

Social Behavior and the Brain: An Introduction to Social Neuroscience
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Week - 01
Lecture – 02

Hello and welcome to the course Social Behavior in the Brain and Introduction to Social Neuroscience. I am Dr. Ark Verma, an Associate Professor in the Department of Cognitive Science at IIT Kanpur and this is a course about Social Neuroscience. Now, this is the first week and we are going to be talking about how do we represent and understand the concept of self and the concept of others and that is what we are going to start with today. Do we know us? Do we know ourselves? How do we know us? How do we know that this particular aspect of our consciousness relates to us and this other particular aspect relates to somebody else? For example, can we distinguish between the emotional states of ourselves and the emotional states of others? Can we distinguish between the fact that let us say I like winters or I like summers or my friend like winters or my friend like summers? How do we represent self and how do we represent others in the brain? That is basically what we are going to talk about in this week. Now this question of whether what and how do we know and think about ourselves has always intrigued humans.

And for a long time across different kinds of disciplines, theology and religion talk about it. philosophy talks about it, more recently neuroscience talks about it, cognitive psychology has always talked about it and there are so many other disciplines even for example in linguistics we wonder with the you know aspect of how do we represent nouns referring to ourselves versus referring to others and pronouns and so on and so forth. So this is a question that is has been intriguing a lot of people over a large period of time and it keeps coming in various discussions Philosophers talk about the self in different ways, psychologists talk about self in different ways, while neuroscientists are actually concerned with figuring out what are the areas of the brain whose functioning, whose activation give us this notion of continuity, give us this notion of connectedness that we identify as self. Again there are several examples, there are several streams of thought.

For example, one of the very common streams of thought which is very popular with psychologists was done by William James who pointed out this unique ability of the self to identify itself both as a subject and object of thought or analysis. Because William James talk about you know the narrative self, the narration about the self, the actor, observer, the experiencer all at the same time. So we really need to and again, while

William James is one of the people who started this discussion. There have been many discussions, many philosophical expositions about the same and I am sort of referring to all of them in a bunch here just to take this point forward that this is a very interesting question. This is a question that we need to start with that how is it that the self can both be the subject and the object of you know, object of analysis.

Now if you look at this in some more detail by virtue of say we can say the self can be deemed to incorporate both of these roles or both of these processes. It can appear as the knower, who knows these experiences for example I am standing in this room I am talking to you I am speaking at the camera and also of the content I am also in the content that I am delivering to you, I am also formulating this content, I am also the object of experience I am the actor, I am the object, I am the experiencer all at the same time. And it is very interesting if you start analyzing it, one of the very interesting discussions about it comes from Ray Descartes work. He talks about you know I think therefore I am where he starts sort of doubting everything that there is to know about the world and starts sort of reducing that and arrives at a conclusion that the only thing one can be certain of is the fact that it is oneself that is having that thought and by virtue of having that thought you can not negate the existence of the self. So I think therefore I am and there are several other philosophical positions, there are philosophical positions in Indian philosophy, in psychology and so many other disciplines.

Now this act of experiencing and reflecting upon one's own experiences would involve being able to represent one's own states as one's own you know states basically knowing them oh this is how I am feeling, I am feeling sad at this point in time while it is also the same person who is experiencing sadness may be in form of some kind of physiological arousal, may be in form of some kind of phenomenal experience but the interesting part is it is us who are experiencing sadness or happiness and it is us who are observing you know this person experiencing sadness or happiness. So it is interesting because and a lot of these things are sometimes into as part of our conscious awareness and a bunch of these things are not for example motoric representations when I am let's say you know stretching out my hand to pick up something from the table or mental calculations that okay how am I formulating these sentences that are coming out of my mouth, the emotional experiences that oh whether I am feeling happy or sad at this point, perceptual you know visceral states, physiological states, bodily am I feeling hungry, am I feeling tired, the experience of these and the knowledge that these states are my mental states, I am feeling sad or I am feeling hungry at this point is something that is very interesting to consider. Now this capacity for self-awareness is supposed to be a fundamental characteristic of human beings. Not that awareness is not you know shared by other species but it is something rather unique to human beings at least to the degree of sophistication that it happens with us. For example, Gusnerd illustrates the fact that cognitive neuroscience as a field or social cognitive neuroscience what we are talking

