MS Podcast - Vitals: BCI
R5 Transcript

00:00:04:34 - 00:00:08:25
Leslie
Hi. Welcome to the vitals, the Mount Sinai health System's newest video podcast.

00:00:08:25 - 00:00:26:32
Leslie
I'm your host, Leslie Schachter, a neurosurgery physician assistant at the Mount Sinai Hospital. Today we're talking about machine learning and the brain computer interface BCI. Mount Sinai Health System is a global leader in BCI, and actually had the first annual BCI symposium last year here in New York.

00:00:26:36 - 00:00:50:44
Leslie
I'm happy to have Doctor Joshua Patterson, professor and chairman of the Department of Neurosurgery at the Mount Sinai Health System. He is a busy practicing skull base and cerebrovascular neurosurgeon and global leader and innovator in the field of advanced digital technology in neurosurgery and leading the field of BCI with his team here at the Mount Sinai Hospital. And I am the physician assistant who works alongside him.

00:00:50:49 - 00:00:58:36
Leslie
We also have Doctor Ignacio Diaz, PhD, an associate professor in the Department of Neuroscience, neurosurgery and Neurology

00:00:58:46 - 00:01:17:27
Leslie
And the director of the Human Neurophysiology Laboratory at the Icahn School of Medicine, at the Mount Sinai Hospital and the Friedman Brain Institute. His research focuses on understanding how human cognition arises from the interaction of multiple brain areas and neurotransmitter systems, particularly in decision making behavior.

00:01:17:27 - 00:01:23:33
Leslie
We also have Doctor Amit Doshi, professor of radiology at the Icahn School of Medicine at Mount Sinai.

00:01:23:40 - 00:01:48:55
Leslie
He serves as vice chairman of ambulatory services and radiology, chief of the Division of Neuro Radiology, and associate director of Radiology Residency program. He is a board certified

radiologist with a specialty certification in neuro radiology. Thank you guys for all being here. I really appreciate you guys taking the time. So I just introduced you and said a lot of things, but can we all just go quickly around the circle and kind of break it down?

00:01:48:56 - 00:01:51:36
Leslie
What do you do every day? Let's start with you, Doctor Patterson.

00:01:51:35 - 00:02:15:14
Dr. Bederson
most important thing I do is neurosurgery on patients with mainly brain problems. But I also I'm fortunate to run a wonderful department with many neurosurgeons, and I get to collaborate with wonderful scientists and physicians such as doctor C.S and Doctor Doshi in caring for patients and advancing the field.

00:02:15:20 - 00:02:20:52
Leslie
So you take care of sick patients in the moment, but you're also looking towards the future in research and developments.

00:02:20:59 - 00:02:24:32
Dr. Bederson
Yep. And also in training the next generation of neurosurgeons.

00:02:24:33 - 00:02:25:38
Leslie
What about you?

00:02:25:37 - 00:02:43:39
Dr. Saez
I am a scientist, and I work closely with Doctor Bateson and other collaborators in the clinical side of things. And the goal of my laboratories to understand how the human brain works, which is, you know, a lofty goal. But if we can find that a little bit more is how does electrical activity in different brain areas generate?

00:02:43:43 - 00:03:03:41
Dr. Saez
How does that generate, human thoughts and perceptions and feelings and emotions and actions. Right. And part of that is basic neuroscience because we want to understand how the brain works. And also there's a translational aspect of it when it fails because there's a disease happening. How does that feel? And what can we do from a research standpoint to generate new treatments for treating patients?

00:03:03:56 - 00:03:10:17
Leslie
So you're like more research and looking towards the future of helping people in the future. Yeah. Okay. And what about you?

00:03:11:09 - 00:03:36:25
Dr. Doshi
I'm a neuroradiologist, and, you know, I'm a radiologist, so look at pictures, but specifically of the brain and spine. We work very closely with, Doctor Patterson and, other specialties such as neurology, and medicine, to really evaluate pictures, images. MRI is and Cat scans, to see what's happening with the patients really assist in diagnosis and treatment.

00:03:36:39 - 00:03:58:24
Leslie
So I'm a surgical PA. I'm a neurosurgery PA. Like I said, I work with Doctor Patterson, and one of the things that I do is I get patients safely ready for surgery, whether that's to remove a tumor or a vascular malformation or something. And what we do is we get MRI and Cat scans, we put them together and we use that in the operating room.

