Selected Topics in Psychology
Psychological Testing and Assessment
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Neuropsychology and Cognitive Neuroscience Research

Welcome to the talk and understanding human behavior using neuropsychology as a paradigm, and neuroscience as an approach. The idea behind taking up this talk is to understand human behavior using a neuroscientific approach. We all believe that understanding human behavior is very easy, but in fact the science of human behavior is very strong based on certain scientific assumptions. One such assumption lies on the parameters based on neuroscientific approach, I will talk about this neuroscientific approach to the understanding of human behavior, primarily with the notion related to cognition.

And thereafter, critically discussing that why neuroscientific approaches are good to understand human behavior for an objective assessment, regarding what really happens at the higher center of the brain, when a behavior is executed. Remember there are various other approaches as well. The idea of taking up this notion is not to nullify the other approaches. The idea here is to delineate, the relevance the criticalities of neuroscientific approaches in the understanding of human behavior. I would like to talk in terms of a broad perspective of all sciences that try to understand human behavior. It is not psychological science, which is only devoted to the understanding of human behavior, there are various other sciences also contribute to the understanding of human behavior.

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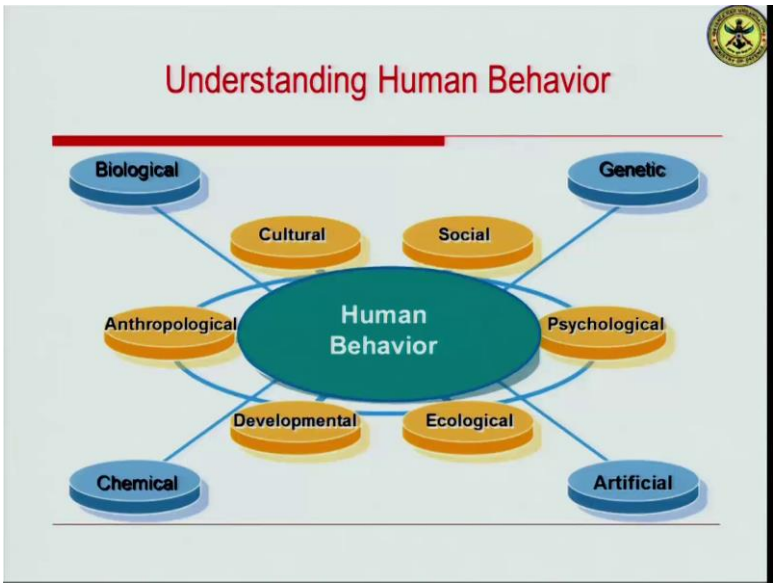

If you try to have a look it at, how many sciences are contributing to the understanding of human behavior, you will find that two major groups are responsible for it, one group of sciences relate to hard sciences which are genetic, biological, chemical, and artificial. These hard sciences give us very objective notion about, how a behavior is formed, executed in the human system. Genetic system tells us, what are the inherited properties of our behavior? Biological system tells us, how such behaviors are express through a biological system.

Chemical science is tell us how such chemical reactions with your chemical reactions take place, when a particular behavior executed. And artificial neural network or mathematical sciences tell us, how can we understand the simplest or the rudimentary part of a behavior through the understanding of mathematical sciences. On the other hand, some of the social scientific approaches also try to understand human behavior. They include social science as such cultural sciences, anthropological sciences, developmental sciences, ecological sciences and psychological sciences.

These social scientific approaches try to understand behavior, how it is embedded into a context or a social context. The cultural of system, the anthropological root, the developmental channels, the ecological perspective, the social perspective and the psychological context all contribute to human behavior. My approach here would be to

understand using understand human behavior, using some kind of psychological system with inputs drawn from primarily, biological system.

And to do that, we are not going to talk about all kinds of human behavior. We would primarily concentrate on cognitive behavior, because other than cognitive, we have got effective behavior, we have got behaviors that are executed through our motor systems will not talk about those systems. Here our effort would be to understand cognition or cognitive behavior using a neuroscientific approach.

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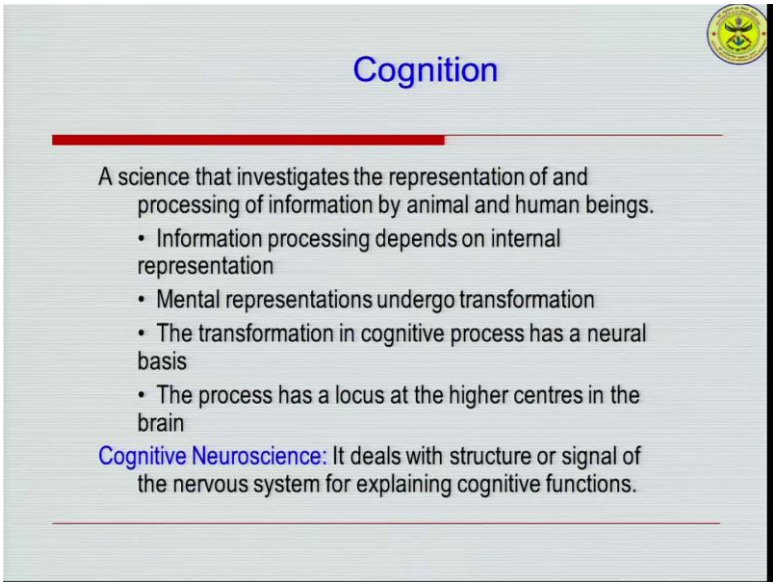

Well, before we enter into cognitive neuroscience, it is important that we understand cognition, what do we mean by cognition? Cognition is basically a science that deals with how a information is registered, how an information is processed and how an information is retrieved. In a rather book ((Refer Time: 05:52)) it is a science that investigates the representation of, and the processing of information by animal and human being. In fact, cognitive science has it is root in animal sciences, and in comparative psychology as well.

So, the representation and the processing of information is the primary area, where cognitive science works. We believe that any information that is registered depends on how we represented internally, the same object may have several forms of representation in our brain. An apple is represented in various forms in a person's brain, one may perceive apple with the red color, one may perceive apple with the yellow color, one may

perceive a bigger apple, one may perceive a apple with some context. When he first got an apple from somebody and one may actually try to represent it through certain reinforcement paradigms.

So, how it is processed in internally represented, is one of the major issue of cognition. Then whenever they are represented, they do not stay as it is any input that comes to our brain, undergo some form of transformation that is the representation changes after sometime. And that change take place, based on our kind of experience that we have. So, any mental representation that we have actually undergo transformation that transformation takes place at a biological, as well as biochemical levels.

