Social Behavior and the Brain: An Introduction to Social Neuroscience
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Week – 07
Lecture – 31

Hello and welcome to the course social behavior 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 7 we will continue talking about various aspects of regulation of social behavior and in this lecture specifically we will talk about asymmetric frontal activity in the regulation of behavior. We will take for example the case of valence and motivation and anger and we will discuss this in some detail. Now, so far we have seen aspects of how prejudice of various forms gets activated instantaneously almost if you remember the Ito and Erlen studies and once it is activated it needs to be controlled through processes of regulation either through automatic or through deliberative mechanisms.

So we have seen so far starting from face perception, empathy and even for example things like you know how racial discrimination etc. sets in, you are showing people faces of you know white participants, faces of black colored people, colored people, faces of white people. There are these you know instantaneous informations get activated, so race, gender, age. All of these things get activated very quickly if you remember the N100, N200, P300 components.

Now once all of this information is instantaneously available it automatically starts affecting the you know the mental processing of an individual for those given schemas. A lot of times it converts into prejudice also it stays it basically manifest as prejudice even if. the person does not want to come out as prejudice. So a lot of studies we have seen so far that people professed being egalitarian, they professed not wanting to affect that prejudice you know not wanting to get affected by that prejudice in their decisions but the prejudice still sorts of you know seeks through. Now, in that case given that social, it is not socially appropriate to come out as racially biased or casteist or communal, people have always tried to regulate their urges or regulate their automatic tendencies for prejudice and discrimination.

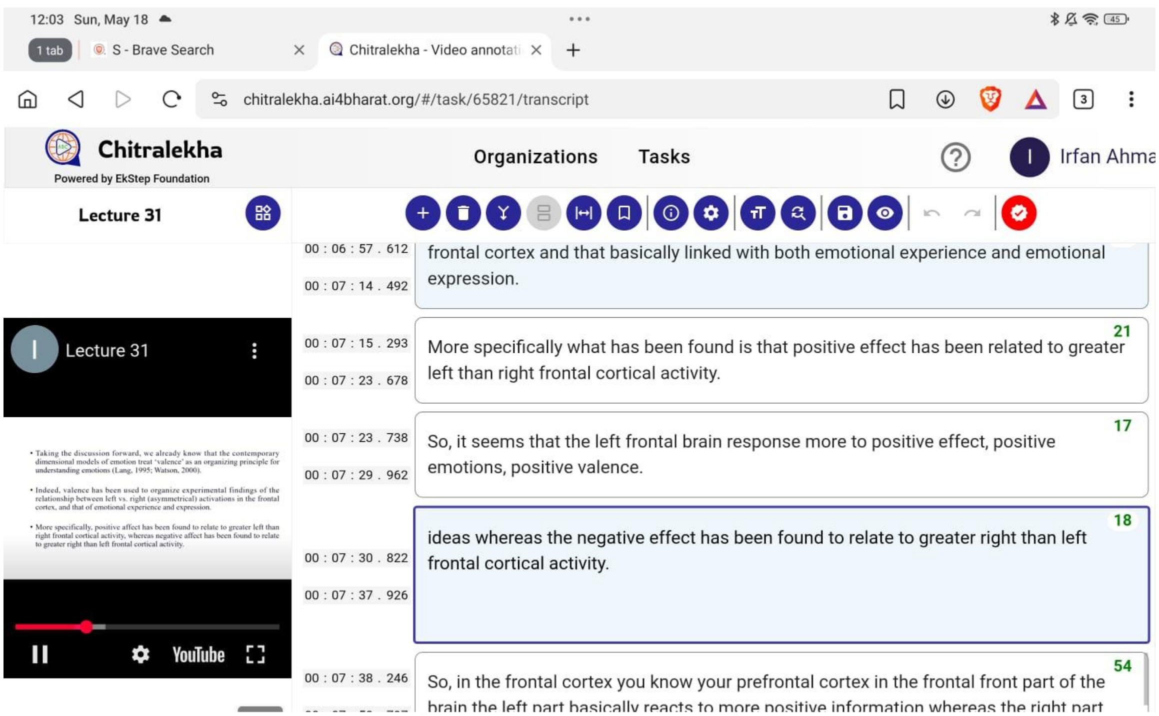
Those regulative mechanisms we studied in detail, they operate through either automatic aspects of behaviour or they operate through deliberative mechanisms. More recently in the previous lecture we have discussed the aspects of emotional decision making, we have looked at various theories of how emotions can basically complement the process of decision making, how can they be part of this process of decision making the contrary to what people have already thought that emotions are detrimental to rational decision making. not really that because we've seen in the last few lectures that emotions can actually form a very important part of how decision making is done. We've also learned about mechanisms that allow for emotions to play a part in decision making and also allow for emotions to be kept away from decision making when they are not acting as relevant information. So, we have done so far, we have also in the most recent lectures looked at the neural basis of decision making.