00:03:58:29 - 00:04:07:45
Leslie
So that's kind of like a joining of these two fields. Can you talk a little bit about how we've used advanced digital technology and images in the O.R., specifically?

00:04:07:45 - 00:04:43:21
Dr. Bederson
Well, the collaboration with neuro radiology has been focused and intense for my entire career. Imaging allows us to look inside the brain before and after we've operated, to pinpoint where the pathologies are, and then to come up with the best strategies to treat them. Many times, as the physics of MRIs have has advanced, the development of new sequences allow us to uncover some of the energy metabolism and chemistry of the brain in addition to its anatomy.

00:04:43:25 - 00:05:08:45
Dr. Bederson
We can really look at functional areas now and how the different brain areas are connected. And, together with our neuro radiology colleagues, we can plan out the best trajectory for safe removal of a tumor. Once we're in the operating room, those images are connected to something that's akin to a GPS for the brain in something called surgical navigation.

00:05:08:50 - 00:05:20:57
Dr. Bederson
And we use the images to guide us, just like we do a GPS guide driving through the streets of Manhattan, referencing our, surgical instruments to the anatomy of the brain as seen on the

images.

00:05:21:35 - 00:05:30:42
Leslie
Kind of like a heads up display, like the millennial generation would know, like Pokemon Go, like. So you're seeing something like artificial intelligence in front of your reality?

00:05:30:49 - 00:05:53:22
Dr. Bederson
Yeah. Well, if you use Pokemon Go as an example, that really is an example of a simulation. And that's exactly what we've started to do. We take an MRI, which is, an or Cat scan, which is an image or a map of the actual brain. Then we create a 3D virtual reality scenario. Think of the movie avatar.

00:05:53:27 - 00:06:14:36
Dr. Bederson
That avatar and that scenario is brought into the operating room. It's connected to the map of the brain. And some of that information is projected on a heads up display. Just like a fighter pilot might use to look for the runway in fog. This helps us really guide, right towards the pathology and to avoid really important structures.

00:06:14:41 - 00:06:17:50
Dr. Bederson
Something that's rapidly evolved over the past five years or so.

00:06:18:16 - 00:06:29:08
Leslie
So the use of technology is critical to getting ready for neurosurgery. And intraoperative along with your brain. Would you agree with that?

00:06:30:13 - 00:06:56:30
Dr. Bederson
You know, it has become almost standard of care. Just like using an autopilot has become standard in the airline industry. However, one of the things that is so important is to know how to operate without those technological, advances. Some people call them crutches, but, sometimes those machines can fail. And what does one do if you're operating when one of those machines fails?

00:06:56:30 - 00:07:02:39
Dr. Bederson
Well, you go back to the basics of neuroanatomy and all the principles that it that we learned over the years of training.

00:07:02:57 - 00:07:23:40
Leslie
One of the things that's been really helpful, I know in the field of radiology is machine learning and artificial intelligence for scans. Years ago, when I would look at a result, it would just be, you know, the impression and the result. Now you can see that you guys have used artificial intelligence. So can you talk a little bit about how you guys are using machine learning and AI in radiology?

00:07:23:41 - 00:07:44:19
Dr. Doshi
Yeah, sure. So, for artificial intelligence, you know, data is important, you know, in computing data, you know, getting the data and having an input and then an output. And radiology is prime for that because there's images, with radiology. So it's a picture. It can be broken up into pixels. And the computer can be taught a variety of different things.

00:07:44:24 - 00:08:04:16
Dr. Doshi
If you look at I kind of in the scope of radiology is kind of three different buckets. There's like the clinical bucket which is a patient interfaces with the imaging. You know, the MRI, the Cat scan and the AI can be used for a variety of different things. Then there's like the more operational things like, you know, if you send an MRI, if you ever got an MRI, it could take 60 minutes to get an MRI.

00:08:04:30 - 00:08:18:31
Dr. Doshi
Well, how can you use AI to make it ten minutes? You know, so that's, you know, a lot of the future of AI in that space. And then the other part is that as we do more scans, is how do we use the AI to help build efficiency? So you don't report doesn't take two weeks to get,

00:08:18:30 - 00:08:20:05
Dr. Doshi
you know, it's it's you get it right away.

