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Music

Host – Robert Frederick
Hello and welcome to the *Science* Magazine Podcast for April 9th, 2010. I'm Robert Frederick. This week: a newly discovered species of hominid; the evolution of human behavior; and a computer tournament to try to understand why copying others is such a good way to learn. All this and more, plus a wrap-up of some of the latest science news—including a story about enzymes that may help you eat sushi—from our online daily news site, *Science*NOW.

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Host – Robert Frederick
Two million years ago is right around the time when scientists think the first members of our genus, *Homo*, evolved. But the fossil record so far has been very limited, especially at around two million years ago, meaning there are a lot of questions about what our genus *Homo* evolved from. Now in a paper in this week's *Science*, Lee Berger and colleagues report their discovery of a new species of hominid right around that 2-million-year-old mark: *Australopithecus sediba*, which the researchers say may be the "Rosetta stone that unlocks our understanding of the genus *Homo*." I spoke with Berger from his home in South Africa and I began by asking him about the condition and completeness of the two fossilized skeletons he and his team describe.

Interviewee – Lee Berger
They are in extremely good condition, in fact, almost unprecedented condition. The bone surfaces—all the muscle details—are preserved there. As far as completeness is concerned, both of the skeletons sit at about 40% completeness, give or take, depending on whether you count ribs and such as that. But they're at about 40% completeness, and complete in different ways. The child, the holotype of *Australopithecus sediba*, has a almost complete skull and mandible, and then the rest of the skeleton – obviously because it's a juvenile – the epitheses, the growth centers, aren't fused. The female is remarkably complete down her left arm in a way that we've just never seen in an early hominid. We have, for example, the entire shoulder girdle all the way down the right arm to the tips of the fingernails, and then down through the hip, the pelvis, and then down into the elements of the lower limb and foot.

Interviewer – Robert Frederick
And from the find, what kind of environment did *sediba* live in?

Interviewee – Lee Berger
That's a good question, you know, it's early days on that. One thing I can tell you is that we will learn what environment they lived in because it's a moment in time. That analysis is still underway. What we can tell you at this relatively early stage is that it is a wooded environment with a lot of browsers in the presence of these hominids.

Interviewer – Robert Frederick
Okay. So, based on the shape—the morphology—of the fossils then, what previously described species is closest?

Interviewee – Lee Berger
Well, that's also a good question because I think you would have to say that it's pretty much equally close to two species that have been described. We're kind of equidistant, it appears, between *Australopithecus africanus* – it appears to be a daughter species of that, or something very much like that – but we're also remarkably close to some of the earliest members of the genus *Homo*. More particularly, though, not all of them, more particularly those that have been assigned to things like *Homo erectus* or *Homo ergaster*. Things like the face is very reminiscent of the Turkana Boy, but the body is something – a complete mix of characters. The arms are incredibly long. In fact, they have what's called a "brachial index," which is the forearm length relative to the humeral length, approximately of that of an orangutan, so it's extraordinarily long-armed. The pelvis and legs, though, are much more derived; they're much more like what you would expect to see in something like *Homo erectus*. So a real mix of traits.

Interviewer – Robert Frederick
It sounds as if there were potentially several different species that were mosaics between early hominids and the *Homo* genus. What, in particular, makes this a new species?

Interviewee – Lee Berger
Well, this is – firstly, this is in a critical time period which there's actually almost no fossil record for. We have a relatively good fossil record older than 2.1 million years for the hominids, and we have a okay fossil record, at least in South Africa, under about 1.6 million years or so. It's this period between sort of 1.8, 1.9 million going into 2 million that has really been almost a black hole. We have literally just a few dozens of fossils in that temporal period. And so these fossils are filling a really crucial gap where we don't have a lot of evidence. What makes them a new species? Well, surprisingly, almost everything about them. We've never seen this combination of traits in any one hominid – a very small brain, yet a brain case that's shaped like much later hominid. The brain's as small as very early Australopithecines, but it's shaped like something like a *Homo erectus* or a *Homo habilis*-type brain. It's got a very advanced face. There's a nose. It's got small dentition, and the anterior teeth are very advanced. It's got long arms though, long ape-like arms, primitive wrists, and short but powerful and curved fingers. And yet,

surprisingly, a pelvis that is clearly evolved for a form of facultative bipedalism, walking on the ground in very much the way we do or *Homo erectus* would have, and long legs. Those kind of combinations have never been seen in any hominid. In fact, it's sort of a mixture between much later hominids and much earlier hominids.

