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Flight Of The Wild Pigeon
Pigeons may not be known for their flying prowess, but they are actually pretty good at maneuvering right angles. Andrew Biewener and colleagues at Harvard's Concord Field Station caught pigeons in a parking garage, made a flying course in the lab and filmed the birds with high speed cameras to see how pigeons make tight turns.
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Next up, it's our spontaneous pick of the week. Well, not quite that spontaneous.
FLATOW: A little bit. With - Flora Lichtman is here, our multimedia editor. What video have we got today?
LICHTMAN: This week, we have an unlikely hero just to continue with the happiness or unhappiness. I think it's an organism that may not make everybody so happy, at least here in New York. The hero of our video pick this week is the pigeon. So researchers at Harvard actually caught them, captured them in a parking garage and then filmed them flying. And here to tell us why on Earth they would do this is Andrew Biewener. He's a professor of biology and the director of the Concord Field Station at Harvard University. Welcome to the program, Dr. Biewener.
BIEWENER: Well, pigeons, they're ubiquitous. They're very successful. And as you said, we were able to find them nearby. For those of us who study animals in the laboratory, it was � our field work was involved, going to a local - the mass transit garage. And we were able to capture some pigeons and show that we could be field biologists. And they're very docile animals. They work well. They don't bite you. And as I think our videos show, when you slow down the high-speed motions that they make - we're interested in understanding how they turn. Something that seems fairly straightforward to try to study and understand, but it's taken us several years to sort that out.
They actually work really well. They fly between perches. We could train to fly down a maneuvering course and make a predictive right or left-handed turn. And so, they're large enough to carry the weight of electronics we put on them. And they're large enough to make maneuvering a challenging enough task so we can actually try to understand how they produce the forces that they need to produce to turn.
LICHTMAN: And they're actually, you know, one thing that was amazing about looking at your video is they're way more graceful than you think of them as. They seemed to be pretty good turners.
BIEWENER: Well, they are. I think the reason you see so many of them in New York City, in any urban landscape is they're well-adapted. They're cliff dwelling, and they're known as rock doves. They have evolved to live in stiff cliff-like environments. And square, rectangular, tall buildings...
BIEWENER: ...provide exactly the right kinds of environments and be successful. And so they are - they're able to fly in a way that makes them very maneuverable at a fairly large body size. They're pretty large bird. And so it's, you know, they're taken for granted because they're so numerous. And I think probably considered a pest species by many. But, in fact, just like a laboratory rat that's - there's reason people study rats and mice. And for those of us that study bird flight, pigeons stand high in the list of why we'd be interested in studying them.
Plus, there's been a lot that's been studied about understanding their neurobiology. And part of what we're interested is trying to understand what birds are looking at, and how they use visual and their sense of balance to control how they move their wings to maneuver in a crowded environment.
LICHTMAN: And you found that they move sort of like helicopters. Can you explain that?
BIEWENER: That's right. Much to our surprise - we thought - like many biologists, we thought that organisms selection had evolved - animals, they really had some unique capabilities. And we thought, with wings, and a left and a right wing, and they could flap in different directions and change the shape of the wings, we though they could redirect the

force their wings would produce, relative to their body. But much to our surprise, very much like helicopters, the forces that they produce with their wings, which keeps them in the air and moves them forward or helps them turn, to make a turn, were actually directed very consistently relative to their body. They don't - aren't able to readjust the direction of the force at a turn. They actually have to change the orientation of their whole body, which changes the forces produced when they're flapping their wings.
LICHTMAN: So they're propelled in one direction by the flapping. And then to turn, they roll or pitch or lean, like you do on a bike or something?
BIEWENER: Exactly. They roll their body. They direct the force inward to make a turn, just as you would on a bike. When you're turning, you lean into the turn. The birds turn their bodies into the turn, and then they have to reorient their bodies to reacquire a forward flight direction after they've already made a turn. So they, you know, pitch up. They'll swivel around or yaw around, and they also, importantly, roll to initiate the turn at the beginning of the turn.
LICHTMAN: And if you want to see this in glorious, high speed, courtesy of Dr. Biewener and his colleagues, including Ivo Ros, go to our website @sciencefriday.com, where we have your awesome footage. It really is fun to watch them. So do all birds maneuver this way?
BIEWENER: Well, we � this - we're the first to study this in this kind of detail. It took nine high-speed cameras and a lot of...
BIEWENER: ...long of periods of analysis by Ivo and other students working on the project, mainly Ivo. And I think what we know is a lot of work has been done studying how insects turn. And it turns out that most of the insects that have been studied are similarly require changes in body orientation to redirect the direction of their flight forces, to turn.
So the pigeons appear to be a large size for a bird, appeared to turn very much like a lot of the insects that have been studied, the ones that's flying insect. So we're - our suspicions are that birds that fly and turn at lower speeds like this have to use these mechanisms. At higher speeds, it may be possible that birds are able to reorient the wing and its shape and its orientation to redirect the forces necessary to turn independent of - relative to their body.
LICHTMAN: So like the flap of one wing differently than the other wing to get a force, sort of,????? F50 LEA, like...
BIEWENER: Exactly. When a bird moving more quickly, it's easier to fly fast than it is to fly slow. It's actually very hard. Few birds can hover for very long times. That's why hummingbirds are so notable. Most birds have to fly at a fairly fast speed to minimize the amount of effort they have to put in the flight. And there are good air dynamic reasons for that. And so turning at higher speed probably allows a greater flexibility.
