Neuroscience of Human Movement
Department of Multidisciplinary
Indian Institute of Technology, Madras

Lecture - 78
Parietal and Premotor cortex - 2

Welcome to this class on Neuroscience of Human Movement. In this class we will discuss Parietal and Premotor cortex. This is part 2 of our discussion on parietal and premotor cortex.

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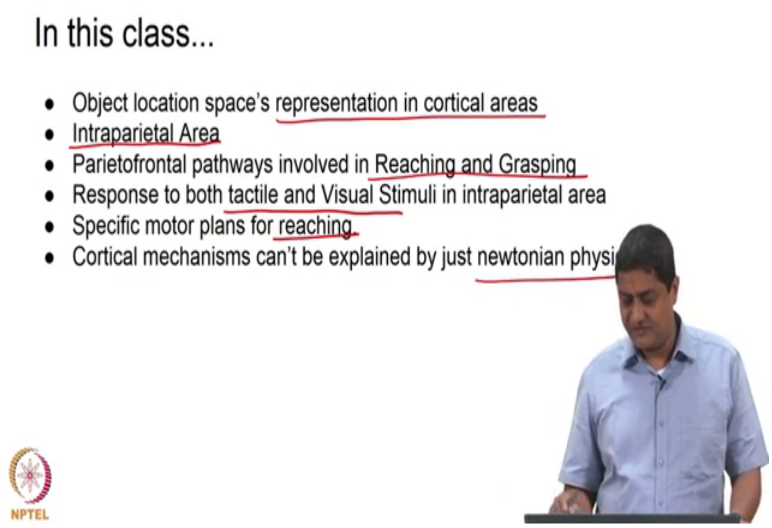

So, in today's class we will be talking about how objects location space is represented in cortical area something that we discussed in the previous class. And the crucial role of the intraparietal area and the parietofrontal pathways involved in reaching and grasping and how different sets of neurons respond to different types of stimuli. For example, tactile and visual stimuli in the intraparietal area, the neurons dedicated for different types of stimuli. And motor plans for reaching and of course, the idea that Newtonian physics alone cannot explain the cortical mechanisms that underlie motor planning right.

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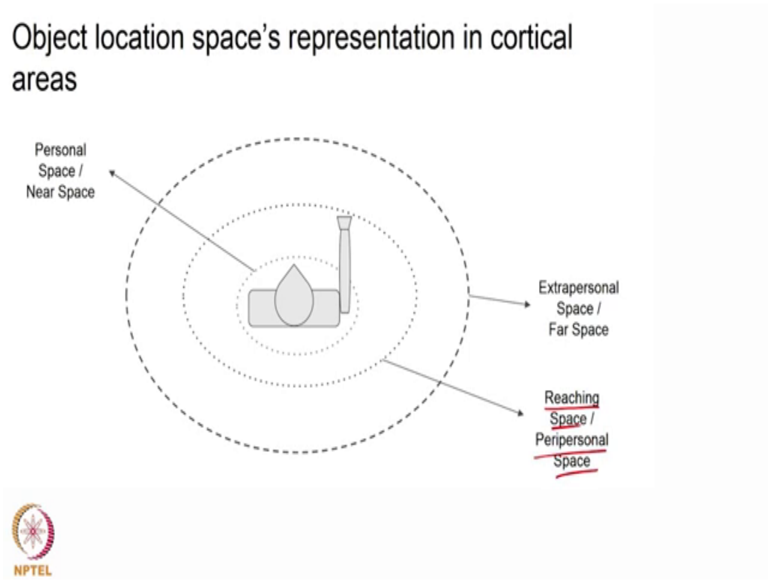

Something that we discussed in the previous class is the notion of near space, the space that is closest to my body is called as near space. And the space that I can reach by extending my limbs is called as peripersonal space or reaching space. And the space that I can view, but not necessarily reach without making leg movements of course, without actually taking a walk, for example, if I am not able to reach then that space is called as far space or extrapersonal space. And as I mentioned that these areas or these maps are encoded in different regions. So, there are independent maps of these 3 regions in different regions of the brain.

