Learning about Learning A Course on Neurobiology of Learning and Memory
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Lecture – 02
Introduction to Learning and Memory - II: Classification

Hello and welcome to the lecture 2 of the Learning and Memory lecture series. In the last class, in the last lecture, we were discussing quite a bit about how we can use 3 letter nonsense word list to study the span of memory or the our ability to retain memories and based on that how one can classify memories into short term, long term and long lasting terms memories.

Then we spent a quite a lot of time discussing about how various different attempts have been made and to localize the memory in the brain of which one of the profound study of H.M, the patient H.M; if you remember he underwent a brain surgery to cure his epilepsy and after the surgery, his epilepsy was definitely much better. He was very much under control.

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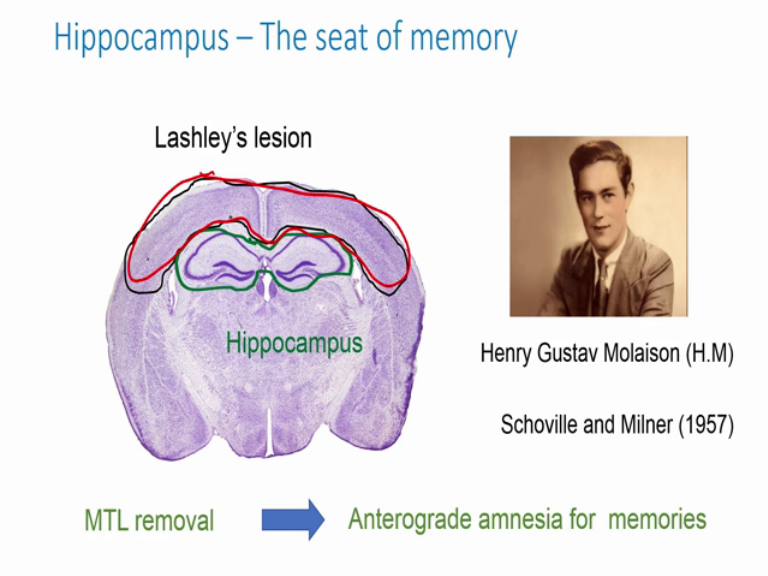

However, he started to exhibit clear deficits in his ability to form new memories right. That is our Henry Gustav Molaison or H.M and we also said why this study is very different from the rodent studies that have been done by Karl Lashley, mainly due to the

region in which these brains have been listened right. The region that was lesion in Lashley studies was right about here in the cortical regions.

While the equivalent regions, we saw that were lesion in H.M where was Hippocampus ok. The conclusion was that if you do lesion medial temporal lobe, then you develop Anterograde amnesia for memories that is your ability to form new memories is last ok, while he was able to retrain his old memories. So, to different extents, but definitely his ability to form new memories is unquestionably lost.

Now what did we learn from here? It turns out that two things are happening; one is that while his ability to form new memories have been lost, his ability to remember old memories his very old memory, childhood memories was completely and intact to the point that it would be intact in any other normal human being. It is common that we do lose some of the memories of the childhood.

And he was losing only to that extent and not any more than that. That itself is surprising right. The very memory the very region that is responsible for forming the new memories without that region he is able to retrieve those old memories one. Next as demonstrated by this very beautiful experiment. So, far we have been talking about memory in the unitary fashions like every single memory belongs to one kind; we put them all in one basket.

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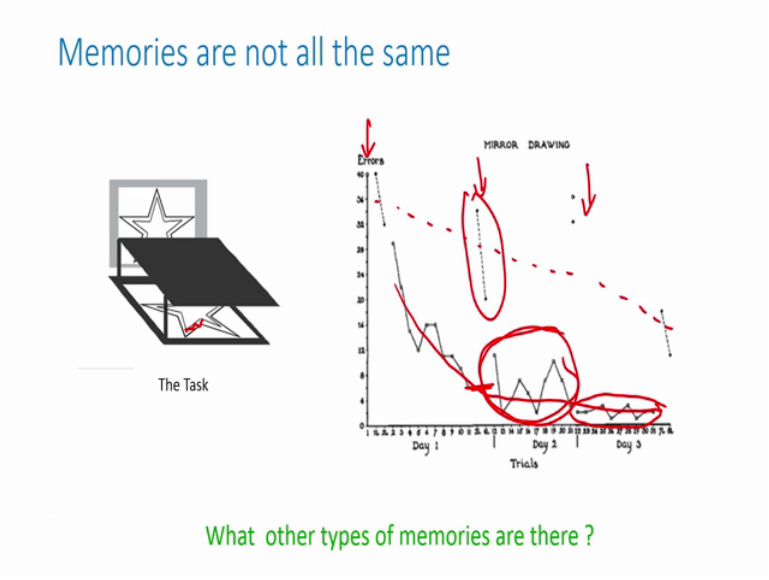

