**Social Behavior and the Brain: An Introduction to Social Neuroscience**

**Dr Ark Verma**
**Department of Cognitive Sciences**
**Indian Institute of Technology Kanpur**

**Week - 04**
**Lecture – 19**

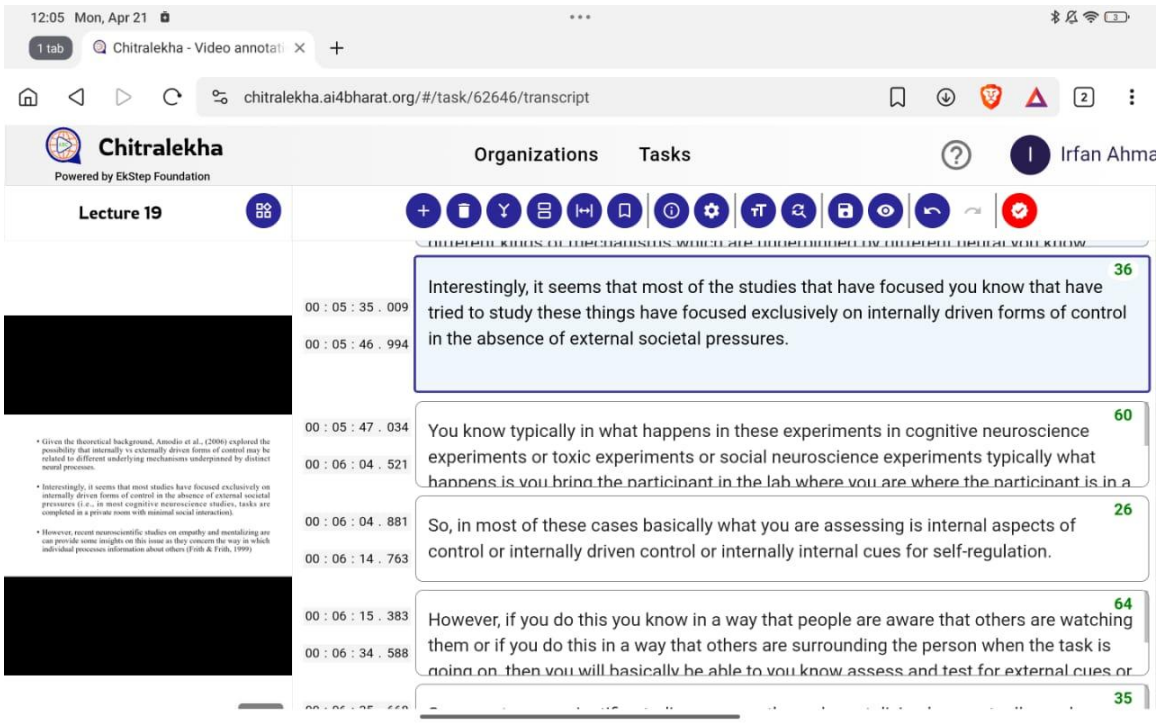
Hello and welcome to the course Social Behaviour and the Brain, an Introduction to Social Neuroscience. I am Dr. Ark Verma, an Associate Professor at the Department of Cognitive Science at IIT Kanpur. This is the fourth week where we are trying to understand and represent social groups and in this lecture we will extend our conversation about regulating racial biases. Now, an important aspect of social psychological research has been this power of situation. If you remember we talked about this quote from Leslie brothers that if there is you know if a social psychologist, if a social scientist is ever asked to be you know is ever stranded in an island and if he is asked that you know what is the one thing that you would want to carry with yourself, it will be the power of situation because the power of situation basically is about appreciating the various variables the dynamics of you know a given situation, the way a particular agent will act, the way the particular external and internal pressures will interact on them.

So, the power of situation is something very interesting because it tells us that in different situations the same person can behave differently. So, for example, social pressures you know from peers or from authority figures can actually have a profound influence on the way people think and behave and modern normative standards for example, they proscribe the expressions of racial bias. 100 years ago, 500 years ago, 200 years ago probably the slavery was all right. Racism was not really considered a negative word, it basically was disguised into the racial superiority of the whites over the blacks.