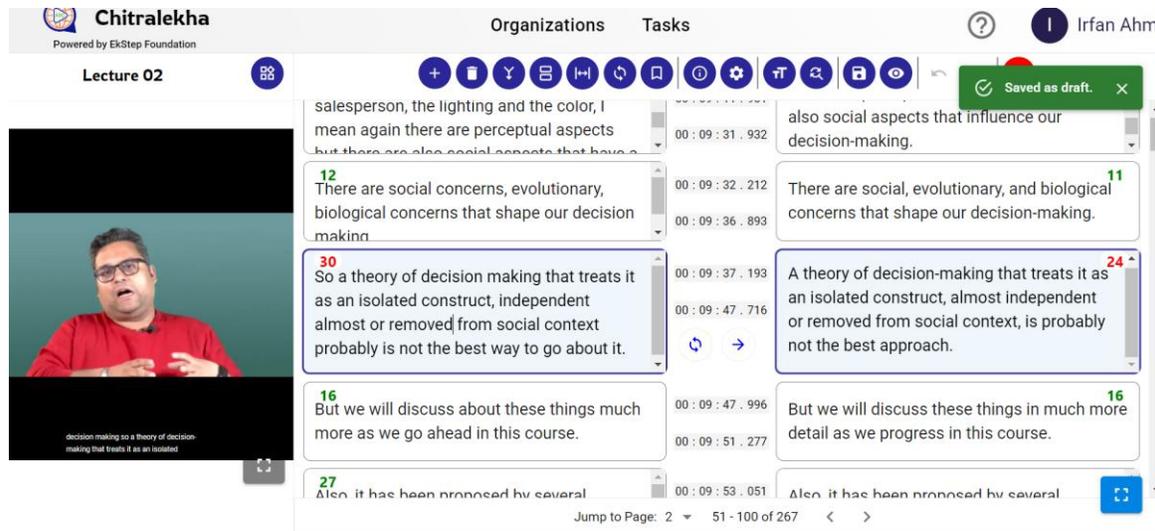
about, cognitive neuroscience per se as a field has traditionally focused on phenomena that can be categorized under the sub personal domain.

What is sub personal? That you don't really need to consider the whole self. For example, attention or sensory processes or perceptual processes or motor systems or language. They don't need to take into account the whole person. They don't need to take into account the whole being of a person. You can talk about let's say if somebody is suffering from aphasia they are producing grammatically incorrect speech.

If somebody is suffering from you know let's say some kind of a stuttering syndrome or something they are that is one aspect of them. It is not that the person is stuttering but the person's speech is stuttering. So, cognitive neuroscience per se or cognitive psychology mostly has you know focused on these phenomena that do not consider the person as a whole as involved in those phenomena and this is a very interesting difference. So, these phenomena are seem to operate at a slightly lower level than that of involving the whole being or the whole individual. Now this could be because of you know the fact that there are not many let's say methodologies available that would allow you to track the mental states or the bodily states of the whole individual while let us say a sentence is being spoken.

So it could be one of, it could be an outcome or an artifact of the limitation of methodology. But more recently what has happened is technological advances have made it possible for example to image or to analyze the person's brain activity in order to observe and explore the neural correlates of various of these under explored aspects of social cognition. And these are not only at first-person level but also say for example how do I understand the intention of a person standing next to me, how do I calculate that the person let's say a salesperson who's trying to sell me a particular you know range of goods is trying to cheat me or is trying to actually hand me a good deal and we are doing it all the time it is interesting and I was talking about this to somebody that this whole idea of understanding people's you know cognitive states or this whole idea of understanding let's say the neural correlates of people's cognitive states in isolation probably does not do justice to the idea that more often than not we are acting in social settings. Decision making for example, you can take decision making as an example, yes we make a lot of individual personal decisions but a lot of times those decisions are influenced with, influenced by the context where those decisions are being taken. For example, whether to buy a particular shirt or not depends on a variety of factors, it depends on the organization of the aisle, the showroom that I am, you know that I have visited, The behavior of the salesperson, the lighting and the color, I mean again there are perceptual aspects but there are also social aspects that have a bearing on our decision making.

There are social concerns, evolutionary, biological concerns that shape our decision making. So a theory of decision making that treats it as an isolated construct, independent almost or removed from social context probably is not the best way to go about it. But we will discuss about these things much more as we go ahead in this course. Also, it has been proposed by several ethologists that some other species for example may share this aspect of self-awareness as I was saying earlier with humans. However, as I said the degree of complexity of human self-awareness is actually unique and it is the most advanced.