It turns out that is not true, why do I say this? We know that from this experiment, the experiment goes like this. You have this double lined star pretty much like our childhood school studies, where as we are trying to learn how to trace or how to write you are supposed to actually trace a line between those lines right. Now my ability to do this is pretty good or like with any just like anybody if I am actually allowed to see this directly, visualize this directly and then do it.

However, if I put a black screen as shown in this image where you are not actually able to draw it on this structure, but rather you have to draw on a paper that is placed under this black sheet which means you cannot see it directly. However, you can you will be a to see only through this mirror all right. So, you had to correct for your errors through the mirror image that task is not that trivial. So, people do make mistakes and then, they cross once in a while these two lines. You can count how many number of times people make this kind of crossings or the errors.

If by doing that you can actually measure the progress of this person as he tries to do it again and again and again and when you plot it in H.M, you can do that for his left hand as well as for his right hand. The dotted lines here represents the left hand and then, the continuous lines with the dots represents the right hand. Within a day he definitely shows progress; clear science of learning and you cannot learn you cannot just learn, if you cannot store it right.

So, clearly there is some kind of memory that is being present. Of course, one can say that look all throughout this point in time you are engaged in the task. So, you are actually not really taking the person out of the task. So, you are kind of probing here the working memory so to speak. But these are individual trials, but anyway the point is that you can do that in a day he is learning. But you bring back H.M to the same task the next day, since he does not have any memory, he does not have the ability to form memories of the lifetime events. You have to explain to him the nuisance of the task all over again. You have to tell him you cannot look underneath the black sheet.

You have to look at the mirror, you have to be. The idea here is to be able to look at the mirror and trace the line between this two star shaped lines. Then you measure how well he is progressing just by just the way you did it in the first step. What you see? It looks as if he is starting from the place where he left on the first day. See that is the second

day's trail alright; left hand and the right hand. Clearly, he is starting from the place where he is left on the first take. Even though he does not know how exactly to do this task on this day, suggesting that there is a reminiscent of what has happened in his life previously, though without his consciousness not just the second day. In fact, you can follow it up.

And then, the third day same thing happens. You have to again explain to him what this whole task is when you bring him back on to the third day. However, when you actually measure how well he is performing in this task, unconsciously he is able to use all the previous learning's as exhibited by his performance; almost as if it is a continuum from the day 1, all the way to day 2 and day 3. Again, the same thing is true for the left hand, that is the right hand and you can actually do it for the left hand and pretty much their performance improves. Even though he does not know every single time the day 1, day 2, the arrows are the places where you had to actually explain to him what the task is about.

So, what is happening here. What is happening is that until now as I was telling we have been treating memories as one unitary phenomenon in putting them in once in one simple basket. It does not seem to be the case, while he is not able to consciously recollect what this task is right, but that requires a conscious recollection. Somebody told you what this task is you need to be able to if you had to tell to the person what this task is and you have to consciously be able to say that ok, look I went there, this is what I did and blah blah blah blah that he is not able to do.

However, when you test his procedural skills right, the skill memory right his it is about he has developed a skill here right; the skill of going between these lines without crossing them. If you test that he definitely shows an improvement in the performance. That is the memory that he is able to form, of course, without his consciousness. Now, that for the first time allowed people to think in terms of memory being indifferent classes.

