Social Behavior and the Brain: An Introduction to Social Neuroscience
Dr Ark Verma
Department of Cognitive Sciences
Indian Institute of Technology Kanpur
Week - 06
Lecture – 28

Hello and welcome to the course Social Behavior and the Brain Introduction to Social Neuroscience. I am Dr. Ark Verma, an associate professor in the Department of Cognitive Science at IIT Kanpur. This is the week 6 of the course and we have been talking about regulation of social behavior. However, from this lecture onwards we will move towards a slightly different topic. We will start talking about emotional decision making and various nuances associated with it.

Now, one of the very important very critical aspect of social behavior is the decisions that we take, how do we act, how do we behave in specific situations. And a lot of these times given that we are talking about social situations, social agents and social actors a lot of these times these decisions that we make are under the influence of emotions . You might be happy, you might be you know sad, you might be angry, you might be excited, you might be disgusted and therefore you are you know behaving hatefully towards somebody else. So, a lot of these decisions are made under the you know influence of emotions and sometimes you know they are in sync, sometimes they are not so much in sync with rationality as well.

The classical view that you know several disciplines in theology and the common parlance understanding is that emotions actually work contrary to reason you know it is you will hear everybody saying oh he is a very emotional person because he is a emotional person he will not be able to take rational decisions he will not be able to be objective about something So, traditionally the way we you know the society structured and traditionally what you see going around is that people are not very you know they they think of emotions as either weaknesses, they think of emotions as factors that cloud your general rational judgment. But, this view has been called into question several times alright. So, the classical view that emotions work contrary to reason seems actually questionable in light of a recent lot of recent research both in social psychology as well as social cognitive neuroscience. In fact, what has been found is very interesting that in emotions have been found to play a very important role in assisting the decision making performance of individuals. So, it is not that emotions hamper decision making rather than rather the fact that emotions complement and they support decision making in a various nuanced ways.

So, that is what we will go forward with. Now typically as I was saying in I think previous or the lecture before that that emotions have three aspects they have valence, arousal and dominance. So valence when we talk about valence we are talking about positive and negative emotional states. So positive and negative emotional states may indeed have adaptive functions as they actually prepare the individual for information processing and subsequent action. So, as and when new information is coming new you are interacting with new stimuli, the initial impression on whether that stimuli is positive or negative actually has something to do or it influences how you interact with those stimuli.

So, neuroscientists have also, so this is we are talking about psychologist, but neuroscientists also view emotions as an adaptive force in decision making. If the orbitofrontal cortex is damaged which is one of the areas involved in the you know emotional processing, it has been found to impair decision making. So, an area that is considered very pertinent, very important for emotional processing, if if that area is damaged, it is also shown to have corresponding deficits in decision making It is a very you know it is a very good proof in order to say that yes emotional processing and decision making are linked with each other because they are subserved by common neural areas ok. Now the role of orbitofrontal cortex in decision making also needs to be understood however in a bit more detail. It is not that you know it is the we still do not understand how does the orbitofrontal cortex play out here.

