Hugo Spiers

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**SPEAKERS**

Hugo Spiers, Caswell Barry, Selina Wray

**Selina Wray** 00:03

Hello and welcome to brain stories. I'm Selina Wray. And I'm here with my co host Caswell Barry,

**Caswell Barry** 00:08

on brain stories, we aim to provide a behind the scenes profile of the latest and greatest work in neuroscience, highlighting the stories and the scientists who are making this field tick.

**Selina Wray** 00:18

We don't just ask about the science, we asked how the scientists got to where they are today, and where do they think their field is going in the future.

**Caswell Barry** 00:26

So today, we're really lucky to be joined by Hugo Spiers. So Hugo, who I've known for some time, is professor of cognitive neuroscience at the Department of experimental psychology at UCL, he did his PhD with Neal Burgess, and I know this because we briefly overlapped when I was a lowly master's student, I think Hugo might have been in his first or maybe second year of his PhD a long time ago. After that, he moved on to do postdocs with Kim Graham in Cambridge, and then came back to UCL at the Wellcome Trust Centre for neuro imaging, which in Queens square where it was with Elena McGuire. And after that he, he joined the Ibn became independent, and welcome, Hugo.

**Hugo Spiers** 01:09

Oh, thank you very much for having me on, on the podcast.

**Caswell Barry** 01:12

No not at all we're very excited to talk to you. There's loads of ground to cover. I've got notes down here, which says taxis exclamation mark C Hero Quest, exclamation mark, and Royal Institute navigation and exclamation mark. And also six music Sophie Scott exclamation mark. So loads of cool stuff to go over, I guess the sort of unifying theme and feel free to correct me here about your work is that you're you're interested in how the brain represents a move through space. And I guess you've predominantly worked with humans, so people playing computer games, in this case and and patients. But also, I believe you have an interest in how people interact with architecture. Maybe we could also come to that. So where to start? I mean, I guess I was talking to a taxi driver yesterday and actually mentioned mentioned UCL and he immediately talked about taxi drivers having their brain scanned, Could you Could you fill us in on what all what all that's about and why you're associated with that.

**Hugo Spiers** 02:15

So there's various taxi drivers in London and licenced taxi drivers. One is in the black cabs, also known as cabbie number of studies where it's been shown that their stereo hippocampus is larger, and indeed, changes with the training they do. So the thing I find amazing about London taxi drivers is just what they have to do to get the job, they have to memorise like 26 to maybe 50,000 street names, and how they're all connected. And the exam is I'll pick two random places in London, and you have to tell me every street connecting them this exactly on the shortest path. And if you go off by a little bit, you're not allowed your badge. And they spend four years training to get this typically, and they'll fail the exam many, many, many times before, they're actually licenced, but the evidence over many studies suggest they do have a big hippocampus in their posterior part. And my role in that is really that we've I was involved in several of the key studies that Ellen McGuire, her lab who've been really studying this from the beginning, in a ran to show this, and then I've been following up again in recent so I've got a project called taxi brains running, where we've gone back and the imaging is obviously got better, we can look at structures in detail. But I wanted to learn more about how they do their job. And so we've been looking at how they recall routes through London, and it's just blowing my mind. So yeah, if you ever get a chance to ask one of them to do a read out of the streets and say, Oh, you want to go from Piccadilly Circus to Maida Vale station, they in theory can tell you every single street that will take and read it all. And it is just amazing to see them piece it all together. So yeah, they are. Yeah, it's incredible.

**Selina Wray** 03:59

And so this is this is what they call the knowledge. Is that right? If I got the name?

**Hugo Spiers** 04:03

That's right. Yeah. The knowledge Yeah.

**Selina Wray** 04:07

Other particular strategies that they can use to build up that kind of map of London in their brains.

**Hugo Spiers** 04:15

Yeah, that's, that's a question. We we had a research paper out early this year, where we documented that it's a long paper. It's like a sort of anthropological study of sending a student to embed in the tribe and learn all the secrets they have and then writing it up. They use a whole toolbox of strategies to do that task. The number one thing is that the government issue them a list of routes they recommend they follow to learn because the blue book runs and so what taxi drivers for long as I am aware, will do is sit on mopeds with a map in front of them and memorise a particular route they need to learn and once they pieced all these together, they have an incredibly detailed knowledge of of London. And so each of these routes is like filled with facts, they need to learn about the points of interest around it. And the and they're all interconnected like a large web. But the thing I think, for neuroscientists, that seems like a practical thing, but the some of the trick tricks I found really interesting as a neuroscientist, where they would really focus on visualising landmarks, they had like six, he taught to kind of in their mind's eyes, see things and picture them, which is interesting. The other one was the sort of like ghost riding in their mind. So you do a route, and it'll be this through the back streets. And some of the say that, in their mind, also following another journey through space whilst they're following a current one, which is a very odd thing to do. It's not something I've ever done, but it kind of once you've got that capability. And I think there's, I, for the research I've done, I had to learn tiny bits of London in enough detail to work with London taxi drivers. And there's something amazing about knowing a bit of space as well as taxi drivers do. They always used to say to me, oh, you know, 56 days of streets, it's all like my living room, when you want to reach out for the remote control. I just know where it is. You say Piccadilly Circus, I know where that is, Adam and Eve court, I'll know where that is just over there. It's it's absolutely incredible feeling of power, that this knowledge gives the taxi drivers kind of own London, I think is one way to look at it. But yeah, the brains do appear to be different. And we're trying to replicate the results again, in 2022. We're waiting to press that button, which is a bit nerve racking right?

**Caswell Barry** 06:33

Yeah, imagine. What what do you think the newer, more powerful imaging technologies is going to go in to be able to reveal or add on to sort of the core results? What are you hoping for?

