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

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**Week - 07**
**Lecture – 35**

Hello and welcome to the course social behavior in the brain and introduction to social neuroscience. I am Dr. Ark Verma an associate professor in the department of cognitive science at IIT Kanpur. This is week 7 and we are at the final lecture where we will compare research on anger and violence. So far we have seen that the results indicating that relatively greater left frontal activity is associated with increased approach oriented anger and behaviors that are seemingly and behavior that are seemingly inconsistent with evidence suggesting that violent individuals have reduced frontal lobe function. So, we are basically seeing that higher anger is associated with you know greater left frontal cortical activity, but there are also results let's say that violent individuals have reduced frontal lobe activation.

So these are basically findings that don't go together. So we will try and understand what is really happening here. Also there are these and other results that have led some to conclude that the PFC or the prefrontal cortex particularly the left orbital frontal cortex is involved in regulation of negative effects like anger. Remember in the last lecture we were seeing that in some of the experiments especially the imaginary related experiment there was higher activity in the left orbital frontal cortex when people you know which was supposed to be involved in inhibition of anger.

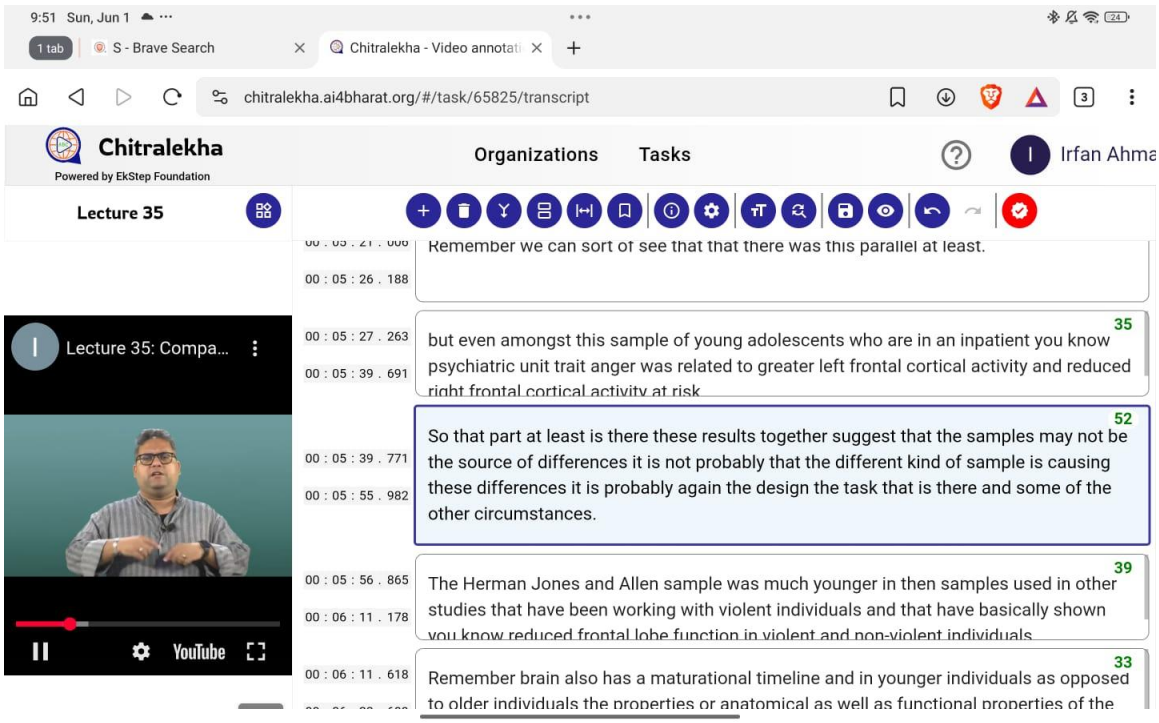
Whereas we are talking about increased left frontal cortical activity when expression and experience of anger. So how are these two things coming together or whether these two things come together let us try and understand. Research has very strongly implicated reduced activity in the right frontal regions with related to violence so that part is alright. these findings are consistent with the reviewed EEG research that we've looked at so far which found that approach oriented anger was associated with reduced right frontal activity ok. So, approach oriented anger you see you if you remember the last two lectures we have said approach oriented anger basically manifest is increased left frontal cortical activity and reduced right frontal cortical activity which is again you know makes sense.

