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00:06 Sarah Crespi: Welcome to the Science podcast for May 19, 2017. I'm Sarah Crespi. In this week's show, news editor Elizabeth Culatta joins us to talk about human migrations, ancient and modern. And, David Grimm is here to give us this week's hits from our online news site. We're still getting free transcripts from Scribie.com this week. Please let us know if you find it useful. So a special thanks to Scribie.com, audio transcription perfected, 75 cents a minute at 99% accuracy, the best deal on the internet for audio transcription.

00:46 SC: Now we have David Grimm, editor for our daily news site. He's here to talk about some recent online stories. First up, we have a story on overriding out-of-control AR. [chuckle] This is augmented reality, different from virtual reality, which is a complete immersion in a simulated environment. AR is more like a layer between you and the world, filled with helpful and not-so-helpful messages and icons and ads and sounds, and little toys, little pets. [chuckle] But, the not-so-helpful ones are what we're gonna focus on today. And before we even get to that, Dave, what is your killer app for AR? What do you want to see in your glasses that's not really there in the world?

01:29 David Grimm: What do I want to see? Oh, man, I wanna see everybody I look at have a cat head.

[chuckle]

01:37 SC: So you just want cat vision? But, a vision of cats.

01:41 DG: Yeah, not cat vision, but a vision of cats. I don't think we're gonna get that, but this is important because you can think more practically if you're driving down the road and your windshield has augmented reality, maybe your windshield is telling you, "Hey, slow down. There's traffic ahead. There's a pedestrian about to cross the street. Hey, you should make sure you see that stop sign," and maybe it's a little obscured by the bushes or whatever. So you can imagine something like that being very useful in a driving situation. But you can also imagine if ads start popping up in your windshield or some hacker takes over your windshield and obscures that pedestrian or that stop sign, you're gonna be in a lot of trouble.

02:16 SC: Right. And just to add, my killer app, which is not that killer, is bird identification. It analyzes the birds that you're looking at and tells you what they are. I don't know why I'm into this right now, but every time I see a bird, I really wanna know what it is and what it's doing.

02:31 DG: I don't think your bird app and my cat app are gonna get along.

[laughter]

02:35 SC: So, one of the things that we're gonna talk about is, this all sounds helpful and fun, but there's this concern that these things could interfere with your safety or your everyday life. So what are scientists thinking that we should do about that?

02:49 DG: Well, the researchers created this program called ARIA, which for you, Game of Thrones fan, is actually named after a Game of Thrones character. But, basically what it does is it plays air traffic controller. It really pays attention to all the information coming to, say, your virtual windshield, and it prioritizes what you're gonna see versus what gets hidden.

03:08 SC: For example, your cat app is on, so everybody has a cat head, but they're much bigger than human heads, and the cat head is blocking something important, perhaps?

03:16 DG: Like a stop sign.

03:16 SC: Like a stop sign, right. [laughter] So it's gonna somehow control that. What kind of rules would it operate under?

03:24 DG: Don't allow any augmented reality objects to block important augmented reality objects or any augmented reality objects, so nothing's blocking anything else. Don't obscure really important things like pedestrians and road signs.

03:37 SC: This is a solution, but I feel like there's not really a problem yet. I don't have access to AR right now, [chuckle] and certainly I don't have an experience of overlapping AR objects or logos, so is this a solution in search of a problem?

03:52 DG: Well, that's what I like about this study. It feels like we're always talking about stuff like there's a problem, now researchers have to come up with a solution. Here, the researchers are actually being proactive. They're like, "This is a problem you could have in five to 10 years. Let's tackle it now."

04:05 SC: Yeah, and I like that there is an outside comment that says, "I have a problem with this solution."

04:10 DG: Right. [chuckle] Right. And this person's basically saying, "We shouldn't be so quick to stem the flow of information. Information's good. Plus, he has this [chuckle] anecdote about trying to play Ninja in his yard and fighting zombies and augmented reality. All of a sudden, he looks at a stop sign and the zombies disappear because ARIA has said the stop sign's more important than the zombies and he's not able to Ninja-kick his zombies anymore. Another problem that maybe nobody's encountered yet, [chuckle] and maybe there'll be a solution for it.

04:41 SC: Now we have a story on repairing big bone breaks. We made a video about this study

and hunting for a good x-ray image of a broken bone was torture for me. [chuckle] I don't like looking at this stuff, but they are really common. Something like 100,000 people a year, in the US, get fractures that are so big that you can't just splint it and the person heals gradually by themselves.

05:07 DG: Right. A cast isn't gonna do anything for these things. You've got these big gaps where the bone should be. And in that case, the best that doctors can do is they'll try to do a bone transplant, sometimes from you, they may take part of your pelvis, which causes its own complications, or they may try to get a bone from a cadaver, but those never really work very well. So, there's really no great solutions if you've got one of these massive, what doctors call a non-union fracture.

