Social Behavior and the Brain: An Introduction to Social Neuroscience

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Week – 03
Lecture - 11

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 third where we are trying to understand the representation of self and others in the brain and in this lecture in the lecture 11 we are going to continue a little bit of a discussion about the role of amygdala and the evaluation of neutral phases. Now the amygdala is a subcortical region in the brain which is involved in the evaluation of novel stimuli. It is involved for example in fear conditioning, consolidation of emotional memories as well as the evaluation of trustworthiness in faces.

In the previous lectures we have seen how different regions of the brain are utilized or recruited to evaluate the facial emotions on faces, things like trustworthiness, dominance and so on. So in this lecture we are going to focus on the role of the amygdala in evaluating these facial emotions from faces and also we will be you know the special focus will be on evaluating neutral faces. Vincent and colleagues in an fMRI study demonstrated that the amygdalas response to faces increases as they perceived trustworthiness decrease irrespective of whether the task involved explicit or implicit evaluation. Now this is interesting because so far we have seen you know regions of the brain that sort of you know the responses of whom increase when the facial trustworthiness you know increase, so they were linearly correlated.

Now, here interestingly what happens is that the amygdala the response of the amygdala increases as the trustworthiness of the faces decreases which probably hints to a vigilance sort of a response which hints to a response that ask you to be cautious or careful about these individuals. It might be a self preserving or you know in some sense response that ask us to be careful about these individuals that we are considering. So, the authors Engels and colleague actually replicated these findings using a single implicit task to rule out the effect of prior performance on explicit evaluation trials. So, they were concerns about whether the effects that they were observing were basically a practice effects that were coming from previous trials. So, they basically just use a single implicit task and they try to investigate the same.

So, in their study participants what they did was that the participants were presented with the series of faces in a memory task and they were asked after each block of 11 faces to indicate whether a test face was presented in the previous block, block 1. Even though the participants here did not explicitly evaluate the faces, the amygdala response did increase with the decrease in the perceived trustworthiness of faces. So, it seems that this is not really a task based effect, it is not really an effect that would change in you know in face

of explicit versus implicit judgment, but this is in a natural sort of a response from the amygdala when the trustworthiness of a given face is decreasing. So, the authors tested whether the amygdala's response to phase trustworthiness was actually driven by certain kinds of structural characteristics of the phase that indicated trustworthiness across observers or just by the idiosyncratic components of trustworthiness judgments. See, it could be because we are showing these different phases to the participants, it could be that there are peculiarities in the phases that are being considered which is causing this response in the amygdala. Or on the other hand it could basically mean that it has something to do with the process of making this trustworthiness judgment that is leading to this response. So, the authors were rather interested in investigating this fact as well and see what did they find. They find that the amygdalas responses were better predicted by judgments of trustworthiness aggregated across a large number of participants and separate from the fMRI participants than by fMRI participants individual judgments. So, the idea here is that this is not really a property of the task or the individual phase because this is an effect which is coming in aggregation of all phases put together all kinds of judgments put together. So, also when the analysis control for the shared variance of individual and consensus judgments, there was still residual variance accounted for by individual judgments in the amygdala.

So, it seems that the amygdala is particularly sensitive, particularly responsive to the trustworthiness component in these phases. So, in the next study what the authors did was they first constructed a computational model of the face trustworthiness based on behavioral judgments, next they generated novel faces from this model and then use these novel faces in another fMRI study using this time an implicit task which had already been used in a previous study. What did they find now? How does the amygdala respond to trustworthiness in this case? So they found that the right amygdala's response to the faces increased with decrease in face trustworthiness. So again you can see that the amygdala is responding to the notion of trustworthiness that can be adjudged from these faces. Also what these authors found is that there was non-linear response in the left amygdala such that extremely trustworthy faces evoke a stronger response than faces in the middle of the continuum or middle of the dimension.

Remember if we treat trustworthiness as a factor as a you know characteristic of the faces obviously you can think of this on a continuum on one end they will be extremely trustworthy faces on the other end they will be extremely untrustworthy faces. Now, where does the amygdala sort of factor in, how does it respond? You can see here that while the right amygdala sort of response you know proportional to the in fact inversely proportional to the perceived face trustworthiness, the left amygdala sort of response non-linearly because it responds a bit higher to the stronger you know to the faces at the extreme end of the trustworthiness dimension than at the middle of it. So, we have to sort of try and understand this. Now, across three different studies, if you step back a bit and look at the overall, you know, studies or larger number of studies on this topic, it was demonstrated that the responses to faces in the amygdala were actually linearly related to the judgments of face trustworthiness. But as we have seen as per the dimensional model of evaluation of emotionally neutral faces in the last week, that judgments of face trustworthiness are highly correlated with other kinds of judgments as well.