For example, we have looked at several theories for example, the somatic marker theory or the dynamic filtering theory and so on. So, this is basically the recap so far and now let us take this conversation forward. Now, we already know that one of the organizing principles for emotional information is valence, you know something being positive versus negative. Positive emotions are things like happiness and pleasure and joy and so on whereas negative emotions are fear, sadness, disgust and so on. So valence the positivity or the negativity of emotions has actually been used to organize experimental findings of the relationship between left versus right asymmetrical activations in the frontal cortex and that of emotional experience and expression.

Now here in this lecture and the lectures coming forward I will introduce you to the idea of asymmetry or lateral asymmetry or hemispheric asymmetry. Now so far you have seen me mentioning you know areas of the brain, basically the limbic areas and frontal cortex areas, the medial prefrontal cortex, the dorsolateral prefrontal cortex, the anterior cingulate cortex, we have also talked about say for example the thalamus and the hypothalamus, the precuneus and so many other things. One of the very interesting aspects of the brain is that there are two hemispheres of the brain the left hemisphere and the right hemisphere and for certain tasks the left hemisphere is more adept whereas for certain other tasks the right hemisphere be more may be more adept it does not mean that at any point in time the left hemisphere exclusively performs a task or the right hemisphere exclusively performs a task, it just means that for that specific cognitive function the left hemisphere may be contributing more to the overall decision making or to the overall processing. This particular phenomena can be described loosely as hemispheric asymmetry. Established hemispheric asymmetries are for cognitive functions like language production wherein we know rather definitively that the Broca's area in the you know inferior temporal part of the left hemisphere basically is responsible for production of language.

Also for example, we know that the right hemisphere you know the fusiform area in the right temporal lobe is responsible for perception of faces. Broadly put left hemisphere is basically ascribed to doing functions such as language, mathematical functions and you know tool making, motor functions and so on. Whereas right hemisphere is basically used in typically you know implicated in understanding figurative aspects of language, music, understanding you know visual, visuospatial information and so on. Now, where emotions are concerned the right hemisphere is supposed to be particularly active, particularly important for processing of emotions, but here what we are going to talk about is asymmetries in the frontal cortex. We are not talking about the asymmetries of the overall two hemispheres and how they function with respect to emotional processing.

We will try and focus in the asymmetries in the frontal cortical activity. So, this lecture and the other three four lectures in this week I am going to be focusing on asymmetric frontal activity either towards the left side or towards the right side and how does this happen you know to in what in response to what kind of stimulate happens and so on. So, please keep an eye out for this. So coming back we were saying that valence has been used to organize experimental findings of the relationship between the left versus right asymmetrical activations in the frontal cortex and that basically linked with both emotional experience and emotional expression. More specifically what has been found is that positive effect has been related to greater left than right frontal cortical activity.



So, it seems that the left frontal brain response more to positive effect, positive emotions, positive valence. ideas whereas the negative effect has been found to relate to greater right than left frontal cortical activity. So, in the frontal cortex you know your prefrontal cortex in the frontal front part of the brain the left part basically reacts to more positive information whereas the right part reacts to more negative information and this has consequences for processing which is what we are going to understand as we go forward. So, this relationship has been sparked or has been discovered by systematic observations. For example, that damage to the left frontal cortex leads to depression because you are not able to process positive effect, positive information, positive emotions, whereas damage to the right frontal cortex causes mania because you are basically not able to mellow down any of the, you know, positive hysteria that comes through by sort of dampening it by processing negative information.