**Hugo Spiers** 06:44

So the data that's been published so far, is really asked whether the posterior or the anterior hippocampus is larger or smaller. And obviously, there's a lot a lot of sub structures in there. So there are bits of the hippocampus dentate gyrus, where there's debate about its its role in neurogenesis. But there appears to be, you know, good evidence to think it's doing some interesting things. So it might be that the changes that we've seen in taxi drivers are really quite focal to some substructure within the hippocampus. And given its detailed connections as Caswell, you know, it's a fascinating bit of the brain, with all these bits going out at a very particular connections. So if we were to discover that the taxi drivers over their training experience, actually see major changes in one of these particular structures, I think that would be quite an important theoretical insight to see. It's worth noting at this point, that it's not just taxi drivers, I mean, that the validation is not like taxi drivers are weird. And this is really odd science. And I do occasionally come across people say, What a load of junk this sounds ridiculous, I think, you know, and that is, that is, that is a kind of reasonable perspective, as scientists, you should be very sceptical, as some sort of taxi drivers got a bigger brain was like no, actually, their brains not at all bigger. It's just, you know, their posterior hippocampus is larger. In fact, their anterior one is slightly smaller. But we also see these kinds of changes in squirrels and shrews and other animals where there's some change in their behaviour. That means they need to store like squirrels need to store nuts, you know, in winter is memorise where they put things. And you can see changes in the size of the hippocampus, in these in these other mammals. So I think taxi drivers are just when you realise what it is they're doing with their brain, memorising, like 56,000 streets, and all they do their day job is navigate. It kind of makes sense to me. So yeah, there's there's a lot we can learn.

**Selina Wray** 08:39

And so do you think that their brains are different? Because they're really learning this information? Or are the people who pass the exam and get their badge able to do that? Because their brains a difference? If that makes sense?

**Hugo Spiers** 08:56

It's a great and it was a question that a funding agency funded so that was on the money. And I can tell you the result that funding agency funded so Elena McGuire, very quite rightly asked that question. With Cattier willows, tastic researcher in a lab, they Cattier track down a hold of people waiting to train to become taxi drivers, and the very boring group of people not training to be taxi drivers, and then followed these people through. And step one, the first result she found was taxi drivers brains are boring before they start training, there is no difference at all to the other people who are not taxi drivers who have age and sex matched. So that's the answer to question one, they don't have a large hippocampus evidence suggests at the beginning of training, but beautifully by the end of it. So after four years, the boring people like me, you can no change in the hippocampus. There is no four years so there's no decline in size or anything. But there was a significant increase in the posterior hippocampus of London taxi drivers after that four year intensive training, but more is beautifully, only for the drivers that pass the test. Wow. So they had a whole group of taxi driver trainees who drained and drained and didn't pass it. And for those it wasn't like there was a little bit of an increase. It was as if they'd done nothing in terms of their hippocampus. So, yeah, so really beautiful piece of work that was published in Current Biology in 2011. And, yeah, that's that's a lot of work doing sort of longitudinal follow up with taxi drivers. So we're hoping we'll be able to track individuals over time now and follow a group of taxi drivers. That's certainly our plan. But these this this, this particular thing was people that want to train. So yeah, I agree is really fascinating result.

**Caswell Barry** 10:43

Do we know? I guess maybe I should know the answer to this, but I'm not sure I do. Do we know what it is that's actually causing the volume change? Is this the sort of much vaunted neurogenesis of the dentate gyrus? Or is this just a bunch of new bigger better synapses? Is does does anyone know? And is it? I mean, I'm really intrigued by this thing about the people who don't pass, despite doing the training, just don't show a volume increase? Is it possible, there's some sort of genetic predisposition that some people just have a higher level of plasticity, and you can just load the information in more? It's just sounds awesome.

**Hugo Spiers** 11:20

Yeah, those two are two great questions there. And I think the the scientists, the answer, we don't know is quite often the answer to question one. Both right. What we can say, as you look at shrews, and squirrels, and so on, it's not just neurogenesis, there does seem to be remodelling of the synapses, and so on. So it seems likely that the taxi driver effects we're seeing, you know, probably to do with remodelling of the synapses in the cells rather than new neurons being born. But you know, once we've done our higher resolution imaging analysis, we might have a better handle on where is this occurring? Is it in the region that people think neurogenesis occurs? That'll be interesting. And there's a good question as to why the anterior part actually declines in size. So it seems like the hippocampus is sort of shuffling towards the back, it's all moving backwards inside. It's obviously not, there's no movement of cells, but it's just that the density is distribution is changing. It's important to know Elena McGuire is absolutely fantastic work in this domain. And I'm really following up on answering the bits that I think have missed. One of the key studies she did was to look at medical students and consultants and everyone on the whole medical ladder to see if if you gain a vast amount of medical knowledge. Do you end up with a larger hippocampus? Is it just storing that knowledge? And the answer was no, medics are boring, their brain doesn't change.

**Selina Wray** 12:42

Love that, can we have that a bit louder, I'd like to play that to a lot of my colleagues.

**Hugo Spiers** 12:50

Friends, yeah. It's proven their brains. It's also true of London bus drivers. So a lot of good questions about the taxi drivers sort of fiddling lines of maybe it's just driving every day, all day that drives it, maybe it's the London pollution that's driving this, dealing with annoying customers might drive some of these things. So none of that all that sort of corrected for bus drivers, and they don't show it a larger Canvas. So there's been a lot of phones, this is a well studied domain of research. But in 2022, we do want to see if we can replicate with a large group of taxi drivers. And, you know, we've asked them millions of questions about their lifestyle. You did ask another question there, which was the what is it? Is there a propensity for it genetically? And then that's a really great one. We don't know. You know, I think if we get down the line if we get a huge cohort of taxi drivers who might double look at the genetics, but you're never going to have the vast numbers you need to really genetically profile a group but yeah, we don't know. And that's, that's a really an interesting unknown. Is there a propensity? I certainly think not everyone can memorise that amount of spatial information and piece it together there is there's got to be some sort of predisposition, I think,

**Caswell Barry** 14:02

yeah, I could well believe that. I mean, it's, it's fascinating. It's just sort of yielding so many potential sort of questions and hopefully the answers to them as well. Now we've Wait there's lots of there's lots more to cover. We can't just stay on taxis. So I've noticed you appearing in the various forms of media that even reached me quite a lot recently Hugo and Celine was pointing out that she'd she'd she'd heard you on six music on or heard about John six music I should say, When Sophie Scott, and this is all in the context of the awesome see her request. Could you tell us a little bit about that what it is why it is I've heard of it how it is you got an N in excess of 3 million I believe on one of your studies, which is pretty impressive.

