AT Banter Podcast Episode 253 - Brain Computer Interfaces

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SPEAKERS

Rob Mineault, David Moses, Ryan Fleury

R **Rob Mineault** 01:07
Hey, and welcome to another episode of AT banter

R **Ryan Fleury** 01:13
Banter, banter.

R **Rob Mineault** 01:16
My name is Rob Mineault. And joining me today in the opposite corner, coming in at 225 pounds. Ryan, the PinBall, Fleury.

R **Ryan Fleury** 01:34
Hello, everybody. And no I'm not 225 pounds

R **Rob Mineault** 01:38
I'm really bad at weight guessing weights.

R Ryan Fleury 01:40
Well, we haven't seen each other in two years.

R Rob Mineault 01:44
True. That even if we had I don't know, Is that about right?

R Ryan Fleury 01:49
Well, take out high or low take off about 27 pounds.

R Rob Mineault 01:53
Oh, really? Oh, was it good for you see, sorry, I see.

R Ryan Fleury 01:58
when we were at Aroga you know, at one point I was 240.

R Rob Mineault 02:06
Oh, is that right? Okay. Let's see.

R Ryan Fleury 02:09
Yeah, I was 240. Below 200.

R Rob Mineault 02:13
I don't feel so bad that I wasn't that far off. Yeah. Well, that's good. Congratulations on losing the weight, then.

R Ryan Fleury 02:21
Thank you very much.

R Rob Mineault 02:23
Not easy to do in a pandemic. Let me tell you

R Ryan Fleury 02:27
I've eaten away more Doritos than I ever have. They are so good.

R Rob Mineault 02:31
I can relate to that?

R Ryan Fleury 02:34
Yep.

R Rob Mineault 02:37
How are you doing?

R Ryan Fleury 02:40
I'm doing all right. You know, this is the final week that Mr. Barclay is a way so you know, we're coming around the other side, I'm looking forward to him being back. School is going to be starting soon. So things will definitely start picking up as well. So it's all good.

R Rob Mineault 02:57
I find it really funny that he that during his absence from the show, we had like, definitely shows that he would have totally been interested in.We talked with Daryl Lennox, the comedian, talked about sex last week.

R Ryan Fleury 03:17
Well, we got to have a beer episode, then he can be all over that one.

R Rob Mineault 03:21
There you go. Well, hey, speaking of which, what do we what are we up to today?

R Ryan Fleury 03:27
Today, we are speaking with David Moses, who is a post doctoral engineer at the University of California, who is joining us to talk all about a brain computer interface they

are working on.

R Rob Mineault 03:38

Yeah, this takes me way back into like the first year of the podcast, and the episode that we did do on brain computer interfaces. And I feel like that was like the first episode that we really did like a lot of research about.

R Ryan Fleury 03:52

Yeah, there was one product and I think we've highlighted it called the BrainPort. Unless that came later. But that seems to stick in my mind.

R Rob Mineault 04:02

Yeah, I think you're right, we talked about that. There's, there's a bunch of there's a bunch of like, mainstream sort of novelty devices where you could, you know, you'd wear like a little little electrodes on top your, to top your head. And you could do things like drive a remote control car, and you could go up and down or your forward and back and left and right and steer it with your brain waves. I'm doing the air quotes brain waves. So yeah, so that's the, you know, example of a very rudimentary sort of, sort of mainstream device. I don't even know where that space is these days. I don't know if you can still get those. There was another one called I believe there was called the emotive headset. Because I think that the company that we were at for a while we were kicking around the idea of picking that up as a as a product. Yeah, nothing ever came of that. But yeah, so there was a few different things. products in that space. But this is completely different. This is, you know, the stuff that David's working on. These are actual implants that we're talking about. And they're doing some pretty amazing stuff in that space since we've talked about it last. So it's, it's gonna be interesting to talk to somebody who's working in that field.

R Ryan Fleury 05:16

Yeah, absolutely. This is brain surgery. This isn't just, you know, electrodes, like you say, he draped over your head and, you know, gets the information or the signals through the skull, this is actually going into the brain. So the detail of information is going to be way more accurate. And it's gonna be interesting to see what he has to say and where this is going.

R Rob Mineault 05:40
Yes, indeed, I love it when we have people who know what they're talking about on the show, as opposed to people listening to us.

R Ryan Fleury 05:48
Right?

R Rob Mineault 05:49
Hey, have you been watching any Paralympics

R Ryan Fleury 05:53
Little bits here and there. We've actually have been recording some of it. So we watched a few minutes of rugby the other day. Yesterday was some wasn't tandem cycling. It was cycling in the velodrome but I think it was four, C five, C six. So I guess partial paralysis. So these were fairly able bodied. They were riding regular bikes and stuff. So we haven't watched a whole lot of it yet, but little bits here and there.

R Rob Mineault 06:26
Yeah, I actually watched just this morning, I watched a stream from last night who the the women's goalball team playing against Israel, the Canadian women's Goalball team playing against Israel. And it was really cool. I had never actually watched the complete Goalball game back to front. So that was pretty cool. Yeah, I liked it.

R Ryan Fleury 06:49
Yeah, I've actually never ever seen Goalball. You know, I've heard people talk about playing it. And one of our ex co workers, Carrie Anton was a gold medalist at the Australian Olympics in Goalball. So yeah, it's near and dear to us. I just don't know much about it.

R Rob Mineault 07:06
Well, there dude, you get to get on that. Yeah, the women's are they just played last night they won against Israel. So I don't know who they're playing next.

R Ryan Fleury 07:14
I'm sure we have it recorded. So we'll probably catch you later tonight or this weekend?

R Rob Mineault 07:20
Oh, sorry. I just spoiled it for you, then.

R Ryan Fleury 07:22
Well, that's all right. You know, it's one of those things where I sort of wish that when I lost my sight in 1995, I would have been told about stuff like blind sports. What was available, you know, as a sighted person, I loved being on a bike, I could ride for hours and hours. I loved mountain biking, I loved all cycling. And you know, even goalball might have been something I would have been interested in. But just was really never impressed upon me that it was a thing and here we are. I'm gonna be older this year. I just don't think flopping around on a court beat having a ball toss to my head.

