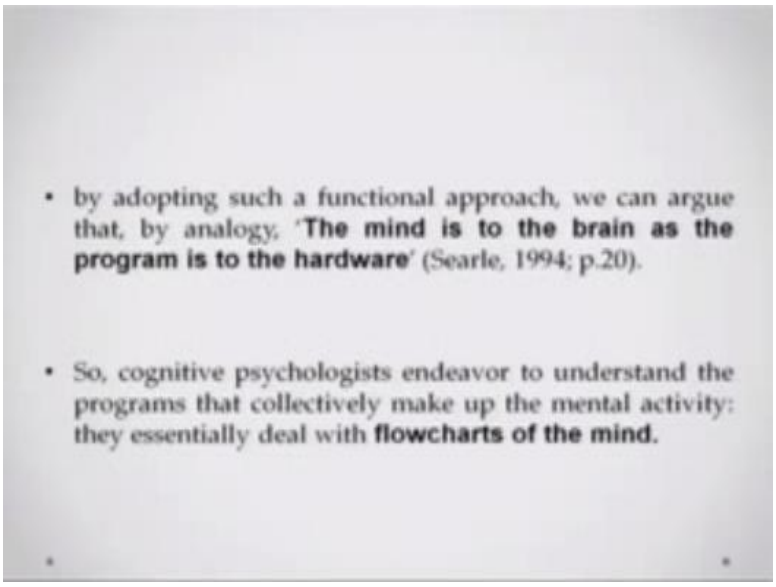

So by if you adopt such a functional approach for the human behaviour we can actually say something to the effect like the mind is to the brain as the program is to the hardware. This is something which was given by says a statement he said that in around 1994, so cognitive psychologist actually endeavour to understand this programs. They want to understand the programs that collectively make up the mental activity okay.

Which is what basically is then can be described as the flowcharts of the mind. So what all things happen, what all decisions take place in the mental world, in the mental states that leads to particular kinds of behaviours. Say for example, you might be feeling a sad that sadness leads you to feeling hungry and if you hungry you over eat, things like that.

So we will be talking about and we generally say the idea is that this is the general level of explanation, or general currency of conversation that really cognitive psychologist engage him okay. Let me take an example here, let us not talk about the brain for a while, let us talked about thermostat or other simple device.

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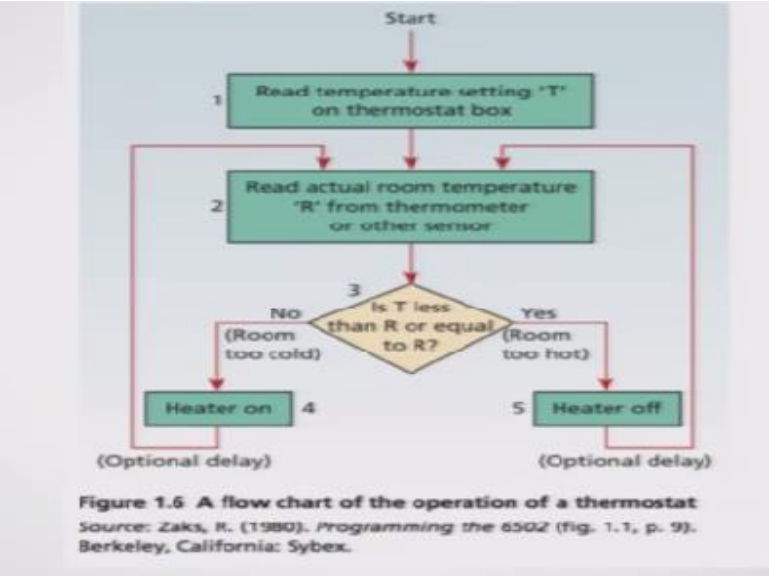

Figure 1.6 A flow chart of the operation of a thermostat
Source: Zaks, R. (1980). *Programming the 6502* (fig. 1.1, p. 9). Berkeley, California: Sybex.

Now here you can see flowchart of how the thermostat actually functions. So at the top you can see that the thermostat needs to start and the first step that it will take is actually it will read at the thermostat box. What is the temperature that is being registered at the thermostat box? The second thing is it then reads the actual room temperature wherever the thermostat is actually placed okay.

You can do that by help of a thermometer or some other kind of sensor. The second thing that the thing after that the third step that can helping this. Let is compares the two temperature, so it compares the temperature T of the thermostat box to the temperature R which is the room temperature. So the question could be like is still less than or equal to R. and they could be two possibilities okay.

If the temperature T is not less than or equal to R that is room is too cold, then what you do is then the heater gets on then thermostat actually takes a decision that the heater needs to go on. So that we increase the R note to the level of the T which is the thermostat box. Or in another scenario what might happen is that the temperature T is less than or equal to R that is room is actually too hot now.

So what it may need to do is, it will switch off the heater and this is what can keep on happening in a cycle in terms of wherever you place that thermostat okay. Now you see here

I just talked about the decisions and the calculations and the evaluations that the thermostat box was doing without really referring to what is the details of the sensor that really measures the temperature. What is the detail of the machine that really compares these two temperatures, pretty much what we aim to doing cognitive psychology as well. We do not really I mean to an extent we do not really want to talk about the neural structures all the time.

Obviously, we do and obviously we need to do that for a full explanation, but talking our discussions of mental states and human behaviour are not limited by that. Let us take that in mind.