Interviewer – Robert Frederick
So what, if any, insight does this discovery of *sediba* provide into the origin of our own genus, *Homo*?

Interviewee – Lee Berger
Well, I think that, you know, it's the opinion of my colleagues and I that *sediba* may very well be the Rosetta Stone that unlocks our understanding of the genus *Homo*. There has been, as you're probably aware of, a muddle in the middle, if you will, between about 1.6, 1.7 million years back to 2 million, where we've had some candidates for the origin of genus *Homo* – *Homo habilis*, *Homo rudolfensis*, as well as a few others – but their morphologies have never quite fit perfectly, or the evidence has been very, very small for those species. Now we're looking at a species in that time gap that's carrying a morphology and preservation that really is unprecedented. And I think that over the next months, years, and decades, as these fossils are analyzed and compared to everything else, we're going to find that we may be able to unlock the origin of the genus Homo and really get a good understanding of what happened in that transition between early Australopithecines, like Lucy-like species, like Mrs. Ples, these type of things, and the first direct ancestors of ours, say something like the Turkana Boy, *Homo ergaster*, *Homo erectus*.

Interviewer – Robert Frederick
So why not the genus *Homo*?

Interviewee – Lee Berger
You know, one of the things that we did is we had to make a decision: "Is this early *Homo*, or is it an Australopithecine?" And, you know, a lot of people would say that naming a genus is just semantic at that point, you know, that it's an argument. But we actually do feel that these fossils are so complete and so remarkable in their combination of traits that, that we might actually be, at some stage, able to define the genus *Homo* based upon *Australopithecus sediba*. And so we chose to go with putting it in the genus *Australopithecus*, because *sediba* doesn't have the whole package. If you look at *Homo erectus*, *Homo erectus* is basically us with a small brain, and it shares those features, other than the small brain, with Neanderthals, with *Homo sapiens*, and with some of the archaic *Homo sapiens*. *Sediba* is so close, in the face, in the form of the skull, but it has a small brain. It has some characters of the posterior dentition that say it's primitive, but most critically, it has those long arms. It's still climbing trees. And so our argument is that it hasn't made that grade-level shift to the genus *Homo*. And so now, for the first time, we can tell you what it is when something isn't *Homo*. It's going to not have the whole package. And that's part of the subtle argument we're making.

Interviewer – Robert Frederick

Lee Berger, thank you very much.

Interviewee – Lee Berger
And thank you.

Host – Robert Frederick
Lee Berger of the University of Witwatersrand is lead author of a paper on *Australopithecus sediba*, a new species of *Homo*-like Australopith. Berger is also senior author of a paper on the geological setting and age of *sediba*. Find both papers and a related News of the Week article by *Science* contributing correspondent Michael Balter in this week's issue and online at www.sciencemag.org/extra/sediba. That's S-E-D-I-B-A.

Music

Host – Robert Frederick
The British government announced last week that it had created the world's largest marine preserve. Here with more about it is *Science* Policy Forum editor Brad Wible.

Policy Forum Editor – Brad Wible
Foreign Secretary David Miliband indicated that 545,000 square kilometers of British territory in the Indian Ocean, including 55 islands of the Chagos Archipelago, would be protected from commercial fishing, deep sea mining, and other harvesting activities. Until this announcement, the largest marine reserve had been the Papahanaumokuakea Marine National Monument in northwestern Hawaiian waters, set aside in 2006 by the United States.

Spanning an area larger than California, this preserve will dramatically increase the amount of protected ocean, expanding from roughly two-tenths to three-tenths of a percent of global ocean area. The preserve, home to the world's largest coral atoll and many other reefs, will protect over 70 species considered endangered according to the International Union for Conservation of Nature.

These reefs have been very resilient to temperature changes over the past several decades, and have extremely low levels of pollutants. This could make them extremely valuable for providing global reference baselines when assessing impacts of climate change.

While many in the conservation community are excited, there remain some skeptics. The Republic of Mauritius claims sovereignty, a claim that Britain intends to acknowledge once the region is no longer required for defense purposes. Residents were evicted in the 1960s and '70s to make way for a U.S Air Force base on the island of Diego Garcia. Those residents have turned to British courts seeking the right to return.

Host – Robert Frederick
That was Policy Forum editor Brad Wible with a policy update from *Science* and the AAAS Center for Science, Technology, and Congress.

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Interviewee – Elizabeth Culotta
So this is a package on the evolution of human behavior, and it looks at the question of "What is it that humans do that other species don't?"

