00:00 Sarah Crespi: Welcome to the Science Podcast for May 10, 2019. I'm Sarah Crespi. In this week's show, I talk with online news editor David Grimm about domesticated cat cognition. What are our feline friends thinking, and why has it been so hard to figure out? And Meagan Cantwell talks with Gregory Erhart about research into the effect of ride-sharing services like Uber and Lyft on traffic.

00:37 SC: Now we have David Grimm, online news editor for Science. Hi, Dave.

00:43 David Grimm: Hey, Sarah.

00:43 SC: Dave, you've finally done it.

00:44 DG: Cats.

00:44 SC: Yes, you've asked that big question what about cats, this time in feature form.

00:50 DG: That's right. This is all about scientists studying the social mind of cats. So in other words, how do they bond with us? How do they communicate with us? How did they, how have they kind of learned and evolved to live with us? And people have been studying this in dogs for decades, but nobody's studying cats, or nobody had been until recently. Which was very upsetting for me, 'cause I really wanted a story about how smart cats are but haven't had the opportunity to do so until now.

01:14 SC: Right, that's my question every time we do, "Oh, look how smart this animal is. Look how well it understands the world and social interactions." And I'm like, "What about cats?" I have a cat, he definitely tells me things that he wants.

01:25 DG: For sure. And I have two cats, and cat owners empirically know a lot of this stuff to be true, but it's one thing to sort of see it in your home and it's another thing to test it scientifically.

01:34 SC: Yeah, your cat may tell you it's hungry, it may tell you it wants to go out with different cries, different behaviors, but how do you capture that and say how it works in cats more generally?

01:43 DG: That's right.

01:43 SC: So what kind of stuff, what kind of questions were they asking about cats when you were visiting this lab in Oregon?

01:49 DG: This is a lab out in Oregon, Oregon State University. One of the things they're trying to figure out is how emotionally attached cats are to us. Do they pick up on our emotional cues? And one of the experiments they do is they actually have a researcher go into a room with a cat. And you know the cat's already kind of freaked out 'cause it's a weird environment. Cats don't like leaving

their home. The owner then leaves the room and the cat's alone by itself. So now the cat's even more freaked out. Then the owner comes back in after a couple of minutes, and often the cat will come greet the owner and want to get loved and petted by the owner. And what will often happen is the cat will start to go off and explore the room on her own.

02:23 DG: So the cat may be starting to look into crevices, to sniff around, to maybe play with toys. And a lot of people would see that, and say, "Well, the cat clearly doesn't care about the owner. The owner just showed back up and the cat sort of said hi to the owner, and then the cat went off again." But actually, this is a sign that the cat is emotionally attached to the owner, or at least socially attached to the owner, because the cat is essentially saying, "You're here. I know who you are. I trust you. Now I can go off and do my cat thing. I can go explore this room. I feel safe that you're here." So it actually does show a type of emotional bonding that cats have with us.

02:52 SC: And they've been able to do this with different pairs of animals and owners?

02:56 DG: Exactly. They've shown this consistently. And different cats have different personalities, not all cats are gonna do this, but the fact that some cats are able to do this suggests that this is something that inherently cats are able to do, that they actually have this ability to be very emotionally and socially connected with us.

03:11 SC: Is that unexpected considering that they are domesticated animals?

03:15 DG: It's weird because in some ways we would expect domesticated animals to be somewhat comfortable around us, but clearly, there's a range. I mean, a horse, or a cow, or chicken, there's a different relationship there that we have with cats and dogs. Pigs aren't sleeping in our beds for the most part and we don't have horses in our house. So cats and dogs, you would think they would have to take this to the next level. They don't just need to be kind of socially aware and emotionally aware of us, but they have to have, really be tuned into us. They have to know, for example, what we mean when we make certain gestures sometimes.

03:44 DG: So one of the famous experiments with dogs is researchers will point at one of two bowls, or gaze at one of two bowls. And dogs are actually able to follow this very well. And the whole idea was, "Oh wow, dogs must be like so tuned into us that they know what our gestures mean." 'Cause even chimpanzees, when we point at something, they don't know what that means. A lot of other animals struggle with this, especially with the gaze like if you just look really quickly at something. This is something that's been very rarely observed in any other type of animal. So dogs have really taken that to the next level. And it turns out, cats can do that too. So the fact that cats and dogs can do it may suggest that they have this social bond with us, this social intelligence that a lot of other animals, even other domesticated animals, might not have.

