Learning about learning A Course on Neurobiology of Learning and Memory
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Lecture – 09
Application of Rescorla Wagner Model – IV

Hello, and welcome to the lecture 9 of the Learning about learning series. And we have we were actually looking at how the background conditioning prohibits the learning to tone CS; when you are presenting in an non contingent fashion all right. So, that I was telling that how we were calculating the learning for the CS and the US presentations and for the CS here being tone.

And we were also calculating the learning due to the background which is omnipresent all throughout. And it does not come into the existence until somebody mean you have a US star. When you have a US at a point, where there is no experimental provided CS then the animal associates with that of the background so we were actually calculating that. And in there what we saw was that you can actually segregate into the back learning due to the background and learning due to the tone.

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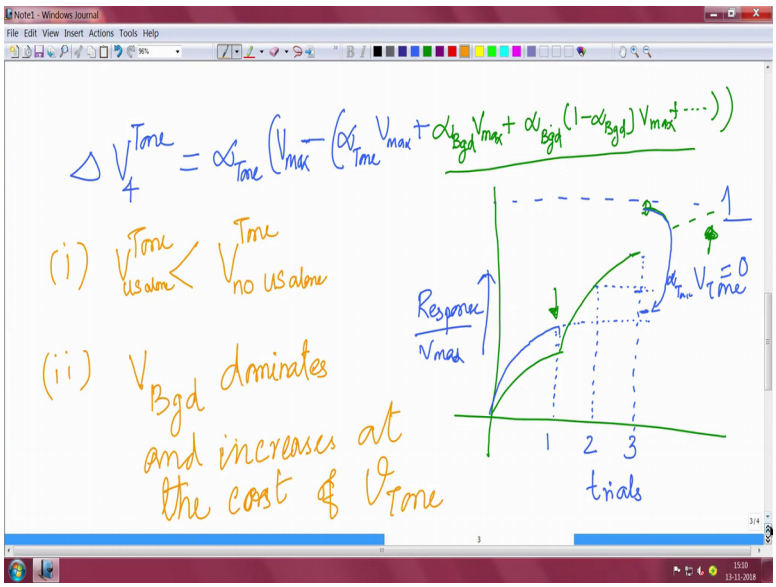

And when you mark it out we saw that, whenever there is a co presentation of the CS and the US; there is increase in learning for or increase in response for both the tone induced as well as the background. However, when there is no presentation of the tone no

presentation of the CS, but US alone; then the increase that you see is purely due to the background. And if there is sufficient number of such presentations had happened.

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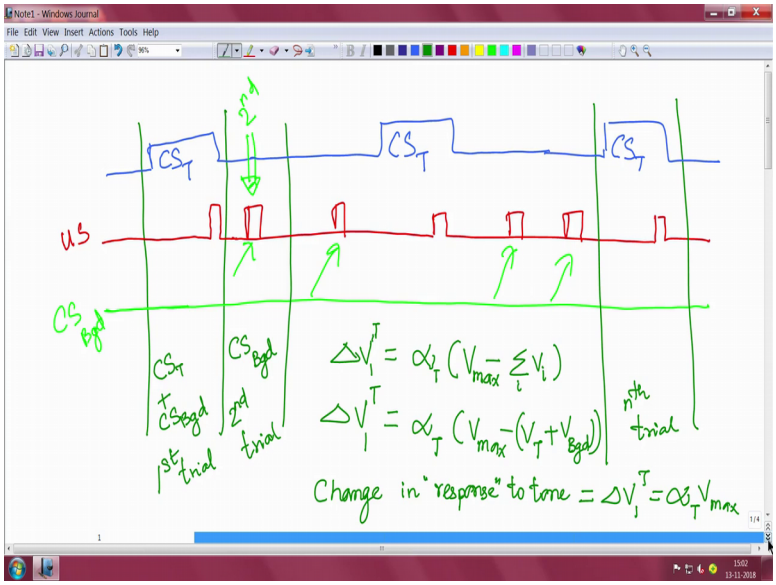

Let us see like for example, first second and third right. So, after this into the fourth presentation right; which has the tone and the background, I mean which has been present which is similar to any of these the first trial. Then in that case what is happening is that, the amount of learning that the animal incurs for the tone. I am trying to show here will be lesser than what it would have learned in the case where these shocks were not present. If the shocks were not present, then these terms would be 0 right all of these terms would be 0.

