

Social Behavior and the Brain: An Introduction to Social Neuroscience

Dr Ark Verma

Department of Cognitive Sciences

Indian Institute of Technology Kanpur

Week - 08

Lecture – 38

Hello and welcome to the course Social Behaviour and the Brain, an Introduction to Social Neuroscience. I am Dr. Ark Verma, an Associate Professor in the Department of Cognitive Science at IIT Kanpur. This is week 8 where we are talking about social effect processing with the focus on negative effect and the role of the right ventrolateral prefrontal cortex. Now in the previous lecture just concluded we were talking about the idea that the symbolic processing of effect in the right ventrolateral prefrontal cortex could be behind could be the driving force in the inhibitory activity in limbic regions such as the amygdala, the insula and the anterior cingulate cortex which are associated with processing effective experience. In the current lecture, let us you know try and look at the neural feasibility of the same.

How does the RVL-PFC do that? What are the neural sort of pathways or neural mechanisms that might be allowing the RVL-PFC to you know pull off such a role, pull off such a processing? Now, the RVL-PFC typically has a strong bidirectional connections to both of these regions, the insula and the amygdala. The neuro anatomical connections from the RVL-PFC to the amygdala are relatively more complex on the one hand and there are then there are direct connections from the RVL-PFC to the amygdala. Remember the amygdala is one of the region that is responsible for quick processing of emotional information. for immediate identification of both positive and negative, mainly negative and threat information that is present in the environment.

And you can see that the fact that the RVL-PFC has a direct connection to it, it seems that in cases where immediate dampening is required through these direct projections from the RVL-PFC to the amygdala that actually can be achieved, it is you know neurally feasible. Now Carmichael and Price made anterograde tracer injections into area 12 L the region which is homologous to broadman's area 47 in humans. They found that the projection of this area 12 L to the basolateral nucleus of the amygdala. So, there again it is just basically tells us that it is connected this region is connected directly to the amygdala. Interestingly, these projections are not particularly dense causing you know calling into question whether these direct you know projections may be sufficient to allow the RVL PFC to regulate what the amygdala is responding or how the amygdala is responding.

While there are these direct projections, they may, they are not very dense. So, you may wonder or you know neuroscientists wonder whether it is enough for the RVL-PFC to modulate the amygdala responses. Remember all the stereotypes that we have been talking about, the negative emotions we have been talking about, aspects of fear, aspects of danger, threat calculation, all of that is something that the amygdala does. So, if you have to you know down regulate these the experience of these negative feelings it is you know it seems apt that the responses of the amygdala be regulated and the RVL-PFC seems to be in a in an ideal position to do that. Now as suggested by Phelps and colleagues The right ventrolateral prefrontal cortex could also be having this effect on the amygdala indirectly by way of its projections from RVL-PFC to the medial prefrontal cortex which in turn has rather dense projections to the amygdala.

So remember, whenever we are talking about empathy, whenever we are talking about regulation of stereotypes or emotional responses, throughout this course or whenever you study about emotional regulation, control and so on, the medial peripheral cortex is the critical region. It seems to be the most important region there. Now, we are working with the possibility of the right ventrolateral peripheral cortex playing this role in down regulation of this negative affective experience through the symbolic crossing of effect. Now, there are two possibilities either the RVL-PFC is able to modulate amygdala response by direct connections to the amygdala which it has, but does not have too dense connection. So, people were wondering how you know this can be pulled off.

9:14 Tue, Jun 10 ...

1 tab Chitralkha - Video annotati...

chitralkha.ai4bharat.org/#/task/65828/transcript

Organizations Tasks

Chitralkha
Powered by EkStep Foundation

Lecture 38

00 : 04 : 36 . 760 So, there emerges this alternate track, this alternate pathway that maybe the RVL-PFC is modulating the responses of the amygdala by modulating you know the connection between the medial prefrontal cortex and the amygdala 34

00 : 04 : 51 . 960

00 : 04 : 53 . 932 this is something that seems plausible because the medial peripheral cortex is known to regulate the amygdala in studies of extinction of fear and so on. 26

00 : 05 : 02 . 679

00 : 05 : 03 . 139 So, it seems that there is this indirect connection that is working its way through and that is helping this down regulation of negative affect that we are observing. 31

00 : 05 : 11 . 866

00 : 05 : 12 . 827 Also, research suggests that the right ventrolateral prefrontal cortex not only inhibits motor and cognitive responses but also inhibits negative affective responses both in terms of subjective reports of negative affect and in terms of activity in the limbic regions associated with negative affect and distress. 46

00 : 05 : 32 . 774

00 : 05 : 33 . 294 So it basically seems that you know RVL PFC if you remember from the previous lecture 50

Further, research suggests that RVL PFC not only inhibits motor and cognitive responses but also inhibits negative affective responses both in terms of subjective reports of negative affect and in terms of activity in limbic regions associated with negative affect and distress.

