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PROFESSOR: All right, let's get started. I want to finish talking about Konrad Lorenz' jackdaws today, and maybe I hope to be able to start with the next topic, because at the beginning of the next hour we're going to watch a video, so we'll have less time to go over some of the questions.

We just got started with this last time. The reading was from Konrad Lorenz' little book, called *King Solomon's Ring*, published a long time ago, but very interesting descriptions of his early studies of animals. Remember, jackdaws are a crow-like corvid living in Europe. They nest in high places, not always on a cliff face, like the Kittiwake gull, but often high in trees, and often in the area where he studied them, they nest in rooftops. They often live near humans. He starts, remember, by talking about play. I introduced this last time.

If anybody gets interested in play behavior, it would be interesting to look in the recent literature and see if there are any new studies of play that have something interesting to say. If you are interested in that and do some searches online, please go over it with me, and I can let you know whether part of that would be an interesting project report.

What made jackdaws such interesting pets for this young man in Germany, Konrad Lorenz, who had liked animals since he was very young? He was just 22 in 1925 when he began studying these animals. What were the properties that make jackdaws interesting? Well for one thing, like other corvids, they're very intelligent animals. What makes dogs so interesting? Part of it is their intelligence. Dogs are very smart. They're probably as smart as chimpanzees-- somewhat different types of intelligence. They're specialized in different ways--yes?

AUDIENCE: Also they're faithful. They're loyal to their humans.

PROFESSOR: Dogs are probably more faithful than jackdaws, but believe me if a jackdaw is attached, you're quite right. They will definitely stick close to one human being. Their attack behavior is a little more specialized. They can even attack their own owner, as you will see. Yes?

AUDIENCE: I noticed that they imprinted on the human [INAUDIBLE].

PROFESSOR: Whenever there's a lot of other noise, I can't understand anything.

AUDIENCE: That it really imprinted on the human, and almost thought of itself as a human-- like when it would walk.

PROFESSOR: That's part of their social nature. They're very social, like dogs. And like dogs, they can imprint on humans. A young dog, a puppy, as I mentioned last time, if they're socialized to humans very early, they treat humans as part of their pack. In fact, humans will be the alphas. The alpha male might be a female human, but the alpha male to a dog is the dominant animal in the pack.

That's the way some dogs, some species, become much more centered on one owner, the master, than other dogs. Some dogs just simply become attached to the whole family. Even a dog that's very, very attached-- like say, a doberman-- to one master, they're still social animals. They live in a larger pack, and they will defend the pack, so they are a pretty good guard dog in that respect.

They're very social. They're very intelligent, and they are adapted to living near humans. They have been for a long time. In Altenburg, Germany, where Lorenz lived at that time, there was many jackdaws living in different rooftops in the town.

This is a quote from Lorenz-- "like the stones of a mosaic, the inherited and acquired elements of a young bird's behavior are pieced together to produce a perfect pattern, but in a bird that's been reared by hand, the natural harmony of this design is necessarily somewhat disturbed."

I suppose if you're interested in natural behavior of dogs, you could say a dog's

behaviors is pretty disturbed by being raised by humans, too, so you don't see all the natural behaviors of a dog that's become a human pet. But it's more dramatic in the case of the birds, and Lorenz goes through this.

The disturbances he talks about are all results of early learning, causing fixation on the wrong species. It's very interesting. We think of imprinting as a single thing, and when it was discovered with birds, as we'll see in the video, next class, where Lorenz discovered this in ducks, in the case of the jackdaws, he observed that it's not just related to fixating on a parent.

They can be fixated for different functions on different animals. He wrote a pretty well-known paper-- at least it's well known in German-- "Der Kumpan in der Umwelt de Terre," but it's roughly translated Companionship in Bird Life. He describes many of these things in that scientific paper. For example, a bird that's imprinted on humans, when it reaches sexual maturity, may court only humans as potential mates.

He describes jackdaws and the dramatic way these fixations are manifested. In fact, they can be imprinted on a particular human. One became fixated on a maid that worked for him, but then moved to another location-- left his household, and the bird eventually found her and tried to mate with her over there-- but only for mating. Then it would fly back, because it lived with Lorenz in an aviary attached to his house.