R Rob Mineault 08:12
It's very interesting. It's a it's a very interesting paced game. And, yeah, there's a lot of throwing yourself in the direction of where you think the ball is going and blocking your body. So I can imagine that you come up with you come out of a match with a lot of bruises. Or even though they say that, like, you know, the pants are padded, and they have knee pads and elbow pads and but they don't wear a helmet or anything. And that ball looks heavy.

R Ryan Fleury 08:41
Like it seems to suck to take a ball to the face. Right?

R Rob Mineault 08:44
It's I think they said it's like a it's over a kilogram. And it's got bells in it. Yeah. So I mean, that can't be pleasant to get hit in the head with it at all.

R Ryan Fleury 08:56
Or the groin.

R Rob Mineault 08:57
So yeah, but that does remind, that's how we pretty much I played volleyball, I just throw myself at the ball. So maybe I can get into Goalball. I

R Ryan Fleury 09:08
don't know, you need that sit volleyball.

R Rob Mineault 09:13
But you know, it's, it's, it brings up an interesting point. Like, I really wonder what body type is sort of the right body type for for goalball because it seems to me like if you're if you're sort of big, like a basketball player, you have a like a large arm span. And you're sort of gangly, I could see that being an advantage because you know, you're you have more sort of more reach to cover the goal long, right, like, and then I'm thinking like, well, maybe his body mass is good too, like so maybe like if you're bigger and heavier like maybe you can't move as fast but you take up more space so I just thought I wonder what their strategy is or maybe maybe there's a strategy where like, you know, you have a couple big bulky people on and you have a couple quicker ones and and I know that they like it's it's a you know You have sort of a right wing and a left wing and somebody who's sort of plays gold, but you're all kind of all playing golf. It's interesting. I this is I've watched one match now and I really I do want to learn more about it. So I think I'm going to check out the rest of the coverage for the rest of the week.

R Ryan Fleury 10:16
Well, maybe it's time to bring BC Blind Sports back on. It's kind of weird though watching the Olympics because it says, You're watching the Tokyo 2020 Paralympics. It's like, We're in 2021. It's just weird to hear them. reference the 2020 Olympics, because that's when it was supposed to originally be.

R Rob Mineault 10:32
Yeah, it's also weird to watch these matches without a crowd. Like it's just empty an empty stadium. It's it is weird, but you get used to it after a while.

R Ryan Fleury 10:43
well I can't see them anyway. You can put in audience noises by audio engineers .

R Rob Mineault 10:51
Actually they should have done that.

R Ryan Fleury 10:52
Absolutely.

R Rob Mineault 10:54
Hey, well, Hey, dude, before we bring on David, there's one other thing that I wanted to talk to rant a little bit about, I saw this article come up in my feed. And it's a it's a study that was done by the University of Toronto. And the name of the study is "adults with disabilities, face barriers, accessing food, leading to food insecurity". And this is a study that the University of Toronto did that they just recently published. And it's, they did a lot of this stuff, a few years back. And essentially, they interviewed a bunch of adults with disabilities who experienced physical barriers and mobility issues between 2017 and 2018. And one of the researchers actually followed people around to get an idea of their, of their everyday routines and what they had to do on a typical day to go get food at a grocery store. And what these researchers came out with was, they were just, they were shocked at the amount of barriers that would rise from just a mere trip to the grocery store, like everything from, you know, garbage cans, or block pathways to stores that were set up. So that were the the aisles were so small that somebody in say, a powered wheelchair could barely fit through them. Just all kinds of barriers across all the different types of disabilities. Well, you know, and the interesting thing about the study to audit not only addresses, you know, sort of the trip to the grocery store, but you know, it looked at the everything right from income, and what people what people could buy, to even in accessibility in the home. You know, they're talking about people who are limited income or living in subsidized housing, you know, a lot of these people are living in spaces that were that weren't accessible. So they can't even move comfortably, with their, with their wheelchair or whatever in their own kitchen. You know, that added to, you know, inaccessible stores, and limited income, it's just, it all adds up to food insecurity being a real problem in the disability community way, way more so than then able bodied, and even even food banks, were proving to be inaccessible in some cases, right. I wanted to bring this up too, because, you know, we're looking down the barrel of another election next month. And these are things that, you know, I don't hear anybody running on know, these, these things need to be fixed. And the frustrating thing to me is that even just outside of Okay, like increasing the amount of disability benefits that people get, like, if you can't live if you can't buy food, and you can't access your own kitchen, I mean, that's those are some real problems.

R Ryan Fleury 13:54

This affects way more people than just the disability community. But you're right, nobody's talking about it.

R Rob Mineault 14:00

Yeah. It really is infuriating, because this, there's just no call for this. Especially we have all the solutions, you know, we can and I know, okay, I mean, fine outside of, you know, we won't even get into like, you know, increasing disability benefits because what are you know, I understand that's a, you know, they'll it's complicated, whatever. But, Okay, what about fixing the fact that people can't even get to the grocery store and shop properly, if they have some sort of a mobility aid or just in accessibility, that way of just going to the grocery store, if that's, like such an enormous chore for somebody with a physical disability to do, that's a problem.

R Ryan Fleury 14:44

And so, and that's just one option like that's going to the grocery store, let's get either getting a cab or booking your Handy Dart or whatever the accessible transit is in your city, to get to the grocery store to make it up and down the aisles to get your wallet out to pay that Just one instance. What about if you're trying to place your grocery orders online and have at home delivered? Well, now we're into the whole web accessibility stuff, right?

R Rob Mineault 15:10

Like, well, yeah, for sure. And I was gonna bring that up. I mean, that is, you know, that is seems to me that is the solution, or one of a potential solution. But the trouble with that, even outside the digital accessibility is that those services are all expensive, I've totally ordered, like off instacart or something. And it's, it's expensive, it adds like, I don't know, 10-15 bucks on your grocery order to get it delivered. And for some people, when they're already on low income, that's just not a viable solution. Like, there should be some sort of a government funded program that just allows for free delivery, like this should just be a free service to these people. And, yeah, and but you bring up to the right to bring up the digital accessibility part of that, too, because that's absolutely a case. A lot of these, you know, skip the dishes, instacart, Uber Eats all the all of these delivery services. I don't know, I don't know how accessible those applications are. And as we know, with any sort of mobile apps like that, they tend to break accessibility quite often, because the developers will update the app, and they won't pay any attention to accessibility. So, you know, one day someone's gonna wake up, and they need their groceries delivered, and oh,

look, the app updated. It was accessible yesterday. And today, it's not like these are the types of real world situations that happen with digital accessibility. It's not it's it's just so important. And it's so frustrating that people still don't seem to get it.