Since this is 0 and remember this is coming as a subtractive term. So, since this is 0 you are taking away some number from here. The learning that the animal could have incurred how if only the shocks were not present would be higher. But because the shocks were present these were nonzero quantities as a result it takes away more from the V max as a result the fraction that contributes to the learning of the tone is reduced number 1 right. So, number 1 what we see is that so number 1 what we see is that the learning to tone is lesser than learning to tone.

When the CS is presented in a contingent manner right which is there are no let us call it as no US alone evens. If we have two scenarios a scenario 1 where there are no under no condition the US itself is presented. So, whenever the US is presented there is always a

CS. In such a condition we call that as a contingent finally, that is when you say that the predictability of the CS right. the predictability of the predictable power of the CS of signaling a US straw is higher right in that case you see the learning is higher to not naturally.

However in this case where we tone we are measuring in the case of US alones are shock alone things were presented. So, the more the number of US alone you can actually see that this car would have kept going up up up like that the green here you know. The curve could have kept going up like that the more the number of US that you are giving. So, let US put it as dotted lines with hypothesis tickle case then that much less the tone would have been. Say for example, right at this point if you had to give us see the tone and the background right at this point if you had to give the V tone V tone in the blue we are been writing.

So, the V tone would be 0; because the maxi well learning the V max has been already associated to the background. Thus you can see at the cost of not learning the CS and the US association the animal learns to associate the US to the background. So, that see the CS here I am talking about the experimental provided CS the experimental provided CS is the tone. And since the tone and the shock was provided in an in contingent manner. Non contingent manner the shocks that were presented in the absence of the CS in the absence of the tone takes over or attributes an association to the background the animal attributes the those CS's to the background learning as a result it thinks the that becomes the dominant learning here.

In an in between case where say right in this book current situation where you are presenting the CS and the US like the tone experimental provided CS tone and along with the background. So, then even here what we see is that the tone learning will be moderate right that the tone learning will increase from because the left out surprise element is only this much. In this alpha fraction alpha tone fraction would be added to this right. So, this times alpha tone would be somewhere here.

Eventually when you actually this plus the way you want to look at this you have to add this together this which means actually you will be overshooting little bit quite a bit. So, it can be negative learning so we will go back here. So, we will take this as the tone. So, when you do that then we are going to add this number to this number so let us say

somewhere around here at this point right. Green at this point when you add both of them together so let us say hypothetically we are around about here. So, whatever the small difference that we see here right.

So, that small difference the alpha fraction alpha a fraction of that small difference gets added to this. So, the tone gets increased by that small moderate amount. And the next time what is happening is that you are actually when you are presented the animal is actually overshooting the V max here. So, that is a special case when it overshoots what is going to happen will be a special case that we will see in a little bit so hold on to that. But the point I want to drive across here is that V background dominates and increases at the cost of V tone.

Now that is essentially the conclusion we have drawn from the initial experiments right. So, the initial experiment was consisting of two groups. So, where the group a is where we have presented a random group where there are we threw in some of the US's in the absence of CS. While in the control group what was provided what was presented is we are contingent presentation of which is whenever there is a CS there is US.