So far, we have been able to establish a role of the RVL PFC in

- inhibitory processes
- Symbolic processing of negative affect
- Processing neuro-anatomical connections to limbic regions, it is perhaps not a giant leap to suggest that RVL PFC may contribute to the inhibition of motor, cognitive and affective responses.
- These serve as a critical stepping-stone to full-blown disruption effects that we will now discuss.

So, there emerges this alternate track, this alternate pathway that maybe the RVL-PFC is modulating the responses of the amygdala by modulating you know the connection between the medial prefrontal cortex and the amygdala. This is something that seems plausible because the medial prefrontal cortex is known to regulate the amygdala in studies of extinction of fear and so on. So, it seems that maybe there is this indirect connection that is working its way through and that is helping this down regulation of negative effect that we are observing. Also, research suggests that the right ventrolateral prefrontal cortex not only inhibits motor and cognitive responses but also inhibits negative affective responses both in terms of subjective reports of negative effect and in terms of activity in the limbic regions associated with negative effect and distress. So it basically seems that you know RVL PFC if you remember from the previous lecture if you remember from the lecture before that is involved in all kinds of inhibition mainly however motor inhibition also cognitive responses while you are doing expressive writing or reflecting upon your negative feelings.

It also inhibits, it is also known to inhibit negative affective responses both in terms of subjective reports of how you are feeling, how angry or how enraged or how disgusted you are feeling at any point in time. And it is doing this by modulating the activity in the limbic regions, remember the amygdala, the insula, the anterior cingulate cortex and so on, the limbic circuit you know for emotional processing. So, so far if you look at you know the previous lecture and this one there seems to be a certain role for the right ventrolateral prefrontal cortex in inhibitory processes, in symbolic processing of negative effect, also in possessing the neuroanatomical connection to the limbic regions which is perhaps not really a giant leap to suggest that RVL-PFC you know from this it does not seem to be a giant leap to suggest that the RVL-PFC may be contributing to the inhibition of motoric cognitive and affective responses. So, it seems that this region is ideally placed to exercise this influence to modulate the activity not only in the amygdala but in the entire limbic circuit. This basic idea is basically the proposal that Lieberman puts out and he says that this disruption of negative effect that we have been talking about since the first lecture of this week is mediated through this critical region called the right ventrolateral prefrontal cortex.

So, this serves as a critical stepping stone to full blown disruption effects that we are now going to discuss. So, RVL-PFC is one of the regions that has been associated with increased pain analgesia. More recently a number of studies have observed that placebo effects appear to be mediated by RVL-PFC along with the rostral, ACC, rostral and insular cortex. In one study, Lieberman and colleagues examined a group of patients with irritable bowel syndrome which is a chronic pain condition associated with heightened pain sensitivity in the limbic system. The irritable bowel syndrome patients were scanned prior to and then again after receiving three weeks of sham treatments just placebo you know for their pain.

During each scanning session, patients received painful rectal stimulation, stimulating the symptoms of how you know the IBS really manifests and generating a measure of current neural responses to the simulation, how much pain they are feeling, it is basically being measured you know during these scans. Now Lieberman and colleagues find that to the extent that participants reported improvements in the pain system in the pain symptom sorry at the end of the placebo regimen compared to before the regimen began they also showed increased activity in the RVL PFC and decreased activity in the dorsal anterior cingulate cortex from the first scan session to the second. So, as they are reporting feeling better again remember that this is just placebo treatment happening there is no actual medication or you know treatment that is being given to these people, but it is being done across a number of days and across a number of sessions. the degree to which they are reporting that oh we are feeling less pain oh things are getting better etc etc is correlated with the degree of activity with the increase in the degree of activity in this right ventrolateral prefrontal cortex. So it seems that this is the region you know which is indeed involved in the placebo effect in the placebo treatment that is happening and that is contributing to this you know relief from pain in these IBS patients.

And this is not only this is not the single study this there are several other studies which have observed within session placebo effects associated with increased RVL PFC activity and decreased limbic activity in the domains of physical pain. So, it is not only that the RVL PFC is a helping people out with respect to diminishing you know the phenomenal experience of negatively experienced emotions but also in domains of physical pain. So it seems to be a very very critical area in that respect. Now the authors examined the role of the RVL-PFC in the regulation of social pain as well. The pain that comes from observing the society around us, the injustice, the unfairness, the discrimination, the stereotypes.

