Introduction to Brain and Behaviour
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Lecture – 26
Emotion

Hello and welcome to the course Introduction to Brain and Behaviour. I am doctor Ark Verma from IIT Kanpur. This is the sixth week of the course and we will talk about emotions in this week.

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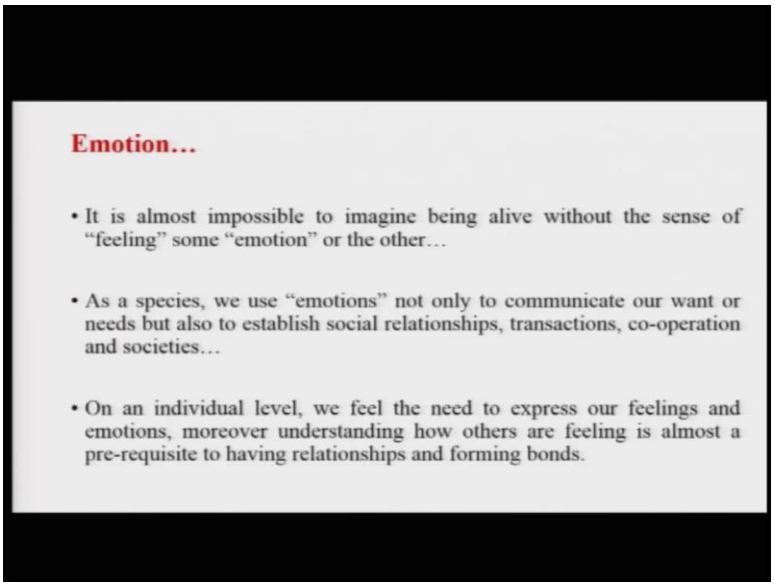

Now, it is almost impossible to imagine being alive without the sense of feeling some kind of emotion or the other. You might feel happiness, despair, sadness, disgust, shame, pride. There is an entire gambit of emotions that we feel you know on a momentary basis sometimes on longer periods of time.

But, all the time there is the possibility of somebody asks you. You can describe your state of mind, your state of life as you know a particular emotional expression. And as a species we use emotions not only to communicate our wants or needs. Say for example, you can tell somebody that I am very happy; let us go out for a cup of coffee or I am feeling very sad and stay inside, inside the home etc. etc. But, we use these emotions not only to communicate our wants or our needs, but also to establish social relationships to establish transactions, cooperation's and to form societies.

Emotional understanding and expression of emotions is both a very-very important aspect of communication and that is basically the basis on which you know a human civil societies are formed. On an individual level however if we talk about it, we do feel the need to express our feelings and emotions.

Moreover understanding how others feel or how others are feeling at any given point in time is also a pre-requisite or it is also very basic to be able to form relationships and to be able to form bonds. So, in that sense you can see that emotions are very-very integral part of our lives. They are very integral part of our psychology of our behaviour of also our social interactions as well.

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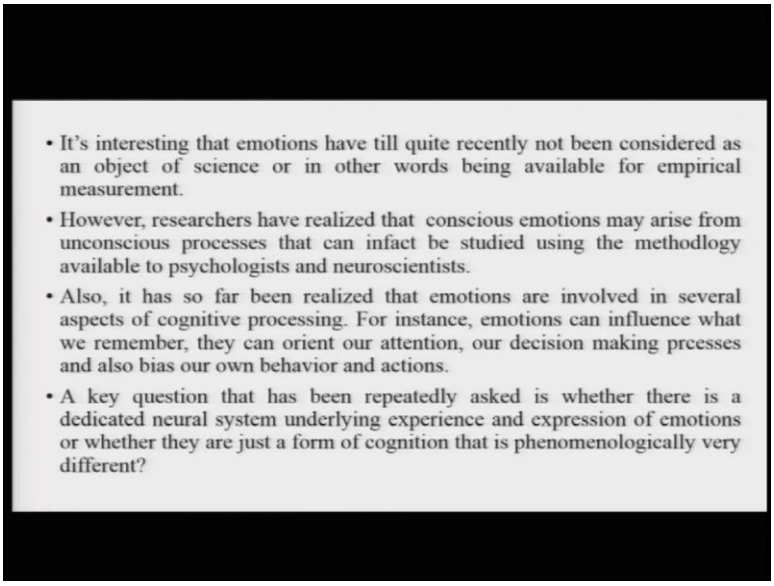

Now, it is interesting that till now or till very recently let us say emotions have been considered or not been considered as an object of science or in other words as available for empirical analysis or measurement. However, researchers have realized eventually that conscious emotion may be arising from unconscious processes; that can be in fact be studied using the methodologies available to psychologists and neuroscientists.

So, in a sense there is an idea that you can measure or you can understand an emotions using the tools that are available to psychologists and neuroscientists. Also, it has so far been realized that emotions are involved in several aspects of cognitive processing. For example, emotions can influence what we remember; they can orient or grab our attention.

They can influence on decision making processes and also bias our behaviour and actions. So, key question that can be asked and repeatedly been asked is whether there is a dedicated neural system underlying the experience and expression of emotions or they are just a form of or they are just general form of cognition that is just phenomenologically very different?

What do you mean by phenomenologically very different? Is that experience of emotions or the way we feel any kind of emotions, is fundamentally different from other kinds of mental or cognitive processing. So, this is a question we will partly try and answer in the course of this week.