**Hugo Spiers** 14:52

Yeah, this is this is a long story. I'll try and create a nutshell like what is the story in a nutshell, is that see her request is a very Video Game, fully commercial video game that people can download on the App Store, or google play and play on their mobile phone. And it's a video game you play a little boat that you sort of steer around these different tropical mystical islands and different sea seascapes looking for mystical sea creatures. Crucially, the reason I'm attached to it is that while you're playing it, the game stores locally on your phone, coordinate information, trajectory information about anyone playing the game. And the task of the game just happens to be because we designed it navigating. And the reason we designed this game see here request test navigation was that really there's been a drive in the in the Alzheimer's field to try and build more tools that are really tap into some of the core diagnostic early features. And back then the projects kicked off in 2016. There was a real drive and so around 2016, can we build better disease monitoring tools, and spatial navigation has always been on the checklist of clinicians looking to see what whether someone might be experiencing the early signs of Alzheimer's Becoming disoriented. But you can't test that in a in a in a GP surgery, whether someone's navigating well, they stay very, you need to have some standardised tests. So C request provides the aim was to provide a standardised test. And the project was funded by Deutsche Telecom T Mobile. And that made a significant difference because they one of the there's a lot of different angles to this story, I could talk about it. But one of the one of the reasons we were so successful with it was that the they want this company wanted to achieve a sort of reach out with their branding to do something good. And so they wanted their brand to appear next to we were fighting outside of this disease. And that we brought in Alzheimer's Research UK fantastic funding agency who is charity support this, they've backed us all the way. So working with these two organisations meant there was particular was enough money on the table to employ a commercial games company, which are not cheap. Quite an expensive if you want that Hollywood style budgets to make really good video games, and there was advertising. So when I run a study and I say, Oh, I'd like to recruit from participants, I don't normally have a large advertising budget to go and make sure my game or task appears on YouTube or on Google just pops up in the advertising section. So that made a huge difference, as well, to this project was that a, we were setting out to build this kind of diagnostic tool to create the world's big world, like global benchmark of how well people navigate. And yeah, we were able to reach out. And as you mentioned, in fact, we've got over 4 million downloads, which we were we were blown away in the first weeks, they came back and we said, we were hoping previous big project after a year, just around the year before we collected 20,000 people. And that seemed off the scale for what normal studies did. And so we thought we've got a bit of budget here,

**Hugo Spiers** 18:00

we'll get maybe 100,000 or something, and we got 100,000, within a week of download opening and launching, I think we'd underestimated the global reach of a telecom telecoms company. So one of the aspects of this research study is that if you if you are able to partner and get a someone like that on board, you can do things you wouldn't otherwise do. It's, you know, it's a, it was an opportunity that really came our way we didn't knock on their door, they knocked on our door. And the door they knocked on was my good friend, Michael Hornberger, who's professor of dementia at university Spangler. And he really took the idea to them and said, let you go. And I would like to build this test and, and do this. And they they went with this over lots of other possible projects. We're very fortunate. But yeah, you can imagine what 4 million people's data that yeah, we, you know, we're still kind of working away years later to, to really understand what's in there. And we've published a number of papers, and we've got quite a few under review. And we've got several in prep, and they're just, it's a joy to have that level of precision to say, you know, is this or this not? And so, you know, I don't want to preempt because of all the publicity, but one of the factors we've we've looked at with 700,000 people we've really identified and screened in on because you can you can really focus with big data that we find absolutely nothing like there is no effect of this, this thing that theoretically should have some effect. And it's quite amazing to see you can get effects. We had a we're very fortunate to have a Nature paper in March where we went through the editorial process in nature and it finally made it over the line with one of the other bits so I'll talk about that if you're happy to but yeah, definitely. It's it's it's been a hell of a ride. And a lot of work on that project is really logistics and planning and interacting with making games designers. You know, making sure that worked. We had a valid game. There wasn't just as a piece of science, but people were downloading it to play it for fun.

**Selina Wray** 19:58

I'm one of your fans and I have to say I'm appallingly bad. I don't know what that says about me i'll put that in the next question. But for anybody who's listening who hasn't played, I mean, I would really encourage you to go and download it, because it's such a beautiful interface. And, you know, you can play with it without having any idea that it's foreign experiment, which is exactly what you're aiming for. Really, it just just feels like a game. Yeah, it's beautiful. So I'd love to hear a bit without trying to take it too, personally about what you found in your latest Nature paper and what insights you've got from this data?