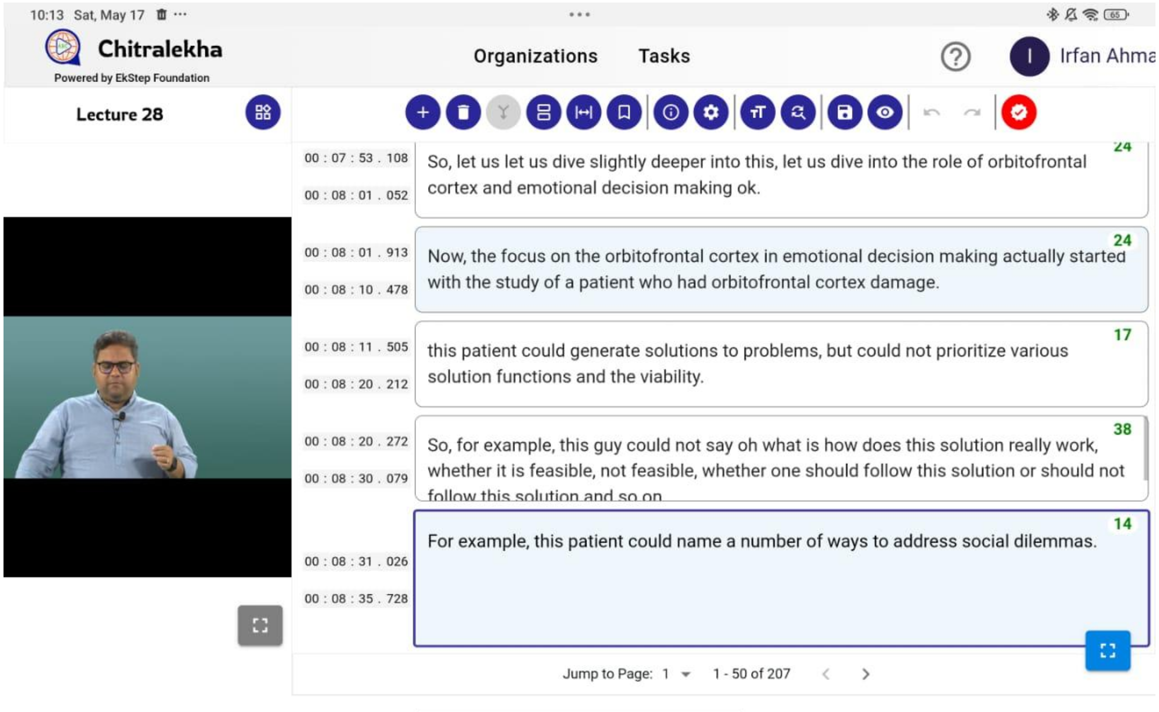
What role does it exactly play, whether it you know up regulates, down regulates emotions, whether it takes away the influence of emotional decision making, whether it integrates the effects of emotional decision making, these things we do not really know a lot about, alright. For instance, I mean this whole study of orbitofrontal cortex, recent research drawing on both social, psychological and neuroscientific approaches has suggested that one of the functions that the orbitofrontal cortex might be doing is as supporting self-insight, making us conscious about what we are feeling at any point in time. When we are going to do this action, whether it is going to generate positive or negative feelings in us. And this self-insight sometimes can be used as a proxy to guide our decision about right and wrong. Should we do this? Should we not do this? So, in that respect, the orbitofrontal cortex seems to have a slightly distal influence on emotional decision making.

Madam, let us take this formula and move on. Indeed self-insight processes may affect which emotions are generated and these emotions and how these emotions affect subsequent decision making. But lot of this research does not really you know include or does or basically refutes The theory is adaptive you know it is it does not refute the theory is adaptive role of emotions and decision making instead what it does is it highlights the need to expand the focus on neural investigations of emotional decision making into systems outside the orbit of frontal cortex as well. So, it is obviously the orbit of frontal cortex is involved. So, if you delve deeper into the research with the effects of orbitofrontal cortex one realizes that yes emotions have an adaptive role in decision making, but it also highlights the need that we should also be talking about other areas outside the orbitofrontal cortex and their contribution to management of emotions as well as the idea of decision making.

So, a few studies that have suggested that other brain regions may also support the adaptive role of emotions in decision making, but these may not really be you know providing us a very strong support of strong strong support to differential conclusions, but let us look at what kind of studies are being done. So, according to some studies emotional decision making was you know was not really the main focus of these studies. Also they did not they do not show behavioral effects. So, it makes it difficult to interpret the psychological meaning of the neural activity. So, what happens is a bunch of research has been done on emotions and decision making, a bunch of research has been done on orbitofrontal cortex observing orbitofrontal cortex activity and activity in other areas as well, but because this research is is you know it was not directly investigating the questions that we are talking about.