There are so many things to be unhappy or sad about. Or say, for example, more personally, the distress associated with social rejection, when you are treated unfairly, when people don't give you their due, and so on and so forth. So, in one study participants you know were ostensibly playing a game of internet catch with two other players who are again computer simulation. So, basically there is only one human player. part of the way through the game what happens is the other players stop throwing the ball, this is just a game of catch ok.

So, if if three people are there you are throwing the ball and you know it is almost like it goes in in in a triangle or a circle depending on how many people are there. So, I pass on the ball to player one, player one passes to player two, player two passes back to me and so on. Now this is happening on the internet, so there are two other players who are just computer simulations and there is one human player. What is happening? Part of the way through the game the other players stop throwing the ball to this participant and thus

excluded the participant for the rest of the game alright. So, basically something is going on and then you are rejected or excluded out of that.

This one and numerous other studies have demonstrated that this kind of exclusion or this kind of exclusion manipulation basically causes considerable distress in the participants a lot of disappointment and hurt in these participants even even in cases when they know that the other two players are just computer simulation. So, it is not that somebody is actively hurting them, it is just that the system is sort of you know designed that way that the computer simulation is now playing amongst itself and not making you the part of this whole catch game. Participants of this study reported being distressed in response to being excluded in response to being excluded and actually showed a pattern of neural activity consistent with you know the experience of actual visceral pain emotional pain. Interestingly the participants produced increased activity in the dorsal anterior cingulate cortex to the extent that they felt distress. However, to the extent that the RVL-PFC was active, participants reported feeling less distressed by this episode of exclusion.

So, when the, you know, dorsal ACC etc are activated, they are feeling that pain, the limbic system seems to be kicking in, it seems to be, you know, making them feel that exclusion. Whereas, when the RVL-PFC is active and that is being recruited, it sort of diminishes their experience of pain, it diminishes their feeling of hurt that they are going through in this episode of exclusion. Interestingly, activity in the RVL-PFC was also found to be negatively correlated with the dorsal anterior cingulate cortex activity and changes in this dorsal anterior cingulate cortex activity actually mediated the relationship between the RVL-PFC and distress. So, it seems that RVL-PFC is also to a certain degree modulating the activity of the dorsal anterior cingulate cortex which is part of this limbic circuit for you know processing and understanding emotional experience. Now, as I just said, so it seems that the increased RVL-PFC activity may be helping to down regulate the dACC responses which in turn were you know associated with reduced distress.

So, the amount of distress that is being felt gets reduced by reducing the activity in the dorsal anterior cingulate cortex that is basically what is happening here. Now, in contrast to these kind of studies which have social and physical pain you know manipulations, fMRI studies of reappraisal where you basically ask to reconsider a particular emotional scenario. Reappraisal studies actually explicitly instruct subjects to engage in emotional regulation. They actually ask them to that you know suppose you are feeling something like this and now can you sort of have a relook at this picture, use some kind of reasoning and down regulate how you know intensely bad you are feeling about something. So, nearly all of the fMRI studies of reappraisal have actually observed activity in or around the RVL-PFC along with other prefrontal regions like the MPFC and so on.

Interestingly, a bunch of other studies have implicated the RVL-PFC in the regulation of emotional behavior in general as well. These studies may be sort of a blend between the

motor inhibition studies and the emotional regulation studies. Still, the findings actually support the idea that the RVL-PFC is involved in a continuum of regulatory effects. You know it helps in the regulation of emotional responses, more specifically negative emotional responses. Let us take for example one study you know in one of these studies Small and colleagues participants were required to eat a piece of chocolate during each of a series of PET scans.

After each scan participants indicated how much they wanted to have another piece. So they ate piece of chocolate and they are enjoying it but again they are probably thinking about it and then a scan is being done. after the scan they were asked oh do you want chocolate, do you want more chocolate and they had to basically indicate how badly or how much they really wanted to have this another piece. Now interestingly in this study activity in the right ventrolateral prefrontal cortex or the RVL PFC was strongly associated with self-reports of not wanting to eat any more chocolate despite being asked by the experimenter to continue eating it. So see here some kind of regulation is happening.

Everybody likes chocolates. Everybody knows that chocolates are not good for your health. So when people are actually saying, oh, I don't want to eat any more chocolate despite being offered by the experimenter, the RVL-PFC activity is sort of kicking in. It suggests that the RVL PFC therefore seems to be involved in suppressing the desire to reject the chocolate to comply with the requirements of the study. So, eating this you know so the the fact that they are ignoring or refusing to eat chocolate needs some kind of regulative you know mechanism and that regulative mechanism is coming from this particular region of the brain that we are calling the RVL PFC the right ventrolateral prefrontal cortex. Interestingly, although not framed as such in this study, the results may have implications for future work on the neural correlates of both compliance and conformity as well.

