**Social Behavior and the Brain: An Introduction to Social Neuroscience**
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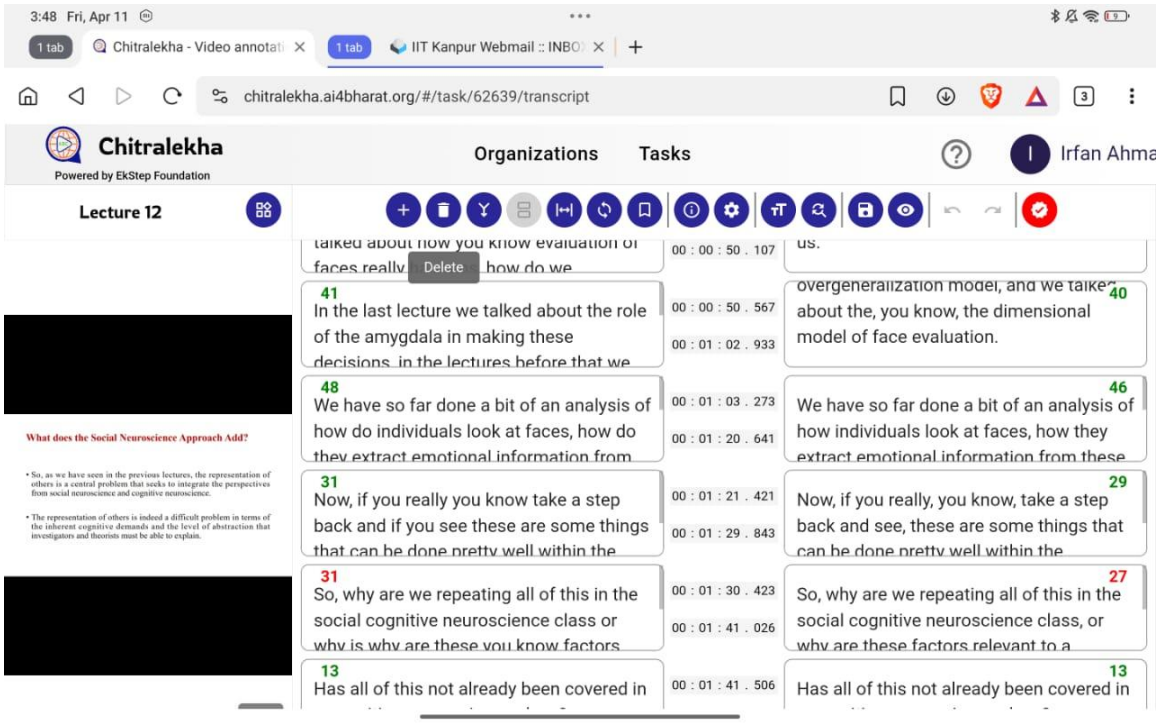
**Week - 03**
**Lecture – 12**

Hello and welcome to the course social behavior and the brain and introduction to social neuroscience. I am Dr. Ark Verma and associate professor at the department of cognitive science IIT Kanpur. This is week three we are trying to understand and represent self and others and in this lecture twelve we are going to sort of revisit what we have done so far. Remember in the last week or so we have talked about how you know evaluation of faces really happens, how do we represent the faces of self, familiar people and others that are not relevant to us. In the last lecture we talked about the role of the amygdala in making these decisions, in the lectures before that we talked about the emotional over generalization model, we talked about the you know the dimensional model of face evaluation.




We have so far done a bit of an analysis of how do individuals look at faces, how do they extract emotional information from these faces and how is this process being modulated by task factors, by factors of context, by implicit versus explicit processing and so on. Now, if you really you know take a step back and if you see these are some things that

can be done pretty well within the cognitive neuroscience approach as well. So, why are we repeating all of this in the social cognitive neuroscience class or why is why are these you know factors relevant to a discussion in social cognitive neuroscience? Has all of this not already been covered in a cognitive neuroscience class? So, let us try and you know dive a little bit deeper and see what is it that the social neuroscience approach adds to the investigation and understanding of these processes. So, the representation of others is an indeed you know it is a difficult problem in terms of the inherent cognitive demands and the levels of abstraction that might be you know required from the individuals and also how would the you know investigators and theorists model and explain this because they can be any number of you know features that might be getting encoded features low level features say for example facial differences.

