Social Behavior and the Brain: An Introduction to Social Neuroscience

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Week - 01
Lecture – 05

Hello and welcome to the course Social Behaviour in the Brain and Introduction to Social Neuroscience. I am Dr. Ark Verma. I am an Associate Professor of Cognitive Science at the Indian Institute of Technology, Kanpur. This is the first week of the course and in this lecture we will continue talking about self and other related processing. If you remember we are basically considering a meta-analysis published by Zaki and Ochsner in Todorovsky and Prentice's book and we are basically looking at this meta-analysis from the perspective of two things there are there is a two cross two organization of this meta analysis there is directive mode of processing and reflective mode of processing and there is the self as a target and the other as a target.

So in today's lecture we are basically trying to look at the interaction between the target and the mode of processing. So what kind of mode of processing and what kind of target and how do they interact. Now, so far we have seen that there might be overlaps or dissociations in the self or the other related processing depending upon whether the processing mode is engaged is direct or reflective. So, remember we talked about the dual process model in the previous lecture the dual process model says.

There is one mode of processing called the direct mode of processing which is basically concerned with autonomic and you know autonomic automatic and fast responses to a evaluation of stimuli and then there is a slightly more slower reflective or deliberative mode of processing which basically evaluates the responses coming from this autonomic or automatic mode and decides on you know whether to sort of amplify dampen or continue with the same magnitude of response. So, in today's lecture what we are trying to do is basically try and see how does the target that is whether self related or other related stimulus is being processed interact with the mode of processing. So if you take a step back you know take the previous lecture also in mind it will not be difficult to realize that it is you know for when you considering the whole brain when you considering that the whole brain is involved in evaluation of you know a lot of these social stimuli separating the two types of stimuli per say or separating the two types of processing modes per say becomes difficult it is Almost as if they are working in tandem they are working you know complementary to each other and therefore it is very difficult to tease about the effects of direct or reflective processing or processing of the self and processing of the other. This sort of a quandary leads to several different questions. For example as

we go forward the authors plot activations for self and other processing for only one kind of processing mode.

So at first in today's lecture we will only look at the direct processing of self and other through the virtue of let's say perception of pain and perception of emotion whereas in the next lecture we will talk about reflective processing of the self and the other and we will try to understand that while direct processing is engaged. How is self-processing and other processing influenced and when reflective processing is engaged, how is self-processing and other processing affected. They dissociated, for us to be able to do this, they dissociated activations associated with different types of judgment and or stimulus contained wherein they considered if the activations would get segregated for studies involving pain, emotion or purely cognitive judgments about these non-effective beliefs. The goal that they sort of had in this section of the analysis was to determine whether distinct processing systems would subserve the perception of self and the other but only when engaged in a particular type of processing or direct processing or reflective processing and how does that interact with specific types of stimulus. So when you are looking at let us say words or pictures or you know other kinds of faces for example they have basically tried to you know tease about these events.

So in today's lecture let's talk about direct processing of self and the other. Now the theories that we have seen so far have suggested that there must be an overlap, there is an overlap between the processes involved in self and other perception during direct processing and it is you know much more apparent when direct processing modes are engaged. All of these theories basically draw from data which comes from studies involving mirror neurons and their engagement during the observation of motor actions as well as mirror neuron like responses when people are you know observing and experiencing pain, disgust and you know other kinds of emotions in other people. Now if you look at this from one hand it has led to the view that researcher that perceivers understand social targets let's say others you know in the environment by automatically activating their own sensory motor and affective system. So basically it means that if I am observing another person if I am observing another person experiencing let's say pain you know you going on the road somebody meets an accident or somebody sort of you know gets hit by something.

It is almost that you are reliving simulating the pain that the other person is experiencing and this is basically coming from the observation of the fact that there are overlapping neural regions, overlapping areas of the brain that are involved in processing not only our own experienced pain but also the pain that is being experienced by others. And this is interesting because this seems to be one of the fundamental basis for you know aspects like empathy. Let us dive in and look at this a bit more closely. Now the author start with the considering pain, so let us talk about that. Now a compelling case for this overlap in

brain systems for self and other perception is actually made based on studies that involve you know investigation into pain perception.