R Ryan Fleury 16:51

Well. That's why I don't know why. I don't understand why it's still an issue. This is not a new conversation. I don't understand what the barrier is, are we the people not talking to the right community, you know, is cniv as much as they're advocating? Or the CCB? Or whoever the organization is? Are we not talking to the right people? Because like I said, this is not a new conversation. Why are we still having this conversation? It makes no sense to me, you don't be dealt with already. And I don't mean to go down too far of a rabbit hole, because I do want to bring David on and, and talk about brain computer interfaces.

R Rob Mineault 17:29

But this is important, because here's where I think this is where I land on this. The problem is, is that people with disabilities are one of the lowest voter turnout demographics in the country, you know after 18 to 24 year olds.

R Ryan Fleury 17:46

If you have trouble going to the grocery store, how you're going to get to the polling station?

R Rob Mineault 17:49

That's a problem. Yes, accessibility is definitely an issue. But I really feel like it's, it's like voting with your dollars in terms of, you know, driving the retail market. You know, if if politicians don't really think that people with disabilities have much voting power? Well, you know, what are those types of issues, they're not really going to have a strong stance on it, that's not going to be the top of their list of things to fix, because they don't think that it matters.

R Ryan Fleury 18:21

well, it's 20% of the population has disability. It's a minority.

R Rob Mineault 18:25

Right. But I mean, they also don't seem to vote all that off, right. So I guess, and I, again, I don't mean to be cynical and error or anything, but I, what I wanted, the point I want to drive home here is that this is it's so important to get out there and vote and make your voice heard, because that's the way you're going to affect change. Because if you don't vote, they're not going to pay attention to you.

R Ryan Fleury 18:50

Yeah, absolutely. You know, and I, personally still don't know who or which way I'm going to vote. To be honest, I haven't actually done a lot of research or listening to the leaders to find out what their platforms are for the most part. But yeah, I don't know.

R Rob Mineault 19:16

Well, your assignment for the week, do some research.

R Ryan Fleury 19:20

Something I have to do because my wife and I, you know, have requested our mail in ballots. So you know, we are going to vote. But I just, I don't know, maybe what we should do.

R Rob Mineault 19:29

We should plan an episode in the coming weeks where we take a look at each party and their actual platform in terms of disability and spread the word because maybe nobody else is talking about it and it needs debt that needs to be done. We need to know what Yeah, what the platforms are. But anyways, in any case, I encourage everybody to go out there, do your due diligence, do some research, and vote, get out there and vote because that's the way that you're going to get people to pay attention to this stuff. And get some of it's starting to change because this is ridiculous. I can't believe we're in 2021. And there's still people starving these issues. It's, it's, it's crazy to me. I was just I was gobsmacked at this article, you know, include this in the show notes because it's important for people to take a look at. That's my rant for the day.

R Ryan Fleury 20:23

Excellent. Well, we both had a chance to rant. So yeah, there you go feels good. There you

go.

R Rob Mineault 20:29
Okay, well, you know what it now that now that we feel better? Let's talk a little bit about brain computer interfaces and bring David on.

R Ryan Fleury 20:37
All right. Joining us now is David Moses. David, thank you so much for joining us.

D David Moses 20:42
It's my pleasure.

R Rob Mineault 20:44
Awesome, well, let's start out really basic for the listeners, and maybe just walk us through what is meant by the term brain computer interface.

D David Moses 20:54
Sure, so in general, a brain computer interface means some kind of device or combination of devices, that allows that enables recording of brain activity and analysis of that activity to, you know, extract some kind of information for some kind of use. So a very general purpose, anything that, you know, for example, if you were like a eg, electrode, array. So maybe if you're getting, like a sleep study or, or something, there's plenty of uses for that, that that's kind of a brain computer interface, there's sensors that sit on your skull, and they try to detect your brain activity, and try to use that information for something. So that's like a very simple one. And the one, you know, this ranges, to much more invasive technology that by invasive I mean, like, medically surgically invasive, so electrodes actually implanted in the brain, for example, the neuro pace, which is like a deep brain stimulation for epilepsy treatment, who tries to like stimulate your brain to help prevent seizures. And so that's a type of, you know, a little more intense brain computer interface. But that's kind of hopefully that gives the breadth of this technology.

R Rob Mineault 22:21
So how long in general, have we been working on this for?

D David Moses 22:26

That's a really good question. You know, as you might imagine, this is a fairly new field. For some, like, for example, the deep brain stimulation that I described, for it to be in its current form factor is like a commercially available technology. I think that that's fairly new. I would guess, in the past few decades only. But I'm sure that the technology of actually sensing brain activity from electrical sensors is older that might be closer to a century or even more. Sorry, I don't have the exact answer.

R Rob Mineault 23:06

Yeah, no, I'm just curious. Because, like, I like I'm curious about the technology, in general, and just how, like, what what parts of the technology has really sort of hindered movement in the field. So for example, like the sensors that you're talking about, like, did they need to get like to be able to build be built small enough in order to get implanted? Or? Or was it sort of the the algorithms that that we're using to connect to decode the different the different brain signals? Like did that need to be developed? Or was it a combination of a bunch of different technologies that needed to sort of fall into place before we could move forward with some of this stuff?

D David Moses 23:54

Yeah, I think it's definitely a multi pronged approach. And I think a lot of it is hardware, and a lot of it is software too. So on the hardware side, you know, these, some of these, especially the ones that require surgical implantation, you know, these have been tested in animals, you know, non human primates, for example, or mice before reaching the point where we can have clinical trials with this technology for for humans. And so that entire process, and all the while, you know, the technology is improving smaller electrodes, perhaps better materials, so you can get better signals so you can get more channels, just get more breath and quality of information from the brain. And then also on the software side, I mean, it it's in some ways, it kind of mirrors the speech recognition field, which is for example, when you talk in your phone and it knows what you want to say, or even like the text dictation from earlier, so that technology, some of the principles underlying it have been around for a long time. But really, it's the increase in computational efficiency, you know, more advanced chips that's kind of on the hardware side, but also more advanced techniques on the software side better algorithms. And that's really enable the big breakthroughs in this kind of technology that we've seen. And it's somewhat similar for the statistical analyses that are required to process brain activity and, and interpret it.