And therefore, we cannot really interpret those results to get an insight about how is the orbitofrontal cortex playing a role in emotional processing and decision making. Also that these studies do not have behavioral counterparts, they basically have something is happening and brain activity is observed. So, we cannot really if you know make or interpret that neural activity in particular light. So, let us let us dive slightly deeper into this, let us dive into the role of orbitofrontal cortex and emotional decision making ok. Now, the focus on the orbitofrontal cortex in emotional decision making actually started with the study of a patient who had orbitofrontal cortex damage.

This patient could generate solutions to problems, but could not prioritize various solution functions and the viability. So, for example, this guy could not say oh what is how does this solution really work, whether it is feasible, not feasible, whether one should follow this solution or should not follow this solution and so on. For example, this patient could name a number of ways to address social dilemmas. For example, two roommates who cannot agree on which television program to watch, so how do they deal you know with it, how do they come up with a solution, but this individual could not distinguish which solutions are most likely to be effective. So, you can say there is a conflict, people are not able to decide what to eat, people are not able to decide what show to watch on Netflix.



So, what can be done is you know you do this, you do that, you do this, you do that and so on. So, there are 5 solutions, there are 10 solutions on the board. But the individual was not able to prioritize and tell this solution will work best in consideration of factors A, B and C. So, this is something that this person was lacking. What does this tell us? It tells us that the orbitofrontal cortex was associated with emotional functions so that the disc I mean and basically it led to the discovery of decision making impairment when people were having damage in orbitofrontal cortex.

Now the difficulties that we just described, a pattern of difficulties, this pattern of difficulties raises the question about the role of emotions in decision making. What do emotions actually add to the process of decision making? Typically because the view is that decisions are made rationally, some kind of logic is computed, some kind of economic feasibility you know, loss aversion and so many of these maximizing of gains. There are so many theories in decision making literature that are there. What does emotion do here? What is the role of emotions in all of this, you know, processing? So, one idea could be that maybe emotions allow us to optimize our decisions given people and given context. One of the hypothesis that tries to address this particular question is called the somatic marker hypothesis.

According to this hypothesis poor decision making occurs when somatic information basically information about how would how would someone feel is not available to guide decision making. For example, you may be in a situation that oh you don't want to go to a particular party for reasons x, y and z. If you have no idea of how that other person will feel, you can take that decision and be fine and you take your decision so on or you may disregard it also. But, if that if that information is available that oh if I do not go to this person party he is a close friend he will get angry or he will be hurt without hurt when I do this. So, this adds extra information to your decision.

It basically tells you that ok while this seems to be the right thing to do given that I am very busy and I do not have time a lot of times you will see people actually still go ahead and visit that party because they think they do not want to hurt the other individual. ok. So, some of this kind of information seems to be very valuable at least in terms of social decisions that have to be made. So, the orbitofrontal cortex structures have been theorized to support the learning of associations between complex situations and somatic changes. So, sometimes when you come across a complicated scenario, a conflict and the associated emotional or somatic state, orbitofrontal cortex have been hypothesized that these are the structures that connect these two things, they that create a mapping between somatic you know aspects, somatic states and the possible ah you know ah decision ah space ok.