For example, judgments of happiness and judgments of, you know, pleasantness and so on. So, the so basically you can say it you know correlates highly with the approximate valence evaluation of these emotionally neutral phases. Now, remember it is it is a interesting thing that when you are evaluating an emotionally neutral phase there could be a degree of projection, there could be a degree of making out what this phase might be looking like. or attribution of certain you know emotional certain degree of emotional valence in these faces and it is to this perceived valence that the amygdala seems to be responding. So, since the authors use the same phases in these new fMRI studies as had been used earlier during the model testing, the authors now were in a position to be able to test the hypothesis that the amygdala probably is involved in a general valence evaluation of emotionally neutral phases rather than an evaluation on specific trait dimensions.

Remember in the previous week we discussed at length that you know trustworthiness is linked to you know valence, happiness you know more specifically and similarly there was dominance which was linked to physical strength, so we have this whole idea but given that the evaluation of trustworthiness is broadly linked to you know ah the facial valence, it seems that maybe it is possible that the amygdala is not really responding to trustworthiness, but it is responding to a more generic facial ah you know valence evaluation of these faces. So, let us see what happens. So, if you if you look at this ah or if you look at this hypothesis that whether the amygdala is involved in general valence evaluation of these emotionally neutral faces. So, the hypothesis would be that face variations on any social dimension for example, whether it is the positive things of trustworthiness or attractiveness or aggressiveness it would engage the amygdala to an extent that the dimension has a valence content accordingly variations on the dimensions with clear valence connotations such as trustworthiness and meanness it should engage the amygdala slightly more strongly than variations on the dimensions with less clear valence connotations. So, what they are basically saying is if the response of the amygdala is correlated to the amount of valence or the kind of valence that is present in these faces, it will be more strongly engaged when the faces show a clear valence connotation rather than when the faces do not show a clear valence connotation.

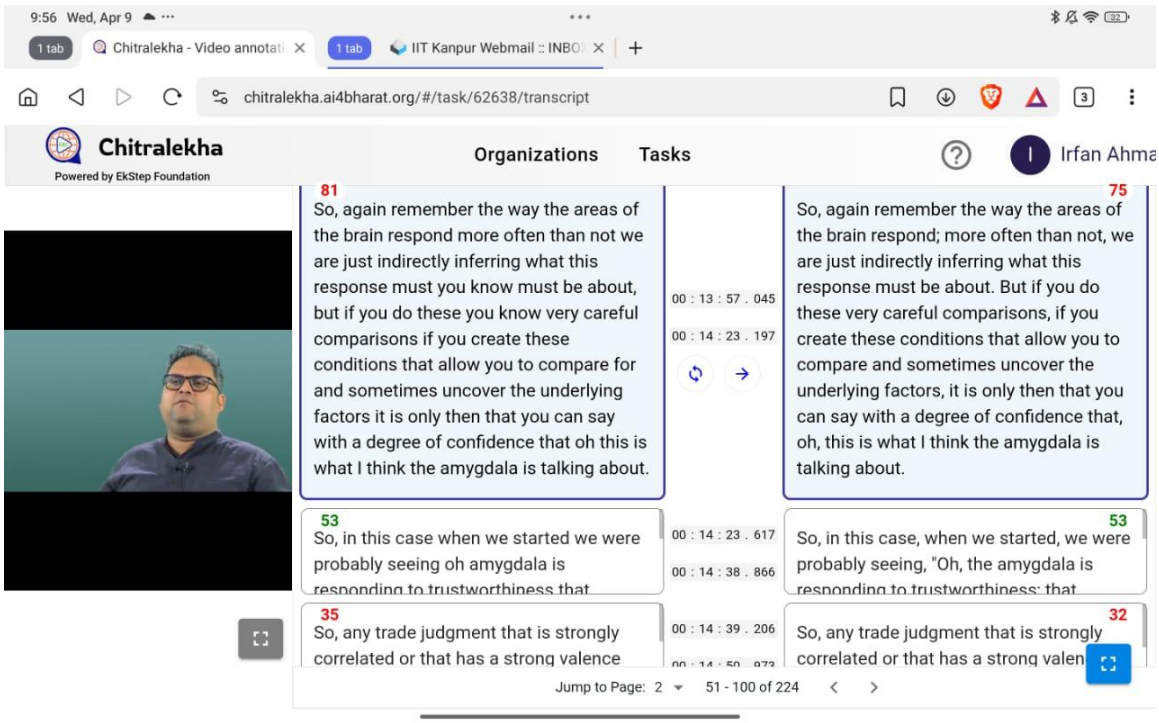
You know you should be able to see oh this is a positively happy face is a you know perfectly happy face or it is a perfectly sad face, but if there are you know attributes in the middle then the response of the amygdala will not be as strong as is expected. So, they wanted to test this hypothesis and for that they derived the response to each of the phases in the phase responsive voxels in the amygdala and then correlated this response that these voxels were giving with the mean trait evaluation of the phases. So, again you can see that for you know each of the phase that the individual is seeing there are phase specific responses that are happening in the amygdala which can be you know extracted, and then they are being correlated with the overall trait evaluation of these species. As expected in confirmation with the hypothesis, the amygdala activation actually correlated negatively with all judgments on positive traits, and positively with all judgments on negative traits. Now, remember amygdala is involved in fear conditioning, it is involved

in you know, automatic computation of facial emotion and here what we can see is a very interesting thing that.