You know in terms of the color of the skin, the overall symmetry of the face, there can be any number of these low level features as well. There can be motivational factors as well as we saw in the previous class, whether you are inclined to like or dislike a person. There can be contextual factors as well. Say for example, the person has been presented to you with a narrative that oh this person has robbed a car in the neighborhood or this person is a good Samaritan and has saved so many people from you know different kinds of dangers and so on. So, there are a bunch of these factors that need to be taken into account and there needs to be therefore, an integration of the perspectives from social neuroscience and cognitive neuroscience that needs to be brought together.

So, let us do this from the beginning again let us try and understand if there are any differences or any merits to this social cognitive neuroscience idea or investigation of these things. To begin with infants from a very young age are able to distinguish between two classes of entities in the world, objects and agents. So, for example, this is a bat, this is a ball, this is a person, the person uses the bat to hit the ball. Now, these are objects, the bat and the ball are objects, but the objects are being manipulated by an agent who is doing some action. and it is interesting that infants from a very young age from you know birth they have this idea of who are agents and what are objects ok.

As I said as I was just giving in my example objects move in response to external forces just like you know if I push the door if I pick up the bat if I toss the ball and agents generate their own actions as an agent I can generate my own hand movement I can generate my own head movement and so on. So, since object movement can mostly be understood in terms of observable external forces. So, I apply some force on you know this particular let us say this were an object I apply external force to this and the place of the object changes from place A to place B. This is tangibly you know understood, but if you try to understand the movement of agents it requires a representation of their mental states the unobservable internal states that would initiate direct and motivate that behavior. For example, you know I am with an infant and I suddenly take out a glass of

water and I start drinking it, the infant would need to understand it or the person might be thirsty and that is why they reached out for that glass of water and drank it up, alright.

This is something that the infant would need to understand in order to have a representation of this causal action that just took place. Now, these unobservable inner states are inferred from the behavior of these agents you know that I am thirsty can be inferred by the fact that I am drinking water or I wanted water or any of that. And this inference is a very difficult job and it is a more difficult problem than understanding the movement of physical objects or physical interaction among objects. Two balls thrown towards each other collide and move in different directions is much easier to understand than for example, two people pushing each other or let us say you know hugging each other, why are they doing this, what is the context of their behavior, what is going on in their heads, what are the internal states of these individuals are relatively more complex computations which also need to be taken into account when an individual, when an infant or an adult is trying to understand what is happening in this world. So, it seems that these kinds of activities the you know interaction between agents can actually be a set of specialized you know ideas can may require a set of specialized functions, recruit a set of specialized regions in the brain that will allow us to achieve these kind of things.