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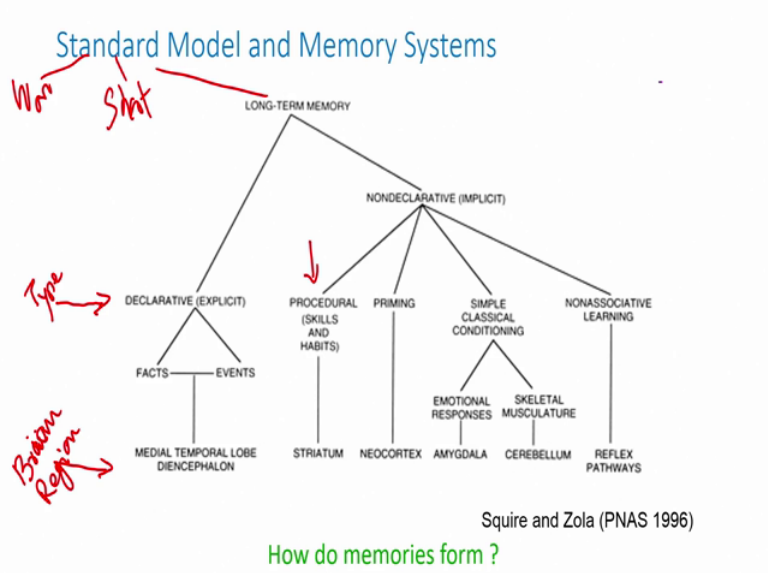

Now, we know the memory per say here I am talking about Long-Term Memory. Why long-term? Because can actually see that we are talking about memories across days; clearly it is not about within a day or within a task with across days. So, when you are actually looking at this long term memory, they themselves have different classes. Remember we talked about working memory, short-term memory and the long-term memory right; 3 different classes to start with.

The long term memory that I am talking about here can again be divided into different classes. The memories that you can consciously be able to recollect, you call them as declarative memory, are also explicit memory. The memories that do not require your consciousness that you do not need to I mean that you do not use your consciousness to recollect, you call that as non declarative memory.

It turns out when you do this kind of a classification you can actually 0 in on which kind of memory depends on which region of the brain. So, that is the type of the memory that I am talking about and that bottom line tells you the brain region; brain region that you are that we think is responsible for that that type of memory.

For example, here the declarative memory, the memories that is required that you are able to consciously recollect right, they are dependent on medial temporal lobe. If you remove the medial temporal lobe, you do see the deficit you do see amnesia that is what happened in H.M. Like that in the non declarative memory again, there are subtypes. You

can talk in terms of procedural memory, this is the memory that was intact in H.M. We tested it using asking him to draw a line in between the two lines like tracing a star.

Now, that is dependent on striatum, if you had to leash know try a term you would see a deficit on this. So, that this is the kind of memory that lets you ride your bicycle without having to think consciously about where you are footers or to play a game or a sport without having to consciously think about it. In fact, you do not want to think consciously about it left. For example, if you are playing a cricket match, you do not want to be thinking about – 'Hey look, the ball is actually falling on half side line half stamp line and its going to be pitching in. It is pitching in this direction'. If you do not have that kind of a time to think about this. You were hand and the leg need to move depending on what has happened previously in your past without consciously thinking about it. Those kind of memories are called Procedural memories or Skills and Habits that you acquire over a period of time. They are dependent on striatum.

A classical example of a conflict between the Declarative and that Procedural memory is when you go to an ATM and you are trying to retrieve money using your debit card, you typically forget if somebody ask you what is a pin you will not be able to tell the number. However, you just put your hand before the keypad, your hand automatically types in the pin, that is because you might have forgotten through a declare how to consciously recollect the number. However, the procedure skill that you have been typing that with your hand in the same format again and again in different ATMs lets your hand to automatically retrieve that number that is procedural memory. Similarly, there is something called Priming. What is priming here?