An important aspect of our survival is the fact that you know nociceptive which is noxious and painful stimuli will allow us to move away from let's say a hot stove if you are if you hold a hot cup by mistake you will take your hand away and this is basically because you realize that you know the cup you know the touching of the cup is painful it can harm your skin and you take your hand away. But isn't it also the case that we not only learn from our own experiences from danger or hurt and things like that, but we also learn from others. Say for example, if somebody else touched a particular cup, they found it hot, they took their hand away and if the cup is here, I will also have learned that I should not be touching that cup. It is too hot for touch at the moment and I will wait till it cools down where I can hold it and maybe you know sip my drink from it. So over 20 years of experience has or over 20 years of research has actually documented this phenomena which is called vicarious conditioning and these have provided a model for this phenomena by showing very similar skin conductance and heart rate responses when perceivers observe Others learning to fear conditioned stimuli those that they are they experiencing themselves and also those that others are experiencing and these are and individuals are just observing others go through that you know thing.

For example, if you yourself experience an electric shock versus if you are in a room and you you know from let's say a glass window see somebody else going through the shock it almost sort of makes you feel that pain. You may remember several scenes in you know movies and serials on OTT you will find that you know the police people are torturing one person you know giving him or her you know extreme pain and extreme hurt and the other individuals just by looking at this person getting beaten up actually succumb to this pressure and they confess. So it is probably because of the fact that we can almost stimulate the pain that the other people are experiencing. Now this phenomena has been referred to as empathic pain and it has been studied through neuro imaging studies and basically has shown activation in overlapping regions of the anterior cingulate cortex and the anterior insula the AI. both when individuals themselves experience pain directly and also when they observe other people experiencing pain.

So you can see that there is indeed a neurological basis for empathy, there is indeed a neurological basis for the fact that if I am experiencing the same pain or somebody else is experiencing the same pain I sort of have to learn from that and save myself, preserve myself from you know possible hurt. Now the fact that these two regions are primarily associated with affective responses has been taken to suggest that instead of understanding someone else's pain in a cold cognitive manner we actually simulate or we feel the pain to the same extent almost, isn't it? So, it is obviously that we are not you know actually feeling the pain but the same areas of the brain are involved, it gives us the impression, it gives us you know the idea that how painful that particular stimulus might

be. And while these findings of overlapping activity for self and others pain have been slightly, have been highly informative for theories of empathy, there are also differences that we must look into, there are also differences that people have observed. So going to differences it must be noted that understanding someone else's pain is not really just an effective response but it also involves a series of other kinds of steps. Let's look at them.