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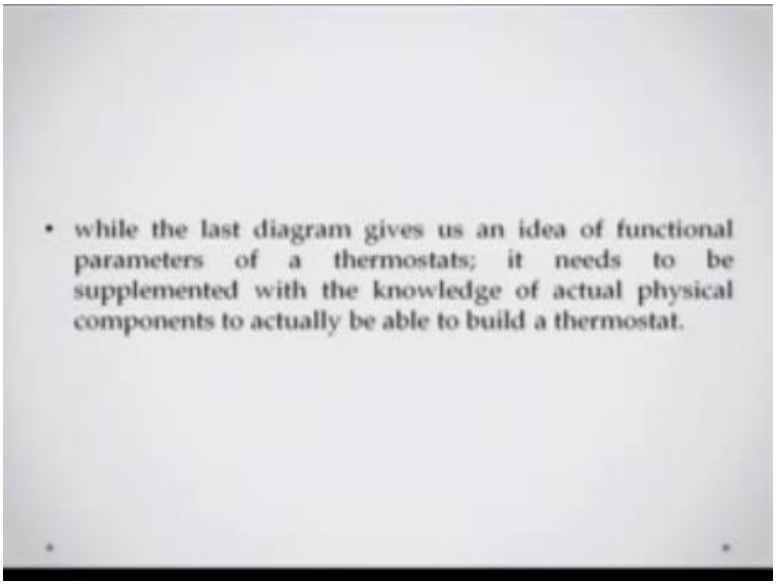

Now if you see the last diagram gives us an idea of the functional parameters of the thermostat it needs to be supplemented with the knowledge of the actual physical components as well.

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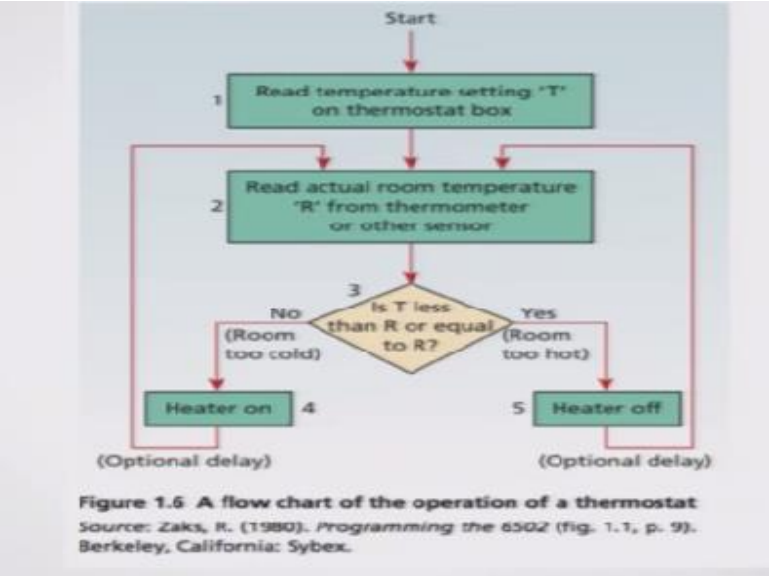

Figure 1.6 A flow chart of the operation of a thermostat
Source: Zaks, R. (1980). *Programming the 6502* (fig. 1.1, p. 9). Berkeley, California: Sybex.

If you just give the last diagram which is the flowchart to somebody it might not suffices really given actual explanation of what the thermostat is about. That you would know that how the thermostat functions, but say for example, there is somebody was never seen a thermostat okay.

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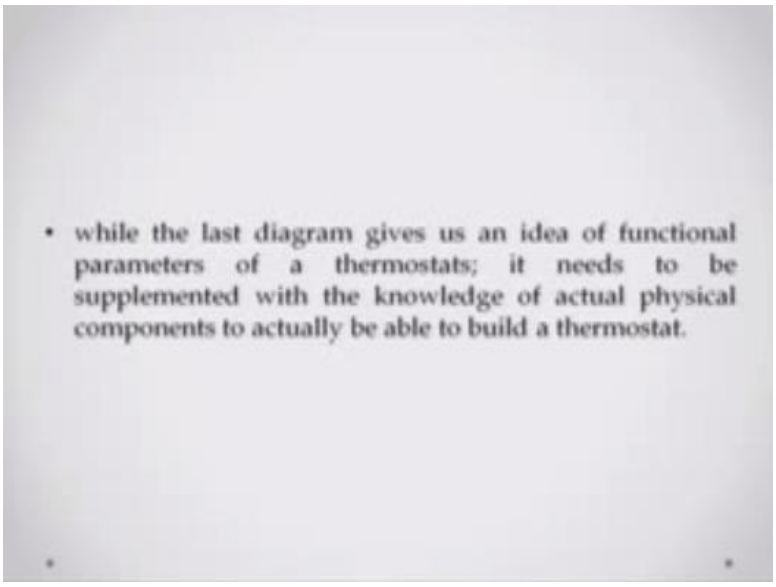

So you need to supply them additionally with the knowledge of the actual physical components that are required to build up a thermostat. So that is where the whole experience of the thermostat for some person really gets completed.

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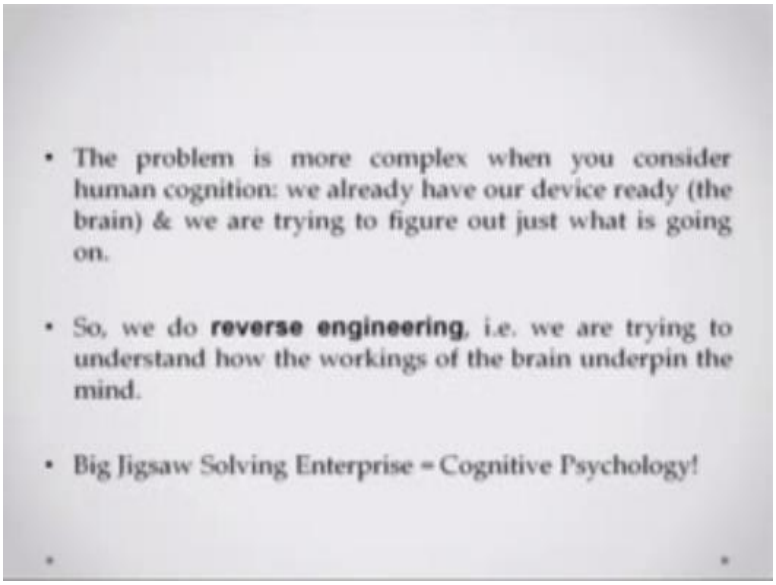

Now the problem with the human behaviour or human mind and this is a slightly more complex. When you consider human cognition we already have a device study. We already have our brain. So we do not really know what are the different components, and how are they attached and those kind of structural connections, etc., are not really known to the best possible level okay.