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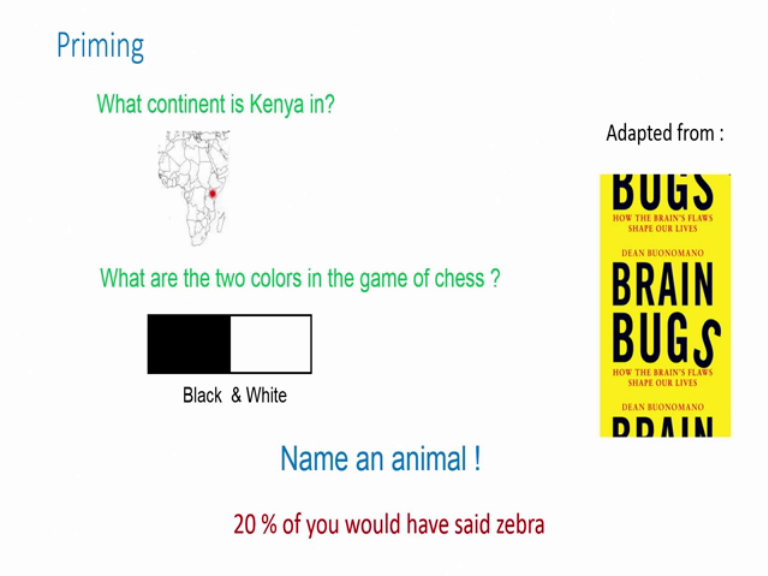

Let us look at Priming in detail through this experiment. This is an adapter from a book called Brain Bugs titled Brain Bugs, interesting to read I would strongly recommend if you anybody who is interested in understanding the insights of the brain and in a reasonably Layman language to read this book. What is this experiment about? I am going to be popping up few questions here and I want you to answer as quickly as possible and you will see towards the end, what the effect of this framing is. Let us start by asking what continent is Kenya in? Many of you said Africa and what are the two colors in the game of chess? You will see black and white. Now go ahead and name an animal. Quickly if when you do that you will see about 20 percent of you would have said Zebra all right.

Now, that number is not a majority. However, what is striking is if I do not ask this question. What continent is Kenya in or what are the two colors in the game of chess and then, ask you to name an animal. Almost less than a percent are about a single digit percent would have said zebra that is very striking. The fact that you normally would not have said, normally many people do not have recollected zebra, but then me asking what continent the Kenya is. The origin of the Place where you most often see a zebra and the colors black and white can invoke a response that you normally would not have is priming.

Eventhough, this is classified as non declarative memory and you will see many of these procedural as well as the priming effects rely on the memories that are formed in the conscious me, in a declarative way manner right. We will see that in a detail when we talk about the research part of what we do in the lab, but very much towards the end of the course.

But the point to remember is that these priming and procedural memories can make use of the declarative memory networks that have been stowed alright. So but like that you can actually classify 2 more things which is simple classical conditioning and non associative learning. The bottom line here is that each of these types of memory are dependent on different brain regions and removing or lesioning out or that brain region are having a problem in that brain region can cause deficiency of this function.

Now that is a very big finding you which we did not know about until patients like H.M and many other Misuk models came into existence. We so far talked about memories and how what are the different classes and of this memory frame. Memories by themselves do not form by themselves not necessarily, you acquire them. Now, how do we acquire brings to the, I am next topic in the course which is the art of learning itself.

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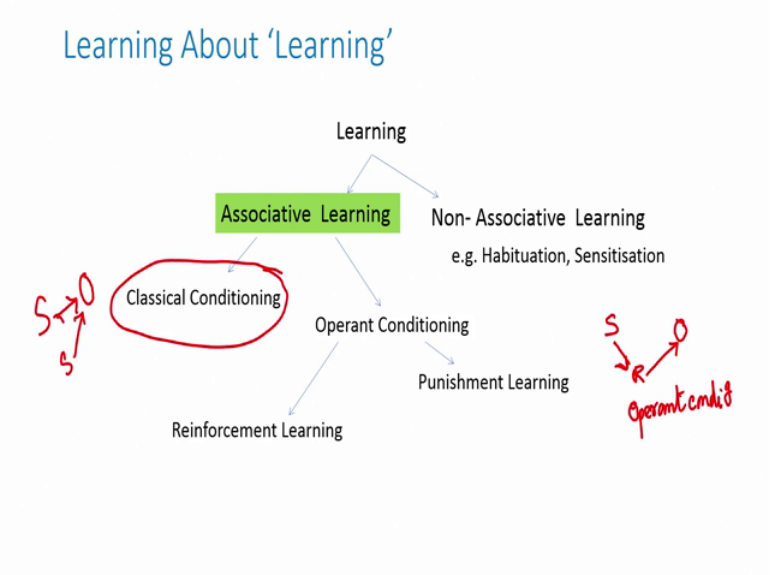

So, let us spend a little time about understanding what we call learning and how we classify learning in that process you will realize we will be mostly talking about simple classical conditioning that I described to you here and I would in the past by mention

what non associative learning means. So, what is learning? Learning itself can be classified into two different kinds; associative and non-associative learning. Non-associative learning is any alteration in an animal's behavior for a given stimuli. So, there are various different stimuli that are existing in the environment; each to many of the stimulus are capable of eliciting a response.

