PROFESSOR: OK. So we've started talking about many of the key concepts in behavioral studies of learning. And I'm basing this on Konrad Lorenz. And this is where we ended.

We were about to talk about avoidance responses acquired through trauma. We had just talked about conditioned reflexes. Remember, he sees the conditioned reflex, as the way it has been studied in experimental situations, as a kind of stimulus selection. And that's always the way it's interpreted. And there are many, many experiments that perfectly fit the Lorenz definition, even though Pavlov's original experiment that so popularly described as an example of classical conditioning.

So we'll bring that up again a little later because you'll see, then, what Lorenz calls it. But first let's finish talking about learning through association without feedback, without feedback reporting the success of the movement.

So we'll talk about avoidance response acquired through trauma. It's very interesting kind of learning, because it's pretty irreversible. It's another type of stimulus selection. It can occur after just one experience, and then be considerably permanent.

He talks about how trainers of dogs and horses-- just like psychoanalysts-- they know how, once an animal learns to avoid something, some stimulus in his environment becomes associated with avoidance, something that's frightened the animal a lot, or frightened the person, becomes associated with certain stimuli, it's very difficult to change that.

In the laboratory usually it's done by pairing sound with electric shock. Sometimes it's not sound, it's another stimulus. And then later, with later presentations of the sound, you will get autonomic responses, increased heart rate and blood pressure. And at least some forms of it are just one trial learning, one experience.

The most common type in the laboratory, as many of you know, is what we call the step down response, because a little rodent on a raised platform will tend to step down from a platform, unless his vision indicates that he's very high up, then he's much less likely to step down. But if he can step down fairly comfortably he will do it.

But when he steps down, the grid-- he steps on an electrified grid-- then, just in that one trial, you bring him back later, and he'll just stay and stay and stay on the platform. So that's an example of avoidance responses acquired through trauma.

And I just point out here that most psychologists-- anything I've added in red on these slides is not in the thing posted online, but I'll change that to the annotated version later on. So most psychologists include this kind of learning in the classical conditioning category. But it's got enough differences, as Lorenz points out, to separate it.

In other words, animals appear to have evolved differences. That's why this type is so irreversible compared with other types of stimulus selection learning.

And then imprinting, which we have talked about before. I said here-- this is on the posted slides, both of the previous two-- that is, both avoidance response acquired through trauma and conditioned reflexes are irreversible. It's certainly true of the avoidance responses acquired through trauma. Relatively speaking, it's irreversible. Other types of classical conditioning are perhaps less irreversible.

But we know that imprinting will cause a fixation of specific responses. They're very specific. We've learned that birds don't become imprinted on humans. There's no such thing. They become imprinted for particular situations, particular kind of responses, like his jackdaws. Because of early imprinting, they can become fixated on companions for sex, or they can become separately imprinted on companions for flocking and flying, and separately for parental care.

And these things are quite separable. And all that became clear in his studies of jackdaws.

And it's also clear in geese. Geese that are raised with humans can become imprinted for what he calls filial and social responses. And yet in their sexual behavior they're not affected. They will have sexual behavior normally with other members of their species. And so there are real species differences in this.

You can separate imprinting from conditioning with reward by simply pitting them against each other. For example, you can have animals that are imprinted on, say, humans as sexual partners. And we've had examples of that, especially in the jackdaws. But it's been done with a number of other species.

And in his book, he describes specific species where a species was imprinted for mating on another species, a similar species but different. Well, if you deprive the animal for a long period of time, you never expose him anymore to that species he's imprinted on, he eventually will-- because his action-specific-- what happens? You deprive an animal for a very long time, the action-specific potential, that is, the internal drive becomes so high, thresholds are lowered, he's likely to start mating with its own species.

OK. So you let him do that for a while, taking care of young, everything. And now you bring back the other species that he was imprinted on. What happens? Either immediately or gradually, he switches over, he switches back. With all the reward and everything associated with mating with his own species, he still will switch back to the imprint of species, which shows the independence of these two processes.

Then he gives the example of innate releasing mechanisms in mallard males and females. The males can be sexually imprinted to other species, but not the females. The reason is they're so dominated by innate releasing mechanisms that respond to the mallard drake's colors, his mating colors, nuptial colors. So it's a very different situation for male and female. Just like there are differences from one species to the other, there can be differences between the two sexes.