**Hugo Spiers** 20:39

Yeah, I should first up say that the game is available on the App Store and Google Play, but you can only get into it now with the code. So you need a research study to give you a code to get back in. So I think on the podcast, you can leave details, they can contact me if anyone wants to place your request, they can get in touch with our research team. And we'll provide codes for them to get in. So yeah, that so so yeah, and it's great. So I should also say we'd much rather have people go in and find it really hard. And and like think, Oh, I'm terrible at navigating this is difficult. That's much better for us. Because if everyone just does it, and they're fantastic, we don't learn very much science is really all about errors. If you you know, you build an experiment like Castle, they would rats, and they just run and they do nothing, there's no mistakes, and nothing, it's, you can't tell very much about the behaviour. So that's first step. So anyone who's bad at navigating, please go and play it. It's great. We absolutely value people who are bad, even possibly more than people who are good, because although you Selina you think you're probably doing badly, you would be you know, shocked at the scale at which it's possible to do that. And you can taxi drivers. Taxi drivers will say there's there's one way to do it perfect. And there's a billion ways to do it, you know, the wrong way to go between two places. And that's kind of true in the game. And the thing I love about the data or go into the study we published is that with data, so you got 4 million people, and no two people have it was taken exactly the same path. So you've got the capacity to kind of profile the fingerprint on 4 million people and see what is it that's going on there in the data? So it's really exciting data from that perspective. That's a man indeed going. Yeah, so going into that. It's like what we've done so far is really quite boring. So our recent Nature paper we're very fortunate to be on the front cover we I the first author Antoine Kudrow, who we hired as a postdoctoral fellow to start working now for the CNRS position. And it's really built his career on this. He suggested some designs to the team in nature, and they ran with one aspect of it and it was great. So what why were we on the front cover? Why was it a picture of Prague and Chicago overlaid? for that month? It's very strange. What we asked and see requests are a whole lot of background demographics, how old are you? What's your A, sir? What's your agenda? You know, do you travel much and the whole questions we've kind of honed in on, one of them was did you grew up in a city or in a rural setting, or some mix of these, on the hunch that the environment you grew up in might have some impact on navigation skill. And the perspective at that point was really, it could go either way. Because cities are really complicated, there's a million decisions you can make the king of the taxi driver is a good example of how many ways they can travel between points. But at the same time, you know, there's a lot of easy guidance, you know, you can maybe use satnavs, quite efficiently in cities. So rural settings, maybe more harder, you got to go longer distances, keep track of your changing directions, there's good reason to think these might matter. And they certainly did, we were really shocked. And we looked at the data that we can see really quite large effect sizes for growing up in cities worldwide, we found that there was a negative effect to growing up in a city, which was sort of puzzled was like, what is it specifically cities? So even just getting a bit of a mix seems to improve? And the question was really about where did you grow up? It's not do you live now in a city it was did you grew up in a city. So now, so on average, across the world, across 38 Different countries on every continent, not Antarctica? I would say that. But on most of the continents of the world, we can see that cities are on average, bad for your navigation skill. But we delved into this and had a great, you know, process of diving into the data, trying to understand it more. And one of the key insights was just looking at which countries is affected really big in, and it was really big Canada, the US, Australia, Argentina, and a few other places. Where if you think about it, and you've been to these countries, sure. Selena and Castle, you've been to SFM in a number of locations. Thinking of Chicago, it's really, really gritty. And you can just sort of work out how you're going to get somewhere by the number of blocks, you've got to go. So the demand or navigating is much, much less than, say London or Prague or somewhere else or Rome, or Sao Paulo is an example of credit The intricate city. The beautiful thing was that a geographer had spent time analysing the street layouts of all these different major cities in the world, and quantifying how disorganised The streets were, and scoring that as a metric of entropy. So this classic measurement, it's used in physics and lots of disciplines of how disorganised as a system, and you can look for cities. And that was helpful to us, because we could then show there was a strong negative correlation between how bad cities affected you and how greedy The streets were. So the more greedy the streets, the stronger the negative effects are growing up in cities was. So for example, the effect size is much, much bigger in the USA than it is in most of Europe, for growing up in cities. And for some European cities. In fact, it's countries whose it's makes no difference growing up in cities at all.

**Hugo Spiers** 25:51

So we then had a handle on why why are cities bad, it's not a city's about view, and then do somebody hand wrote me a letter on gold and paper saying, I think it's fluoride, I disagree with the conclusions in your paper. So if you get enough media coverage, we'll get you get sort of crazy letters. But we can see it seems to be gritty cities. And then the beautiful thing Antoine did was to pull apart our game levels, we have 45 levels, Selena, you will have played your way through, maybe not all of them. Not everybody gets all the way to the end of the game. But it's hard,

**Caswell Barry** 26:22

Are you stuck on level one, Selena.

**Selina Wray** 26:27

Not far off

**Hugo Spiers** 26:30

So the great thing was then looking at these countries where people that cities have a really strong impact. So people who grew up in cities where there's a big impact of gritty cities are really sensitive to how gritty the levels are. So a really they'll do really badly on the most entropically disorganised game levels, and actually quite interesting to us, they've got a slight advantage in the gritty levels in the game. So someone from Chicago actually is slightly better in a gritty level in the game. Amazing. So the title of the paper we published in Nature is not cities are bad for you get out of them, it's that they shape your navigation skills. So they kind of you kind of adapt your the way. It's a bit like, you know, I when I walk into a new house, I expect most of the rooms activity rectangular, they're not going to be curved and oval. And I think this is what's happening effectively for that's what we say in the paper, you kind of shapes your expectations about what will happen when you navigate.

**Caswell Barry** 27:24

This suggests a question Tim with I really want to know the answer to these gate, blending the two things we've been talking about these these taxi drivers that pass the knowledge, where are they from? Are they all from London? There's not many gritty cities in the UK, but I'm pretty sure Glasgow is quite gritty. And it's used to stand in for US cities in a lot of Hollywood films. Is there a tempted to to put two and two together and get 10 million?

**Hugo Spiers** 27:52

Do you mean by the question we should be looking at are taxi drivers. phenomenally good at navigate?