When you are able to modify that response by repeated presentation of the stimuli; then you say that the learning has happened or occurred. In such a case you can think of a broad class of two different learning's; one is called Habituation, where in animals ability to start to ignore a benign stimuli which is not harmful, but it has the ability to elicit a response ok. So, you by you repeated presentation of that, you kind of mellow down your response and almost go to a non responding state and you call that as Habituation.

Sensitisation, the other hand is that to start with you have a certain amount of response. However, this if the stimuli is harmful, then it progressively increases its response and the resulting learning you call it as Sensitisation. These two can be traced down to very different pathways molecularly and hence, on and you classify them as two different kinds Habituation and Sensitisation.

In short, you are decreasing an existing response or to a stimuli are you sorry, you are altering an existing response to a stimuli and here we are talking about a stimuli. There is nothing to correlate to and you call that is why we are talking about we are saying that it is a non-associative learning. Well, we will not be talking much about this and a kind of learning in this course, but a lot of this non associative learning is done using Aplysia.

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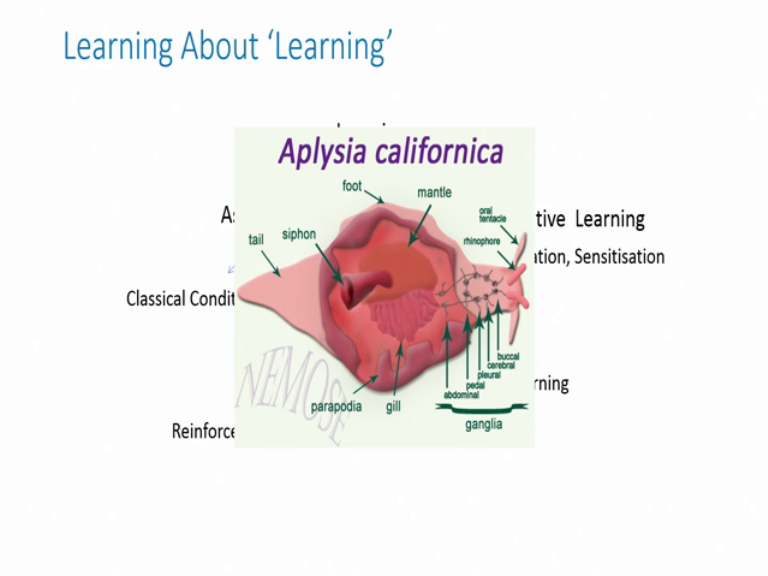

Yes, sneeze sea snail as an model organism where in, the snail has a response suited epic response. The snail has external gill that can be accommodated into a man into its mantle and a protrusion of this gill external gill is organ called siphon. Typically, when you touch the mantle or a siphon or anywhere close to that the response of the snail is to withdraw the gill into the shell.

Now, if you do it repeatedly like mail touches, the animal starts to reduce its gill way travel progressively. If you do it 10 to 15 times it reduces to the extent that it does not even respond. So, that is Habituation. However, if you present as little mind electrical shock to its tail and then, now if you go ahead and touch that siphon the extent the rate and the extent at which the gill which will it all happens is much larger. You call I mean compared to the name untrained animal. So, you call that as Sensitisation. You have been able to sensitize the gill withdrawal response to a harmful environment and as a result any even the what you thought of benign is what one thinks as a benign stimuli like a touch can elicit a much bigger response in this animal.

Now, these are non associative learning and as I was telling that we only talking much about this in this course. But we will be concentrating a lot on Associative Learning. Associative learning by itself can be further classified into classical and operant conditioning. First let us start with what is associative learning? Unlike a non-associative learning where you are altering a response to a one stimuli, here we are trying to learn a

relationship between 2 stimuli, 2 or more stimuli in classical conditioning. What we have is a stimuli that is capable of eliciting a response on its own when it is co presented with the stimuli that normally does not respond that is not realistic to respond, it can develop a response.