Therefore, the transformation in cognitive process we say, that it has got a neural basis, based on the neural basis the transformation actually takes place. And finally, the whole transformation with a neural backdrop, is turn at the higher center of the brain therefore, cognition has a relevance greatly with the brain sciences, which we actually termed as cognitive neuroscience. Therefore, under cognitive neuroscience as a subject matter, we talk about the structure and signal of nervous system, for explaining any cognitive function that is any kind of information processing that takes place, at the neural level.

And how they are represented, how they are transformed, and how ultimately they are retrieved through a cognitive system is the subject matter, where cognitive science deals with it primarily. So, the questions coming up, under cognitive science is basically a science with information processing capability, where any information that is transformed in a formation, is just not a random input. So, any input that reaches brain, and transformed in some kind of formation becomes information, all kinds of informations are not registered automatically, and transformed and processed.

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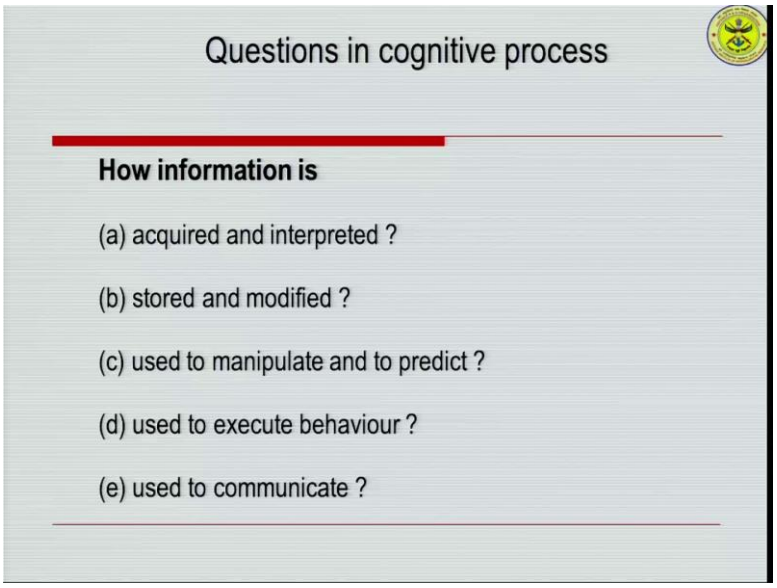

So, the patterning of the input, in some formation is basically a cognitive science, where we try to understand, how these inputs are acquired and interpreted, because we do not take up or acquire all kinds of information in the brain, and then interpret it. How they are stored and modified, how we used those information to manipulate and to predict, how we use information to execute a behavior.

And how such a behavior are executed, or utilized to communicate to another person. These are the basic questions in cognitive processes. So, under cognitive process, we try to understand the whole area of questions, right from how it is acquired to interpreted, stored, modified, manipulated, executed, and how they are utilized for communication purposes.

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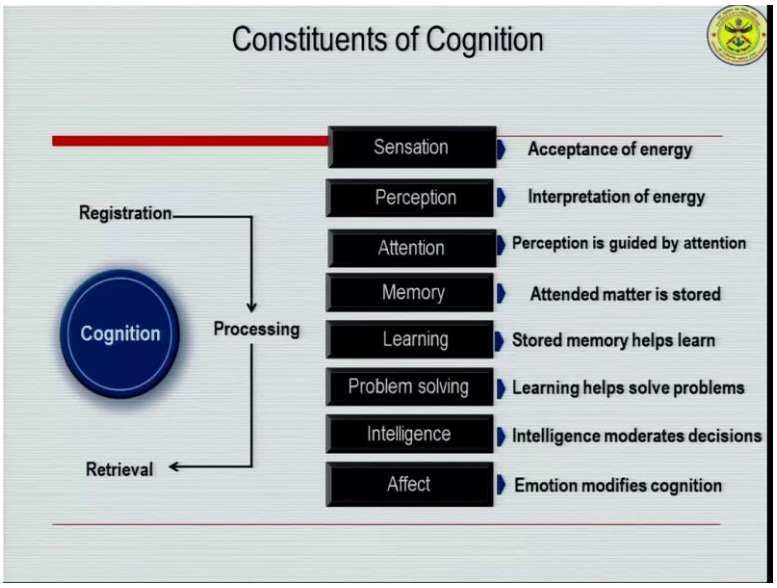

I will give you now, what are the constituents of cognition, because in order to answer for this questions, we must know how a particular behavior is executed, through different array or different steps in cognition. As I said, that any input, the registration of it, the processing it off, and the retrieval put together is called cognition, but that is elements view about what cognition is, when we try to translate cognition into certain steps.

The first step comes here is in the form of sensation, that is until and unless we accept some kind of energy, through our sense organ, the cognition cannot start. Any energy that is not accepted with our within our system, cannot actually either be represented transformed, or utilized for making some kind of behavior through communication system. Now, after we accept a particular energy, which is termed as sensation, we try to interpret energy; however, we accept many energies, but we do not try to interpret all kinds of energies.

Now, interpretation of energy is a very important concept, which we called perception, now until and unless we perceived those energy, they becomes redundant and do not come to our system, following a meaningful way. Now, when we interpret energy, we find that all energies are also not interpreted, like all energies are not accepted, either through gastritis channel, or visual channel, or auditory channel, or tactile channel. All energies are not accepted; likewise all energies are not interpreted, because our perception is primarily guided by certain attentional factors.

We cannot actually attend to everything, we have limited capacities. So, we filtered those mechanisms, through our cognitive system, which we call as attention, and these perceptions the interpretation of energy gets guided by attention. After we attended to it, we try to store the material through memory, because until and unless we store it, we have to learn that material every day. Therefore, attended material when it is stored it becomes memory, there can be any kind of memory, it can go into our long term memory, which we never forget really forget.

It can go into our short term memory, which remains within our system for short period, or it can be of any kind. After we stored it, we actually try to utilize it through a process, because the storing process is important through learning, because if we do not store that energy, we may have to learn the same thing every day. Now, if I learn how to thread a needle, I remember it and if I fail to remember it, I will have to learn it every day therefore; memory and learning are very important linkages.

After we learnt it, we understand that the learning process itself helps us in solving various kinds of problem, because learning as a component, help us problem solving problem in our day to day life. Because, if we fail to solve problem, learning becomes meaningless, now this problem solving, and learning as an approach is possible through our intelligence, which is our basic capability based on which we take decisions into our day to day life.