Also research has revealed that increased activity in the right frontal cortex is associated with withdrawal motivation rather than approach motivation, ok. So it seems that violent individuals who show reduced right frontal cortical activity in the studies of Raine and colleagues which we just saw lagged the behavioral constraints engendered by the

withdrawal motivation system that may be partially instantiated in the right frontal cortex. So, the participants of Raine and colleagues which actually showed reduced right frontal cortical activity they basically lagged these behavioral constraints which are engendered by withdrawal motivation. So, they were not properly able to withdraw the withdrawal system was not functioning properly you know in their brains. Also more research studies have implicated reduced activity in both left and right frontal cortices with respect to violence and aggression.

Now this is a slightly different finding to what we have been discussing so far in the previous four lectures. For example Raine and colleagues found in a PET study that effective murderers you know people who commit you know crime of passion you know violently murdering somebody because of being overcome by extreme emotion, extreme anger and so on. So effective murderers as compared to predatory murders you know who plan and do cold blooded murders and normal control. So three parties are compared effective murderers, predatory murderers and normal controls. They actually evidenced the effective murderers evidenced reduced lateral and medial prefrontal activity in both hemispheres during a continuous performance task.

So, it seems that there is you know the areas that are typically involved in response inhibition and control are seemingly you know showing reduced activation in these effective murderers as compared to both cold blooded or predatory murderers or normal controls. also differences in participant samples the ones that we are seeing here can actually explain the differences in the results you know most of the anger studies have involved typically normal individuals whereas the studies in violence have involved extremely violent individuals so remember again that the brain acts brain also has a lot of unique and individual properties our own experiences throughout our lifetime our traits and our personality characteristics all of them will have a bearing on our brain. So if you are comparing two you know samples one of normal individuals one of extremely violent individuals there are bound to be differences in the activity of the brain remember one of the critical truths about the brain is the fact that there is individual differences not only in terms of functionality but also anatomical differences ok. So, in the study by Harmon-Jones and Allen that we were looking at in the previous lectures some participants were adolescents who were in an inpatient psychiatric unit for impulse control disorders ok. Remember we can sort of see that that there was this parallel at least.




But even amongst this sample of young adolescents who are in an inpatient you know psychiatric unit trait anger was related to greater left frontal cortical activity and reduced right frontal cortical activity at risk. So that part at least is there these results together suggest that the samples may not be the source of differences it is not probably that the different kind of sample is causing these differences it is probably again the design the task that is there and some of the other circumstances. The Herman-Jones and Allen sample was much younger in then samples used in other studies that have been working with violent individuals and that have basically shown you know reduced frontal lobe function in violent and non-violent individuals. Remember brain also has a maturational timeline and in younger individuals as opposed to older individuals the properties or anatomical as well as functional properties of the brain are subject to change. So what point you know here we are making is that in the Harman-Jones and Allen studies that we were reviewing in the previous two lectures where we saw increased frontal left frontal cortical activity with response to anger expression and experience cannot directly be compared with some of these later studies for example the Raine and colleagues study where they have actually studied slightly older individuals who were also extremely violent.

So, they are comparing effective murderers, they are comparing predatory murderers and then they are comparing older normal individuals. So, it does not mean that findings of either of the studies are wrong, but it means that there are basic differences between the kind of sample that they have chosen and also some other things that their findings are not essentially comparable. So, the longer lifetime of violence in adults may actually

relate to reduction. So, the proposal is to in order to reconcile these findings, the proposal is that the longer lifetime of violence in adults may actually relate to reductions in the frontal cortical activity. Now this is a little bit of a profound statement I don't want to draw a lot from this, but just remember what is the frontal cortex doing it is trying to inhibit control your responses.