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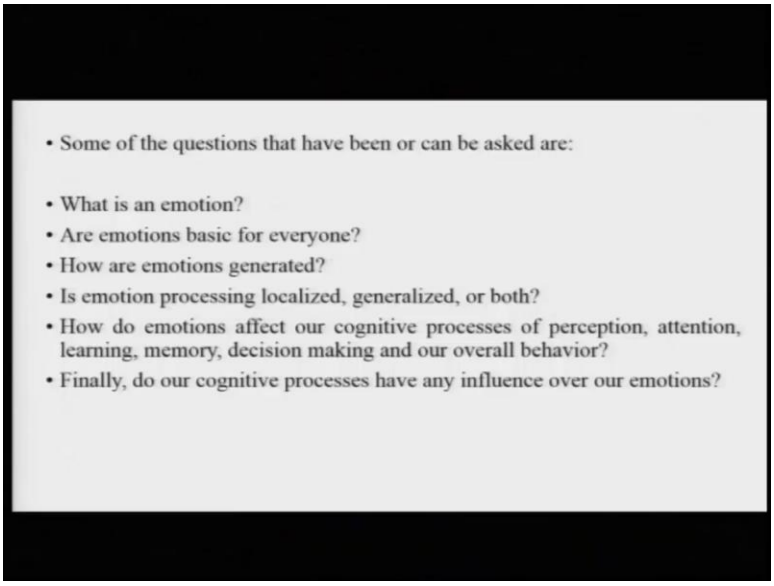

And in addition we might several of the other questions is well. Say for example, we can talk about what is a particular emotion? What do you mean by saying that I am feeling happy or I am sad? Or say for example, I am in love or I hate somebody. Because each of these various emotions also you know correspond to significant and distinct physiological responses in the body.

So, when I am saying that let us say I am happy am I talking about a particular kind of a physiological response pattern that my body is going through. Or is it that I have thought that I am happy and I am describing a state of being or a state of my thought process. So, there is ample debate about what and how to divide an emotion. Secondly, our emotions basic for everyone? Our emotions available in the same manner, in the same kind for the entire species?

That is also question that we will talk about. We will talk about whether people across cultures whether people across nations and other kinds of boundaries, experienced emotions in much the same way. Also we will talk a little bit about how our emotions generated? What is the process that helps us generate these emotions? What is the process that helps us come up with these ideas of feeling happy or sad?

Other thing that we will talk about is, whether emotional processing with respect to the brain is localized to a specific area; or is it generalized and distributed across the entire area of the brain or it might be both. So, we will talk about that is well. Will also talk about the fact that whether how do emotions affect our cognitive processes like perception, attention, learning, memory, decision making and then our overall behaviour.

Is it possible or does this happen that emotions interact with the way we learned about our surrounding. The way we sampled the data that is present there. Remember in the last week we talked about memory. So, do emotions affect our cognitive processes of attention, perception, learning?

Do emotions affects you know that, what portion of information about a particular episode. We will remember and what portion of that episode we will forget. So, finally do our cognitive processes have any influence on our emotions? That is the other question is just flipping the earlier question around. And asking does our memory impact how we going to feel or can our memory influence how we going to feel about particular things.

Or let us say can our attention make us feel happier or more sad in an even scenario. So, is there a two way interaction? Is there a one way modulation or what is this direction of this modulation are all things that we are going to ponder it and discussed in the rest of this week.

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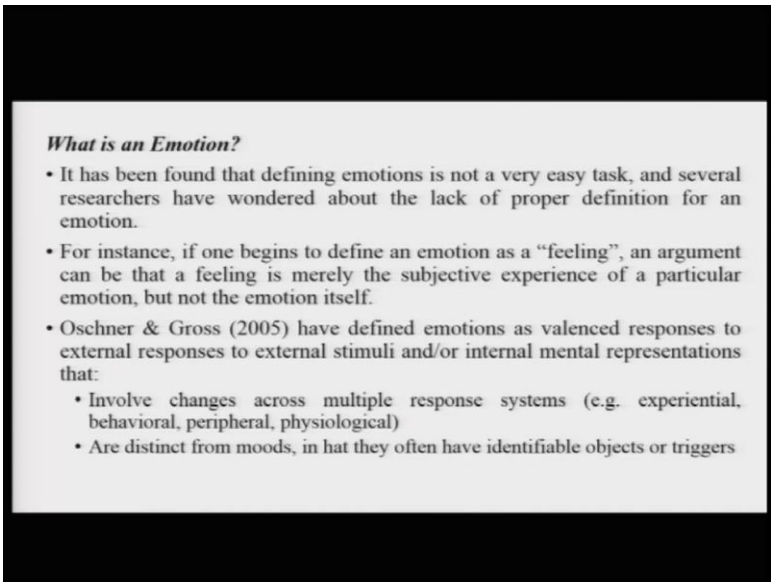

Now, let us begin with talking about the first question. What is an emotion? It has been found that defining emotions is not really been a very easy task and several researchers have actually wondered about the lack of a proper definition for an emotion. People have say for example you know written chapters in books were they have just wondered and talked about the fact that there is no appropriate definition of emotion that is available.