R Ryan Fleury 25:35

We've seen articles in the past that have had devices that, like you previously mentioned, are kind of mounted, or you were over your head, and it senses through your skull. But your technology seems to access a part of the brain that I don't know, how has that ever actually been accessed before? To accomplish what you guys have accomplished with, you know, being able to produce 50 words per minute using your thoughts?

D David Moses 26:07

Yeah, so there's a few things I'd like to clarify. One is the vocabulary size was 50 words, right? So we were only at about 15 words per minute on average. And also, it is, I know that it is a brain computer interface, but it this is, okay. So a lot of times we get these kind of Doomsday or not Doomsday, but kind of conspiracy, theory style, like interpretations of the work that it can be used for interrogations and things like that government, bad actors, etc. So I just want to clarify, you know, I know you you weren't, it's an entirely inaccurate to say that, like, the person is thinking to try to control the device. But really, the way it's working is that we are recording from the part of the brain that normally controls the vocal tract. So we've actually had you mentioned that has this brain part of the brain been accessed before it has, in some of our previous studies, just not with a person with severe paralysis. So we found that this part of the brain is really tied to you know, how we orchestrate the vocal tract because it's very complicated actually, to speak. Even though it feels effortless for us. Um, there's a lot of coordination of small muscles that have to happen to kind of shape, you know, the air we exhale into, into words. And, and so this part of the brain that kind of coordinates that that's the part that we are recording from with our participant in this study. And so, you know, the participant has to try to speak, that's the point I'm trying to get to. It's definitely not, you know, any kind of mind reading.

R Ryan Fleury 27:56

yeah, no, absolutely. Because, you know, yesterday, when I was doing some thinking about this show, and how we were going to approach it, I was thinking, wow, this would never work for me, because I would be thinking a pizza, beer, pizza, beer, pizza, never get anything accomplished, right? I'm glad you could clarify that.

D David Moses 28:16

Yeah, no worries. Now, you'd have to be wanting to say pizza, then maybe that's what would come out. But there's one other aspect, just briefly of your question that I think I'd like to address, which is, you know, what's the difference between centers placed on the

outside and us in this study, having to go, you know, require surgery to implant these electrodes, the basic explanation is that the signals are much better, right, you can get inside the skull, because the skull, I mean, it is great and serves great purpose for us to protect our brains, which is, of course, incredibly important. But when it comes time for trying to acquire brain activity, as part of a brain computer interface, that actually acts as a, you know, signal attenuator, basically, for high frequency. So what this means is some of the very information rich brain patterns and brain activity that that gets lost in the signal is much harder to detect when you use sensors on the outside of the skull. So that's why when we go invasive like this, actually in the skull and on the surface of the brain, we get you know, really good access to signals that we find are related to all kinds of things including speech as we show in this study.

R Rob Mineault 29:35

So I'm just kind of curious about the the different parts of the brain and the different work that's being done in different fields because we've heard for a while about work, that's that's being done say in the in the motor cortex, where you can plug in and, you know, working on being able to do things like move artificial limbs or move a cursor across the screen. That type of Thing is, is that a very, very different process than, say, accessing the speech center and doing the work that you guys are doing? Is it? Is it a lot more complicated to trying to, to work in that in that vocal center? Or is is the premise essentially the same? It's just the algorithm that that you're working with, to decode the signals has to be different than, say, the work that's being done in the motor cortex?

D David Moses 30:31

Yeah, there are a few, I think key differences. One is the actual neural interface device that we use is different than what's traditionally been done in the motor cortex, motor cortex. And especially with this most recent paper from that Shenoy group, where they show is by Frank Willett and others, where they show that you can actually decode imagined handwriting, it's really, really awesome paper. And that, in that study, and in some similar studies, they use what's called micro electrode arrays, which are kind of penetrating electrode. So these, you kind of stick into the brain, and they like thin electrodes actually penetrate a little bit deeper into the brain to record signals, and you can get really, really nice signals this way. In our study, we use a technique called electrocorticography, or ecog. And this is actually the sensors placed on the surface of the brain. So there's kind of like circular like disc electrodes that you place in an array. And this has some advantages and disadvantages compared to their to the like, micro electrode array approach, we get more coverage. So because speech is, is a pretty broad, you know, there's lots of brain areas implicated in speech. And even within small brain areas, or like specific brain areas,

there's still a lot of, of surface area that you need to cover to like, get all of the relevant activity, basically, and this, that a lot, I'm sure have more research will clarify this further. But for us, the point I'm trying to get at is that the type of technology that we use, gives us access to a little bit more brain areas, even though we don't get single neuron resolution, like you would with micro electrode arrays. So that's, that's one big difference. And I think the other one to emphasize is, yeah, the speeches, because there's so many degrees of freedom and tight in terms of how you can produce speech sounds, and all of the different shapes that your vocal tract can take, and the dynamics associated with articulation. You know, this is a very complicated process. And we think it is, indeed more complicated than three dimensional cursor control, or like imagined hand or arm movements in, in the kind of 2d space. Now, I'm not saying that, you know, what they're working on these other groups have it easy or anything like that. I'm just saying, yes, there's a, I think there's a reason why it took this long for the first kind of speech, brain computer interface that tries to go directly to attempted words and sentences, like, what we've done is, you know, this is kind of a new frontier. And that's one of the reasons it's so exciting is because this is one of the first demonstrations that this is possible. And so there are definitely a lot of challenges and a lot of complexities. But, you know, it was pretty promising first step, in our opinion.

R Ryan Fleury 33:31

What is the process for a person who has been approved to go through this, this study this research, you know, become a subject for you guys to do these tests and trials with? Like, what sort of training is involved to get them to be able to produce words?