**Caswell Barry** 27:57

Well, I guess what I'm taking this is sort of your childhood experience of a certain sort of layout is predisposing both your general navigation ability, but also setting up sort of some prior beliefs about how, what the layout of a city should look like. And so I'm curious where that plays out in taxi drivers. I mean, I guess Yeah. Are they are all the black cab drivers actually from London, and you just need you just need to have been exposed to it, at some level to actually even have a chance of like passing the knowledge or could could you get? Are there any cab drivers in driving cabs in London from Chicago is basically what I want to know,

**Hugo Spiers** 28:35

I would hope I've put my mortgage on the fact that we'll be no taxi drivers from Chicago who spent their life growing up in Chicago who then go on not because it's going to disperse. It's going to put them off, but it's very likely the kind of disposition to become a taxi driver is to have got a lot of years and kind of feeling like you know, London, you start to think, Oh, I could do the knowledge. I know lots of bits of London. In our study, we actually want the best stories. We had a team running the study said one of the taxi drivers. We asked them this, why did you do this? Why didn't you do the knowledge? Guy said oh, it was to marry my wife said he said her father, his his father in law. Now his father in law said you're not going to marry my daughter unless you can do the knowledge. And so he set out for years to memorise London pass the knowledge and marry this taxi drivers daughter and he spent his whole career loving it so that's true.

**Selina Wray** 29:31

Who loves you as much as that taxi driver loves his wife?

**Hugo Spiers** 29:36

Yeah, exactly. So there's a really is they are a wonderfully diverse group. They are not all from one small region in Essex, you know, you will get clumps of taxi. I know historical regions of London that tend to have groups of taxi drivers. But they are their real characters. And I've really enjoyed every bit of work I've done with taxi drivers. So the ones who come forward for the research are also the ones who are for helping out with charity. And then the other thing working with taxi drivers and where they really seem to get involved in charitable work a lot more than other sectors. So, so I have a lot of time and respect for London taxi drivers. But yeah, yeah, I think one thing that was odd actually going back to your point about Glasgow in the UK, is that when in 2016, we got the data in, I noticed that the whole cluster of European cities were kind of in a big central mass. We're all pretty gritty, and there's not much impact of cities. For some reason, UK was kind of out there, like a Brexit nation for exiting from the rest of the cluster of countries where it is worse in the UK growing up in a city, I we don't have a good answer as to why they're just it's an anomaly in the data chart, where the where the sort of annoying bit of salt in your data. Yeah, it doesn't doesn't fit. Norway was kind of there as well. So it was like nations that don't like have a euro and are kind of slightly out there seem to be but I'm almost certain that's a red herring. Obviously, there's very little chance that yeah, that's driving it.

**Caswell Barry** 31:03

Wait, you heard it here. First, the Euro is good for your hippocampus is that.

**Hugo Spiers** 31:09

That's a bit like eating lots of chocolate is associated with Nobel Prizes. Shot the production for a country and over pricing comes highly correlated.

**Caswell Barry** 31:17

How interesting

**Selina Wray** 31:18

coming back to this idea of kind of cities being bad for navigation, is there potentially an element here of use it or lose it because I think often how reliant I am now if I need to get from A to B, I'm entirely reliant on following the blue dot on my iPhone, mainly out of convenience. And should I you know, should we not be doing that? Should we be trying to tap into our navigation skills a little bit more?

**Hugo Spiers** 31:45

Yeah, yeah, I certainly think that's the case. And I think we're, we're at the moment where in 2022, you can either kind of use the blue dot and a system like Google Maps, and you know, follow that through, or you can try and scratch your head and try memorise it. There's nothing in between. And so part of my research projects, we try to we fail, as great as a scientist actually quite liked when things really fail. And you think, Wow, he really got it wrong. So we've been trying to figure out how we can get somewhere in between those two, between you just scratching your head, like a taxi driver kind of go, How is this all connected, and all I'm going to be late now, because I made a mistake, or the blue dot, and it's somewhere in between, in my view is that you need some system that's going to highlight the kind of key mistakes you're going to make in a route and help you memorise it. And we don't have that kind of tool yet. But it would be great to have an augmented system that said, don't worry about the blue dot. But let me tell you, this is what you need to do. rundown instructions to get somewhere. And now, you can use your hippocampus to your long term memory to do that. And I think that would be quite a fun system. But again, you're kind of on the money with the funders. So one of the other funded projects that Elena McGuire ran was to go after retired taxi drivers, and the title of the paper was use it or lose it. And the this is a Philosophical Transactions article in 22,009, where effectively, we tracked down 10 retired taxi drivers after a year of painstaking work, because you can carry on into your late 90s being a taxi driver. So these chaps are all people who had to stop for various medical reasons. And the hippocampus was not as large there presumably campus as the full time age equivalent taxi drivers. But it wasn't as small as the non taxi drivers bus drivers example. So it did seem but it's the most sort of scant evidence base to say use it or lose it might well be the case. But yeah, it's lovely to follow that up. But it's very hard to find retired taxi drivers.

**Selina Wray** 33:45

So you got I've been desperate to ask you this since we started recording. And you gave us a little teaser on Twitter with a little poll where you said Which celebrity do you think screwed up one of our research experiments. And the people on that list were well self and Karl Pilkington, Benedict Cumberbatch and Richard bacon. Now not none of them are taxi drivers are related to this. And but I'm desperate to find out who it is and what they did to screw up one of your experiment.

**Hugo Spiers** 34:19

So I was very keen, I've never used Twitter poll. So this was a good opportunity to do it for this podcast. So very grateful 101 People that filled out that poll. And the key thing with each of those four people, there is a story behind every single one of those celebrities. They've all worked. In fact, they've all worked. Three of them have worked with us on projects, and one person didn't work with us on projects and screwed up an experiment. So I can tell you the winner, the actual correct person, and I was impressed that Twitter, the Twitter poll, the group voting you say put it to an audience to vote on it. We're on the money so Benedict Cumberbatch screwed up one of our experiments.

**Selina Wray** 34:57

So I'm glad I got the right answer as well.

**Caswell Barry** 35:00

Did I thought it was will self dammit No,

**Hugo Spiers** 35:03

no, exactly. So I'm glad you voted that way because if everyone just voted for Benedict then it would be a bit like oh, you know, it's obvious it was so obvious a point. I was quite glad actually he was doing very well initially Benedict. But then Tim Behrens intervened

**Caswell Barry** 35:17

What were you do it like we need more called like, what? Just imagine like, you and Tim and Benedict Cumberbatch walking down the street or something together like what was what was happening.