00:08:20:20 - 00:08:24:38
Dr. Doshi
Doctor Peterson gets it right away so that he can, you know, make decisions quickly.

00:08:24:42 - 00:08:26:59
Speaker 1
So thank you. By the way, we want to like immediately.

00:08:26:59 - 00:08:35:23
Dr. Doshi

Right. Exactly, exactly. So we gotta we gotta hit that. And so we, you know, if you look at really like the clinical side of it, most of the AI is done is for triaging.

00:08:35:23 - 00:08:41:39
Dr. Doshi
And so and what that means by that is you come into the emergency room or you come into a setting where there's something acutely happening.

00:08:41:39 - 00:09:00:49
Dr. Doshi
Right? We're worried about a brain bleed. We're worried about a stroke. We were worried about a fracture. So the AI, these are common things, are important things to identify early. The AI can be used to, look at the images and flag it and say, hey, you should look at me next. It's not at a point where it totally diagnoses it and says.

00:09:00:50 - 00:09:10:55
Leslie
so the scan, the patient gets a scan, the scans are done, the images are sitting there, and AI is looking through it and kind of triaging and putting it up for the radiologist to read. Correct.

00:09:10:58 - 00:09:14:19
Dr. Doshi
Correct. Yeah, yeah. It's exactly right. So if you have a work list,

00:09:14:19 - 00:09:25:00
Dr. Doshi
going, we're looking at scans, and scans are coming from a lot of different places. So if you can imagine if you had a work lists of 100 scans that you were looking at and that's your work for the day, how do you know which scan to look at first?

00:09:25:00 - 00:09:25:27
Dr. Doshi
You know, you

00:09:25:41 - 00:09:27:27
Leslie
Whichever was done first, I would imagine.

00:09:27:27 - 00:09:30:17
Dr. Doshi
you would. Right. You know, that's how we used to do it.

00:09:30:18 - 00:09:42:42

Dr. Doshi
So you just go sequentially where someone calls you and says, hey, this patient only has an issue. But now using the AI, the images can be sent to a server. The AI processes it and pushes it back to our, system.

00:09:42:47 - 00:09:44:33
Dr. Doshi
And then it allows the worklist to flag

00:09:44:33 - 00:10:04:33
Dr. Doshi
it and say, hey, look at this. Next we think it's there might be a hemorrhage or we might think there's a stroke. And so it gives us an opportunity to, to look at those images first, and then just beyond that, you know, when you're talking about, surgical planning and following up tumors and things like that, AI is really, start this is kind of the beginning.

00:10:04:33 - 00:10:25:16
Dr. Doshi
And a lot of innovation is happening around this where we can segment. So if you had a tumor, you would actually be able to, define the tumor and then the inflammation around the tumor. And you might be able to follow that over the course of three years. And then we can tell a patient, we can tell the doctor that, oh, this is actually getting a little worse over three years, or it's getting better.

00:10:25:21 - 00:10:28:50
Dr. Doshi
Or it's stable. And that can be helpful in the treatment management.

00:10:28:59 - 00:10:34:19
Leslie
Are you guys able to let's say the it's the AI is learning what normal is

00:10:34:17 - 00:10:34:32
Leslie
Right.

00:10:34:36 - 00:10:43:29
Leslie
There's normal normal variations. Are you guys able to while you're reading it tag abnormal so that the machine can learn over time abnormalities and learn from itself.

00:10:43:37 - 00:11:04:04
Dr. Doshi

Yeah. So a lot of that work was done initially. But as AI evolved, there are lots of different ways that engineers and people who are in the AI space can change images and create new images and train the images on that. So that's less of an issue nowadays, and we have much more of a pathway to to get those AI models trained.

00:11:04:19 - 00:11:29:26
Dr. Doshi
And, you know, the the FDA has cleared numerous, you know, I, related, algorithms for, for radiology. So all of this has kind of been trained and has been evaluated from a governing body to to really say, okay, this is okay to be in practice. So we're less doing the clicking of what is positive and negative.

00:11:29:31 - 00:11:45:42
Dr. Doshi
And, you know, a lot of the background is most of the AI companies are not coming to the radiologists, to the surgeons and saying, what is it that you need? You know, sometimes the AI is telling you something you may not need. We need to know there's a hemorrhage. We want to follow a tumor over time.