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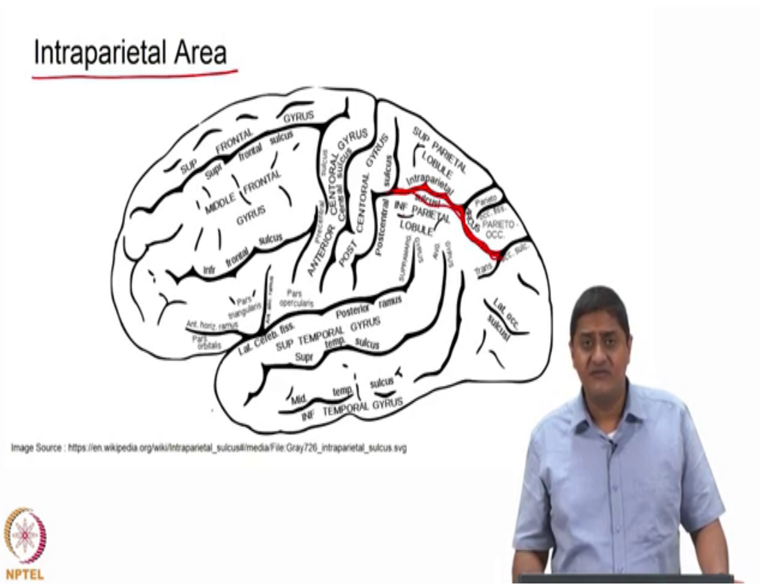

So, that is something we discussed in the previous class. Of particular interest for us in this discussion is the intraparietal area, turns out at that is the intraparietal region. And, specific regions within the intraparietal region contribute to specific function something that we will very briefly discuss in this class right.

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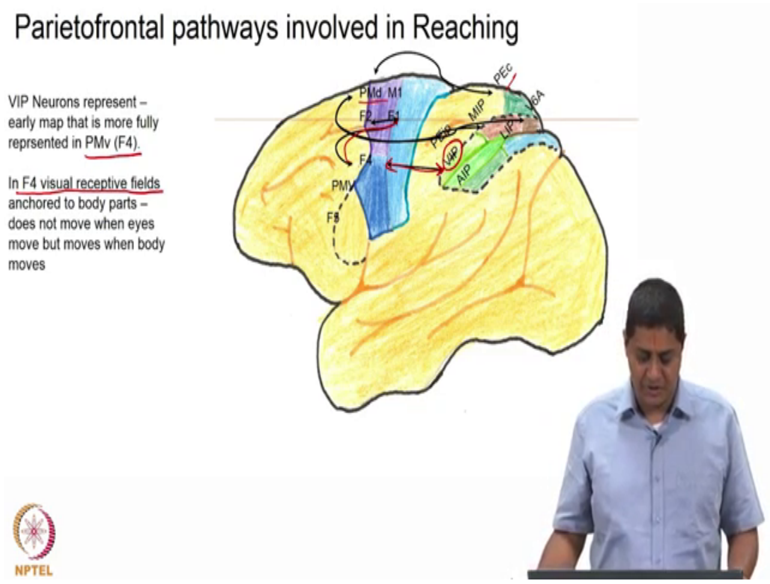

For example, there is an area here right that is called as the VIP area. VIP means Ventral Intraparietal area not very important person, but rather ventral intraparietal area or the neurons in the ventral intraparietal area right. And these neurons have reciprocal projections or reciprocal connections with the area F4 or the ventral pre motor area ok. And what has this area F4 itself do? Right, F4 are the ventral pre motor region actually has visual receptive fields that are anchored to specific body parts.

So; that means, that this particular region has something to do with how are the stared of the particular part of the body. So, it turns out that when the eyes are making a movement, but not the body parts, it turns out that these set of neurons are not active. But, they are active when the specific region of the body is actually moving.