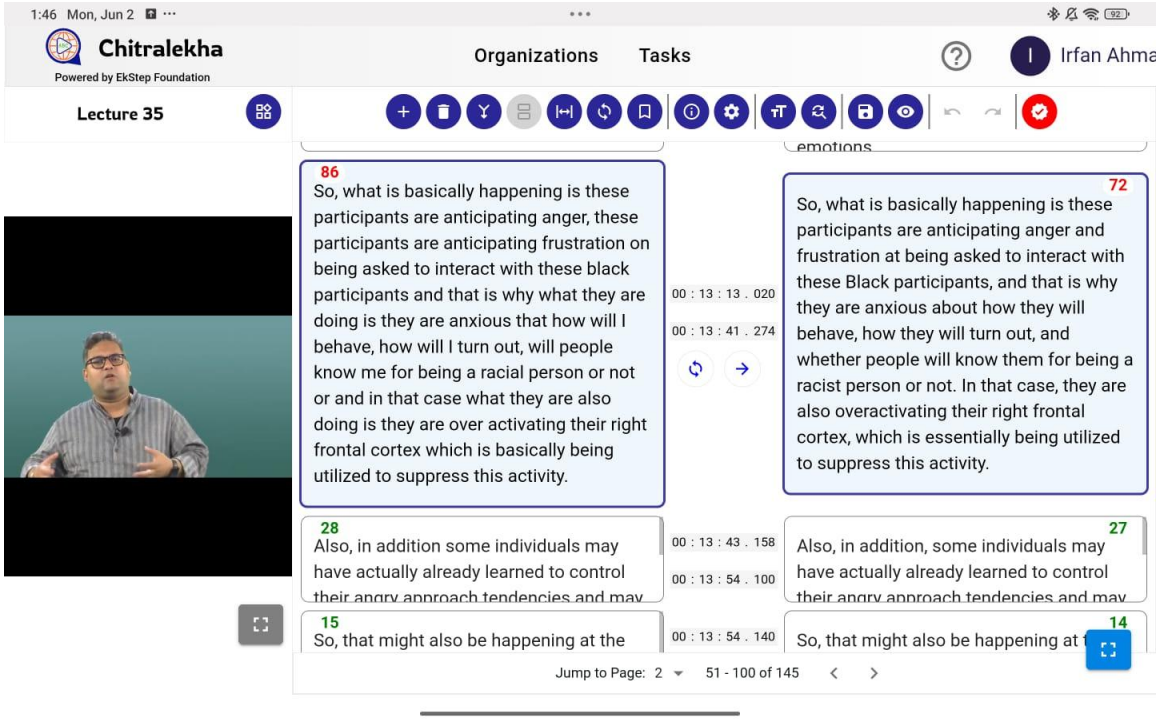
If people are in this constant habit of engaging in violence against their impulses or in you know under the charge of their influences under the influence of their impulses then basically what happens is if this keeps happening again and again for over a lifetime then obviously these areas the areas that are supposed to be involved in behavioral control, response selection, response inhibition their functionality will reduce over time probably they will also show anatomical changes such as reduction in volume. The studies comparing the brain functions of violent and non-violent individuals typically assess frontal lobe function either at rest or during a cognitive task and not during anger arousing situation, see because these individuals are known to be problematic when they are angry, they are known to engage in explicit violence that is why typically what people have done so far and again you can see it is a design matter is that they have assessed their frontal lobe function either at rest basically when nothing is happening or during a task that is not have to do anything with anger and that also could be you know reason why their findings are coming different, but it is not really clear that how the reduced frontal lobe function measured during task causes violence. So, how is this related, how is the measured frontal lobe function basically you know how can you measure this during task that may incite violence and so on. So, let us look at that. the violent individuals as compared to non-violent individuals who display less prefrontal cortex activity during cognitive tasks may simply be less emotively engaged by the relatively unemotional nature of these tasks, see for violent individuals you would need a more provocative cue So, that they get emotionally charged by these things and unless they are getting emotionally charged or emotionally involved by these things their behavior also their brain activity will not reveal the kind of patterns the kind of activations that you are looking for.