The activation in the amygdala is you know correlated negatively with judgments on positive traits and its correlated positively with judgment on negative traits. So, if there is an aspect of threat if there is an aspect of having a negative attribute that is when the amygdala comes into play it probably alarms us it is asking us to be cautious and careful about the stimuli and that is where it starts responding strongly. So, across the trait dimensions the amygdala actually responded more strongly to phases that were evaluated negatively. Okay, further while all trait judgments except for dominance correlated significantly with the amygdalas response there was considerable variation in the magnitude of the correlations. Again see it seems like the amygdala is generically responding to threat or is generically responding to these negative traits and depending upon the strength of the negative trait or the attribute of the negative attribute that is what is probably moderating or modulating the response of the amygdala in this case.

Now according to this valence hypothesis such variations should be predicted by the valence content of these different judgments. So, as I said depending upon how much valence content a particular phase presents or a particular phase has that should be you know predicting or moderating the response of the amygdala to these phases. So to test for the same the authors use the valence component from the principle component analysis of the trade judgments as a measure of general valence evaluation. So basically they said okay they performed a PCA and they basically said this is the component for valence and they correlated with this you know they took that as a measure of general valence evaluation and then when they did this comparison they found that this component was correlated with both the response in the left and the right amygdala. So, amygdala as a region seems to be involved in generic valence evaluation of the faces rather than more specifically to trustworthiness or you know dominance for that matter.

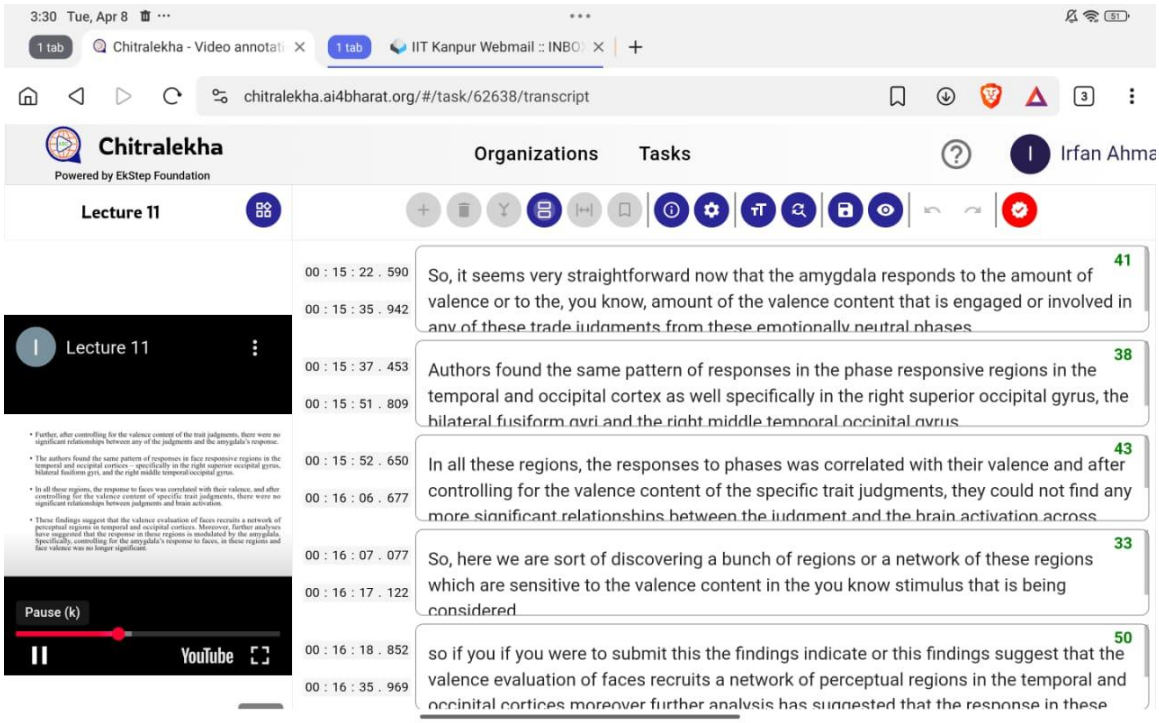
So they wanted to compare this, so for comparison the amygdala's response was found to be uncorrelated with the dominance component. This time it's rather clear that it is not dominance or physical strength that the amygdala is responding to, it is responding to perceived threat, it is responding to perceived danger that could be attributed to the phase that are being considered. so they use the variance accounted for by the valence component for each trade judgment as an estimate of the valence content of the trade dimension and they basically wanted to see or look at this in combination of amygdala activation so the valence component for example accounted for 90 percent of the variance of the trustworthiness dimensions and 9 percent of the variance of dominance judgment. So, it seems here remember we were just saying that this response of the amygdala was basically you know going ahead with trustworthiness judgment it was inversely proportional to trustworthiness judgment, but the interesting part here is it is not trustworthiness that the amygdala probably is responding to it is responding to the valence content. and that is why since the trustworthiness judgment has about 90 percent of the valence component it is probably because of that that the amygdala is getting recruited.