And it was perfectly normal to you know own a slave, to make them work, to buy a slave in a market and all of that was perfectly normal. If you want to see there are there are bunch of movies that are about slavery. For example, I remember at this point Quentin Tarantino's Django Unchained, that is 12 years a slave. There are number of these movies that you can actually look at which will obviously you know present a slightly hyperbolic in description of the situation, but it will describe the situation nonetheless, it was normal you know to have these racial feelings at that point in time. But if you look at modern normative standards, if you look at now, if you look at post industrial revolution, if you look at the modern era.

Then obviously, harboring and exercising racial biases or these prejudices or carrying these stereotypes in your actions and in your decisions is not considered a great thing. And if and it is because of this that regulating of these biases, regulation of these stereotypes and prejudices becomes a very important you know function of the brain, it becomes a very important aspect of our social behavior. Although early approaches again I mean moving ahead from here early approaches in social psychology actually do not distinguish between mechanisms that underlie internal versus external forces on behavior. Several different lines of research if you look at them they suggest that internal and external impetuses for different kinds of control may actually involve different processes. So, you might remember in the previous class I was talking about people who are internally personally motivated to respond without bias versus people who are doing it because of external pressures.

The way they will behave, the way their conflict monitoring system will act will be different and that and those kinds of studies have actually led to the belief that may be these things are you know being governed from entirely different processes. Interestingly in the intergroup you know literature individual differences in the strength of personal and normative motivations to respond without prejudice actually have been treated independently. So, if you look at a bunch of you know literature about intergroup dynamics, group behavior, social cognition you will see that the strength of the personal motivation that somebody has to you know avoid racial bias or prejudice or you know those kinds of implicit biases and if they are normatively trying to do that these two have been treated separately and have been you know understood differently. Also research on these motivations has identified different qualities of behavior motivated by personal versus normative reason such that personally motivated behaviors tend to be more stable and they tend to be more consistent whereas normally motivated behaviors will not be that consistent as soon as the external stimulus goes away the person goes back to responding in you know bias manners. As I said in the previous class people behave differently when they are in their private circles versus they behave differently when they are you know in the public scenarios and with other people.




DC and Ryan's you know theory concerning different motivations for behavior has actually been applied to explain individual differences in implicit and explicit relations expressions of race bias which we saw in the previous lecture as well. Now, given this theoretical background, Modi and colleagues they explored the possibility that externally versus internally driven forms of control may be related to different kinds of mechanisms which are underpinned by different neural you know processes. Interestingly, it seems that most of the studies that have focused you know that have tried to study these things have focused exclusively on internally driven forms of control in the absence of external societal pressures. You know typically in what happens in these experiments in cognitive neuroscience experiments or toxic experiments or social neuroscience experiments typically what happens is you bring the participant in the lab where you are where the participant is in a secluded dark kind of a room then there is nobody watching and then you ask them to do these tasks. So, in most of these cases basically what you are assessing is internal aspects of control or internally driven control or internally internal cues for self-regulation.

However, if you do this you know in a way that people are aware that others are watching them or if you do this in a way that others are surrounding the person when the task is going on, then you will basically be able to you know assess and test for external cues or the external societal pressures on inhibitory or regulatory behavior. So, recent neuroscientific studies on empathy and mentalizing have actually you know tried to provide some insights on this issue because they concern the way in which you know individuals process information about the other. So, they allow the assessment of how an

individual will behave, how an individual will process information about these other individuals and how will that affect their actual behavior. For instance, in studies of empathy and mentalizing, these externally oriented processes are typically associated with activity in the regions of the medial prefrontal cortex and the rostral anterior cingulate cortex. Now, although this body of research has not really emphasized a regulatory role for these medial prefrontal activations, it has been hypothesized that these more anterior regions of the medial prefrontal cortex may actually be important for externally driven forms of self-regulation in contrast to the dorsal anterior cingulate cortex which is linked to conflict management from internal cues for self-regulation.

