

Social Behavior and the Brain: An Introduction to Social Neuroscience

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Week - 01

Lecture – 04

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 at the Department of Cognitive Science, IIT Kanpur. This is week 1 of the course where we are trying to understand the representations of self versus the other and in this lecture we will try and look into self and other perception in a bit more detail than we have done so far. Now as we talked about in the previous lecture, a very important component of the explanatory model that social cognitive neuroscience follows is this distinction between the automatic processes and the deliberative processes.

So automatic processes which are fast, automatic and deliberative processes that they take some time, evaluate the outcomes of those automatic processes and in some sense moderate our social behavior. Now, for the purpose of studying self and other representation as I said we are going through Zaki and Ochsner's book chapter. We are going to consider a study or a meta-analysis study that they have reported in this book and this report basically encompasses several neuroimaging studies which are basically the going to be the subject of our current discussion. Now you look at this table here, the meta analysis basically is compiled into these 2 cross 2 sort of matrix where you have looked at the perception for either self or other and the actual things that they are evaluating is traits, emotions, preferences or perception of pain, arousal, emotion, agency in self, in one's own self or in others and there are two modes of processing that have been studied.

So, some studies have employed the direct mode of processing whereas some studies have arranged for a reflective mode of processing. So, we have two kinds of processing and we have two targets. So, it is a two cross two matrix that you see here in this figure presented by Zaki and Ochsner and this is basically the paradigm or this is basically the framework within which we are going to study self and other representations processing. Now, here is the bunch of studies that they have drawn upon and you can basically look up, look this up in a book and figure out if you need to read each of these studies separately. Now, before we go ahead, it must be noted that the following discussion would center mainly around the perception of emotion in self versus the others because this is something that the authors found to be most easy to study as it was you know something that could be presented in all of these four boxes.

So direct processing, reflective processing, self processing, other processing. Emotions is something that could be easily found across all the four of these boxes. So for you know purposes of contemplation, perception of emotion seems to be a very good starting point to understand how do we process self versus how do we process others with respect to whether we do it in a direct mode or we do it in a reflective mode. Also using a factorial approach the authors have sought to isolate patterns of activations that would map on to one or the one of the four aspects at a given time. So for example they have tried to find activations that would map on to either a main effect of self versus others or for example the main effect of direct processing versus reflective processing and broadly we discuss about these two kinds of processing.

And then we might zoom into self in directive, direct processing or others in direct processing or self in reflective processing or you know others in reflective processing. We will talk about these as we go ahead. Now let's start with this different modes of processing. So for example whether we are direct where we are talking about directive, direct processing or we are talking about reflective processing. Now the authors for this purpose collapse activations across the different studies for both direct and reflective processing modes and organize them by the target of you know perception.

So whether we are talking about the self or we are talking about the other and this allowed them to test whether the neural structures implicated in the self would overlap or be the same or be very different from those that are implicated in the perception of the other. It is evident, I will show you the images in a bit from this next slide that a distinction between the areas representing the self and the other cannot really be made out you know practically with a broad brush. There are a lot of overlapping areas, there are obviously distinct areas as well and there are a lot of areas that sort of are correlated with each other. Studies of both self-perception and other perception have reported activations in regions of the brain associated with processing information about emotions, traits and intentions. So let us look at this figure here.

You can see that there are lot of these red regions that are associated to processing of cells. There are lot of these green regions associated with the processing of other and you can see that there is a sufficient degree of overlap between the red and the green regions basically telling us A. Again from the outside you can see it is a very distributed sort of a map of how you know self is processed in the brain or the other is processed in the brain but the striking part is that there is a considerable degree of overlap between the two areas as well or between the areas for self perception or areas for other perception as well. Now more specifically a large majority of studies implicate both the dorsal and the ventral medial prefrontal cortex irrespective of the fact, irrespective of whether the participants were looking at self representations or other representations. So the dorsal and ventral medial prefrontal cortex seem to be involved in both kinds of processing. Also a range of other areas involved in emotion perception and social cognition for

instance the superior temporal sulcus, the anterior insula, the amygdala and the posterior cingulate cortex were found to be involved in both self and other perception ok. So as I was telling about the overlap these are the regions which will experience this Now each of these regions the STS, the AI, the amygdala and the PCC also the ventral and dorsal medial prefrontal cortex are actually attributed to play a important role in person perception generally ok. For instance the superior temporal sulcus has been implicated in decoding the social meaning of non-verbal cues such as eyes and that varying the direction of gaze, moving lips and forms with biologically plausible motion. and task involving the assessment of theory of mind or trait attribution. So, the superior temporal circle seems to be very important area when it comes to inferring social information from these visual or verbal cues or motor cues for that matter.