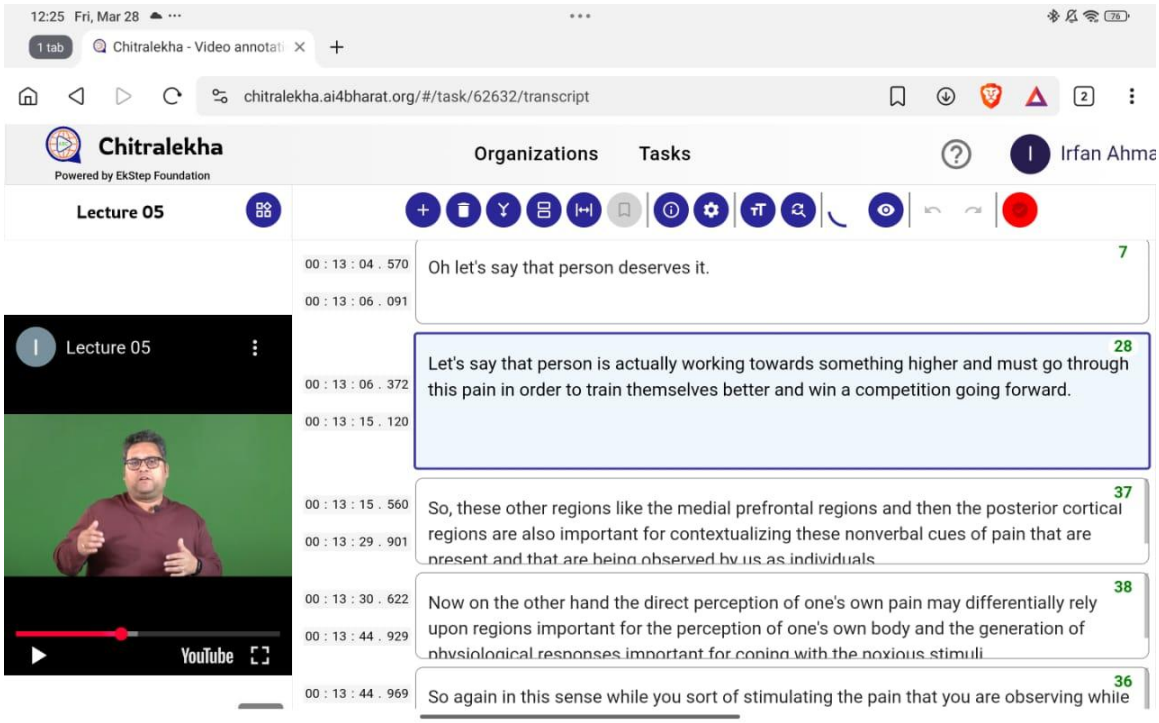
For instance individuals might also need to attend to other non-verbal visual cues such as facial expressions or body language that can be indicative of you know how much pain the other person is feeling. You know just go to that torture example. Even if this person say for example is not really you know you know it's not really cutting up and there's not a lot of bleeding and there's not a lot of blacking and blueing and bruising but if the person is wincing the face and the teeth are clenched and the you know the overall expression is of fear and pain you will basically be able to interpret these non-verbal cues also and understand the degree of pain that this other person is feeling and this estimation of the degree of pain that this other person is feeling is bound to you know invoke proportional feelings of pain and fear in us because of the involvement of these areas the anterior cingulate cortex and the anterior insula. Also some understanding of the motivational relevance of the painful situation is also required for someone else to be used to constrain one's own understanding of the target pains experience. Now again you know as I have been mentioning in the previous lectures.

Social cognitive neuroscience is very concerned with the contextual situation of experiences. Now if you are seeing somebody actually going through pain but let us say he or she is an athlete who is training very hard for a competition that is going to come in a few days. Now you will see that this person is in absolute pain and you sort of are going to feel you know equally unpleasant, equally displeased about it but if you have this idea of the fact that you know the motivation of the pain is to be able to win a competition which is happening let's say next week or next month and so on, you can moderate the feeling of pain that you are sort of simulating in yourself. and this you know sensitivity to contextual situation is something that is very interesting and we are seeing that the areas of the brain are also sensitive to these context they are also sensitive to the motivation and the relevance of the kind of pain that other persons are experiencing. Interestingly some of these additional steps that I was just mentioning should also be able to recruit therefore neural systems beyond those which commonly support the representation of pain effect in self and other.

And what are these extra regions other than the ACC and the AI? They are, these are the medial prefrontal regions described earlier as important for reflecting on the nature of one's own mental states. Now the thing is if you are observing somebody feeling pain and you already yourself start feeling you know nauseated and pained and displeased there is also these other regions which are sort of observing you . They are also telling you that

you know you should not be feeling like that. Let's say you know there can be two kinds of thought. Oh let's say that person deserves it.