So, two regions the medial anterior region or dorsal anterior cingulate cortex is implicated in external cues in managing external cues or responding to external cues for self-regulation and the dorsal anterior cingulate cortex is involved in managing conflict based on internal cues. So, this is the hypothesis. Now, the authors wanted to test this hypothesis by measuring ERPs as participants completed the weapons identification task either they were doing this task in private as you know is the tradition. Or they were doing this task while being observed on a video monitor by an experimenter for signs of prejudice. So, in one case they know that somebody is watching and in the other case they are alone in the room just performing these experiments.

Now, the ERN component as in the previous study that we discussed was treated as an index of the conflict monitoring processes. Now, to assess the activation of the rostral ACC and the medial prefrontal cortex, the authors examined another component the error positivity wave which is a positive polarity ERP component that immediately follows the ERN and is strongest in the frontal central scalp site. So, it is something that emanate from the anterior regions of the frontal cortex and this is probably also you know it and it goes along with the ERN and it can therefore, you know index the successful operation of this regulatory behavior. Previous work has localized this error positivity wave to the rostral ACC and the neighboring regions of the medial prefrontal cortex and this component has a relatively slower time course than the ERN which you know peaks at around 200 milliseconds. This has also been associated with the conscious perception of an unintended response.

If you do a mistake, if there is a faux pas, if there is a you know mistake that you have committed, you have said something you did not mean to say. Now, this is where you know or most probably this is the wave that will register that and it will make you perceive and try and correct those things. Also, the putative neural generator for this error positivity which is which happens to be in the rostral ACC and the medial prefrontal cortex suggests stronger connections to the areas of the brains linked with the theory of mind, social cognition and reward processing, whereas this dorsal ACC is more richly connected to regions of brain linked to attention and motor control. So, you can see how the external versus internal you know cues might be manifested in the different regions of

the brain. Now, given these distinctions in the connectivity between the dorsal and the rostral regions of the ACC and the MPFC, the authors actually expected that the behavioral control driven by once internal cues or internal motivations would relate to the conflict monitoring and thus dorsal anterior cortex activity as would be indicated by the ERN.

So, when you are talking about internal cues the dorsal anterior cingulate cortex will be implicated and if you are following the external cues then the rostral ACC and MPFC will be implicated. So, they expected that behavioral control motivated by societal pressures would also be associated with more complex social cognitive processing and thus the rostral ACC and the MPFC activity as indicated by the error positivity wave that we talked about. So, the hypothesis are relatively clear, they have mapped the external operation cues and the internal operation cues to different areas of the brain. So, all participants reported what happens all participants reported being personally motivated to respond without bias such that they would make a strong effort to inhibit the influence of stereotypes on their responses. So, remember all of these participants actually say explicitly state that they want to respond without bias.

So, they are mainly always going to try and suppress these biases, suppress the automatic implicit prejudice tendencies. In addition, the authors also pre-selected the participants who reported being either high or low in the sensitivity to external normative pressures to respond without prejudice using the scale that was used by Plant and Divine in 1998. So, you have in your participants everybody who really wants to respond without bias and within that group you have separated the authors have separated people who have a higher sensitivity of conflict monitoring system and a lower sensitivity of the conflict monitoring system. So, now this is the arrangement what this does it that it allows the authors to test the hypothesis that the rostral AACC and the MPFC are actually important regions for regulating behaviors on the basis of external cues and it will happen mainly for people who are sensitive to these kind of cues. what what happens what happened in the results the results actually suggested that the ERN and the error positivity amplitudes were uncorrelated across participants interestingly you can see now there is a divergence divergence on the basis of where the cues are coming from The internally cued control and the externally cued control, it seems is diverging in the form of the ERN and the PE amplitudes.