So, you are developing a new response to a stimuli that is not rest that does not evoke a response in classical conditioning. While in operant conditioning you are actually, what you are doing is that you are coupling are bringing in a feedback mechanism; wherein, you are presenting a stimuli upon which the animal need to respond. Depending on your response, you are actually going to either reward or you are going to determine an outcome for the task. Such kind of stimulus eliciting a response and based on that you develop an outcome.

Now that is stimulus eliciting a response and then, that response based on that response you are actually presenting an outcome. We will see this SOR relationships, much more in detail, but right and then we will modify a little bit of this and then, how we can actually get a overall picture of the associative learning towards the end, but that is the goal. Let us in order to reach that goal, let us start with the basics of the associative learning, the classical conditioning.

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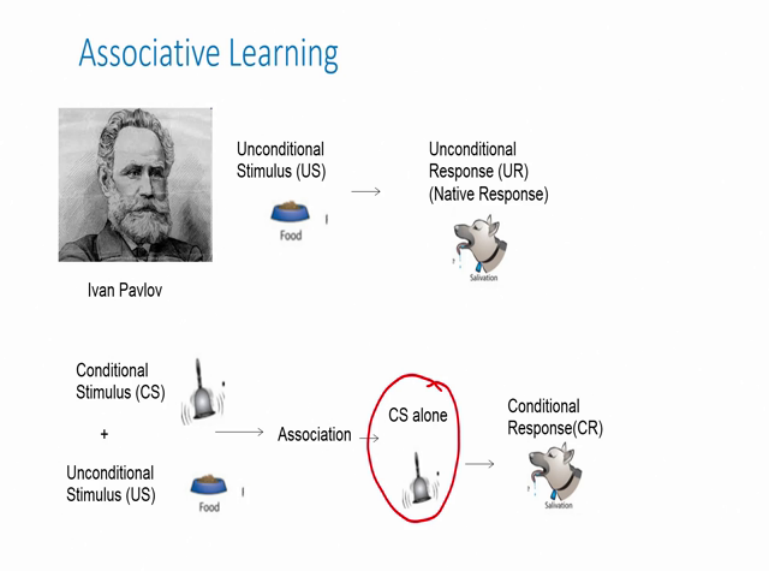

This is from the age old experiment of Pavlov. He observed that there are certain stimuli such as food which is capable of eliciting which was presented to a hungry dog is

capable of eliciting a response of salivation. So, he called those stimuli which are capable of eliciting and native response by themselves as unconditional stimuli and the response which the stimuli elicits a sign conditional response.

However, the interesting fact that he observed is that you can take this stimuli; one of this stimuli and couple with a stimuli that normally does not have any meaning or any response in this context. Such as hear a sound from a metronome in illustration as a bell and over a period of time the animal develops an association such that when you present the conditional stimuli alone later right that the stimuli that does not have a response on its own later. It by itself elicits a response without having to have present the food. Here the response is salivation.

Now note, the sound of a metronome or the bell is able to elicit the response conditional to the fact that it has been paired or represented before to the animal in along with an unconditional stimuli which is capable of eliciting response all by itself. So, he called those stimuli which does not have a native response to start with, but can acquire an native response when presented with an unconditional stimuli a conditional stimuli and the response that you develop over a period of time as the conditional response CR. It is important to understand these terminologies.

Unconditional stimuli, the stimuli that is capable of eliciting a response on its own and the response, you call it as unconditional response. Conditioned stimuli are the stimuli that does not have native response. To start with in this context, however can develop a response when presented with an unconditional stimuli. Now the conditional response and the unconditional response in this case happens to be both salivation, but they do not need to be same.

In fact, they are not many in many experimental setting, but the point here is that often when we are discussing about the Pavlov experiment the we are led to a good misconception, good misconception in a good amount of time I should say which is ‘Hey, the dog learns to predict’. Learns that the tone actually predicts food as a result I should actually start to salivate. It turns out that is the misconception that is not correct at all. What we will see towards the end is that in fact, the dog thinks most of the time at least that the bell is the food, which is drastically different from saying that the bell predicts the food.

Now how is that brought about and how do we actually go about testing this and why do we why and why do we think that why does the dog think that it is the bell is the food, all will be the subject matter for the following lectures.

Thank you.