UCL Brain Stories Episode 17 - Jenny Bizley

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SPEAKERS

Steve Flemming, Caswell Barry

Steve Flemming

interested in? How How does the brain allow you to pick your friend's voice out from a sea of other voices when you're in a restaurant or a bar? And to do that, as you said, you use attentional mechanisms you use vision? And of course you use hearing. So yeah, how your brain does that is, is the central question that we're interested in.

C Caswell Barry 01:35

So I think people might be quite surprised by that sort of statement, the end that what you can see, or indeed what you know, is around you affects how you hear things. I mean, so what do we know about that? I mean, it seems kind of weird, although I can give one anecdote which might inform this. So I'm incredibly short sighted where it was before I had laser eye surgery. And I realised at the hairdresser's, if you can't see the hairdresser, I couldn't hear what they were saying. It's quite quite an interesting effect. Is that is that at all related to the sorts of things you're you're thinking about?

02:08

Yeah, I mean, I think we all experienced this through COVID. With mask wearing, right, a mask produces an acoustic barrier, but mostly it masks someone's facial movements. And those lip movements are probably the most kind of obvious and fundamental way that we experience every day how vision affects what you hear. But, yeah, I think it's a lot, it can be a lot more rich, potentially, than simply lip movements, in terms of how sort of even low level visual features. So you know, if you look at the hand movements of a guitarist, strumming their strings, or the bow movements of a violin and the string quartet, you'll be able to pull that sound that melody out of the mixture much more effectively. And you can kind of play these games, if you're listening to an orchestra or a string quartet, you can choose which which thread of the music you want to listen to, simply by watching the source or the movements of the source that are generating them. And that, to me, suggests that there's really something fundamental about how vision can help you organise auditory scenes that goes beyond simply, there's probably quite human specific combat, combining of information from lip movements to help you understand speech better.

C Caswell Barry 03:22

I mean, how much do we know about how that works? When it feels like you're the the what's now outdated view of the brain of sort of all these different modules doing different bits, you might sort of, if you were thinking about, it might naively think like there's a there's an auditory bit, I just hear sound processes at fine. Whereas the sorts of information we're talking about, you know, things you can see, things you know, about the sort of space around you those are attached to what traditionally attached are quite distinct bits of brain? Does that mean there's more communication between those them we know about does it mean that we shouldn't really be labelling things as like auditory cortex? It's all like doing interesting things. It should be auditory spatial with a bit of vision. Yeah, I

04:06

think you're exactly right, this kind of textbook idea, that canonical idea that, you know,

11:47

So I also know embarrassingly little it turns out now I think about it, about the evolutionary sequence. But I think you could make a counter argument that would be that actually, audition is your only long range panoramic, danger alert system. And there are kind of things like even sort of electro sensing and fish and the cochlea is existing in frogs. Of course, they're also fish. And yeah, I'm not sure why evolutionarily there would be a need for vision overhearing. First of all, that I'm really making this up now.

Steve Flemming 12:27

Maybe we should move on to things that we feel like we could talk about, I

Caswell Barry 12:31

have a distant memory of reading something as a child, which probably totally bogus when someone was arguing something along the lines of our cars in evolutionary history, humans used to hang out around seashores. And so vision is not very good, because the Seashore is crinkly. And if you want to talk to people nearby, then like that, that there should be some sort of dominance of information transmission via audition. And this is a slightly different thing. But it's what why is language audit? I guess the argument, their argument was, why was language auditory and not like, visual, right? I've gotten it sounds totally made up? No, I think about it. But yeah.

12:38

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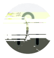

13:39

Yeah, so at the moment, we've been taking a sort of a multi pronged approach, which I hope will soon kind of converge to, instead of sort of perhaps circumnavigating the problem actually answering it. So we do psychophysics in humans, which allows us to kind of test a lot more hypotheses a lot more quickly than training animals. So we can kind of refine paradigms and develop ideas and tests of models more efficiently and humans. And we can then kind of take them into animal model, which is the ferret. In a ferret, what we've done is a series of kind of anatomical work to look at the potential input stored at xi cortex in the sort of hope that that would at least rule out some possible hypotheses about what vision might be doing. We've made kind of basic recordings to sort of chart things like as you move from primary cortex to secondary cortex, the proportion of visual responses increases, but that's using very, very simple stimuli. And then we've done studies like the one I described previously, where we record single neurons from from auditory cortex and animals that are listening to the same stimuli that we have used in our human psycho acoustic paradigms. And then we try and kind of put The whole lot together, of course, what we want to do, and what we're now beginning to do is actually train the animals in the behavioural paradigms that we've developed in the humans, to show that they show the same audio visual effects, and then actually record from single neurons during behaviour, because then we get the kind of trial to trial fluctuations to say, okay, like this neuron shows an influence of visual stimulus. And the firing of it in some way correlates or predicts the animal's behaviour on a trial to trial basis. And that kind of tells us that, it, it's more strongly suggestive that these audio visual interactions that we see an auditory cortex are actually feeding forward into behaviour. And of course, like then on top of that, you can do some kind of circuit manipulation, potentially, to eliminate a visual input and show that the animal's behaviour is influenced. But we're still in the ferret model a number of years away from really successfully being able to do that.

Caswell Barry 15:56

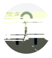
This is the dream, isn't it, putting all these things together, sort of, you know, behavioural measures, reading out for neural populations and then manipulating them. But it seems that you've made your life even harder by doing that in the ferret, rather than like rats, or mice that, I guess the vast majority of systems neuroscientists, well, systems neuroscientists like meat maybe spend their time doing is there. I mean, what's the advantage of ferrets over rodents, [illegible] mice, their hearing ranges way above the kind of pitch zone, and ra problem, like how do you get these neurons that represent distinct features of an object to actually you form that object, that perceptual representation that we experience? And, yeah, we have some reasonably good evidence that auditory cortex is playing that role, both from recordings but also kind of manipulating activity and auditory cortex. But I think exactly how it's doing it is one of the big unanswered questions. And I think the sort of large scale neural recordings that we're now able to do alongside behaviour might hopefully give us the insight that we've been lacking on that front.