Then he describes this jackdaw pet that he called Jacques-- turned out to be female actually-- courted only humans for mating. But when he wanted to fly, he was fixated on crows, because apparently when he first learned to fly, it was crows flying over that initiated his interest. He was just learning to fly. He flew with the crows.

He had a lot of trouble getting Jacques to give up that habit, so he often would fly with the crows until he became lost. Sometimes Lorenz would go out and make jackdaw calls, trying to find Jacques, get him to come back. Why would we expect care of young, which we call brood tending in ethology to be largely innate in many animal species?

AUDIENCE: [INAUDIBLE].

PROFESSOR: Like the species we study in the lab, you can take a hamster and breed them, and they can raise young though they've never grown up in families. They leave the mother after weaning and separate, so they don't live socially. They're solitary. They live in a solitary way, although they do live in proximity to other hamsters, from what we know about them.

It's been difficult to study wild hamsters, because they live in Syria. As you know, Syria's been a difficult place for people from Europe or America to go to study animals. I had one student that went there when it was a little less dangerous, but it was difficult to get a visa, so he just went in from Lebanon and managed to interact with people there. He brought back a group of hamsters for the first time since the initial capture of hamsters in the 1930s.

Why would it be expected to be innate, and how would you look for learned components of the behavior? Why would it almost have to be innate in many species? Because once they mate, they're going to have the babies. If they don't know how to take care of them, if they don't have instinctive ability to take care of them, the babies are not going to survive. Their reproduction will be unsuccessful.

So they have evolved to be able to take care of them on the first try, but it doesn't mean they don't learn anything. So what do you look for? Some of you are in labs where you're studying mice or rats. I don't think there's any hamsters now, because I don't keep the hamsters anymore. But for years I had them, and it was very evident to me that things were being learned. I can tell you several things. One is I would notice that first litters, I would discover injured pups much more frequently. They were handled more roughly by the mother.

If I would separate the mother from the nest-- and sometimes I did that because of experiments I was conducting and then put the mother back-- an inexperienced mother-- if it was her first litter-- would be much more likely to lose her maternal mood altogether. She would treat her pups like they were insects, and she would

attack them. Sometimes that would be brief, and then she would recover her maternal mood and go back, but that almost never happened in second and third litters.

Hamsters are capable of having multiple litters. They're very prolific in their reproduction. Let's see what else I wrote here. They of course, have to be able to do it, because the first time they're exposed to young is when they start having them. It's not completely innate in many animals, especially primates where more is learned.

It's not that humans don't have brood-tending instincts, but abnormalities are much more likely in the higher animals, because so much more is learned, and some of that learning can not be beneficial for brood tending. Any individual variations you can see among-- let's say you have a litter of animals, and you study all the females? You get them to mate, and they all have litters. You will pretty soon see individual differences appearing.

You have to be sharp to notice them, but there will be individual differences because there are-- even though genetically they're very uniform, hamsters more than just about any other laboratory animal. One reason they're a good experimental animal is because of that genetic uniformity. They all arose from, I believe, a single male and two females who were captured near Aleppo, Syria, by an Israeli scientist named Aharoni, and he introduced them for laboratory work, and they spread to other countries, including America.

Let's talk about a different kind of learning. How do young jackdaws come to recognize predators? The very interesting interaction between innate components and learned components-- and Lorenz described his experience with an innate reaction of jackdaws. You should know that story. I give the pages, there.

Certain stimuli that could cause the jackdaws in the vicinity to attack him. What was he doing that caused the jackdaws he was rearing-- so they were very familiar with him-- to start treating him like an enemy?

AUDIENCE: He would hold the young chicks, and the chick had a very dark, black object, really--

PROFESSOR: Yeah, didn't even have to be a jackdaw-like object. He could be holding anything black, especially if it was dangling, you know, like a hunter carrying a dead bird. Remember, he said one time he just was removing a roll of film-- of course, the film was in a black reel, and it looks dark when it comes out of the camera. He was removing film from a camera.