00:11:45:46 - 00:11:50:21
Dr. Doshi
So as they start to understand what we need, they're building tools for that type of thing.

00:11:50:45 - 00:12:08:08
Leslie
So we talked a lot about machine learning and AI. But another key phrase we hear about is BCI brain computer interface. So what's how do you transition from like acute problems and using technology into like the future of improvement. So like what is BCI.

00:12:08:10 - 00:12:20:28
Dr. Saez
So brain computer interfaces are technologies that are designed to read, activity from the brain and, affect some sort of, change or manipulate something, that is eventually handled by a computer.

00:12:20:28 - 00:12:40:28
Dr. Saez
So a classical example of BCI is motor BCI, in which patients, for example, with spinal cord injury, have, an intact brain that generates the motor commands that are necessary to reach and grasp and touch something. But that information doesn't get all the way to the muscles because the like them the the waist cut right there.

00:12:40:41 - 00:12:59:48

Dr. Saez
There's a, there's an injury. And so the information is still present in the brain. And if we can read it and transform it into a command that goes, to the muscles by passing it or some sort of, exoskeleton or something like that, then we can basically recuperate the function that's missing. By virtue of that injury.

00:12:59:48 - 00:13:08:07
Dr. Saez
Right. So, it's brain activity that's being read, and, and the computer is making sense of it to actually, effect those changes.

00:13:08:36 - 00:13:13:06
Leslie
How long have researchers and scientists been working on this technology?

00:13:13:23 - 00:13:38:25
Dr. Bederson
Well, the kind of technology that Doctor Science has been talk is talking about. It's been actively under research for 10 to 20 years. But I would step back a second and define brain computer interface a little more broadly. One of the things that Doctor Doshi was talking about is how a computer connected to an AI algorithm can help us interpret an image

00:13:38:25 - 00:13:41:26
Dr. Bederson
in surgery that's that can be quite useful.

00:13:41:26 - 00:13:54:46
Dr. Bederson
You know, imagine you're looking at a topographical map of a national park, and you would like to pick a route through the mountains and over streams and through forests. And you want to

00:13:54:46 - 00:14:13:36
Dr. Bederson
avoid the danger points, but you need to know, you know what? You're what you anticipate seeing. We do the same thing during every surgery. We have to identify on each scan for each new patient, the pathways that safely guide us to the tumor, where the tumor is in relation to the blood vessels, the nerves, and so on.

00:14:13:41 - 00:14:39:48
Dr. Bederson
AI has now helped us identify these objects or structures, and once that is done within seconds, we can then generate a map that we bring into the operating room. So in a sense that is a brain computer interface, because the brain of the patient is interfacing with the computer, the AI

interprets the image and helps me interface again with the patient's brain.

00:14:39:52 - 00:14:48:50
Dr. Bederson
As we go further and further down the path of BCI, we can start to interpret more than just the anatomy of the brain, which is what I was just talking

00:14:48:49 - 00:15:05:52
Dr. Bederson
about recently. We've more recently, in the past 10 to 20 years, we've gotten better in interpreting the electrical signals of the brain, knowing how those electrical signals underlie or control motor movement, speech sensation, seizures,

00:15:05:52 - 00:15:09:55
Dr. Bederson
whole host of normal functions, and abnormal function.

00:15:10:00 - 00:15:43:32
Dr. Bederson
And when we talk about BCI, now, one of the most important areas is interpreting the motor signals of the brain so that we can have output to computers or other structures. So it's a brain computer interface in the sense that the brain is creating signals. There's an electrical interface with the brain, a computer interpreting those signals. And now we're transmitting those to another computer that might be operating a Microsoft operating system or an Apple operating system to control a computer, for example.

00:15:43:45 - 00:15:44:20
Dr. Bederson
Does that make sense?

00:15:44:31 - 00:15:48:41
Leslie
Yeah. I mean, to me, hopefully it makes sense to everyone that was just listening.

00:15:48:43 - 00:16:17:35
Leslie
If not, they can come to the next symposium. But, what? So really, I mean, this just on a daily, everyday basis, this is what we do. So we're really using BCI every day. But when I think of BCI, I think of somebody who had like maybe a major stroke or a major neurologic condition and doesn't have function of a limb, and they're using some sort of BCI technology to function again.