D David Moses 33:48

Yeah, so I think what you're referring to is after the full recruitment process, because that's a, that's a long and meticulous process to make sure that candidates will be a good fit for the study. But, you know, after surgical implantation of the sensors, and you know, the participant recovers and is ready to now, start our tasks. It's actually we tried to keep the tests very simple. So to train the system, they, you know, right now, there was only 50 words in this study. So basically, they would see one of the words, and they would get a little visual cue. That would tell them exactly when to start saying the word. And so they, the participant tries to say the word when he gets this cue, and then we move on to the next word. And we just do this, you know, visually 1000s of times, so that we get lots of samples of him trying to say each of the 50 words. And then offline, we train these kind of advanced computational models that try to relate subtle patterns in the sense that there's 128 channels that we're recording from simultaneously. We try to relate Just kind of population level activity across all the sensors with the speech targets. And then once we

train that model, we can actually detect his attempts to speak, and try to figure out what he was trying to say, in real time. And that's what we use eventually, when we show him sentences, and he tries to recreate those sentences, you know, by saying each word in the sentence,

R Ryan Fleury 35:24
Right, so AI must be super beneficial in in trying to predict what the subject is trying to say.

D David Moses 35:33
Exactly. Yes, that's exactly right.

R Rob Mineault 35:36
So I must be really challenging because the brain is, is still very much a mystery, in a lot of ways. We still don't really know, just how it exactly works. Does that kind of play into the research as well, like you, in some ways, you're just kind of working in the dark?

D David Moses 35:54
Yeah, unfortunately, I think a lot of these types of research studies, you know, you'll, as you say, the brain is not completely understood, we, the amount that we know about, it seems to be increasing every year with, you know, with research and stuff. That's where all the tax dollars for neuroscience research goes, trying to better understand the brain, and, you know, neurons and everything, all aspects of, of, you know, neural processing. But, yeah, in terms of this study, I think a lot of it was kind of trusting what we knew from before with some of our previous patients, which I can talk about, if there's interest, you know, we had previous participants in previous studies who were not paralyzed. And we could figure out some things about speech, and how its represented in the brain with those participants. And so we just kind of trusted that research and trusted the device and the methodology of recording this, this brain data. And even though we don't fully understand every aspect of what's happening, and of course, the decoding system isn't perfect. But we are able to see reliable patterns, and we are able to, you know, sometimes exploit those patterns to enable decoding. And that's, that's what gave us the results that we saw.

R Rob Mineault 37:22
And so like, how many different - and you may or may not know the answer to this question- but like, so how many different fields are we talking about? Like, you know, you

guys are working on speech, I know that people are working on sort of motor control. Are there other other other studies going on with different parts of the brain other than those?

D David Moses 37:42

Well, I know before one of the very popular brain computer interfaces even also for communication, is there was this kind of what's called a p 300. speller, which is basically where you attend to a screen. And there's different letters flash, it's a visual paradigm, and you're trying to attend to letters that you want to say that you want to type while the screen is flashing. And some part of the visual signal can get recognized by a system and use to decode it. So that that did use a different brain area. And that can be done non invasively. But as you might imagine, you know, wanting to spell things out in that manner is pretty tedious. It's pretty laborious. So I think that that is, you know, I'm not sure what the latest is in that field. But it seems like definitely, the handwriting one that I briefly mentioned before, that's kind of the state of the art for the like, for the imagined hand in our movement decoding. And I think that is mostly mostly it and then are now we're hoping you know, speech will also be seen as a viable control signal for communication BCI.

R Rob Mineault 39:01

I want to step back a little bit and go back to talking about the sort of the surface level brainwaves with the with just the sort of the electrodes on the on the head versus the actual surgical procedure is the intrusive nature of of the surgery and stuff. Is that kind of what slows there the research down. And do you ever see a place where we can get the sensors sensitive enough where we can just do away with the intrusive part of that and just work with like, the skullcap with with the electrodes on it? is there is there a day where we could maybe just go with that?

D David Moses 39:42

Yeah, that's, that's definitely great questions. I think for the first question about what is kind of making this a little slower than maybe it could be. I think it is because it is invasive. There is risk it's it is brain surgery after all. So the there's definitely some risk. I think from what we've seen, these kinds of surgical procedures are pretty, you know, well tolerated, like, there doesn't seem to be that many adverse events. Although I'm sure there's some literature that, you know, can give you exactly the frequency. But to the best of my knowledge, it seems that the risk is fairly low, given how intense of a procedure it is. But still, you know, these things should be taken seriously. And the FDA and, and other regulatory bodies, really make sure that the participants are protected. And so yeah, it it's

definitely a kind of a slow process, even though I'm not complaining or anything, I'm glad that there's kind of regulatory oversight to make sure that volunteers aren't abuser, put into risky situations. But in terms of your other question, there are a lot of research groups, and actually companies now that are trying to improve, you know, non invasive signal acquisition from the brain. And so this is not just the kind of eg electrodes that you can put on, but there is now using spectroscopy. So, for example, one is this, you know, infrared spectra, spectroscopy. And so what this technology does is, it's something that sits, if you can imagine, like a helmet that you wear, and it shoots kind of basically lasers, or not lasers, I should say, just light, light in certain frequency, what's at a certain frequency into your brain, and depending on the blood oxygenation, it actually reflects, you know, refracts light in different ways. And you can kind of use this to measure neural activation in different brain regions. It's not completely unlike a functional MRI that, that uses blood oxygenation to determine, you know, neural activation. So, basically, this, this is another way to try and get really good signals out of the brain. But it's, it's still very difficult, and that technology just isn't there yet. I don't know. If it will ever get there. It might, you know, it's really hard to say, but it's just such an incredibly difficult problem. But there's still some companies kernel, I think, is the name of a company that is actually manufacturing these helmets are I don't know if it's available to purchase yet. But you can wear them and it tells you some some pretty broad things like your attentiveness to a task or, you know, I don't know exactly what their product offers, but I know that you can get some information out is the the kind of summary. But you it doesn't appear that you can get the same level of information as you could get from these invasive recording methodologies with these invasive processes.

R Ryan Fleury 42:56

Is there a lifespan to these? You know, at some point these implants have to be removed and replaced? Or how does that work?

D David Moses 43:06

Yeah, that's still being studied. I mean, that that that is a really great question for us in our clinical trial, our razor approved for up to five years for testing. So we can test for, you know, up to five years with no participant. And I know that actually, just extremely recently, maybe even today, a study just came out summarizing a five year study with the micro electrode arrays, and you know, they saw pretty favorable results do so right now, it seems about five years, it seems to be the limit of what we know. There may be more information from this, like a neuro pace device that I described earlier. But I think even they, yeah, I'm not sure if they've shown anything longer than five years in a single person. Yeah, so I think longevity is definitely an aspect. I think it's just we'll have to see more

research. to figure that out. Yeah.