In contrast, the anterior insula has been implicated in representing the internal body, bodily states. For example, perception of one's own self as well as in processing of pain. However, the anterior insula has also been shown to be active when participants focus on the pain and the bodily states of other people. So, maybe this is where the empathy is coming from. Suggesting that the anterior insula is tied to not only to the perception of the bodily states in the self but also takes care of perception of these states like emotions or you know pain perception in other individuals.

Finally the posterior cingulate cortex has been associated with the self-directed thought as well as drawing attention to salient external cues and it is also the area that shows high functional connectivity with the medial prefrontal cortex suggesting that these regions may be working together during reflection about oneself and reflection about others. You know what is self-directed? Oh I should be doing this, you know am I a good person, am I am a bad person, am I punctual, am I meeting my goals perfectly or not, these kind of selfdirected thoughts. The posterior cingulate cortex seems to be implicated in them but it also seems to be implicated when you are thinking about oh that person is a good person or a bad person, I should be hanging out with that person more or less and those kind of things. So you can see these are the areas which have specific functions which have more defined objective that they might be playing in this whole person perception matrix but these defined goals are not limited to perception for self but also perception for others at the same time.

Moving on. Other than these overlaps two differences between the self and other related peak activation peaks have also been reported in these studies. For example, other related activations in the posterior medial prefrontal cortex were found to be located slightly more dorsally than self related activation. So, other related thing is action is happening in the more dorsal regions than self related activations. Their self-related activation peaks were observed along the cortex adjacent to the corpus callosum. Other related peaks were often more docile to the cingulate gyrus.

Now this is just the distribution of how those activations are found within this specific region of the brain. Now given this fact you know you add this to the idea to the you know knowledge that the medial prefrontal cortex has evolved in a more radial fashion. With architectonically, you know, ancient three-layered single-layered gyrus gradually developing into adjacent six-layered portion of the medial peripheral cortex, it seems that there might be a developmental relationship between these areas that are involved in processing of self and processing of others. Also more activation peaks in the thalamus and the hypothalamus have been observed for cell processing than other processing.

While we are talking about overlaps these are the differences. So the hypothalamus seems to serve a very critical function in regulating automatic responses to emotionally salient stimuli and also shares connections with the brain region involved in you know other aspects of emotion processing such as the subgenual anterior cingulate and the orbitofrontal cortex. Also, the hypothalamus is found to be preferentially activated during self-related processing and this fact has been taken to reflect that the increased effects of autonomic arousal and sensory processing when perceiving or deciding about one's own internal state. So, when you are observing yourself, when you are thinking about your own mental states, hypothalamus is found to be more preferentially activated. as compared to when you are observing or inferring the mental states like these for other individuals. So there is obviously an overlap but there is also these points of difference between the regions that are implicated in self-related processing versus other related processing.

All in all the most interesting aspects of activations between the self and the other have been observed the you know has been the observed overlap between the progressing steps that individuals go through to understand themselves and others. So it seems to be a chronological sort of you know arrangement where there is a sequence of steps that happen with respect to when you are trying to understand about yourself and as compared to when you are trying to understand about the others. Remember the template example that we were giving. Now looking at the analysis in a different way, so let's say look at the analysis by you know mode of processing, direct processing or reflective processing. Now interesting patterns of results were observed when the activations across the studies in the meta-analysis were collapsed based on type of processing involved that is direct versus reflective processing as compared to the type of target that was being considered. Now when you compare direct versus reflective processing, a contrast by mode of processing illustrated a clear dissociation of the activation peaks in the medial peripheral cortex and the anterior cingulate cortex in a manner that is reflective of processing of traits, emotions and mental states was shown to activate more anterior points within these regions and the direct processing of emotion or pain activated more posterior medial peripheral and anterior cingulate the cortex, irrespective of whether the target was self or the other. So it seems that more direct processing and more deliberative processing are

