PROFESSOR: We have just this topic to cover before the midterm exam. So we'll probably have a little bit of it to cover on Friday, but I'm working on a review for you. And I won't answer everything on the review, of course. We won't have time for that. But I will try to go over some of the points that students have asked me about in the past before the midterm, points that seem to cause more confusion. And I'll give you a few clues to the kind of things I put on the exam. But it's basically a short-answer exam. There might be some matching.

We got started with this last time, primary and secondary defense mechanisms. We talked a little bit about countershading in camouflage. And this is where we left. Many predators developed search images by perceptual learning, and then they learn to search for their prey, remembering what they've been successful with in the past.

And I asked what octopus and squid do. And for that, I would like to show a video. Let me see if I'm online here. Some of you may not be familiar with this. The mimic octopus. I'll only take a couple of minutes.

PROFESSOR: Anyway, you can find a little more online if you want.

So that behavior of the octopus-- and there's another example right here in the cover of your book-- another octopus that can change color patterns on its surface. It can mimic predators. Actually, this animal can create a thing that looks like two big eyes facing you, so it looks like a predator. Most predators have forward-facing eyes.

It's related to mimicry, and I want to talk here about the different kinds of mimicry. There's two kinds: Mullerian and Batesian. With Mullerian, different species that are all poisonous evolved to look similar to each other, because then they all benefit, like the vespid wasps.

So, an animal learns by trying to eat one vespid wasp. They taste bad. They're poisonous. The animal, the predator, learns to avoid not just at one species, but other vespids, too, because they look fairly similar. They all have the bands-- yellow and black bands-- on her abdomen. And that's the evolution of Mullerian mimicry.

With Batesian mimicry, animals that are not poisonous will evolve to look like a poisonous one. The best-known is the monarch butterfly, which is poisonous and bad tasting. Animals learn to avoid it. Birds will generally not attack monarchs.

And this is an example right here the viceroy butterfly that's evolved to look very much like the monarch. Here's a female monarch. Here's a male monarch butterfly. And there's several species that have evolved to look like a monarch.

Now, let's talk about other ways to avoid predation. The ground-nesting birds: why do some birds nest in the open, on the ground? They must have some advantages. And you can see one clear advantage: they can see any approaching predator, because there's no concealment.

But, of course, their nest isn't all that well concealed, either. So, what do they do to protect their nests from an approaching predator, like a fox or a polecat? And one of the best known examples that's usually cited is the way the plovers behave.

Here's a couple: the black-headed plover and a Piping Plover. They both nest on the ground, so they have that problem: what to do if there is a predator. They want to protect their eggs. They, of course, can flay away, but that leaves the eggs unprotected.

One of the things they do is reminiscent of what we saw in that very first video we showed in class of the stickleback. Remember, the male stickleback can have his

nest attacked by female sticklebacks, and he'll behave like he's got a nest some other place. He creates a false nest, and he attracts them to that. So they, then, are led away from his real nest.

And that's what these birds do. They'll pretend they're nesting in the wrong place, attract the predator, and, of course, they fly away, and then the predator doesn't get their eggs.

Another method is to approach the predator, if there's tall grass where he can do it. And then, suddenly, they'll duck down, so they're hidden in the grass, and they'll scurry away, squeaking like a rodent. And the predator finds that irresistible. He chases after the rodent. And, of course, that rodent mimic, the Plover is leading the animal away from their nest.

And there's another couple of methods they can use. Especially if the predator's already pretty close, they can run directly at it. They can run or fly towards it. They'll call very loudly. They turn away the last second, and move away from the nest. That way, they attract the predator to attack them. But they're quite able to get away.

Another well known one-- and a few of you may have occasionally seen this in the wild-- if you like to observe birds' nests, the broken-wing display. This animal that's being attacked can flee along the ground, acting like he can't fly, looking exactly like he's got an injured wing.

And, again, predators can't resist that. An injured bird is their best chance, catching a bird. Normally, they can't catch birds, but they can catch them if they're injured. That way, the plover can lead the animal away from their nest.

So all of that's kind of secondary defense: reduces the success of an attack, reducing the probability of attack. Its, sorry, primary.

Now, secondary defense is when an animal is actually caught by the predator. What does he do to reduce the chances he's going to be killed? They're not totally helpless, even if they're caught.

Scott describes the behavior of a chick. Chicks, of course, are a lot less able than adult chickens. They can't fly yet. They can't even run very fast. They're much more likely to get caught in the jaws of a predator.