As with past research, larger ERN amplitudes predicted a pattern of less bias responding across conditions and for all participants, which is again consistent with the idea that the internal cues are always present. There is some degree of internal motivation at all times. However, in confirmation with the proposed hypothesis, the error positivity wave actually emerged as a very strong predictor of control among the participants in the public response condition, where they are responding to this external societal pressure and in those participants specifically who reported being highly sensitive to these external

pressures. So, you can see now that there is a divergence between people who are responding or people who are trying to regulate or control their behavior on the basis of either external cues or on the basis of internal cue. More analysis was done and it confirmed that the ERN and the PE waves actually influence behavior by affecting control, but not automatic forms of processing.

So, automatic forms of processing still exist, but the actual moderation was done on the controlled or deliberative parts of control. Altogether, the pattern of findings actually confirm the initial evidence that internally versus externally driven forms of prejudice control arise from independent neural mechanisms, divergent separate neural mechanisms which are associated with the dorsal ACC and the rostral ACC and MPFC respectively. The dorsal ACC responds to internal cues for control, the rostral ACC and the MPFC respond to external cues for control. So, this overall body of research we have just reviewed one study, but there are several others that you can consider. This covered body of research actually therefore, proposes a regulatory role of the medial prefrontal cortex in addition to the information processing functions that are typically assigned to this region.

So, we know that the see when you are studying cognitive control, when you are studying social cognition the frontal cortex is the main region and within this frontal cortex the medial prefrontal cortex  Remember, if you can remember from the previous weeks, it is implied in empathy, it is implied in a bunch of function, it is implied in processing of you know mentalizing other people's mental states and so on. But the current studies that we have just reviewed also tell us that it is also implied in controlling behavior on the basis of external cues. So, this is basically what we have sort of figured out in terms of the varying cues for social control. Now, a lot of times people intentionally want to you know suppress their bias, avoid prejudice and so on. So, how is it, how can we implement intentional responses to prejudice.

As soon as the regulatory system identifies that there is a need for control it detects conflict additional mechanisms from the executive functions are engaged to override these unwanted impulses with intentional responses. There is as we said there is an implicit bias which kicks in very quickly, but if your actual tendency is going on the other direction and the implicit biases are pulling in the other direction there is this conflict that is detected and as soon as this conflict is detected the executive functions are engaged and they kick in to try and control the situation. What are these executive functions remember these executive functions basically refer to a set of processes that are involved in implementing intentional behavior most of which has obviously been linked to the regions of the lateral prefrontal cortex all right. So, it is notable interestingly that the same regions of the prefrontal cortex  that are associated with cognitive control have also been associated with the long list of functions. For example, working memory,

episodic retrieval, rehearsal of information, semantic monitoring, motivational orientation as we just saw and attentional gating.

So, these areas you know in the prefrontal cortex, in the you know frontal cortex, the lateral PFC, the MPFC, the VLPFC, the DLPFC are all very important reasons and they are actually performing several kinds of roles at once and the way they will activate depends on the task situation, depend on the situation where a individual is operating and all of these things are taking care of by these you know regions that we just mentioned. Also, although the specific regions of the prefrontal cortex activated by task that engage these different processes may be sometimes distinguishable, the regions per say and their activity per say is found to be generally overlapping across different kinds of situations. So, if you sort of put this together the range of processes that are linked to the lateral PFC found to be corresponding to some aspect of organizing and implementing deliberative and at intentional responses. So, how do we implement these intentional responses, intentional unbiased and fair responses? We take help of these regions that we just talked about. Now, moving slightly in a different direction, how do we inhibit racial biases? How can we sort of inhibit a tendency that is prepotent, that is dispositional almost because as we saw in the face recognition literature, these things become available to us in a very short time and they are there and they start influencing our behavior unless we intentionally and actively and consciously control them.

So, this idea that there is this need for inhibition is something not new you know it is something that is present and it you may have read about it you will come across it in several different you know situations. So, it is not new in either psychology or philosophy. For example, if you look at Descartes he believed that humans should strive to inhibit the base urges of the body. And, if you have, you know, read of any Freud, Freud also talks about his psychodynamic approach to therapy, constantly talks about the need to inhibit, you know, unwanted drives, you know, for violence or for sex or unwanted fantasies, those kinds of things. So, this idea that human behavior needs inhibition.