What we are trying to figure out as cognitive psychologist is just what is going on, what is happening in the different areas of the brain and how these different areas, how activity in the different areas of the brain is leading to particular kinds of brain. That is what we are trying to do. So in a sense you could say that we are actually trying to do a kind of reverse engineering okay.

We are not trying to build up something, but we are trying to in some as deconstruct something okay. So we are trying to understand how the working of the brain underpin the human mind. There actually really talking about it but how the working of the mind , brain you really underpin the mind. So for example, how gets mind really can be how can mind be explained by different neural activities that are going on in the brain. That is what we are trying to do.

So in some sense you would also say that this big jig so puzzle kind of a thing that is your human mind and this big jig so solving enterprise is what cognitive psychology is actually about. For some people it can be very interesting for some others it might be bit dry, but all idea is, it is other fascinating to understand how this human mind is made up on the basis of these different neural activities.

We do not really know what the nature of this human mind is. We are just looking at something which is componential nature which is the human brain and how that is really leading to the human mind. There are obviously debates on this issue and that basically go on in the field of study called philosophy of mind which might also interest some of you.

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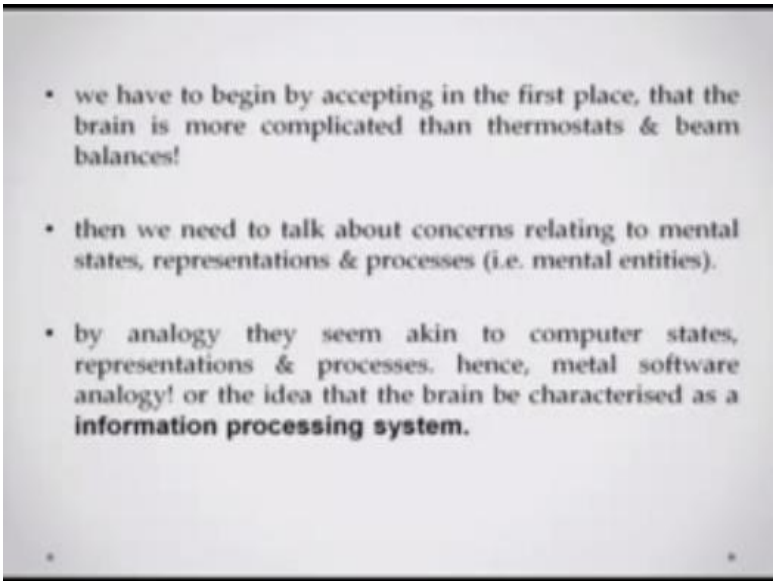

So we have to begin by excepting in the first place that the brain is slightly more complicated and thermostats and beam balances. At least that is one assumption that you begin with. Then what we need to do is to talk about concerns relating to mental states representations and processes how is the brain representing the outside world. How is the brain leading to these different mental states, and how is the brain actually leading to the interactions between these mental states.

If you remember an earlier example there are william felt hungry and he decided to make a sandwich how is the brain really supporting this kind of an interaction how is the brain going

from feeling hungry to deciding to make a sandwich to actually doing all that is required to make a sandwich. That is what we are actually interested in here. By analogy these things seem very similar to what goes on in the computer okay.

Representations and processes in how is the computer really representing these different numbers, how would this called calculations really happening. Those kind of that is why the computer hardware, software analysis actually taking to explain the mind, brain relationship sometimes okay. Also something interesting that one needs to understand is how does the brain really work in processing information.

So how is the brain really regarded as a information processing system. We talk about that as we go ahead in this course. Then we need to talk about the information from the world, how does the information from the world, that is your input the course that represent this input that is a representation and how that responses are generated that is the output. So I am trying to like in the human brain to what a computer is.

So that is input which is information around the world there it is representation processes the algorithms and then there is an output that response is being generated. Now somebody who is done an excellent job of actually explaining these interactions and relationships was David Marr.

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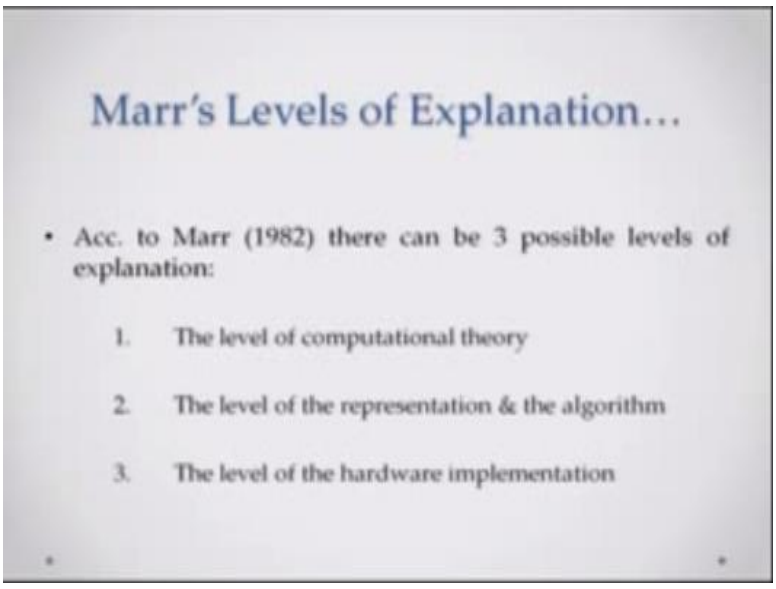

In 1982 David Marr actually came out with these three possible levels of explanation of the kind of interaction we are talking about the mind and the brain interaction. He said that the three levels at which you can actually explain this interaction okay. So first level which he gave was the level of computational theory, the second level that he gave was the level of algorithm, the third level that he gave was the level of implementation. We will see each of them as we go ahead now.