So, you have to do something about the kind of design that you are implementing the kind of stimuli that you are using and the kind of task that you are asking your participants to engage in. Further the frontal lobe function of violent individuals during a more emotively engaging situation such as an interpersonal provocation remember the insult task or the teasing task that you have seen in past that has not really been assessed I am sure because of logistical reasons. It is possible that reduced frontal lobe function might not be seen in these individuals in such a situation where you know an actually a provocative scenario is created. Brain activations during anger inducing events may be more predictive of violent behavior than brain activations during non motivating cognitive task. Remember, anger is an approach motivated task, anger leads to violence.

If the task is not inciting violence, anger and violence will both not manifest in the brain in ways that spur action, ok. There is another difficulty here which emerges when attempting to compare studies of violent offenders with the studies on with the studies on anger. Anger and violence also can be are different you know operational constructs if not conceptual constructs but they are different conceptual constructs also but they are also different you know operational constructs. Anger can be manipulated in the lab, in the lab you can actually make somebody angry or less angry, but in the lab you cannot obviously incite violent and you cannot you know manipulate a violent offender that oh now you start beating up people and now you stop beating up people and then we are measuring your you know brain activity. So, the latter correlation studies that have been done are therefore very difficult to interpret at least in the terms of the theory that we have been seeing so far.

So overall the idea that anger is associated with approach motivational tendencies is supported by behavioral and neuroimaging evidence, however it is possible that some instances of anger such as anger mixed with fear may be associated with withdrawal motivational tendencies. We've seen that in the in the previous lecture or lecture before that when we were talking about offensive and defensive aggression. Indeed in one study the authors observed such an effect for example white individuals in that study prepared to interact with a black person under the guise of an interest in exploring interracial interactions, so they were basically asked to interact on some pretext. in that kind of context societal pressure dictates that anger should not be expressed even if you are getting angry you are interacting with these black people and you have some racial prejudice towards them you probably making you angry but obviously the social norm is to not express that anger. So in this kind of a situation the experience of anger may coincide with anxiety and a desire to avoid the situation.

Cortical activity was measured with white participants, cortical activity was measured with while white participants anticipated the interracial interaction. So while they were at preparing for this interaction then their cortical activity was measured  Again consistent with expectations self-reported anger was associated with anxiety and relatively high frontal activity. Remember what is the right frontal activity for? It is for suppressing anger, it is for suppressing these negative emotions. Left frontal activity was associated with expressing these negative emotions. So, what is basically happening is these participants are anticipating anger, these participants are anticipating frustration on being asked to interact with these black participants and that is why what they are doing is they are anxious that how will I behave, how will I turn out, will people know me for being a racial person or not or and in that case what they are also doing is they are over activating their right frontal cortex which is basically being utilized to suppress this activity.




Also, in addition some individuals may have actually already learned to control their angry approach tendencies and may have instead converted these angry tendencies into withdrawal oriented behavior. So, that might also be happening at the same time depends from individual to individual. So, obviously more research is needed to understand whether and how this type of angry expression may emerge or manifest with respect to neural activity. Now we have sort of discussed anger as a very important emotion, we have discussed whether it is a aspect of valence or whether it is an aspect of approach motivation, there is more that we have to talk about, there is more that you know we need to try and bring together here. So far we have understood that approach motivations such as anger involve a range of brain regions you know they involve several brain regions, but the reviewed research so far especially the EEG research establishes the importance of the left prefrontal cortex in approach motivation independent of effective valence, independent of whether anger is an negative you know emotion or a positive emotion that anger is approach related basically causes it to increase activity in the left frontal cortex.