The animal instincts the base and the carnal tendencies need to be suppressed need to be inhibited somehow for us to be able to operate in you know peaceful and cooperative society. So, this is again something not new and it has been studied from various perspective different you know angles have been used and different angles have tried to figure out what are the neural underpinnings of these processes. So, the emphasis on inhibition as a very important component of control continues to be a very major theme in modern psychology and it is very popular in social psychological models of control. It is also popular for example, in models of control when you are talking about bilingualism, task switching, those kinds of things as well. I remember David Green's model of you know inhibitory control model of language switching and those kinds of things are there as well.

So, research on inhibitory mechanisms in the brain has mainly focused on the right ventrolateral prefrontal cortex and you know initial findings from studies of patients have actually suggested that these that the right ventrolateral prefrontal cortex is uniquely associated with performance on response inhibition task such as for example, the stop signal task or the Wisconsin card sorting task. So, it seems that when you are talking about inhibition and you are talking about the implementation of inhibition of any of these biases that we have been talking about, the right VLPFC is something that becomes critical, it is something that manifests and moderates how successfully we are going to be able to inhibit these tendencies. Now, using this model for the for understanding the regulation of you know these racial biases, Lieberman and colleagues basically examined the changes they wanted to investigate the changes in the VLPFC activity in the context of race bias responding while these participants are performing a task in the fMRI scanner. Now, in their study participants were made to view faces of either white or black individuals which was presented in the center of the screen and at the bottom of the screen participants were either shown two faces to which they have to just match the face or two kinds of labels African American or Caucasian. So, basically you have to either match this central face to another face either of the two faces at the bottom or a label whether this face is an African face or it is a Caucasian face.

Participants here were as I said were required to make these matches the idea why did they do this the idea behind such manipulation at least according to this theme was that when they are matching the face with a symbolic lexical you know a verbal representation of the group it would require more complex social processing and then just matching the pictorial because it could be done on a lower level you can just look at the complexion of the of the skin and just make these matches. But, if you are you know evaluating the phase and evaluating what this particular lexical label means you know African American or Caucasian you are processing this at a slightly more complicated a slightly more deeper level. The authors also argued that the process of this labeling involves active inhibition of automatically activated effective responses to phases. So, if you if you ask them to perform this more complicated processing, it allows them the chance to inhibit the pre potent responses that would be coming their way. What happened? How did the, you know, experiment pan out? In line with the expectations, participants actually showed greater activity in the amygdala when they were watching the faces of, when they were matching the faces of black versus white people, but they showed no amygdala activity when they were matching with just labels.

So, the prepotency, the activation of the scan, the activation of the vigilance response, if you have seen, remember the previous, you know, lectures, that happens in the amygdala. When they were just matching labels, there was no amygdala activity. Now, on comparison matching labels of black faces actually elicited more significant VLPFC activity as compared to when the matching the labels with the white faces. So, here you

know the more deeper level of processing and the way this deeper level of processing is moderating the brain activity really comes up. So, the degree of VLPFC activation during labeling was negatively correlated with the amygdala activation in response to black faces.

So, just saying that the VLPFC may be actively inhibiting the implicit prejudice responses that is may have been arising from amygdala. Remember we have talked about that the amygdala brings in a vigilant response when you are looking at the member of another racial group or another religion, another gender and so on. So, this is basically little bit of how you know intentional responses are there, how do we inhibit you know these responses. Now, another question a very linked question for that matter is how can we choose to be egalitarian, how can we not only profess, but practice egalitarianism that everybody is equal and that we should be fair and just and equally behaving with everybody else. A very critical aspect of prejudice control is this implementation of an intended non-biased response, alright.