**Hugo Spiers** 35:28

So Tim, Tim intervene on Twitter to suggest it might be comfortable content and then he'll continue was it was a you know, in the lead for a while and then got picked up the post before the poll closed, but

**Selina Wray** 35:37

I bet it's close between them as well.

**Hugo Spiers** 35:39

Yeah, Yeah. It's kind of interesting question of who people think would screw up something.

**Selina Wray** 35:44

Everyone seems to think that Richard bacon is very trustworthy. To us results,no one thought it was him.

**Hugo Spiers** 35:51

I thought a lot of people might not know who he was in the US. Maybe we're entering the poll. That's possibly why he got low votes, maybe or will self so it's kind of the two people people that heard off we're getting the votes as I suspect was going on. But the story behind better. So what is why is he listed so I screwed up. So we were running it we'd run an a really successful brain imaging study where we taken film footage and recreated SoHo in High Definition film inside an MRI scanner and peered inside people's brains and seen all sorts of bits going on while they navigated the film footage. And we thought Great, well, we've got these amazing in the advances recently in EEG, electro electric encephalography, mobile EEG can be done. As we thought we try out just setting up a system when this technology is ready. We'll take people over Soho, and we'll actually record their brains whilst they're navigating in situ in Soho. And we got the whole system to work, it was doing great and one of the participants was really hard, diligently navigating Soho trying to get to a bar that we've instructed them to get to. And I wasn't there but I heard for team, they just stopped in the middle of the experiment and screamed, you know, and you know, with the sperm and want people to just like do the task and do it. They screamed and ran over the street screaming Benedict. And it was it was Benedict Cumberbatch. Cumberbatch is walking down the road, just as you do in Soho is a celebrity. And this woman, and this is the thing, this woman's screaming his name. He's just reading the walking, relaxing, walking through Soho. This woman's screaming his name running at him over the road with her head covered in wires. His face I think I can imagine that's the thing somewhat surprised and confused. But yeah, obviously that that entire day's data was just screwed up by so he didn't he didn't sort of do anything bad. He was absolutely lovely. I'm sure he's signed her order and was absolutely charming. I cannot imagine anything other than that with with Benedict Cumberbatch. We lost Yeah, we lost data from Benedict Cumberbatch with Richard bacon. I worked with Richard on a project on Channel Four where we tested 1000s of people to find the best navigators then put them through this Soho test and the top top applicant a person through all that it's just unbelievable like a robot solving things in under a millisecond getting all these decisions, right that that was that was great fun where Richard was just amazing to where he's full of energy really full of energy as a presenter. And it was great fun project and that project was Richard bacon. The end they put they took the top person and threw them into the hills in the middle of Wales and your Snowdonia in like the most disparate part of it and made them just find their way but had an Army team kind of train them to find their way back and my son Max was four at the time and half the film footage of it he's sleeping in the vehicle right just off offset with Richard babies it couldn't get him out so that was interesting for him Richard bacon and he didn't screw anything up the other two too bit to wrap up around will self we managed to scan will self doing the Soho experiment, getting his thoughts on what was going through his mind while he was being brain scanned. And everyone else who asked this question says things like, Oh, I was doing your tasks you told me will self said something like I was thinking of like sex death and Margaret Thatcher

**Caswell Barry** 39:07

not at the same time, I hope.

**Hugo Spiers** 39:09

Yeah, well he's again utter joy to work with yourself who's so funny, and sardonic, you know, he's, you know, he's exactly like you can imagine he is a real hero. And then the last person this was Karl Pilkington, I couldn't believe it. One day. I got an email from Karl Pilkington. Say, can I come and have an A Br? Can I have a brain scan? Because I'd like to put it in my book is a picture. And so yeah, Kalkan just popped in one day to our brain imaging system and we scanned his brain and made into his is insightful but cold pill cold all the pills I think it's called ology is book on the exploring science and and he did indeed have a very spherical head and brain is he's famous for and that people don't know Karl Pilkington these imagined some most people will but there might be some people don't know Karl Pilkington. So kind of broadcaster he was originally As an editor, I think we've spent extensive career work and Ricky Gervais, Stephen Merchant. Yeah, he was charming, asked a tonne of great fundable research questions actually. Which really was impressive, because he's famous for being stupid. But he asked some questions about neuroscience. I thought Bloody hell, sorry to swear. That's a very good question.

**Caswell Barry** 40:20

Interests. If trying to imagine what he looks like several people have told me I look like him, which I'm not 100% pleased with. Although they also say that like Dominic Cummings, I don't know which way I'd rather take. This is so fascinating here. I mean, I'm just aware that we're sort of clocking through the time talking about all the many exciting science things you've been involved in. And we haven't really got to talking about you which, which we'd really like to because, you know, you've been on quite a journey. I mean, you've done all the different things. I know, you also do animal based neuroscience. And I guess we just want to understand how this has sort of developed, was this always the plan? Where did you? How did how did your interest in sort of spatial neuroscience start? Or is it something that's just naturally evolved along the way?