04:25 SC: Other kinds of domestication are often for service or jobs, like, "You're gonna be food, you're gonna plow my field." But with cats it's been much more like, "You're gonna live with me."

04:36 DG: Right. And that's one of the really surprising things here is too, because cats and dogs have a very different background. Dogs, they were very heavily domesticated by people, we think.

And they were heavily bred to be workers and companions, helping us hunt and do all these very complicated tasks. And so the idea was, "Well, dogs must be much more tuned into us because we've done this very aggressive domestication with them." Whereas cats, as you alluded to, Sarah, we kind of just, once cats showed up and started hunting mice and rats we just kinda let them be cats. We didn't do a lot of stuff with them in terms of domestication. And yet, we're seeing that cats have evolved a lot of the same skillset that dogs have. Which may indicate that this is the skillset both animals really need in order to live in these very close, kind of intimate situations with human beings.

05:22 SC: This is something researchers weren't really doing while dogs got their day in the sun. But what other labs are involved, and what kind of questions are they looking at?

05:31 DG: Right, and so exactly, and one of the reasons I wrote this story is because before five or six years ago there was very little being done, at least in terms of social intelligence, on cats. And now we're seeing these labs pop up all over the world. So there's this lab in Oregon, there's a lab in Mexico, there's a couple of labs in Japan, there's a couple of labs in Turkey. And they're studying a variety of things, like the gaze study I alluded to. Also, other ideas with social attachment. So if you go into a room with a scary object with your cat, like a fan with streamers.

05:55 SC: I love this fan, the scary fan.

05:56 DG: The streamers are coming out of it. We've got a picture of it with the story. This is something that's really gonna freak out the cat, you would expect, and often it does, but what's really interesting is if the owner behaves very calmly around this object and even tries to quote-unquote make friends with it, says, "What a nice fan," and to the cat, like, "Don't you wanna meet this fan? It's such a nice fan." What was remarkable is some research has shown that the cats actually can pick up on these emotional cues and, instead of freaking out, they'll actually go up and approach the fan. I saw a cat actually go up to a fan and just lie down right in front of it, this scary fan with streamers coming out of it, 'cause the owner was being very calm and really projecting this very, a friendly, calm state of mind that the cat seemed to be picking up on.

06:35 SC: And what does that mean exactly?

06:37 DG: And that means, again, that cats, and similar work has been shown with dogs, that they're very tuned into us. Not just to what we're saying, but also how we're feeling. That these... They can really pick up on these emotional cues that we let out.

06:48 SC: A lot of this seems like something a cat owner or a cat aficionado, someone who is tuned into their animals, would kind of expect. But are there bigger question that they're trying to answer besides, do our cats understand us and kind of get what we're saying sometimes?

07:03 DG: Well, one of these bigger questions is, what actually happened over the course of domestication? Not with just cats and dogs, but with some of these other animals we've been talking about. And if we can figure out that even cats and dogs have these similarities, it may say something about inherently some of the stuff that happens over domestication. One of the other

interesting things is that there's this idea that human beings actually self-domesticated.

07:24 DG: That we used to be a very aggressive, uncooperative species, and that we found a way to be much more friendly and cooperative with each other. And something very similar we know or we suspect happened with cats is they also self-domesticated. 'Cause humans seem to have played very little role in their domestication, and yet they were able to figure out a way to become more friendly and more cooperative and more used to living around other creatures than their ancestor was. And so it's possible that if we can tease apart what happened in the cat mind, we can maybe shed a little bit of light about what happened in the human mind as well.

07:53 SC: Wow. Alright, so as a cat expert, was there anything that you, was surprising to you as you were visiting these labs and reading this new literature?

08:02 DG: Yeah, I think one of the things that surprised me is that scientists are actually getting brave enough to study cats. Because nobody really wants to study cats. You bring a dog into a laboratory and a dog, for the most part, is really willing to do whatever you want it to do.