Current research demonstrates that both trait and state positive effect was associated with increased left frontal cortical activity whereas trait and negative effect was found to be associated with increased right frontal activity. Now at this point what you have to do is you have to treat the you know frontal lobe as overall you know brain and basically think of right frontal brain as the left frontal brain and how they are involved in the processing of negative and positive information respectively. Now similar results like the one I just mentioned have also been obtained using a wide variety of neuroscientific methods including things like lesion studies, repetitive transcranial magnetic stimulation, positron emission tomography, the PET scans. the event related potentials, the electroencephalographic data and also these effects have been observed with both human studies as well as animal studies. So, this asymmetry in frontal cortical activity with respect to positive versus negative emotions has been replicated has been found through different methods and has also has been found in both human and animal subjects.

Further it has been proposed by Harmon Jones in Harmon Jones 2011 that studies still in the 1990s typically what they were doing is they were seeking to examine the relationship between asymmetrical frontal activity and emotion you know that basically studies that sought to examine the relationship between asymmetrical frontal activity and emotion confounded affective valence with the direction of motivation. Now it is very interesting that whenever we are, you know, encountered with positive emotion, there is also a tendency to approach those things. So anything that we like, anything that, you know, inspires joy or happiness or elation, there is an automatic, you know, approach tendency towards it, alright. Similarly, anything that we don't like, say for example, fear or, you know, disgust or any other negative emotion like even anger for that matter, but we will talk about anger in more detail going forward, anger for that matter the aggressive aggression for that matter typically leads to a withdrawal response. Now what people have said I mean the authors of this particular chapter they basically point out is that till the 1990s most of the studies that have looked at the you know study of emotional you know expression and emotional experience they have rather confounded the typical valence part as well as the motivation direction of motivation part.

So, while these things are very similar and they may be correlated, the author's point is that they are not identical and should not be confused as such. We should be able to tease apart the effects of valence and effects of approach because it is possible that there are things which are not so positive, but still you know invite approach motivation and are not so negative, but still avoid you know still basically incite avoidance motivation. So, we should study that also. So, more specifically what has happened in the literature so far is that all positive affective state or traits for example, joy or interest or curiosity that have been empirically examined were typically examine approach motivations whereas all the studied negative states and traits for example, fear or disgust were typically confounded with withdrawal motivations. So, they point out a very interesting gap in the literature and they basically point out the need to tease apart these two you know aspects these two conceptual variables.

How would we do that? Now to understand whether these asymmetrical frontal cortical activations result from either affective valence or from motivational direction, the authors sought to examine a specific emotive state that avoided the confounding of valence and direction of motivation. So they were looking for a candidate emotion that may be positive but still incites avoidance or that may be negative but still incites some kind of an approach motivation. let us look at what they chose now to that effect the authors began investigating the relationship of anger with asymmetrical frontal cortical activity and it's because past social psychological and animal behavior researches suggested that anger still being a negative emotion but it evokes in a lot of cases approach motivational tendencies so anger sometimes leads to you know approach tendencies for example if you are very angry sometimes you might be in you know interested or inclined to approach or behave or act out aggressively all right so in in that case anger is as a negative emotion or it has negative valence but carries approach tendency so it seems to be at a crossroads for valence and motivational direction Now, they basically thought the authors when they chose anger as a candidate for exploration, they thought that if asymmetrical frontal activity relates to motivational direction, then anger should relate to greater left than right frontal activity because remember left frontal activity was linked with positive as well as approach motivation also. So, because anger is associated with approach motivational direction. On the other hand, if asymmetrical frontal cortical activity would relate to effective valence, then anger should basically relate to greater right than left frontal activity because anger is always associated with negative valence.