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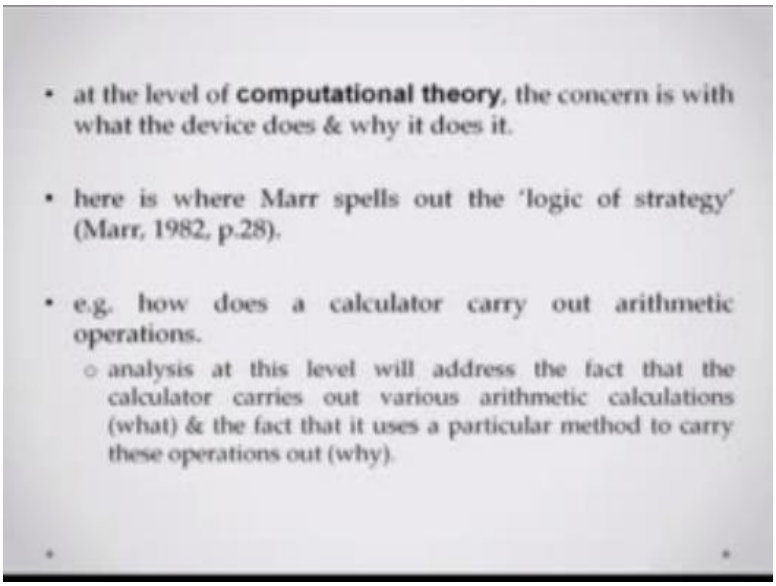

At the level of computational theory you are basically concern with what is that the device needs to do and how is and why is it doing it okay. Here is where Marr spells out something which as the logic of strategy how do you go about doing something okay. You are not doing it yet. You are not really exactly planning all the steps but how do you need to do it. How do you need to say for example make tea okay.

You need to have milk, water, tea, and sugar okay. This is your computational, you know that these four things are needed to make tea okay. So let us take an another example for now, so how does the calculator carry out arithmetic operations. Analysis at this level will actually address the fact that the calculator carried out this various arithmetic calculations and the fact that it needs a particular method to carry out this calculations.

The fact that it does and the fact that they has to be a method okay. When we talk about the method we will go to the next level just talking about the computational part a bit more.

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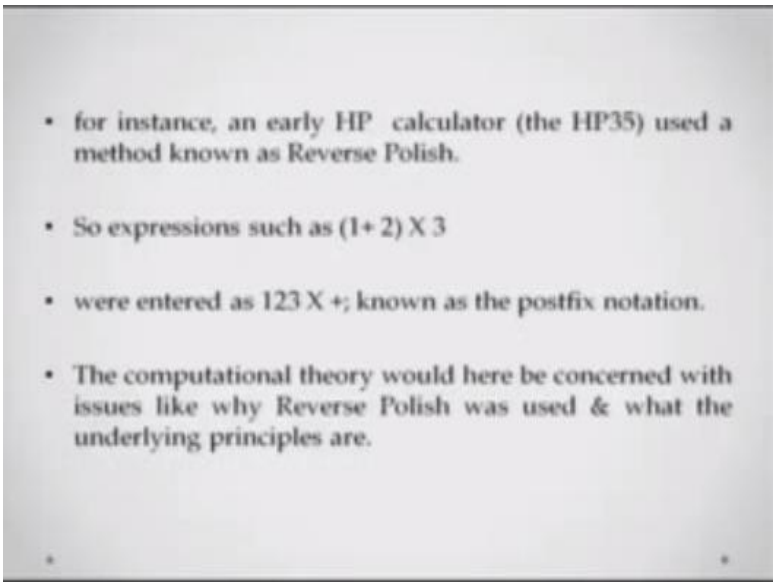

For example, if you have this early hp calculator this basically used to use a method called reverse polish. So if you give it an expression like 1 + 2 multiplied by 3 and 1 +2 is in parentheses then you would need to enter these like 1, 2 and 3 you enter all the numbers first and then you actually enter the operators okay. This is basically known as the post fix notation.

So the computation level explanation of the computational theory basically in this will be concerned with issues like why do you need to use reverse polish here and what are the underlying principles of reverse polish that you actually use here to solve that problem or to explain that problem in some sense.

That is your computational level that is your computational level of explanation. What we need ahead then we need an algorithm, how do you really implement these steps okay.

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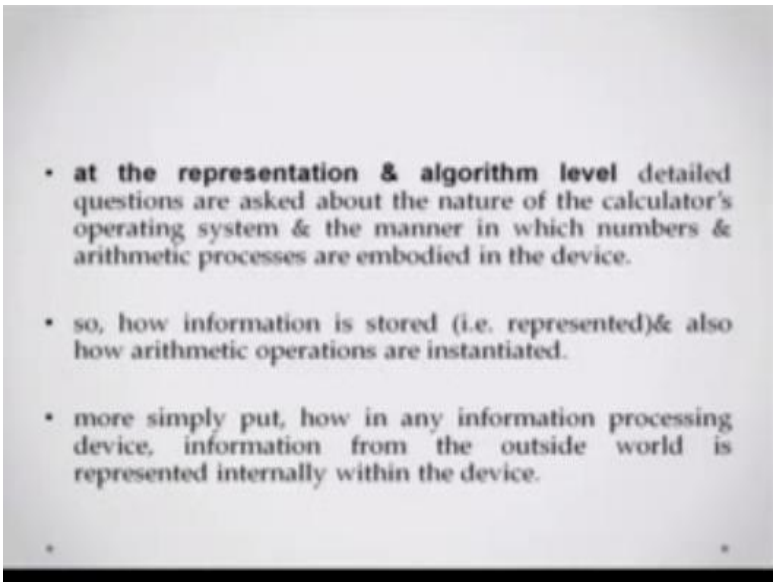

So this is the level of the representation the algorithm level is the level, we had questions are actually asked about nature of the calculators operating systems. What kind of operating system is there? What are the steps that you will take and the manner in which the numbers are represented, embodied in the device? So we are talking about the calculated here. So how information is stored and how arithmetic operations are instantiated.