So, this variance therefore was found to be strongly correlated with the variance accounted for by each judgment in the amygdalas responses to phases and the stronger the association of a trade judgment with the valence component the stronger this judgment engaged the amygdala. So, again remember the way the areas of the brain respond more often than not we are just indirectly inferring what this response must you know must be about, but if you do these you know very careful comparisons if you create these conditions that allow you to compare for and sometimes uncover the underlying factors it is only then that you can say with a degree of confidence that oh this is what I think the amygdala is talking about. So, in this case when we started we were probably seeing oh amygdala is responding to trustworthiness that response is inversely proportional, but if you dig a little bit deeper we find and we understand that oh it is probably that the amygdala is responding to the valence component in the trade judgment. So, any trade judgment that is strongly correlated or that has a strong valence component to it that is where the amygdala will get recruited and that is where the amygdala will start showing responses. So, here you can basically see the relationship of the amygdalas response to neutral phases and variations of these phases on trade dimension.

You can see this figure the response of the amygdala with respect to trustworthiness, caring, responsibility, emotionally, stableness and so on. So, these are some of the things that you can come back and revisit as well. Now, after controlling for the valence content of the trade judgments, there was no significant relationships between any of the judgments and the response of the amygdala. So, it seems very straightforward now that the amygdala responds to the amount of valence or to the, you know, amount of the valence content that is engaged or involved in any of these trade judgments from these emotionally neutral phases. Authors found the same pattern of responses in the phase

responsive regions in the temporal and occipital cortex as well specifically in the right superior occipital gyrus, the bilateral fusiform gyri and the right middle temporal occipital gyrus.



In all these regions, the responses to phases was correlated with their valence and after controlling for the valence content of the specific trait judgments, they could not find any more significant relationships between the judgment and the brain activation across these regions. So, here we are sort of discovering a bunch of regions or a network of these regions which are sensitive to the valence content in the you know stimulus that is being considered. so if you if you were to submit this the findings indicate or this findings suggest that the valence evaluation of faces recruits a network of perceptual regions in the temporal and occipital cortices moreover further analysis has suggested that the response in these regions is modulated by the amygdala. So, the amygdala is basically that is coordinating the activity between these areas. More specifically controlling for the amygdala's response to phases in these regions and phase valence, but then it was no longer significant.

So, even these regions are responding via the amygdala or the response in these regions is being controlled via the amygdala because if you keep the amygdala activation out, if you keep the valence content out, then these you know there is no significant pattern of activation in these regions. on the other hand the relationship between the activation in the amygdala and face valence remains significant even after controlling for the activation in these regions. So, if you do this kind of a subtractive analysis what you get is that it is the relationship between the amygdala and the valence content in these faces that is basically driving these activations rather than that this entire network you know being responsible for it. Yes, this network gets engaged, but to the extent that it is

recruited by the amygdala and the critical factor that you know requires the amygdala to recruit these regions is the valence content in these phases. So, these findings again they are in consonance, they are in confirmation with the hypothesis that the amygdala seems to be amplifying attention to emotionally salient you know stimuli in perceptual regions.

Again this is a more you know social cognitive neuroscience interpretation, but a generic interpretation can also be drawn that yes the amygdala amplifies attention, it requires or it makes us pay attention to emotionally salient stimuli and attend to them in more detail. Now, Wuhlmeier demonstrated that whereas patients with hippocampal lesions show slightly enhanced responses in regions in occipital and inferotemporal cortex to emotionally salient, but unattended stimuli, patients with amygdala lesions do not show such enhanced responses. So, there seems to be a connection between the attentional orienting and the response of the amygdala to valence in these phases. So, these regions which are not responding included the same regions that we have observed in the earlier study. Now, anatomical evidence from studies of the macaque brain also show that the projection from the amygdala to the visual cortex are relatively more extensive than those from the visual cortex to the amygdala.