So and then finally what he calls conditioned inhibition. And we train domestic animals and circus animals. We even train tigers and bears for circus performance. And they learn, they are taught, to inhibit natural responses. Obviously you're going to be in a circus, you don't want them to be showing prey-catching responses and so forth to a little child running in front of the audience.

So you can suppress, you can condition them so they're inhibiting their normal responses. The problem is, if the action-specific potentials build up and build up and build up because of long suppression, you can sometimes have very dangerous consequences.

And his examples are pack animals, like wolves. A dominant pack member can totally suppress resistance by other members of the pack. And so you'll have passive members of the pack. But they're really-- if he's at the bottom of the totem pole he's really repressed. He can suddenly-- his desire to respond more normally and oppose that leader can suddenly break out, and basically all hell breaks loose and the animal becomes very dangerous, because the normal inhibitions can suddenly fail.

And there are specific examples Lorenz goes through. Hugo Van Lawick studied this in African hunting dogs. And he showed examples of it. They're another group-living animal. There's a dominant animal, and the animals low down on the social hierarchy can occasionally do this if their normal behavior is suppressed for too long. We mentioned they're already in wolves.

It happens in humans, too, in a situation that certainly has legal consequences, namely spousal murder. So it usually happens when a woman is so totally controlled by a spouse that her normal reactions are totally suppressed. Her normal drives she cannot express. And if this goes on and on and on, especially if she's cruelly treated, she eventually-- her inhibitions can suddenly fail, and she just kills him.

And when that comes to the court, women in that situation are often acquitted. So this does have some recognition in our legal system, this consequences of basically conditioned inhibition, although in the legal sense it's not called that.

So now, learning affected by the consequences of behavior. These are the common kinds.

Conditioned appetitive behavior we'll deal with first. Conditioned aversion, conditioned action. Conditioned aversion we've talked about. Conditioned taste aversion is the usual phenomenon we talk about.

Then conditioned action, conditioned appetitive behavior directed at quiescence, when there's some very strong annoyer like hunger or thirst, or anything that's extremely bothersome and difficult and uncomfortable.

And finally operant conditioning, which is not stimulus conditioning at all but response selection, which Lorenz claims is much less common than people tend to be taught that learn about what they call instrumental conditioning. It's usually operant conditioning, which involves response selection.

This is just an introduction to that. Lorenz. We've been talking mainly about Type S or stimulus selection types of learning. He says much exploratory behavior is that way, and it's the most common.

Type R conditioning, response selection, is a little more rare. It includes operant conditioning, like with a confined animal that's trying every response he can in order to escape. It involves reinforcement, some kind of reward. He likes the word encouraging rather than reinforcement.

And then he talks about, applies this to the study of fixed action patterns, where you have-- it starts with the drive, the action-specific potential which leads to appetitive behavior, which basically he's looking for the stimulus that can release the response of that response side of the fixed action pattern.

So then his innate releasing mechanism is activated, which causes the consummatory behavior, the consummatory response. And then the feedback from that behavior, a the feedback affects the action-specific potential. It lowers it. It usually stops the consummatory behavior, reduces the drive. And so it reduces appetitive behavior.

And it can actually shape the original releasing mechanism, because there's-- learning in these innate behavior sequences is mostly on the stimulus side. Like an animal that has built-in responses.

We talked about the smiling response. It's a fixed action pattern. They will smile spontaneously sometimes, but they normally respond in almost reflex fashion to this specific configuration. And yet over time it acquires other characteristics, and his smiling becomes more limited, restricted to certain situations. OK

And he has this interesting statement about why behaviorists have oversimplified the problem of learning and instinct. And he's talking about American comparative psychology.

He says, they hope to be able to abstract generally valid laws prevailing in all learning processes, if not all behavior. And there have been many books written like this, almost all over here in America. In this way they hope to find a shortcut to an understanding of animal and human behavior without going to the trouble of analyzing the immensely complicated physiological machinery whose function is behavior.

And I couldn't agree with him more.

So these are the different kinds of learning affected by the consequences of behavior, the major categories.

Start with conditioned appetitive behavior. And he says that that and conditioned appetitive behavior directed at quiescence are the most common types. And I also point out that usually operant conditioning is lumped together with conditioned appetitive behavior, even though they really are quite separable, as Lorenz points out.