The screenshot shows a video player interface for 'Lecture 02' on the Chitralkha platform. The video shows a man in a red shirt speaking. The subtitle list includes:

- 12: There are social concerns, evolutionary, biological concerns that shape our decision making.
- 30: So a theory of decision making that treats it as an isolated construct, independent almost or removed from social context probably is not the best way to go about it.
- 16: But we will discuss about these things much more as we go ahead in this course.
- 27: Also, it has been proposed by several

Other subtitles visible in the background include:

- 11: There are social, evolutionary, and biological concerns that shape our decision-making.
- 24: A theory of decision-making that treats it as an isolated construct, almost independent or removed from social context, is probably not the best approach.
- 16: But we will discuss these things in much more detail as we progress in this course.

So you look at the degree to which we are aware of not only ourselves but our mental states, our thought processes. What are we planning for the future? How are our decisions derived from our past experiences? How do we infer or how do we make our decisions in response to other people's mental states and intentions? All of these aspects actually contribute to tell us that human self-awareness is a much more complicated, it's a much more sophisticated rather phenomena than let's say the self-awareness that is exhibited by some other animal species. So, these comparisons across different animal species actually demonstrate that evolutionary steps for the development of an increasingly multi-dimensional capacity for self-awareness is unique to humans and is by nature an outcome of millions of years of evolution. Finally the capacity for this consciousness, you know you can talk about self or understanding self as an aspect of consciousness, as an aspect of awareness and again consciousness is the hard problem in cognitive science. So, where is this coming from? This has been attributed for example to facilitate the planning and rehearsal of intended behavior.

For example, by Edelman and Tononi with important functions performed within the confines of a global workspace. So this self-awareness is actually a situated phenomena, it is actually a phenomena which is embedded in a particular context, in a particular social setting and it is embedded in the confines of a workspace. For example, I am

deciding say for example at this point I am delivering this lecture an hour from now I want to be enjoying my dinner, hour maybe tomorrow I want to be travelling and so on and so forth. So when you are reasoning about yourself, when you are talking about yourself, when you are analysing your own mental, you know mental states. We are doing it in the context of a given situation and that is something that is you know very very important that is something that is being paid attention to and that is something that social cognitive neuroscience seeks to do let us say in contrast to what cognitive neuroscientists have been trying to do.

Again I am not making a watertight distinction between the two disciplines but just saying that what can be added or what you can expect extra from the kind of analysis from the kind of explanations that you will come across in the rest of the course. Now researchers have opined that self-awareness may involve the process of discrimination and evaluation for the purposes of guiding and optimizing certain behaviors. Now as I started this lecture today I was talking to you about the fact that it is very important for us to be able to distinguish ourselves with others. distinguish that this is something that is my mental state rather than somebody else's mental state. This is something that I am feeling and this is something that I am not feeling.

So the idea is discrimination of these sensory impressions, discrimination of and evaluation of our mental states, analysis of these mental states as belonging to us is something that is a very important aspect of self-awareness. For instance, let us take an example, it has been proposed that self-awareness in form of a conscious body image may have arisen to enhance the planning and minimize the risk of climbing and jumping across trees in the arboreal higher primates. Now, you know these higher primates, these larger apes. would probably be you know these terrestrial animals jumping from the top of one tree to the other, they would need to develop this sense of a particular body, sense of a particular body image so as to be able to preserve that body. So as to have a sense of that is my tail, this is my limb, this is my ear, this is my head etc.

So that they can actually be sure of that when they are jumping from one of trees to the other, they are able to preserve and you know save the entire body or have a sense of the entire body moving from point A to point B and preventing it from coming to harm, preventing it from sort of you know brushing against a twig, brushing against a tree's branch and so on. So the idea is when the individual is making this decision to jump, the decision of jumping from point A to point B is taken in the context of the whole body. Whether my whole body with whatever its dimensions be will be able to squeeze through that gap for example. So that probably something that would have evolutionary, evolutionarily arisen in these higher primates in order to allow them to preserve their bodies while they are navigating these difficult terrains. However again this is not something that humans are doing and we also seem to have this sense of body image.