So, it seems that there is this slightly unidirectional you know connection that is there. So, whereas the amygdala receives what is the consequence of this whereas the amygdala receives visual input only from the temporal visual areas it projects to multiple areas in both the temporal and the occipital visual areas including early visual areas you know the V1, V2, V3, V4 and so on. See a lot of this geography that I am geography of the brain or the anatomy of the brain that I am mentioning you will be best place if you keep a brain atlas with you, you will be best place if you sort of. you know can get your hands to the book which I show in the references there is where you will be able to see all of these areas ok. Now if you put all of this together these findings suggest that the amygdala seems to be automatically evaluating the novel phases along a general valence dimension and that it modulates a phase responsive network of regions in occipital and temporal cortices which are recruited specifically for this kind of evaluation.

All in all what we are finding so far is that the amygdala is involved in performing a general valence evaluation of these faces and it basically recruits a network of regions in the occipital in the temporal areas that enable or that assist the amygdala in this task of facial you know valence evaluation. Now the degree to which the amygdala may be engaged in tracking the variations of faces on social dimensions seems to be a function of the valence content of these dimensions. So, wherever or whenever the amygdala is involved in judging the you know variations or the dynamic facial emotional features of these faces basically it seems to be a function of the amount of valence content that will be there in these faces. Also, given the higher correlation between trustworthiness judgments and valence evaluations of faces, it is not surprising that the previous studies have actually linked the amygdala with the evaluation of face trustworthiness. So, you see here there is a very natural confound because there is a third variable.

The amygdala seemed in the lecture so far we were seeing that the amygdala is you know potentially involved in the evaluation of trustworthiness, but it is actually in a more you

know latent a more underlying dimension that the amygdala is responding to which is the valence content of these faces and since the valence content of these faces you know is related almost 90 percent it explains the variance of up to 90 percent in the trustworthiness judgments it is therefore that this connection is being formed. Now if you consider these findings it might be suggested that instead of collecting multiple social judgments of faces to estimate their valence evaluation it could be a you know a shortcut it could be a useful idea to collect just the judgments of trustworthiness as an approximation of general valence evaluation. There are several dimensions when you are talking about valence, positive valence, negative valence and they can be you know happy, surprise those kind of things, they can be sad, angry, annoyed those kind of things. So, if you really want to evaluate a face on you know a generic valence content, you might need to basically ask the participants to judge the faces on several dimensions and in that sense it makes this task rather bulky and rather cumbersome. The option that these you know the authors are suggesting based on whatever we have seen so far is that since valence computation is linked very closely as we saw up to 90 percent with the you know things with the judgment of a single trait like trustworthiness, it might be a better of idea that we just ask participants to rate this spaces on trustworthiness and then we use those judgments as an approximation as a proxy for judgments of valence.

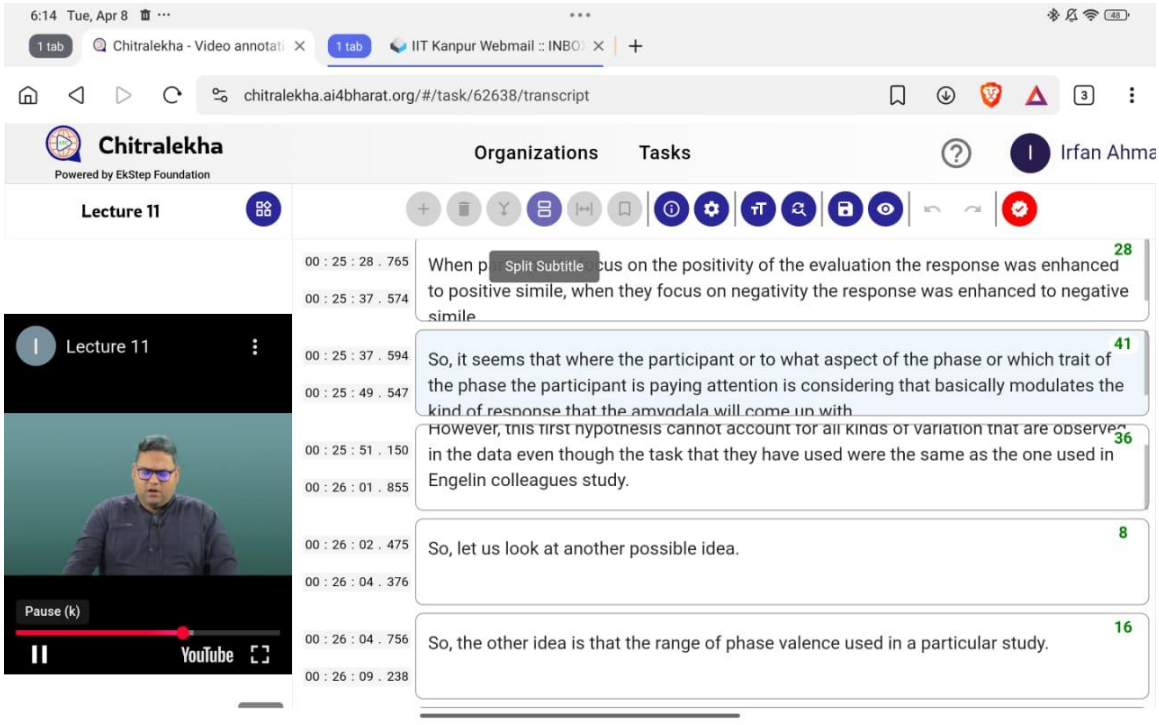
And then we will see the amygdala response anyways. So, this is something that is come up as an idea based on their studies that we have seen so far. Now, while most of the studies actually report a slightly linear response of the amygdala to face valence, more recent studies have also reported a tendency for non-linear amygdala response to face trustworthiness. Let us try and understand it also you know some detail. More specifically, it has been noted that for the left amygdala, the activation was stronger to the faces at the extremes of these dimensions, so extremely trustworthy or extremely untrustworthy than to faces at the middle of these dimensions.

