Learning about Learning: A Course on Neurobiology of Learning and Memory

Prof. Balaji Jayaprakash
Department of Centre for Neuroscience
Indian Institute of Science, Bangalore

Lecture - 14
Sign vs Goal Tracking, Linking complex behaviors to simple molecules

Hello and welcome to lecture 14 Learning about Learning lecture series. In this lecture as I promised we will be talking about Sign Tracking Sign or Sign directed responses versus Goal oriented or Goal Tracking responses. And I will explain to you what that behavior will be using. And what do I mean by sign tracking versus goal tracking or sign directed versus goal oriented behavior what they are. And how do we study them these be kind of behaviors in rodents in a lab setting.

Then I would the motivation of this would be to be able to understand from these complex behaviors, how we can seemingly relate this seemingly complex behaviors to simple molecules right. These are simple molecules as small as a few 100 molecular weight molecules or even less than that. And we can actually by measuring the amount of these molecules in the brain one can relate and predict which we are given animal would go.

We can modulate them it take a given animal and then inhibit or present more of one more of these molecules and then change the sign directed animals to become goal oriented and vice versa. So, in order to step into this first let us define what we mean by a sign oriented or sign tracking behavior in an animal.

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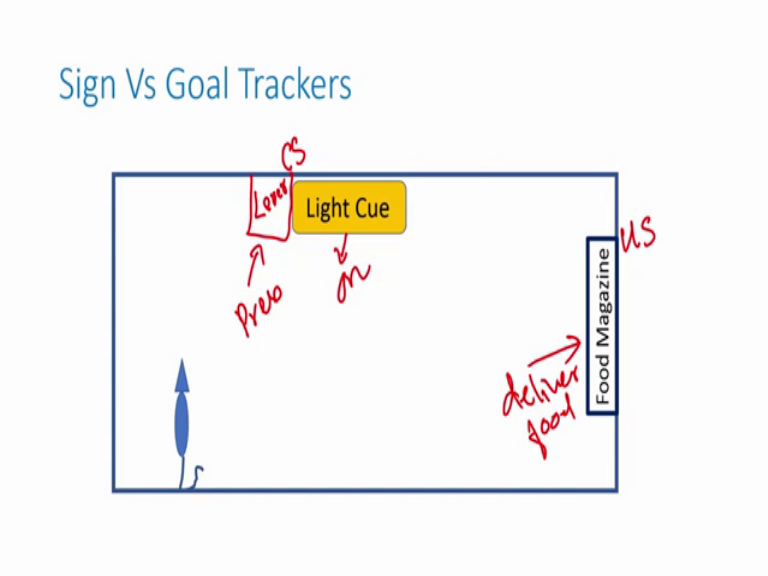

Remember we were talking about towards the end as setting a skinner box kind of a setting where in you have a mice or a rat or any rodent for that matter will be training them in a operant conditioning right. So, there is a light cue inside this box. So, right next to it in this light cue is lever. So, now, the idea here is that we want to train the animal such that in response to the light cue you have to press the lever. And when you press the lever in response to that animals press pressing the lever, we are going to deliver a food in the food magazine ok.

So, there is a light cue that turns on that goes on that is the sequence of events. The light cue goes on the animal then has to press the lever upon pressing the lever you are going to get the so, lever press and then delivery of the food. So, this is the sequence of events that is going to happen and we are going to train the animal to get this I get acquainted with this and then develop the habit of pressing the lever.

Well in doing so it turns out you can actually study this behavior a little bit more intensely or little bit more in an intricate fashion. Such that you ask the question if you if you put break this thing down into a pavlovian scenario what you are actually doing is that than in the animals brain pressing the lever right crosses the food to be delivered ok. So, there is a stimulus in response to that stimulus the animal actually presses the lever.

I mean there is a lever and then you press that lever in turn because of this response you get the food. So, that would be clearly an US and lever the sight of the lever together

with the light cue you would call it as the CS, but the act of pressing would be your response. So, now what you want to ask is that when the animal learnt that you need to go through this process what exactly does the animal learn? Does the animal understand you need to this animal understand that one needs to press the lever to get the food is that what you are actually learning.

Or in other hand is just that it goes blindly there is a light I need to press next I am going to get the food that is it. There is no connection between pressing the lever and the food it is just the sequential thing sequence of things that happen and that happens there. It turns out as with everything there is a population diversity in this when you train them animals in this task. And some of them after your training them when you present them with the light cue after the training what happens is that you see they go directly to the food magazine.