Consider an example, suppose how will you define an emotion? If you begin to define an emotion in a manner of feeling arguments can be made that the feeling is basically the experience of the emotion; is mainly the subjective experience of a particular emotion. Say for example, you feel like this when you are happy you feel like that when you are sad. It feels like this when you are angry. But, is the feeling exactly equivalent to what the emotion itself is? This is a question that many people have grappled with.

Oschner & Gross in 2005 have defined emotions in a sort of a slightly broad definition. And they have defined emotions as valenced responses to external stimuli and or internal or mental representations. So, the idea is that, emotions are external are valenced responses to external stimuli. Valenced basically meaning either positive or negative and this might vary over to continue. So, they say that emotions involve changes across multiple response systems. There are different ways in which you can respond with emotions.

Say for example, there is an experiential response. What are you feeling, when you are confronted with the particular kind of a system. Suppose for example, you are watching a favourite movie or you are meeting a favourite person or somehow kind of come across somebody who has hurt you in the past. Somebody who you have not been not very comfortable with, that is an experiential response. There could be behavioral response as well. Say for example, what do you decide to do then? Do you run away? Do you stay? Do you attack the person? Do you try and forget it and ignore the person. How does that really workout?

Similarly, we can talk about physiological responses as well. Physiological responses say for example, if you suddenly encountered a snake in your garden. What is the response going to be? Are you going to be think and decide, whether I should be afraid or not? Or you will automatically experience a physiological response basically you know increasing of the heart rate, the sweating of the palms, shortness of the breath all of that. So, basically emotions involve changes across these various response systems, in response to external stimuli. So, that is something very-very important.

Now, emotions Oschner & Gross actually distinguish emotions from moods. Because moods basically are sort of permanent and slightly longish experiences of particular kinds of emotion. And in that sense they might or might not have particular trigger. But, emotions often have identifiable objects or triggers. For mood it is not easy to determine, why I am in happy mood or why I am in sad mood today or why I am feeling very lethargic or dull today.

But say for example, if suddenly you are feeling very happy or suddenly if you are feeling very angry. It is usually in response to an identifiable object or an event that would act as a trigger. So, the idea is that you have to be able to identify, what is causing this emotion at this moment in time.

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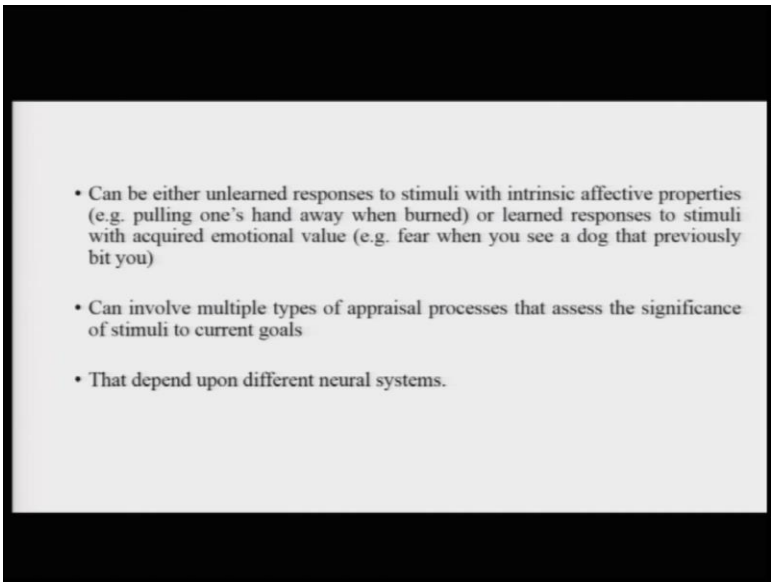

Now, emotions can also be either unlearned responses to stimuli with intrinsic affective properties. Say for example, when you touch something that is prickly or hot you will immediately you know drag your hand backwards. So, emotions can also say for example in sense be either unlearned responses to these kinds of stimuli, which have these intrinsic affective properties.

Or sometimes they can be learned responses to assembly to acquired emotional values. Say for example, you will fear when you come across let us say, a pet dog you know of somebody else that is bitten you in the past. Let say for example, a stray dog bitten you in the past. You will have a say for example, even if the snake has not really bitten you ever or ever spider has not really hurt you ever. But, as soon as you come across the snake or spider you will automatically learn to fear that. So, that is basically one of the ideas.

Now, emotions can involve multiple types of appraisal processes that assess the significance of the stimuli towards your current goals. So, the idea is that emotions can basically involve these kinds of appraisal processes. Wherein you are evaluating what is the stimulus mean for me. Say for example, if you very you know hungry a plate some any of your favourite food might seem very appealing. But, say for example if you not feeling very hungry, then the plate with the same food might not seem very appealing to you.

Similarly, people all the time are appraising the significance of an event. Say for example, if you are given a particular news that a friend x or y coming to town. Now, if you really looking forward to meet that friend and this friend you will be happy about it. Or suppose if he is coming at not so good time when you are busy with your work or something else. You might not feel as happy or as exited than in the scenario.

So, emotions continuously and you know they involve in multiple types of these appraisal processes. Now, also one of the things that is peculiar about the emotions that, they may depend upon different kinds of neurologists. Say for example, sadness and happiness may be governed by different neural circuits in the brain. And all of these basically in that sense something that scientist have been working to figure out.