Host – Robert Frederick
Science contributing editor Elizabeth Culotta reports and edits a package of stories in this week's News Focus on the evolution of human behavior.

Interviewee – Elizabeth Culotta
And one thing we do, of course, is that we're smart. And so some scientists have suggested that, in particular, the way in which we're smart—it's different from what other animals do—is that we have a better working memory, and working memory is a kind of a short-term memory. You are using your working memory as you are listening to me right now, because you have to remember what it is I just said, you have to remember that you're listening to a podcast from *Science* magazine, you're keeping all that in your mind, and you may be doing something else while you listen, so that you have to put all this together and yet keep your focus on working memory, say. So you're using your working memory as you listen. So one idea is that working memory—an advance in working memory—was the key thing that allowed humans to become different from other animals to set out on our unique path. But other people have a different idea and they say, "Well, you know, it may not be something that's related to our individual cognition, it may be what we do in groups. That is, when we get together, we can do so much more than any one person alone." And so other people have modeled some possibilities how it may be that the way we have been able to create complex culture like art and symbolism comes from getting together rather than an increase in working memory.

Interviewer – Robert Frederick
What was the reasoning behind the hypothesis that the evolution of working memory was what made *Homo sapiens* smarter than our ancestors?

Interviewee – Elizabeth Culotta
Well, it's really interesting how this came about, because there was a psychologist named Fred Coolidge who got together with an archeologist named Tom Wynn, and so these two guys put their two specialties together, and they said, "Look, it seems like if you look at humans compared to past hominids, it looks like what we can do, but they couldn't – say what Neanderthals couldn't do or what *Homo erectus* couldn't do – is that it could be our working memory that's different." And what they mean by that, in particular, working memory is composed of a bunch of things—that's what the current model is—and one of them is that you remember certain things, like you remember, might remember what something looks like or you might remember what something sounds like or you might remember words, and so the idea is that there's different bins for remembering these certain kinds of things. But, also, that there's what they call an "executive function" that kind of controls all this and keeps your attention focused on the

task and kind of controls information flow. And so these guys proposed that humans are better at all of this than, say, Neanderthals were. And they say that if you look at what Neanderthals did, Neanderthals were good toolmakers, but they didn't really change their tools for a really long time, like hundreds of thousands of years. There's not much imagination or creativity when you look at their tool record. And when you look at what modern humans did, it's really different. There's different kinds of tools for different needs, and they also, of course, have the ability to create art. And one example that Wynn and Coolidge suggest is this lion-man. And what it is, is it's a statue that's got the body of a human but the head of a lion. And so to make something like that, you have to remember what a lion looks like, know what a human looks like, and then imagine something that is neither and put it all together and create it. And so that, they say, would really take a lot of working memory to do. And, by the way, you can read a lot more about this in Michael Balter's article.

Interviewer – Robert Frederick
Besides this invention of tools, or this development of better tools, why would working memory itself be subject to natural selection, and so drive the evolution of human cognition?

Interviewee – Elizabeth Culotta
Working memory has two key features that could make it subject to natural selection. It varies among people, and that variation may have a genetic basis. And actually it's interesting: some psychologists think that working memory is so important that intelligence tests actually measure it, and so that when you measure someone's intelligence, you're actually measuring their working memory. But you can see that, for example, some people with developmental disabilities, they have less working memory, and some of that seems to be genetically based. So there's variation with a genetic basis, and you need both those things to be subject to natural selection. But working memory fits that bill; it passes those tests.

Interviewer – Robert Frederick
Let's turn then to this other competing hypothesis: what evidence is there that people just got together and that led to the evolution of what we call "human behavior," or what makes us "us", rather than some change in genes or in human cognition?

Interviewee – Elizabeth Culotta
Well, so the thing about the working memory hypothesis is that many archeologists think it has one flaw. Well, some people think that it might have more than one flaw, but there is one flaw that some people point to, and that is that when you look at the archeological record, you do not see a sudden advance in what people are able to do, as you might imagine you would see if there was a cognitive advance. I mean, if we suddenly improved our working memory, if, you know, prehistoric humans suddenly got smarter, you would expect those prehistoric humans to spread, and you would expect that ability to spread. So once one person can do it, and then they pass on their genes, and then pretty soon everybody could do it. So you'd expect it to appear and then spread. But that's not what you see. When you look in the archeological record for things like