So; that means, these are more related to the motor functions. So, than the visual receptive field; however, they are more active during actions of specific regions of the body ok. So, this is the VIP set of neurons and what is also present is the reciprocal connections between the other regions such as PEC and the simple mode of cortex. And how area in F1 and F4 are having reciprocal connections some of these that will discuss in future slides right.

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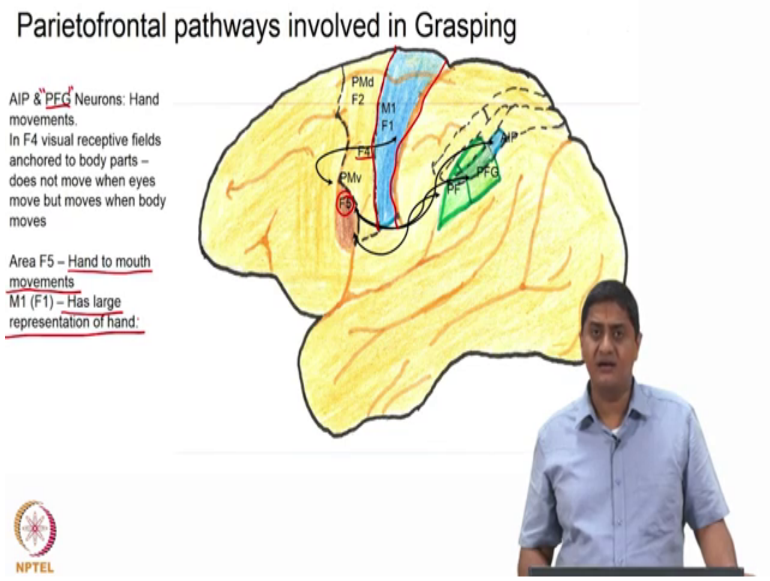

When it comes to grasping though right anterior intraparietal neurons and the so, called PFG neurons they are called as PFG neurons this is the name of the neurons. They are believed to be responsible for hand movements, hand movements means movements within the hand not reaching movements. Reaching movements involve movements of the arm where as the AIP and PFG neurons are believed to contribute for hand movements right.

And as I mentioned the area F4 is active when the particular part of the body moves, but not necessarily when the eyes move. So, vision is something that going to affect this less than actual movement right. And also it is believed that area F5 has a set of neurons that can coordinate the hand to mouth movements right eating movement.

Evolutionarily a very important activity for survival, is it not. So, there are special neurons that are dedicated for this activity the hand to mouth movements also it is very well known. Of course, we have had several discussion in great detail about how the primary motor cortex or the area that is just rostral to the central cells right, as a very large disproportionate representation of hand are the are has a large number of neurons that control hand function right.

We also saw the importance of cartico motor neurons are those motor neuron that provide monosenaptic projections to alpha motor neurons that control the finger function, is it not something that we saw in previous classes. So, importantly M1 has a large representation of hand and area F5 has specific neurons dedicated for hand to mouth movement right. And anterior intraparietal neurons and the PFG neurons are believed to be responsible for hand movements right.

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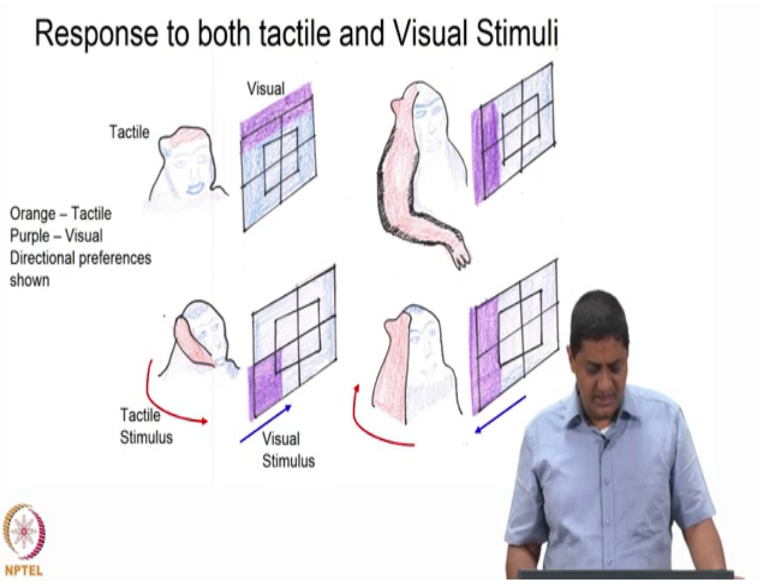