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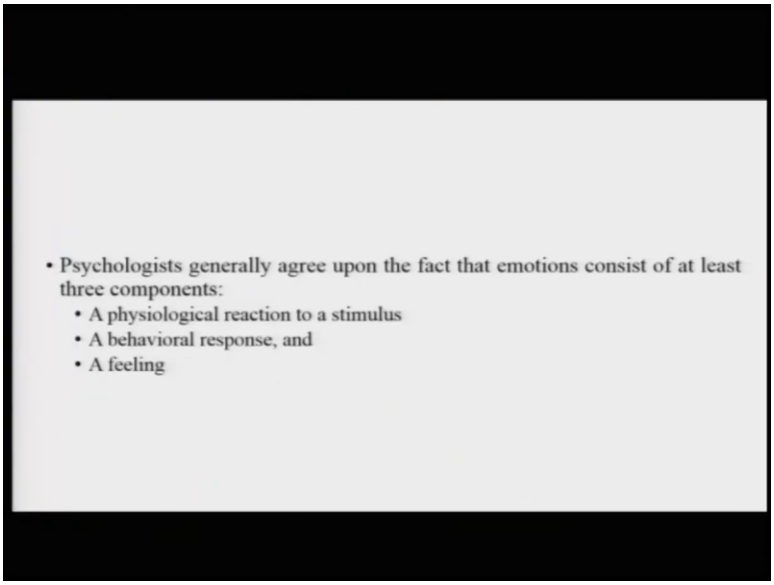

Now, psychologists generally agree upon the fact that emotions consist of at least three components. A first is, a physiological reaction to a stimulus if you coming across snake. If you step on snake by mistake or say for example, confronted with the wild animal or say for example even a dog that is infamous for biting people. There will be a degree of physiological reaction.

There will be a as I am saying there is rising of heart beat there is sweating of palms, shortness of breath and so on. So, the one of the major components of an emotion is the physiological response. The other component is a behavioural response. What do you do after that? Do you fight or do you flee away? So, the idea is that what you are going to do in response to the

emotion triggering stimulus is a very-very important component of how you understand or define emotions. Finally, there is also this very important aspect of subjectively how you are feeling about a particular stimulus.

Say for example, whether you are feeling very happy about it whether you are feeling not so happy about it. Whether you are feeling rather sad about it. What is it that is happening at the feeling level, not at the physiological level necessarily, but at the feeling level? How are you feeling? How can you describe your state of mind? If you want to elaborate on this.

So, there are three components of emotions, first is the physiological response to any given stimulus. The second is the behavioural response basically what is it that you going to do? And third is the feeling that you have the subjective experience of the emotion. These three are very-very important component of emotions.

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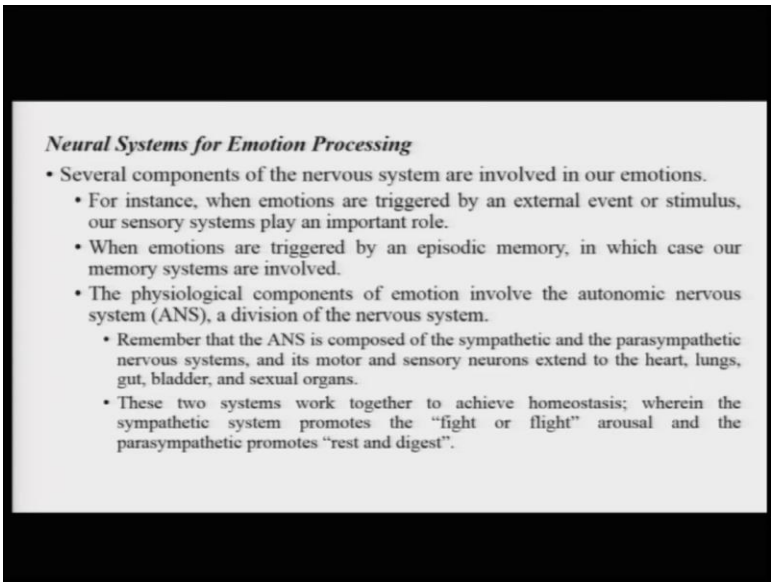

Now, let us look at some of the neural systems for the emotion processing. Now, several components of the nervous system have been basically implicated in the experience of emotions. Say for example, when emotions are triggered by an external event or stimulus, our sensory systems play an important role. Say for example again let us go to the snake example or a biting dog example.

As soon as you see the snake let us say in your garden the initial is work by sensory systems where there is analyzing and understanding the stimulus. There is this noise and this slathering movement in the grass it must be a snake. So, the first window is basically the sensory analysis that you are actually carrying out. So, that is that is very important part. Now, when emotions are triggered let us say, there is a chance where the emotion is being triggered by these external events or these external stimuli. Like a snake or a dog or a lion you came across, which is basically there.

But, then the sensory system kind of a is the window or let us say is the primary triggered to causing the particular emotion; because there is where the first analysis come from. However, sometimes emotions can also be generated just by your own memory there is nothing outside. But, say for example, you are seating there just idealing and suddenly you come to think of something rather funny. Or suddenly you come to think of something that is very important experience from your childhood. A very happy experience from your childhood and automatically there is a smile on your face and you feel slightly uplifted, slightly happier and in a good mood.