So, again what we are seeing here is a very you know application based you know idea of how this particular region or activity in this particular region may be trained, we saw neurofeedback study earlier may be trained to help people regulate themselves better, regulate their emotional responses better both in and also in terms of both compliance or conformity. In another study for example, Tabibnia and colleagues 2008, the authors examined how individuals overcome the slight of insulting unfair offers in an ultimatum game, in a financial bargaining game to accept advantageous offers. Remember we have talked about the ultimatum game earlier as well, participants who are basically playing the role of the responder in several just one shot version. So, it is just one offer is being made, you either accept it or reject it and that is basically the game. So, the proposer is basically asked to split a sum of money between himself or herself and the responder, the participants are all responders ok.

So, there is an experimenter who is probably playing the role of the proposer. Now, if the proposal is allocated 10 dollars, he or she may propose an even split of 5 dollars each or more unfair split of 8 dollars for themselves and 2 dollars for the responders. So, that is there. Now, the responder will have to decide then whether or not to accept the offer. If the responder accepts then the proposer and the responder will get exactly what the proposer proposed.

So, for example, if the responder if the proposer is saying 5, 5 dollars each and you accept great you are both getting 5 dollars. If the proposer says 8 dollars for me, 2 dollars for you and then you accept then he is getting 8 dollars you are getting 2 dollars. Interestingly remember we have talked about this game earlier while refusing the unfair offer is you know seems to be the more likely thing it also involves it becomes a financially unviable decision because if you refuse the offer you are getting 0. If you are accepting the unfair offer you are at least to the extent let us say getting 1 at least 1 dollar 9 and 1 or 2 and 8 in that proportion. Now, so if there is ponder which are these participants reject the proposal, neither participant would receive anything.

And either way there is no additional bargaining possible after the responder has chosen, I accept this offer or I reject this offer. A previous study of previous FMI study Sanfi and colleagues we have discussed this in the past, compared the neural responses to fair and unfair offers. So, 5 out of 10 or 1 out of 10 offers and the main finding that they basically report was that unfair offers were associated with an increased activity in the anterior insula a region that has previously been associated with responses of disgust. You are disgusted at the unfairness of the offer and your insula is sort of acting out. Interestingly in this current study the authors also included they add a different condition where the you know the offers that were unfair yet still financially desirable to undergraduate participants.

So, while the offer is unfair it is designed in such a way that it becomes financially you know appealing. Interestingly, in the Sanfey and colleagues study, both kinds of offers represented very little conflict as 5 dollar offers were both fair and desirable. Financially, whereas 1 and 2 dollars were unfair and not that desirable. So, 1 and 2 dollars is too less amount of money that you will sort of you know trample over yourself respect to accept those offers. So, to sort of create this financially desirable unfair offer what they did was they included offers such as 5 dollars out of 10 which are both insulting, but yet financially desirable 5 dollars is at least enough to get you a sandwich and a cold drink.

So, in that sense while it is very less it is in that you know in range of being very unfair offer, but it is still will get you something whereas one or two dollars will not get you anything so why would you sort of trample over in your own pride when you are not getting anything viable in return in this case in this manipulation the undergraduate students at least are still getting something out of it so they wanted to see what is

happening here Interestingly, the authors of the current study found across a number of different analysis that the tendency to reject the unfair but financially desirable offer was associated with the activity in the anterior insula. So, some kind of moderation of the anterior insula is required, which is again you know consistent with Sanfey and colleagues study. However, interestingly they found that the tendency to accept the unfair, but financially appealing offer was associated with increased activity in the RVL PFC. It seems that the RVL PFC is basically helping people down regulate the disgust that they are feeling and making them accept the unfair, but financially appealing offers. So, greater RVL PFC activity on these trials was found to be associated with diminished anterior insular activity and changes in anterior insular activity was mediated by the relationship between the RVL PFC activity and the tendency to accept unfair offer.

So, you can see here how interestingly the right ventrolateral prefrontal cortex is modulating activity of the insula, the instance of feeling disgust in order to get people to accept the unfair but still financially viable offer. So, here is a very interesting case where you actually needed some kind of down regulation because if you are you know so disgusted by the unfairness of the offer and you reject anything reject these offers you are going to get nothing out of it. So, if you want to accept the 5 dollars out of 23 dollars kind of offer, you need to calm down, you need to reappraise this whole thing and this is something that seems to be mediated by the ah RVL PFC which is doing this by down regulating the activity in the anterior insula. So, these results were found to be consistent with this idea again that we have been sort of harping around in the last two lectures that RVL-PFC is certainly involved in dampening the responses of the limbic system to this insulting offer allowing the individual to for example, swallow one's pride and accept the unfair offer.

So, again as I just said. This is all for this current lecture. I will meet you and extend this discussion the same in the next lecture. Thank you.