S Steve Flemming 21:12

And does that have a I can imagine that has quite some clinical implications as well for if you're, if there is a problem with not necessarily hearing per se, but the kind of cognitive level of passing the scene, then that might manifest as essentially being unable to track conversations and so on. So how much in your line of work do you do you think about that potential bridge over to clinical application.

21:40

So cochlear implants are probably the most successful example of a neural prosthesis, and they probably work so well, although, of course, they still have limitations because they can put a frequency representation in the ear, which we understand. And while they can help a lot of people that you know, large numbers of people who either have central auditory processing disorder, so there's nothing wrong with that error at all. And it's some kind of cortical problem, or, you know, people who have acoustic neuromas or something like that, where the auditory nerve itself is damaged, there's no point in, in inputting into the cochlea, because that information is still can't access to the, into the brain. So there is quite a movement to sort of develop cortical implants that could help people who cannot benefit from a cochlear implant. The problem is that because we know so little about the code, there is this cause frequency representation that still exists in auditory cortex. But attempts to use that as some kind of input have really been quite unsuccessful. And even in something like the inferior colliculus, which is a few synapses beyond the Cochlear, and still a few synapses away from the auditory cortex. It's pretty poor, the outcomes are pretty poor compared to a cochlear implant. So I think for me, so my work has sort of two ways in which I sort of think about clinical impact. So the first is in terms of just trying to understand auditory cortex better such that we could potentially design a better cortical implant or better signal processing for hearing aids, which are also pretty hopeless for these sort of complex noisy situations we think about. And the second is I do do more sort of direct clinical line in that some of the hearing tests that we've developed, initially actually in animals and then tweaked for humans have now become outcome measures for clinical trials for cochlear implant users and stuff. So there's a clinical trial called the both ears project that is running at the moment led by W. Vickers in Cambridge, who is really looking at the the NICE guidelines now say that children who are born congenitally deaf should have two cochlear implants. But they don't seem to use them in the way that you would hope. Essentially, most children rely on one of them on their on their better aid, rather than kind of actually getting the benefit of binaural hearing that you would hope you would get by replacing hearing in both ears. You know, the aim of this clinical trial is to train hopefully to try and train these children to use both implants more effectively. So yeah, we've provided a test that's the outcome measure for that. So because I'm one of the nice things about being embedded in the

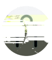


27:03

Absolutely nothing.

Steve Flemming 27:06

You still you still rowing



27:10

I ha'stil

Steve Flemming 31:01

Well, barges barges used to get pulled by horses, you could have a horse pulling your boat.

Caswell Barry 31:09

So along along that journey, have you ever sort of have you ever been tempted away from auditory neuroscience? Or is it does it? Do you think this sort of, I guess, especially because a lot of Bucha spoke about has been you telling us how, how, essentially, more than just hearing your cortex is or how it's sort of so important for integrating these other other sorts of information? Has that sort of tempted you away? Have you you know, other other other bits of the brain that you have your your eye on? Or different fields? Indeed, you know, he spoke about clinical implications? Do you do you see yourself sort of winding up doing more of more of that sort of work? Or is it basic science all the way?

31:53

I quite like the mix that I have at the moment, which is like mostly basic science, but with some kind of clinical stuff, and a lot depends on? Yeah, I've done a lot more clinical work over the past few years, because I had a really brilliant clinical PhD student who led a lot of that work. So it's sort of, I would say, my clinical work is sort of opportunities driven. For the fundamental science, we are increasingly kind of I mean, as you know, recording and all sorts of different bits of the brain from hippocampus, frontal cortex, parietal cortex, anywhere that might have some kind of role in sound, or be interesting from the point of view of the ferret model, I mean, we've also kind of flirted with a few areas, just because we think the kind of comparative aspect could be kind of interesting and useful. But I think my kind of fundamental passion is really for answering the kind of auditory inspired questions. And also, you know, like, it's a bit presumptuous to think you can just jump into someone else's field. With that, yeah, with the hippocampal work we've been doing. It's very firmly been with people like Dan Bender, who knows an awful lot about the hippocampus. And I think, yeah, we need that otherwise, yeah, we're probably not going to do anything terribly useful.

Steve Flemming 33:10

This might be going off on a bit of a tangent, but it just occurred to me that there could be also implications of the work you're doing here for artificial systems, speech, perception and AI more broadly. So I'm just wondering whether you could say a little bit about that, whether this is anything you get involved in or you see yourself getting involved in more in the future.

33:29

Hopefully Caswell and I have a student actually thinking, you know, who might be doing some work to look at how hearing can be kind of integrated into spatial models. And there are certainly so for example, Nick Klassiker, at the Ear Institute is doing a lot of really interesting articles on artificial intelligence work, looking at speech encoding throughout the brain, in particular in the inferior colliculus. So, that work is going on, I find it very interesting. Again, it's something that I tend to do in collaboration. We're not kind of actually getting our hands dirty with it in the lab, yet sales?

Caswell Barry 34:07

I promise, I didn't put Steve up to that question, boy, just to get to talk. I mean, there it's true, though, there is, you know, people working into machine learning and AI have have always instilled do have an eye on, you know, how the brain solves these problems. And as, as you're starting to make, like really substantial progress in sort of new learning about the tricks that make the

So I think my favou r