So, this is why they are choosing anger as a candidate for exploration. Now, by investigating the relationship of anger with asymmetrical frontal cortical activity, the authors were in a position to gain a more complete understanding of the psychological and behavioral functions of asymmetrical frontal activity. Also, basic research on anger and its underlying neural systems can also provide us insights useful for understanding the relationship of how motivational direction and valence are sort of you know linked with each other. Most contemporary theories, however, of emotion operate on the assumption that positive effect is only related to approach motivation, whereas negative effects are related to withdrawal motivation. So, this similarity anyways is a well established, well practiced similarity, but here we have a chance of teasing these things apart.

Let us see how it comes across. So, by focusing on anger the authors shall be placed in a better position to understand how these two dimensions that is dimension of valence and dimension of direction of motivation are related to each other. Finally, by understanding the basic process involved in anger, the researchers all in the discipline shall also be better equipped to explain, predict and control anger whenever required. So, we will discuss, we will talk about their entire enterprise in some more detail, but before we go there, I thought it might be a good idea to just revise some of the methods that we are going to be using, alright. Now, most research on asymmetrical frontal cortical activity and emotion has relied on the EEG paradigm electroencephalography paradigm more particularly the power in the alpha frequency band.

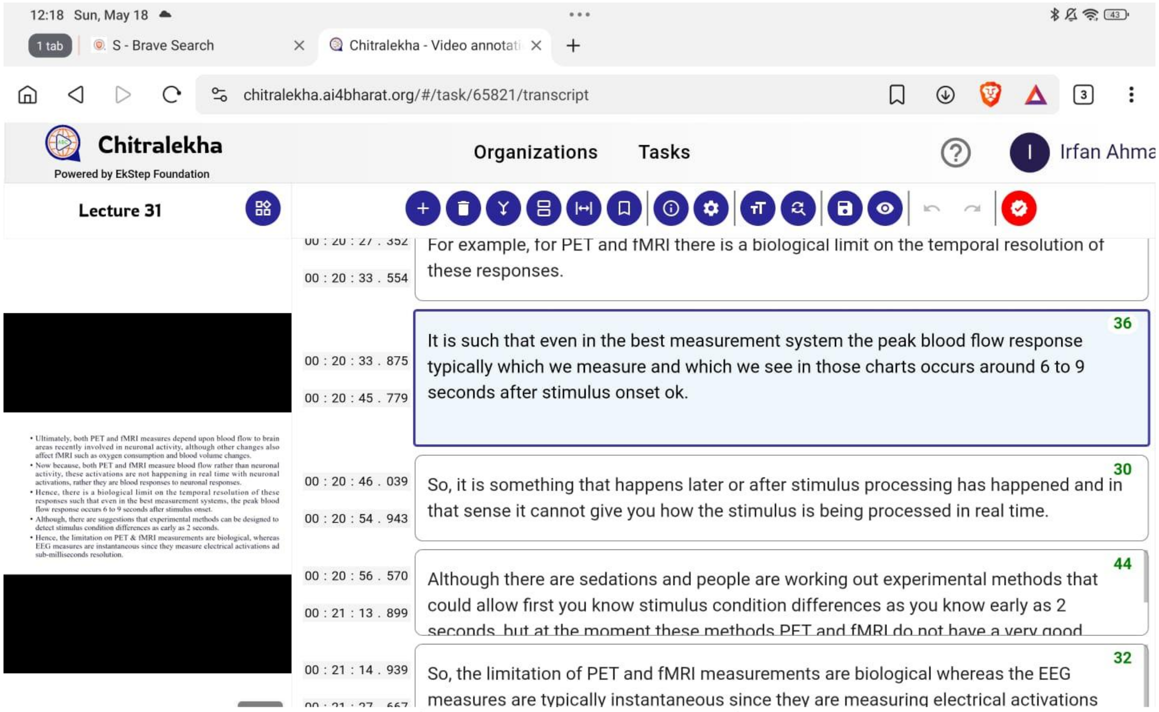
So, you might remember from the previous courses that electroencephalograph basically measures the electrical activity in the brain which is as an outcome of the neuronal and the electrical activity in the neurons a bunch of neurons are active simultaneously and cumulative activity of those neurons is you know measured in these EEG bands. Now, as I said the raw EEG signal is a complex waveform that can be decomposed using fast Fourier transforms wherein several frequency bands can be extracted from the unprocessed EEG data. So, typically when you place the you know cap with the electrodes on the on a participant's head there is a lot of electrical activity going on in the brain. you want to really understand you know or process a specific type of activity contingent to specific type of mental process. So, what can be typically done as a beginning is you use fast Fourier transform to separate out the different frequency bands and study particular frequency band that is of interest to you.