For example, the dimensions of trustworthiness and attractiveness. Now, this kind of non-linear response is not really surprising. If you are following the lecture so far, you might go back and refer to them. This non-linear response does not seem very surprising because it is in some sense generally consistent with the previously discussed emotional over generalization hypothesis.

Let us talk about that in a bit. So, from the previous discussion as we have seen as I was mentioning we had seen earlier that the behavioral and the modeling findings indicated that variations on the dimension of trustworthiness can be understood in terms of similarity to expressions of happiness on the positive extreme of the dimension and expressions of anger on the negative end. So, you can see trustworthiness is not really a simple construct it is linked in its you know various facets to these other judgments as well. so a number of fmri studies have actually found a stronger amygdala response to happy than to neutral faces remember this is basically happening via the valence computation so it should therefore be possible to observe a non-linear response to face trustworthiness with elevated response to both extremely trustworthy and untrustworthy faces as i was just saying Also, if this is the case one should be able to specify the conditions under which the amygdala response to phase valence is linear and the

conditions in which this response would be non-linear. So, in this regard whether you know whether the amygdala response will be linear whether it will be non-linear what should we expect two hypothesis have been you know proposed let us look at them. As with the first hypothesis, the nature of evaluation is critical.

If the evaluation is implicit or if it is explicit and it is a critical component in deciding how the amygdala will respond to this valence content. Just to sort of go in more detail, in study conducted by Engel and colleagues 2007, or in contrast to this study actually participants in the said and colleague study evaluated faces on trustworthiness and this may have bias their attention to extreme faces ok. Now, in a recent study Cunningham and colleagues observed similar quadratic responses in the amygdala in a valence evaluation task for famous people. okay When participants focus on the positivity of the evaluation the response was enhanced to positive simile, when they focus on negativity the response was enhanced to negative simile. So, it seems that where the participant or to what aspect of the phase or which trait of the phase the participant is paying attention is considering that basically modulates the kind of response that the amygdala will come up with.



However, this first hypothesis cannot account for all kinds of variation that are observed in the data even though the task that they have used were the same as the one used in Engelin colleagues study. So, let us look at another possible idea. So, the other idea is that the range of phase valence used in a particular study. may determine the nature of the amygdala response. Again remember all of these dimensions that we are talking about are not dichotomic dimensions, it is not that a face is either trustworthy or untrustworthy, it is not that the face is either happy or not happy.

Typically these dimensions can be conceived of as lying across a continuum and the range of values on this continuum that are approximated by the faces that are being used as stimuli may actually modulate the response of the amygdala. Let us look at this in a slightly more detail. Now, for this having this wider range of phase balance then if you have a whole group then the response may be quadratic because it may be a certain type at one end of the continuum and certain other type at the other end of the continuum. For example, the authors wanted to compare the trustworthiness of faces used in the Todorov and colleagues study and the study of Engel and colleagues and they basically wanted to do this in the computational model that we had discussed earlier the Ustorov and Todorov model. So, the range of trustworthiness of faces in the former study was minus 3.26 to 2.64 in SD units whereas the range in the latter study was minus 1.79 to 1.53. ah in the different study in the said in colleague study the in which participants were doing explicit judgments the range was slightly ah limited it was minus 0.271 to ah 1.37. Now mostly studies on attractiveness typically use extremely attractive or extremely unattractive phases and given the high correlation between attractiveness and phase swellings this can somehow inflate the responses and lead them to be non-linear in the amygdala as was observed by Vincent and colleagues. So, if you see both of these things one says that it is probably due to the range of you know values that are there and the other hypothesis says that it is probably function of implicit versus explicit. If you put all of this together these hypothesis you know as well as the linear and non-linear responses in the amygdala are consistent with this idea of a common attentional mechanism according to which the you know bias of attention towards stimuli that are of content motivational significance to the person sort of seems to be you know directing or controlling this response. So, if your attention is biased and why should the attention be biased? If you are looking for a specific, if you are looking for a positive aspect in the phase versus if you are looking for a negative aspect in the phase, this particular motivation will moderate your attention accordingly and it is based on this common attentional mechanism or the attentional biases that follow thereof, the response of the amygdala will be modulated.