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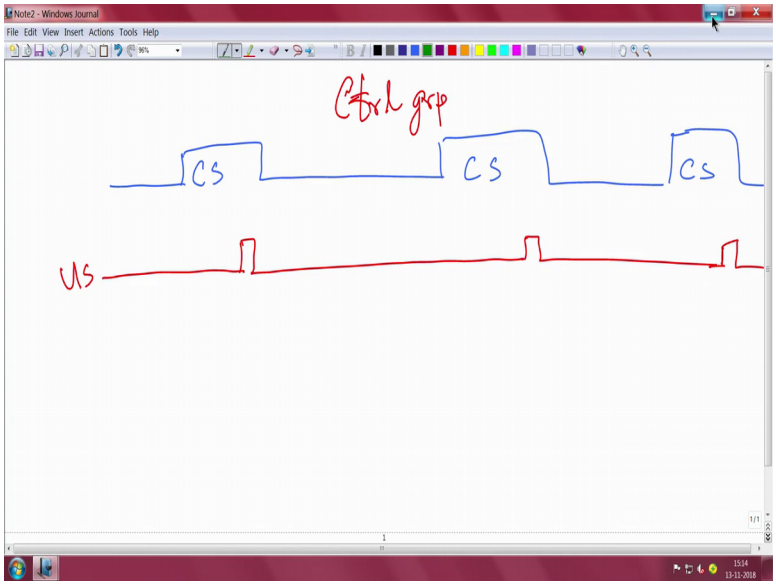

And whenever there is a CS and only whenever there is a CS there is US ok. You could how the omission of the CS's when there is a omission of the US's when there is a CS present. you can actually go back and do that analysis you will see that it really does not matter there. However, the main crux of the matter is occurrence of the US in the

absence of CS that is what makes a difference between this control group where we see a beautiful learning association between the tone on the shock compared to the random group where; this exact same thing is presented in addition you have few shocks where there is no CS.

So, it is through this that is a compound present a compound integration of multiple stimuli and then the distribution of learning across all of this stimuli. And given the fact that you can have a maximal learning of V max, Rescorla and Wagner model incorporates the contingency. Just to summarize again it is this ability of having a finite learning of V max and distributing that V max across several CS that gives the ability of the Rescorla Wagner model to abstract contingency extract out which are all the contingent stimuli and which are all not. Now so these three cases kind of illustrates through these cases we have a three cases we have illustrated how we can use the Rescorla Wagner model to explain the observations we have seen so far.

But the usefulness of the model as I have been saying is not in just explaining what this observe or what the previous observations have been, But can it make new predictions that this not obvious at least at this at the point in time where the model was proposed The answer is a big yes, one of the crucial such predictions in this model that is coming out from this model was, a notion or our concept of over expectation. we kind of alluded to that during in during our analysis of the random group learning. But let us look at it in a much more formal way.

So, the Rescorla hypothesized that; if this model had to be true, then directly coming out from this model we he predicted not only a positive learning that should happen when you are presenting CS and US together. But under some unique cases when you are presenting CS and US together that can be a negative learning. The negative learning itself is not surprising right we have already seen extinction happens right. So, you can have negative learning when there is a V max set to 0 then the things the term can go to negative that is not the point here.

The point is you can have negative learning when you are presenting the CS and the US together right. Extinction is about negative learning when there is no US all right you are correcting or so to speak you are learning to correct what you have learned before. Here he said under certain conditions when I am presenting the CS and the US together that

can be negative learning. What kind of situations are this? Imagine a situation he argued let us say we take CS 1.

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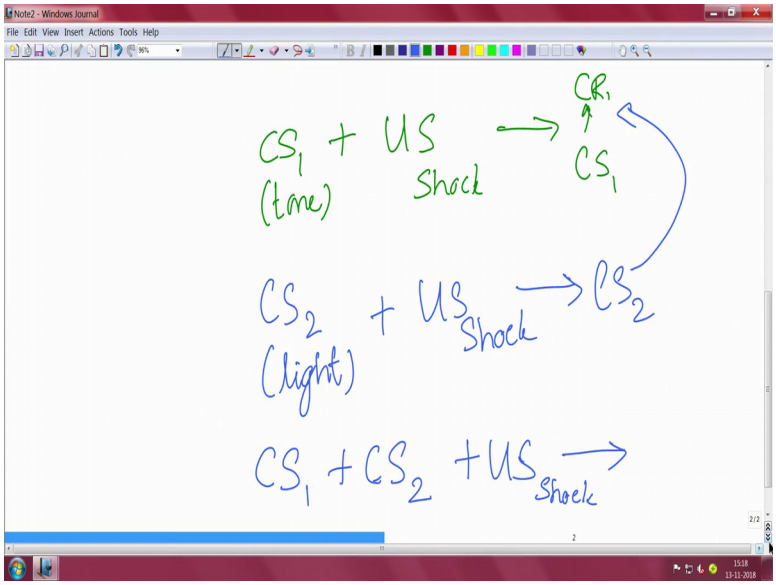

And then pair it with the US let us say tone here and then pair it with the shock. There will be some amount of association that will be developed such that the CS alone can develop a CR. Now you can do the same thing with another CS. So, different color and let us see CS 2 let us say light from the same shock exact same intensity and everything being same.

