PROFESSOR: A few things from last time, and then I want to say a few things about communication among animals.

We ended with some things on navigation, and how animals find their way. For example, how mice or rats solve a maze in which they can't see the platform that supports them, keeps them from having to swim in the water. It's under the water, and water is milky, so they can't see it. How they find it? And yet they can learn to pretty quickly find it when their in that maze. And they do it mostly by using visual cues, usually overhead cues, and they need the hippocampus in the brain to do that. And I just mentioned here that homing pigeons with damage to that structure in the bird brain. It doesn't look like the hippocampus in a mammal. It's called the medial pallial area, the medial pallium. They still find their direction. They'll go in the right direction when their a long ways from home. But when they get near home, then they get lost, because they lose their map of the local environment.

Scott, in his book, discusses stuff a study of two different, very closely-related species, the blue tits and the marsh tits. He has studied the blue tits quite a lot there, especially their aggressive behavior, and he points out that the marsh tits create food hoards. They hide food in various places, and they have to remember where the food is, whereas the blue tits don't do that. And when you have two closely related species like that-- one that has to remember a lot of different places, the other that doesn't-- it's pretty general finding in these kinds of studies to find a larger medial pallium or hippocampal formation than the ones that can. That's just the way the experimental neurology has interacted with the animal behavior studies.

This question, a very simple one: why would animals migrate very long distances, just in order to mate? Some of them migrate practically halfway around the earth, and they do that every year. In the cases that I know of, the all do it once a year. We know that many large birds, herons for example, will migrate for example from Siberia into India. And they have to cross the Himalayas to do that, which is very treacherous, and yet they brave that difficulty, and the stronger ones anyway make it every year. So why would they do that? What's the simple answer you can think of? You've probably read it. If you haven't, you should be able to think why an animal would do that. Humans don't do it.

Why does the salmon do it? Why does the salmon come from open ocean, sometimes very long distances, finds the river that leads to the stream, following it inland to where that salmon was hatched? And they will go back there, in order to breed. Why does the monarch butterfly migrate from North America and Canada, all the way down into Mexico, in order to breed? This tiny little butterfly.

There's got to be very good reasons, and the reason's very simple. They're more successful at reproducing that way, because they go to safe areas to reproduce, even though the physical demands are huge. These are some of the other species that have these very long-distance migrations: the green turtles, sockeye salmon, the black-capped warblers in Europe, Australian silvereyes.

And then to end with, these three questions on migration: how do you get evidence that birds use stars to guide long-distance migration? These are birds that often fly at night, and they will fly even on moonless nights. How do we know that they're using the stars? They could be using magnetic cues, right? So it's a real experimental question. Can you think of any practical methods for doing that? And what cues besides the stars could they use? I already mentioned they could use magnetic cues. They could fly during the day and use the sun, if they use that direction. There's other possible cues they can use, too. I mentioned a couple of them that pigeons use: patterns of infrasound that differ from one region to another. And the last question is, how do we know that migration behavior like this is innate?

And these are just-- I want to get through this quickly, so I'm just going to show you very simple answers. They look at initial flight directions in a planetarium. Because when they get restless, they're about to migrate. You can tell by the way they behave. The birds get more and more restless, and finally animals and the birds in a region will all take off at about the same time, and they fly all in about the same direction. So if they look at the initial direction, when they take off and you have them in a planetarium so the only visual cues they're getting that you can vary are the pattern of constellations, you find out that they are consistent in flying in a certain direction with respect to those constellations. And that was discovered in a planetarium in the Max Planck Institute for Behavioral Physiology. And I say these in the same location where Konrad Lorenz has his section for studying geese and ducks.