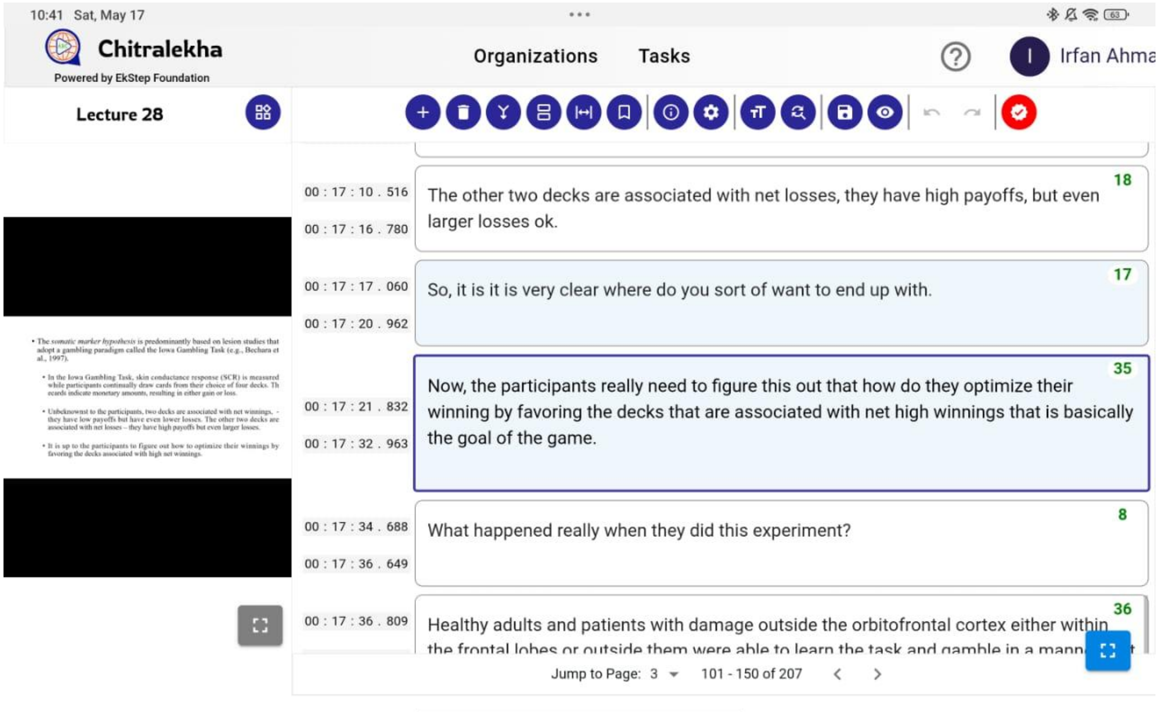
So, a distributed network of activity is supposed to be modulated by the orbitofrontal cortex and this activity is supposed to reflect the brains attempt to recreate previously experienced associations between internal physiology and external situations. So, for example, last time when you missed this guy's party ah how did he feel was he ah unaffected was he really hurt and disappointed and called you and told you, oh why did you not come, I was waiting for you, I had prepared this food for you and so on or the person was relieved that, oh it is good, I did not come, you know those kind of things. So basically what they are saying is that there is this distributed pattern of activity that is being managed by the orbit of frontal cortex and this activity is basically you know it is reflecting how the brain is attempting to recreate these previous situations. When you have a sense of oh this happened last time, this happened you know that other occasion and so on or when that guy missed this person's party, this friend's party he was really hurt. So, then you can use all of this data to optimize your decisions.

Ok, I do not have time, but I will still go meet the guy and come back in 10 minutes because you know it is important for me that the person does not feel bad. ok. And this is typically what happens in social situations, social situations are complex they have plenty of variables, they have not only variables that concern you, but also variables that concern the mental state of others. Complex social situations therefore, they engage the orbitofrontal cortex which then activates the somatic efforts, somatic effectors sorry in the amygdala, the hypothalamus and the brain stem nuclei you know the thalamus and so on and they basically together create this simulation of if I take this decision how am I going to feel and how are others going to feel and this becomes a very interesting network that informs our process of decision making. Now, somatic markers actually permit the rapid processing of possible behavioral responses and the evaluation of the adaptive value of their associated outcomes.