00:16:18:01 - 00:16:27:29
Leslie

So how how long has that been going on where I know here at Mount Sinai where we're looking at this, how long is that been going? Where we're helping people with major illness

00:16:27:37 - 00:16:50:44
Dr. Bederson
was 10 to 20 years ago. And there have been patients who have been implanted for upwards of a decade, just a handful of patients. The original interface were very invasive, with needle electrodes implanted directly into the cortex and a, a platform screwed into the skull that then was attached to the surface, and, to a computer.

00:16:50:49 - 00:17:23:28
Dr. Bederson
Some of those patients are still going with those long term implants. Over the past several years. So one of the most important advancements has been in less invasive interfaces with the brain. Which I think is really interesting. You know, we've spoken and in our symposium about the two most interesting ones to me. One of them is called a stent road, which is, a set of electrodes implanted inside a stent similar to a cardiac stent.

00:17:23:33 - 00:17:55:54
Dr. Bederson
But now this is implanted in one of the major veins of the brain right next to the motor cortex of the leg. And those patients, have been taught to move their leg instead to operate a mouse because they're paralyzed, often with something like a degenerative disease like ALS. You also mentioned stroke. Doctor Sanders mentioned stroke. That's another use for brain computer interface, spinal cord injury, intracerebral hemorrhage.

00:17:55:59 - 00:18:13:28
Dr. Bederson
There's also BCI for speech problems, in people who have had certain strokes that render them unable to speak. But these are these are this is the common use of the word BCI motor BCI for stroke, ALS, spinal cord injury and speech problems.

00:18:14:20 - 00:18:21:36
Leslie
How close are we to achieving like real time movement or speech with these technologies?

00:18:21:43 - 00:18:51:06
Dr. Bederson
It's happening now. Patients who have been implanted with some of these speech reproducing systems have been able to generate computerized speech by thought alone. We have patients who have been implanted with the Synchro Stent Road who are currently able to communicate very well with a computer, who are completely paralyzed and unable to move their extremities.

00:18:51:11 - 00:19:03:25
Dr. Bederson
So it's happening now? I will say that these are all part of experimental protocols. And one of the biggest challenges going forward will be scaling this up in large scale clinical trials.

00:19:04:17 - 00:19:21:02
Leslie
Doctors say, is one of the most difficult parts of having an injury or a condition like this is having autonomy and being able to take care of yourself. Are these things providing that level of privacy and autonomy, or are they still reliant on other people, other people's helps?

00:19:21:08 - 00:19:42:09
Dr. Saez
Well, so far, like Doctor Bateson said, it's early stages, meaning, it's still clinical trials and the autonomy is not quite there yet. It's very fundamentally a goal of these interventions to restore autonomy for these patients, for example, so they can feed themselves or right, or more. But most importantly, communicate with others through computers and mouses and cursors and so on.

00:19:42:14 - 00:20:11:24
Dr. Saez
It's, it's it's not quite there yet, but, but it's fundamentally a goal. The, the I think you mentioned privacy. That is what you said. Yeah. Privacy. Yeah. So, so that's, that's that's kind of a whole other, aspect to these, to this whole thing because it gets into the ethical, mind frame of mind breeding. Right? Which is, are we is it legitimate and licit to go in there and basically listen to someone's thoughts in real time to do something useful with them?

00:20:11:24 - 00:20:14:07
Dr. Saez
Right. And this is one of those things that are going to

00:20:14:07 - 00:20:28:23
Dr. Saez
it's already happening and it's going to continue happening as we get better at it. And we are capable of building BCI to do not just, are not just capable of moving a cursor, but are, moving in the direction of something that's a lot more dense.

00:20:28:23 - 00:20:41:55
Dr. Saez
Like, can you read intentions, can you read emotions, can you read things? And some of those might be done for translational therapeutic purposes. Right. Because if you have, for example, a psychiatry condition and your mood is affected, you want to have a way to bring that facial back to normal.

00:20:41:54 - 00:20:54:15
Dr. Saez
Now what happens with that information outside of the clinicians and the patients and so on, is kind of a a growing concern, for the community of researchers and clinicians.

00:20:54:15 - 00:21:05:43
Dr. Saez
Right. Because you are actually tapping into someone's thoughts directly. Right. And so there's, there's there's a bit of a need for an ethical framework that is a pendant to all of these, to understand how to best use the technology.