Say for example, how does calculator store number 2, 3, 4 and how does it invoke the addition and those kind of things. Those things we are actually talking about when you talking about the algorithm and the representation level. We are simply put how in any information, so if you just leave the example of the calculator for while and talk about any information processing system.

The question will be that how in any information processing system the information from the outside world is represented okay. Say for example, we see a lot of things how the picture or how this object right in front me say represented in my eyes or in my brain. What are those aspects in my eyes and in the brain that are actually helping the code the object outside which I have actually seen. That is the level of representation that you need to be talking about.

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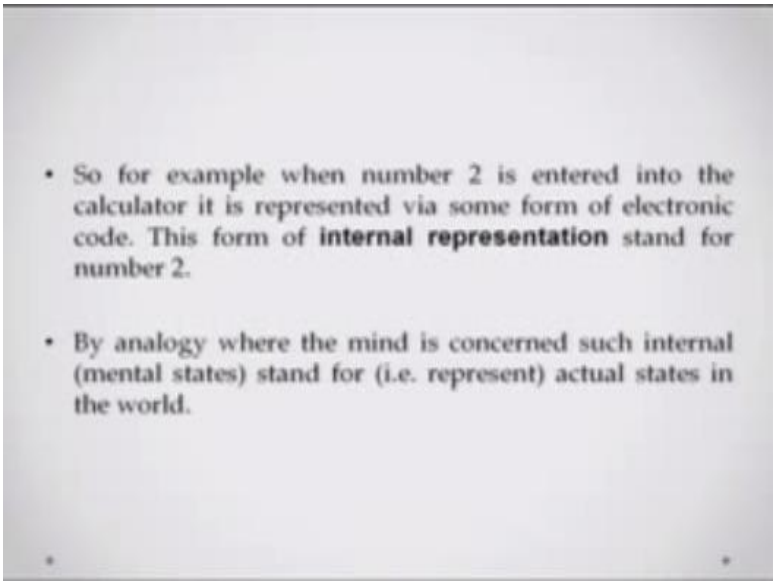

Coming back to the calculator example say for example when number two is entered into the calculator it is represented by some form of this electronic code. Now this electronic code is what represents number 2. That is your internal representation level, by analogy when you talk about the mind, the mind the mental states basically need to represent the actual states in the world.

As I said if you would actually watching flower, if you walking in the garden and you see a flower, if you see a rose for example they will be a representation of the color and the shape of the rose in your head through your eyes which basically you will then process and say for example have memories about in stuff. But the first step for the most basic step is how is that colour red represented.

That is what is the level of representation, and that is what basically this level of representation is all about.

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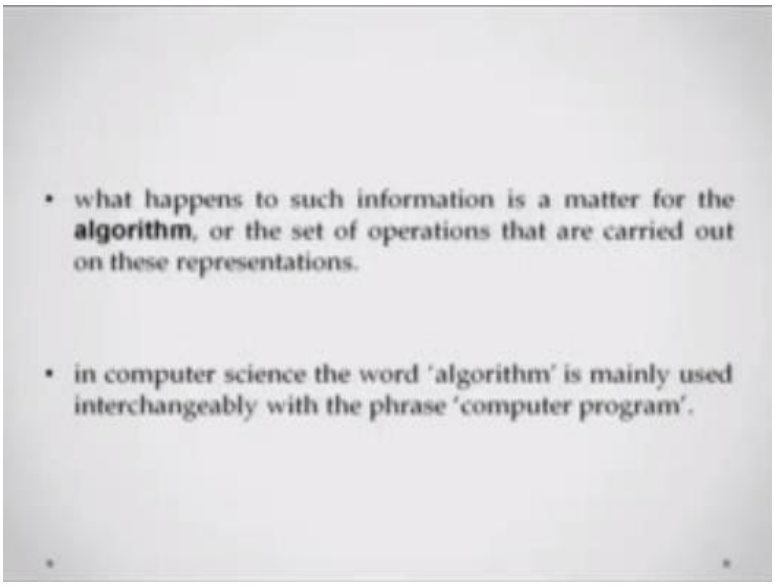

Now what happens to when you have represented rate, when you have set of codes or say set of neuron that fire to code a rate, what do you do after that what ahead okay. So what ahead basically is explained in the level of algorithm okay. The level of algorithm basically helps you specify the set of operations that are carried out on those representation, so you combined the rate and combined the shape and you then have a complete perceptions of what a rose is.

Similarly, say for example you have to make tea you know that tea and sugar and milk and water needed, and the next step will be how do you really combine them to come up with tea. You will need to know the algorithm the exact sequence of steps that you will need to take in order to able to make tea okay. So in computer science this world algorithm is mainly use interchangeably with the word called program, it is pretty much the same thing how something is really being done.