So, given that the orbitofrontal cortex is able to you know generate these somatic markers and integrate these somatic markers with possible behavioral outcomes, it basically tells you that if I do this, this will happen, if I do this, this will happen. Say for example, you really want to take a particular you know job. but your parents do not really want you to go away from home. So, how do you decide you basically run out these several simulations you say if I go here this will happen if I go here I will probably get larger salary, but my parents will be extremely unhappy or if I do this somebody else will be extremely unhappy. So, you factor in all of these things and what we are seeing is that the orbitofrontal cortex is basically mediating with the structures involved in you know emotional processing such as the amygdala hypothalamus thalamus and so on.

And allowing us this simulation and evaluation of these different outcomes, hence being adaptive, hence adding the adaptive and survival value here. also however decision making can then selectively focus on option outcome pairings that are potentially rewarding or you know give loss. So, what happens is emotion in the form of these somatic markers how will you actually feel will be particularly beneficial in ambiguous situations where there is no clear outcomes you know where there is no idea that oh this is anyways going to be great and everybody is going to like it or oh this is going to be universally condemned by my family members and friends and so on. In in between regions you know where there is ambiguity you need to perform this simulation you need to bring all of those factors in and only then your decisions sort of make sense ok and this can be due to you know simulation of future and where does this simulation of future happen it happens on the basis of previous or past experiences. Now, the somatic marker hypothesis is predominantly based on lesion studies, a lot of them which have adopted a gambling paradigm called the Iowa gambling task, ok.

What is this task? I talked about this briefly in the previous lecture as well. In the Iowa gambling task people are given a choice of four decks of cards, ok. 2 decks are designed such that when people are drawing from them they will eventually get high gains, 2 decks are designed such that they will eventually get high losses ok, this is the arrangement. Now, in this task at least in this experiment skin context response was measured while participants were drawing cards from the choice of 4 decks ok. These cards indicate monetary amounts resulting either in gain or in loss.



Now, as I as I was saying unbeknownst to the participants two decks are associated with net winnings, they have low payoffs, but have even lower losses. The other two decks are associated with net losses, they have high payoffs, but even larger losses ok. So, it is it is very clear where do you sort of want to end up with. Now, the participants really need to figure this out that how do they optimize their winning by favoring the decks that are associated with net high winnings that is basically the goal of the game. What happened really when they did this experiment? Healthy adults and patients with damage outside the orbitofrontal cortex either within the frontal lobes or outside them were able to learn the task and gamble in a manner that allowed them to win maximally, ok.

So, healthy adults could do it, makes sense. Patients which did not have damage in the orbitofrontal cortex, their damage could be in prefrontal cortex, their damage could be in other areas of the brain, they also could able to learn this. On the contrary, people who had damage in the orbitofrontal cortex failed to implement an optimal gambling strategy on a behavior level and hence they performed poorly on this gambling task. So, this failure is interpreted as resulting from a parallel deficit in physiological responses to the task. So, it was basically you know some kind of it is basically deficit in the physiological responses to the task.

You are not being able to feel bad when you are losing, you are not being able to feel great if you are winning and because the physiological responses are not contingent they are you know they are not informing you well enough and well in advance so as to change your strategy of picking up card see you there are four decks of cards here I am picking from this oh I lost the money I should feel bad unless I feel bad I will not move to the other deck Alright, and this is what is probably happening with this patients with orbitofrontal cortex damage that they are not able to feel the somatic states that are associated with winnings or losses and that is why they are performing poorly on this task. So, healthy adults showed an increase in skin conductance response in anticipation of you know making a risky gamble. For example, oh I do not know what I am going to get. So, there is anticipation, there is higher physiological arousal. So, skin conductance response, a heightened skin conductance response is there.