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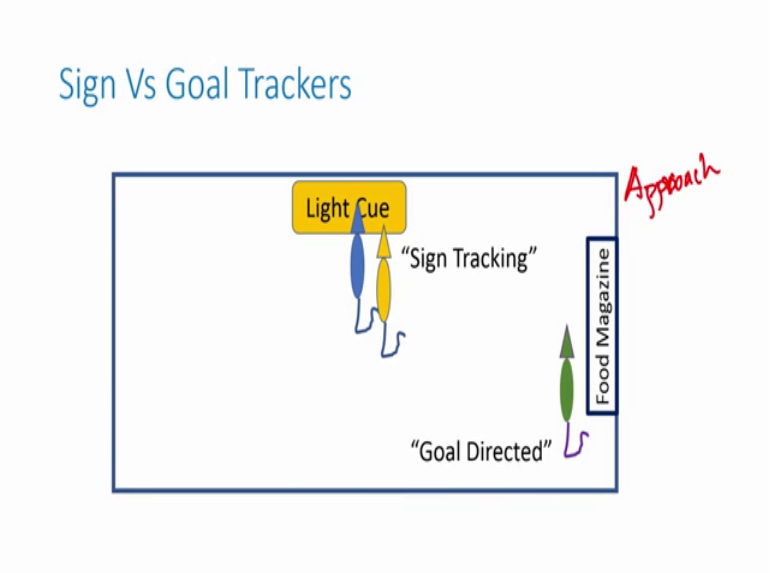

While some others so let us call them as green mouse while some others go directly to the light cue or around the lever region where they are actually pressing them ok. So, let us label them with orange. Now, these orange guys I mean this these orange guys go remember this you have to train them. And once you train them they go in response to the light right it is not as if they put them into the box they directly go there.

Once you press once the light cue comes in they go there and then they spend a lot of time around that lever. In fact, they even start pressing the levers all on the other hand the

green guys, they would directly go to the food magazine ok. So, you can distinguish these two kinds of behavior and we are distinguishing them based on their approach. Approach to the light cue or to the food magazine right if you do that and we distinguish them in two type two types.

The green guys we call them as goal directed because they know that the ultimately I need to get the food that is the goal that is the idea ok. It is for getting the food I am pressing the lever right. Even though they know that without pressing the lever I am not going to get the food they did still go there because that is where the food is so they seem to be doing that. While on the other hand these guys or the other guys or sign tracking.

Sign tracking because when you actually train them as soon as the light turns on they go and press start towards the lever and then start pressing them even though they know that until the CS's ending. So, because the whole training is such that you co terminate the or delay slightly at the end of the CS you are presenting the us you are not presenting the food before that all right. So, even if you even if they know that it is going to be not present I mean the food is not going to be presented and unless until the light goes on and then you press the lever just start pressing the lever while even during the light is presented there even while the CS's still being presented the CR gets expressed.

These guys we call them as sign tracking. In fact, much more profound effort is that when you are actually testing them that is you do not need to present the food. But you just decouple them that just there is a light cue and then ask them what they want to do. The sign tracking guys will go and keep on pressing the lever all the time. So, much so you can actually offer them the food without even having to couple the, I mean after training them with the stimulus response outcome.

You now decouple the response and the outcome there is no contingency of whether there is no requirement of pressing the lever to get the food. Even then they will keep on going and pressing the lever. So, that is a very very profound difference in their behavior. While the goal directed guys quickly understand; hey look I do not no longer need to go and press the lever because they anyway go to the food magazine they explore that they get that.

So, they immediately catch up and then they do not go and keep pressing the lever at all they decouple that very quickly. You can actually classify these two characteristics in an

animal. And then say that those guys the orange guys are sign tracking guys while the green guys are goal directed guys. It is not just response in this behavior. You can actually do a couple more things there are very very interesting characteristics that is associated with this sign tracking and the goal director or goal oriented animals.

So, one of them being so how exactly you classify them outside of the skinner box itself. So, these sign trackers it turns out when they were the people were researching and trying to find out if they can actually get a one pure group of mice that is purely sign tracking versus other group of mice that is purely goal tracking. Then they were actually trying to study something else.