In that respect, a truly egalitarian response would be one that is entirely not affected by bias. It is not linked with either appeasement or discrimination. It has to be a totally just, totally fair, factually, you know, based response. And hence if you are talking about prejudice control, prejudice control should actually represent an individuals ability to respond in an intentional manner irrespective of the potentially biasing effects of automatic prejudices and stereotypes. So, you are interacting with a particular member of another racial group, you are interacting with a member of you know another religion, caste, etcetera, etcetera, any number of you know biases can exist, but proper model of prejudice control, a proper application of a prejudice control would be the implementation of an intended non-biased response.

So, this is something which is very interesting. Now, social science research on these control processes have mainly implicated the dorsolateral prefrontal cortex in the context of these kinds of race biases. So, if there is a reason that, if there is a region of the brain that is implicated and that needs to be managed, it is the DLPFC. For instance, Amodian colleagues 2003 study, they suggest that the lateral and the orbital PFC are more likely to support intentional aspects of racial responses based on prevalent theories in cognitive and affective neuroscience. And also researchers applying the conflict monitoring theory to issues of prejudice control have posited that the DLPFC is implied in the implementation of a non prejudice response.

So, several studies Amodio study 2003, 2004 different studies have actually converged and they point out that the DLPFC should be involved when you are trying to make an intentional unbiased response. How are you practicing egalitarianism actually? A very interesting study Richardson and colleagues have found or they report that exposure to black versus white faces actually elicited activations of the ACC and the DLPFC, but not

the amygdala in their white participants. So, the amygdala you know is not involved because there is in the white participants you know there is this activation is not really necessary. The authors actually interpreted this as a spontaneous effort to exert control when they are viewing a black face. So, it is not it is basically intentional activation of control and because this is intentional activation of control you are seeing that the DLPFC is implicated all right.

And, when once the participants came out of the fMRI scanner, they were actually made to interact with the black experimenter. And then, under the instruction of a white experimenter, they completed a standard Stroop color naming task. So, they were basically made they had or did not have bias at least they have professed that they want to you know respond in an unbiased manner. They do this task they come out they are made to interact with this black individual and then after some time a white experimenter leads them to do another experiment there is basically a scoop experiment. So, if you remember J R Stroop developed this task where you have to name colors.

So, the colors you know the names of the colors are written in different colored inks and your automatic response is to name the word and sometimes that conflicts with the color of the ink. So, that is basically the Stroop effect. Now, performing well in the stroop task actually requires ability of inhibitory control, it requires your cognitive control mechanisms, your executive functions to be operating at top speed, so that the successful suppression of the word names you know can happen and you can successfully name the color of the ink. In this situation, they basically create a scenario where the participant is already interacted with this black experimenter and if there are any pre potent biases, if there are any implicit prejudice tendencies, these will be expended, these will be spent in that interaction. So, their cognitive resources for control may have been worn out by the time they are doing this group task.

So, what happens they hypothesize that any self regulatory effort that was expended during that interaction presumably for example, to inhibit the science of race bias would deplete their resources leaving them to perform more poorly in this group task. So, the more they needed to inhibit they will be tired they will have expended their mental resources and the poorly they will the poorer they will perform on this group task. Actually this is what happened participants who exhibited greater prefrontal cortex activity while viewing black faces performed worse on the stroop task following the interracial interaction. So, they have expanded they have sort of utilized all of their inhibitory control capabilities and once they are you know led to do the stroop task they sort of you know stumble. On the same lines there is another study that was done Cunningham and colleagues where experiment participants washed faces of white and black individuals and they indicated whether the image presented was appearing to the right or the left side of the monitor.

When these faces were clearly visible. You know for 525 milliseconds black faces activated the ACC and some DLPFC areas more than white faces. So, as soon as you are seeing the black face and there is this intentional tendency to act in a egalitarian manner to act in an unbiased manner the DLPFC is automatically recruited. And, because these regions have been regions have been implicated in the aspects of control in previous research, it is possible to sort of decipher that these activations were actually related to control of prejudice. We know this, we know that what the DLPFC does and because of that we can deduce that the activation of DLPFC in this kind of a task is related to exercising control when they are watching the black faces. Also, even since these activations did not correlate with the participants self-reported prejudice.