05:33 SC: None of these are ideal; grafting with your own bone, getting some cadaver bone, amputation. So, researchers have been looking for ways of improving grafting and, in this case, they're looking at using gene therapy to assist bone grafts. How would this work?

05:49 DG: Well, what they're trying to do is they create the scaffolding that will bridge this gap. The ideal is to fill it with cells that are actually going to make bone. You make bone for yourself. And the cells that do this are these bone-forming cells called mesenchymal stem cells, or MSCs. And you really want them to migrate into the area and to also differentiate into what are called osteocytes, which are the bone-producing cells, and as you can imagine, that's not, none of those are easy tasks.

06:15 SC: Researchers have been working really hard through all these steps; getting the scaffolding, getting the cells to migrate in, getting the cells to differentiate. And that's where we're at now, getting a good level of differentiation of these stem cells in a broken bone. And gene therapy comes in. How does that work, Dave?

06:31 DG: Well, usually gene therapy works with a virus, but research doesn't have a whole lot of luck with that, especially for this type of procedure. And so here, what they did was they started with this scaffolding, they had this what they call a collagen matrix. Then they create this solution that contains genes, it's filled with these genes which are gonna cause the MSCs to differentiate into osteocytes to create bones. And these genes are actually encased in these gas-filled, really tiny bubbles. And what happens is they inject this solution of these bubbles into the fracture site and then they go over the area with an ultrasonic wand, and what happens is the wand's ultrasound actually bursts these micro-bubbles and this briefly pinches nano-sized holes in any stem cells that are around, allowing the gene to get in and, ostensibly, allowing these stem cells to turn into osteocytes and thus create bone.

07:24 SC: The researchers tested this in animals and they got results that are as good as a self graft, but obviously without the pain of having a piece of bone removed from your pelvis. This sounds very promising. What are the caveats here?

07:39 DG: Well, this is in pigs, not in people. It was also done in young animals and mostly, young animals tend to have more MSCs than older animals do and older humans do, and older humans are

more likely to break their bones. So the question is, is this gonna work on people? Is it gonna work in older people? So, a couple more hurdles to be overcome, but experts seem excited about it and think it could move into clinical trials fairly soon.

08:05 SC: Last up, we have a story on gecko-like robot feet or hands. If you want a robot to pick up a tomato, you're in for some programming. It needs to grip firmly enough to grasp the fruit, but not so firm as to bruise it. And that strength may need to vary from tomato to tomato. To get around this problem, researchers thought, "What if we just make the robot's hands really sticky?"

08:31 DG: Like gecko sticky.

08:31 SC: Like gecko level sticky. [chuckle] And let's talk about what makes the gecko foot sticky.

08:36 DG: Well, gecko feet rely on what are called Van der Waals forces. And basically what these forces involve is atoms which tend to be slightly positively charged on one side and negatively charged on the other. When they come close to each other the Van der Waals forces can generate an attraction and then geckos' toe pads are covered with tiny hair-like fibers that maximizes contact with surfaces which amplifies this effect and that's why geckos are able to climb walls, climb upside down, basically to be like Spiderman.

09:05 SC: Okay, so build me a robot like that.

[chuckle]

09:07 DG: Right, so it seems simple enough, but the problem is if you try to do that with a robot you have to have a really strong backing material, almost like a paddle, and you can imagine if you got a robot hand that looks like a paddle, it's not gonna be able to grip something like a tomato 'cause it can't curve, it's gonna be too rigid, and so the question is can you make something that's flexible, but also has these gecko-like properties.

09:28 SC: Okay, so you need the gecko foot to be even more gecko-like. How did they introduce this flexibility to robot hands?

09:36 DG: They created what they call fibrillar adhesives on a membrane, or FAM for short. And that basically is the flexible backing. And what they found is that even with a very small hand, something on the order of 2.5 square centimeters, which is about the size of a dime, their gripper could lift objects weighing more than 300 grams, maybe something the weight of a can of soda.

10:00 SC: What can these be used for? I mean, we've talked about tomatoes, we've talked about soda. I mean, what, [chuckle] are we gonna just be eating with these?

10:06 DG: Well, other than having a robot in your kitchen that can make you really nice sliced cherry tomatoes...

10:11 SC: Feed me. Feed me one grape at a time.

10:13 DG: Exactly. There's factories that deal with delicate electronics that are maybe small, they're oddly shaped and you can't handle those roughly. Or we could have robots that climb walls, especially very irregular walls that aren't just straight flat surfaces, but actually have maybe a lot of curves and contours in them. Now, what that would be useful for, things like search and rescue, exploring other planets. Who knows?

10:38 SC: Okay. [chuckle] What else is on the site this week, Dave?