jewelry and art, what you see is this flickering in and out. For example, about 90,000 years ago in Israel, people were making these little tiny marine shell beads, jewelry: 90,000 years ago. But then they stopped doing that. It vanishes from the record. Then about 75,000 years ago in Africa, thousands of miles away, you find people making more shell beads and also making little geometric scratchings on ochre, and, apparently, using red ochre in decorative ways. So people there have suddenly begun to do symbolic behavior, but then that stops. And then 60,000 years ago, you find people etching these ostrich eggshells with, again, geometric designs. And so what you see in the record is this flickering in and out, and it doesn't seem to be what you'd expect from a cognitive advance. So, researchers said, "Well, what could this be?" and they modeled, some folks modeled what they call "demographic aspects." And what that means is factors that have to do with groups of people, like just population size. Like if you have a bigger population – supposing you're trying to make a tool and you've got a big population of people trying to make this tool, well, just because you've got a bigger population, probably somebody in that population is going to be able to make a good tool, maybe better than the previous best tool, so that means you have a better chance of being able to learn from a really good model. So if you're in a bigger population, you have a better chance of crafting a really good tool than if you're in a small population. So they modeled this with their models in the computer, and they found that that really is what you see: a big population is likely to have more complex culture, that is, better tools, more jewelry, that kind of stuff; and a small population might actually lose culture, that is, you might know how to do something and lose it, and subsequent generations would not know how to do it.

Interviewer – Robert Frederick
This flaw and this modeling, though, just seems to be an elaborate attempt to explain gaps in the archeological record. Is what's needed just more archeology?

Interviewee – Elizabeth Culotta
Oh, that's a good question. People don't think so because they have extensive records of archeological sites from some of these times and places, but you just don't see symbolism or art or jewelry. It only seems to come in and then go out. So they really think that, although, of course, the archeological record is extremely imperfect and you're never going to have a continuous record, it just doesn't seem to make sense for something to pop up 90,000 years ago in Israel, then vanish throughout the rest of the archeological record, and only pop up again 20,000 miles away 15,000 years later, and then do that very same thing again. But that's a good question and it's something that they always have to wonder about the archeological record. So to address that, Rob Boyd and his grad student, Michelle Klein – two scientists – tried to look at data from people who were alive recently. And they looked at people who live on the islands of Oceania – and these were traditional societies when they were first contacted – and they looked at how complex their toolkits were and how big their populations were. So, these people made their living from the sea, and so they looked at what kind of tools they used to fish or to gather, you know, invertebrates or whatever, and they would look at how many tools they had and how complicated the tools were. Like if you have a net, the net could have the net itself and a draw cord, maybe something to make it sink, so it might have several

components. So they looked at all this and what they found was that small islands with little populations had very few and simple tools. Big islands with big populations had lots of tools. They couldn't find anything else really made much difference. So this really proved what the modelers had thought, which is that just by changing populations, you can really get a change in culture. So what this suggests is that if there was a cognitive leap, okay, that would have happened early, before you see this happening in the archeological record, maybe 90,000 years ago, you know, and then after that, the appearances and disappearances of some of these art and jewelry has to do more with population sizes and how often people traveled, than with how smart people were. But all this, this question of sort of cognition versus learning from other people, social learning, you know, these are hypotheses and people are trying to look for new ways to test them. And that one way to test them might be to use computer things again or to have a contest. And that is exactly what some other scientists did: they posed a contest to try to test the advantages of social learning versus individual innovation.

Interviewer – Robert Frederick
And we'll be talking to first author of that study, Luke Rendell, in just a moment.

Interviewee – Elizabeth Culotta
And Elizabeth Pennisi describes how that contest was set up in her news article.

Interviewer – Robert Frederick
Elizabeth Culotta, thank you very much.

Interviewee – Elizabeth Culotta
Thank you, Rob.

Host – Robert Frederick
Science contributing editor Elizabeth Culotta reports and edits a package of stories in this week's News Focus on the evolution of human behavior.

Music

Host – Robert Frederick
In most, if not every human society, there's some mechanism that protects innovation and provides a potential reward, too – such as copyright, trademark, and patent laws. That may be because it's a lot more advantageous to copy someone else than it is to innovate yourself. After all, without any protection or reward, why innovate if everyone else can copy it? But it remains somewhat of a mystery how best to copy others, including when. In a paper in this week's *Science*, Luke Rendell and colleagues report their insights from a computer tournament they held in which participants submitted strategies for when to observe and when to innovate in a game that took place in a precisely defined virtual world. The winning strategy relied almost exclusively on observing what others did all the time. I spoke with Rendell from his office at the University of St. Andrews in Scotland.