So for humans the function of self-awareness may be slightly more profound than just for preserving the body from physical damage. It might have to do with let's say as I said body image you know how am I looking today. Am I looking too fair? Am I looking dark? Am I looking tired? Am I looking fat? Am I looking thin? Anything of that sort. How am I and how is my entire being, my body interacting with the rest of the environment? Is there enough space on that stool for me to sit? you know, am I feeling too hot or too cold when I am touching a particular surface. So, this sense of self-awareness with respect to the body is also something that is rather unique and forms a very important part of what we call self-awareness.

Again, it is something that is, that seems slightly pedantic but has a lot to contribute in terms of the overall idea of self that we are going to talk about. Now different philosophers have tried to understand and understand the function and purpose of self-awareness in humans. And they have laid importance to the fact that there is a relationship between self-awareness and the ability of the subject to be able to discriminate itself as a decision making agent with an embodied and a specific first person perspective and also the capacity for control and experience of ownership of intended action. Again, it's a very complicated sentence.

Let's try and break it down. First idea is there is a relationship between self-awareness knowing ourselves, knowing our being physically and you know in an abstract sense as a representation and being able to discriminate it as a decision making agent. So for example this is what I have decided to do, I have decided to push this particular object on my table, I have decided to pick this up, I have decided to move two steps left, two steps right and so on, things like that. and this has to happen with an embodied sense so for example the sense of self must be tied in to some degree to the sense of our body as well it is something that is arising not only out of the brain or not only say for example if some people prefer the term mind It probably at least for cognitive neuroscientist or social cognitive neuroscientist it must be tied to some extent to the overall body. So, it is something that is arising out of the entire you know the perception of our entire body ok. And there also has to be a specific very specific first person perspective and capacity for control in that sense.

So for example one should be able to say oh this is a decision that I have taken, I am the actor in this scenario, I am the agent who has control. Say for example if you are playing a particular sport, you are playing cricket, you are playing tennis, badminton whatever it is you who are playing that particular shot, it is you who are wielding your bat in a particular way. or catching the ball in a particular way and you have a sense of control on that things don't start happening involuntarily although in some cases there are reflex actions and so on. Also the ownership and sense of agency for intentional actions this is again a very very important aspect. of our being that we have a sense of agency when we are doing something.

The screenshot displays the Chitrallekha video player interface. On the left, a video player shows a man in a red shirt speaking. The main area on the right contains a transcript of the video content. The transcript is organized into numbered segments (20, 32, 41, 33) with corresponding timestamps. The text in the transcript discusses concepts like 'specific first person perspective and capacity for control', 'actor in this scenario', and 'sense of control'. The interface includes navigation buttons at the top and a 'Jump to Page: 3' indicator at the bottom.

So if I am say for example picking up a particular pen I have a sense of agency that oh I have picked up this pen, this pen has not left its place by its own volition but it is me who has caused this action or displacement in the position of the pen. Also, there is there has to be a sense of you know binding with intentional action. This is something that I did intentionally versus this is something that happened by itself. So, all of these small aspects put together will give you know rise to this combined sense of self or sense of self-awareness that we are talking about. And this is again something that does not happen all of a sudden or suddenly arises in adulthood.

It is something that develops gradually and insights from human developmental psychology have actually underlined the fact that the complex capacities for self-awareness they develop gradually at later ages to promote increasing competencies in perceptual discrimination, categorization and even self-regulation. So the idea is for example if you look at the you know the development of motor actions in babies. So, it is only you know so the first thing that they develop is basically develop you know the control of the head, the control of the neck and then gradually the control of the torso and they start moving and so on. So, the development of motor action happen gradually, gradually they gain control of overall of their body and they learn to then perceptually discriminate between things, they learn to sort of have a degree of intended action, awareness and so on. Also self-regulation, oh I am feeling very sad but I should probably you know hold myself and talk about let's say if you are angry, you know extremely angry in a given situation, you probably or mostly or at all times regulate your anger and try and find a more appropriate moment for expressing that anger.

So again these are also things that are very very important and contribute to the sense of awareness of self, contribute to the sense of how things have to run. Now literature has pointed out the fact that self-awareness might be associated with the evaluation of the agent's behavior relative either to the person or against the socially derived standards. So

for example, am I experiencing pain? So pain is something which is you know more of seen more of as a learned behavior, learned phenomena. If you hit a child slightly and the child you know and then you give a very exaggerated reaction to it when the child is observing that action say for example person A is hitting person B slightly and this other person is wailing and howling loudly. And next time you do that same action to the child, the child will learn to express what the you know pain or at least their reaction in a very similar way.