Let's say that person is actually working towards something higher and must go through this pain in order to train themselves better and win a competition going forward. So, these other regions like the medial prefrontal regions and then the posterior cortical regions are also important for contextualizing these nonverbal cues of pain that are present and that are being observed by us as individuals. Now on the other hand the direct perception of one's own pain may differentially rely upon regions important for the perception of one's own body and the generation of physiological responses important for coping with the noxious stimuli. So again in this sense while you sort of stimulating the pain that you are observing while you are recruiting these regions that are sort of you know adding a commentary to all of this. It is also important you know in a sense to you know have these regions be able to differentiate one's own pain versus others pain ok because otherwise you know it is always going to be case that even if you are not in pain, you are observing others pain and your life sort of becomes visible, you are constantly experiencing those things.

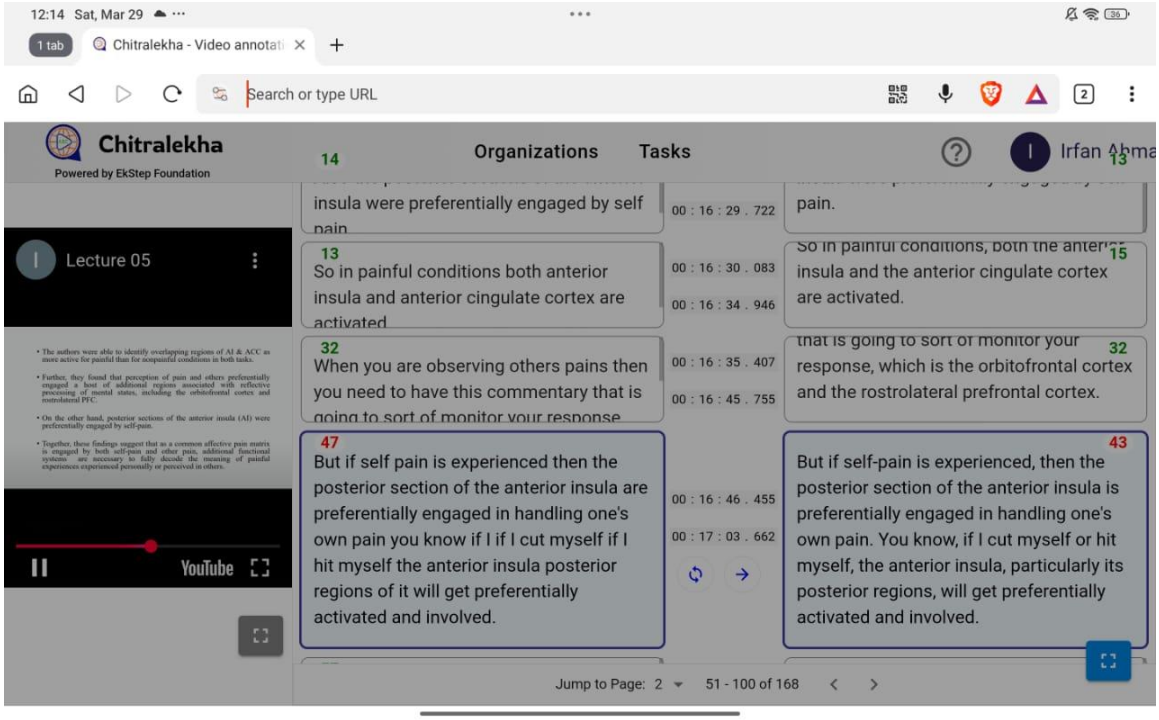


The body needs to know or the brain needs to know what is the pain that we are directly experiencing versus what is the pain that we are observing in others or we are seeing others experiencing. So regions such as the anterior insula AI the hypothalamus and the thalamus may be recruited to play a role in such processes. So in direct perception of pain in the perception of pain that you are yourself experiencing the anterior insula the

hypothalamus and the thalamus are the regions that sort of are contributing. So, Ochsner and colleagues actually you know in a previous study wanted to sort of you know dissociate this, they wanted to investigate this further and therefore what they did was that they asked participants to complete two kinds of tasks. They put them in a self pain task wherein participants were exposed to both painful and non painful stimuli, you know thermal stimuli and in another pain task participants saw others in painful and non painful conditions.