But when patients with orbitofrontal cortex you know observing them, they actually do not show any change in you know the skin conducting response in the anticipation of either wins or losses. So, if you put these results together what do we get? We get that these results can be interpreted as indicating that orbitofrontal damage specifically to the right side impairs decision making because somatic markers are not triggered and therefore, they are unable to guide the gambling decisions that these individuals are making. What do these findings tell us? Such a pattern of findings are consistent with another lesion study that suggested that patients with orbitofrontal damage may actually sometimes make better financial decisions because their decisions are not shaped by emotions presumed to arise from the outcome of their last financial decision. So, see it is in some sense a double edged sword, sometimes because your emotional states are affecting your decisions it may be helpful to you, but sometimes somebody would say oh this person is really a cold hearted player because he does not get affected by emotions. So, he is probably going to make the right rational choices going forward.

So, again remember, but both of these things the lesion study as well as the previous study with that we you know considered actually tell us pretty much the same or a very similar story. So, in this study let us look at this in a bit more detail participants were asked to complete a series of trials where they could buy a chance to participate in a lottery 50-50 percent chance that they would win either 2.5 dollars or lose 1 dollar ok. Or they could just decline to play in that trial say I do not want you know anything to do with this I have nothing to gain or to lose. Healthy controls tended to decline a chance to play much more often if they had lost previously and orbitofrontal patients decisions to buy a chance at the lottery was not correlated as a function of whether they had lost or won in the previous trial ok.

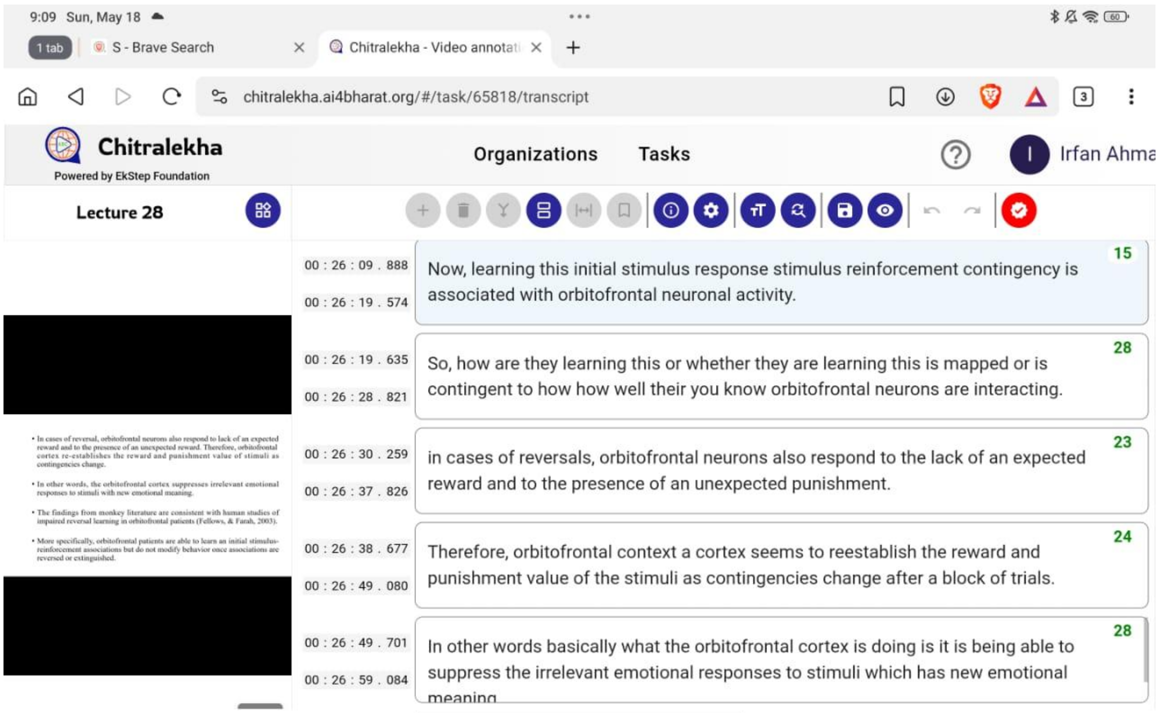
So, this is again very interesting, but a similar outcome that we were seeing previously. The researchers on the basis of these results suggest that the healthy controls actually experienced negative emotions after a loss and this emotional state reduced their propensity to risk money in the next trial. On the other hand, the orbitofrontal cortex damaged patients did not you know get this and therefore, they continued to play. They were basically you know evaluating every trial as is and deciding whether to play on this or whether to not. So, this monetary gain is was only possible through participation in lottery therefore, orbitofrontal patients higher rates of lottery participation allowed them interestingly to perform better in this task because overall may be you perform more you win more eventually your net monetary gain will anyways be there.