actually being taken care of by different regions of the same you know or different portions of the same areas of the brain. So, when you are doing reflective processing, more anterior regions are lighting up of the MPFC and the ACC. When you are talking about more direct processing, slightly posterior areas of the medial prefrontal cortex and the anterior cingulate cortex seem to be lighting up. This is what you can basically see. So, you can see when you are talking about direct processing, it is anterior areas that are getting activated. When you are talking about reflective processing, it is the more posterior areas that seem to be activated. Now the observed this this observed anterior to posterior gradient for the involvement of the medial prefrontal cortex and the anterior cingulate cortex with respect to reflective and directive process and direct processing is consistent with the idea that high level reflective secondary appraisals of one's own or you know another person's emotions are neurally and cognitively separable from primary appraisals of the potential let's say threat value of stimuli as found in individual studies. Now what does this actually tell us? What does this all mean? It basically means that the operation of automatic processes in first in the first appraisal of emotional stimuli or first appraisal of let's say social stimuli that might be useful to us may carry value or may carry threat is done separately as opposed to a more deliberative, a more controlled way of processing these things. So the first reaction, the first emotional reaction, the first emotional response to something may be arising out of different areas as opposed to a slightly more delayed you know response or slightly more deliberative response, this is basically what is being found.

An interesting study in this regards was you know could be this Kalish and Gollick study where the authors induced anxiety through the anticipation of painful shock in participants while these participants were asked to perform concurrent working memory task in either high or low load conditions. While autonomic arousal and self-reported anxiety were not really affected by the mode of processing or by the load in the working memory task, a rostral medial prefrontal cortex region was found to be more activated for anxiety versus non-anxiety conditions. So there is a difference in response to anxiety. And, this is happening under low load. So, when participants could actually attend to oh, I am anxious or I am not then is where this region is getting activated and is getting involved.

This finding was taken to suggest that the rostral medial prefrontal cortex may underlie the appraisal of internal and emotional states. So, you know observing of or observing one's own feelings, oh I am very nervous at this point, I am very confident at this time, these kind of evaluations are probably being mediated by the rostral medial prefrontal cortex and it is when subjects are attending to their own mental states. Also this is in line with the theories about the function of the ventral and orbital prefrontal cortex which implicate this as a zone of convergence basically integrating information from internal body state bodily states through connections with the hypothalamus and the anterior

insula and the external cues are processed in the superior temporal gyrus and the amygdala. So this basically seems to be a region where there is a convergence of information about the internal bodily states as well as the external cues that are being gained from the environment. On the other hand this region the anterior cingulate cortex is implicated to react in a more automatic rather than bottom up fashion in response to a goal relevant effective you know effectively salient stimulus.

To illustrate there was this study by DiMarco and colleagues which used structural equation modeling to effectively explore the connectivity between the prefrontal cortex, the anterior cingulate cortex, the amygdala when participants were asked to view emotional faces and they were basically either reading the gender of the face or the emotion on the face. So when you are reading the gender of the face you are basically doing a direct emotional processing. See gender, race, ethnicity information is computed more directly whereas emotion requires a bit of consideration, deliberation and requires a degree of deliberative processing or reflective processing. So in these cases or with these participants it was observed that during direct processing information of the amygdala travel to the ACC and then to the prefrontal cortex whereas during reflective processing this information was basically travelling from the prefrontal cortex to the ACC and then to the amygdala. Since the amygdala activation can be taken as an early signal or early cortical mechanism responding to emotional salience the cortical region it actually it would it projects to may provide a clue as to the type of appraisals made about this and we see the amygdala is the region in the brain that is responsible for the first emotional evaluation of stimulus.

So since it is it seems to be part of an early cortical mechanism the information that is that it is sending to another region you know. the other cortical region that it is projecting to may provide the clue as to the type of appraisal that is being made. So, if it is directly sort of sending information to regions for action versus it is sending information to you know prefrontal cortex for more deliberative processing, you can make a difference there. Now, following this same the connectivity pattern observed was found to be in line with the idea at under a reflective mode of processing a presence of emotion value are made in a top down manner. So, the amygdala is you know projecting to the medial prefrontal cortex before reaching areas such as the amygdala or associated with automatic reaction. Now together these data basically tell us you know they fall along the obtained distribution of activations. They suggest that reflecting on emotional states depends upon the engagement of these medial prefrontal regions that we are talking about which also are found to support high level appraisal processes used to represent information about the nature of one's own or somebody else's mental states. The whole point is that when you are deliberating upon others mental states you know in the task on emotional perception a different kind of connectivity pattern will be observed as opposed to when you are just making you know a direct an instinctive response to particular kinds of