And as you know, sometimes-- like the Russians interpreted all behavior in terms of conditioned reflexes for many, many, many years. I don't know, people are natural lumpers, maybe.

But Lorenz is more of a splitter here. He likes to divide it up because-- and I think this is much more relevant to any brain studies, because if you can't separate them, you won't be looking for different brain mechanisms. And in fact there are many distinct brain mechanisms going on, which we'll talk about at the end here.

So these are examples of conditioned appetitive behavior. Von Frisch, Karl Von Frisch, had kept a pet fish. And he always whistled for it before he fed it. So the fish learned to begin searching for food as soon as he heard that whistle.

The honey bees studied by Von Frisch. The insect searches for the stimulus situation which proved rewarding in the past. For example, you could teach it to fly to specifically colored patches. It's a type of learning that he's rewarded if he goes to those colors.

Now the study of Pavlov's dogs. There's an interesting story about that from Howard Liddell. I can actually read what he said about that, because it's pretty interesting. He's quoting Liddell.

In most of Pavlov's experiments, active appetitive behavior is made invisible by shackling the dog to a framework, the experimental apparatus, so that salivation is just about the only response which is not precluded. He can't do anything else. He's locked in the apparatus.

And then Howard Liddell told him how he once conditioned the dog to salivate, using the conventional Pavlovian method, whenever a constantly ticking metronome was made to accelerate its beat.

So he trained it, and he got the salivation in the typical Pavlovian sense. Then he untied the dog, and as soon as the dog was released from the apparatus, it ran up to the metronome at once, whined, wagged its tail violently, and pushed against the metronome with its nose, salivating intensely all the while, even though the metronome had not changed its rhythm.

What had really been conditioned is that the dog was-- and the dog wasn't a reflex. There's no conditioned reflex here. But rather it was a complex and specific system of appetitive behavior by which a dog begs for food. That's what was conditioned.

It's an interesting contrast, because what we call classical conditioning now in the laboratory, like conditioned eye blink in response to specific stimuli, is really very different from this.

Anyway, this is conditioned appetitive behavior. He talks then about nest building in social weaver birds, or corvine birds. like crows and ravens. The weavers have an innate preference for a particular kind of grass. So if they get that grass, that's what they bring to the nest.

But the corvines, like the jackdaws and the ravens, they use whatever nest material gives good feedback during nest-building actions. So they get twigs of the right shape and size, little twigs. He says it causes an orgastic climax when they're stuck in the nest because it gives them the right feedback. It gives them a real joy, and it rewards them.

In fact, they can get supernormal feedback if they use soft metal wire because it gives such strong feedback, it works so well on that particular response. They become addicted to it, just like what happens in human addictions, even though the wire doesn't make a very good nest. But it gives the right feedback.

Now when they evolved, of course, there wasn't wire mesh around. So there wasn't anything like that that could give that super normal feedback and result in maladaptive behavior. But because of humans, now they can acquire this kind of abnormal addiction to the wire.

All right. So that's conditioned appetitive behavior.

Now a little bit about conditioned aversion, the second kind of learning affected by the consequences of behavior. This is John Garcia's discovery that we've talked about, the poison bait effect. I just want to point out that the sickness, the response here, the nausea, the illness, that becomes associated with a stimulus, not the most recently encountered stimulus. It associates the most novel previous stimulus.

Now I'd like to know, are there other cases of conditioned aversion other than ingestion-related behaviors? It's likely that there are, but this is the one that's been most studied. Lorenz believes that conditioned aversion is more common in many animals in nature than is something like operant conditioning, which we will talk about in a minute.

And I just remind you that Garcia's discovery of this was initially suppressed by the editors of American behavior magazines. It didn't fit the beliefs about conditioning and learning. They're not supposed to become conditioned to something that occurred a lot earlier, but only the most recent stimuli. But actually they become conditioned to the more novel stimulus, even though it might have occurred much earlier.

And then conditioned action. This is usually an artificial kind of motor learning, like you shape actions by circus animals. You-- I said initially elicit a fixed action pattern in response to a command. You're actually eliciting a fixed motor pattern in response to a command. So the horse's capriole, that is the leap and kicking that a horse does to try to get rid of a predator that's attacking it-- they will learn to perform that just to get sugar. So that's a conditioned action.