So, emotions can sometimes be triggered by just an episodic memory, in which case the memory system the detail of the memory. Say for example, you talked in the last chapter about the details of episodic memories or say for example if the memories too old. Then there are just the chases; but if you probate if few might be able to remember, some more aspects about that particular memory.

So, then your memory systems will be involved. Now, the physiological component of emotions involves the autonomic nervous system. If you remember we talked about this in the first chapter itself. We talked about that there is a central nervous system and there is a autonomic nervous system. This autonomic nervous system basically has connections to all the organs of the body and the peripherals.

And it basically is composed of two branches. What are the two branches? The first branch is the sympathetic nervous system and the second is the parasympathetic nervous system. What do these do? These branches are basically connected to the motor in the sensory neurons. Which extend to the heart, the lungs, the gut, the bladder, the sexual organs, the genital area that is. And

in that sense these organs are capable these connections, through these connections the autonomic nervous system is able to modulate the activity of each of these organs through these connections.

Now, these two systems the sympathetic nervous system and the parasympathetic nervous system can work together to achieve homeostasis. What is homeostasis? Homeostasis is the balance of optimal survival conditions or optimal conditions for the body. So, these two systems basically work together, the sympathetic and the parasympathetic nervous systems work together to achieve what is called homeostasis. Wherein the sympathetic nervous system promotes the fight of light response. It would basically say for example, supply mode oxygen it will basically slower the digestion.

It will dilate your pupil setting prepare you for the fight of light response. It will prepare you for some kind of action in response to a particular emotion triggering event. Whereas the parasympathetic nervous system basically works to rest and digest. Whereas basically the system is focused on its focused on calming you down. Its focused on basically slowing the entire reactionary response of the body. It is focused on calming you down and in some ways sedating the bodies via control through these organs that I talked about.

So, it will lower the heart rate, normalized the blood pressure. It will basically supply give more time to the guts to start digesting and getting more energy and so on. So, the idea is that the physiological components of emotion are typically governed by the autonomic nervous system which basically balances the excitement or the sedation part by the sympathetic versus parasympathetic nervous system.

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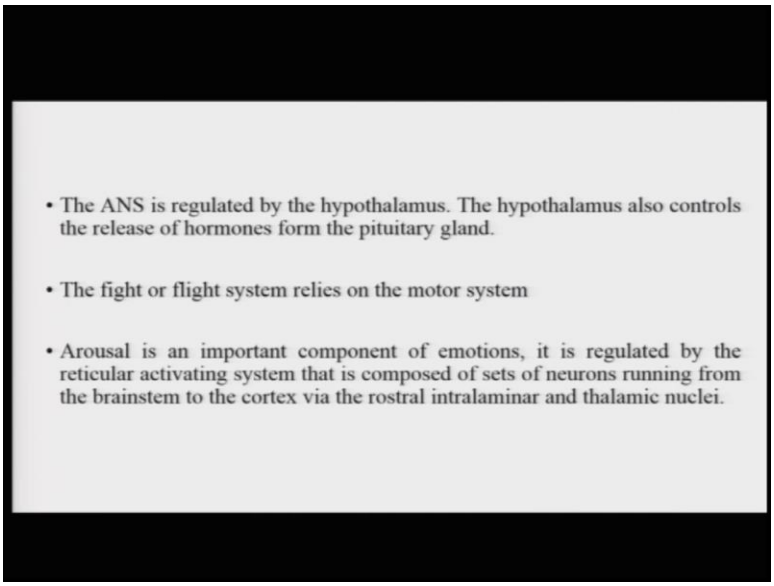

Now, the autonomic nervous system in itself is basically regulated by the hypothalamus. We seen the photos of the hypothalamus we have seen where it is basically is part of the mid brain. Now, the hypothalamus also controls the release of the hormones from the pituitary gland. And basically the fight of the flight system obviously it relies on the motor system because it will either prepare your body to be in readiness to fight response or to be in readiness for a flight response to run away from a particular place.

Now, Arousal is a very-very important component of emotions. And it is supposed to be regulated by this reticular activating system and this reticular activating system basically is composed of the sets of neurons. That basically extends from the brainstem to the cortex via the rostral intralaminar and thalamic nuclei.

So, the arousal aspect of emotions, arousal is basically and will talk about arousal going in the next lectures. But, I will just give you brief idea that arousal is very-very important component of emotions. More often, more often not or let say to simply describe just what arousal means? Is basically means the intensity level of the emotion. You might be feeling happy or sad or angry; but the intensity of physiological excitement is basically given by arousal.