10:41 DG: Well, Sarah, we've got a story and a video about how some tiny hopping birds may shed light on how some of the first dinosaurs took flight. Also a story about mice with 3D printed ovaries that were able to produce live offspring. And for Science Insider, our policy blog, we've got the latest in the saga of Paolo Macchiarini, a former superstar surgeon that fell from grace in Sweden and now has fallen from grace in Russia as well. Also a story about an invasion in genetically engineered petunias and what the government is doing about it. So, be sure to check out all these stories on the site.

11:19 SC: [chuckle] Thanks, Dave.

11:20 DG: Thanks, Sarah.

11:21 SC: David Grimm is the editor for our online daily news site. I'm Sarah Crespi.

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11:31 SC: This episode is brought to you by Dignity Health. Dignity Health is the fifth largest health system in the US and the largest in California. Their mission is delivering compassionate, high quality, affordable health services for all. With a history rooted in kindness, the mission and values Dignity Health were founded upon remain the same today. Polls show that Americans want to be more mindful, to pay attention to where they are and what they're doing in the moment. But busy lives and busy brains make this very difficult to accomplish. Last month, Science actually featured a career story on the mental health challenges for being a graduate student in science. This week, Nature has a long story on managing work-life balance for researchers in the face of burnout.

12:19 SC: Going all out in science and medicine can be tough on the mind. Sometimes beating back burnout literally means taking two minutes to yourself. Dignity Health is working to make mindfulness a practice for 39 of its hospitals, encouraging employees to set aside daily time for quiet contemplation. Join Dignity Health and set aside two minutes every day to check in with yourself and reflect on your relationships, work, or daily activities. To help promote this effort use the #take2mins. That's take, the number two, mins on social media. And visit dignityhealth.org/take2mins for more mindfulness research and tips.

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13:06 SC: This week's issue features a large section on migration, with stories on ancient travels and new ones. Elizabeth Culatta edited the news section, and is here to talk us through it. Welcome, Elizabeth.

13:17 Elizabeth Culatta: Thanks, Sarah.

13:19 SC: Why is now a good time to write about human migration?

13:23 EC: Because there are more people migrating than ever before. There are 250 million international migrants today. That's more than ever before in human history. It's also about 3% of the world population. So migration is really something that affects everybody, both those people on the move and also the people in host countries who are having to accommodate these international immigrants.

13:47 SC: Well, Ann Gibbons contributed a story on ancient human migrations and mixing. It focuses on the contrast between folklore and what new science is telling us about human history. Can you share a couple of the surprises that turned up in her story?

14:02 EC: Sure. And the reason she did this story, by the way, is because although there are more migrants than ever before, migration is old. In other words, we have always done it. Homo sapiens has been migrating since we arose more than 50,000 years ago. So Ann looked at some of the stories that ethnic groups like to tell about their migration, and then what science is doing to test those. So for example, there's a myth about the first Germans. And the first German is a guy called Hermann, [chuckle] or Arminius, and Arminius is a Roman name because he was a guy who lived during Roman times. And the myth is that he united the Germanic tribes, and they rose up in a rebellion against the Romans and defeated them. And now there's some truth to this, 'cause there was a battle where Arminius got together with a few other tribes, and they beat back the Romans, much to the Romans' shock. However, science has tested that myth and found that, for starters, Arminius, or Hermann, was not a pure German, if a pure German means somebody whose ancestors have always lived, say, in central and northern Europe. Because all Europeans, as it turns out, are composites. They are the descendants of many, many migrations, and three big ones in particular. So over the past 15,000 years, three big migrations have contributed to all Europeans. And so Hermann, and Germans of his day and later, are composites.

15:32 SC: What kinds of new research are helping to unearth these past passages that people have taken?

15:39 EC: There's two specific techniques, revolutionary techniques really, that allow us to do this. One is ancient DNA, because ancient DNA is where you can look at the DNA from remains, from skeletons tens of thousands of years old, and that's a really great way to find out who was related to whom. That's the gold standard for that. Another technique is isotopes. Now, isotopes are little chemical differences in substances. And they can look at the isotopes in, say, an ancient skeleton's bones or teeth, and they can find out if the person migrated during their life or if they stayed in one

place, if they stayed in the place that they were born. And the reason they can do that is because when we eat and drink, our bodies take in isotopes, these chemical isotopes, and they reflect our local surroundings. So if you were to, for example, grow up in the Black Forest of Germany and then migrate to Spain, your bones and teeth would have a record of that.

16:37 SC: A lot of the myths that are busted in this story are European. Why is there this regional focus, and does the science reflect that or are there other parts of the world that are also receiving this kind of scrutiny?

16:50 EC: There is more work being done in Europe, probably for two reasons. One is because many of the researchers working on this are European, and the cutting-edge techniques arose in Europe, but also because they have access to ancient skeletons. In some parts of the world, people are very hesitant to do studies on ancient skeletons, but Europeans are okay with this. And so you can get access to the skeletons and do the studies. However, people are looking at other parts of the world, and one interesting one is in the Middle East where people are exploring the identity of the Philistines of the Bible. The Philistines, the word 'philistine' in English is still a slur, it means somebody who...