Von Frisch conditioned a parakeet to defecate in order to be released from his stage. The reward was getting released from his cage. So that was certainly a conditioned action, a kind of artificial learning. But then he points out that a lot of actions you just can't do that with. You can't condition them like that. Like tendon reflexes, sexual action patterns in most animals. You can't condition like that. Bill shaking in mallards.

And I did a lot of work on hamsters. And I tried to condition their orienting. For example, normally you present the stimulus here, he turns. It's an innate response. And we know the pathway in the brain from retina to the midbrain tectum and the superior colliculus that controls it. And then we know the output pathway as well.

But what if you never rewarded them when they turn? You reward them over here and stimulate their whiskers afterwards. So you present it visually over here. And then you immediately touch the whiskers and they turn and get the reward.

What happens? Well, you've seen the conditioning action. He does learn. But if you look at the behavior in detail, you'll see that actually there's a little hesitation. He'll usually start to turn the correct direction, and then he'll inhibit that. He learns to inhibit the behavior and then turn to get the reward.

And if he's really learned that and there's any disturbance, like a novel stimulus, something that changes the environment a little bit, the normal behavior comes right back. You can't release press. You can't condition it in the sense of the earlier examples here. The innate responses will dominate.

The other situation was when I was able to get the optic tract to literally go to the wrong side of the brain by an early brain lesion. So again, you present the stimulus, they always turn the wrong direction. But they never get rewarded for that unless you do it artificially.

So what happens? I found that in that area of the visual field that's affected, they never do learn, in spite of them always being rewarded. Because they're never rewarded. They never learn to turn in the right direction even though it would be adaptive to do so, because the connection won't change just because of learning.

So that's what's underlying the innate behavior. And even if he learns to totally suppress, that you will bring out-- it's very easy to train him. One reward where you're getting the wrong direction training and it all comes right back.

So conditioned appetitive behavior directed at quiescence. Now this is very common. We're talking here about annoyers, tension reduction. The tension or the annoyer is hunger or thirst or stress, a state of stress or conflict. You classify habitat selection this way because when an animal's searching for a habitat, it's another drive that's not being satisfied. He's uncomfortable. The drive is high, and it can only be satisfied if he finds a satisfactory habitat. And that reduces the tension and causes his reward.

So that's conditioned appetitive behavior directed at quiescence. So it usually involves a search for a stimulus situation that leads to a reward. It's another kind of stimulus selection. The reward is the reduction in the tension, the stress, the anxiety, the annoyance, whatever it is.

So most of the kind of learning studied in rats, where they're looking at what we call instrumental conditioning, is actually stimulus selection. So we'll talk about response selection.

Now, operant conditioning. Very different from this. Even though a lot of scientists group these two, conditioned appetitive behavior directed at quiescence and operant conditioning, together. So this is a kind of response selection.

Very highly studied, like in Skinnerian conditioning. Like you put a cat in a puzzle box, and he will try every response that he's able. He will try everything in order to-- and eventually, if possible, he'll discover some response that helps him get out of the puzzle box.

You put a male dog eager to mate, and the female dog, the bitch, is confined, but there is some way to get to her, he will try every response in order to get to her. So that's response selection. He's trying to find a response that works.

He points out that in nature operant conditioning is rarer than generally assumed. It occurs in situations of appetitive behavior directed at quiescence, or in exploratory behavior.

Now we come to real motor learning, where the motor responses themselves can change. We know that skilled movements can be shaped. We try this in sports all the time. In nature you'll see animals acquire path habits. When they acquire a path habit they can follow that path with much greater speed. It includes things like recitation from memory. You can learn to rattle off a poem. Even if you forget even what the poem's about, you can learn all the words and everything.

And there are examples in animal behavior. For example, a little vole kept as a pet by, I think it was Lorenz, always followed, ran in a certain pattern to get back to his nest. And animals learn this all the time. When they're in their local environment, they learn actions that bring them rapidly back to the nest. And if there's one action that they are commonly done-- like it might involve leaping onto an obstacle on their way to the nest. Well, suddenly you just take the obstacle away.

This is how you show it's a learned motor pattern. He has shaped his motor behavior, because he still goes through the whole thing. And suddenly that object's not there to land on. And what happens? He leaps anyway and hits a big surprise, because he falls further and lands on the ground.

These kinds of learned habits can be pretty resistant to change. They have a lot of similarities to fixed motor patterns. In fact, they acquire their own appetitive behavior, in many cases. People that learn particular patterns of movement in sports can become very motivated to do those things. And we know that different parts of the brain are involved in changing motor patterns, especially cerebellar mechanisms.