So, for example, here we are going to be talking about the alpha frequency band when you are talking about REM sleep and non-REM sleep, there are other bands that are used in depression, there are other frequency bands that might be useful and therefore, the area of interest or say for example, the frequency band of interest is actually studied in more detail. Now, what is this alpha frequency band? Alpha frequency is basically that one that ranges from h to 13 hertz and previous research has suggested that the alpha power is inversely related to cortical activation using a variety of other measures of cortical activation as well such as fMRI. So, what is alpha, what is basically this alpha frequency band? It is the range of frequencies that operate between 8 to 13 hertz periodically and it is inversely related to the amount of cortical activation present. So, when there is high cortical activation there will be lower you know alpha frequency range. also remember that the EEG alpha power is inversely correlated with PET and fMRI measures because those measures actually are directly correlated or linearly correlated with the amount of neuronal activity that is observed.

So, it might be assessing different aspects of brain you know activity for example pre or post synaptic potentials. We will talk about this as we go ahead. Ultimately if you remember the both positron emission tomography and fMRI measures typically depend upon blood flow to brain areas recently involved in neuronal activity Although other changes might also affect fMRI such as oxygen consumption and blood volume changes. Now, remember we have talked about positron emission tomography. What happens in positron emission tomography? A radioactive isotope is injected in the blood and the way it travels through the brain and wherever you know the brain is basically being engaged for example, it is engaged in processing a specific type of stimulus.

The idea is that there will be larger amount of blood flow to that region and you can basically detect the larger amount of blood flow to that specific region by tracing this particular isotope. positron emission tomography just very loosely defined. Similarly in fMRI we basically use the bold signal blood oxygen level dependent response where basically again you know it is contingent on the amount of blood flow reaching or the larger amount of blood flow reaching the area of the brain that is you know highly active where basically you know the blood the mental function start using of the oxygen neurons in that area become deoxygenated and that is basically what is measured. So, both of these measures are actually depending upon as I said on blood flow to the brain areas and they are in that sense different from how the EEG activity is actually measured. So, since both PET and fMRI measured blood flow rather than neuronal activity, these activations are not really happening in the real time with you know with neuronal activations, they are basically after effects of neuronal activations ok.

And they are therefore, they can be seen as blood responses to you know blood responses to neuronal activation. So, once neurons have started processing they start using up more and more oxygen therefore, they need more oxygenated blood and that is what is measured by PET and fMRI. The interesting part here is that the EEG method actually provides a different kind of you know processing advantage. For example, for PET and fMRI there is a biological limit on the temporal resolution of these responses. It is such that even in the best measurement system the peak blood flow response typically which we measure and which we see in those charts occurs around 6 to 9 seconds after stimulus onset ok.



So, it is something that happens later or after stimulus processing has happened and in that sense it cannot give you how the stimulus is being processed in real time. Although there are sedations and people are working out experimental methods that could allow first you know stimulus condition differences as you know early as 2 seconds, but at the moment these methods PET and fMRI do not have a very good temporal resolution. So, the limitation of PET and fMRI measurements are biological whereas the EEG measures are typically instantaneous since they are measuring electrical activations directly and they operate on a sub milliseconds resolution. So, in that sense you can see there is a difference between the merits of the PET fMRI methods and the EEG ERP methods. However, spatial resolution of the EEG you know which is the ability to determine which specific areas of the brain generate the signal recorded is not as good as a spatial resolution of PET and fMRI methods.

See both of these methods have a very important pro and a very important con. whereas PET and fMRI have a very good spatial resolution you can exactly know which area of the brain received that highest you know oxygenated blood and which area was basically involved in processing a particular stimulus. So, you know the spatial region of the brain very well. Yes, the temporal resolution is pretty bad. So, you do not know whether this region is doing the after processing or you know it is difficult to know whether this region was directly involved in processing of that stimulus and that makes it difficult for you know interpreting the results from PET and fMRI.