Interviewee – Luke Rendell
Animals and human beings copy each other all the time, and they rely on what we call "social information," that is, information in the environment that's generated by other individuals, other people, other animals. Fred is tucking into a very nice fruit over there, and you learn from that that that's a nice fruit to eat. But all our kind of theoretical understanding up to that point has suggested, well, social learning's okay as long as it's cheap, so you don't take any risks, you don't risk eating a fruit that's poisonous, for example, which you would have to do if you wanted to figure out fruit palatability for yourself. But if there's too much of it, then everyone is relying on these "Chinese whispers" because they're copying someone who copied someone who copied someone who copied someone, and the risk of your information becoming out of date or incorrect is too high. And so there's a kind of mismatch between our understanding and what we observe in the real world, which is that copying is right. Lots of animals do it, and humans do it all the time. And it's the basis of our culture, our material and technological culture, which has enabled us to change the environment around us. So we wanted to understand, we wanted to attack this kind of problem, and the main sort of way to get over this kind of mismatch, we thought, was that, well, you don't just copy blindly, you do it smartly. You copy when it's a good idea to copy and you figure things out for yourself when that's the best thing to do. But the question is, what strategy should you use to decide between those two options?

Interviewer – Robert Frederick
And so what prompted and your team to choose to organize a computer tournament to try to find insights into social learning strategies?

Interviewee – Luke Rendell
Okay. Well, we were inspired by a guy called Robert Axelrod who back in the '80s organized a similar tournament around the problem of the evolution of cooperation, and he got the entrants to play a very specific game called The Prisoner's Dilemma. And as that emerged, the finding that a very simple strategy called "tit-for-tat" was very, very hard to beat. And it was a wonderful exercise for the field. And since then the study of evolution of cooperation has really taken off in a big way. So we were very inspired by that. We wanted to try and get as many people as we could thinking about this problem because if you just think about it, you sit down and say, "Well, what strategy would you use in this situation?" There's a huge number of possible things you could try. And we were very aware of like our own limitations of, you know, how much we could come up with ourselves. So we thought the best thing to do was to try and recruit as many bright people as we could, lure them in with a cash prize, and get them to think about this problem. And, in a way, they could explore way more of the possible sort of strategy space, if you like, than we ever could by ourselves.

Interviewer – Robert Frederick
And what were participants to do in your tournament? And what was the payoff?

Interviewee – Luke Rendell

Well, the payoff was a 10,000 Euro prize, so roughly $10,000, I guess, for the strategy that did best. And what they had to do was read our description of a virtual world, if you like, that we were going to drop a bunch of agents into. And then they had to come up with a kind of behavioral program that would be loaded into the heads of these agents in order to survive and prosper in that virtual world.

Interviewer – Robert Frederick
And participants could use any behavioral strategy they wanted?

Interviewee – Luke Rendell
Yeah. So there were rules so that the world operated in a kind of turn-based way. Every turn, you got to choose between one of three moves. Two of them were learning moves, so you could "innovate," which meant you learnt something by yourself, or you could "observe," which meant you copied – you learnt something that somebody that somebody else was doing. Or you could "exploit" something that you already knew about, and doing it was in that way was the only way that you could actually get points or get a score in the game. So what the entrants had to do is write a set of rules or instructions for how the agents would decide about which of those moves they wanted to do at any given point in the game.

Interviewer – Robert Frederick
How much variability was there in the learning strategies taken by the top 10 teams?

Interviewee – Luke Rendell
Well, once you got down to the top 10, they all shared some traits. So they would all copy, they would all use social learning quite a lot of the time, at least 60 percent of the time.

Interviewer – Robert Frederick
This is the "observe" category, right?

Interviewee – Luke Rendell
Yeah, exactly. So when they learnt, they would always play observe. And they wouldn't learn too much. That is, you know, they wouldn't spend too much of their life learning as compared to exploiting behaviors that they knew about. So, you know, one of the principle messages from that part of the tournament was if you spend too much time learning, then life is going to pass you by.

Interviewer – Robert Frederick
And how about the winning strategy? Was it a clear winner, and, if so, what set it apart from the others?

Interviewee – Luke Rendell
It was a pretty clear winner, yeah, it clearly outperformed even the rest of the top 10. The things that set it apart was it played observe a lot, and by that I mean it did it all the time. It never would resort to innovating. And it also was very smart in the way that it would

value the information that it already had – the things that it already learnt about – it would value them less and less as time went on because as the environment changes, then that information is more and more likely to be out of date. And it would then estimate how good the things it knew about were by kind of projecting forward in time and thinking about – in as much as a computer program can think – thinking about what was going to likely to give it the highest payoff: doing something that it knew about already now, or investing in some learning now in order to do something better later.