**Hugo Spiers** 41:08

Yeah, I think it's evolved along the way. I guess there's a sort of sense of an epiphany moment in science where you discover that you read an article or you discover something and you think, wow, that's mind blowing. And for me that was really reading about play cells, which Caswell I know is an expert in the field, spent your career recording and studying play cells. And this is a phenomenon. So these are these are the cells in the hippocampus, the ones that are taxi drivers and studying that are very large in in rats that are predominantly studied. These cells are discovered by John OKeefe, and Jonathan Ostrowski, and when he won, John won the Nobel Prize, long story there. But these cells are mind blowing, because of how they appear to create this sort of multimodal representation of space deep in the brain and this highly central kind of part of the brain, the hippocampus. And this sort of you could list on a long list of all the crazy amazing things these cells do. But the question would be, I find that mind blowing and amazing, and I didn't jump straight into studying blank cells. I think there wasn't, there wasn't a project available to do that. When I was a student project, I fell into studying patients who'd had their hippocampus removed surgically, to see if they were having problems navigating. And indeed they did if it was removed in the right hemisphere. So I started my career in neuropsychology, and then moved to brain imaging, and then the rats. So I think I think, yeah, it's been a it's been a, you know, a journey focused on space the entire time, I've always been interested in how we represent space, partly because I think space is a tangible thing you can measure, but it's the sort of fabric of reality, it's what, what is out there. So we've got all these things in space, houses, people, cars, everything's out there. But it fits into a space and it's philosophically an interesting concept to think what is space, and then you can study it in the brain and sort of get a sense of the kind of the matrix inside our head, this reality that our brain creates, at a level that I find interesting, as opposed to say, how do brain cells represent lines and bars or the colour red or other people are interested in I find space absolutely compelling. And also the sort of sense of how the brain builds a map. Maps inherently are interesting objects. But how the brain does that. So I think probably I could go through a very boring list of my career, and you started the programme with who I've worked with, but I think the interesting bit to pull out as a short nugget, was I'd worked away humans for maybe eight years, you know, got to the second postdoc, at which point you should just really settle down and start a lab and do what you're good at now. Right? And that's exactly what I didn't do. I was very glad I didn't do that. I didn't just settle and build a lab. It's a Thursday afternoon, I spotted there was a funding call where you could apply to literally and you could only obtain the funding for this. If you switch track completely. You had to show evidence you were going to drop what you're doing and learn something else. And this was the Wellcome Trust, advanced training fellowships. And says ces provided three years personal money, but I found it on a Thursday and the deadline was Monday. So I got it and I very stressful thing is cousins leaning, you know is getting a budget. You've been drafted and approved by a team and UCL on a Friday for a Monday deadline. Yeah. And it turned out Monday was a bank holiday. So we had I did my blood pressure. Yeah, exactly. And it pulled it off, luckily, but it's probably one of the biggest pull off heist in my career. But it was a case of Ventura rapidly trying to design like three years of rat based electrophysiology experiments, not having ever done a single one in my life. And, you know, very, very huge thanks to K Jeffery for me on the phone on email a lot, who agreed to take me into a lab to run this. And we went after what I spend a lot of my time doing, which is goal coding, how might the hippocampus represent places you want to go to as opposed to where you currently are. And that changes everything. So I've now managed to publish a number of studies since several weeks as well. And we've got a new paper that I think may will be out in Current Biology by the time this podcast is released, or around it, where we've been looking at rats and comparing. I think that that that for me is we've got a paper coming out as well. And I've worked on where, for me, this is a really exciting point where I spent years studying humans Yes, in rats, and finally pieced them together one paper to show in the same exact framework, same exact task, how do they navigate and they're really similar surprising to me.

**Hugo Spiers** 45:50

But it's, it's been a joy doing doing that. And yeah, so I think their career trajectory is kind of careers experiences saying, Yeah, take these things, go for it. The only other anecdote was, I think, I think, as boring that career stories is on April Fool's Day. In 28 2009, I got an email that started, congratulations, you've been awarded $600,000. All you need to do is write back with a blob up. I didn't even read further because you'd get emails around it. Time. Hi, I'm a Nigerian prince $1 million. And a week later, I got an email that said, Did you see our email requesting you apply for $600,000? You now only have a week left before the deadline would you like to apply before we hand this over? And I realised Oh, man. This was real. And again, I had to cover I had to cobble a six year research plan together in a waiting and get the all the funding approved and everything. And again, luckily, in that scenario, it came off. And I was awarded $600,000, which was paid for and Boeing shares from the James McDonald foundation Scholar Award. Absolutely crazy funding. So yeah, they're nutshot My My advice to people whose Yeah, keep your eyes open, when when things look too good to be true. Sometimes they might actually be true, or, you know, funding deadlines come up in a way we can do this. It is possible sometimes with the right levers.

**Caswell Barry** 47:19

That's amazing. That's amazing, the right place at the right time where the sounds are, and then just taking those opportunities. I like that a lot. And I realised that actually we have we, we did two things on Twitter. Not only do we have the poll of which celebrity had interfered with your research, we actually asked people for questions that we should put to you. And I'm really I'm really keen to do this, because I'm aware that we'll run out of time otherwise, and I want to I want to do our followers, right? So I'm gonna ask you a Twitter question. Now. Here you go. Are you ready?

**Hugo Spiers** 47:49

I am ready. Yeah,

**Caswell Barry** 47:50

I guess the Twitter question we received was this, I'd like to ask how much is known about cognitive visual reorientation, illusions VR eyes, some have developed an ability to turn the world around to differently perceived orientations just by thinking it is this bi conscious firing of head direction or place cells? I'm not sure. I'm not. I don't know what VRI is. I don't know what the is that? Is that a human neuroscience thing that I doesn't happen to rats?

**Hugo Spiers** 48:18

Yeah, I know who this is. This is a Twitter question from a person whose entire research is on this topic. And it's a great question. It's got a nice way in which is the as far as I understand the phenomenon they're looking at is that experience of you maybe come out of a subway in London or how this happens to me, Hoban in London, you come out of that shoe and you think which way am I facing and you think you're facing a particular way. And then suddenly, you realise you're not you're 180 degrees off, and your your map inside your head has to just spin. So you have this visual orientation illusion of like, this space you've been disoriented in is not how you thought it was. And indeed the questions right, it would be amazing to see the head direction system just jump and go crazy for a moment. And the whole system kind of reorient and there have been beautiful experiments, I think, with rats to see head direction circuits going to suddenly update when the world has they've realised the rats realised. It's not so think there is some evidence of head orientation head head direction cells in rats doing this, but it's very hard to study in humans if you want to put out an MRI scanner and keep confusing and read disorienting people and reliably recording it. Good luck because that that's going to be very hard. But I think it's a fascinating phenomenon. I really like that that sort of what's happening in your head. And as if you've ever experienced that Selena and Caswell I actually feel slightly nauseous when suddenly the world's spun round. Nothing's physically happened but your stomach is like being on a fairground ride. So it's also fascinating.