So, you are again the task is a 2 cross 2 task painful non painful self and other and this is basically you know neuro imaging is done in this and basically to identify the regions that are recruited. Now the authors were actually able to identify overlapping regions of the anterior insula and the anterior cingulate cortex as more active for painful than for known painful conditions. So as we have been saying in the last few slides the anterior insula and the anterior cingulate cortex seem to be responsible for comprehension or experience of pain as opposed to non painful conditions. So in both tasks these two regions are recruited. However, they also found that the perception of pain and other pain of you know of pain in others preferentially engaged a host of additional regions associated with reflective processing of mental states including the orbitofrontal cortex and the rostrolateral prefrontal cortex.

So, if you are observing the pain of others these other regions are sort of you know recruited in order to observe one's own mental states and moderate our response to observing the pain of others. Also the posterior sections of the anterior insula were preferentially engaged by self pain. So in painful conditions both anterior insula and anterior cingulate cortex are activated. When you are observing others pains then you need to have this commentary that is going to sort of monitor your response which is the orbitofrontal cortex and the rostrolateral prefrontal cortex. But if self pain is experienced then the posterior section of the anterior insula are preferentially engaged in handling one's own pain you know if I if I cut myself if I hit myself the anterior insula posterior regions of it will get preferentially activated and involved.



If you put these things together, these findings suggest that they can be this common affective pain matrix that is engaged by both self pain and others pain and then there is this additional information systems which are necessary to fully decode the meaning of painful experiences which are being experienced either by ourselves or by others. So, remember as I have said in previous lectures pain is something of a learned response and it is something that you know that the magnitude of how much pain we feel may be comes through experience, it comes through training, it comes through observation and it comes through observation of others responses to pain alright. So, you can see when you are observing others pain there are these extra regions activated that are telling you that ok you know your response to be. should be proportional to whether it is relevant to that given situation or not. But when you are experiencing pain yourself, the posterior regions of the anterior insula sort of in are involved in managing the kind of pain you are experiencing.

Also the authors hypothesize that although self pain and other pain both involve the activation of anterior insula and the anterior cingulate cortex. They may be part of these different, you know, this activation may also be part of different cognitive and neural networks activity in both of these cases. And to investigate this, they sort of use, they try to use what is called functional connectivity analysis. How does information flow in the brain from point A to point B and point C and how does it sort of complete its loop and so on. What did they find? They found that whereas the main effect contrasts that average activity across time and individuals may be insensitive to regions whose activity across the two types of condition let us say co-varies you know self pain and other pain,