So, you can see here how an a non-emotional individual may perform well in let us say a stock market or in any of kind of these gambles because they are not extremely perturbed by emotions or somatic states contingent to their decisions. Now, there is another you know theory that we can talk about. This was just the about the involvement of the OFC, but there are other things that we can talk about the process of how this is happening. So, one interesting perspective that seems to be able to account for the role of the orbitofrontal cortex in emotional decision making basically proposes that it happens through a process of reinforcement and reversal.

Let us look at this in more detail. So, this perspective proposes that the medial orbitofrontal cortex computes the reward value of the stimuli and the lateral orbitofrontal cortex computes the punishing value of the stimuli. So, the positive and the negative, medial tells you the positive side, the lateral tells you the negative side. from this perspective emotions emotion necessarily arises from either reward or punishment as environmental context change the orbital frontal cortex learns new reward and punishment associations it is ok if i do this this this i maximize my reward if i do this i have a chance to lose So, what happens is that the orbitofrontal patients make poor decisions because they are unable to adjust the behavior in reference to changing rewards and punishment. So, for example, if the you know medial part of the orbitofrontal cortex is learning ok, if I do this I will gain. How will they gain? If they use this learning to change their response strategy.

How will they avoid losses? If they say oh I am going to lose, this is you know response that leads to losses, they should learn it and try to not make that response further. But if the orbitofrontal cortex is damaged, it does not allow the person to adjust their response strategies based on either of the two outcomes and therefore, it basically makes them poorer generally in performing at these tasks. This is a very interesting theoretical position, but one that is you know draws on both animal research as well as human research. For example, single cell recording from orbitofrontal neurons in research monkeys you know were collected during a reversal go no go task. You know you know a go no go task on some cases you have to press a button give a response on some cases you have to withhold your response and not give a response that is a no go trial.

Now, in a go no go task participant learn to respond with go with hold a response to stimuli based on their association with the delivery of a reward or punishment. For example, they learn to press a key in response to particular geometric shapes let us say triangles just for you know hypothetical purposes or to earn juice rewards and avoid electric shock. if this shape comes you are going to get a juice reward you have to press a key if this shape comes you do not have to press a key because otherwise you will get a electric shock. In the reversal version what happens because you have to change the whole thing, you have to basically you know reverse these pairings, the stimuli values were periodically reassigned. So, that the reward or punishment values of the stimuli keep changing throughout the task.



First block of trials it was A gives response, B gives punishment, on the next block of trials it could be B gives B gives reward and A gives punishment. healthy control a healthy monkey should be able to learn this and accordingly change their response strategies as well. Now, learning this initial stimulus response stimulus reinforcement contingency is associated with orbitofrontal neuronal activity. So, how are they learning this or whether they are learning this is mapped or is contingent to how how well their you know orbitofrontal neurons are interacting. in cases of reversals, orbitofrontal neurons also respond to the lack of an expected reward and to the presence of an unexpected punishment.

Therefore, orbitofrontal context a cortex seems to reestablish the reward and punishment value of the stimuli as contingencies change after a block of trials. In other words basically what the orbitofrontal cortex is doing is it is being able to suppress the irrelevant emotional responses to stimuli which has new emotional meaning. See suppose on a block of trials every time a triangle came you won a juice reward. Now, this is good you learn this and you kept waiting for the triangle to press a key, so that you get a juice reward all good. You get another shape let us say a square and you get a shock you learn this all good.