Further in discussions of the function of the prefrontal cortex researchers have suggested that the prefrontal cortex is involved in higher level cognitive functions such as working memory and inhibitory processes. Now, part of the reason the scientist reserve the prefrontal cortex for higher level cognitive processes is because it is a region that is much larger in humans than non-human animals. See it is above the brain, above the older brain as you know some people call it, it is one of the most important region of the brain which is involved and which is very different from  I mean in some sense at least functionally very different from other species both mammalian and non-mammalian ok. So, it is a

region that is much larger in humans and therefore, it is correlated with higher cognitive intellectual kind of functioning that the humans involve in. Also you know the idea of being able to live in a civil society, cooperating, helping each other out, you know tactfully deciding this and that.

So the prefrontal cortex is actually a very very important region. This logic also continues for example if the prefrontal cortex were to be a relatively recent development in evolution then it must be the source of all of these psychological processes that we are talking about you know civilization coming together farming all of those difficult sort of thing that we have been doing and that is what separates us from the other animal groups as well. Now interestingly this logic is at least partially correct, but it is not foolproof there are chinks in this particular logic as well. For example, recent single cell research with rats has revealed that the prefrontal cortex is involved in aggression and most of the cells activated are not really inhibitory cells. So, it seems that you know it is something that also allows for aggression and in some cases maybe is not involved in inhibiting all of these things.

Again remember the prefrontal cortex we were talking about the left orbital frontal cortex and its function the left dorsal lateral prefrontal cortex there are differences within the prefrontal cortex also. So, we need to understand that the prefrontal cortex is actually a rather vast area it is a vast territory and it is likely involved in a number of psychological processes. For example structures that are involved in certain psychological and behavioral processes in non-human animals may actually be involved in different processes in humans. So you have to also get a sense of that. Also anatomical details of the components of emotional response circuits are also different in humans and you know non-human primates.

So the organization, the connectivity and some functions of the amygdala. prefrontal cortex and the anterior cingulate differ between rodents and primates, we know that. In addition, evidence suggests that areas throughout the brain are activated during a variety of mental processes rather than processes just being localized in one area. So, it is basically a network that is working together. The size, the complexity and the activity of the human prefrontal cortex suggests that it is integrated for many many processes, alright.

Just continuing this humans are better able to plan behavior and control their responses to emotional stimuli than other animals and it is the prefrontal cortex that seems to be involved in these processes, however this planning and execution of behavior is not always in the service of inhibiting destructive motivation sometimes it is for you know spurring actions, spurring kind of aggression, self-defense and those kind of things as well. For example, some behaviors that are said to distinguish humans from other mammals such as war and genocide involve a high degree of planning and control and it