Apparently, it had been exposed, and he was going to get rid of it, put new film in. And of course, he unraveled it, and there's that dangling thing, and immediately he was attacked by jackdaws, because they have an innate reaction that's in response to what we call key stimuli-- very simple stimuli, usually are all that's necessary to elicit fixed action patterns.

It's not that these key stimuli can't change over time, but initially the stimuli are very, very simple. Over time some animals do learn, and more complex stimuli come to elicit the behavior, but with jackdaws, any dark, dangling object will elicit the stimulus. Now how does learning enter this? What do they learn? Somebody else. Yes?

AUDIENCE: They also have sort of a call that designates when one of the members of the group sees something that it has previously identified as being vicious of a threat to the population. So other crows, when they hear the sound, they realize that that sound is the sound that designates the presence of a predator, even if they haven't witnessed the predator actually.

PROFESSOR: That's right. They start calling-- this zik-zik-zik-zik-zik-- a very raspy kind of sound that jackdaws make that indicates there's danger. But why would they do that? Humans aren't dangerous to them. It's because once you do something like that, and you elicit that innate reaction, it causes the animal to emit that cry, and he actually learns the face of the human.

He doesn't react to all humans that way. He reacts to the specific human that did that. They become quote "enemies of jackdaws." There are studies done more

recently based on the early Lorenz studies of crows. For example, it started in Japan, some very interesting studies of crow behavior-- not just cognitive behavior, but innate reactions as well.

But the studies done in the US-- and I believe it's been done in other countries, too-- investigated this. They would elicit that reaction. But they were wearing masks, and the animal learned to recognize that mask and would treat that person like an enemy if he was wearing that mask. They were able to show that it was very dependent on the specific stimuli. It could even be a different person, but wearing that mask, they were an enemy of crows.

The reason they did that experiment was a very interesting one. They wanted to see could that crow-- and I don't know if this has been done with jackdaws, but they're very similar birds, both corvids, both very intelligent, and both have very good memories-- they wanted to see could that knowledge of an enemy of crows be passed on to their offspring.

They carefully followed these animals with no more exposure to that mask until the young were old enough to fly and to make these sounds that would indicate the recognizing an enemy. Then they started using the mask again when no adults were around. They already knew that if the young heard an adult making that sound, responding-- and of course, they actually are sensitive to eye direction, they will see who the jackdaw was looking at-- and the young will learn from the adults.

But in this case, they waited until only the young were around. They found that if that young had lived with the adult a sufficient amount of time-- obviously, they didn't even know when the adult had responded to the mask-- but if the young was around, could learn from the adult that just the visual shape indicated an enemy.

Obviously they had to be exposed in order to learn, but they didn't have to be experience the stimulus itself. They never had to see the black, dangling object. They only had to hear their parent, and they could learn. So traditions could develop then in a group. It's dangerous to do that around jackdaws. You can become an enemy of jackdaws for a long time.

This is an animal, the Golden Eagle, that are enemies of jackdaws, real enemies of jackdaws. Many birds do have innate responses to certain kinds of flight patterns. The Golden Eagle flight pattern is one of those that, with a certain characteristic of their flight, that will elicit escape reactions of various sorts and these cries from various birds.

Now what about can they learn to recognize individuals? We already mentioned that they could recognize individual humans, because they can recognize an individual human, one particular type of human, or a particular mask as an enemy of jackdaws, but what about other jackdaws?

What is the evidence-- and it's of several sorts, if you study jackdaw social behavior-- what was the evidence that Lorenz presents that shows that they can recognize each other? Unless you really keep jackdaws, and you're observing them all the time, they all look pretty similar to you. But they start looking different when you're very, very familiar with them.

Remember, in the Kittiwake gulls, they had to pay attention to the details of their wing patterns in order to be able to tell them apart. Jackdaws don't have patterns like that, but they're a little bit different in how heavy they are, the way they fluff their feathers, in their weight, the sheen of their feathers, and they're different in their behavior.