And this intelligence in turn are also affected by some kind of our emotional inputs, which modifies our cognitive system. So, apart from affect all other steps, right from sensation to intelligence, actually are different constituents of cognition. And when we study cognitive science, we actually study them as a process, as a whole or we study it is unitary concept, at various level of sensation, perception, attention, memory, learning, problems solving, and intelligence.

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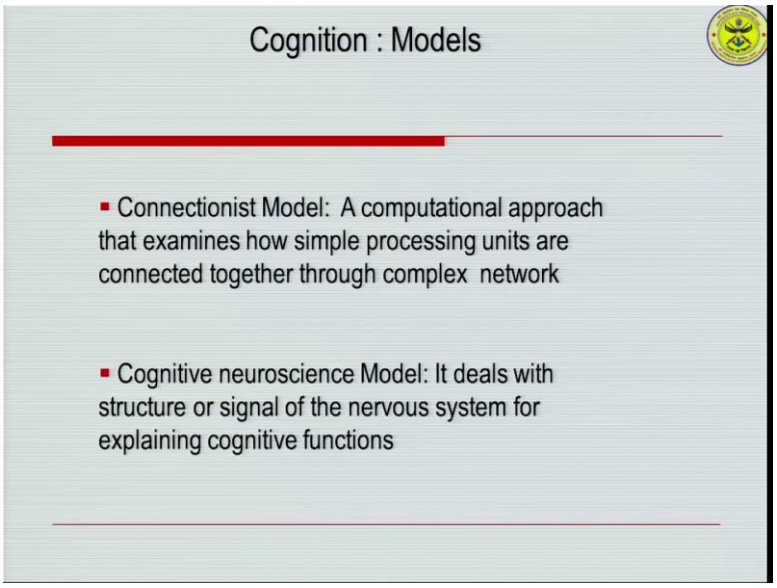

Now, we should try to understand, what are the two major models to understand cognition? Now cognition as a science, has it is origin in behavioral science, but both mathematical science, as well as neuroscience has their own models to understand it. The mathematical science actually is based on connectionist model. This model is a computational approach, which examines how simple processing units are connected together, towards the network of complex understanding. So, the mathematical processes to understanding cognition, the whole process try to understand the unitary concepts in cognition.

And how they are linked in a certain process, which mathematically if we can calibrate would be able to tell, that how such networks develop. While the mathematical approach is to understand the minimum unit of our understanding, right from understanding or acceptance of energy to the higher level of processing, of decision making. The cognitive neuroscience process deals with, the structure and signal of the nervous strengths, for explaining such kind of behavior what kind of signals, we generate in the brain.

When we accept such energy, how we interpret it, how we represent it, and how we transform it, at the higher centre of the brain, which is dealt with by cognitive neuroscience model. So, these are the two major models, which try to understand cognition, one has got a basis in mathematical science, other has a basis in the biological science. To understand the outcome of a process called cognition, which has got this root

in behavioral science. So, you understand that, how cognitive science is a science has a derivative from behavioral science from mathematical science, as well as from biological sciences.

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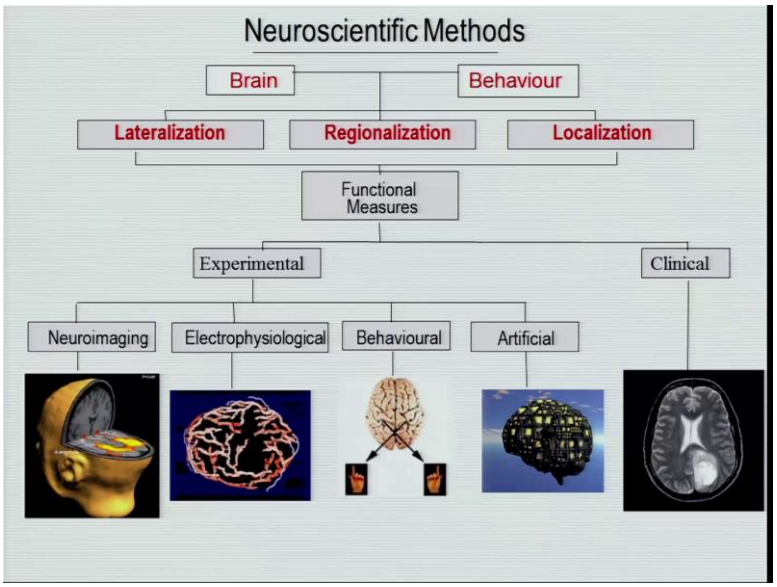

I would like to now tell you that how brain and behavior is related, and what are the different neuroscientific method, because my attempt here it be to understand using cognitive neuroscience model, rather than connectivistic model. Now, when we try to understand cognition from brain and behavior perspective, we have 3 models in hand, these 3 models try to understand human behavior through different processes and perspectives. One is a localization model, one is called a regionalization model, and one is called a lateralization model. Now, I would try to explain each of these models, in order to understand human behavior.

The localization model has it is origin in the deficiency model, which started with ducts in 19 189 6, wherein we tried to understand human behavior through a clinical approach. And the approach suggest that if there is a lesion, a tumor, a damage in the brain, what kind of impairment to you are going to get in future, thereby making a link between the impairment observed, and the damaged to a given site. They are correlated in the localization model, and by having that localization model, we try to predict which part of the brain is meant for what kind of behavior.

The regionalization model is different slightly different form the localization model, while localization models say that, how one part of the brain is related to one kind of function. The regionalization concept tells that, the different regions of the brain may be responsible for one kind of behavior, or several behaviors may also be located in one part of the brain. So, in regionalization model we try to understand, what are the different regions that get activated? When a mental function is there, so localization model is primarily utilized in brain damaged cases, and thereby making an inference between a cognitive behavior and a particular impairment.

Regionalization model primarily deals with the intact brain subjects, where we try to understand that when a particular mental function is executed, what are different regions that get activated? Now, these activations are studied through different mechanisms, which I will be telling you shortly and thereafter, a model comes which is called lateralization model. The lateralization model is neither a purely localized model at a given side, nor a regionalization model which considers the whole brain into account.

Lateralization model actually says that which part of the brain is meant for what kind of behavior, like left brain has got different kind behaviors, which are executed cognitive behavior, right kind right side of the brain is meant for different kind of cognitive behavior, and how they are executed. So, lateralization is a concept which deals with left brain as well as right brain. And it uses both clinical model as well as an experimental model, while regionalization utilizes primarily and experimental model, and while localization utilizes primarily and clinical model.