And cues besides the stars. Besides the sun they, can use the polarity of light. So they don't actually have to see the sun itself. They can use the magnetic field of the earth. They could use olfactory cues, but that is difficult at first and depends on where they are. One very convincing study showing the innate nature of the behavior is illustrated in the Scott book. Do you remember? Two really closely related species of warbler. The European black capped warblers that live in different places, so they migrate in different initial directions when they take off to fly to their breeding areas. But they will interbreed. And when you integrate them, the initial directions, at least the mean, is right in between the directions of each of those groups. It's a really nice study. Of course, the results aren't perfect. But if you look at the-- they show the individual data points in the graph in the book, and it's pretty good evidence that it's innate behavior.

Just want to mention one other thing. A recent-- no, not that recent now, 2006-- evidence that certain migratory songbirds that use the geomagnetic field or stars or the Sun to navigate, they show in this particular song bird, the savanna sparrow, they recalibrate their magnetic compass at both sunrise and sunset by the polarization of light. They use the light near the horizon. It's an interesting study, and not yet known whether all birds have this kind of recalibration procedure, but it's important, especially if they're from different regions, first of all that the magnetic field can fluctuate, the magnetic field of the earth. So it needs recalibration if it's going to be really precise-- and of course birds in different areas, if they're all flying to the same place, but they live in disparate areas-- they would need to adjust that compass for their region.

All right. Let's start talking about communication. And there's two videos, actually there's more than two, that are very relevant that I have. One is a video showing meerkats of the Kalahari Desert. And I want to ask you, how many of you have seen the video, *Meerkats United?* I know some of you must have seen it. They became very popular after the Public Broadcasting Company made this half-hour film of meerkat behavior. George Page was the narrator. You can still find a lot of meerkat videos online, but they're not as comprehensive or as good as the George Page video, so I'm going to show that today. I have another one on horse communication. I know some of you have special interest in horses. This link that I've put here still works last time I tried, which was just recently. So this one lasts about 10 minutes, and you shall should watch it. And I've asked some questions about it in the study questions.

As far as this meerkat video, I posted this a while back, but some of you may not have seen it. These are questions on this meerkat video, and I want you to answer these questions by Friday and turn it in as homework. I posted it already. First of all, I want to know about interactions between different species . How do different species communicate with each other and interact? Give a couple of examples of communication among the meerkats. Very important in the video. If you watch it, you can't miss that. Similarly, describe two examples of altruistic helping behaviors among meerkats. Again, it's obvious in the film. And then I want you to describe two behaviors that appear to be fixed-action patterns used in foraging when these animals are looking for food. And again, very obvious video. They spend quite a bit of time on it. And I'm asking for the major adaptation of the species for predators. Can't miss that either.

The last one is one that you might have a little more difficult with. There are some inaccuracies in the way they portray meerkat behavior-- and remember, this was done for public television-- George Page isn't an animal behaviorist, but it's still pretty good in making animal videos, and they have good consultants. But they did miss some things that are important, and some of these have been subject to scientific study in recent years. You can easily find it using Google Scholar, but I've also put a couple of articles I found in my own searches on meerkats on the website, and one of them is directly relevant to this question.

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PROFESSOR: The closely related mongoose in India is actually kept by Indians as a pet, because it's protection from cobras. They'll actually killed cobras. It's a little larger than the meerkat.

Scott starts out by defining communication as an intentional transfer of information, either voluntary or involuntary. And he points out that honesty of the communication can vary. You can have dishonest communication. Because individuals don't do things just for the group. They do it for themselves, and sometimes they have an advantage by fooling the others. When their communications are detected by a predator, then of course it's a non-adaptive use of their attempts to communicate, so it's not intentional. So he doesn't include that as part of animal communication.

You don't always have auditory communication. Most frog and toad communicate by auditory signals, but there's one species of frog in Panama that doesn't. It's the Panamanian golden frog. It lives in very noisy streams. He calls it frog semaphore, because they're making signals with their limbs. And can you think of other species that use visual communication? Think of animals that live or forage long distances from each other. And if it's not always easy to communicate by auditory means, visual means might be better. For example, giraffes. We know that birds depend mainly on visual communication with each other, but auditory communication is probably equally important. In humans, we sometimes aren't very aware of how much of our communication is actually visual. It's often called body language. It's nonverbal, and it's very common in combination with auditory communication.