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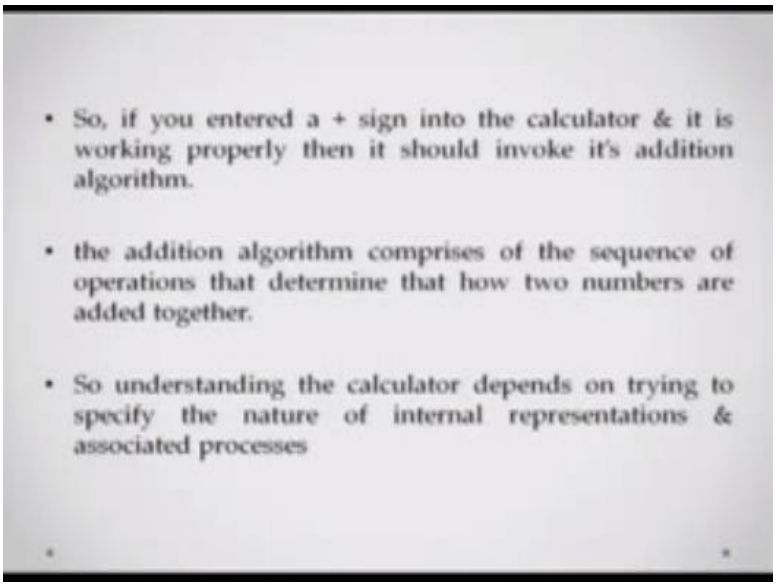

So if you entered a + sign into the calculator and it is working properly then what it should do is it should invoke the addition algorithm. You tied 1, 2, 3 and then you tied a + sign, the + sign should invoke the addition algorithm for these numbers that are there. So the + sign is telling the computer that invoke the additional algorithm for these representation of numbers that I have already had okay.

So understanding what is this additional algorithm comprise of, this additional algorithm basically comprise of the sequence of operations that determined how these two numbers are going to be added. So then is where we actually talk about how a particular function is taking place, how this addition is really happening. So understanding a calculator then if you really want to understand a get a good picture of what the calculator does really depends on trying to specify the nature of the internal representations.

How is the calculator representing numbers and the associated process, how is the calculator actually really added up stuff okay. This is what you want you want to talk about when you talking about the representation and algorithm. In terms of leave the calculator and the tea making example aside and you come back to the cognition example comeback to how mind and behaviour are to be explained, then what we need to do is, we really need to consider both mental processes and mental representations and mental processes.

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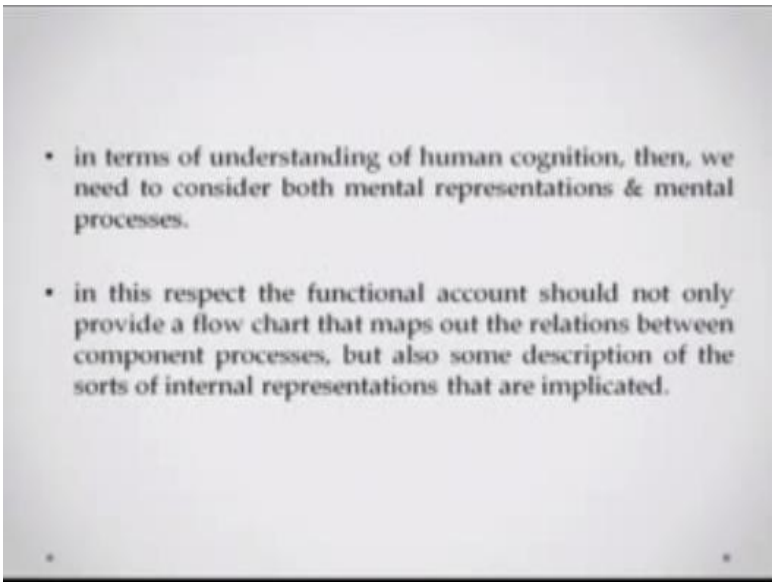

How is the mind representing depth? How is the mind representing colour? How is the mind representing shapes and then what it does to combine those color and shape and depth information to really give you full perception of say for example, if there is a person, if there is a place how do you navigate through a part all of those kind of things basically are coming from this atomic level of representation okay.

That is something which is one of the most important questions that is the errant cognitive psychology that cognitive psychology attempts to explain. In this expect by the way the functional account should not only provide the flow chart that maps out the relationship between these different component processes, but also it gives you some description of the sorts of internal representations that are implicated.

When you talk about a flowchart like we talked about in the example of the thermostat the flowchart should also have that this is how particular shape, or flower, or something particular is represented and this is how it will be combined and that is what we lead you to the full perception or experience of the flower okay. Coming to the third level, the third level is actually when you really get on to doing things how something is really implemented.

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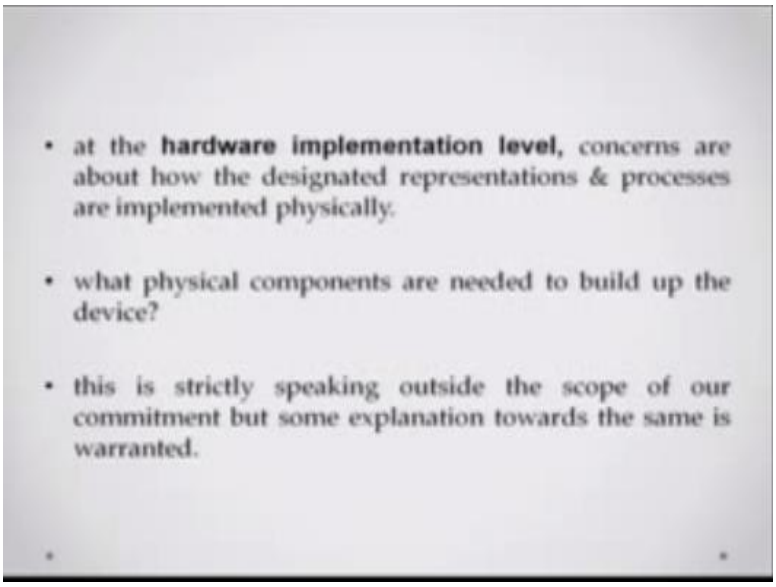

For example, in the case of the thermostat what is the sensor exactly, what is the sensor that is really measuring the temperature of the room something like that. So at the hardware implementation level concerns are about how the designative representations and processes are implemented physically those kind of explanation, so all those kinds of issues. So what physical components are needed to build at the thermostat.

Now this is, if you talk about the human brain and you talk about mind and stuff, this is pretty much slightly out of the scope of our discussion probably that is more suited to a class of neuro science. I will not really be talking about a lot in detail about these things. But, let me go to slightly related but a different issue. We will talk about all those explanation still is deserved that is what we will talk about now.