So, when we try to understand all 3 models, the clinical approach is primarily as I said executed by localization model. Regionalization, lateralization models are somewhat different, regionalization model primarily deals with experimental model, the studies are primarily done with intact brain subjects, while lateralization is dealing with both clinical cases, as well as experimental point of view as well. So, when we talk about the experimental paradigm in the understanding of the neuroscientific issues related to brain and behavior.

There are 4 kinds of techniques that we have been utilizing, one technique is of course, neuroimaging a non invasive imaging process through functional m r i. Where we try to understand the oxygenation process in the brain, whenever there is a metal function, the

neural signal a neural signal is fired, and oxygen is consumed. The movement oxygen is consumed, and the depletion the nearby capillary is open, and they rush to compensate for the oxygen impairment, while they are rushed the oxygenated and deoxygenated components within that given area gets identified through a computer scan and process.

And through a complex statistical analysis, we understand that which part of the brain is oxygenated, and which part of the brain is deoxygenated. So, with this method which is called functional magnetic regency matching, we understand which regions of the brain get activated, when a mental function is occurring. The other approach is electro physiological approach, which is a age long approaches, where we try to understand the electrical activities associated with the brain, whenever there is a cognitive function is executed.

The behavioral method primarily deals the lateralization program, where we try to understand what kind of mental function, or cognitive function is located in which side of the brain, the left side as well as the right side. And the artificial is basically a mathematical model, where we try to understand, how a cognitive function is executed, I mean how a cognitive function is networked through an array of activities, which can be calibrated and calculated through a mathematical process or software. In any case, these are all experimental methods, these can be done on intact brains objects, the clinical method as I had said is primarily a deficiency model not a efficacy model.

It tells if there is a tumor as you see in this scan, what kind of impairment takes place following a particular damage in the particular site. With these methodologies, I would now like to tell you this localization, regionalization and lateralization, each of these methods had their own advantages and disadvantages. Now, advantages are known to us, because lateralization helps us very clearly without using sophisticated tools and procedures, that how the two sides of the brain functions.

Localization gives us a clear correlation between, what kind of damage and what kind of impairment? One can very easily calculate that, in regionalization also we understand what are the different regions that are getting activated, when a mental function is executed, but each of these methods has his own lacuna, here I would like to critically discuss, how these methodologies suffer from different kind of difficulties, because that

will give us a comparative understanding of how they 2 or how they 3 approaches differ, and how they are complementary to each other.

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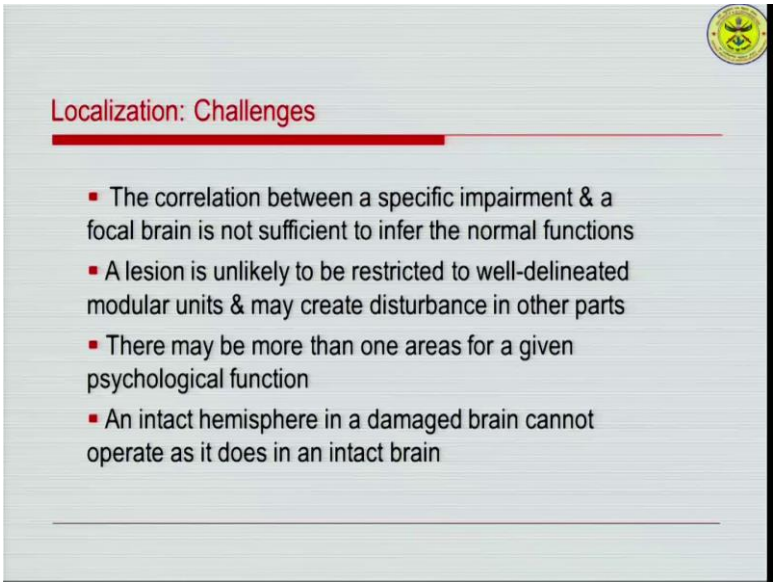

For example in localization, the challenge is that there are various kind of challenges, once a challenge is that the various assumptions that the correlation, there is a correlation between a specific impairment, and a focal brain is not sufficient to in for the normal brain functions. In fact from an impairment, we are trying to talk about the efficiency or the performance of a given particular area. So, the correlation between a specific impairment, and a focal brain is not sufficient may not be sufficient to in for the normal functions.

It may be taken over by other sides of the brain, which we do not know; in clinical and the localization method we simply say that, after this damage there is a set of impairment. So, that particular site must be related in a intact brain for such kind of behavior, which may not be true, it may not be sufficient, likewise a lesion, when it is studied within a brain in a localization model is unlikely to be restricted in a while delineated modular unit, and may create disturbance in other parts, I may be having a tumor in the front lobe, but the pressure may be created somewhere back in my temporal lobe or maybe fronted temporal lobe, may be and they oxypital lobe.

So, functionally the changes may occur, where the pressure is created rather than, where it is physically limited to therefore, it is very important to understand that when we refer

about a lesion in terms of a side, site and size, they may not be restricted to a well delineated modular unit. And they may actually create disturbance in various other parts, which are physically not possible for us to see. And it is also possible that there may be more than one areas for a given a psychological function in the brain.

They very hypothesis that there is one to one relationship between one part of the brain with one kind of psychological function, may not be true, it is possible that various psychological functions are located in one part of the brain, and it is also possible that various parts of the brain are actually required to execute one kind of mental function. As of now we do not have a very clear notion, that whether brain is distributed both by some form of equip potentiality or some form of localization or not.

So, that is a very difficult area, where cognitive neuroscience find it difficult, through neuroscience find it difficult to understand mental function through localization paradigm. Finally it is also there, that a intact hemisphere in a bad damaged brain which we find in a localization model, if there is a damaged in the right brain, the left brain may be intact, but there is no reason to believe that a intact hemisphere in a damaged brain, can operate as it does in a intact brain.

I meant to say that, if the left hemisphere is in intact in a damaged brain, we should not presume that the left hemisphere will function normally, because in a damaged brain the whole system may be damaged. So, localization as a system, localization as an approach to the understanding of cognitive aspects of a human function or human behavior has its own disadvantages, but it has got it own advantages as well, which I have talked too.