00:21:06:07 - 00:21:13:29
Leslie
And how does that relate to neuroplasticity. Like, are these things something that only work when they're in use, or can there be some

00:21:13:26 - 00:21:18:22
Leslie
of movement in the direction of neuroplasticity, where the brain can learn from it on its own?

00:21:18:25 - 00:21:39:06
Dr. Saez
I, I think for the moment, the majority of, strategies and technologies that we use are not designed to leverage and or plasticity directly. Right? They're listening to brain activity and they're translating it into something that's useful in the real world. But you're absolutely right that the brain is plastic and it can change and it can adapt.

00:21:39:11 - 00:21:58:19
Dr. Saez
And in fact, many of the disorders that we care about are acquired disorders, right? We had a healthy brain. And for example, think about, PTSD. You have a healthy brain, and then something traumatic happens. And now you have someone who suffers from these devastating conditions. Right. And so that is plasticity. It's the kind of bad plasticity in a way, because there

00:21:58:19 - 00:21:59:19
Leslie
there's good and bad

00:21:59:19 - 00:22:22:25
Dr. Saez
There's things change. Right. And if they don't change in the in in if they change in a bad direction. Yes, that's that's about plasticity. So you can easily conceive an application of BCI that

is designed as a crutch to run the plasticity in reverse. Right. And say, okay, we're in a bad state. We're going to unlearn these or run this learning process in reverse and bring the brain back to normal.

00:22:22:30 - 00:22:25:59
Dr. Saez
That might be very well facilitated by some BCI applications, right?

00:22:25:59 - 00:22:43:34
Dr. Saez
We have a pretty good understanding of how plasticity happens in the brain at a cellular molecular level. So it is possible that we can use a device to say, okay, you have learned this thing. It's an association between, you know, a specific context or an object or a person and a feeling which is bad.

00:22:43:39 - 00:23:01:31
Dr. Saez
Can we actually undo that association? So you can experience those things and see those places and visit those locations and not have this really bad emotional response that could be very well done with the help of BCI technology. But really tapping into that neuroplasticity that you mentioned,

00:23:01:31 - 00:23:28:55
Dr. Bederson
just following up on this concept of intention and plasticity, we find that the patients who have had these species have to teach themselves how to use it. The BCI gets implanted and they don't know how to use it yet. Someone who's completely paralyzed, who has an electrode implanted near the leg area of their cortex, has to learn how to move his leg.

00:23:29:00 - 00:23:48:58
Dr. Bederson
In fact, he's. He said in order to move the mouse, I've got to kick my right leg out. That's how I do it. And then in order to click, I've got to stamp my foot down. Of course, neither his foot nor his hand, nor the mouse, are being moved by his body. But this is a form of plasticity in training himself to use a BCI.

00:23:50:18 - 00:24:07:51
Dr. Bederson
It's also relates to the point that you made, that it's really his intention to move his leg because he's not moving his leg. Right. So plasticity intention, this is all happening in real time right now with with BCI. One of the things I find the most interesting

00:24:07:51 - 00:24:18:39

Dr. Bederson
is reinterpreting what we call the homunculus, or the design of the cortex, particularly over, the motor and sensory areas that Doctor Synapse have been.

00:24:18:50 - 00:24:44:37
Dr. Bederson
And I have been working on with the implementation of high density cortical surface electrodes. We're discovering, for example, that there are individual cortical signatures for each finger, each finger movement. When we stimulate the fingers in the hand, we see that individual areas of the cortex light up, if you will, differently than we've ever seen before. So this is a field that's rapidly advancing.

00:24:44:42 - 00:25:01:50
Dr. Bederson
It's very exciting to see, where it's going to go. I'm very excited about what Ignacio has been talking about and reversing the bad plasticity. I feel like we're months, two years away from starting to unlock some of these secrets.

00:25:01:50 - 00:25:09:57
Leslie
He were talking about plasticity. People who have mood disorders, depression, PTSD, it's it's reversing. Bad behavior.

00:25:10:13 - 00:25:10:58
Dr. Saez
Right? I mean,

00:25:10:58 - 00:25:11:22
Leslie
intent,

00:25:11:20 - 00:25:29:38
Dr. Saez
Yes, exactly. Right. So like I said, those are acquired conditions. But fundamentally there's not a massive biological change that underlies those. It's it's a it's an experience. It's a it's something that you've lived through that has affected those changes. Some other brain disorders are kind of not like that. Right. Because the brain itself is damaged.