Interviewer – Robert Frederick
Did your virtual environment in this tournament account for the time differences required to observe versus innovate – the trial-and-error strategy?

Interviewee – Luke Rendell
No, it didn't, and that was a deliberate decision because most of the other models up until this point had assumed that there was some kind of structural cost to figuring something out for yourself. So, for example, I mentioned before about, you know, if you were trying to figure out what fruit is good to eat and you eat something that's poisonous, then you pay a cost there. If you're trying to figure out where's a good place to forage safely, then you take a risk in terms of, you know, predators being attracted to you. And most of the models out there in literature prior to this had kind of assumed there was some kind of cost associated to individual learning, and it's a pretty intuitive assumption. But we wanted to explore, like, what happens if you don't have those costs? Is there something inherent about social learning that is of value, even when it's not necessarily any cheaper?

Interviewer – Robert Frederick
So how precisely, then, does this explain why social learning is so common in nature?

Interviewee – Luke Rendell
I guess the key insight is that in our model there were a number of different ways in which you could get something, but some ways were better than others. And the reason that social learning turns out to be such a good idea is because it relies on other individuals doing what's best for them. So if you know about two or three things, and you want to do the thing that's best for you, you'll choose the best thing you know about. But then if someone else comes along and then copies you, they've already effectively short-circuited your learning of three different things, and they only have to invest the time to learn one thing, which is the best thing that you know about. And so they already have kind of at least two learning moves up on you, if you see what I mean.

Interviewer – Robert Frederick
And what, if any, insights does this tournament provide for why humans, particularly, are so good at social learning compared with other animals?

Interviewee – Luke Rendell

That's still an area of sort of intense speculation really, but one of the things that might be suggested by our results is that if you look at how successful *discountmachine* was when it was able to take into account the passage of time.

Interviewer – Robert Frederick
This is the winning strategy?

Interviewee – Luke Rendell
Yes, *discountmachine* being the winning strategy. And I explained to you to some extent how it was able to take into account the passage of time in terms of discounting information that was relatively old, and how it was able to kind of look forward in terms of estimating what was going to be the best thing to do, whether it would be better to make hay now, or invest in some learning now in order to get better payoffs later. And there's some active research going on on this idea of how good animals are at doing this kind of – the technical term is "mental time-travel." Are they able to project themselves and their situation into the future, or to what extent can they remember situations they've experienced in the past? And there seems to be some, you know – the emerging consensus is certainly that if animals are able to do this, they can only do it in a pretty limited way, whereas human beings are patently able to imagine themselves into the future and also to look back and review experiences in their past. And maybe this ability is kind of very important in the way that we evaluate information in the environment around us.

Interviewer – Robert Frederick
Luke Rendell, thank you very much.

Interviewee – Luke Rendell
You're welcome. Thanks.

Host – Robert Frederick
Luke Rendell of the University of St. Andrews is lead author of a paper on the insights from the social learning strategies tournament. Find the paper and a related news focus story by *Science*'s Elizabeth Pennisi in this week's issue.

Music

Host – Robert Frederick
Finally today, David Grimm, editor of *Science*'s online daily news site, *Science*NOW, is here with a wrap-up of some of the latest science news, including a story about how Japanese people's guts seem to be specialized for sushi. You mean mine's not?

Interviewee – David Grimm
Well, not if you're a North American, apparently. According to this new study, there is a big difference between the guts of people that live in North America and those that live in Japan, at least according to a sampling of a small number of people from both of these regions. The difference appears to be in a couple of enzymes that break down

carbohydrates on seaweed. And, as you know, Rob, seaweed is a big component of sushi; it forms the wrapping of a lot of sushi. And researchers found that there are a couple of enzymes that belong to marine bacteria, and you would imagine, of course, marine bacteria because they're eating seaweed among a lot of other things. But what was really unusual in this new study is researchers found a couple of these enzymes in the human gut, but only in the guts of Japanese people they looked at, not in the guts of North Americans.

Interviewer – Robert Frederick
And do researchers have any idea about how those enzymes got there?