On the other hand if the baby sort of you know pushes himself or herself against the wall, against the window or something and it is just you know he observes that you know the socially driven, socially derived standard is that you just brush it off and get on with your business then the child will learn to not express pain unless it is absolutely unbearable. So, again So, the agent's behavior or the individual evaluate, individuals evaluate their own behavior sometimes against an internal standard, oh I am a brave person, I should not express you know the fact that I am experiencing pain, I am a strong person, I should not be crying, I am a self-controlled restrained person, so I should not be very loudly happy and so on or against a socially derived standard. Say for example, oh it is not socially acceptable to be shouting on the top of my voice in a given classroom for example. So, people are constantly evaluating their own actions against either their internal standards or a standard that is governed by the society. Also it must be noted that self-awareness as pointed out by some does not completely dominate the flow of our subjective experience and it does not constantly dominate the you know a lot of our behavior because our behavior has both parts.

It has automatic, involuntary, reflexive parts and it has volitional, deliberative and planned parts alright. So, learned behavior for example. So a lot of our behavior actually happens without explicit conscious supervision and constant evaluation of our performance. For example, I am speaking to you, I am not constantly evaluating whether each sentence that I am speaking or each word that I am speaking is being correctly pronounced, each sentence that I am speaking is grammatically correct or not. I am doing it because I am, you know, I have learned English, I am, you know, speaker of English and I can actually do it without constantly planning each and every sentence.

Remember, this is different when you have just learned a new language. For example, if I had just learned English a week ago, I would probably be much more conscious of each of these sentences or words coming out of my mouth. So, while self-awareness is a very important theme, evaluation of our own actions in performance is a very important theme, it is not all of our being. It is not that we are constantly evaluating our actions, it is not that we are constantly evaluating our behavior, but only where it is absolutely necessary or only in situations say for example if I am going for an interview, if I am giving a talk I must be you know aware of how am I looking, how am I speaking, how am I sitting and things like that where you will see that people become very conscious or

self-aware in specific circumstances. So, discrimination and evaluation have been deemed as very important aspects of self-awareness.

They have been linked with dynamic interactions in the thalamocortical system involving reentrant connections of the new perceptual categorizations with previously established categorizations in the memory. Now how do we deal with our physical world around us, how do we sort of understand what is happening, how the world runs and so on. So for example if I am looking at you know in the aspects of this room I know that there is a camera, there are lights, there is a wall, there is a door, there is a window etc. etc. etc. ok.

Now the thing is there are these categorizations, there are these, this, there is this organization of the world that I have you know in my head but if I were to encode it personally say for example I like that window, I am encoding that information with the reference to the cell. So, what is happening is that this thalamocortical connection that we are talking about the connection with the thalamus and other cortical regions is basically a dynamic and it is constantly evaluating things that we have to store in reference to ourselves versus things that may have a only a general description. Another aspect that is been found Useful here is this aspect of stabilization. What is stabilization? Now stabilization is deemed as a process of continuous updating of the memory systems with new perceptual organizations and it is supposed to take several hundreds of milliseconds to complete. It is something for example when our memory is constantly updating itself.

So for example at any given moment in time, so time t_0 , t_1 , t_2 , t_3 up till t_n . As you are going across this timeline experiencing ourselves we are constantly updating our you know memory the fact that oh I have raised my hand, I have raised another hand and I am moving them in a systematic manner to convey a particular point. So, these you know this bootstrapping of memory, this continuous updating of memory in reference to say for example my actions or my feelings or my mental states is something that is continuously happening and it is involves the continuous updating of our working memory which as you know is a you know is almost like a global workspace for us. It is like the RAM that you have in your computers or mobile phones and so on. And again once you are constantly doing this there is also an aspect of evaluation against either a socially driven standard or you know personally established standard.