All those things can lead to cues that someone watching them all the time can learn to recognize. Hamsters are similar-- very, very difficult to tell them apart. It's mainly, in fact, unless they're very different in weight-- you can recognize the sexes very easily. Otherwise, it's just in the behavioral pattern you learn to tell the difference. So how do we know jackdaws can recognize, much more quickly than humans, in fact, individual jackdaws? What would you look for? Yes, in the back?

AUDIENCE: There's an established pecking order, which means that in order to feed, somebody at the top would--

PROFESSOR: Yeah, social dominance rank, exactly. We call it the pecking order, as you said.

They can consistently recognize who's at the bottom, who's in the middle. They recognize their rank with respect to other animals. They know where they are in that pecking order. They know who the dominant jackdaw is. They know the relative rank. They know who his mate is. Generally the female-- it's almost always a male, but not always, but let's say it's a male-- then that female, once she becomes the mate to that male, she's going to have the high rank, too. They all learn that very quickly. They know where they fit.

Another way of course, is when they mate, they recognize their mate. Of course, they do recognize friends and enemies. I put enemies in quotes here, because if there's any real enemy, then all the jackdaws are friends, and they support each other. But otherwise in normal social behaviors, they're more friendly with some birds than others, and this is consistent. It's obvious that they can recognize each other.

How do mammals do it? Well certainly for the very visual animals, the primates and other very visual animals like giraffes, as an example, they also use visual cues to recognize individuals. But in most mammals, especially nocturnal mammals, olfaction is much more important, and they recognize individual odor patterns. Even animals like dogs-- different breeds of dogs look very different to us-- but to dogs, their smell is even more important.

There's been more formal studies of some of that in crows. A lot of things that Lorenz observed and gave detailed observations about-- he did do simple experiments with his jackdaws-- but a lot of those have been followed up-- not so much with jackdaws, but with other corvids in experimental work-- and most of Lawrence's observations have been supported.

In this question, I'm just pointing out that the male jackdaw lacks the plumage of a peacock for displaying towards a female. Then how does the young jackdaw who gets attracted-- he falls in love with a female jackdaw-- how does he get her attention and try to get a positive response? It must be through his behavior, right?

He has a specific ceremony for calling a female to his nest. It has auditory

components, or the way he calls, and it also has visual components. These do elicit response in other animals if they decide to attend to him. If a female is interested in finding a mate too, she will attend more to some males than others. When she attends, then she will begin to respond to these stimuli.

He points out that he noticed sex differences in eye direction, very reminiscent of human behavior. For example, what we call coyness in humans-- they attend to, but they don't stare directly at a potential mate. This is the female responding to the male. She doesn't look directly at him. He might be staring at her, but she doesn't look directly, but she's also really attending to him.

This can go on for quite a long time. How do you tell when a bird is looking or not looking? Unless they're owls, they've got laterally-placed eyes, so they could seem to be facing over here, but they could still be looking over here. Because their eyes are dark, you can't actually see the pupil.

The jackdaws are amazing in their ability to tell what the bird is actually attending to, because the male won't struggle forever to gain the attention of the female if she is totally ignoring him. In fact, she'll eventually just fly away. But if she is interested, she won't fly away, but she won't directly respond for a long time.

How does she respond if she is really interested? How does she get engaged to that male? Lorenz points out that it happens a full year before they actually start mating. So unlike many species, these animals have this betrothal ceremony a year before they actually start mating.

What she does is engage in this ritual mating invitation. It's a particular posture. They crouch down, fluff their feathers in a certain way, widen their wings a little bit. It's used throughout life, later as a greeting ceremony, in a pair of jackdaws. Lorenz has some nice drawings of that in the book. This is a typical posturing that animals do that has a specific communication function.

Once they are betrothed, even before they've started to mate, Lorenz describes two behaviors that occur frequently in a pair of jackdaws. And when they pair, how long

does it last? Many animals will mate with only one animal in a season, but the next season, there's no preference for the original mate. But other animals, it's very different. Some animals are promiscuous even within the mating season. They'll mate with many different animals.