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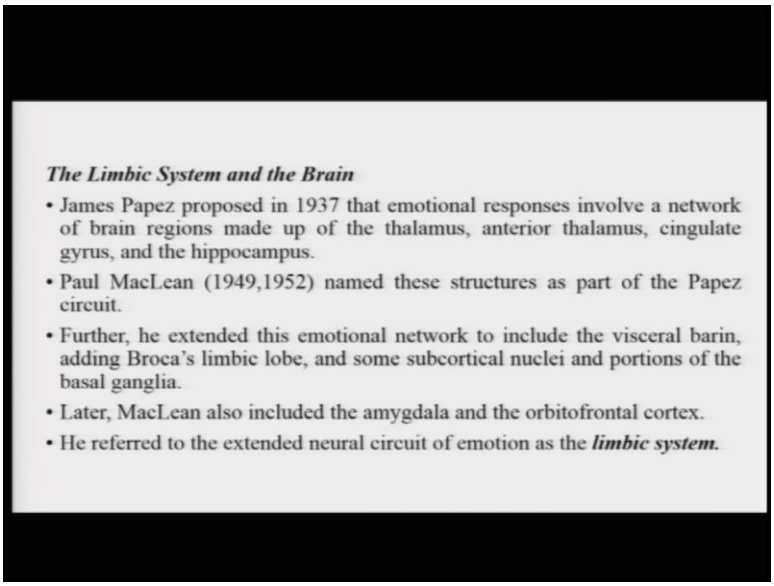

Now, let us talk about the Limbic system. Now, the limbic system basically is the system that is responsible or is a system, is the circuit, neural circuit that is responsible for expression and experience of emotions. Now, James Papez in 1937 had proposed that emotional responses involve a network of brain regions; that are basically made up of the thalamus, the anterior thalamus, cingulated gyrus and the hippocampus.

So, he said that this is basically the circuit that is responsible for, emotional processing let us say. Paul MacLean in 1949, 52 named these structures as part as being part of what call them Papez circuit. Now, further MacLean extended emotional network to include the visceral brain, as it would call it. Adding the Broca's limbic lobe and some of the subcortical nuclei and some portions of the basal ganglia.

So you see the network Papez is expanding in a manner. Now, later MacLean also you know added amygdala and the orbitfrontal cortex to the system. And together this entire neural circuit was referred to as the limbic system. And that name limbic system is still very-very popular and still used by several scientists to refer to the emotion processing network.

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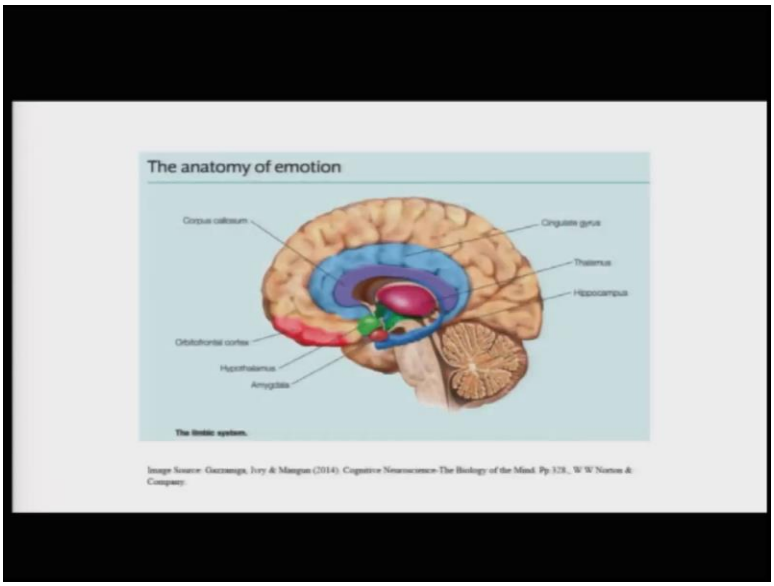

Here is where you can see the limbic system; you can see the orbitfrontal cortex, hypothalamus, amygdala, hippocampus, thalamus, cingulate gyrus and you can see the corpus caliosum, which is connecting the hemispheres.

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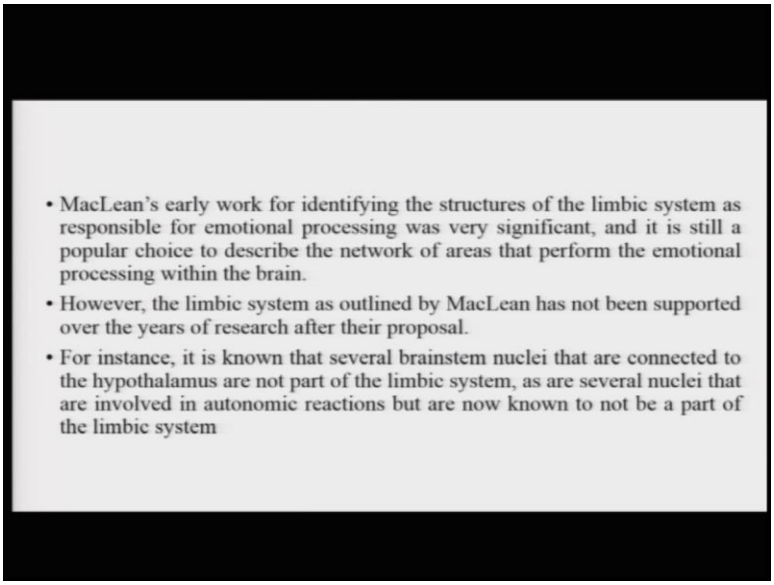

Now, MacLean's early work for identifying the structures of the limbic system as responsible for emotional processing was very significant. And it is still as you know it is still a popular choice the name limbic system is very popular choice to describe the network of areas that perform the task of emotional processing within the brain. However, the limbic system as was outlined by

Papez or MacLean has not really found support in research over the years after their proposal. For instance say for example it is known that several brainstem nuclei that are connected to the hypothalamus are actually not the part of the limbic system.