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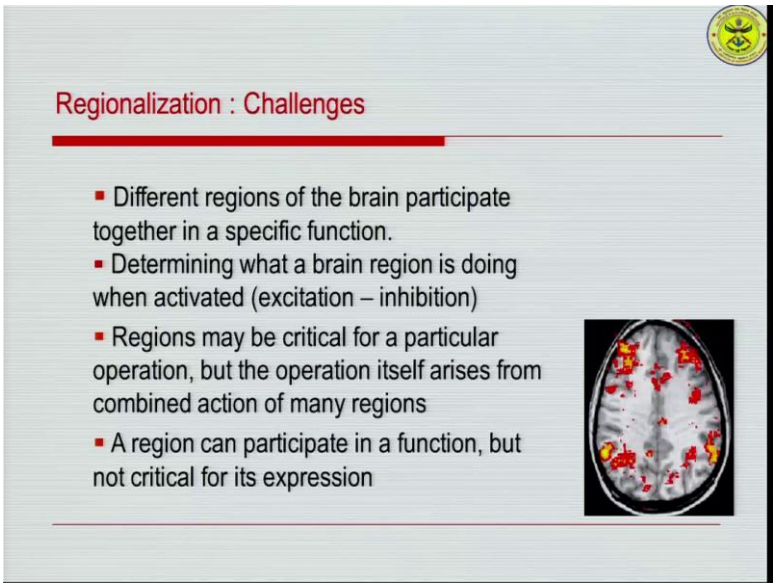

I will now talk about the regionalization as a critical notion, regionalization is also having this own disadvantages, has its own challenges. It is possible that different regions of the brain participate together in a specific function. So, the point that there is one region for one function or they maybe there may be different functions located in one particular region, applies to regionalization hypothesis as well. Likewise determining what a brain is doing? When it is activated is also not known, activation means what is not interpreted, we only know there is an activation.

Now, whether it is due to sulfarmo visitation or some of form of innovation, we are not very sure, it is not very clear that if I get activation, whether my efficiencies referred by some form of activation and not. If a person is doing very well in mathematics, will you get more activation or if a person is finding a difficult to do mathematics, will you get more activation. Activation per say refers to what is it excitation or inhibition is also not very clear, we get activation, we know there is a processing going on, but the activation per say does not refer, whether it is part of the excitation process or a inhibition process.

Likewise region may be critical for a particular operation, but the operation itself arises from combined action of many regions, the region that we finally home in for a given function, that we try to understand or link it with a particular behavior, but the point is that, before the activation takes place the entire operation may arise from different other sections of the brain, which may not have been activated at that point of time. So, regions

may be critical for a particular operation, but the operation the processing itself arises, may arise from a combine action of many regions.

And finally, a region can participate in a function, but may not be critical for it is expression, now this is very important, you get an activation in a given region, but that region may not be critical for the expression. A different region maybe critical for that, it is only finally executed by a particular region for which you are getting the activation, therefore it is very important to understand that cognitive function per say and the regional activation, they may not be directly related in a one to one matter manner.

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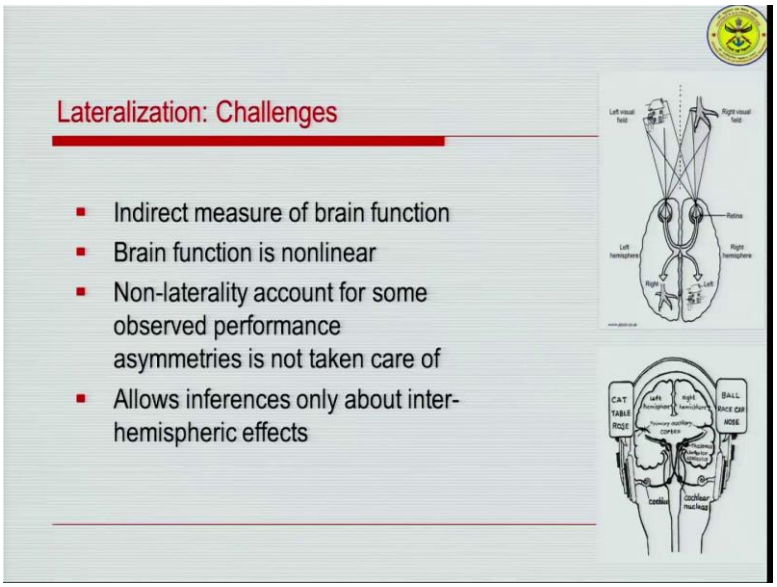

Likewise, we have certain challenges for lateralization paradigms also, in lateral lateralization paradigm unlike regionalization or localization these are mostly computer generated methodologies. Where we have two major or three major techniques, which are called split visual field technique, where we try to understand how the two sides of the brain process visual information, we have got a dichotic listening technique, where we try to understand which site of the brain process, what kind of acoustic information.

And we have a dichaptic method, where we try to understand with site of the body kinetically process what kind of information. These techniques are behavioral techniques basically they are done for intact brains objects technique, but they have got their own difficulties as well, because some such techniques are not centrally executed that is they do not involve any central nervous system or processing per say. There are certain

peripheral mechanisms also, where in we try to understand which site of the brain is activated for what kind of function.

For example, if we are right handed we presume that the left brain is dominant for that particular person, if somebody is purely left handed or left footer we try to presume that probably the person is more right sided, such kind of peripheral measures are also utilize, but more often to draw a conclusion about the brain involvement in lateralization pattern, through the study of cerebral hemisphericity. We generally utilize split visual field technique, which I am showing it here as a technique, wherein the two sides of the visual field: left visual field and the right visual field they are stimulated with some kind of visual stimuli.

And we try to understand that which side of the stimuli is actually processed by which side of the brain. Normally these stimuli are presented in less than 200 milliseconds, so that there is no saccadic eye movement before that, and the information is not exchanged from one side of the brain to another side of the brain. With this paradigm, we try to understand with a presentation of visual stimuli and the two visual field, left visual field and right visual field and less than 200 millisecond. We try to understand, which side of the brain is processing what kind of information.

The other technique is called dichotic listening technique, in which the two sides of the two ears are simultaneously stimulated at the same temporal point. Thereby trying to understand, whether there is a interference or a facilitation, or whether there is greater advantage of processing of one side of the brain, over the another side on the processing of a caustic stimuli. This methodology was devised by Turin Komura a scientist long back; it is a excellent technique through which we can understand this cerebral hemisphericity.

When the two sides of the brain or the two ears as simultaneously stimulated at the same temporal point, the epcilateral pathways are invited the contra lateral pathways are facilitated. Therefore, if we get two different noises or two different lexical stimuli at two different ears, the ear the side which is dominant for processing a particular lexical stimuli, gives gets a priority in terms of processing, like a and b. If the two ears are stimulated with two different alphabets, the one that is presented at the right ear gets an

accesses over the one that is presented in the left ear, because generally the left hemisphere is more dominant in the processing of lexical stimuli.