**Selina Wray** 49:48

Oh interesting. I Absolutely no that sensation and it's really something quite unpleasant. I find it actually

**Caswell Barry** 49:55

you need to be as bad at navigating as I am. I'm really I have this a lot actually. Interesting. I mean, recently, I had to navigate from my house in South London to, to King's College Hospital for a checkup of my leg. Yeah, and those, you know, it's right next to the shard, which is a massive landmark. And I was pretty sure I should be able to do this without, you know, on my bike without looking at a map. And at some point, I lost sight of the shard, it's like, it's just over there, kept riding. And I was 180 degrees off, I sort of wrote along and ended up nearly heading back to my house. And it was it was exactly it was like 180 degree rotation in sort of your sense of direction. It's just such an interesting experience. It's just like really aware that like I spent so long thinking about the precise Angular integration of head direction circuits in the space of five minutes, I screwed it up as much as possible. And was totally unaware of this. And was also totally confident that I was going in the right direction as well.

**Hugo Spiers** 50:52

We we rebuild, see requests as a tool now that anyone can use as a scientific team. So we've got a whole portal. So that means if you're running any experiment, you even you can, as long as you got ethics as the as the idea, you can, you can apply into the portal, and we've got 130 Register studies now of people using see her request, one of them we noticed was in the Faroe Islands, and another one was in Indonesia. So it really is spreading out. But we're happy for undergraduates who wants to do a research project to just go in, it's automated. So the data is sent back to people that's all securely held by servers in Cambridge and, or dealt with by charity. So that's a really perhaps a nice thing to take on and say to anyone listen to podcasts, anyone who's interested in spatial research and wants to do something, we have a tool available, it's incredibly easy to use. And then if you wanted to compare your friends, you test it. Every test. Caswell and Selena, we've got the 4 million people's data to compare the output to. So it's, it's, and we are we're looking to run. The other thing we're looking to run is really running a campaign next year, I want to really pick up and go global and find out more about people's health and potentially the risk factors. We know modifiable risk factors for lifestyle that may be important to understand more about for Alzheimer's disease, and find out more about those would see your request globally next year. So watch this space for what happens. But right now anyone can go in and set up a little study or big study if they want. It's up to them.

**Caswell Barry** 52:22

That's fantastic. But we'll definitely include that hopefully a drummer more uses for this fantastic, fantastic dataset. So I think Hugo, we've covered an awful lot of ground as his traditional. Selina has our most important question for you,

**Selina Wray** 52:38

Hugo. I mean, you've told us some wonderful anecdotes, so I feel slightly bad putting in extra pressure on to come up with another stellar fact. But we ask all of our guests What is your favourite fact about the brain?

**Hugo Spiers** 52:53

It's a really hard so when you say What's your favourite thing? What's your favourite film or your favourite book? It's actually I'm one of those people that just don't I have I have a not a not a good one thing. So I'll give I'll give I'll give you some facts that I think are ones that I've found fascinating. I mean, I think probably the very this is very boring facts, but are actually is because everybody repeats them. But it just the the amount of I think the the number of times if you take the human brain and you rolled out all the all of the axons and dendrites around you'd loop round the earth several times there's some some incredible I don't know the exact details of it, but it's insanely long, lined up all the neurons. But I think for me, there are kind of strange facts of some of the when I was learning my urine acid me years ago, we learned about some strange syndromes and things. And they're not always very positive these things but the facts about the brain that there's this thalamic pain syndrome, where if you get this lesion in your Thalamus, you'll end up with just your entire body and pain continually. And it's really pretty Yes, like a factor of a brace is absolutely the number one condition you never ever want to get. And there's no back then at least there's no treatment for this. So the fact your brain can do that to us, but there's also a clinical condition of septal rage. Oh, yeah. Does YouTube aware of this? I know about. Yeah. Which again, I was learning about the brain and facts about the brain that yeah, this particular like a slight lesion in the septum can end up causing absolute rage, death attack mode in animals and humans. So this idea of just a tiny nuclei in your brain can can Gover kind of govern that kind of rage attack. And castle and I know as chap in research in Canada, might Brandon was someone we had one I know who was studying the medial septum.

**Caswell Barry** 54:45

Exactly. He I was just thinking of what I was thinking of.

**Hugo Spiers** 54:49

Accidentally and activating the lateral septum and causing this like vicious attack. So I think there are that those sort of facts that and that leads into another fact about the brain probably is the fact you've got these parental circuits, I mean that that line of work if I had to restart my career again, I love space, I love everything I thought the other possible career, I'd go into studying parental behaviour, because that that line of research right down to the particular receptors on individual groups of neurons is now becoming insane. But the idea there of circuits that are really you can be parental, or you can kill, and they're just lickable. So you can kind of turn on and off adopted genetics, an animal can acrossing a room to pick up a baby pup and protect it or and switch it into crossover, the rumen wants to kill it within the flick of an optogenetic signal to a particular bit of the brain, I think is just remarkable. So those are kind of maybe not the kind of textbook facts and you say, Oh, what is it you know, how big or small or, but the fact that these sort of crazy phenomenon going on in the brain is just just amazing.

**Caswell Barry** 55:53

So Hugo, that was a fantastic discussion. Thank you so much for joining us on this episode of brain stories. And to the audience. We'll we'll see you next time.

**Hugo Spiers** 56:05

Thank you very much for having me on the show. It's fantastic.

**Selina Wray** 56:08

We'd like to thank Matt Wakelin, Maya Sapir and Trevor Smart for their roles in taking brain stories from an idea to a fully fledged podcast, Patrick Robinson and UCL digital education for editing and mixing. You can follow us on Twitter at UCL brain stories for updates and information about forthcoming episodes.