And this is in line with some of the previous results. For example, early studies in social cognition have shown that the allocation of attention to social stimuli exhibits non-linear quadratic responses to people as a function of their extremeness rather than their valence. So, the nonlinearity comes with the range of values that are there and more recent studies have shown that evaluative processes are also context dependent. What is it that you are looking for? Were you looking for positive? Were you looking were you inclined to like the person for example? If you are inclined to like the person the way you will evaluate a given face will be different than when you are inclined to reject the person. So, the valence evaluation of faces may be I mean or evaluation of valence for these faces may actually be in the service of approach or avoidance decisions. This is consistent with the findings you know in the macaque monkey that macaque monkeys with bilateral amygdala lesions actually exhibit uninhibited approach behaviors during social interactions and with theories that posit that one of the primary functions of the amygdala is to provide continuous vigilance by evaluating objects and agents prior to interacting with them.

Again, we are circling back to what we started with. The amygdala seems to be, you know, responding as per a vigilance component. It seems to be evaluating the stimuli around us with respect to, you know, whether they pose a threat, whether they do not pose a threat. And if they pose a threat, they are alarmed, the amygdala seems to be alarming us and preparing us to respond in a particular manner. So, all in all the evaluation processes in the amygdala are not only you know they are not only enhancing attention and the processing of the stimuli in perceptual areas, but they are also you know influencing the approach slash avoidance decisions via interactions with this orbitofrontal cortex. So, this is basically you know what we are seen about the amygdala so far.

Now, there is other things also that we can consider for example inferring impressions from behaviors. Before the advent of these fMRI studies to investigate the neural basis of social cognition research indicates that people form impressions from observing behaviors of other people. It is not always that you sort of are able to interact with their faces or look at their faces, but also how a person is behaving around you. can also sort of give us an idea or an impression about them. And several studies on this spontaneous trait inferences you know with behaviors have demonstrated that such inferences are associated with the faces that accompany these behaviors.

So, you are sort of tagging the kind of face with the kind of behavior that the person is doing and that together is giving you this idea of forming an impression or it is biasing your impression formation. In a bunch of these self, you know, spontaneous straight inference studies, people randomly assigned the behaviors to faces to avoid effects of facial appearance on inferences and subsequent judgments, but they found that the decisions of the participants actually went and they linked the face to the behavior that was being observed. Now to investigate whether rapidly acquired person knowledge affects the neural representation of faces, the authors conducted an fMRI study, Todorov and colleagues 2007 and which was modeled after their behavioral paradigm where they presented faces with single behavioral descriptions for a few seconds. So, a face is presented and it is written oh it is a punctual person, another face is presented it is a caring person, another face is presented it is a responsible person. What did they do? In the first phase, participants familiarize themselves with faces and behaviors.

In the second stage, they were presented with just the faces that were associated with these behaviors. And these faces were intermixed with the novel faces also. There were another small list of these faces. Now, although this task was basically a perceptual task wherein they had to decide whether each face was the same as the preceding one. So, it is like a n-back matching task and it did not really demand the retrieval of person knowledge that is the behavior of this person.

The rapidly acquired person knowledge actually came to the fore and it modulated the response of two faces in a number of brain regions. So, it basically tells us that it is not only the face that we are Remembering, we are remembering the behavior or the impression associated with each phase. More specifically, phases that were associated with behaviors evoked a stronger response in the medial peripheral cortex and the superior temporal sulcus than novel phases about which the participants were not aware

about anything or any of their behavior. Also, the type of behavior that was associated to these faces also affected how the individuals responded to these faces. For instance, faces associated with disgusting behaviors evoked a slightly stronger response in the anterior insula, another region that is implicated in the processing of disgust related stimuli.

And again this pattern of results is consistent with Leslie brothers hypothesis that personal knowledge is something that is computed automatically and it plays a very important part in face perception. Now, again this seems to be you know fairly intuitive and it is an adaptive point that people should be able to rapidly you know learn from other people and they must be able to override these initial impressions. The same is demonstrated by certain you know this bunch of findings about person learning or representing persons. For example, this initial impression formation from behavior occurs after a very small time exposure to both faces and behaviors. You just need one glance to link oh this person is behaving responsibly, this person is being mean to this person and you link the face and you link the behavior and you may recall it back again when you are interacting with that same person again or you are supposed to be taking a decision about this person.