Also note that there are sets of neurons whose field of activity are can be tactile or can be visual. So, what is present at here is neuron whose field is whose tactile filed is here. Note, that tactile field are presented in orange and visual field are presented in purple right.

So, this is the tactile field of none neuron this is the tactile field of different neuron is it not. The purple regions though indicate the indicate the visual fields for a different sets of neurons. Note that there may be directional preferences within these neurons, some of this neurons may have specific directional preferences or in other words may be involved in movements in a particular direction, but not the opposite direction also, this is the another thing.

Note, this is something that we saw in the previous classes where we discussed the work of chargeable, that we discussed how activity of population of neurons in the primary motor cortex encode or predict the direction of movement right. Here also this is true there are neurons that have specific directional tuning associated with it right.

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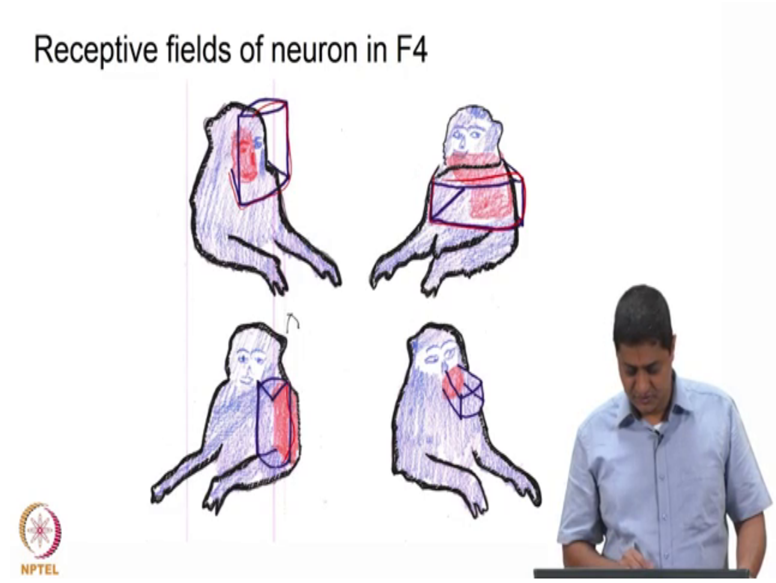

Also receptive fields of neurons in region F4 for example, can be 3 dimensional for example, like that for example, like that etcetera right. So, these are receptive fields are of different sets of neurons. Note, the net behavior of the organism is combination of activity of all these neurons, is it not? This is not a single neuron, the animal has millions of neurons here what we prevent is the receptive field of a smaller subset of those neurons is it not so, just presenting the various possibilities here right.