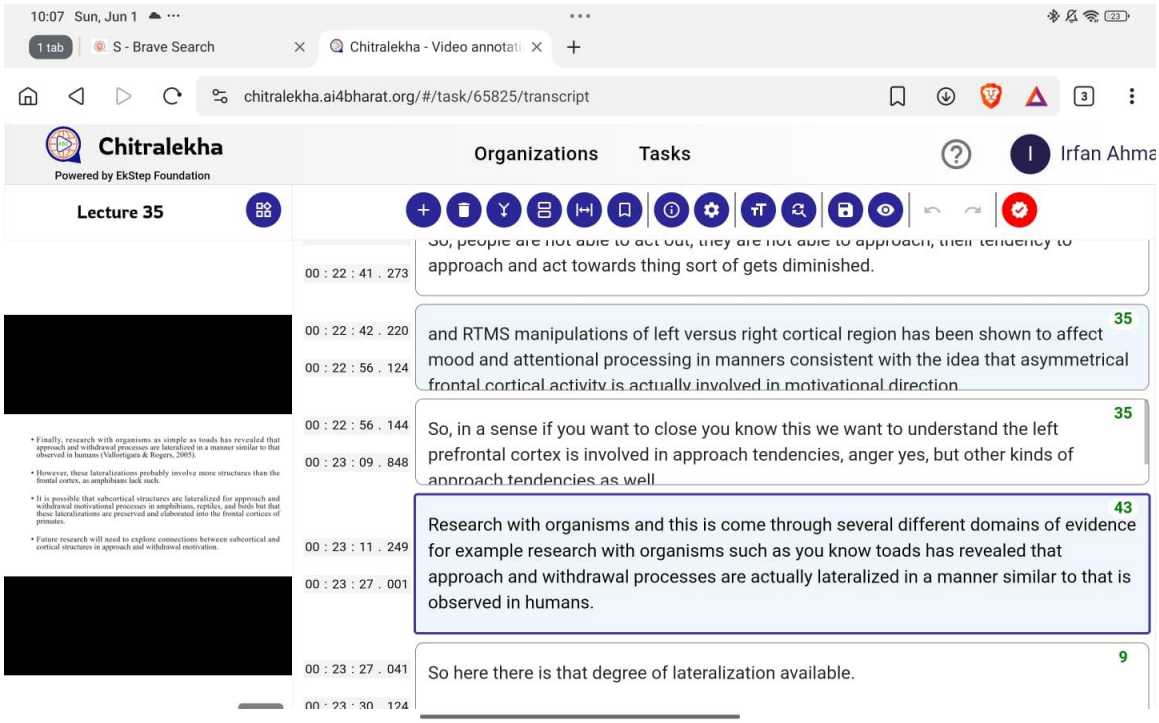
does actually enhance the destructiveness of approach oriented aggressive motivation. We have been living in societies, we have been living in nation states and so on and there have been wars, there have been so many of these things, there are still you know wars going on in the present world. So it seems you know the brain supports this, the brain supports the idea of going on to war to safeguard some interest for self-defense, for furthering your own economic and political interest all of that the brain does. So it seems that it is not that the brain is constantly involved in suppressing the violent tendencies.

Sometimes, it is actually involved in magnifying the destructiveness of the violent approach and that is also a property of the human brain. also research on anger related with asymmetrical frontal cortical activity when considered in a while it strongly suggest that the left prefrontal cortex region is involved in more than just the inhibition of negative effect as some have suggested. So it is involved in a bunch of things we are seeing that in the previous four lectures  Relative frontal cortical activation has consistently been associated with self-report stated as self-reported state anger and behavioral aggression and also approach motivated behavior, so it is not that the frontal cortex is constantly involved in inhibition The left frontal cortex for example is also involved in approach motivated behavior in behavioral aggression and in self reported state anger. So it does a bit of both at least if you want to you know have a holistic picture. Individuals with proneness towards mania and individuals higher in trait anger actually show even greater relative left frontal activation in response to angry events again something that we have seen already.

Moreover, manipulated increases in left frontal cortex activation cause approach related angry, attentional and memory responses. So, while there is this left with this prefrontal cortex, the left prefrontal cortex can be singled out to be involved in higher approach related aggressive actions. Finally to you know sum this up overall even at resting baseline individuals who are higher in trait anger show relatively greater left frontal cortical activity and this relationship also occurs in adolescents which are for example remember Harmon-Jones and Allen study they are they were in the psychiatric inpatient units for impulse control. So, if you put this put all of this together it would be illogical to actually suggest that all of these individuals are actually constantly inhibiting anger more than the individuals which do not have a high level of state anger, trait anger, approach behavior, aggression or mania. So, it seems that both of these you know the regions of the brain are sort of involved in both of these capacities, the left frontal cortex is typically involved in expression and experience of anger whereas the rest of the frontal cortex  the right and the dorsolateral part right orbital frontal parts are involved in managing behavior suppressing and you know overall providing control.

The approach in withdrawal processes that we have been talking about implemented by asymmetrical frontal cortices have also been observed not only in humans, but in rhesus monkeys as well as early as 2 to 3 days of age. So, it is something that happens from the

start. Also, in addition damage to these regions of the frontal cortex causes depression versus mania, it does not cause mania, it causes depression. So, people are not able to act out, they are not able to approach, their tendency to approach and act towards thing sort of gets diminished. and RTMS manipulations of left versus right cortical region has been shown to affect mood and attentional processing in manners consistent with the idea that asymmetrical frontal cortical activity is actually involved in motivational direction.