So while you are deliberating, while you are updating your memory there are opportunities to see oh this is, this moment that I did was wrong, this moment that I did was right and sort of you know making a note that okay next time when I raise my hand I will probably move this you know more slowly or it will not be a jerky reaction and so on. So, the way we are going about, the way we are constantly encoding the environment and our own actions in this environment is seems to be a continuous process that involves continuous updating of memory and is something that stabilizes over time which tells us

that ok this is the action that I am taking or these are the mental states that I am experiencing. Now again we are talking about neuroscience, so obviously neuroimaging is a very important methodology. So, some neuroimaging data actually seems to suggest that neural mechanisms that explain the fact that self-awareness does not continuously dominate the flow of subjective experience also suggest that self-awareness may rather be a property of our experiences aided by the coordination of brain networks. So it is not something that we need to artificially impose, it is probably something that once we are undergoing a particular experience we are aware of that this is our experience.

It is not something that we continuously need to do or continuously need to sort of supervise or you know monitor our actions rather it is something like if you are going through a particular stream of actions we know that these are our actions. So, what the assumption is that self-awareness seems to be the property of our experiences rather than an analysis of our experiences. These are interesting and slightly nuanced point, but it is something that will make sense when we go forward. Now let us look at some insights from you know functional neuroimaging studies of self-awareness. Now when you talk about functional neuroimaging studies just to sort of revise for people who have not done the cognitive neuroscience course you can do you know you can go and do the course brain and behavior : an introduction to cognitive neuroscience that I have offered.

But just coming back here, what is fMRI? The full form is functional magnetic resonance imaging. How does it work? It works basically on the principle that when the, when a particular area of the brain is engaged in a given task, it receives more oxygenated blood. The blood is, you know, sort of, you know, it uses up a lot of hemoglobin. And therefore, you know, say for example areas of the brain involved in particular functions, show what is called a blood oxygen level dependent response or the BOLD signal. Now this BOLD signal typically the way it is interpreted is it is basically you know a fundamental change in the blood flow in a particular area of the brain that is for example engaged in a particular activity.

To give you an example if I am showing you faces and I am showing you houses and I am showing you faces a particular area of the brain called the fusiform face area typically in the right hemisphere will receive more oxygenated blood because it is you know, It is supposed to be involved in recognizing faces alright. So this change in blood flow is what is you know measured by the fMRI you know machine and this is what we sort of get you get heat maps at oh this area of the blood had most oxygenated blood at that time seems which seems that it is it must be involved in that particular function. Now when the flow of blood in the activated areas of the brain increases the consumption of oxygen and utilization of glucose also increases markedly and that actually becomes the basis for this bold signal the blood oxygen level dependent response which is as I said measured by the fMRI. Now obviously for the most part this BOLD signal is accompanied by increases in spatially localized you know signal directly and monotonically reflecting an increase in

the activity of neural activity in that specific area of the brain although it is slightly delayed. So an interesting problem with fMRI is that the signal takes some time to develop, takes around 2 seconds and plateaus at around 7 seconds.

So it is something that develops very gradually and does not offer a very good temporal resolution of neural activity rather it offers a decent what you call spatial localization of brain activity, which area of the brain was involved in this particular task, not essentially chronologically whether this area was you know involved the first and or in the last. So, that is a bit of a limitation with this. Now just sort of taking this forward, interestingly while increases in the bold signal have been studied traditionally, people have also reported and people have been interested in decreases in this bold signal and you know, contingent to different kinds of activity or sometimes contingent to brain's own activity or sometimes it happens in the resting state of the brain. We will talk about it now. So, more specifically these kind of decreases have been found to appear exclusively between or within perceptual systems.

For instances these focal decreases in activity may appear in auditory or somatosensory cortices when people are engaged in a task involving visual perception or within portions of the somatosensory or visual systems while other portions of these systems exhibit increases. So, within the somatosensory cortices or within the auditory cortices or the temporal cortex Portions of the temporal cortex may show increased bold signal or increased neural activity in response to a stimulation. Suppose you are hearing, listening to a song or hearing somebody call out your name, obviously that portion is experiencing increase in neural activity as indexed by the bold signal. But it is possible that other regions within that area of the brain are experiencing a corresponding decrease in activity. And this is something that has caught the interest of several researchers.

These signal decreases within these sensory areas have typically been observed to exhibit decreases in activity in average data related to even a passive resting state. So, passive resting state when you know the person is closed his eyes and he is resting and some activity anyways is going on in the brain at all times compared to that activity some of these areas show a decrease in brain activity. Typically, for the most part what do we study in fMRI? This is resting state activity when you present the stimulus brain activity increases. In some cases brain activity in particular regions can decrease also or the bold signal can show decreases as well.