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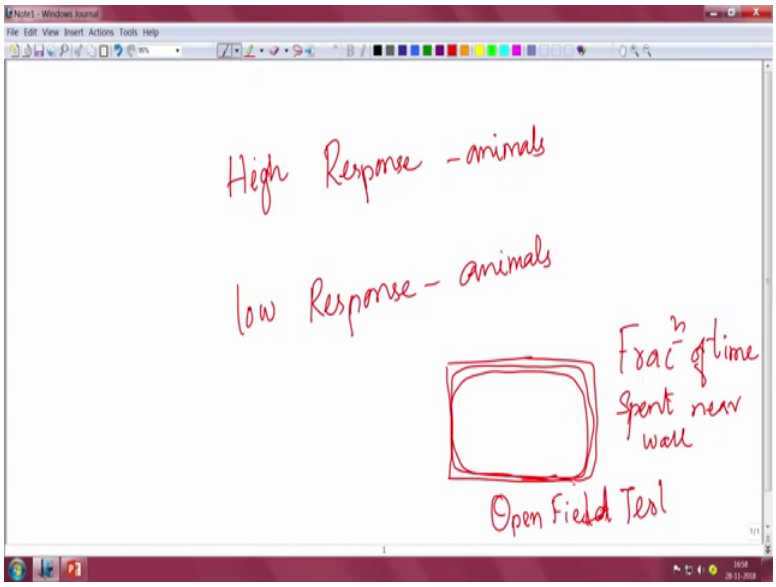

They are trying to they were trying to study what is called as high there they were actually trying to study response responsivity of animals they call them as high response animals. High response versus low response; what it means is, you can measure the locomotor activity in these animals ok. How do you do that is that it is very very simple this is one of the very initial test that you do when you are actually generating a new kind of a mice or in a lab setting or you want to study locomotor action or anxiety related behaviors.

What you do is that you take the mice and then put them in into a big open box; I mean reasonably big open box. The walls are about a 6 inch to 8 inch tall depending on the kind of rodent you are using. And it is reasonably lit box ok. So, the idea here is that for a

mice they do not like to go into a very vast open fields because there they the innate behavior of putting them into a vast open field exposes them to the predators.

And that they thereby there is an anxiety associated with that behavior and they naturally I mean by nature they do not necessarily go towards the center of the box that easily. Versus so what they do is that they try to move around the wall it is called as a wall hugging behavior. They do this pretty nicely you can estimate in a after putting in a mice in this open arena it is called open field test open field test.

You can estimate in this open field the fraction of the time the animal spends in this wall hanging behavior. Fraction of time spent in the wall hanging behavior near the wall let us go to the near wall. Now this fraction goes up when the anxiety level goes up and it is also generally high in the guys who are little bit more lethargic they do not necessarily go move around that much right.

Again this is goes to the fact that the animals that are fast moving and tend to be a little bit more explorative and they are they can come back faster that is one of the reasons they tend to go and the next floor more into the central regions. So, when you are actually measuring the fraction of the fraction of time spent near the wall you can also classify them based on their locomotor action right locomotor the speed at which they are executing the locomotor action that is moving around.

And based on that you call it them as high responsive or high response elements high response animals you call them as HR animals and then LR animals. What a group of scientists did are that they took these animals ok. Rats to be more precise they took these rats and classified them into high response versus low response. And they selectively bred them ok. So, the high response elements would be crossed with the high response elements to get the f ones and then they are bred again and again and again and in about 20 or 30 such crosses across the generations.

After 20 30 generations they are now class apart they are now compare these two groups the HR group versus the LR group. And they differentiate that by their inbred so they are called BHR versus BLR will be studying these groups in a little while. So, we are bringing in this nomenclature they are very vastly different in their locomotor responsivity. Not just that they are also different in something else they studied you can

their hypothesis is that this may somehow be related to the sign and directed versus goal director impulsive reactions so on and so forth.

So, put the they are going to put this I mean with once generate these kind of inbred lines or rats have been generated they are going to put this at across set of behavioral battery tests to actually classify them which way they are going to which way they are going to fall. So, one of them is called as impulse control task alright. So, now, what is this task? As the task name suggests it is about the it is measures the animals ability to control impulsive behavior. What you call it as an impulsive behavior.