Also, this you know impression formation from behavior is relatively independent of the availability of cognitive resources. People have been shown to be able to do this even when they were working under high working memory load conditions. another thing this impression formation seems to be independent of the explicit goals to form impression it is not that they are that you are constantly knowingly evaluating the people and their behaviors around you even if you are not doing that even if you are not really explicitly evaluating the person if a person is linked to a certain behavior that you know connection is quickly made and remembered. Finally, subsequent effects on perception and judgment are independent of the explicit memory for behavior. So, it may happen that you saw a person behave in a particularly mean way or a particularly nice way sometime and then you have forgotten that instance, you have forgotten that context, but still your behavior that manifests as your liking or disliking of that person, it still manifests irrespective of you I mean sometimes people will not be able to remember oh why do I think that I do not like this person or why do I think that I like this person a lot.

It may be that you have observed something in the past, now you have forgotten that explicitly, but that judgment is actually playing a role or that you know memory is you know playing a role in the way you are going to respond about these individuals. Also, findings from studies of patients with brain lesions are also have been found consistent with the idea of robust person learning mechanisms as we just saw. And it is a very interesting case of brain damage which Tranel and Damasio described that there was this patient with an extensive damage in the medial temporal lobe and orbital frontal lobe, he had dense amnesia and did not recognize the face of the caregivers could not even show you know the increase galvanic skin response to familiar faces which is taken as an evidence of familiar face processing. However, if this individual was consistently treated nicely by a caregiver Boswell showed a remarkable and a reliable preference for the face in a forced choice preference task. So, again the person has no memory is not being able

to connect these things, but the nascent impression is still affecting the person's decision in these choice preference tasks.

Similarly, in other set of cases with Korsakoff patients it is also been shown that they can acquire and preserve effective responses to people's faces despite the lack of explicit memory. So, these people will not be able to recognize oh this is my friend, this is my brother, this is my parent, but they will remember the nascent impression about them oh I get careful vibes with this person, I get carefree vibes with this person or say for example, I get a pleasant or an unpleasant vibe with this person. Remember a lot of these things that we use you know rather carelessly actually have some kind of you know bearing in our past experiences and as is being you know shown here through our you know responses of the brain. So, these authors who are dealing with these Korsakoff patients presented such patients with two pictures and described one of the two people as bad. Say for example, X stole a car, robbed an old man who lived in the neighborhood and the other one as good, joined the navy, saved a fellow sailor.

The patients reliably preferred the good person despite lack of any memory of the origin of why they like or dislike this person. Recently in a conceptual replication of Johnson and colleagues study, the authors also studied how inferences from facial appearance and behavioral description were integrated in these person impressions. What did they find? In their study, normal participants and three patients with amnesia which was caused by lesions in the hippocampus, they were presented with trustworthy and untrustworthy faces or trustworthy and untrustworthy behaviors. After the learning stage was passed the participants were asked to judge the faces on a number of trait dimensions. Now one patient who had a localized lesion in the hippocampus showed excellent learning just as young and older cultural participants did.

Faces associated with positive behaviors were judged more positively than faces associated with negative behaviors and this learning effect was stronger than the effect of facial appearance. So, it seems that there is this nascent quality about goodness or badness which is learned very quickly and it forms the you know it influences the responses that these participants will give even if they will not be very good at forming explicit memories. The other two patients whose lesions extended to the left amygdala and the left temporal pole actually showed little evidence of learning. So, it seems that the amygdala is critically involved in this learning of the impression and at the same time all patients showed effects of facial appearance on judgments similar to the effects observed for prosopagnosics. Remember prosopagnosics cannot remember faces explicitly, but they sometimes rely on other modalities to remember these faces.

So, together these findings suggest that the hippocampus may not be absolutely necessary for the forming of affective associations with faces, it is probably the amygdala that is doing that job. Other structures in the medial temporal lobe like the amygdala as I said may be critical for this kind of process. Just to sum this up. behavioral findings show that learning can overwrite initial impressions based on facial appearance. See you will make the first impression on based on facial appearance, but if you were told if extra

information is provided you are able to imbibe that you know extra information in your impression of the person that is basically what we are saying here.

However, at present we lack models that are being able to specify how are people integrating the first impression to this information that you typically learn with time. One of the most important task therefore, for future research has to be to specify models of how different sources of person information are integrated you know in coherent person representations. So, it seems therefore, that the amygdala is very very important area involved in face perception, it is involved in the general valence evaluation and it is also involved in a general judgment of whether behavior about a person is positive or negative. Thank you, I will see you in the next class.