So, there is this you know slight caveat with this particular study that since these activations do not correlate with the participants self-reported prejudice attitudes or with the behavioral index of control, there seems to be a little bit of doubt or room for doubt in understanding the role of the prefrontal cortex in the control of such a prejudice response and that is something that probably more research will be required to do. However, if you move on and if you put these findings together the two studies are actually in line with the idea that the prefrontal cortex may be related to control forms of processing. Yes, additional research is required and additional research will demonstrate that these activations are indeed directly linked to the control of prejudice. So, what happens? Few studies have actually looked into that. So, few studies so far have reported that there is a direct link between the prefrontal cortex activity and the regulation of bias and control patterns of behavior.

Hence, for example, Pizagali and colleagues sought to examine the role of this specific brain region in the behavioral regulation of prejudice. They reported that there was a stronger interest in prejudice reduction activities and it was associated with great left frontal activity whereas, participants desire to engage in any other activity was not related to this kind of activity. So, if you are intentionally trying to control the left prefrontal cortex is something that seems to be implicated. Also, an interesting aspect of prejudice control if you sort of leave aside all of these studies, you can wonder and you can basically ask this question to yourself is that when you are talking about prejudice control, what is it that we are actually talking about? Are we talking about controlling the emotions? Are we talking about controlling the thoughts? Are we talking about controlling behavior? What is it that prejudice control is operating upon? And interestingly if you sort of you know dig a little bit deeper you will find that humans have been found to be really poor at controlling their thoughts. You remember the white elephant experiment or you know the pink elephant experiment actually or you can just do this very interesting experiment you can just ask somebody that oh please do not think of apple at this point or please do not think of dinner at this point.

You know they will actually start thinking more about those things. So, people are actually rather poor at controlling their thoughts or even emotions for that matter if they are feeling sad or happy or excited or disgusted you cannot control that they are not able to control that. Similar effects, however, have also been observed in the context of control of prejudice and stereotyping. Although, interestingly research has shown that individuals are more successful at regulating their behavior rather than regulating their thoughts and emotions. So, may be a good way would be that you do not ask people to you know to suppress their implicit biases, but just ask them to control it better all right.

So, this is a very interesting idea you know backed by research which says that if prejudice control has to happen, it has to happen consistent with the anatomical activity of the frontal cortex and study suggests that if people are sort of you know engage in this. It is the lateral regions of the frontal cortex that are primarily you know interconnected with the neural regions linked to motor activity. Indeed this idea that behavior can be effectively controlled is also consistent with the anatomical connectivity of the frontal cortex. See the studies that suggest that the lateral regions of the frontal cortex are associated with control, they are primarily connected with neural regions linked to motor activity.

But they have very sparse connections to the amygdala. So, these regions the lateral prefrontal regions cannot actually they are not in a position to suppress implicit biases happening through the amygdala, but they are equipped better equipped so to speak in suppressing the activations from the you know suppressing motor activity and behavior therefore. Also the lateral peripheral cortex has been found to have particularly dense receptive fields for dopamine which is a neurotransmitter important for orchestrating goal driven behavior suggesting that the lateral PFC may be most strongly involved in controlling behavior as opposed to inhibiting thoughts or emotions. So, the lateral PFC seems to be more equipped for controlling behavior, regulating behavior rather than controlling implicit thoughts, emotions and biases that are you know pre-potently executed from the side of the amygdala. So, this is something that I was saying these insights can be particularly useful, they are particularly pertinent to the investigation of prejudice reduction efforts. Because, if you are treating, even if you are helping people fight these things, the strategies for the same should focus more on regulating behavior rather than controlling unwanted thoughts or emotions.

So, this is basically the entire section on controlling prejudice, regulating racial biases and so on. We will move in the next lecture to a slightly different direction and I will talk to you about dehumanized perception at that point. Thank you.