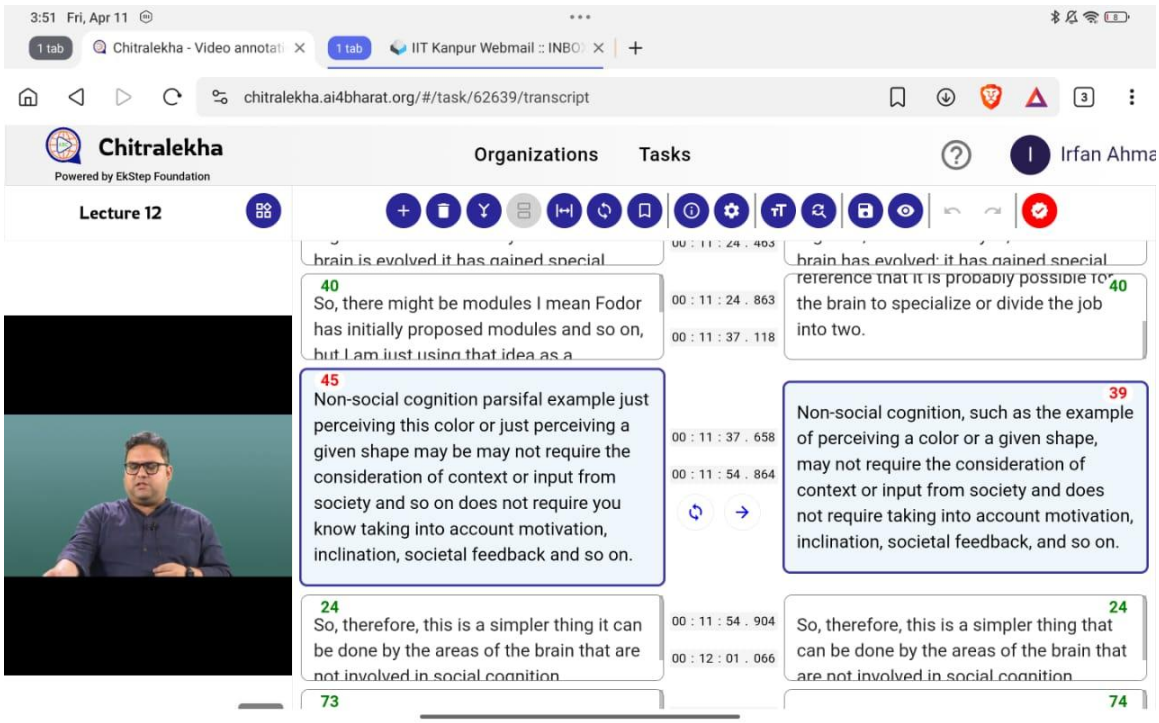
And this has been or can be referred to as what is called the social brain. and the social brain it seems to be organized for the representation of agents and the inner states of these agents that underlie their behavior why do you you know love somebody why do you hate somebody why do you shout on somebody why do you hit them why do you pat them lovingly ,all of these kind of things if children or others are trying to make sense of they will need to understand this they will need to have a sense of oh you know let us say the child did a good job and therefore, the father patted on their head or on their back in a loving manner. The child misbehaved shouted you know broke their toys that is why the mother sort of you know slapped them softly and try to reprimand them on their actions. They have we have to have this internal theory in this internal understanding of the internal states of the agents. Now the social brain hypothesis as I was just saying has taken two very you know important forms there are two ideas that emanate from the social brain hypothesis.

Now the first social brain hypothesis proposes that the human brain has actually evolved into its current form as regards its size and functional organization to actually handle the cognitive demands that are posed by living in large and complex social groups. Now, this is a very interesting proposition that came across and I was evaluating in my head as well that for the most part if you are doing or studying cognitive neuroscience, we are studying the actions and you know representations of the human brain as if it is performing a task. as if say for example, perception is merely a task of looking at the objects visually, making sense of what these objects are and then linking that whole