Just more about shaping of motor patterns. There's a lot of species differences here. Let's just remind ourselves of species differences in locomotion, because it gives an example of what you can train and what you cannot train an animal to do.

So horses are very adapted to running on flat ground. They can't adjust well to uneven terrain no matter how much you try to train them. They're very limited in the responses available to them, the types of movements they can make. Donkeys are more sure-footed because they've got more responses available.

Goats, the chamois, they're adapted to hills and mountains. They're very sure-footed. So what is that sure-footedness? Smaller units of action. And with smaller units, they can adjust direction, adjust for foot placement more readily in these rapid actions.

In other words, higher control has more possibilities. There's more movement patterns to control. And that leads to a discussion of what we mean by voluntary action. He points out that arboreal creatures, they need a lot more action patterns to negotiate the trees. So it's a lot easier to shape movements in primates and squirrels and tree shrews and so forth that live in trees.

We talk about will or volition when it really amounts to higher level initiation of fixed motor patterns, or learned sequences, skilled movements. And we've already talked about species differences on how small the elements of movements are.

And the example he gives about voluntary movement and insight concerns his studies of geese. He says that their spatial insight can exceed their motor abilities because they don't have so many different motor patterns available to them. So you can teach them to climb stairs fairly well. But when you try to teach them how to descend a stairway, they can't even learn to adjust the length of their stride well enough. And they will stumble. They have a lot of trouble going down the stairs.

So species differ a lot in how much they can control when they want to. Voluntary control, we call it. It's the influence of motivational systems on higher level control systems.

And then he comes to a discussion of exploratory behavior. Exploratory behavior or curiosity. And this is pretty interesting. When you study exploratory behavior, of course, it's very influenced by novelty.

Many animals are, in fact, highly motivated to explore novel situations, and they will direct multiple different patterns of behavior, sometimes unrelated. Even the little hamster. You put them in a novel room with different objects that they're not accustomed to seeing. It's amazing. Their initial response, if it's very novel, will be fright. Their tension levels go way up.

But in fact, if you've got them in a situation that they're used to, you test them in an apparatus they're very familiar with, they will explore. And you will see them trying all different kinds of motor patterns. You'll see rapid switching between different behavior patterns or motor patterns. And when there's a strong action-specific potential behind that's causing those motor patterns, you don't see that switching from one to the other.

So in exploratory behavior, there's a difference in the structure of what's behind the movement. And exploratory behavior is not as well understood as fixed action patterns, because now the motor part can become uncoupled with the normal action. The motivation here is curiosity.

Very similar to play behavior. He says it occurs in a field devoid of tension. And yet the motivation to explore can be so strong, an animal sometimes prefer that rather than eating, even if he's hungry. And it does have a function, very important functions.

When the environment changes, it helps the animal, it's adaptive for the animal to explore it. He needs to learn the spatial layout of the environment around him in relation to visual landmarks and other sensory cues, because if they change, then he's in trouble if he gets mixed up trying to get home, trying to escape. It makes his life a lot more efficient if he stays familiar with the novel situation.

There were experiments on this using hamsters because they're so curious. Actually, my first publication's called "Curiosity and the Hamster." I was using exploratory behavior to reward them for doing other things. Reward them for pressing a bar, reward them for going through doors.

It was so novel at the time, people still believed that this wasn't supposed to be possible. I had to play around at home with a pet hamster, and I found out I could teach him to press a bar made out of a knife taped to a baby rattle. And I could teach them to do this. And my professor was so intrigued by that, he got me to write a paper about it.

And that was because of the theories that were dominating American psychology at that time. But Catherine Blanc in Europe-- I think it was in France, but I don't remember for sure anymore-- but she studied this experimentally. And she found out that in their exploratory behavior, they are acquiring knowledge that they can use in other situations. They become more efficient in finding their way in another situation.

And then Lorenz points out that exploratory behavior is especially highly developed in unspecialized species. He says their specialization is being versatile, like humans, like rats, like ravens. These are animals that aren't so limited to one type of environment. We should add crows to that. Mice are certainly more general than most voles, for example, because they can adapt to more different situations.

And all of this type of animal shows a lot of exploratory behavior.

AUDIENCE: What would be a specialized species?