So until we can actually set up the experiments to fly the birds at high speeds - and we simply don't have the buildings large enough. We probably need sort of an aircraft development,??????, aeronautical engineering facility for that sort of an experiment. But the space we had was large enough that we could actually study the turning flight at these speeds at around 10 miles per hour.
LICHTMAN: Oh, wow. What about other flying organisms that do - that hover, like a hummingbird or, you know, we've done videos on hawk moths...
BIEWENER: Well,?? ????? F50, their - you're looking - at least in bird world, hummingbirds are certainly the most maneuverable of any species. I mean, that's the collective group of hummingbirds. But they're noteworthy for being able to hover and stabilize and just highly maneuverable. So they're very easy to study in terms of how they maneuver. But the - and it seems like the work that we've done, in collaboration with some other groups on hummingbirds, suggest that they are able to reorient the forces of one wing relative to the other. So they can change the direction of the force relative to their body more effectively than what we found with pigeons.
LICHTMAN: For people who are making little robots that fly or helicopters, are there any lessons that you think they can get from the way pigeons fly?
BIEWENER: Well, that's certainly one of the motivations for this work. We, actually, currently are collaborating with groups at MIT, Carnegie Mellon and NYU trying to understand how birds make path planning decisions when they're flying and avoiding obstacles. And the goal there is to be able to understand how information taken with video cameras could be use to guide a small, micro air vehicle. I'd say the - what we have found is that the bird - if you have the ability to be very maneuverable, that is birds are able to change the orientation of force by rotating their bodies very quickly in different directions. So being highly maneuverable has real advantages. And that allows animals like a pigeon or other birds to be able to react quickly to obstacles.
Now, I'd say where we're, you know, we're dealing with animals that are flapping their wings, which have - that adds an additional demand on how they actually propel themselves through the air. A lot of the micro air vehicles are using a typical propeller or a jet engine, would be using a more traditional way of generating the forces of - for flying the craft. So it's - having a fixed wing aircraft is the kind of airplanes that we fly around. And it changes how they might actually change the direction of forces compared to the way a bird is able to change those forces.
LICHTMAN: Hmm. You're listening to SCIENCE FRIDAY on NPR. I'm Flora Lichtman. And we're talking with Andrew Biewener, who's the director of the Concord Field Station, which I really want to ask you about because I was perusing your website. And there's pictures of, I think, emus on treadmills, and wallabies jumping up hills, and goats being herded. That does not remind me of the Harvard Campus.
BIEWENER: No. We're a defunct Nike missile facility that Harvard acquired back in the 1960s.
BIEWENER: So we can be glad the Cold War era worrying about Russians coming over to bomb the US ended quickly. And the facility was defunct and Harvard was looking for a field lab site associated with land they had off-campus. And they acquired what became as we come to know as the Concord Field Station. And it's largely been a lab used for larger animal comparative biomechanics and physiology works. So animals - a lot of my lab group studies terrestrial locomotion, animals running around, on the ground, on treadmills or over force plates, as well as the flight studies where we can fly birds there. And so it offers a lot more space and resources.
But it's a special facility that, I think, we've done well with making use of what was created more as a missile defense system that went defunct back in the middle '60s. And it started out its years a facility that my predecessor and who was also my PhD advisor, Richard Taylor, was instrumental in, sort of, understanding the energetics(ph) of animals running on treadmills of different sizes and body shapes, and whether they're bipeds, like a two-legged runners, like a human or an ostrich, or a four-legged animal like a dog or a horse. So all those animals been run on treadmills. And they measure the energetics as they would in a human study by measuring the amount of oxygen that the animal consumes while it's running.
LICHTMAN: I can just imagine the challenges of getting an emu on a treadmill.
BIEWENER: It - well, we start young. We got someone - they're hatchlings. And when the - most young animals are very docile and not too feisty. And so the emu, as little hatchlings, actually are very cute, and they're all about a little over half foot, three quarters or a foot in size, maybe nine or 10 inches. And they do pretty well. And when they get up to be on the order of 100 pounds when they're adult weight, then you're - they're used to it and you're used to - you've grown up with them, basically, and it's easier to work with them.
But they are a challenge. You have to know how to understand the behavior of the animal that you're working with and understand how to get on a treadmill so that it's not going to be too stressed by that experience.
FLATOW: Dr. Biewener, Ira Flatow here. Thank you for taking time to be with us today. And...
BIEWENER: Well, thank you for having me. It was my pleasure.
FLATOW: And if you had - I'd give you the blank check question. Is there's some sort of technological thing you'd love to have to make your research easier? Some sort of a gadget, gizmo, something...
BIEWENER: Well, I guess, I'd like to be able to have a way to track animals and their motions in a much more direct way than we have. So we actually - we have to have ways of tracking motion with these high-speed video cameras. So the technology is changing, so where we can actually put a neural sensors on the animal and try to record from what those sensors are telling us about what the animals seeing and doing. But it's a, you know, that's the trick. I think we're working in that direction. But being able to track - I think the work is really moving to trying to study how animals move in their natural environment rather than on a treadmill on a runway area. And it's being able to track motion and seeing what the animal is doing.
FLATOW: Right,??????? ?????7 Ski Crystal Mountain. You want to replace B.F. Skinner with Konrad Lorenz. Thank you very much.
FLATOW: Andrew Biewener is professor of biology and director of the Concord Field Station at Harvard University. Thank you, Flora.
FLATOW: Plus, Video Pick of the Week is up there on our website. This is great video of watching these pigeons fly. And if you wonder how they do that, and they get around the corners in New York and these other cities, you can actually watch them do this sort of thing.
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