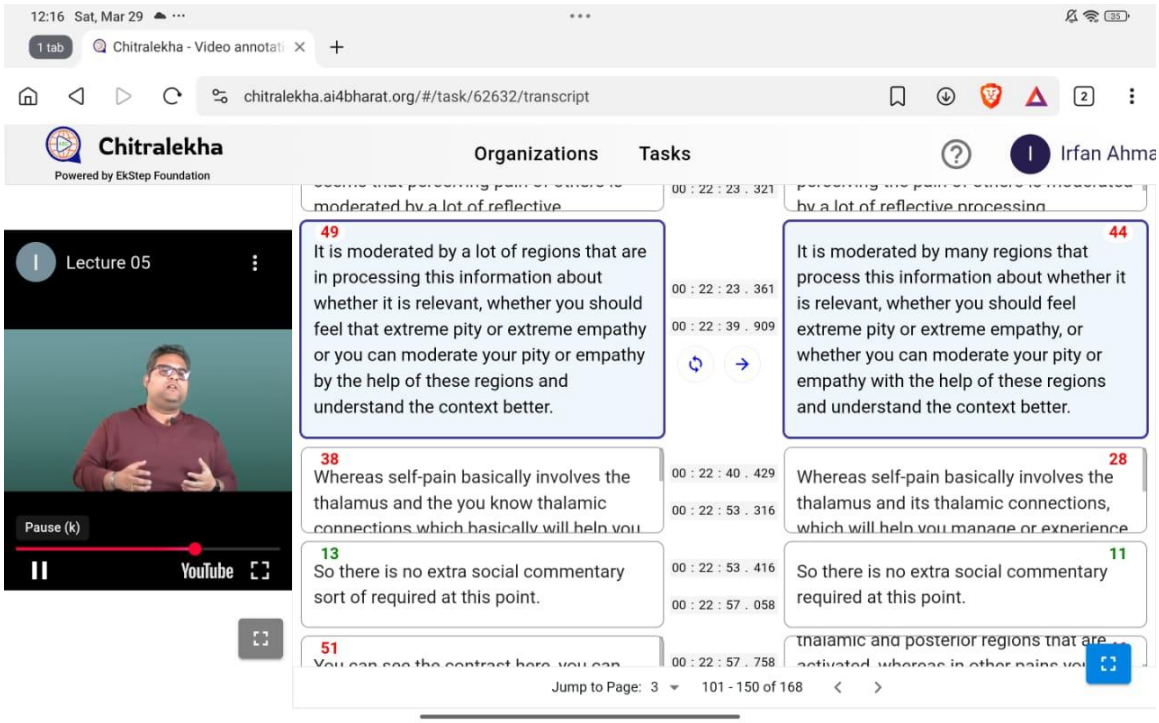
functional connectivity analysis are actually sensitive to this difference and this sort of tell us a little bit more about these dynamic fluctuations.

So, in the context for the empathy for pain, this analysis showed that during other pain as opposed to self pain, overlap in the areas of ACC and the anterior insula became more connected to the medial prefrontal regions associated with this you know and which is also associated by the way with the theory of mind task. And whereas during self pain the ACC and AI become more connected to the hypothalamus and the periquedictal grey regions associated with processing autonomic responses. So you can see as far as functional connectivity or flow of information is concerned in the brain there is a slight dissociation. The ACC and the AI are connected to more medial prefrontal regions when you are observing others pain and they are more connected to the hypothalamus and the periquedictal grey regions when you are yourself conducting pain. So yes the brain has specificity, the brain has the power to discriminate our own pain versus others pain.

Now on the basis of these findings, the authors created a schematic representation of brain networks which was involved in perceiving self pain and others pain. So you can look at the left, the figure is from Zaki and Ochsner. You can see that there is this functional connectivity, you can see that the blue areas are more connected during others you know during observing others pain and the red areas are more connected when you are you know when you are experiencing pain yourself. And the other regions which are in the yellow are actually just anatomical connections which have been shown through previous work. So, if you look at this model, it can be utilized as an example of, you know, dissociation, a seemingly very similar set of processes, seemingly overlapping set of processes, which is observing your own pain versus observing others in pain.

Now to investigate the dissociation of self processing and other processing in the context of pain, the authors plotted activations from the previous studies of pain perception in the self and the other. So they start of you know are looking a bit more you know zooming in into these kind of studies. And although the authors of these studies, you know these few studies that are being looked at emphasize the overlap for self-perception, you know self-pain perception and other pain perception in this effective pain matrix as can be seen, I will show you the slide in the next one, there were also important differences which were under-emphasized which are not really highlighted that much. So, to elaborate just to you know look at those differences whereas self pain was commonly found to activate the thalamus and the areas along the central sulcus, other pain usually activated the medial prefrontal cortex, the bilateral ventrolateral prefrontal cortex and the orbitofrontal cortex as well as some visual association areas because you are observing others in pain, you are also decoding the visual cues and the non-verbal cues that are there. Also, all the activation peaks anterior to the genu of the corpus callosum representing associative regions of the prefrontal cortex occurred during pain perception for other only.