They are not involved in emotional processing, as are several nuclei that are involved in the autonomic reactions. But, now say for example they are known, that they are to not be known as not being part of this process of this circuit that processes and emotions.

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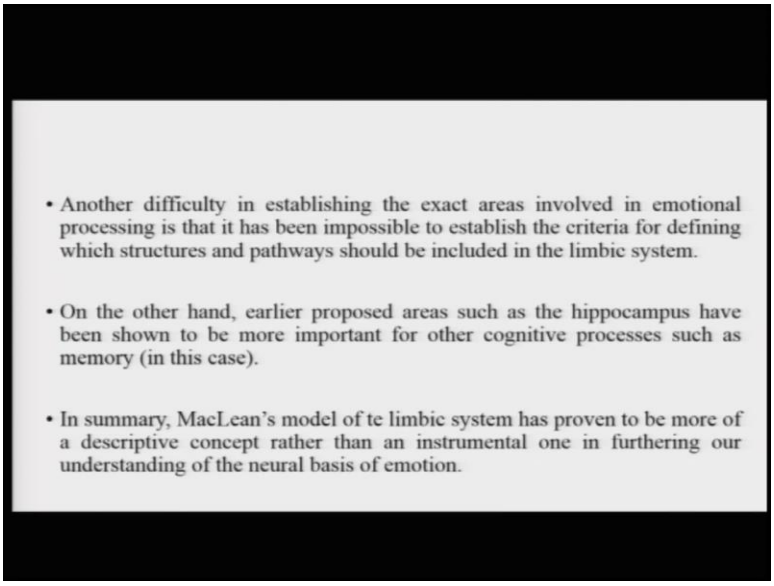

Another difficulty in establishing the exact areas involved in emotional processing is that it has been impossible to establish the criteria for defining which structures and which pathways should be included in the limbic system. So, it is not rally clear on the basis of what do you include a particular area as part of the emotional processing.

On the other hand, earlier proposed areas such as the hippocampus have been shown to be more important, some other kinds of cognitive processes other than emotional processing. We done the chapter on memory in the last week and am sure you know by now that the hippocampus is very-very important organ for memory processing.

It is not really showed very-very relevant or probably discussed in the coming lectures; or not really showed to be pre-dominantly important for emotional processing. In summary, MacLean's

model of the limbic system has proven to be more like a descriptive concept rather than being an instrumental one in furthering the understanding of the neural basis of emotion.

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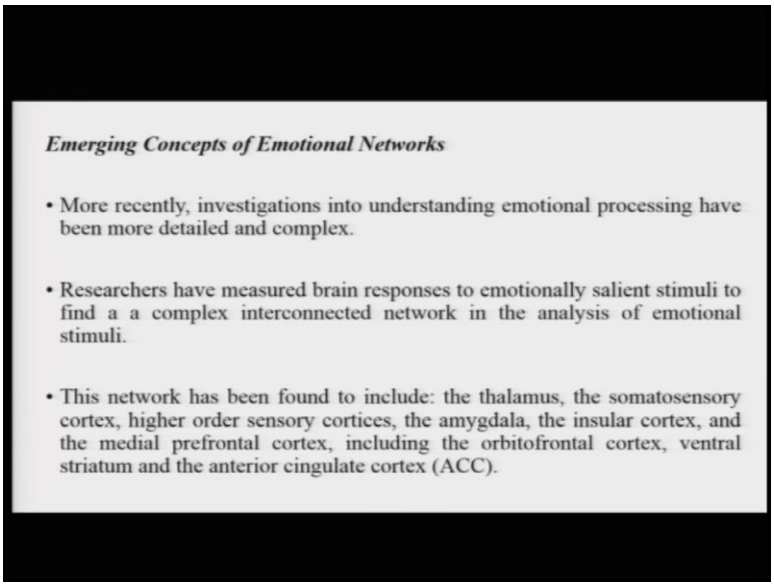

Let us look at some of the emerging concepts about these emotional processing. We talked little bit about the limbic system; let us known at the moment. More recently, investigations into understanding emotional processing have been more detailed and complex. Researchers have measured the brain response to emotionally salient stimuli and if kind of and you know find out a complex interconnected network in the analysis of the emotional stimuli or emotional processing.

Now, this network has been found to be has been found to be include these areas. The thalamus, the somato-sensory cortex, higher order sensory cortices, the amygdala, the insular cortex, and the medial prefrontal cortex, including the ofc, ventral striatum and the anterior cingulate cortex. So, this is the network of areas that has been sort of found to be implicated in emotional processing. And these are the areas which are found to be part of what was earlier being referred to as the limbic system.