Interviewee – David Grimm
Well, they have a really interesting theory, and they point to the fact that Japanese people have been eating seaweed for hundreds of years. In fact, there's tax records going back to the 8th century A.D. in Japan that show that seaweed was actually used as a form of payment in Japanese society. So the researchers' speculation is because Japanese people have been eating seaweed for so long, they've also been eating a lot of these microbes that feed on seaweed. And what researchers know is that when microbes come into close contact with each other, they can actually exchange genes. So the theory is that over hundreds of years, as Japanese people were swallowing these microbes that have these special enzymes for digesting seaweed, the genes for these enzymes were actually getting transferred into the normal, what researchers call "gut flora," these are all the millions of bacteria, or maybe even billions of bacteria, that live in our gut and help us digest food. The idea is that some of these bacteria would have actually taken up these enzymes from these marine bacteria and incorporated them into their own genome, and you would see this happening a lot more, obviously, in Japan where seaweed is a much more of a staple of the diet than it is in North America.

Interviewer – Robert Frederick
So is this enzyme something that I could get in my gut bacteria, too?

Interviewee – David Grimm
Well, theoretically, Rob, if you ate a lot of these marine bacteria that contain the genes for this enzyme, and these bacteria transfer that enzyme to your gut bacteria, it could happen. Probably what's happening here is a lot more complicated, something that developed potentially over hundreds of years of eating these types of food and digesting these algae, because this is probably not a very efficient process, these bacteria transferring these genes to your gut bacteria, so unlikely that if you just consumed a bunch of marine bacteria that it's going to help you out in terms of having these enzymes. But it does raise the larger question, does having these enzymes actually help us at all? I mean, we know it helps these marine bacteria because it helps them digest seaweed, but you and I can eat sushi without any problems even though we're from North America.

Interviewer – Robert Frederick
Yeah, what do the Japanese get out of it?

Interviewee – David Grimm
And that's still an open question. The researchers speculate that the Japanese may be able to get more nutrients than we would be able to get out of the seaweed, so both us and a group of Japanese people would be able to digest sushi just fine, but maybe the Japanese people would have an easier time breaking down the carbohydrates in seaweed, or, perhaps, they would be able to break down more of the carbohydrates, so maybe they would get a little extra out of this food than we would. But, again, still, an open question.

Interviewer – Robert Frederick
Okay, so what other stories have you brought with you this week?

Interviewee – David Grimm
Well, Rob, from bacteria to birds. This next story is all about birds that don't like rain, even though they live in the rainforest.

Interviewer – Robert Frederick
How could researchers tell that they don't like rain?

Interviewee – David Grimm
Well, researchers here were studying migration patterns in a bird known as the white-ruffed manakin, and this is a chickadee-sized bird that eats fruit, and this study took place in Costa Rica where these birds live. You know, the common theory about, you know, bird migrations is that birds will migrate to where the food is. But in this new study, the researchers found out that that may be true, to some extent, but the birds also seem to be migrating because they just don't like getting rained on.

Interviewer – Robert Frederick
So they're migrating out of the rainforest?

Interviewee – David Grimm
No, actually they're migrating to a lower elevation. At the lower elevations of the rainforest, this particular rainforest, you tend to have less rain. And what the researchers did in this study was, they tracked a group of these white-ruffed manakins from mid-October to late December. And the birds started out at this higher elevation. And very serendipitously for the study, there was this huge storm that lasted for 10 days that occurred in mid-November. And, after the storm, a lot of these birds had moved down to the lower elevation. What the researchers did was throughout the course of this study, they actually captured these birds and took some blood from them to measure the level of stress hormones in their blood. And what they found was that the stress hormones were much higher on rainy days than they were on non-rainy days. So the birds were getting a lot more stressed out when it was raining outside, and they were also, overall, tending to move to these lower elevations as the months went by and these higher elevations were getting a lot more rain.

Interviewer – Robert Frederick
Why do researchers think the rain is stressing them out?

Interviewee – David Grimm
Well, Rob, in addition to stress levels, the researchers also saw signs in these birds' blood that they were burning stored fat, a sign that they weren't getting enough food, and this also correlated with a heavy rainfall. And so the researchers' idea is that when it rains really hard, it's impeding the ability of these birds to find food, and especially the smaller males, and the birds really start freaking out. They're saying, "I'm not getting enough food, or I'm not going to be able to get enough food; I really need to move to a different location where I might be able to find more food."

Interviewer – Robert Frederick
Might this be true of other birds besides the white-ruffed manakins?

Interviewee – David Grimm
Well, Rob, there are a couple thousand species that are, what they call "altitudinal migrants" throughout the world, you know, these birds that migrate from higher to lower elevations or vise-versa, and it's not clear what the researchers found in this study is going to be applicable to all of them.

Interviewer – Robert Frederick
Okay, so last story. What's this last one about?