R Ryan Fleury 44:04

Do you think we'll get to a point, maybe in our lifetimes, where we'll be able to access this sort of systems that you guys are doing on a handheld device, mobile device?

D David Moses 44:16

I know. It's, it's, it's possible. Yeah. in our lifetime. I know. For example, Elon Musk's company, neuro link, they are trying to this is basically one of their goals. They want to have brain implants that send signals via Bluetooth to your phones and that you can, you know, interact with. I think, right now, for us, our focus is definitely on something on assisting people who are unable to speak you know, people who have severe paralysis, and the method that we actually get the information out via to a computer or handheld device. You know, I think that if you have a reliable way to, to understand the brain signals and to extract the brain signals then I think it could be possible to access some of the decoded information from a handheld device. You know, for us, our main focus is definitely on trying to re enable speech. So be that through tablet or computer or however, we we feel the best way for it to be done, then that's probably what we're gonna try to do.

R Rob Mineault 45:23

Yeah, stuff like, that's always interesting, right? There's, there's always people that are working on sort of, you know, commercially viable applications to different technology, that, you know, if they crack that code, it can benefit the people that are working on say, the more focused, you know, assistive technology, part of that, that technology. But so sort of, to sort of just sort of extend off that. Because I know that, you know, we talked here on the show, about some brain computer interfaces, probably in our first year of podcasting, and that was about four or five years ago. And we at the time, there were commercially available devices are headsets that you could buy, where you could do, like, you know, really, really basic things like you could train a toy car to, you know, move back and forth, or left and right, using your quote, you know, brain, it was just, you know, it was just trading the the, again, the algorithm to steer the car. What's, what's that space, like? Now? Has there been a lot more products that have come out? Based on the improvement in technology? Or, and, and sort of, are we going to get to a space where, you know, we're gonna see more and more of these of these headsets available?

D David Moses 46:57

That's great question. Yeah, I forgot about those. I think there was also at some point, a pretty sure at one point, I saw an eg controlled like wheelchair, someone couldn't at least navigate for directions, using like a headset, or a band or something like that they that they wore, and just like thinking about the some representation of the direction they wanted to go, maybe they mapped it to some keywords, so or something like that. But yeah, so I do think that this technology only stands to improve as perhaps some of the signal processing techniques improve. And definitely, as the algorithms improve, you know, machine learning is huge right now, of course. And so there's lots of developments from all kinds of fields that that can be applicable to neural decoding actually. So even in our study here, we used some techniques that were kind of Pioneer for speech recognition, and even image classification, that we were able to apply to actually decoding the neural signals into words. Now, again, I just don't know how, I don't know how far this these kinds of technologies can go, there really hasn't been anything to show that you can get a lot of really high fidelity signals out of the brain if you don't actually go through the skull. So maybe for basic applications, those are improving, but yeah, I'm not. I'm not sure if you could get something like, you know, restored speech from from that kind of interface.

R Rob Mineault 48:35

So kind of sounds like it's still like, you know, it was a little bit of a novelty item, then and it sounds like it's kind of still in that space now.

D David Moses 48:43

Yeah, I'm not super sure. I haven't been keeping up too closely with, but I haven't seen any, like big breakthroughs that have come across kind of what I've been seeing.

R Rob Mineault 48:53

Well, if anybody does it, good old Elon

D David Moses 48:55

Well, his will be invasive, too. So he's going for that brain surgery to get his device.

R Rob Mineault 49:03

Yeah. Well, and you probably need to go to space to do it, too. So I'm just curious what,

what got you interested in this field?

D David Moses 49:15

Yeah. You know, it's kind of I don't know, I feel like a lot of these things are a little unpredictable. And I didn't know. I can go kind of way back briefly in high school I started getting interested in and software and programming. I was on the computer science team, which was, yeah, that was fun. I got to college to undergrad and I ended up going to bio engineering but still some interest in computer science. Towards the end, I started getting more interested in the brain and all that although I still didn't really know exactly what I wanted to do. Then when I started my PhD. It's a joint bioengineering program between UC Berkeley and UCSF and I kind of wanted to do the arm reaching like motor control, like robotic arm kind of thing. That's that's kind of where I was at. But I took seminar and I saw Dr. Chang give a give a presentation about speech. And it was, yeah, I was very interested. So I asked him if I could do a rotation. That that's, that's basically, that's basically it, you know, I did my PhD in his lab. And I've stayed on afterwards. And, and I'm still still in the lab today. So it started out with doing a lot of, I was really interested in speech decoding, with people who can speak because we are first participants were not, they were not paralyzed. And they were kind of volunteers who were getting treated for epilepsy. And so while they were undergoing that treatment, they volunteered to participate in speech studies, that's what a lot of our findings have been over the past decade is from these, you know, really selfless volunteers who have kind of graciously spent their time working with us. And so I was very interested in speech decoding throughout all my PhD and published a few papers on that, and then this opportunity came up to be, you know, to kind of participate in and eventually, you know, oversee a lot of the clinical trial, the speech side of the research for the trial. And that's really been quite a great opportunity. And so, yeah, I'm still here, still really interested in it, and definitely still want to keep pushing the field forward here.

R Rob Mineault 51:32

Well, it's an amazing field. It's super interesting. And I have to, again, thank you for, for coming on, and helping us sort some of this stuff out because it's, you know, it's fascinating to read. And it's always really interesting when news of these little breakthroughs hit the mainstream media. And, and people sort of take notice, so, but it's Yeah, it's great to have you on and actually be able to explain some of this stuff to us.

R Ryan Fleury 51:58

Well, I think we have to thank the volunteers especially right, there's only so much you can

do with primates and mice.

D David Moses 52:04
Oh, there's no doubt. Yeah. I mean, I don't know if you there was a really nice kind of, in some ways tribute to our participant who goes by the nickname Poncho in this in the New York Times who describes his journey. As he went, he became paralyzed at such a young age. And then eventually, part, you know, became a participant in our trial. And he's just truly incredible. You know, we owe so much to him. He's the best colleague anyone could ask for.