In the lateralization paradigm though these paradigms are rare relatively easier to execute, there are certain disadvantages in it as well. For example, these are indirect measures of brain function they are not direct measures, like regionalization there is a direct measure of brain function, or in localization we directly understand that the particular part of the brain is damaged. Here in lateralization paradigm, we do not get any such input it is a direct measure. It is also a challenge, the understanding that the brain function is a clear linear process that is left will get the access to right side, and right will get access to left side there is no such linear relationship.

Brain functions are often non linear, so therefore a clear cut linear relationship, a correlation cannot actually tell about which side of the brain is performing, what kind of information. The non laterality account of some of the observed performance asymmetries is not generally taken care of the some observed performance, at asymmetries are not clearly understood through lateral paradigms. Everything cannot be understood through a laterality paradigm, there are activities in the brain which are not lateralized clearly.

So, to understand such behaviors, other than the motor behavior, for example the higher order complex mental processes are not fully lateralized. In fact the rudimentary behaviors, the more rudimentary the behavior is greater there is a chance that there are lateralization, but higher centers of the brain or the higher complex mental processes cognitive processes are not lateralized to that extent. And it allows inferences only about inter hemispheric effects, it does not talk about anything else, than other than understanding a relationship between a particular cognitive process and a particular side of the brain.

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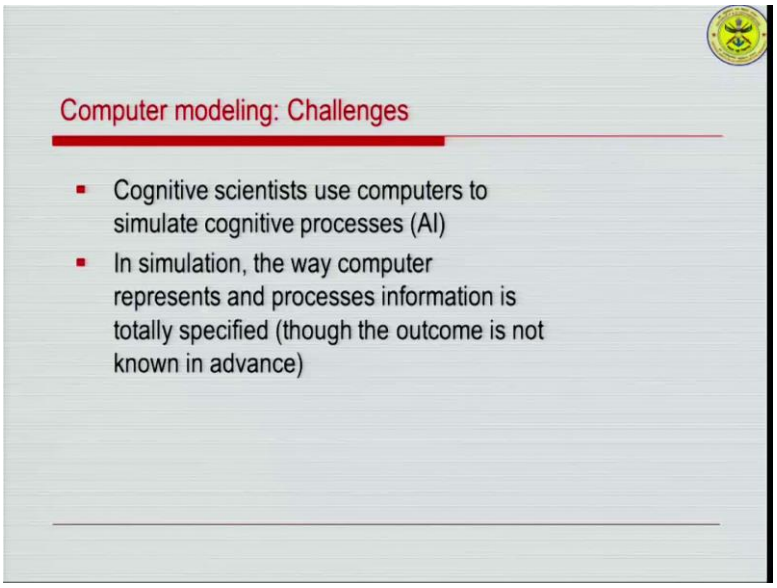

There are computer modeling also as I said in the experimental modeling, the artificial neural network also comes into picture, AI comes also into picture, other than the brain sciences, but they also face different kind of challenges. The cognitive scientists use computers to actually simulate cognitive processes; it is possible that in computer we can simulate such process. But in simulation, the way computer represents and process information is totally specified, though the outcome is not known in advance, everything is specified.

So that specificity, that linearity, that sequentiality does not explained fully, the parallel processing capacity of the human brain. In fact, cognitive processing is not only sequential they are parallel as well, that parallel understanding is not fully possible for us to represent through some form of softwares, which AI as a methodology artificial intelligence as a methodology tries to develop.

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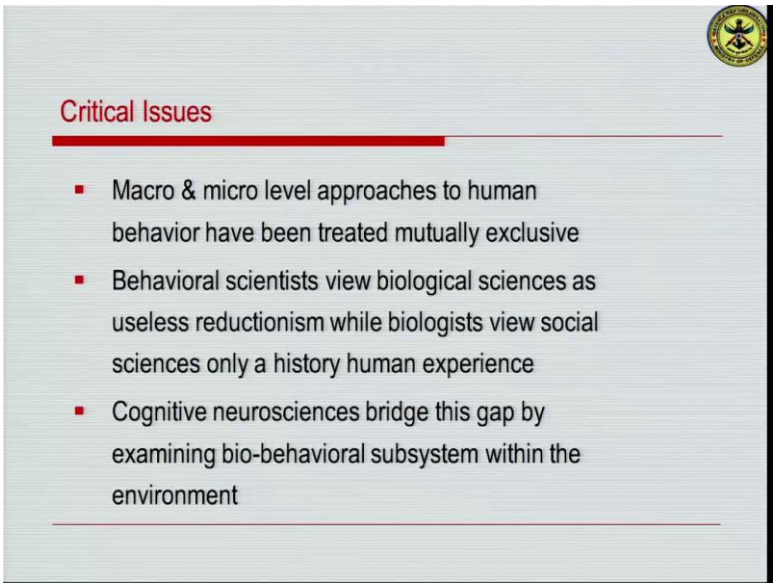

So, the critical issues what it is coming up, that in cognitive neuroscience we utilize biological system, biological signals to interpret our cognitive behavior. While mathematical science try to understand how the network is created. In behavioral science, we try to understand behavior at a macro level rather than at a micro level as I said, the hard sciences, the biological sciences, the genetic sciences, the biochemical sciences, the artificial sciences they all try to understand human behavior or cognitive behavior at a very micro level.

But behavioral science has their own approaches at a very macro level, but the problem is that the understandings at a micro level, as well as a macro level toward the understanding of human behavior are generally treated as mutually exclusive. They are never taken into consideration in some kind of relationship, the micro level understanding is done separately; the macro level understandings are also done separately. As a result what happens, the behavioral scientists view biological sciences as useless reductionism, that at a molecular level if we try to understand the human behavior.

Ultimately we get to understand what, what changes at, what changes are happening at the molecular level, does not have any correlation what behavior is executed at a holistic manner. And even if that behavior is executed, under what circumstances, what are the contexts? What are the social, ecological, developmental and other issues, which bring in

changes into human behavior, are not at all understood in the reductionist approach. While biologists view that social science is nothing, they cannot tell anything about cause effect relationship of a human behavior.

So, they are simply a history of human experience, they simply talk about human experience of that the behavior is executed, they talk only about the experience that the human being has actually gone through. So, there is a difficulty here in the understanding of cognitive science as a whole, where a macro sciences has their own approaches, the micro sciences has their own approaches. Cognitive neuroscience is a science, where we try to bridge the gap by examining the bio behavioral subsystem within the environment.