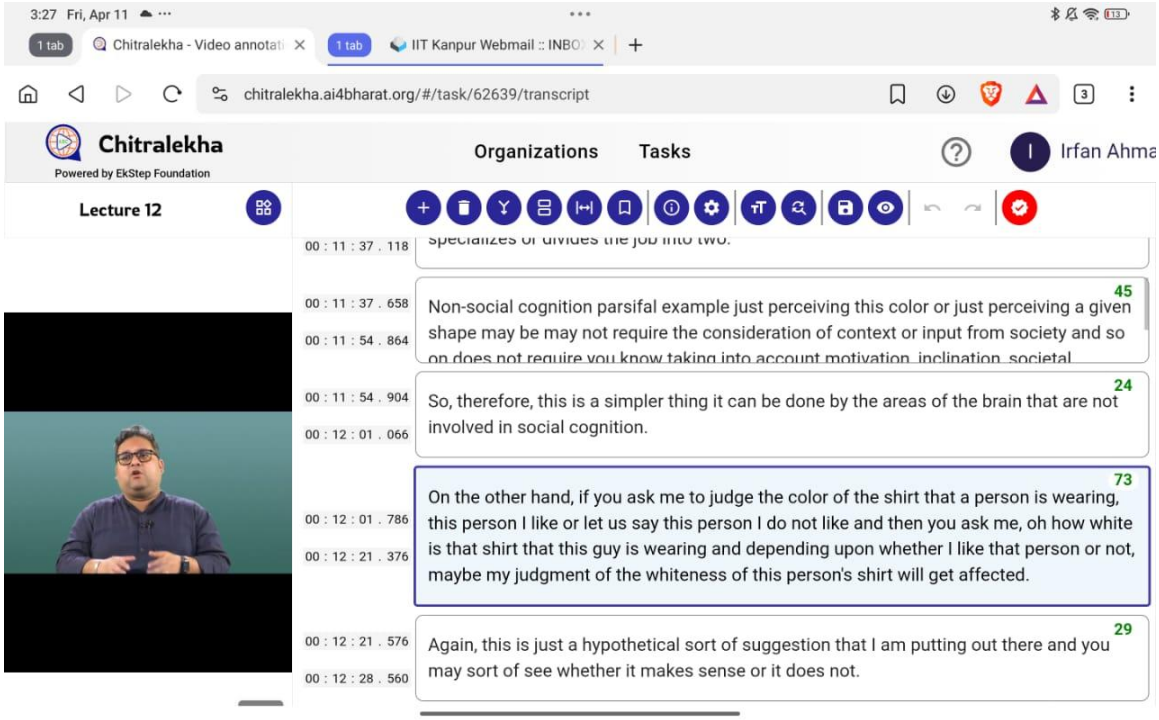
recognition to memory and bringing back all of that. Similarly, you know language, similarly there are so many of these cognitive functions that we try and understand attention, perception, language, decision making, emotion cognition all of these things when you study them from a cognitive science perspective it tells you that these are important task and the brain is absolutely capable of doing them, but something that is missing a lot of times is that all of this happens within a particular context ok. So, we understand, we view things.

We sometimes do this due to a motivated inclination or sometimes we are interpreting what is happening in the world in the against the background of context, all right. And this is something which is fairly interesting because humans have forever lived as social animals, we have lived in societies and it has always been important for us to understand how the different agents within a particular society are interacting. It can start from you know your partner to your family to your parents actually start from your parents to when you get older than your you know friends and then you get even older than your partner and the rest of the society and so on. So, it has always been absolutely imperative for the human brain to understand and be able to explain and represent the actions of agents in this social world and that is what this first social brain hypothesis says. It says that it seems that the brain has evolved into this complex organ to be able to handle the multifaceted demands that are posed by living in this large and complex social group.

So, as per this hypothesis the human brain has evolved as a social brain in its evolution it has learned all of these things and the single pressure that seems to be you know directing the evolution of the brain is this pressure of social living is this pressure of being able to you know correctly understand and infer the states of mind of people around us, the theory of mind as we have called it in previous lectures and to be able to make take choose correct responses, take correct actions so that we can actually have you know a perfectly coordinated cooperative living. So, this is the first social brain hypothesis and there is the other idea as well. So, the second social brain hypothesis proposes that the human brain contains systems that are specialized for social cognition and which are relatively independent of the systems for non social cognition. So, here what we are doing is we are saying oh there are aspects which are you know relevant which do not really require the input from the society or consideration of context and those things may be called as non-social cognition whereas, there is this brain this part of the brain this aspect of the brain which is involved in social cognition or social aspects of these different cognitive functions that we talk about and therefore, the brain has two parts to it or let us say two faces to it non-social cognition and social cognition. and if you look at these two hypothesis they are not really mutually exclusive for example, the human brain may have become a social brain via the evolution of specialized systems for social cognition.