So, clearly CS 2 also develops the ability to elicit a response from the animal. So, let US call that that also CR. Now take these two instances they take these animals which are undergone training. In both tone alone pad with shock light alone pad with shock. Now let us put in a situation where you are giving a compound stimuli of tone plus light or CS 1 plus CS 2 and pair it with US same shock. In this case whether the response to the tone will it increase decrease or remain same is not a given that is what the model predicted..

You would assume that in a in any case. So, the CS 1 is paired with shock and next time again you are presenting the CS 1 and pairing with the shock you are anyway going to increase all right because you are increasing the contingency that it is happening. So, it should actually increase it turns out that is not the case at least that is not the case always. It depends it depends on what level of response the tone and the light are able to elicit at

the beginning of this compound stream line right. we can easily see this if you are following our mathematical model.

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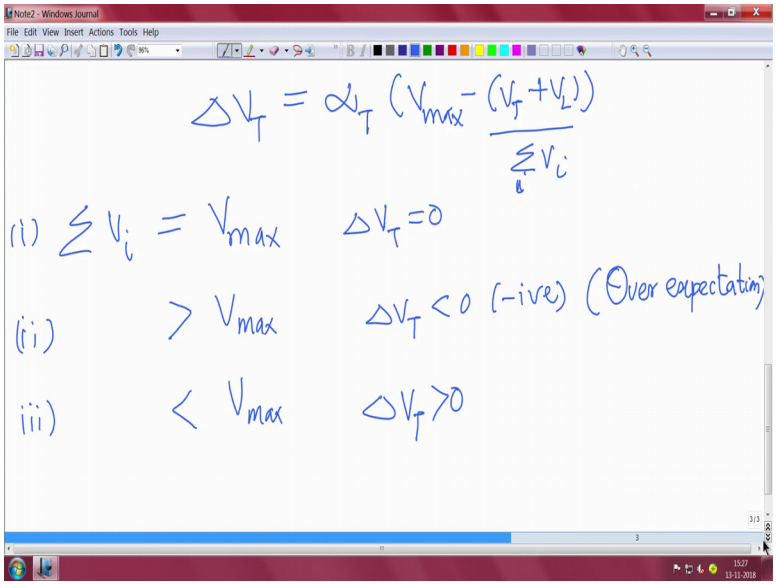

Where what will we do is that in order to ask what happened or to the learning to tone or change in response to tone at the end of the compound stimuli we need to write V tone equals alpha tone times V max. So, that is same because the US the shock intensity is same in frequency same etcetera. So, V max minus summation of V T plus V light. Now you can imagine multiple scenarios here; a scenario 1 where this summation term right let us call let us call this I mean I like to write as this. So, summation of all the CS responses.

If this summation term is equal to V max; case number 1. Case number 2; is greater than V max Case number 3 lesser than V max. As you can see if it is equal to V max right if they have both the light and the tone the individual responses add up to the V max. Then the response you will see for the change in response you will see will be 0 the tone delta V tone will be 0 if it is greater than V max now that might seem little counterintuitive or inconsistent. Because we said V max is the maximum response that the animal can have.

So, in that case how can an animal animals response be greater than V max. In fact, it does not and individually when you test for the tone on the light they may have responses and they those responses are less than V max. But this being a compound stimuli it tries to respond. Now it when it is trying to respond it tries to respond for both

the stimuli that light and the tone and clearly it cannot respond beyond the V max. As a result what it is doing is that maybe I am overreacting I need to correct it and that correction means a reduction in the V tone.