In the second half of the experiment when this changes, when a triangle is giving you shock and the square is giving you juice reward, then you have to change your strategy. Whenever the triangle comes you have to now no go, you have do not have to respond. Whenever a square comes now you have to press the key. Now what is happening is that these values have to be reassigned and the orbitofrontal cortex has to facilitate this kind of learning.

This is basically what they found. So, the findings from this monkey literature as we were just saying is also consistent with findings from human studies that basically tell us about impaired reversal learning in orbitofrontal damaged patients. More specifically what did they find? Their orbitofrontal patients are able to learn an internal stimulus reinforcement association, but they are not able to modify their behavior once these associations are reassigned or reversed. So, this preservation is not observed in patients with damage outside of the orbitofrontal cortex or in healthy control participants. So, it seems that it is the orbitofrontal cortex which is the critical area here. One interesting study for instance suggested that errors on reversal and extinction tasks predict the extent of participants social disinhibition as rated by staff members.

You behave in a social situation in particular way it gives get you reward in, but in some situations the same behavior will not get you a reward. So, you should be able to change your behavior and behave accordingly that is rewarding in that situation. So, people sometimes are able to do it, but people with orbitofrontal damage are not able of doing it. So, social problems are supposed to or proposed to arise from difficulties in making these new behavioral decisions, updating these new stimulus reinforcement contingencies and it is this case where the orbitofrontal cortex becomes most critical. Now, there is another theory that we can talk about the dynamic filtering theory.

For the from the you know whatever you seen from the orbitofrontal cortex, the orbitofrontal region of the prefrontal cortex is also been implicated in integrating emotion and cognitive information through some kind of a gating mechanism. This is a theory put forward by Shimamura in 2000. This theory basically say draws on the general executive functioning of the prefrontal lobes and it focuses on the orbitofrontal cortex as a region of that controls over emotional processing because of its heavy connections to both sensory areas as well as limbic areas the emotional circuit. Now, patients with orbitofrontal ah damage ah according to this theory may be overwhelmed by their emotions as they are unable to inhibit any neural activity associated with emotional processing.

So, it seems that the gate is gone, the flood gates keep open. In this case it would be expected that the patients with orbitofrontal damage will actually show increased emotional bias you know initial evaluations and so on in decision making as they are not able to control as they are not able to suppress their emotional responses. Does this really happen? This proposal that the orbitofrontal damage actually impairs the ability to suppress emotional responses is actually supported through ERP studies conducted with orbitofrontal patients. More specifically, participants including patients with orbitofrontal damage or dorsolateral prefrontal damage and healthy control subjects were presented with mild shocks or distracting noises while they were watching a movie. Now, in this task the shocks and distracting noises were meant to elicit some kind of emotional responses, you know it should be either happy, sad, disgusted, angry whatever. In comparison to the DLPFC group and healthy controls the OFC patients actually showed greater P300 amplitudes in both the shock and the noise condition.

So, how will you interpret it? Healthy control subjects I will come to that healthy control subjects eventually got habituated for the shock condition, but the orbitofrontal patients actually never did. So, it seems that they are not being able to learn this contingency as we have been seeing so far. And there was no significant difference for habituation for by either the auditory stimuli between the orbitofrontal and the control groups. If you take these findings together, what does it suggest? It suggests that the orbitofrontal cortex is important for regulating neural activity that is associated with emotional stimulus processes.

Alright. And patients with orbitofrontal damage are not able to habituate to aversive somatosensory stimuli presumably because they cannot suppress their responses to such stimuli. So, the same kind of response keeps coming up and they are never habituated and they are not able to moderate or you know change their initial responses to these kinds of stimuli. Alright. So, I will stop here. I will continue this discussion about emotional decision making in the next two lectures of this week. Thank you.