This is the Panamanian golden frog. It's a Very beautiful animal. There's always some kind of communication involved in courtship behavior, and some animals evolved specific courtship behavior that's based on exploiting sensory, basically innate releasing mechanisms of the opposite sex. And I'll give you a couple of examples of sensory export exploitation in the insects, but in the book, Scott starts by describing a species of orchid that resembles certain female insects, and it's very interesting. This is a paper that I found in American Naturalist 2008. Orchid sexual deceit provokes ejaculation in insects. And if it does that, the question was, why do they keep doing it? They not only waste sperm, but it might keep them from actually mating. And they show that orchid species that provoke this extreme pollinator behavior actually have the highest pollination success. So the orchid's doing really well. So how can the deception persist, because of the costs to the pollinator?

He points the author's point out that the sexually deceptive orchid pollinators are almost always solitary and haplodiploid species. That means that if eggs are not fertilized, they become males. The develop into males. If they're fertilized, they can develop into females that can reproduce. So female insects deprived of matings by orchid deception could still produce male offspring, and that may even enhance the orchid pollination, to get more males.

Back to the water mites that I mention in question. The courtship display of the male water mite-- it uses vibrations on the water surface that resemble the vibrations produced by prey that these water mites feed on. Here's a picture of the water mites. And you find the same thing in this insect, that little insect that walks on the surface water using surface tension, the male water strider also uses water surface signals that trick females into approaching them, as if they were prey. And as soon as the female's close enough, the male forcefully initiates mating. A kind of rape behavior is actually pretty common in insects, and some other species as well. So that's a kind of exploiting the innate releasing mechanisms of the female.

We might have to end here. I want to talk about the female Swordtail fish. It's commonly kept by people in aquariums, that like tropical fish. And I want to mention the kind of related things in human behavior. Now there's the swordfish male at the top, and the female down below. The female will select for mating males with the long tails. They don't have to have bigger bodies. They just have to have a long tail, because their innate releasing mechanism responds to a huge male with a short tail the same way she responds to a smaller male with a long tail. We're talking here about sexual selection, how that female has evolved to respond to specific characteristics of the male that don't seem directly related to the male's ability to reproduce. It's simply related to his ability to attract a female.

And because of sexual selection, it makes you wonder: what limits it? Why doesn't the swordfish male develop longer and longer tails? And you get a lot of variability in this. And you find it in humans, too. One example of it is right on the 920 home page, where I have a picture that I took at the Boston Zoological Park. It shows a male peacock-- beautiful example of sexual selection. Why does the peacock have such beautiful feathers that he displays? It's certainly not helping him avoid predators. In fact, it tends to do the opposite. It can cost the individual by reducing his reproductive potential, making it more likely that a predator will attack him. And so that definitely limits how far that can go.

And these are just some examples in humans. This will be where we end. It's obvious, some of it. Physical characteristics of one sex can be enhanced. Humans do this all the time. It's not directly related to reproductive abilities, but of course many aspects of a human female that attract males are related to reproductive potential, but not all characteristics. It also affects behavior, like young males will drive fast, fancy cars. Very common in your high schools. Other males may wear, the older males especially, might wear Rolex watches, because what females are interested. Not Rolex watches, but the ability of the male to provide. And women in some areas and some cultures will wear gold bangles, diamond earrings and so forth, just wear the latest fashions as part because it makes her more attractive. Of course, it has other purposes, too. There's a lot of cultural and local variations.

OK, so we will talk a lot more about sexual selection. We'll start here next time. And I do have a video showing many examples of sexual selection. I don't know how far we get that next time. But if we don't get to it next time, it comes up again when we study sociobiology, so we'll study it again.