stimuli. Such kind of a reflection can be found useful for other types of top down processing as well such as those implicated in cognitive forms of emotional regulation that depends upon the ability to know what someone else might be feeling about. So the idea is you know a lot of times there is a automatic emotional reaction that we have in response to certain kinds of stimuli, you may be extremely happy about something. We may be extremely angry about something, we may be extremely disgusted with something that is happening and that is basically the first emotional reaction that we have. But isn't it the case that we are not consciously or we are not always expressing this out you know loudly. A lot of times the way we express our feelings and our emotions is moderated by our knowledge of the surroundings or who are we you know in front you know who are we in front of. So for example whether it is acceptable for me to express my disgust or express my anger in such a manner in this social setting. So, what is required then? A proper reappraisal, a proper reevaluation, a deliberative consideration of our own emotional state in context of the situation or in context of the social surroundings is required so that we can actually regulate our emotion. We might be feeling extremely angry let's say feeling like slapping somebody but given the particular social context we might hold back our anger and just say a small word and get away from there.

So this reappraisal is something that seems to be you know very very important and it seems to engage cognitive and deliberative processing strategies. An example of this is what is called reappraisal which is the ability of actively rethinking the meaning of emotionally charged stimulus in ways that change the trajectory of one's emotional response to the same you know something that I was saying something happens you are seeing something and you are inclined to express a knee jerk reaction to it But then given the situation you might be encouraged or you might tell yourself to actively reevaluate whether this is the correct response that I need to be making in this situation or I just need to you know swallow my anger, say a kind word and get out of the place, express my anger maybe in isolation or maybe in front of my friends or family and so on. So, this reappraisal is a very interesting ability that we have and it involves awareness of and reflection on the nature of one's own emotional response as well as the reflection on the intentions and beliefs of others. Somebody sort of hurt you by mistake you know you actually really hurt and your finger is paining or your hand is paining but you immediately sort of you know the initial reaction is you know you want to shout or shriek.

And so on but the other moment you quickly realize oh this is this was done by mistake it is not somebody else's fault and it is not intentionally the person is not intentionally hurt us. So what you will do is you will recalibrate your emotional response by means of reappraisal because you are actively thinking and evaluating the meaning of this emotionally charged experience that you have just had. So, regions that are involved in

these reappraisals actually may be serving two jobs. They are helping us perform social cognitive tasks as well as they are helping us do emotional regulation. They are making us aware of our own emotional states but at the same time they are making us aware of our own emotional state in context of the social situation, the beliefs, the intentions, the actions of others are also taken into account.

And that is where you become say for example more restrained, more calm because you have re-appraised, you have re-evaluated, you have reconsidered the kind of response that you need to be making. And in such a scenario the medial prefrontal cortex may communicate with cortical and subcortical regions involved in the direct bottom up processing of affective cues either by amplifying or modulating their activity according to the nature of the reflective demand. So if the reflective demand says oh no you should cool down and you should not say anything this is not the right thing or let's say the person has hurt you by mistake you sort of you know recalibrate you lower your response. and you deal with the situation in that manner. In another situation reflective response is oh I can let this go but you know if I let this go it will become a habit so I must speak up.

So maybe you will amplify this whole thing and you basically play out and give out a slightly louder reaction. So the reappraisal thing basically involves the medial prefrontal cortex communicating with the centers for this direct or bottom up processing as well which are you know happening in the cortical and other subcortical regions. Now these processes could therefore you know be engaged and this whole idea of cognitive reappraisal of emotions could actually be engaged in cognitive therapy where clients can be encouraged to reflect about their emotional states, the causes of their emotional states so as to enable them to effectively modulate and dampen the reaction to affective cues. See for a normal person experiencing high degree of anger or a high degree or very high degree of sadness which can lead you into depression are both sort of unhealthy. So the idea is that if we understand, if we know about these processes of reappraisal we should basically be working out in a way that you know we can use the knowledge that we have about how reappraisal works in cognitive therapy and we can teach patients, we can teach people who are attending these cognitive therapies that okay see this is how you can recalibrate, this is how I can, you can train your brain to dampen your emotional reaction to particular kinds of stimuli.

So I will stop here. I will talk to you more about self and other processing in the next lecture.