08:14 SC: A dog'll sit in an MRI.

08:15 DG: It'll sit in an MRI, it'll do trial after trial after trial of experiment, whereas cats are gonna freak out even if you come into their home. You're a stranger, or they just won't participate, they're just gonna be cats, they're gonna walk away into the other room. Even some of the early experiments weren't replicated because the people that did them were just so frustrated with working with cats. And what's really surprising and actually kind of nice to see now is that a few brave souls, like this group in Oregon and some of these other groups, are taking another shot at it. And they're finding new ways to try to get them to participate in the experiments, and because of that, we now have papers that are starting to come out that are really showing, revealing all of these things about cats that we may have suspected, but we didn't really know for sure scientifically until now.

08:57 SC: Is any of this research going to help us better care for our animals?

09:02 DG: Well, so if you look at the article, we have a table called "How Socially Smart is Your Cat?"

09:07 SC: Oh.

09:07 DG: And you could actually do some of these tests. It's a little more simplified than what the researchers...

09:11 SC: I like it.

09:13 DG: You can try some of this stuff at home and figure out, does your cat know its name, how emotionally bonded to you is your cat? How independent is your cat, does your cat prefer you to food or vice versa? So there's a few relatively simple experiments that you can do to figure out not

only what does this mean for all of cat kind, but what does it mean for your particular cat as well?

09:32 SC: Did you do these tests on your cats?

09:33 DG: I haven't done them yet. I think we did the name test, which I think kind of, I think we showed our cats do know their names, but we haven't done the other tests.

09:40 SC: Do you think your cats would be good test subjects?

09:44 DG: I'm a little afraid to test them personally.

09:46 SC: My cat is afraid of nothing, but he doesn't do anything. That's his problem.

09:49 DG: Yes, that's the other problem. So the two problems with cats are, they're either freaked out or they just really wanna have nothing to do with whatever you wanna try to figure out.

09:58 SC: Alright, well, thank you so much, Dave.

10:00 DG: Thanks, Sarah.

10:01 SC: David Grimm is the online news editor for Science. You can read a link to his cat article at sciencemag.org/podcast. Stay tuned for Meagan Cantwell's interview with Gregory Erhardt about research into the effects of ride-sharing apps on traffic.

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10:21 SC: This week's episode is brought to you in part by KiwiCo. KiwiCo creates super cool hands-on projects for kids that makes learning about science, technology, engineering, art and math fun. With a KiwiCo subscription, each month, the kid in your life will receive a fun, engaging new project which will develop their creativity and their confidence. The projects are designed to spark tinkering and learning in kids of all ages. Every crate includes all the supplies needed for that month's project, detailed easy-to-follow instructions, and an educational magazine to learn even more about the crate's theme. KiwiCo inspires kids to see themselves as makers and is on a mission to empower kids, not just to make a project, but to make a difference. KiwiCo is offering Science Magazine podcast listeners the chance to try them for free. To redeem this offer and learn more about their projects for kids of all ages, visit kiwico.com/magazine. That's kiwico.com/magazine.

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11:30 Meagan Cantwell: When transportation network companies like Lyft and Uber started, they presented a vision of easing congestion in dense cities. Several years after the wide adoption of ride-sourcing apps, have traffic jams actually decreased? I'm here with Greg Erhardt to talk about his research on how ride-sourcing apps have impacted congestion in San Francisco. California. Thanks so much for joining me, Greg.

11:54 Greg Erhardt: Thank you, it's a pleasure to be here.

11:56 MC: When ride-sharing companies presented this vision, how did they believe that their service was gonna transform congestion?

12:02 GE: They've sort of played up this vision of being a complement to public transit, that perhaps they bring people to and from rail stations. There's also a mechanism by which they could discourage people from owning private vehicles, so for example, go to owning no cars instead of one car because I can sometimes use a Uber or a Lyft. And finally, there's sort of this idea that potentially they could promote carpooling. And so there's good theoretical reasons to think that they could be a benefit here.

12:31 MC: So there are definitely some ways where they could increase congestion, though. What are those mechanisms?