So, if you put these two hypothesis together it seems that a yes the human brain is evolved it has gained special functionality for handling the demands of social living, but it does not mean that you know the demands or let us say all of social cognition is identical to all of non-social cognition. So, there might be modules I mean Fodor has initially proposed modules and so on, but I am just using that idea as a reference that it is probably possible that the brain specializes or divides the job into two. Non-social cognition parsifal example just perceiving this color or just perceiving a given shape may be may not require the consideration of context or input from society and so on does not require you know taking into account motivation, inclination, societal feedback and so on. So, therefore, this is a simpler thing it can be done by the areas of the brain that are not involved in social cognition. On the other hand, if you ask me to judge the color of the shirt that a person is wearing, this person I like or let us say this person I do not like and then you ask me, oh how white is that shirt that this guy is wearing and depending upon whether I like that person or not, maybe my judgment of the whiteness of this person's shirt will get affected.




Again, this is just a hypothetical sort of suggestion that I am putting out there and you may sort of see whether it makes sense or it does not. However, if you are trying to form this integrated approach you should also you know consider these two hypothesis separately as well just to understand how these work and if you will do that if you evaluate the two you will realize that the second hypothesis provides a slightly different framework for discussing the relationships between neural systems for social cognition relative to neural systems for non social cognition. If the second hypothesis were true then basically we are talking about two brains sort of hypothetically speaking one that takes part in non-social cognition, the other that takes parts in social cognition and in some sense in a lot of activities they will have to coordinate and connect with each other. So, Jenkins and Mitchell suggest that social cognition recruits brain regions that may be distinct from those that mediate non-social cognition and that the representation of others involves functions that are fundamentally different from the from those that are involved in non-social cognition. Now see whenever you are doing a task just in the context of yourself just in a very personal individual context it may not involve a lot of consideration of context and so on although your goals etcetera might still come in, but again this is more privy to the person.

But when you are talking about representation of others, how do you encode that information? Encoding that information will always have you know an aspect of valence judgment, it will already always have a aspect of judgment of positivity or negativity or context or other related information. So, Jenkins and Mitchell in that sense propose that the representation of others is probably fundamentally different from the representation

of objects that are involved or that are done via these functions for non-social cognition. Also, as we saw in the previous lectures that face perception leads rapidly to accessing person information which can be inferred from physical appearance and trait inferences and also from minimal behaviors or from long term familiarity. it seems that you know face perception can be sort of be linking these things together. So, let us try and zoom in a little bit and let us try and see if these areas are recruited differently according to the different hypothesis that are proposed in the social brain.

Now, if there are two systems, three systems, four systems let us look at this. Now, the first system in the brain the first social brain system seems to be mediating the perception of agents form and motion ok. How do the agents interact in this world and then if you look at it in the visual domain the sub sectors of the lateral occipital area, the lateral part of the fusiform gyrus and the posterior superior temporal sulcus may be recruited in this. Although these areas are generally considered as part of the visual extra state cortex, these are known to mediate more abstract representations that are also supra model. So, again remember these are yes these are areas from this visual cortex, they are involved in the generic non-social visual activities as well, but there is a part of these areas that is probably involved in inferring agent form and motion which is basically a more richer representation than that are more supra model than just drawing input from single modality that is vision now the second social brain system it seems to be mediating the understanding of actions including the activations of motor representations of perceived actions and inferring the intentions and goals implied by those perceived actions shouting at this other person, you are observing somebody frantically moving their hands here and there, frantically walking here and there, doing all sorts of tantrums and antics and so on.

Now, the thing is there is this second brain system that you know is postulated, it needs to understand the actions, it needs to understand how are those actions emanating from what kind of motor representation. actions, but that is not all that is not enough what also needs to be supplied is the representation of intention what also needs to be supplied is the representation of the goal that is driving these perceived actions. So, the representation of these actions are actually happening on a much more richer scale and they are basically including all of these multifaceted information in order for us to understand why the person is acting the way the person is acting. Now, this action understanding system seems to be based on research on mirror neurons which were discovered in the monkey brain by Rizzolatti and colleagues and they are supposed to be you know an extremely important bunch of neurons not only for social cognition, but language evolution and language acquisition as well, but just coming back in the monkey brain the mirror neurons were defined as those that respond to both imitation, perception and execution of actions. So, when you are observing somebody let us say moving their hand like this versus when you are yourself moving your hand like this in both of these cases the mirror neurons are recruited.