An impulsive behavior is a behavior where you know that the behavior that we are going to engage in is not necessarily going to give the outcome that you are wanting to have that the reason why on which you develop that behavior. So, let us look at that stimulus response outcome. So, on a classical example would be you have developed this response. But even though you know that the response is not going to give that outcome you are not able to control inhibiting that response. So, you would go ead and express that response.

Even worse you can actually model this whole thing such that if you had to respond you are not going to get that outcome in even in that case they will continue to exhibit that response. Now how do you go about doing this remember we talked about different scheduling schemes right. And one of the scheduling scheme that I did not talk about, but I am going to give you is going to tell you or give you a measure of impulse control to talk about.

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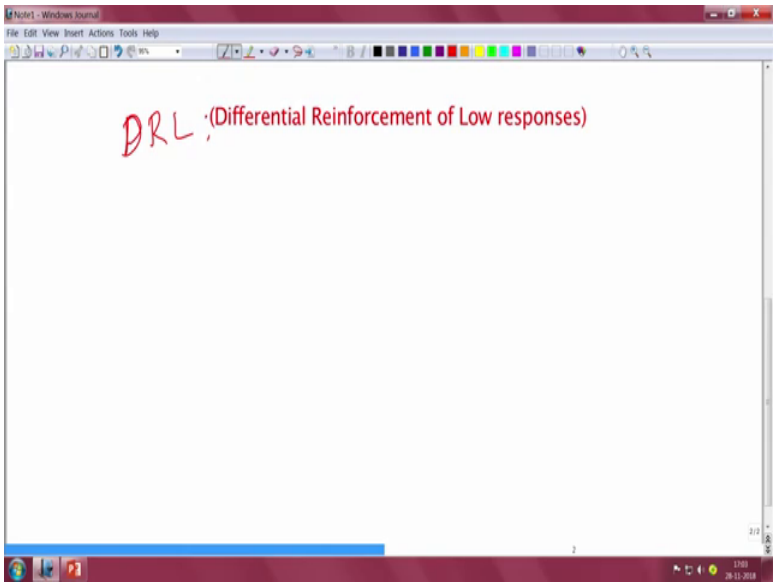

So, this is called as D R L all right let us not worry about the name , but this called us DRL scheme or DRL scheduling. What it means is that you have trained this animals such that you press a lever press gives you a food at and then you are training them in let us say fixed interval series.

Only at these intervals you are actually giving them now you can modify this a little bit. And then say I am not going to give you a food for any lever press at that interval. But what I am going to do is I am going to make sure I am going to remove that interval contingency. But I am going to make sure that if you do not respond for a certain period let us say the animal makes one response.

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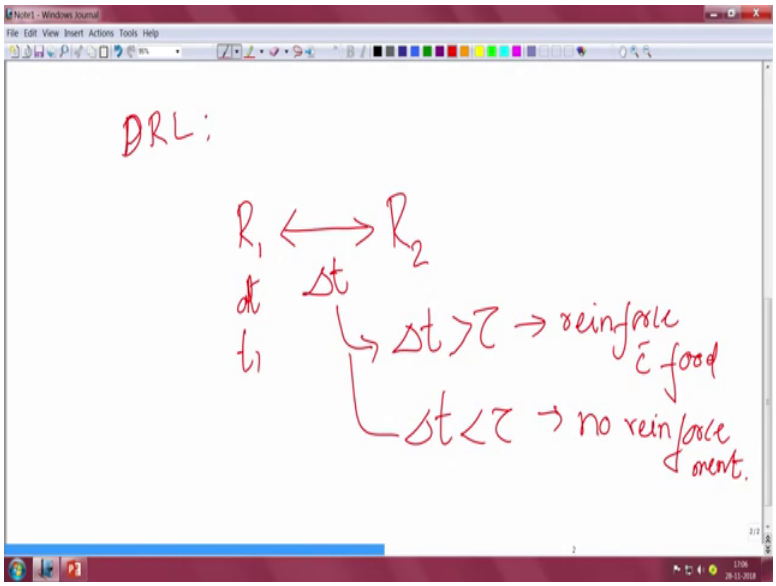

Let us call that as R1 at t 1. Now what we are saying is that we are going to wait for a delta t bit and only and only if this delta t is greater than some tau. So, so we are going to reinforce delta t greater than tau reinforce with food. If delta t is lesser than tau no reinforcements good so, then were going to ask them to perform this task right we were going to put them in.