So, these imaging signal changes. We should assume that you know includes both increases and decreases as the brain adapts to different types of task demands. You know task that involve consciously people in getting you know in a particular task, thinking about something or you know doing it in a involuntary manner. Now as I said the brain typically is around you know 2 percent of the, you know the amount of blood that the brain receives is about 2 percent of what it goes through throughout the entire body but it

accounts for almost 20 percent of the consumed oxygen. ok and in that sense if you see there is constantly some or the other activity going on in the brain even if you are not doing anything and the brain is consuming oxygen it is you know it is using oxygen it is you know using a glucose and energy to continuously be doing something maybe it is just to provide a sense you know a sense of self maybe just to sort of you know when you are closing your eyes you are thinking about something and so on. So, this metabolic activity that we see in response to let's say certain stimulations when you are doing an fMRI task is actually a very small part of the overall activity that the brain is doing.

It is not that in fMRI the brain is totally cold and it is totally silent and suddenly you see a peak activity in response to showing a face or in response to showing a particular house, that is not really a case. The brain is active, it is consuming oxygen, but in some places contingent to a particular kind of stimulus presentation, it may start consuming a little bit more and that may stand out and you know be measured by the fMRI scanner. So, this physiological baseline basically inherits functionally significant signaling processes which sometimes may or may not be directly related to sensory or motor stimulation. So, a lot of the times that the brain is active and it is consuming oxygen, it is doing something, it may not necessarily be in response to stimulation that is receiving from the environment, it could be doing let us say a thing of its own as well.

Maybe it is busy giving us the sense of the fact that we exist. So, it has been proposed that this baseline neural activity may serve more of a preparatory or a facilitatory processing role that might be a necessary component of brain function but not directly related to any type of information processing. See, for example at any point in time if I am giving you a list of words to remember the whole point is that there should be underlying processes that will help you understand the meaning of those words or if I am asking you to move your arm and pick up some object from the table There is some preparation, there is some pre-planning, some processing that has gone even before you can actually move your arm and lift up the object from the table. So, maybe and people have said this baseline neural activity that is going on in the brain independent of sensory stimulation is probably serving as a facilitatory or a preparatory sort of role that keeps the brain ready in order to respond to any kind of stimulation that it will receive. Other researchers have proposed that such baseline neural activity actually may be involved in information processing across a set of association areas which are manifested through signal decreases. So, it is something like ok, you know it is not that the brain is working on its own, going on without you know any purpose, it is probably processing certain kinds of information which basically prepares or makes the person ready for a particular goal directed task.

So there is this idea of these decreases which are there, which are tied to some kind of information processing that keeps the brain ready to respond to any kind of goal directed task. Now the areas that have been involved include the medial frontal and parietal

cortices and also the bilateral lateral parietal cortices which are thought to stay active even during the resting state of the brain and these are the areas which are also supposed to be involved in spontaneous and virtually continuous processes which are disrupted only when individuals engage in certain goal directed tasks. For example, there is an interesting field of study called mind wandering, you are sort of sitting there thinking of something and suddenly a stimulus flashes on the screen and your attention is grabbed by the stimulus and you have been asked to press a key, when you see that stimulus press another key when you see a different stimulus. Before that while you are sitting on your place waiting for the stimulation to appear your mind is doing something certainly it is not it is not a binary switch on switch off kind of a mechanism. So, while the brain is not engaging with tasks or engaging with tangible stimulation around it, it is still doing something and this doing something may be indexed in the signal decreases that have been observed in these different areas the medial frontal parietal cortices, the lateral parietal cortices and so on.

And that is what has sort of you know in you know spurred people on to do resting state analysis to analyze the brain in its resting state. People have explored the inter-regional temporal correlations of these spontaneous bold signals in the resting state in one of these studies for 14 subjects and they found out and they basically use the region of interest method in medial parietal and ventral anterior cingulate cortices and they actually found significant correlations in the spontaneous activity among the group of areas that have been you know earlier found to show these kind of signal decreases. So when they started looking at resting state activation in people they found that there are these set of areas again the medial parietal and medial frontal areas. That actually show a correlated pattern of activity, correlated pattern of signal decrease even before the person is engaged in a goal directed task. Also, another set of researchers have analyzed the variations in these simultaneously acquired EEG frequency bands and found that changes in power within these bands were actually correlated with magnitude variations in the regional bold signal within the brain and you know when normal subjects engaged for 20 minutes in the eye closed resting state.