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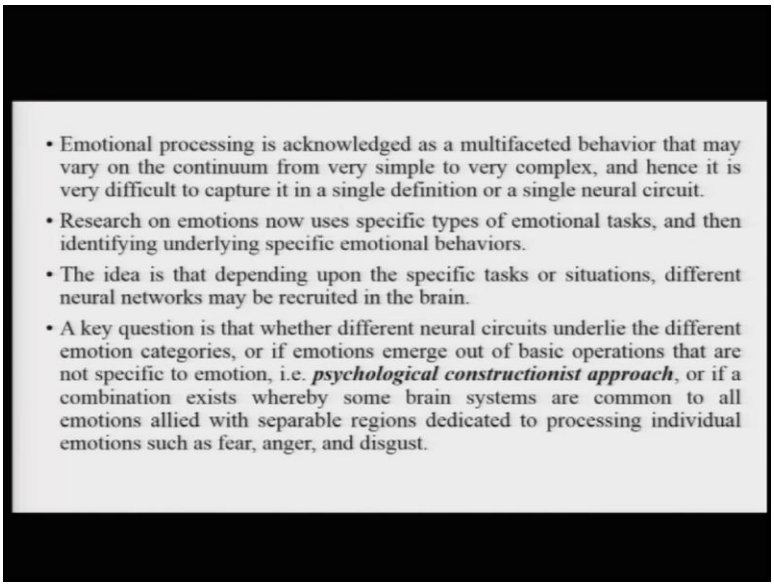

Now, emotional processing is acknowledged as a multifaceted behavior that may vary on the continuum from being very simple to very complex. And hence it in that sense is very difficult to capture it within a single definition or a single neural circuit. Research on emotions now uses specific types of emotional tasks and then identifying and basically on the basis of them underlying specific emotional behaviours.

Now, the idea is that depending upon specific tasks or situations, different neural in the brain may be recruited to kind of govern or to influence our emotions or experience of our emotions. Now, a key question in that sense is weather different neural circuits underlie the different emotion categories, or if emotions merge out of basic operations that are not specific to emotions.

So, it can be say for example, dedicated neural circuits are designated to process specific aspects of emotions. Or it could be possible that say for example, emotional processing is just part of a very slightly generic network of brain areas, which are not exclusively dedicated to emotion. This is referred to as the psychological constructionist approach, or if psychological constructionist approach. It is also been proposed that it could be that just a combination excess that somebody in system are common to emotions allied with separable regions of the brain dedicated to processing individual emotions such as, fear, angry and disgust.

So, the idea is that specific regions of the brain might collaborate with each other to participate in specific emotions such as fear, anger or disgust. These are not supposed to be taught as exclusive networks; but parts of these networks are shared and parts of these networks are slightly unique to these as functions.

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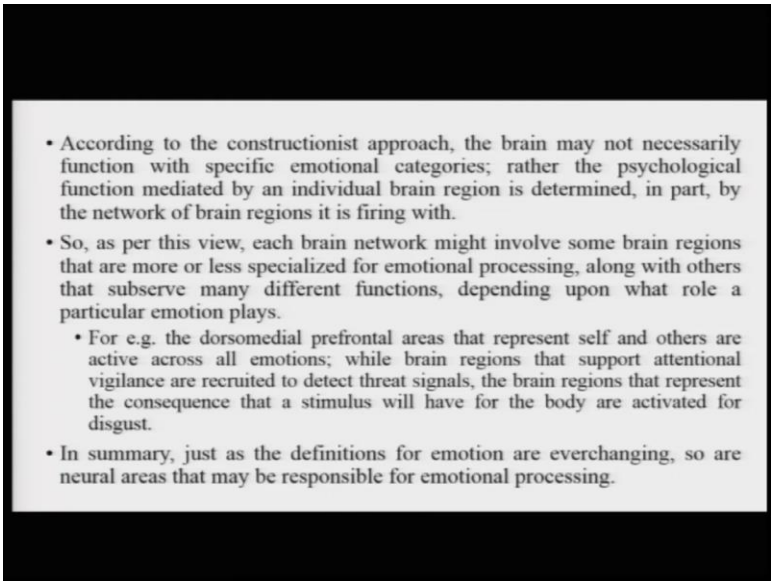

Now, according to the constructionist approach which I was just mentioning, the brain may not necessarily function with the specific emotional categories. Rather the psychological function mediated by an individual brain region might be determined in part by the network of brain regions, it is firing with.

So, the idea is that it is not necessary that the brain is functioning according to specific emotional categories happiness, sadness, anger etc. Rather it is possible that the psychological function that it is mediated by individual brain region is determined in part by the network of brain regions it is firing.

So, basically it is probably network of regions that are governing the processing of particular emotions. So, as per this view each brain network might involve some rain regions that are more or less specialized for emotional processing, along with other regions that may be also part of different brain functions, different kinds of cognitive functions.

Say for example, hippocampus might be participating in some degree of emotional processing. But, it is dedicated for memory base processes or something. So, let see another example, the dorsomedial prefrontal areas that represent self and others are found to be active across all emotions while brain regions that support attentional vigilance are recruited to detect threat signals. The brain regions that represent the consequence that a stimulus will have for the body are activated just for disgust. So, the idea is that there can be brain regions which activate or which are active across the entire set of emotions.

But, some regions are activated specifically for particular emotions. Now, just to sort of summarize this, just as the definitions of emotions are slightly dynamic and they ever are changing. So, are the findings of these neural areas that are held responsible for emotional processing.

So, I have just give you a circuit of brain areas that might be or that is according to current knowledge involved in emotional processing. But, 5 years later, two years later they might be more research. Some of these areas are also involved in a other activities or more areas have to be put into this emotional processing network and so on. So, both of these things are sort of in bit of dynamic phase on a kind of flux kind of a situation.

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That is all for the first lecture. I will talk to you about emotions again in the next chapter.