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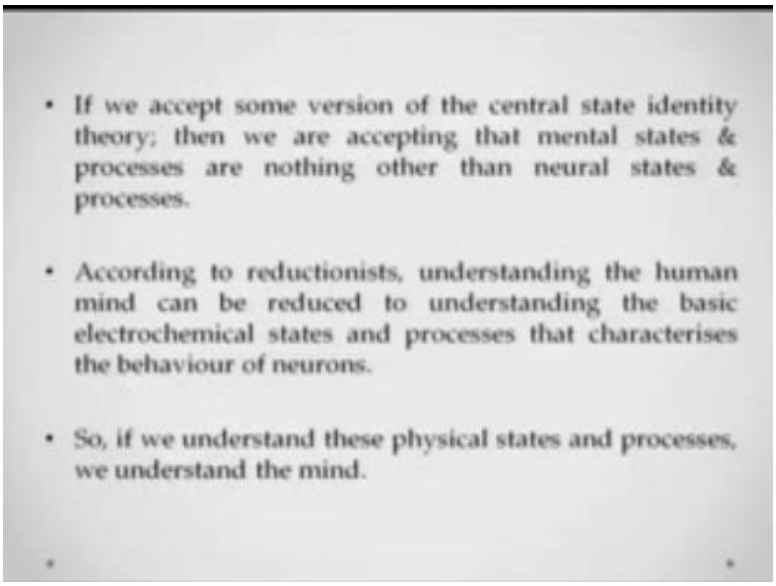

So if we accept some version of the central state identity theory the fact that mental events and neural events are related, then we are excepting that mental states or processes are nothing, but these neural processes. So there are particular neuron fires that leads to a particular kind of memory or particular kind of feeling happiness or sadness and that is what we are talking about.

Now this remember can be rather a strong position to take okay. And there are certain doubts and debates about that. This kind of theory basically this kind of an explanatory stands is called reductionism. So according to reduction is what they say is that understanding the human mind can be reduced to understanding the basic electro chemical states and processes that characterizes the behaviour of neurons okay.

Say for example, if you completely understand how neuron functions and if you completely understand how are the function of the neuron affects another neuron and how this these all neurons are connected together. Then you do not really need to worry about mental states at all. It is pretty much at neuron x will fire, and neuron y will follow, and neuron z will also follow and that will lead to the perception of that.

So then why do you need to have the perception thing there, you can just say that particular neurons firing lead to particular kinds of behaviour okay. That if you really follow the other

strongly can kind of creates problems are cognitive psychology okay. It kind of takes you to the assumption if you understand these physical states completely. We have understood what the mind is. That is the position some of people in the discipline would like to take as well.

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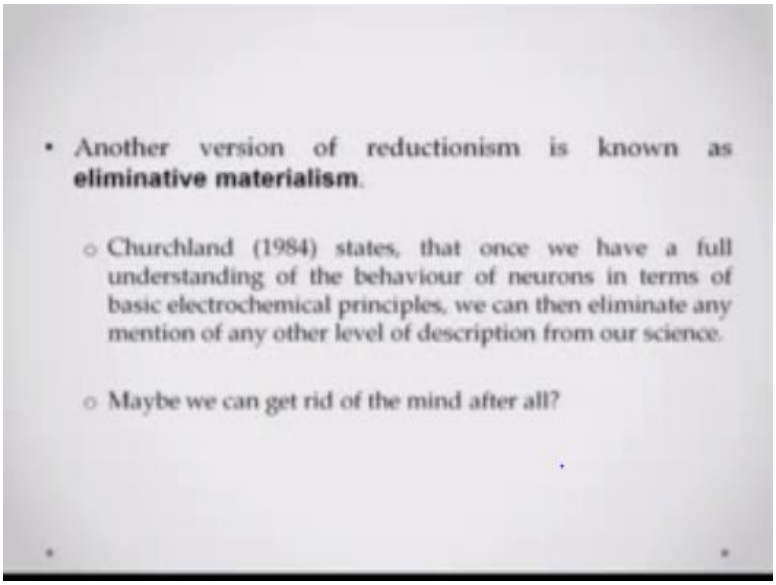

This is one version, another version of reductionism by the way is called eliminative materialism. Eliminative materialism as Churchland states is that once we have a full understanding of the behaviour of neurons in terms of basic electrochemical principles, we can then eliminate any mention of the description of any other level of description that you do not really need to talk about any other levels at all.

So that is pretty much what is rather similar to the earlier explanation of the reductionism that I gave. Now the point is the question that you should ask yourselves and the question you should spend some time wondering about is that maybe, then we can get rid of the mind even. What we can just say is that these are the reactions that are going on in the brain and these reactions are directly leading to those kind of behaviour.

So you do not really need to have the mind. Last time you are saying that those could not be help to explain the mind, but here I am saying that why consider mind at all. You can just consider that these particular interactions of the neurons and these are happening due to various neuro chemicals some hormones are release, some neuro transmitters are release,

something or physical or chemical explanations there and that is pretty much what is leading to particular kinds of behaviour.

There is no need of having the mind or mental states or all of that. There is a slightly harder stands, this is called eliminative materialism. A more harder or stands or reduction is about. Now if this happened say for example, at some point of time, I do not think that time is anywhere near.

But at some point time of neuro scientist really go that level and the understand completely what the functioning of different parts of the brain are, what each of the neuron is doing, how they are connected how the different neuro transmitters hormones, etc., are controlling these neurons. If that level of expective and knowledge as raised then what would cognitive psychology is doing.