What is it for jackdaws? They're monogamous, generally. They mate for life. Once they mate, that's it. That early posturing and the displays they show can result in a lifetime of companionship that, in jackdaws, which are very long-lived birds, can last for 20 years. Because of this, you could say they're married when they start mating, but their engagement is a full year beforehand, if we use the human terms. Lorenz uses the human terms pretty freely, because it's pretty obvious he's talking about the birds when he's talking about them.

These are the two behaviors then. When these occur, then you know that that pair has formed. The male will feed the female, and the female will preen the feathers of the male, particularly in the areas of his neck and head that he cannot reach himself. They also make these sounds that you don't hear, except in this situation and in infant jackdaws. It's very common in many different species for courtship to involve these more infantile behaviors. It occurs in humans.

He describes some of that behavior in more detail. Here's the female getting fed by the male. Literally he's poked some-- or has already finished perhaps putting an insect in her mouth. This is very common behavior during a courtship period, but it can occur later, too, throughout their lives.

Jackdaws are very social, and they form close-knit groups, but it doesn't mean they don't squabble. You get conflicts over nest sites, for example, just like the Kittiwakes. Some nest sites are a lot more conveniently placed than others, so they will fight to get them. Each male has to establish the nest and nest site and attract his female to it. The conflicts are often settled by the kinds of postures-- displays, aggressive displays they make. Similarly, there are defensive displays that will stop the aggressiveness of the attacker.

They will do this, the nest site, and when they engage in this very loud calling, it's

apparently in one season of the year, which in Altenberg, Germany, is February and March. The whole town is filled with this loud-- zik-zik-ziking of the jackdaws. So what happens if the defending jackdaws actually attack. And that does happen, where a jackdaw stops just his aggressive posturing and decides-- hey, I've got a real chance to get this nest site and he attacks the bird. He perceives him as weaker. What happens? Yeah.

AUDIENCE: [INAUDIBLE].

PROFESSOR: Sorry, louder.

AUDIENCE: [INAUDIBLE].

PROFESSOR: Yeah, it actually results in a melee. It gets all the birds involved. They all start this. The zik-zik sounds become louder, and pretty soon there's a whole congregation of animals making this noise. And pretty soon, it gets so confusing that even the animal that was initially attacking or defending, they'll all start doing it. It's totally confusing.

Even the guy who started it, he's joining that crowd, and pretty soon it all just gradually goes back to normal, and they all become un-aggressive again. They've got this built-in social behavior that protects them from too much damage by actual social attacks. Many species have this. Humans have it, too. We ruined it by developing weapons. Then we don't have to face somebody. We can kill them at a distance-- terrible thing. Just think if animals had guns. So most animals have these means. It's not that animals never kill each other, but it's very rare.

There are also innate responses to get a young one who, when he's flying becomes very adventurous and very energetic and might fly so far from home that he gets lost, and it would be difficult for him even to find his way back-- so the older jackdaws will try to entice a young one that's missing. They will find him, and they of course, have very good vision. They can fly up and often find the young that are straying so far.

How do they get them to come back? It's done by, again, the combination of the

auditory and the visual stimuli. They have this fly with me call. The kya-kya sound, and it changes a little bit to what Lorenz calls a kya sound, slightly different in the way it sounds. will make this sound, flying at the young bird, and then they will turn and fly away.

And as they fly away, that produces a visual stimulus that the young jackdaw finds very hard not to follow. The combination of that loud sound they're making, plus the way they're flying, serves as innate releasing stimuli, we would call them. Provide the key stimulus to get the following response-- and they fly after the older animal.

What time are we at, here? I didn't put this in the journal file. I will go to the PowerPoint. I want to get started here with more specific discussion of innate behavior. The technical term in ethology is the fixed action pattern. That will lead to a little bit of discussion of the central nervous system. We won't be talking a lot about the CNS, but we will talk about it.

Next time I will show you the film. It's from a TV program, *The Wild Wild World of Animals*, but it's a historic film that shows Lorenz and his ducks that were imprinted on him. Then the film goes on. It films some of the work of Lorenz and his students and coworkers, showing natural response to predators by geese and some of the work they've done on imprinting and the effects on social life by geese.