R Ryan Fleury 52:37
And its volunteers that allow you guys to push the science forward, right, and you change the world for others.

D David Moses 52:43
Yeah, definitely. I mean, that's also it's really, to be in the situation of the epilepsy volunteers right in the hospital who are in kind of a vulnerable and non vulnerable, but they're in a very kind of unknown. And, you know, it's kind of scary position where they're being, you know, they have to undergo two brain surgeries and get, try to get their condition treated. And for them to volunteer to kind of advance the science, even though they know it won't personally benefit them is also very applaudable.

R Rob Mineault 53:18
Well, listen, you'll have to come back on in the next breakthrough.

D David Moses 53:30
It's really My pleasure. Thanks. Thanks to both of you for having me on.

R Rob Mineault 53:34
Man. I don't know connecting, being able to connect your my phone to my brain is that's a chilling thought.

D David Moses 53:41

It is pretty scary, huh? Yeah, there's a lot, it might be comforting to know. And it might be a good time for me to, you know, give a shout out to this. There's some groups that are kind of pioneering this this discussion over neuroethics which kind of spans to both privacy of brain data? How do you make sure that participants in these studies are treated properly? And also, you know, future proofing against potential? I guess there's, you know, bad things that can arise from from this kind of technology. So there, there definitely are. Definitely are people talking about this. So those discussions you might find interesting and helpful.

R Rob Mineault 54:24

Yeah, no doubt, the ethics of all of this. And yeah, it is actually a really fascinating conversation, too. But that's a whole other can of worms. For sure. before we let you go, it Do you have anything to plug? You know, do you want to give a shout out to your Twitter feed or anything like that.

D David Moses 54:47

I actually just made a Twitter to post the paper being published. So I don't even know. I don't know if I should be doing that. Or like, I guess I don't know much about Twitter to be honest. I just kind of get on to the To say it but my Twitter is at David Moses, it's like at. And then the word at David Moses perfectly. There's another David Moses who got there before me. Also, I would like to shout out to the other two co lead authors of the study, Sean Metzger and Jesse Lowe. They both are grad students in the lab. And yeah, they were essential to the to the work. So it's quick shout out to them as well.

R Rob Mineault 55:28

Well, listen, thanks again, for all your work in this field. It's it's an incredibly important field. And, you know, it's going to make a huge difference in a lot of people's lives. Once we sort of drive the football forward, for sure.

D David Moses 55:41

I really hope so. Yeah. Thank you.

R Ryan Fleury 55:43

Thanks so much, David.

R Rob Mineault 55:45
Whoa, okay. Well, I feel smarter.

R Ryan Fleury 55:49
Really? I don't. I just, it would be really interesting at some point to bring on one of the people who have volunteered for one of these types of studies, types of research for brain computer interfaces that have gone through the processes have gone through the brain surgery. Just to get that to get that perspective.

R Rob Mineault 56:15
Dude, they've been through enough they don't need to be subjected to our show as well. Show some mercy. They had brains planted on their brain, giving them a break, let them watch Netflix.

R Ryan Fleury 56:30
Yeah, that's pretty incredible.

R Rob Mineault 56:33
No, yeah, that is it's it really is incredible to see the work that's being done. This is why it makes me angry. Like guys like Ilan Musk, and that other asshole that went to space. You know, like, Just shut up, like, stop it. Why are we wasting money on space? when, you know, we have so much to learn about the brain? We haven't figured that out there. There's so much work that could be being done in making lives, people's lives better. But no, we're blowing all this money, just shooting millionaires into space and bass.

R Ryan Fleury 57:07
I saw a tweet on Twitter this morning. And I didn't pull up the link, but there's a prosthetic hand that basically slides on like a glove. And again, you know, I don't know if it attaches to your nerves at some point and the glove attaches to that attachment. But, you know, there's a lot of work being done when it comes to brain computer interfaces when it comes to prosthetics. Yeah, it's it's an exciting field.

R Rob Mineault 57:34
Well, it really isn't it this this is even outside of and maybe you know, maybe we should do another episode one day one day soon on, like, I don't know, speculative technology and stuff that's sort of on the cutting edge because even stuff like exoskeletons really light exoskeletons that somebody with, say cerebral palsy could use that would actually just assist in movement and stuff. Like you, we could literally be talking about, like helping people walk again, or, you know, there's all kinds of stuff that's going on. That's, that is really sort of at its infancy that needs funding, and, and dollars to really drive that forward. And it would be nice to see some of that money that's just floating out there in the world that people are just blowing on stupid stuff. used for for like, really valuable research. So I'm just I'm venting today.

R Ryan Fleury 58:32
You are venting

R Rob Mineault 58:34
I'm in a bad mood apparently.

R Ryan Fleury 58:36
Meetings last night, and you get that stuff going on after work today.

R Rob Mineault 58:41
I know. busy busy Rob

R Ryan Fleury 58:46
True, you need to escape into a fantasy world?

R Rob Mineault 58:52
Yeah. Actually, that works. I haven't played I haven't. I haven't sat down and played a video game for a while. This weekend?

R Ryan Fleury 58:59

There you go.

R Rob Mineault 59:01
Well, that's another thing to think about that brain computer interface, like gaming. If you could just Oh, wow. Whoa, you'd be like the matrix.

R Ryan Fleury 59:11
Ma at some point, you know, it's probably bound to happen, you know, if they've got AR and VR, and that's just gonna get better and better at some point or some new technology or surpass it.

R Rob Mineault 59:21
And it'd be crazy if you could like, move around. Like if you're playing a first person shooter in like a virtual reality headset or goggles, and you'd not even have to like, move a mouse to move you would just think about moving or Wow, that could be that could be crazy.

R Ryan Fleury 59:38
That is crazy.

R Rob Mineault 59:39
See, that's where I wish I was 20. Like, oh, man, I could I could possibly make it to where to like where essentially we're living in the Matrix like that's a viable possibilities plug in. And it's just completely immersive. Like that would be pretty cool.

R Ryan Fleury 59:57
Well, next time you're given opportunity to take the blue pill or the red pill. Take the blue pill.

R Rob Mineault 1:00:05
Which one is that again? Because I haven't watched the Matrix in awhile.