Under cognitive neuroscience, we not only look at a molecular level or at a signal level of the brain, what kind of changes are occurring, but how these changes are also getting correlated with a given context, with a given backdrop or with a behavioral subsystem within the environment is also looked after. So, cognitive neuroscience does not exclusively depend on a biological model or a reductionistic model, it actually takes into account both the models into account.

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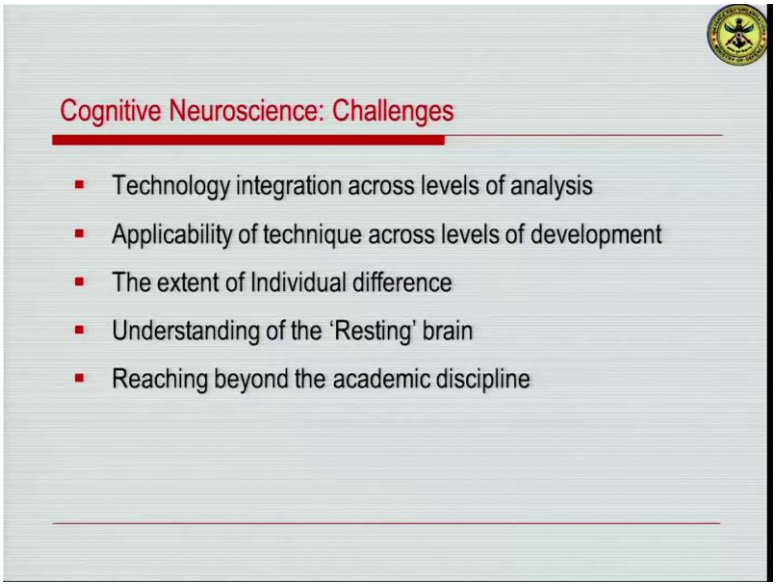

So, the challenges of cognitive neuroscience is therefore, in order to understand since we have now integrated our approaches, and try to understand human behavior through cognitive system. Through a overall process, it is now time to understand that how cognitive neuroscience should progress, now it is important to understand the technology

integration across all levels of analysis, that is I will get input from localization model, I will get input from regionalization, as well as lateralization model.

And using experimental model, we get input neuroimaging sciences, we get input from electro visualogic sciences, we get input from behavioral sciences, we get input from artificial and neurosciences. The question is that, how do we integrate those, how do we integrate this technological input in a overall analysis to understand holistically cognitive science, cognitive behavior as a whole. Then the question comes, even if we understand the applicability of all such technique and understanding, on the overall course of development is a very important phenomenon.

As I said to understand any behavior 5 cornets twins are utilized, one is a theoretical, biological, developmental, cultural and statistical. So, the question comes the developmental train, that is after theoretical, biological we must understand, that how cognitive development takes place an at every stage of the development, how this technique and technological integration can be done is a big challenge for cognitive neuroscience.

Then comes the issue of cognitive neuroscience, the major trouble they are facing with the extent of individual difference, now human two know two human beings are seem, neither two human beings are altogether different. The extent of human difference has never being calibrated; one of the major problem with cognitive sciences is that, if we treat every individual as a different individual developing a notion about cognition. And as a whole is a very difficult task or difficult process, and not only that within the same individual, the cognitive system or the cognitive process changes over a stage, over a period.

So, a child who is of 6 years of age, when he develops reaches at 20 years of age his cognitive system will undergo great change, when he reaches 60 years of age his cognitive system will also undergoing change. So, it is not only between the two individuals, the extent of individual difference that will create difficulty for us to understand cognitive neuroscience. It is also within the same individual, the cognitive systems subsystem that changes over a period of development is also a difficult thing to understand.

Also it is important to understand for us, what does the resting brain is I mean understanding of the resting brain, because as you see all models either localization, regionalization or lateralization. As a model they can be utilized, whenever the brain has some function or the brain is doing something or the brain has got some aberration or some problem. In a intact resting brain, we have no study method to understand it, what the brain is doing at a resting state. So, the understanding of the resting state of the brain is never attempted in any time.

Therefore, it will be a challenge for cognitive neuroscience also to understand resting brain. The acting brain or the damaged brain or the impaired brain or the active brain, there are models to understand it, but there is no such model to understand the resting brain. Finally, reaching beyond the academic discipline, and then actually understanding on ground, how cognition takes place. Is not happening in cognitive neuroscience, it is still remain within the theoretical backdrop, it is still remain within the domain of science and technology.

It has not come out of the academic discipline, the deliverability of the discipline in different forms of sciences or different works of life is still to be done, that is a big challenge for cognitive neuroscience. It remain a subject within a discipline with it certain textbook within certain research group, the deliverability of this cognitive neuroscience, in order to understand for example how the aging takes place. Nowadays later studies are being done with the understanding of cognitive neuroscience, what the mind does for example, how the mind edits a particular environment, how the mind edits when we have a developmental thinking process.

But as of now, we are still within the academic discipline, the deliverability out of this discipline to every work of life to the understanding of a human diseases system, is still a far reaching issue that we must be able to address. Therefore, within the domain of behavioral science, now I would like to tell, which does not require other forms of hardware technologies. The testing as a paradigm, we need to understand how neuropsychological testing can be utilized to understand cognitive neuroscience. One of the major challenge is to do some kind of testing based on simulation, that can we simulate a situation to a perfect normal condition or a perfect reality condition into a laboratory environment.

And then study it for example in virtual reality, can we create such kind of virtual reality in the laboratory setup, in order to understand how actually cognition takes place in real situation. Because until and unless, we understand them under a controlled condition, we would never be able to understand the cause effect relationship, likewise test construction for some kind of non specific behavior within the domain of cognitive neuroscience is also a challenge. The behavior which is non specific for example, understanding the resting brain is a non specific behavior, which is not executed under certain condition, how do we understand it through our normal psychometric process.

Like neuropsychological testing for extreme environment, when the brain is acting or performing under a extreme condition for example in space, for example in a very high altitude. For example in a condition where the pressure is very high, for example in a condition when the temperature gone goes beyond 50 52 degree temperature, what kind of cognitive impairment takes place under certain extreme condition. And how do we assess them through neuropsychological testing, in order to understand cognition at extreme environment is a challenge.

Likewise, it is also important to understand how technology invariant testing procedure can be done, that different kind of different ways. Other than the laboratory based ways, how can we test a person under different condition is also a challenge. And we should also try to understand that cognition is a generic process, but it has also got his cultural input and cultural specificities. Can we devise certain test technique, which are cross cultural neuro psychologically based paradigm issues, that is cross cultural neuropsychology is a subject matter, where the general, the generic the experimentally tested cognitive issues are seen in certain culturally sensitive or contextual areas.