12:37 GE: It depends what the person otherwise does. If instead of taking a TNC, I were driving a private auto, then it's kind of a wash. There's no additional vehicles on the road. And when I refer to a TNC, by the way, it's a transportation network company. However, if I instead switch from walking, biking or transit, then it's a new vehicle trip that otherwise would not be on the road.

13:00 GE: Similarly there's a portion of traffic where the driver is driving around without a passenger looking for a ride, it's called dead-heading and this is a pure addition of new cars to the road. And finally there's the potential effect associated with the pick-ups and drop-offs, so there could be the vehicles when they stop to let a passenger in and out, they block the curb lane of traffic, letting the cars behind them pile up.

13:24 MC: There have been studies in the past that have looked into this. Some say it's eased congestion, some say it's caused more congestion. How does your study differ from these previous attempts to understand its impact?

13:37 GE: I think a lot of the analysis has been based on these theoretical arguments. There's been some limited amount of data, but what's been done before has been largely aggregate. We're looking at things in a very detailed way on specific roadways, at specific times of day. What we find is that the TNCs are actually concentrated in the most congested parts of San Francisco at the most congested times of day, further exacerbating existing congestion. Between 2010 and 2016 vehicle hours of delay, our measure of traffic congestion, increases by 60% in San Francisco. We find that more than half of that increase is attributable to the introduction of Uber and Lyft.

14:19 MC: How did you compare what it was like pre these transportation network companies and now?

14:26 GE: So when we made that comparison, we're able to measure the change in these roadway speeds as our dependent variable, we're able to observe the movement of TNC vehicles in the year 2016, but we're also able to recognize that it's not a perfect controlled experiment, we're not doing this in the laboratory, it's not the only thing that changes. So the other factors that make a difference

here in particular are simply the growth, so more people living in the city, more people employed in the city means more cars driving around, and we're able to control for that as a variable in our model using what we call a background traffic. So the background traffic we estimate using a simulation model of the transportation system and the simulation model is in effect a real world version of Sim City. So, it's simulating where people live, where they work and how they get between those places on a typical week day.

15:19 MC: Were you able to tease out what the main driver of this congestion from these TNCs are, or is it that there are just simply more cars on the road or is it the stopping on the side and letting passengers in and out?

15:31 GE: It's a combination of the two. We started at the beginning three ways in which TNCs could reduce congestion, three ways in which they could increase congestion, we're measuring the net effect of all of those things. When we looked specifically at the pick-ups and drop-offs we find that one pick-up and drop-off on a major arterial, the busier roads in the city, is equivalent to blocking the curb lane for about 140 seconds. If you're on a smaller road, a minor arterial or a less busy, a city street, it's maybe about 70 seconds, and then if you go to a side street there's not a detectable effect, and that's simply because there's fewer cars that are gonna pull up behind me while I stop. So that's an important point because it means that there's some degree to which diverting the pick-ups and drop-offs onto side streets may help mitigate these things. Now, when we look at the total accounting of the vehicles on the road, we find that about two-thirds of TNC vehicles on the street are new vehicles that otherwise would not have been there.

16:34 MC: Interesting. Could you also describe how you teased out the time in between picking up a new passenger and dropping off another passenger?

16:42 GE: One of the major challenges of this work is the lack of data. The TNCs themselves have a tremendous amount of data on all of their trips. We requested the data from the companies, they were unwilling to share that, so we started to look around for a different approach. Two computer scientists, Christo Wilson and Alan, Dr. Alan Mislove at Northeastern University, had written a computer program that essentially simulates the Uber and Lyft apps and pings their API. Their API basically provides data about where the nearest vehicles are. So if you open up the app you can see cars driving around on the app, and those are usually the 10 closest vehicles. So what they did is they set up these calls and they did so simulating client calls to this program in a grid across San Francisco and recorded that information every second for a period of six weeks in late 2016.