So, in a sense if you want to close you know this we want to understand the left prefrontal cortex is involved in approach tendencies, anger yes, but other kinds of approach tendencies as well. Research with organisms and this is come through several different domains of evidence for example research with organisms such as you know toads has revealed that approach and withdrawal processes are actually lateralized in a manner similar to that is observed in humans. So here there is that degree of lateralization available. However, interestingly these lateralizations involve probably more structures than the frontal cortex which the amphibians do not have ok. Ours is a more evolved brain it has several areas and these distinctions between them.

So, the lateralization of approach and avoidance is more well defined in the human brain as opposed to the for example the toad brain. It is possible that subcortical structures are lateralized for approach and withdrawal motivational processes in amphibians, reptiles and birds, but that these lateralizations are preserved and elaborated into the frontal cortex of the human brain, alright. So, future research is certainly needed to explore the connections between subcortical and cortical structures in both the cases of approach and

withdrawal motivation. Now, if you look at all of this along these lines, some research actually suggests that in the left frontal cortex, activations in the left frontal cortex are related to dopaminergic projections from the stratum associated with coordinated action with learning reward contingency. So, it is not really a network that is isolated, but it is connected with say for example, your dopaminergic connections also.

However, it is unlikely that the motivational related activations that are observed in the frontal cortices simply result from just the propagation of these signals from solely subcortical structures as source lateralization from these EEG studies have suggested that at approach withdrawal related frontal asymmetries actually do reflect changes in the dorsolateral prefrontal cortical activity as well. So, it seems that both of these areas are acting complementary to each other, alright. Finally if we conclude research suggests that greater left than right frontal cortical activity is associated with approach motivation, but not positive effect per se. Now in pursuing a better understanding of the role of asymmetrical frontal cortical activity in emotive processes, the research actually sheds a bit of new light on social psychological questions even outside the realm of social neuroscience. For example, neuroscience questions regarding the emotive functions of asymmetrical frontal cortical activity basically prompted a line of research on anger, one of the most socially important emotive states but which has you know interestingly or unfortunately been neglected in major theories of emotion.

Major theories of emotion have typically you know revolved around happy, sad, positive, negative, fear, disgust and those kind of things whereas anger seems to be a relatively under researched area. This research, this line of research on anger has demonstrated very clearly that unlike other negative emotions which are you know negative effect, negative valence leads to withdrawal, anger is often associated with approach motivational tendencies which is been the overall crux of this chapter that we have just studied. Consequently major dimensional theories of attention will actually need to be slightly modified to incorporate the idea that all negative that not all negative aspects of effect are associated with the withdrawal motivation. See when we started this chapter we are talking about positive effect, approach motivation, negative effect, withdrawal motivation. Here through the case study of anger we have understood that not all negatively valence emotions will always sort of you know lead to this withdrawal motivation happening, alright.

The research on anger suggests that social situations and individual differences also may cause anger to be associated with in some cases withdrawal motivation, it's not exclusive in that sense and this work therefore has very important implications for the understanding of inhibition of aggressive behavior as well as the development and maintenance of anxiety disorder. Sometimes when you are you know inhibiting certain kinds of behavioral choices it leads to anxiety, it leads to depression, it leads to other kinds of mental maladies. The research on the emotive functions of asymmetrically

frontal cortical activity which was the subject of study in this chapter has also been extended to assist in understanding the psychological and behavioral functions of other emotions such as guilt as well as processes of cognitive dissonance as well. All in all, social neuroscience is an important area of social psychology that has the potential to actually do this to enhance our understanding of basic psychological issues such as anger and integrate the theories and findings of social psychology as well as other areas of neuroscientific inquiry. So, we will continue doing this you can see we use some of these social neuroscientific methods to understand very well a you know a particular behavioral phenomena that is anger.

We will continue talking about this in the next lecture. Thank you.