We'll talk about the innate responses. I'll go through this next time, some of the stimuli they used. But let's talk about fixed action patterns. We have at least time to define it. This will come up again in the class, and I can tell you, many students get confused about some of this, so I'd like to go through it more than once.

What is a fixed action pattern? When we think of a fixed-action pattern, it sounds like we're just talking about what, to the ethologist, is only one component in the fixed action pattern-- the motor pattern, the fixed motor pattern, an innate sequence of behavior. These are examples in the human-- smiling, frowning, many other expressions of emotion. They're the same or very similar in all humans, in different cultures, in fact.

They're similar, as Eibesfeldt showed, in humans that have never seen another human doing it, because they were going blind or even born blind and deaf. Yet they do it. Walking is another fixed action pattern. It's a particularly important, multi-purpose pattern of action. Eye blink and swallowing are fixed action patterns. Why are we calling them fixed action patterns? Those last two, eye-blink and swallowing are, if you read in the medical texts, they're called reflexes, swallowing reflex and eye-blink reflex.

Is a fixed action pattern any different from a reflex? Isn't it just a more complex reflex? So we'll call that a reflex if it's something very simple like withdrawal of a limb from a painful stimulus, but we'll call it a fixed action pattern if it's a more complex sequence. The author of that little book I'm having you read, Graham Scott-- actually that's the way he uses the term. He really just means automatic. That's what he means by reflex. It's something that happens automatically with a certain stimulus.

But is that not what a fixed action pattern is? And the answer is no. We will follow Konrad Lorenz in talking about it. I want you to learn the Lorenz view, which distinguishes pretty clearly between fixed action pattern and reflex. A reflex is something that's always there, no matter what my motivational state.

When I'm walking, I'm responding in a reflex way to stimuli from my feet. If I'm on uneven terrain, I adjust my gait to the terrain. Some species do that much better than others, like a goat or a donkey, in fact, or a mule does it much better than a horse. Horses evolved to run on the plains. These other animals evolved to live in hillier terrain, so we talk about some animals being more sure-footed than others.

There's just a difference in the reflex patterns that they've inherited. But why am I saying those are reflexes? Because a reflex is something like a mantle you're always wearing. It doesn't matter whether you're hungry or not hungry, whether your horny or not horny-- no matter what your motivational state, you still have those same reflexes.

It's a background. That's why we call it just a mantle. You always have that. But

what about a fixed action pattern? It has a motivational component. So I go through that here. A component of the fixed-action pattern is what Lorenz called-- and different psychologists have used different names for this. In the West we often just talk about a drive or level of motivation, but the ethologists following Lorenz have been much more specific. He calls it an action-specific potential.

Something in the brain that can change in its level, is specific to a specific action, a specific motor pattern. It's an internal level of activation of a drive or a central motivational state. It's been called the central motive state by the psychologist, Peter Milner. He was a physiological psychologist-- or is-- in Canada. Many people here just call it a drive.

The action-specific potential for most fixed action patterns builds up pretty steadily over time. And what that does is increases the probability of discharge of the motor pattern. How it does that is the thresholds for eliciting the fixed-motor pattern become lowered. In fact, they can get so low, if the level of drive is very, very high, that almost any stimulus can elicit it.

When that happens, we could say well it's like they're discharged in a vacuum, almost no stimulus, but all it is is this extreme lowering of thresholds for eliciting the fixed action pattern. That doesn't happen with reflexes. The threshold for eliciting reflex does change with current conditions. Like the tendency to withdraw my limb, the tendency will increase if I'm frightened. Say I go into a dark basement, and somebody tells me there are rats down there, I'm going to be much more likely to withdraw if I touch something I wasn't expecting.

But that's not a fixed action pattern. It's a simple reflex that's threshold has been adjusted by the current situation. But the motivational level of a fixed action pattern will change steadily over time, regardless of the situation. The stimuli you're exposed to, though, can be the major way that its [INAUDIBLE] will change. Its level of activation will change, so in that way it is a little similar to a reflex.

That's the end of the hour. We're going to come back to this slide next time and start there after we see the film.