So, and you see mirror neurons are anyways said to be responsible for our capabilities of imitation. So, this link between intentions and actions or let us say this link between intentions and goals and perceived actions probably seems to be manifested or moderated by the activity of these mirror neurons. but the specificity to this particular actions is a very important criterion that demonstrates that these cells do not simply respond in a global way during perception and action, they actually respond in a much more nuanced way, they actually respond to some specific types of information. Let us look at that. So, this work on the human mirror neuron system cannot use this criterion because it relies on characterizing the tuning function of individual cells, how is each cell, what aspect of the action this each cell is going to tune itself to and how is it going to give an overall response.

So, consequently this human mirror neuron system is defined as a set of brain regions that are active during both perception and execution of action. So, when you are observing a particular action specific neurons will tune to different aspects of that motion and other sets of neurons will basically you know assign themselves the task of executing those actions by yourself. Now, also it must be noted and it is important to consider here that whereas mirror neurons have been you know detected only in the premotor and the inferior parietal cortex in the monkey, investigation in the humans have detected these mirror neurons like activity in the posterior superior temporal sulcus as well. So, it is not that this in human mirror neurons are only limited to the premotor and the inferior parietal cortices, but also in some other regions as well. Now, moving on to this third idea, the third social brain system seems to mediate the representation of person knowledge.

Remember, when you are talking about goals and intentions and actions, they also need to be sort of linked to the idea that who is doing these actions. It is not that oh I am moving my hands frantically and I am jumping around with anger or with excitement. If you are trying to make sense of what is happening you will also need to understand oh who is this person, what do I know about this person, is this a generally aggressive person or a generally excitable person. So, person knowledge will also come into you know play when you are understanding or you are trying to make sense of the actions of agents in the world. So, these kind of movements they include the domains of you know the representation of mental states of others as well.

So, theory of mind if you remember we have talked about that earlier and we will talk about it later again you know the idea of understanding and representing the intentions and internal states of others. And also the representation of enduring traits of others you may have an impression you may have a idea that oh this person is a kind person generally across several years I have observed that this is a kind person. Now, the principal components of the personal knowledge system are the medial prefrontal cortex and the temporo parietal junction, the anterior temporal cortex and the posterior cingulate

cortex or the precuneus are actually sometimes also implicated in this system. Although they seem to be playing a less central role that are associated more with memory biographical knowledge than with making sense of the actions and goals and intentions of these agent actions. Finally, there is this fourth social brain system which seems to be more of a conglomerate of systems that mediate processing between different emotional states.

Again, understanding the emotions of others is a very important function if you are talking about social cognition, if you are talking about how and how in what context you will represent or understand a given action. So, the representation of others involves both the representations of others emotional states as well as one's own emotional responses to these others. You know you may not like and it is it is a odd thing to say you may not like the happiness of somebody who has done something bad to you. even though we have seen in the past that typically we mirror this you know the emotional states of others while trying to make sense of them so typically somebody in front of us is happy we should automatically feel the happiness response empathically but if we don't like that person if I if I really hate this person and this person is extremely happy and voices in front of me it is possible that you know my emotional response will be different and this is also needs to be computed in this idea of inferring you know the action of the agents in the world. Now, it has been proposed that the representation of others emotional states involves mirroring those states by activating the same systems that are involved in experiencing those emotions just as I was saying.