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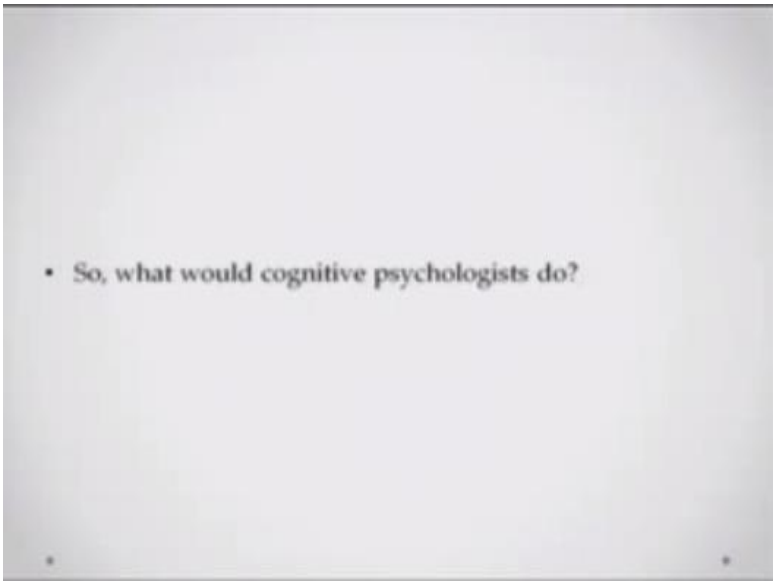

Then we are out of job practically we do not have stuff to talk about, but they could be some we are actually not focussing ourselves on that anyways.

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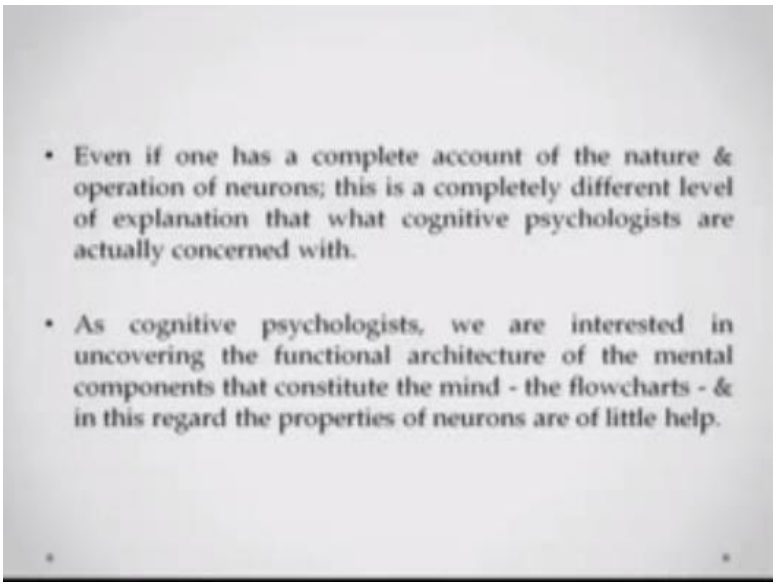

Even if one has a complete account of the nature and operation of neurons, then also this is completely different level of explanation that what cognitive psychologist actually engage in. We never said that we want to be concerned about how the neuron functions in the first place. You are just saying that we are actually operating at a slightly different level. Even if you understand how a particular neuron functions and how different connections lead to particular behaviours.

We are not really concerned with that, you are saying that we can say that okay, this kind of activity in the nerve cells, or in the neurons, or in certain use of the brain lead to this kind of behaviour. And they will be an intervening level of explanation that we will be talking about that is what cognitive psychology anyway is about. As cognitive psychologist and that is something which should be showed to all of us is as cognitive psychologist we are interested in uncovering the functional architecture of the mental components that counts to the mind.

If you just want to know that what leads to us, say for example how memory can lead to a particular experience those kinds of things. So the flowcharts say how a particular decision is taken, how different mental events are connected, those kinds of things we are actually worried about. So at some point you will see how limitations of attention can lead to sometimes faulty perceptions, those kinds of things.

The entire explanation is then based in mental states and that is where our model successfully rests. Completely or if not completely, but reasonably sure of or reasonably distend from these dependents on the neural states. That pretty much what cognitive psychology is about. So this where you basically brings with to the end of the serious of foundation assumptions in cognitive psychology, and this was the third lecture in this serious.

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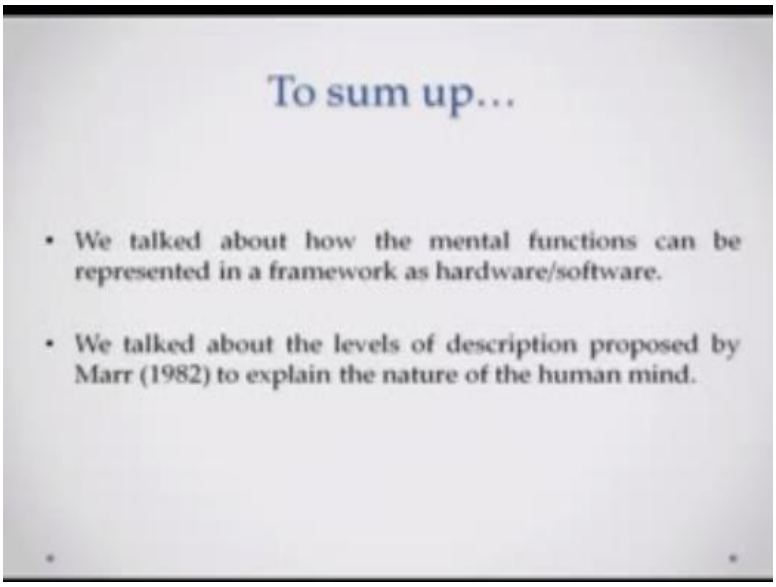

And so just to sum up we were talking about what how mental functions can be represented, in the analogy of the hardware and software. We also talked about these different levels of description that exists which Marr gave, and we talked about how this could lead to a different kind of dispose about mental functions. So this is the end of the session on foundation assumptions of cognitive psychology, we will go towards the some other kinds of approaches to study cognitive psychology in the next class. Thank you.

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