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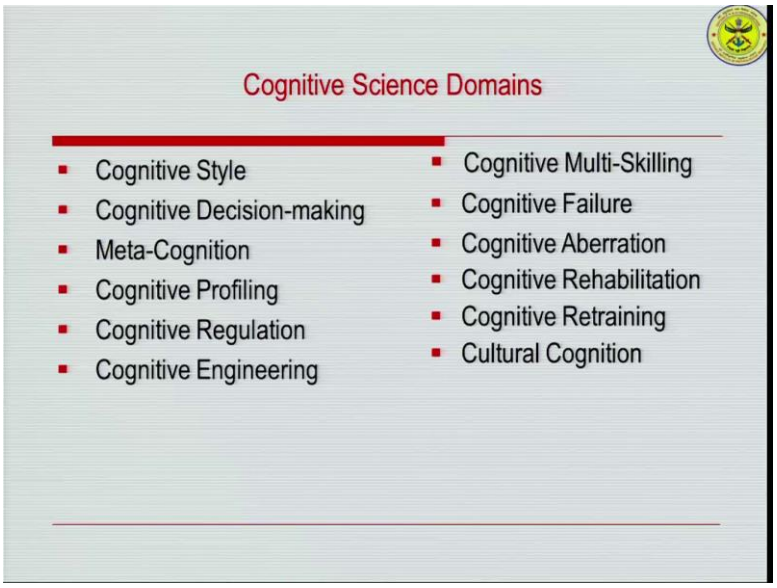

So, can we develop some kind of neuropsychological testing, which is culturally sensitive too that is a challenge. So, cross cultural neuropsychology can give us some input for tomorrows neuropsychological testing paradigms. For understanding cognitive science in a bigger way for people, who would like to do research in the area of cognitive science, a varieties of areas are today in front of us. We can study, what are the different styles of cognition, which is cognitive style or that the person is field dependent or the field independent.

For example, who can identity a camouflaged object better, we know that field dependent cognitive style people fail to do it, while the field independent person can do it very effectively. So, cognitive science as a behavioral domain, and cognitive style as a paradigm generated out of behavioral science can be utilized to do cognitive science research. Cognitive decision making, how a decision is taken, meta cognition the cognition of cognition is another area of research which can go beyond a particular existing paradigm, and behaviorally we can try to understand cognitive science through meta cognitive paradigms.

Cognitive profiling that is right from sensation, perception, to attention, to memory, to learning, to intelligence, to problem solving, to concept formation, how I can profile a person at all levels. It is possible that some people are good in memory, but others are good in learning, others are good in concept formation, but not in other areas of the

cognitive processes. So, how can we create a profile of cognition for a given person, cognitive regulation is another area how can I regulate under difficult conditions? Our cognitive system, cognitive engineering based on machine designing's are done, that how a machine is designed based on our cognitive capability.

Cognitive multi skilling, that is how many cognitive skills we can perform at one time, keeping our secondary resource intact, because in cognitive multi skilling will do not exhaust all our resources while we execute brain resources, while we executed a task, if too many tasks are being done, and the resources are depleted there would be interferences, but too hot extent, what is the threshold? What are the benchmarking for doing some form of cognitive multi skilling is a different area of research, cognitive failure why simple cognitive failure takes place under different conditions, when simple cognitive failure becomes too costly, we can understand that process.

Cognitive aberration under certain diseased conditions is also a possibility there are several cognitively oriented disorders in mental functions, which we studied under cognitive clinical paradigm. Cognitive rehabilitation, how we can rehabilitate a person, restructure a person cognition, how we can retrain them through some kind of guided imagery, it has been found that cognitive disturbances can be overcome with some kind of guided imagery. And cultural cognition, how it different cultures the cognitions take place, because every culture has its own way of looking at things.

We all believe that, we have a free will the way we want to think we can think, actually culture gives as a shape to the particular thinking process, that thinking process which is part of the cognitive system is guided, largely by a stream of thought which is generated out of cultural orientation. So, cultural cognition is another area.

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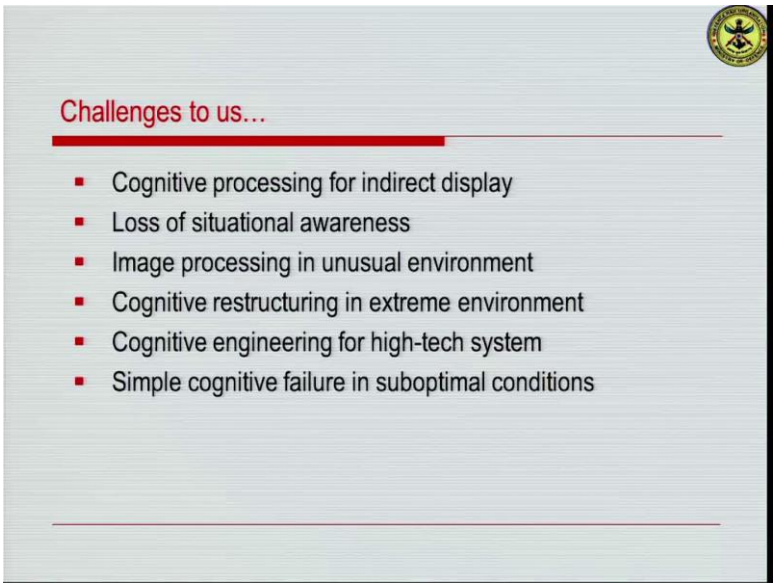

So, the challenges behind before us, that can we do cognitive processing for indirect display it is a latest area of research, how do we lose situational awareness under a cognitive extreme cognitive condition. What kind of image processing that we can do in an unusual environment, can we create a virtual environment one of a extreme and situation. And then can we image the brain, otherwise we have to image the brain in a resting state with or some kind of state within the magnate, but the question is, is it possible to do some kind of non invisible imaging under certain virtual reality condition. Cognitive restructuring under an environmental, extreme environmental condition, cognitive engineering for high tech system, there are as I all know that in a high tech system.

The cognition has to have a reshaping, how we reshape our cognitive system, how we Meta cognize ourselves in high tech system is a interesting area of research. And simple cognitive failure in suboptimal conditions are certain challenges, which we if we can execute the greatest difficulty of cognitive neuroscience as a theoretical sub discipline can be overcome, because the implementability of search researches, the deliverability of search researches will be full proof, when we understand such kind of cause effect relationship, and then see it under a given condition.

Thank you so much for giving attention to it.