The major components of this emotion processing system include the amygdala, the anterior insula and the superior anterior cingulate cortex. So, again it is pretty much the same system. Now, if you see we have so far reviewed the component systems of the social brain, the first, the second, the third and the fourth. These are divisions of the social brain, these are seen to be the networks within the social brain that are helping us perform particular activities. However, the representation of others is a relatively more complex task than this and it basically part of a large domain that involves high level and more complex processes including all of what we have just discussed, but even more even others.

So, it seems to us that the social brain is a distinct from the neural systems for non-social cognition and is composed of brain regions operating on information that poses different computational challenges than that are received by non-social cognition. So, again the social brain is probably carrying out its own dynamics, doing its own computations and these computations may be taking any information from the non-social system, but is a relatively independent system, ok. It is a relatively independent module if you want to use that analogy. Now, some parts of the social brain especially you know the person knowledge system seems to overlap extensively with the default mode or the intrinsic system suggesting that social cognition is not really just served by different brain regions

from those of non-social cognition, but that the processes for social cognition are somehow special and unique because it involves understanding the behaviors of agents as opposed to the understanding of behavior of objects. see your best understanding of physics your best understanding of how physical phenomena manifest in the world around you if you drop a ball it will hit the you know earth because of the gravity if you drop it with some force it will probably come back because of the reaction these are physical facts these are simple physical facts but they may not work in the same way when we talking about agents sometimes if you say for example Talk unkindly to somebody, talk rudely to somebody, they may give you a reaction and they may rudely talk back, but other times they may just not respond at all.

So, understanding how different agents in the world believe is a very important aspect of social cognition and it seems that it is special and unique and different from the factors that we are calling as parts of the non-social cognition. Now, the cognitive functions that are associated with this social brain seem to be of great interest to cognitive neuroscientists and which seems that there has to be a convergence of the fields of both cognitive neuroscience and social cognitive neuroscience. Also, social neuroscientists have found that understanding the neural systems that mediate social cognition helps to understand how these activities sort of manifest, whereas cognitive neuroscience is interested in the same systems from a slightly different angle. Now, the neural systems that mediate for example, face perception were first investigated by cognitive neuroscientists as an instance of high level visual representation or let us say sometimes in face perception literature face is treated as a special slash social object. But it is still studied from that particular frame of reference from that particular perspective.

Similarly, biological motion has been intensely investigated by cognitive neuroscientists because it involves high level representations of complex motion that are optimized because of biological relevance. So, biological motion is moderated by actions, it is moderated by intentions and goals and has to be interpreted from that lens. also the neural systems for understanding action have also been of interest to cognitive neuroscientist as they represent it as a integration of sensory and motor representation. What we are doing here is we are just observing that see these are all the common areas between cognitive neuroscience investigation and social cognitive neuroscience investigations, but we are just you need to appreciate that  even if you are talking about the same area, even if you are talking about the same task or the same stimulus, the analysis can be from different perspectives. And the number of factors that the analysis is prepared to take in may be different based on if you are coming from a social cognitive neuroscience perspective or if you are coming from a cognitive neuroscience perspective.

Finally, emotions influence cognition and vice versa yes cognition sort of influence emotion as well. For example, you know the way you make decisions might be influenced by whether you are feeling happy or sad or angry or excited at any given point

in time and it may sort of bias your decision making to that particular extent. So, understanding emotion or the process for understanding emotion seems very essential for understanding both basic cognitive processes like memory and attention. See people remember tend to remember things better when they are in a happy or a positive state of mind as opposed to when they are in an unpleasant, angry, nervous, afraid kind of state of mind. So, you can see here there is a convergence that tells us that and something that I started this course with that.

Understanding the function of the brain from the cognitive neuroscience perspective seems to be incomplete because it lacks the context that in which these things have to be interpreted in and that is what social cognitive neuroscience seems to supply. All in all, the emergence of social neuroscience as a field, therefore, does not really reflect just the discovery that social cognition has a special or a separate status in the brain. Rather, it reflects the realization that the human brain has actually evolved to handle the difficult cognitive problems that are being posed by human beings being highly social animals. Thank you. I will see you in the next class.