So, they were asked to sort of close their eyes, not think about anything else, but again the areas of the brain were found to be active and working in a coordinated manner. These areas include the dorsolateral parietal and prefrontal cortices and they and these findings together have led the authors to conclude that the resting state of the brain may be characterized by temporal fluctuations in this functional activity that we see from inattention to spontaneous cognition, you know. So, from inattention in terms of mind wandering, you are thinking about something else, you are not present. So, for example, a lot of times in classrooms it happens the person is sitting right in front of me, but his mind is somewhere else and he is not really paying attention. To a state where I ask a

question and the person suddenly comes back and says oh I know the answer or I don't know the answer.

So, again even before we start looking at a lot of self-related neuroimaging activity, it is important to understand that there is a lot of these preparatory you know activity in the brain that happens during the resting state and these are some of the areas that I just mentioned that might be involved in resting state functional activity. Which might be involved let us say and again we will talk about this much you know in much later that may be involved in giving sense to a coordinated sense of self or a coordinated sense of personhood. There are also more specific insights about self-awareness that we can talk about. For example, the areas that we have mentioned so far have been found active not only in the resting state but they have also been attributed to be significantly involved in various aspects of self-awareness. For instance, PET studies have contrasted the altered states of awareness with the normal waking state by varying the levels of anesthesia in people.

So, when they were awake, when they were sleeping and they sort of varied this on a particular continuum to perfectly awake to totally anesthetized and you know out of consciousness and they found that the medial parietal and ventral prefrontal cortices actually the activity in these areas experience decrease in blood flow, decrease in the bold signal contingent to the variation in the state of self-awareness. So when they were moving from an absolutely vegetative state to an absolutely conscious state, the bold signal experienced different degrees of decrease in these few areas. What are these areas? Remember the medial parietal and the ventral prefrontal cortices. Another set of studies have tried to assess brain metabolism in patients during and after recovery from a vegetative state like that of a coma and they sort of you know in a state of impaired awareness. Areas that were found to resume normal metabolism when the patients woke up they came back to consciousness were the medial parietal and lateral parietal areas and which significantly overlapped with the areas that have been shown to experience these signal decreases that I was talking about.

The researchers have also reported altered correlations in activity between these medial parietal cortices and the dorsomedial and lateral prefrontal areas as compared to normal controls when the patients return to normal consciousness. Again remember that these are these areas which are common to you know the description of areas that were that were experiencing the signal decreases in the resting state and are also being shown to be involved when the waking state and the unconscious state is being varied either as a result of a coma or a vegetative state or as a result of changes in the level of anesthetics in these people's body. Finally a bunch of PET and fMRI studies have also emerged basically from the studies of self-referential processing of stimuli such as words or pictures associated with the selves you know, so for example does the adjective punctual describe you, does the adjective lazy describe you, things like that. In such studies

subjects were sometimes asked to make these explicit judgment you know questions like oh does this word apply to you or not. about themselves or sometimes endorse their own experience or the experience of themselves versus another.

Are you feeling sad? Is he feeling sad? That kind of thing. The neural collates of these kind of conscious evaluations and such processes have been regarded as subserving some processes which are utilized in explicit self-focus or self-awareness. Remember, so far when we are varying this level of anesthesia etc. we are talking about a very implicit sense. Here we are talking about the fact that you know So, explicit awareness versus implicit awareness. Explicit evaluations of one's own mental processes have also been shown to engage portions of the medial parietal regions comprising posterior cingulate, pecunius and the retrosplinal cortex.

Again, there is one thing I should probably say because from this lecture onwards I will be mentioning a lot of these areas. One of the things that you could do is that you could actually take you know a brain atlas and when I say these things you draw a brain and just mark these areas with your ticks and crosses and see. So, these are the areas that you know this person is talking about ok. Also accessing semantic information or taking semantic judgments about persons including oneself have also been shown to engage these portions of the medial prefrontal regions as well as the medial parietal and lateral parietal regions in both the hemispheres. So, broadly these are some of these, some of the areas that seem to be involved in explicit and implicit processing of self-awareness, evaluation of semantic aspects about oneself, oh you are you know a male, a female things like that.

So, the conscious awareness of self probably somehow is tied to the activation of these regions. In the next class, I will talk to you about self-awareness from a different perspective. Till then, see you.