And say that hey look can you actually suppress your behavior of lever presses such that for a certain period of time we do not press eventually you have to press. But then you have you should make sure that you are not pressing too much you are not going on to like that yeah you have to make sure that there is a certain amount of gap that that delta t greater than tau is there before you can get your reward when.

So, let us you can you can understand the notion of the impulsivity right impulsivity is just you know that here clearly if you were to actually press too fast you are not going to get a reward the problem is I mean the point is it is impulsive because unless you press you are not going to get the reward too. So, the animal knows that it needs to press but it needs to the point here is it needs to press at a certain interval not before that the key is the interval.

So, can it suppress for that long if it cannot suppress you are going to say it does not have the simples control ok. Now you can do that as a function of this various to us you can delay it for 15 seconds 10 seconds 20 seconds and ask at which point they cannot

with that impulsivity. That serves as a measure of impulse control apart from this . So, this is one way of classifying an animals.

So, animals that have the ability to impulse control and the animals that do not exhibit that very good impulse control. basically what you are trying to say here is that can I inhibit my response at will if I cannot I say that I lack impulsive control or to say I act impulsively. If I can then I say I possess the impulsive control good. So, the bottom line here is I want to convey that at tasks such as did the DRL scheduling task will help us to elucidate if a given group of animals or a given individual has an impulse control and by varying the tau that we described we can actually ask how long or how much of an impulsive control the person has.

So, now what we are going to do is that we have used we know we talked about the open field test where you can actually measure the locomotion. We talked about the DRL task which tells about the impulsive nature of given animal. Since the open field task has a combination of the locomotion and anxiety I think it is a right place for me to actually mention about another behavioral experiment which tells you to measure the anxiety by itself not just necessarily as a complex behavior of the movement on the anxiety that is curled as an elevated place maze.

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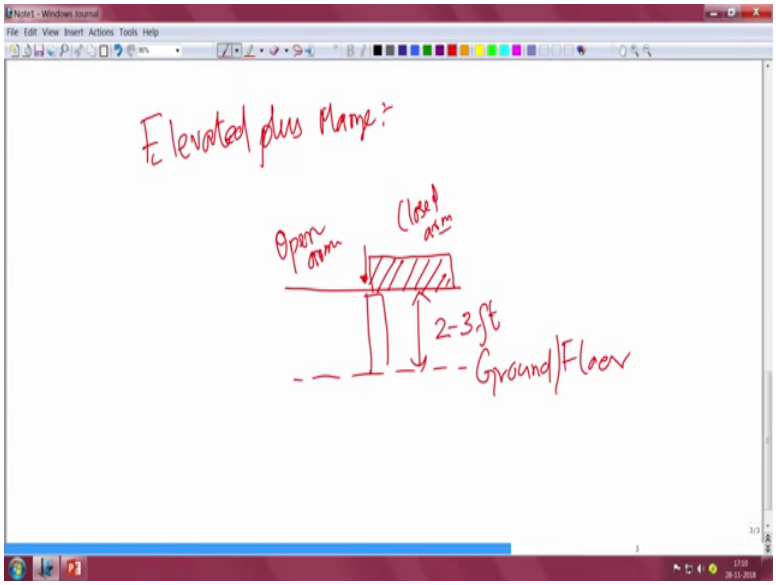

So, whereby you are actually going to measure elevated plus maze. Wherein you are actually going to measure the anxiety and anxiety alone. The task involves a raised

platform. So, when you look from the side it is pretty much like you have that ground or the floor here and then you have a small little platform that is raised well above the ground.

And typically it is about 2 to 3 feet above the ground level. And then one half of the arm has this protection protective sheet I mean it is . It cannot I mean it this is like you going into a sky bridge and then the sky bridge is having a wall I mean and then the rest of the sky bridge does not have a wall you just still have to continue there right. So, the experimenter places the animal right in the middle and then measures the time that the animal spends in what this is called as an open arm.

The animal that are anxious tend to spend more time in the closed arm compared to the open arm. So, with a combination of these three tasks the elevated plus maze open up or in open field tests and the DRL scheduling scheme. We can actually dissect out different behaviors and classify the animals that we have raised in terms of the high response and the low response animals.

And in the next lecture what we will do is that we will look at these animals how they actually classify I mean how they performed in this different task and when you classify them what group of behaviors tend to go into do they even have a group of behaviors that are specific for one kind like the HR probably versus the LR guy. All right I will see you in the next lecture.