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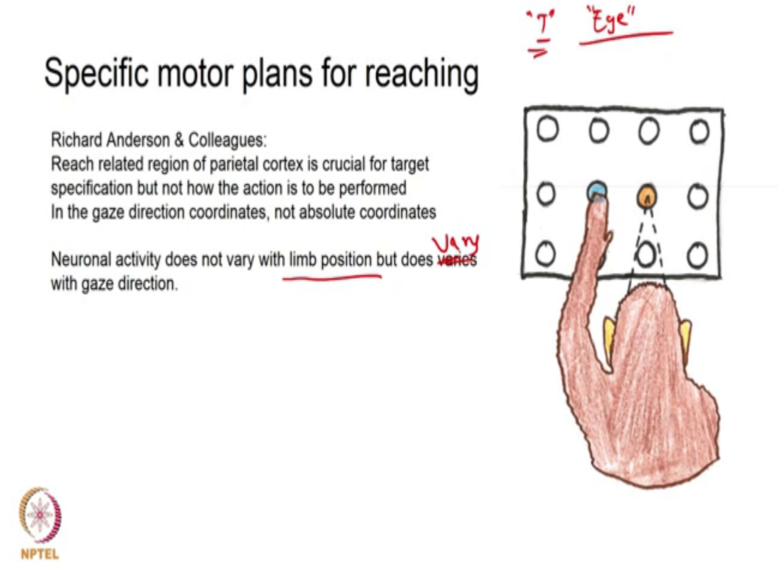

Also Richard Anderson and his colleagues have found that reach related areas of the parietal cortex is very important for specifying the target, but not in how the action is to be performed. That is the target how you got there is beyond the scope of parietal area right.

So, encoding of the location of the target is a crucial function of this region, but exactly how that region will be reached or that particular target will be reached is something that is not encoded, that is not cared for by this region which is a parietal region right. And also note that this is in the coordinate system or in the frame of reference of the gaze, not necessarily in the absolute coordinate system or not necessarily the body centred coordinate system.

So, this is in reference to the eye reference frame right eye has a not eye lot of people have the eye reference frame this is not the reference frame I am talking about I am talking about eye reference frame right.

So, this encoding of target location happens in the frame of reference of the eye right. And neuronal activity actually does not vary with the position of the limb, but it does vary with the direction of gaze. If the direction of gaze is in one particular direction, but limb is in some position. So, depending on the direction of gaze the activity will vary. So; that means, that there are independent neurons that encode the target in the gaze direction frame of reference right.

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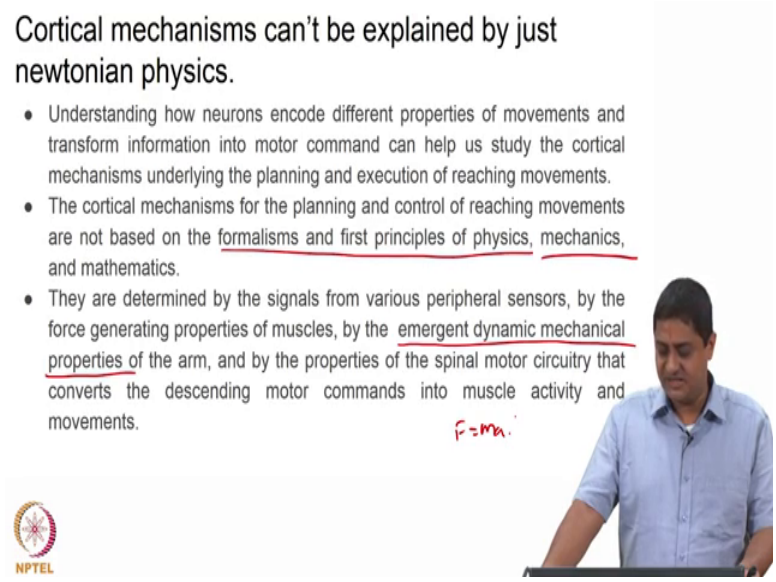

Also importantly cortical mechanisms cannot be explained by merely using Newtonian physics right. Let us take this one a moment and understand what this means. We are organisms who in some sense obey laws of physics is it not. So, just because we are independent organisms, it is not like we can violate Newton's laws right. For example, if you jump of the first floor you will fall down and get injured right. So; that means, we do obey Newton's laws that mean trivially even while walking we obey Newton's laws.

So, we do obey Newton's laws, but the question is not that the question is does the cortical system inherently solve the Newtonian equations, internally does it solve the Newtonian equations. Now, that is a different question right. It turns out that our behavior correlates well with the solutions of Newtonian mechanics, but that does not necessarily mean that our brain is explicitly computing solutions to Newton's equation these are 2 different things is it not.