EEG on the other hand is directly measuring the neuronal activity that is there, but the idea is that the neuronal activity is a summation or accumulation of several neurons getting activated, because it is a summation of several neurons getting activated and it is you know this activity is coming through the pia matter, dura matter in the skull of the brain, it is difficult to identify the source from which the specific you know event related potentials or the specific EEG frequency bands are coming from. So, the spatial resolution of EEG is particularly bad. Obviously, a lot of work is being done to address this lacuna of this particular method as well because people are working out mathematical resolutions to this problem which eventually should allow for EEGs to have better spatial resolution. EEG research on the other hand if you compare the two things is much less costly than fMRI or PET research. Remember EEG research is typically non-invasive whereas fMRI and PET research, PET at least is invasive fMRI is non-invasive but you have to go into the scanner and sometimes people may have you know problems with the scanner people complain of you know different kinds of fears and so on.

Also, it is very expensive, the maintenance and the purchase of an fMRI or a PET machine is very, very expensive, at least very expensive as compared to the EEG machine, alright. So, there is basically per subject scanning cost for an fMRI basically varies between 7 to 10,000, you know, in an educational institution. whereas for EG it is a very low cost although there is a lot of cost of consumables when you are doing EG. So, there are as I said pros and cons in using the two methods. Finally, PET and EEG permit measurement of tonic that is you know resting state or baseline activity as well as phasic that is when activity is happening in response to certain stimulation.

Whereas, fMRI permits measurements of only phasic, but not tonic activity. So, this is again something it depends on the kind of question you are asking, it depends upon what kind of brain activity you are mostly interested in, there is also difference in terms of what kind of brain activity these you know methods are actually relying upon, ok. So, this is just a bit of a primer about what kind of methods are typically used, we have done this earlier as well, but just to sort of you know revise this to you because we are going to be talking about these methods as we go further. Now, scalp related electrical activity is the result of activity of the population of neurons. You know large number of neurons are you know giving up these electrical activations, they are being summated and what that in one electrode probably you know something that is happening over let us say 1 square centimeter all of that is coming up.

So, it is very difficult to disentangle exactly the source, the exact single cells, the exact neurons which whose activity is getting recorded here. You know there are other ways the invasive ways of single cell recording which will give you the exact idea of ok this particular neuron was responding to let us say a horizontal line or a vertical line which people have done and typically do with animal studies, but not so much with human studies. Now this activity gets recorded on the scalp surface because the tissue between the neurons and the scalp acts as a conductor alright voltage conductor. Now since the activity generated by a single neuron is small it is assumed that activity recorded by the scalp is an integrated activity of numerous neurons that are being active synchronously. So, they are all sort of acting you know at the same time firing at the same time if you want to use that.

Moreover, for activity to be recorded at the scalp the electrical fields generated by each neuron must be oriented in such a way that their effects accumulate you know they the electrical field should line up in such a way that their effects sort of get added up all right. The neurons must be arranged therefore, in an open field as opposed to a closed field sort of arrangement. what happens in an open field arrangement the neurons dendrites are all oriented on one side of the structure. So, that all the you know potentials are sort of getting submitted whereas exons are departing from all of the exons are departing from the other side. Now open fields are certainly present when neurons are organized in layers and this is best you know found in most of the cortex parts of thalamus the cerebellum and other structures.

So, these are the regions when you are sort of talking about emotional you know computations these kind of cognitive functions these regions therefore are specially suited for measurement of EEG or ERP responses because there is presence of open fields in these areas. Now because of the need for the summation of electrical potentials the EEG activity is therefore most likely a result of post synaptic potentials which typically have a slightly slower time course and they are more likely to be synchronous over time and then summate then pre synaptic potentials. So, again these are all nitty-gritties about why a particular method is useful and why a particular method is useful for measuring specific type of cognitive function emerging from a specific region of the brain. This is all that I wanted to say. I will take this discussion forward in the next lecture. Thank you.