R Ryan Fleury 1:00:08
The blue pill, the one where you're you come out of the matrix. Well, that's where you go into the matrix.

R Rob Mineault 1:00:13
So yeah, exactly. I take that one. And I would have taken out when I would not come out of the Matrix. Like, unless it was really bad. Like, I guess if I if I was working in a cubicle, in the matrix, like that would be depressing. Like if I had a shit job that I hated. And I was in a virtual reality world, like the Matrix like, that's a bummer.

R Ryan Fleury 1:00:34
Yeah, I think I saw but Matrix 4 is coming out or being something that is totally, I got to watch. One, two, and three. I don't think I ever saw two or three.

R Rob Mineault 1:00:43
I just I don't know, man. They're just they're out of ideas in Hollywood. They're just absolutely, they're just doing another Ghostbusters. And words, another matrix. Now I know, there's no creativity in Hollywood. They just keep rebooting and rehashing old franchises, which is super weird to me.

R Ryan Fleury 1:01:01
Yep. Yep.

R Rob Mineault 1:01:02
Like, like in the 80s. We had all these original properties. This is where all these properties came from. And they're all original. It's not like they were just remakes from stuff that they were doing in the 50s. So I don't know, come on people. We had a pandemic, you've been spending all your days at home, you couldn't come up with some original ideas.

R Ryan Fleury 1:01:23
How many more reality shows Do we need about singing or dancing or dating or divorce? We're just, we're just sitting in a house. Don't even get me started on the Housewives of Atlanta or Jersey or whatever. I've watched what episodes I was down here, the guitar

dungeon one day, and I was doing something on my computer playing guitar or something. It was just on in the back. I was like, Oh my god, what is this? It was like, yeah, Housewives of Jersey, your son was like, Oh my god, like, How can this be made into a TV show? I just makes no sense to me. What a waste of time and money.

R Rob Mineault 1:01:57
Yeah, exactly. See, there's too much money being wasted in this world there is. At least build an underwater base.

R Ryan Fleury 1:02:08
Well, you know, what's next? I saw I saw something this morning, I think on Google News that the International Space Station does seem to be retired. And so they're gonna probably have to start building a new one.

R Rob Mineault 1:02:20
We just put that thing up there! What do you mean retired?

R Ryan Fleury 1:02:25
Getting hit by asteroids or whatever, all the space shit that's floating around out there.

R Rob Mineault 1:02:34
I mean, I guess you want to replace it. But so I want to Well, why like, what, what did we even do that for? Like, what did we get out of the International Space Station? Or no, no, we didn't get nobody even got to go up there other than like, you know, a couple astronauts from Russia and some for the US and what exactly just went up there? No, that's Yeah, that's weird. That's super weird. I want to know what we got out of the International Space Station, if that was worth the billions of dollars it took to build the thing.

R Ryan Fleury 1:03:01
Well, I think they figured out how to grow plants in space. Like they were doing. So stuff like that up there.

R Rob Mineault 1:03:08
I guess, ya know, like, they took some ants up there to see what the no gravity does to ants . It just baffles me. We're a really dumb species. can be

R Ryan Fleury 1:03:21
Yep. Let's leave it on that note.

R Rob Mineault 1:03:28
All right, fine. Hey, Ryan.

R Ryan Fleury 1:03:31
Rob.

R Rob Mineault 1:03:32
Where can people find us?

R Ryan Fleury 1:03:34
They can find us online at atbanter.com

R Rob Mineault 1:03:38
They can also drop us an email if they so desire cowbell@atbanter.com

R Ryan Fleury 1:03:48
They can find us on Facebook, Instagram and Twitter.

R Rob Mineault 1:03:53
We should just call this episode it "old men yelling at clouds" . We are grumpy old men today. That's all right. We need Steve back to inject us with some of that youthful, youthful energy that I'm sure that he'll have after a month of fishing.

R Ryan Fleury 1:04:12
Yeah, maybe.

R Rob Mineault 1:04:14
We shall see how many how much fish can you possibly like if you are fishing for a month?

R Ryan Fleury 1:04:19
He says is his freezers full and he's still got more coming. He doesn't know where he's gonna put it. So he's got fish for a year.

R Rob Mineault 1:04:25
I mean, I would not want to eat fish for a year.

R Ryan Fleury 1:04:29
I know I'm not a big fish person. My wife loves fish love salmon. And I'll eat out once in a while. But yeah, give me steak any day.

R Rob Mineault 1:04:37
Yeah, I mean, I could eat maybe fish like maybe once every couple of weeks. But I mean, if a year's worth of fish he's gonna have to eat that every day.

R Ryan Fleury 1:04:46
Yeah. Oh, yeah. fish tacos and halibut steaks and I don't know. I guess yeah, salmon steaks and salmon and maybe salmon souffles tuna salad. Tuna casseroles remember those growning up?

R Rob Mineault 1:05:11
Yeah but aren't those small? Those are sardines. I don't know my fish. Yeah. Yeah, I don't know.

R Ryan Fleury 1:05:19

I just remember tuna casserole going up you know tuna and peas and macaroni. Bread crumbs. Yeah. In the 80s or 70s. Growing up and eating liver. gotta eat liver. It was. It was affordable meat.

R Rob Mineault 1:05:38
I never had to eat liver.

R Ryan Fleury 1:05:42
Oh, you are so lucky. I still gag on that stuff.

R Rob Mineault 1:05:46
Is that even a thing anymore?

R Ryan Fleury 1:05:49
Sure. you can order liver and onions at restaruants

R Rob Mineault 1:05:59
No kidding.

R Ryan Fleury 1:06:00
Yeah, I haven't looked into it lately because I haven't been in a restaurant two years but I think white spot even used to have liver and onions on their dinner menus.

R Rob Mineault 1:06:11
Blech. Cowbell@atbanter.com. If anybody has any livery stories that they want to tell us.

R Ryan Fleury 1:06:18
True

R Rob Mineault 1:06:19

Orif they want to vent? Apparently, we're the venting show. So they want to have something to rant about and complain about. Let us know. We'll rent will will complain and rant for you.

R Ryan Fleury 1:06:28

Sounds good Yeah.

R Rob Mineault 1:06:31

All right. Well, that is about gonna do it for us this week. Thanks, everybody for listening in. Big thanks to David Moses for joining us. And we will see everybody next week.