17:42 GE: What this gave us was, essentially, traces of where the vehicles were when the driver was available to give a ride. That trace would go offline and then it would show up in a different part of the city a few minutes later, say 10 minutes later, and we could infer that it went offline when the driver accepted a ride and then came back online when the driver completed the ride, and so you could infer that a trip occurred in between there. And we're able to use these data to identify where the pick-ups and drop-offs occurred as well as where the trips occurred and where the dead-heading occurs while drivers are driving around without passengers. So we estimated of the vehicle miles traveled in San Francisco by TNCs, about 20% to 30% is dead-heading.

18:30 MC: It's a considerable amount. Is there maybe something about how the city's structure or

anything like that, that could be contributing to why TNCs are having such a big impact on congestion?

18:40 GE: One thing I would expect with San Francisco is they were a place where TNCs came early, they're a place with relatively young, a relatively wealthy population, a very tech-savvy population. Those are populations that I would expect to use TNCs disproportionately. There's changes going on in the city, the net growth in the city is almost exclusively among households earning more than $100,000 per year, the demographics of the city are changing, so what exact effect those things have is important.

19:12 MC: Are there any other major factors that may have contributed to congestion that you weren't able to account for?

19:19 GE: I think the important limitation as I mentioned is this question of transferability and applicability. What other research has shown is that TNC activity is quite concentrated in the biggest cities and specifically in the downtown centers of those cities. It'd be reasonable to expect similar results in places like Chicago and New York and Los Angeles, the big dense cities. A place like Lexington in Kentucky there's far fewer TNCs on the road and there's less traffic congestion as well, so the impact and the effect is probably quite a bit less here. One of the things that's been criticized in our paper is, well, what about factors such as the increase in delivery vehicles? If we have Amazon trucks driving around, perhaps that increases traffic congestion as well. And that could be, it's hard to say, so it's a trade-off there, there's a delivery truck driving around, but there's also potentially one fewer person driving to the retail store. How that accounting works out isn't immediately clear, but that would be a really interesting thing if we could use some data in order to further analyze that question.

20:29 MC: Have you found that the usage of public transit has also changed with the introduction of these ride-sharing apps?

20:35 GE: I've done an unrelated study or a different study that's looking at that question nationally. What we observed is that just in the past three or four years public transportation in most cities in the United States has declined very steeply, and this is surprising because most of these cities have actually seen pretty strong population and employment growth over this period and many of them are increasing transit service as well, and so there's been a bit of a mystery or quite a bit of speculation as to why that might be. I have a separate paper that's showing that that reduction is correlated with the entry of Uber into those markets, so we speculate and hypothesize that this may be one of the driving factors, and we're looking at this question in more detail in San Francisco.

21:26 MC: You mentioned that you worked with the San Francisco County Transportation Authority on this study, did you discuss any recommendations for how to alleviate this congestion?

21:35 GE: Yeah, so to be clear, this study has specifically avoided making recommendations and provide room for the policy makers to determine their own recommendations. So to give you two examples as a direct result of this study, the chair of the Board of Transportation Commissioners

negotiated a use tax with Uber and Lyft and that tax would be spent on making transportation improvements within the city. And then there's also a consideration and sort of a resurrection of a study that was done 10 years ago, looking at congestion pricing. This would be similar to what's in place in London and would charge vehicles to drive into the downtown core of the city, it's not specifically aimed at TNCs, it would be applied to all vehicles, but it would aim to capture some of the externalities that happen when people are driving in TNCs and in passenger cars.

22:33 MC: Of course, thank you so much, Greg.

22:35 GE: Thank you.

22:35 MC: Greg Erhardt is an Assistant Professor of Civil Engineering at the University of Kentucky. You can find a link to his research at sciencemag.org/podcast.

22:46 SC: And that concludes this edition of the Science Podcast. If you have any comments or suggestions for the show, write to us at sciencepodcast@AAAS.org. You can subscribe to the show on iTunes, Stitcher, Spotify, many other places, or you can listen on the Science website. There you'll also find links to the research and news stories discussed in the episode. That's sciencemag.org/podcast. To place an ad on the podcast, contact midroll.com.

23:17 SC: The show was produced by Sarah Crespi and Meagan Cantwell and edited by Podigy. Jeffrey Cook composed the music. On behalf of Science Magazine and its publisher, AAAS, thanks for joining us.