So, in other words the actual actions, that we make is based on some emergent properties of the dynamic interaction between the central nervous system and the body and the body and the environment. So, lot of dynamic interactions going on between these 2 systems right. And what happens as a outcome is a emergent outcome right, but this is not dependent on the formalisms and first principles of physics or mechanics right.

So, it teach in the department of applied mechanics, this might be surprising for you to know that I am saying that human movements are not actually the outcome of mechanics. I am not saying they do not follow mechanics or rules of mechanics or laws of mechanics. They do, but the actual movements that are made are dependent on factors other than the laws of physics. And it just turns out that the results the outcomes correlates quite well or in other words, we do not explicitly or the central nervous system does not internally solve Newton's equations explicitly right.

So, in other words it is not like F is equal to m a and then there is m and acceleration that is computed right that is not what happens right. So, what happens is probably an emergent outcome and important. So, this is emergent dynamic mechanical properties of the system that is encoded that is that determines the outcome. But, since we do live in constant interaction with the physical world and the physical world or the in element world follows Newton's laws; a lot of our actions are all of our actions also following Newton's laws. But, we do not solve F is equal to m a, F is equal to m a is true for us, but it is not that we are computing this right. So, that is the point.

So, we cannot merely take Newton's laws and say these are the equations that are solved by the cortical mechanisms or the cortical system to achieve movements right so, that is not what is happening. It is definitely tempting to use these as a principles that the central nervous system may be following right.

So, essentially it is easy to say that this is what the central nervous system is doing right because, the methods and approaches in physics and mechanics and engineering are relatively well developed for example, in control theory right. The specific approaches and methods are very well developed in comparison for example, with neuroscience or biology.

So, problem that comes with borrowing terminology from other disciplines is that it is tempting to use the results in those disciplines or interpretations in those disciplines as what happens in the original discipline. For example, the interpretations in physics are not necessarily true from the biological view point right.

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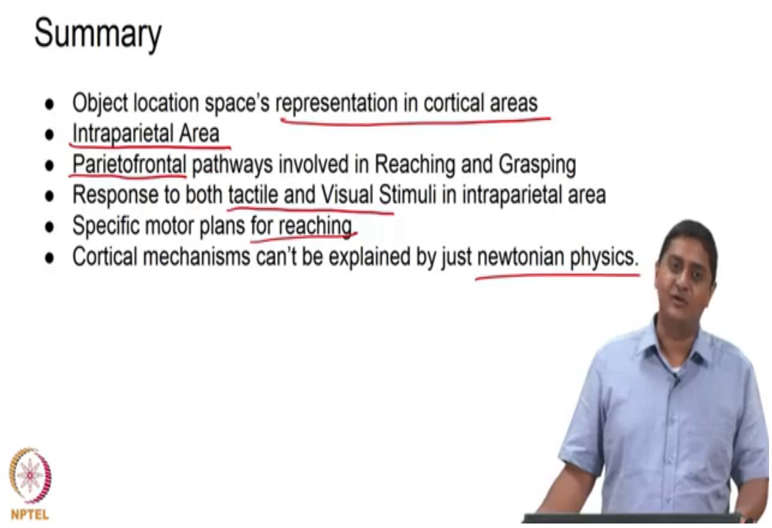

So, in summary the object location in is represented in cortical areas, in multiple independent regions right and the crucial role of the intraparietal area and actually we mentioned 2 of this the VIP and the AIP area. And the specific parietofrontal pathways so, that are involved in reaching and grasping and we also said there are special neurons in area F i that are dedicated to hand to mouth movements.

And there are sets of neurons that are that independently encode tactile and visual stimuli in the intraparietal areas. And the direction of gaze for example, or parietal region encodes plans in the direction of gaze based coordinate system right. And cortical mechanism cannot be explained by using Newtonian physics. So, with this we come to the end of this lecture.

Thank you very much for your attention.