Interviewee – David Grimm
Well, Rob, speaking of altitudes, this last story is about what's happening at very high altitudes on the planet Saturn.

Interviewer – Robert Frederick
What's happening?

Interviewee – David Grimm
Well, what's happening, Rob, is there's this very unusual shape known as "Saturn's Hexagon." This is a giant six-sided figure over Saturn's North Pole.

Interviewer – Robert Frederick
What's causing it?

Interviewee – David Grimm
Well, this hexagon is actually made up of a jet stream. If you look at a photo of Saturn, you'll see various bands wrapping around the planet, and all these bands are part of a jet stream. But if you look at the North Pole, you'll see that one of these bands is not a circle, it's a hexagon. And researchers first noticed this in 1988 when the Voyager spacecraft made a pass over Saturn. They said, 'That's really unusual, you usually don't see geometric shapes like that.' And it's been a mystery pretty much ever since. One of the original theories was that when Voyager first spotted this hexagon, it also saw this storm-like vortex near the hexagon, and they thought, you know, maybe like, you know, like a rock that may disrupt the flow of a stream in a river, this vortex was somehow

disrupting this one jet stream and making it form a hexagon. But when Cassini passed by Saturn in 2006, the vortex wasn't there any more, but the hexagon still was, so clearly there was something else causing it.

Interviewer – Robert Frederick
Did these planetary scientists ever consult a fluid dynamicist?

Interviewee – David Grimm
Well, as far as I know, they didn't, Rob, but fluid dynamics seems to be the potential answer to the riddle here, and the way researchers figured that out was they said – a group of physicists said – 'You know, can we somehow recreate this hexagon in the lab?' And what they did was actually something very simple. They took a 30-liter cylinder, filled it with water, and placed it on a spinning table, and this spinning table created sort of like what you would see these jet streams around Saturn, you'd see, you know, all of these circular bands around the outside of the cylinder. But then what they did was they added a small ring to the cylinder that whirled inside the cylinder at a different rate at which the cylinder was spinning. And so this ring created its own independent stream, which the researchers were able to follow with a green dye. And you can actually see a really cool video of this on the site. And what the researchers noticed was that the faster this ring spun relative to the rest of the cylinder, it started to create a variety of different geometric shapes, and eventually it created a hexagon. And so what the researchers think is happening is that this particular jet stream over Saturn's North Pole is moving at a rate relative to the rest of the planet that it's just optimized for creating this hexagon pattern that all the other jet streams that surround the planet are not creating.

Interviewer – Robert Frederick
Has this kind of thing ever been observed on a planetary scale before, though?

Interviewee – David Grimm
Well, oddly enough, such polygonal formations like this have actually been seen in hurricanes, again where you have these strong, sort of circular forces going on. And what the researchers say is, you know, even at a lot of fluid dynamics experiments that are done every day in the laboratory, you see stuff like that. It's just that the fluid dynamicists and the astronomers had never really gotten together before, and finally they are in this study. And even though this study doesn't actually prove this is actually what's going on on Saturn, it's the strongest clue yet that may help finally solve this cosmic mystery.

Interviewer – Robert Frederick
Well, thanks, Dave.

Interviewee – David Grimm
Thanks, Rob.

Interviewer – Robert Frederick

So, what other stories are you looking into for *Science*NOW or on the policy blog, *Science*Insider?

Interviewee – David Grimm
Well, Rob, for *Science*NOW, we've got a story about the physics of crowds – what makes crowds so hard to push your way through, and also a story about a new compound that appears to help cancer drugs have a much easier time getting into tumors. So potential applications there for cancer therapy. And, for *Science*Insider, *Science's* policy blog, we've got a story about Obama's new nuclear policy, and also a story about the Chilean earthquake that happened a couple months ago – the very, very strong earthquake that struck southern Chile – and what its impact has been on Chilean science. So be sure to check out all these stories on the site.

Host – Robert Frederick
David Grimm is the editor of *Science*NOW, the online daily news site of *Science*. You can check out the latest science news plus all the stories from the science policy blog, *Science*Insider, at news.sciencemag.org.

Music

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Host – Robert Frederick
And that wraps up the April 9th, 2010, *Science* Magazine Podcast. If you have any comments or suggestions for the show, please write us at sciencepodcast@aaas.org. The show is a production of *Science* Magazine. Jeffrey Cook composed the music and I'm Robert Frederick. On behalf of *Science* Magazine and its publisher, AAAS—the Science Society—thanks for joining us.

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