So it seems if you sort of look at it, it seems that perceiving pain of others is moderated by a lot of reflective processing. It is moderated by a lot of regions that are in processing this information about whether it is relevant, whether you should feel that extreme pity or extreme empathy or you can moderate your pity or empathy by the help of these regions and understand the context better. Whereas self-pain basically involves the thalamus and the you know thalamic connections which basically will help you manage or experience the I mean you know manage the pain that you are feeling because you have yourself gotten hurt. So there is no extra social commentary sort of required at this point. You can see the contrast here, you can see in self pain there is more thalamic and you know posterior regions that are activated whereas in others pain you can see that you know these different regions are getting activated which including the orbitofrontal cortex, medial prefrontal cortex and so on.



So you can see in this slide that the regions for self experienced pain. are slightly you know the posterior regions whereas when you are observing others experience pain it is more it is involving the orbitofrontal the medial prefrontal areas and then there are these regions which are you know overlapping and are activated in both of the situation. Moving on, although these differential activations are seldom, are seldom discussed in the accounts of empathic pain, they are also important in at least two ways. For example, they suggest that although there is a neural overlap between self pain and other pain processing, this may exist, which exists in the ACC and the AI, the functional role of the activity in these regions may actually differ in each context. So, the idea is that yes the same neural regions are being invoked when you are experiencing pain or when you are

observing others experience pain, but the connectivity of these regions happens slightly differently.

Also these you know differences provide a means for explaining the paradoxical effects of viewing pain in certain context as I was saying if you are observing somebody go through torture or say for example when you are you know in a fight or in a war situation or you are involved in a competition when you are observing the other competitors pain you will need to sort of you know turn off in a sense you need to moderate your own pain response in order to sort of navigate that whole thing because let's say you are in a boxing match and you know while you landed a punch nicely you got several points of it but you cannot be absolutely overwhelmed or by effect of you know observing this other contestants pain. So, in those situations, there is certainly a degree of moderation required for our pain experience and which is basically achieved by these other regions, you know, the orbitofrontal cortex, the medial frontal cortex that we just observed. Now, the last thing or the next thing that these people looked at was, other than pain perception, was the perception of emotional stimuli. Now, emotional stimuli do not really require a lot of reflective processing because those are more visceral reactions that you know that we come up with but and they affect us you know affect the way we feel, the way we act or the way we process cognitively these things, the emotions you know also without reflection can affect even other aspects of our cognitive and perceptual functioning such as let us say you know if you are feeling very happy maybe you will buy an extra shirt in the store or if you are feeling very sad you will probably not order enough to eat and things like that. Now perception of emotional cues without reflection also has discrete neural correlates.

For example, masked emotional stimuli can actually cause amygdala activation outside of awareness. So you are sort of you know subliminally experiencing your certain kind of emotional surge even though you are not really aware of it, you know a lot of conditioned emotional responses fall in that category as a very interesting example that the book has you know the book took that in the movie Exorcist the directors actually used a bunch of subliminal emotional images that made people extremely nauseated and disgusted even they could not put their hand on oh this is causing me feel in this particular way now as the amygdala is connected to sensory systems via only a few synapses It seems that one of the you know that some of the fastest processing used to assess potential threat may actually rely on cues about the emotional experiences of others who might be responding to similar stimuli. And this leads to different kinds of questions. Does the neural activity accompanying perception of someone else's fear resemble the neural activity we exhibit in response to our own fear? Or say for example, you know, if you look at William James' phrase, does a perceiver become frightened by someone else running from a bear? You know, is the person when you are observing this other person responding to let's say a bear chasing or a dog chasing, do you also get frightened by that response or are you

experiencing the same fear? And if so, does the perceiver's fear originate in an understanding of the frightened sprinter or does the receiver just, you know, perceiver just become prime for that kind of experience? What is it? How are we experiencing others pain, others emotional states and our own emotions? Now, several studies have actually proposed that the latter may indeed be true. We might indeed be able to understand to a certain degree how other people are experiencing these different emotions and we respond in reaction to that.