PROFESSOR: Most of the species we've been talking about are pretty specialized. Every species will show some-- I think all of the mammals show some curiosity. But the amount that they will show will vary.

What is characteristic about ravens, rats, and humans? The first thing you think of is that they've adapted to so many different environments, especially if you group the corvids together, the ravens and the crows. We know that rats can be found everywhere. The same is true for different corvids. They have specific adaptations, of course, that makes the jackdaw common in parts of Europe and the crow much more common over here.

Humans, of course, are the most versatile, the least specialized. That doesn't mean-- we do depend a lot on learning. But what is different about-- for example, back here, when we're talking about shaping of motor learning here.

It depends a lot on how many fixed action patterns you have. The more fixed action patterns that make up your movements, the more versatile you are, which is one reason humans are so versatile. We actually have more fixed action patterns than animals. At least on the motor side, we have many more choices.

Some of the most specialized animals are the ones that are specialized for feeding on very particular things, like the koala. They only can eat certain things, and they don't survive well in other situations.

Why aren't hamsters-- why haven't they spread all over the US? They're just not adaptable like the rat, or even the mouse. So they're only found-- they're native to Syria and the northern part of what is now Israel. And if you even move towards Turkey and that direction, the species changes. It's no longer Syrian hamster. It becomes a different hamster that has adapted specifically to the higher elevations.

If you go north, northeast, you'll see the-- no, sorry, if you go further, you go, say, into Romania, again, another species appears. You go the other way, you start to get the Chinese hamster, or Siberian hamster if you go further. They're all different. They've adapted differently. But the rat, you keep finding the rat in all these different situations.

So any species that's very limited to one habitat you wouldn't call a generalized species. And that's most of the ones that I'm talking about.

OK. What about play behavior? Similar to explorative behavior. The very primitive play are simply-- you could call them in vacua reactions motivated by action-specific potentials or drives that are high.

But there is a difference. You don't call it play if they execute the entire sequence from a high action-specific potential, a high drive level, to the motor pattern, like running and chasing playful fighting or prey catching. The animals will enjoy the motor patterns, and they will do this even before they're using them to catch prey, to feed and so forth.

So it's very common in young animals. And he points out that play can shift to the real thing in some situations. There's a lot of danger in playing with an adult tomcat or badger. You might have tamed it and think it's your pet, but it can switch suddenly to the real thing when their motivation becomes high.

So if you play with an adult tomcat, you have to be pretty careful because of that. You don't want to trigger. And that's certainly true. People get caught off guard all the time when they raise a tiger or other big cat in their home. Or even a champ or a monkey, because even though they seem to be playing, it can switch suddenly to the real thing. And they can kill you or your child or whatever. So it's dangerous to do that.

He points out that, on the motivational side, a cat that has no opportunity to catch and kill prey can compensate by playing. It doesn't mean that it's always totally safe, but they appear to do that. So how do you tell the difference?

Well, one way is physiologically. Because in play, the autonomic nervous system isn't involved in the same way. So if you major autonomic responses, you'll find big differences between the way the heart rate, the breathing, blood pressure changes, and so forth are responding in the two situations.

Now what are the functions of play? And I just felt-- in the last half of his career studied humans and wrote the book *Human Ecology*. He studied development of play in cats and other carnivores. He found evidence of their learning of coordination, learning of stimulus selection, so they could change, so they would respond to more relevant stimuli. And also they would invent, in their play they would invent movement patterns simply by linking different elements, the different inherited elements of their behavior.

And they will do that even though it doesn't lead to any reward. The reward is simply doing it in the play. And he has evidence for all these advantages of play.

And then-- this is interesting-- he says human research is exploratory behavior plus play, mostly exploratory behavior. And human art is mostly playing. He's not putting it down at all. He's just pointed out the value of these things in animals. And now he says, well, if we talk about humans, this is how he sees human research and art.

Just about all these types of learning, remember there are species differences, but we don't know fully all aspects of it.

And what I will talk about next time is I'll talk a little bit about brain localization. We can at least make educated guesses in some cases. Real experiments have been done. And whether there are any general rules. The rules seem to be a little different for all of these different types of learning that Lorenz has described.

So next time we'll be talking here more about brain pathways. Neuroscience has made studies, for example, of hippocampal function and the function of other parts of the brain-- have given us a different way to categorize types of learning. So we'll talk about that next time.