What do they do? Well, they have this physiological change in their body. It's called tonic immobility. We call it "playing dead." But it's a physiological response. It's a fixed action pattern.

Other animals, I ask here whether mammals have such response, and many small mammals do. I still remember, when I was keeping hamsters in a basement-- I kept pet hamsters for awhile before I started studying them in a lab-- and I remember coming down there, and a female had gotten out of the nest, or the cage that I had.

But when I turned the light on and made movement, that animal just froze, became totally immobile. And I thought, as soon as I walk over here, she's just gonna run and get away. I'm gonna have to trap her with food or something, or water. And if you know these animals well, that's fairly easy to do, but it takes a lot of time.

But instead, the animal was totally immobile. I could even touch the animal and move a limb, and it would just stay that way. It was a tonic immobility response, and they maintain it for quite a few minutes.

Hamsters also have that as a response to specific odors. For example, polecat-like animals and certain species of dog. I had it happen with visitors who had dog, but all dogs didn't elicit that, just certain ones. And I never tracked down exactly which ones were more related to the polecat, their odor.

But anyway, these chicks are responding to the vision of those two predator eyes facing 'em. That triggers the tonic immobility. said Generally, the predator, if he doesn't struggle and doesn't move, just keeps him in its nest area, and doesn't immediately kill them. I, mean he doesn't need to, unless he's competing with other animals, in which case he might. This method doesn't always work for the chick.

But the chick lying there will occasionally peek to find out if the predator is still there. And it looks, and it still gets that stimulus, he'll continue in that state of tonic

immobility. But if it doesn't see the eyes-- so the innate releasing mechanism is missing-- he will lose the tonic immobility, and run away.

Now, we know the opossum does something similar there. We talk about opossums playing dead. You don't hear about hamsters, but I can assure you, they also can do that. And many other small mammals with certain kinds of stimulation-- rabbits, for example-- can enter that state.

We talked about anti-predator benefits of group foraging by birds before. You should be able to tell what the major benefits are, and the costs. I can count at least three benefits.

One is dilution effect. We call it the selfish herd. The more animals are there, the less chance that any one animal's going to be caught. And for that reason, in the period of reproduction, many animals reproduce in a colony, because if the colonies attacked, the chances that it will be their nest and their young that are attacked are reduced.

It also, of course, reduces the demands for vigilance on an individual, because there's many more eyes to see the predator. So the chances of their detecting a predator are much greater. As one animal responds, it's quickly communicated to all of them, either because they fly, or they emit alarm calls, or both. And, of course, if they all fly up at once, it confuses the predator, and very often the predator doesn't get any of them.

It has costs, of course. You're competing with a lot of other animals for food. Other animals that are interfering can interfere with your activities. It's, of course, a lot worse if you're not a dominant individual in the flock.

We talked about the optimal group size, which was not specifically rated related to predation, but to food gathering ability. So I won't go back over that now.

I will mention mobbing here. We've talked about mobbing in jackdaws and in geese. You saw examples of that, of the geese in the video. You read about it in Lawrence's description of jackdaws. We saw it in the meerkat video, as well.

Scott discusses the black-headed gulls, which will show mobbing of predators. And he cites data from a study where they looked at colony-nesting gulls, and how frequently they engaged in mobbing as a function of where their nest was in the colony. If they were near the center of the colony, the rate of mobbing in most animals in most nests was the highest. The rate at which they lost eggs to a predator was the lowest. And then, if you went to the edge of the colony, further he got from the center, then they were less likely to engage in the mobbing behavior, but they were much more likely to have their nests predated, and they would lose eggs. So mobbing is an effective kind of anti-predator behavior.

So what they do besides these kinds of behaviors, or just running away? Of course, that's the main defense an animal has. If he's by himself, he's attacked by a predator, he has to run. And the trick is simply not getting caught.

But they can do other things, too. For example, some mollusks, they have these tentacles. Some of these chemicals are actually are pretty meaty, and animals will often-- because they're moving-- are more likely to attack that part of the mollusk. But these things can be shed.

Similarly, lizards. They'll move their tail much more than the rest of their body. And they will do that purposely, because if the animal attacks them, grabs the tail, the lizard just sheds the tail, and the tailless lizard will get away. And, sometimes, the tail will be shed and it keeps wiggling and wiggling and the predator keeps going after it. The movement is irresistible to the predator.