So, such kind of work and there is a lot of studies in this line, extends the logical studies of the so called shared representations to the domain of perceived facial expressions. So, when you are observing emotional faces, it is proposed that you are also almost experiencing the same emotion. If you are watching sad faces, if you are watching a sad movie, you are almost sort of experiencing the same sadness within you. okay because of the shared representations and these shared representations basically call upon as I said earlier mirror neurons.

We will talk about that in a bit. So research has supported theory that when we see someone else's emotion states we almost feel the same emotion as they do by virtue of activating the same brain regions that are activated when we are ourselves experiencing those specific emotions. For instance both seeing and imitating facial expressions activates the amygdala and the anterior insula showing a degree of overlap between perception and sensation of emotions. Now while data suggests that while the direct processing of self emotion and other emotion cues may at least involve partially overlapping mental neural circuitry again there are a few differences and this cannot be the entire story. So, as amygdala is associated with generating the physiological components of emotional responses, people looked at an early meta-analysis and found that more frontal regions including the medial prefrontal cortex and the anterior cingulate cortex are most commonly recruited by emotional stimuli. And even more recent meta-analysis suggested that these regions are associated with emotional experience but amygdala is not.

Amygdala is probably involved in more autonomic responses but not really deliberative experience of pain. and which is basically you know verified by another observational learning paradigm which reported that while watching someone else receive shock activated the amygdala only the subjects own fear of being shocked engage the anterior cingulate cortex. So this would suggest that the perception of emotions experienced by another person may commonly just trigger a autonomic response a warning bell to the self that there is danger here but it does not really engage the prefrontal systems associated with higher level you know reflective processing of mental states and our emotions. Now to further dissociate this the regions or to further dissociate the regions associated with the processing of self emotions and other emotion cues under direct and

reflective modes of processing the authors also selected activation peaks from a group of emotion related neuroimaging studies.

Let us see what they find. Now to investigate them the authors define a direct mode of emotion processing as any emotional response that a participant experiences would you know or observe someone else experiencing but does not really judge or you know evaluate it explicitly. They looked at the contrast in the direct self category if they asked participants for more passively observing or amusing you know or amusing scenes and they also observed the contrast which were included in the direct other category. So direct self and direct other category and let's see what did they find. The results actually showed that the greatest degree of overlap between direct processing of self emotion and other emotion cues actually occurred in the anterior and the posterior sections of the medial prefrontal cortex, dorsal to the genu of the corpus callosum. These regions have been implicated in responding to emotional stimuli in general and also responding to tasks that require a reflective processing of mental states or emotions including tasks like the theory of mind task and other kinds of action monitoring.

Finally, self and other stimuli also produce heavily overlapping patterns of activity in the left superior temporal sulcus associated with the perception of non-verbal social cues. Now given that these regions are engaged both by the reflexive processing of social targets in general and by direct processing of affective cues regardless of the target self or other, it highlights the important role that understanding the intentions of others plays in appraising the affective significance of stimuli. Which basically means that yes while there may be this direct response to perceiving emotional stimuli, this response also needs to be moderated by an understanding of the intentions and the motivations of others while they are sort of you know it displaying emotions that you are observing and this sort of allows for reappraisal and appraisal we talked about it in the last lecture appraisal theories of emotion you know that okay you can reconsider reevaluate the degree of emotional response that is being generated So, several theories of you know several appraisal theories of emotion therefore postulate that specific computations about the intentions of others actually determine whether or not we would feel happy or angry or sad or surprised in response to the actions of other people. You know, just like when you're watching a movie, you might really be affected initially, but gradually you realize, oh, it's just a movie and those people are just acting and not really going through the same emotions that they are displaying.

So that is pretty much all for now. In the next lecture, we'll talk about the reflective processing of self and other. And let's talk about this in a bit more detail. Thank you.