17:31 SC: Non-believer.

17:32 EC: That's right, non-believer. And also if you're a philistine, it seems like you don't know much, you're uncultured. But in the Bible they've always been something of a mystery, because they show up, David slays Goliath, and Goliath was a Philistine, and David was the Israelite with the slingshot. And after that, the Philistines disappear from the Bible and also from other texts, and so people have wondered who these people were. And so the latest science on this suggests that they were actually sea people, maybe even pirates, and they were a combination of cultures, so that they came from other parts of the Middle East and the Mediterranean, and they all came together as forming this sea-fearing culture. And they may have assimilated into the Middle East, into parts of what is now Israel, which means that they may be among the ancestors of some Jewish people alive today.

18:25 SC: Well, let's move on to the next story in the package, and this is on the Yazidi, which may be not everyone is familiar with, so what role does migration play in their lives and what is science telling us about it now?

18:38 EC: The Yazidis are a persecuted minority from Iraq. We're studying them because the Islamic State attacked them, and they were forced to leave their homes in Iraq. Their story is one of really surprising resilience in the face of these horrific attacks. For example, some Yazidi women were captured and forced into sexual slavery, and now researchers have recovered some of those women and are helping them to heal. And so the story of the Yazidis is illuminating the factors that may help refugees heal from some of these horrific traumas.

19:14 SC: The next story is on bias against immigrants. So these are people who have migrated and moved to a new land. And what can research tell us about combating the bias from people who

already live there?

19:27 EC: Yes. We all have a tendency to be biased against outsiders, science has shown us that. But science also shows us that that bias can wax and wane depending on certain conditions. And that in a way is helpful, because if certain things can increase bias, certain other things can perhaps decrease it. For example, contact between refugees and local people is one way to reduce bias from the locals. For example, if migrants quickly learn the new language of their host country, they can better communicate with people, and you can have actual conversations person to person, and this tends to mitigate bias.

20:08 SC: Now, for something completely different. John Bohannon writes in this issue a data-driven story on scientific migrations, how researchers move from place to place during their careers. Where did this data for the data-driven story come from?

20:25 EC: He got this data from an unexpected source. It turns out that scientists are surprisingly hard to track, because science is a very global profession and many scientists cross national borders for their work. But every country keeps statistics differently, and also countries may define scientists differently. So what John did was to go to a set of data from an organization called ORCID.

20:51 SC: So ORCID, O-R-C-I-D, so that ID part is really important, is an international organization that basically exists to give researchers a unique identifier. So it solves the John Smith problem, where researchers have the same name but different scientific output, and we need to be able to keep that straight. So how can that data help track people's movements around the world?

21:15 EC: So it turns out that ORCID offers you the opportunity, offers researchers the opportunity, to put their public CV up on the ORCID database, so in other words your education, your affiliations, your jobs, all this kind of stuff going back several decades, so many scientists have done this. There are three million ORCID users and about one quarter of them have put the details of their education and their work history and its locations into the ORCID system. And so that means that, what we could do and what John Bohannon did, is to analyze the profiles in ORCID to see who went where and when in order to determine migration patterns.

21:58 SC: So one thing that came out of this story was the cover, and the cover of Science this week has the migration path of the most migratory researchers that he was able to pull out of this data set. What do we know about those people?

22:11 EC: This was fascinating. What he was able to do was simply to look for the people who had crossed the most borders. And the most migratory scientist that we could find, in the ORCID database, is a guy named Rimantas Kodzius, he's originally from Lithuania. He says that his home is wherever he works, he has just moved to Shanghai University, he's a synthetic biologist. Several of these most migratory scientists say that there is sometimes a cost to moving so much, and Kodzius, for example, says that he's 42 and still single.

22:44 SC: Well, there are so many stories in this package. What am I missing, is there anything else that you really wanna to particularly mention that appears in these pages?

22:53 EC: I think we covered it. Thank you, Sarah.

[chuckle]

22:56 SC: Thank you so much, Elizabeth.

22:57 EC: Great.

22:58 SC: Elizabeth Culatta is a deputy news editor for Science. She edited this week's big section on human migrations, check it out online at sciencemag.org.

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23:11 SC: And that concludes this edition of the Science podcast. If you have any comments or suggestions for the show, write us at sciencepodcast@aaas.org, or tweet to us @sciencemagazine. You can subscribe to the show on iTunes, Stitcher, and many other apps. Or listen to us on the Science site. The show is a production of Science magazine. Jeffrey Cook composed the music. I'm Sarah Crespi, on behalf of Science magazine and its publisher, AAAS. Thanks for joining us.