We talked about this a little bit, about alarm calls. You should know that there's both altruistic and selfish uses of alarm calls. We know it can be altruistic, it can help others. But, of course, the animal doing the calling, his position is betrayed to the predator. So that's a cost.

And of course, the animal can elicit a mass escape and benefit from the dilution and confusion effects, and he can do that. He's benefiting perhaps more than others, because they head start he gets. And, sometimes, he will do that even if there's not

a predator, just so he gets access to food. So that's another selfish use of the alarm calls.

[? Cresswell ?] in '94 is reviewed by Scott. Collected data on that, these animals that wade around the shallow water and eat fat worms that they find in the bottom of the ponds. He found that the ones that didn't call, and the ones that flew up the latest, were the most likely to be attacked.

So those animals that were doing the calling weren't the most likely to be caught, even though they did betray their position. The calling might attract the predator to the region, but it doesn't make him select the animal to attack. In fact, if the animal's calling, he's probably the one you don't want to attack, because he's the vigilant one that saw you first. They want to attack an animal that's less aware, and that's exactly what they do. The late-flyers and the non-callers were the most likely to be attacked.

And, of course, I mention here at the end that alarm calls can also attract predators of the predator. So it's another occasional benefit of the calling.

Redshanks actually have two distinct ways of escaping. Some animals even have very distinct calls. It gives away which way they're going to escape, and that's because they can be attacked in different ways. And for the redshanks, they have two major predators. The peregrine falcons attack from above, in a rapid-diving attack, so they need to crouch low and remain still, so they're not attracting the vision of that falcon.

Whereas the sparrow hawk attacks flying in just above the ground, low. So their best bet-- if he's already been detected and that hawk is coming towards him-- the best thing he can do is fly up. Those are two very distinct methods of escape, and they each work best for one these predators.

And then we come to a really weird one: stotting behavior. It's caused a lot of confusion in studies of animal behavior. Do know what it is?

These little gazelles will be fleeing from a predator, and as they flee, they're using

extra energy and extra time to leap up high so they can be seen. They make themselves visible to the predator. And this is the way they look like.

And when you're looking at them, as you see in the drawing here, here's a cheetah pursuing one of these Thomson's gazelle. And the cheetah sees him from behind, and what he sees is this, like a white flag, every time the gazelle leaps up. Why would they do that?

There's been multiple hypotheses. The book mentions that there are 11 different hypotheses. He summarizes just three of them, and uses data from Carrol. This is from 1986.

He found that attacks by cheetahs appeared to be deterred by the stotting. It does work, and the interpretation is that it's communicating this: I'm far enough away that I have a high probability of escape, so why waste your time and energy? And, of course, if it does deter the attack of the cheetah, then the animal himself will use less energy. He will not have to flee as long.

And, in fact, they've collected data that is summarized in the book about the frequency of success of these attacks in animals that engage in stotting and those that don't. And those that show the stotting behavior are not caught as often.

So, I want to show this video called *Great Escapes.* Some of you have seen Marty Stouffer on the TV and public television. I don't know if I'll show all of these things, but this is a summary of a number of the things in the earlier part of the video. So let me pull up here. It'll start out with a bobcat, the most common big cat in the USA. Not a real huge cat, but a common predator.

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PROFESSOR: Why didn't the bobcat kill it? We've met this before, when we talked about predatory behavior and the work of Layhuasen and Lawrence. What's your interpretation? Good exam question. Interpret what just happened there. Yes.

AUDIENCE: [INAUDIBLE]

PROFESSOR: If I'm hearing you right, I think you what you said is correct. He had exercised his killing by pretty recently, and killed prey. His motivation for executing the killing bite was reduced below the level where it could be triggered by that prairie chicken. But his motivation to stalk, and even attack, was still high enough that when the stimulus was strong, like that prairie chicken taking off, it elicited the attack. But he wasn't sufficiently motivated to finish that last step, because the action-specific potential, the motivation to do the killing bite, doesn't build up as fast as the motivation for those earlier parts of predatory behavior.

So there's other examples of that in the work of Leyhausen. He wasn't playing with it, but that seems to be what it amounts to. And in fact, these big cats will do that when they themselves have killed and eaten and so forth. They will still actually catch prey without killing it, and bring it to their young, which then can practice.

We're going to see a coyote.

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PROFESSOR: There was only one other thing I could show you. It's just a bobcat attacking a lizard, and the bobcat ends up chasing a tail.

OK, so I will see you on Friday. And we will just have a little bit more on anti-predator behavior, and then we'll do us some reviewing.