So, if it is greater than V max what you are seeing is that your delta V T is going to be negatives it is right. It is going to be lesser than 0 which is negative and it is going to be negative by that it going to decrease by either alpha T right. I mean the alpha T is again the scale by which the animal reduces or alters it is responses that does not change. But the point is that it can go negative right. So, the point here is this is an effect he call it as over expectation. And this is the normal one right when the summation is lesser than V max what you have is the V tone greater than 0. It they alter their individual responses by some amount.

Now this is true for light or tone, but the point here is that you can have this negative responses where the animal later on when you go back and test for just the tone or just the light you will see their response has come down compared to what it was before; before the presentation of the compound stimuli. So, that is pretty counter intuitive that is mean the fact that the effect of a compound stimuli is not it cannot be predicted just by in as one, but it can have three different concept mean it can have three different directions consequent to the fact at that start of the compound stimuli what is the level of learning for the tone and the light.

Now that negative learning is a clear prediction that is coming out from Rescorla and Wagner model. And it was not known before and the Rescorla went a head and tested these observations in his 1971 paper we will see some of these results in the forth coming class. But the thing that about the point I wanted to convey here is that this model with it is very simple one line mathematical summary of the assumptions captures not only whatever the observations have been made on associative learning before. But it can actually make useful and very non intuitive predictions that was not known before.

And now and people have gone ahead and tested how true are these predictions and the answer is true it is definitely true that you would have this negative learning and the over expectations corrections to the over expectations can be done through this process all right. So, with that I would like to bring to an end the description of the model per se.

But what I will like you would like to point out is that with any such model there are limitations..

Howsoever good they are they are limitations and these limit these limitations we will look at it one at a time like toward a couple of them But in by no means I am saying this is the model that it captures every single aspect of associative learning. But this is the model that is proposed and it is for sure one of the very well studied model and it is within it is limits the it completely captures the associative learning paradigm.

The key is within it is limits as long as we know what it is limits are it is very very useful and very accurate in predicting the observations good. Then what the limitations are let me list out the limitations here ah; however, in the next class we will go in a depth at what the experimental evidence Rescorla had for this negative learning. And even to some extent the detailed description of the limitations by themselves.

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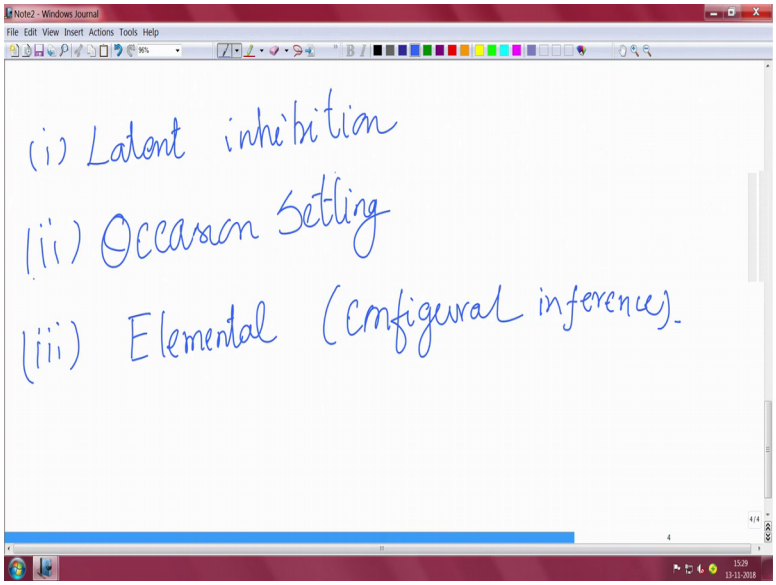

Ah limitation number one we will be talking about something called as latent inhibition all right. And second we will be talking about something called as an occasion setting experiments. These are two instances where we can there is also third which is inherently the model makes an assumption that the in a compound stimuli the responses are additive.

So, you call that such kind of an assumption you call that as this is elemental inferenced by the model makes an assumption of elemental inference by the animal of the various stimuli present there. This need not be the case then animal instead can have a configural inference of the surroundings. So, we will look at these three aspects. And how this model fails or how these things sets a limit on the Rescorla wagners model from their own we will ask some important questions. A question of what exactly is happening when an animal forms an association. see in the next lecture.

Thank you.