00:25:29:38 - 00:25:43:24
Dr. Saez
So for example, in Parkinson's disease, there's a there's a very well known degeneration that happens in a part of the brain dies. Right. And so that is going to be it's much harder to imagine that we can reverse that simply with plasticity. Right. So that's what I meant.

00:25:43:24 - 00:25:51:40
Leslie
what are the risks of these things like can patients get hurt by. Is it. You said it's like an implantation in the brain. What can go wrong.

00:25:51:43 - 00:26:15:14
Dr. Bederson
One of the most exciting things going on right now in the BCI world is the evolution towards less invasive types of implantation. I mentioned this ventral before. That's implanted through a needle into the vein and, that gets implanted. Fortunately, in the patients that have been implanted, there have been no major complications that I'm aware of.

00:26:15:51 - 00:26:31:57
Dr. Bederson
The other main technology we're using is the high density cortical surface electrode. And similarly, in the 10 to 15 patients that have been done, we're not aware of any major complications attributable to that electrode. But like any brain operation,

00:26:31:57 - 00:26:46:49
Dr. Bederson
there are going to be complications, possibility of hemorrhage, infection, stroke exists with any brain surgery. At the moment, we're only implanting these electrodes in patients who need surgery for another reason.

00:26:46:54 - 00:27:01:59
Dr. Bederson
And there thereby, you know, that's a much safer way of testing these. As the FDA improves, approves longer durations of implementations, we'll be on the lookout for any, you know, any possibility of complications.

00:27:02:27 - 00:27:25:03
Leslie
I've worked with you about ten years now, and I've seen you and other of your teammates do incredible things, and you're very capable as these things come out to the masses. That means a lot of neurosurgeons need to learn how to do this. I mean, how long is that going to take for people to learn how to do what you're doing?

00:27:25:48 - 00:27:57:13
Dr. Bederson
I think we have to specify the protocols and simplify them right now. It's a very bespoke process, in which it's a very detailed experiment using all the resources of a laboratory. Like doctor says his lab, a fairly big team of neuroscientists involved in each implantation over time, as with all

the other treatments that have evolved, these will simplify, and we'll come up with the protocols that make it more accessible.

00:27:57:18 - 00:28:20:37
Dr. Bederson
In fact, accessibility is going to be one of the really thorny issues. How do patients get access to the future BCI paradigms? Who will pay for those? These are these are issues that we're working now very closely with the FDA. And the FDA has been very supportive of our efforts. So I'm hoping we see progress over the next few years.

00:28:20:43 - 00:28:28:26
Leslie
How long do you think it will take for this to be available to patients who need it? You know, across the United States.

00:28:29:00 - 00:28:31:53
Dr. Saez
I would say months to years.

00:28:31:52 - 00:28:50:36
Dr. Saez
I mean, the technical issues that we're facing right now, like the person was saying, do require a large number of people working in the room, but that can be streamlined with a talented neurosurgeon in some, in some assistance. I think potentially the the thornier issue is what is the use for these biggies.

00:28:50:36 - 00:29:14:44
Dr. Saez
Right. And we covered the kind of classical use which is motor, restore restoration of, of damaged motor control. And, and that's one particular application that that's been well known and well exploring. We still have gains to make, but I think, part of the pathway towards widespread application is to find new uses for this technology. And the technology itself is very flexible.

00:29:14:44 - 00:29:22:31
Dr. Saez
Right. We're going we're trying to listen to, activity from the brain and make sense of it. That's the fundamental of BCI right

00:29:22:31 - 00:29:38:02
Dr. Saez
brain activity and a computer that helps us interpret and helps us do something useful with it. Motor and and speech control are two fundamental processes that are affected in some

diseases, but there's many others that are in dire need of cures and interventions and so on.

00:29:38:02 - 00:29:49:54
Dr. Saez
Right. So I think part of the challenge, to deploy these to the general, public in general clinical use is to find ways in which we can effectively use that technology. Right.

00:29:50:14 - 00:30:11:19
Leslie
Well, that's what we learned at the symposium. At the end of the symposium, we had two speakers that I thought were great. One, it was Medicare and the other one from the FDA. And one of the things that we learned is in order to get this, to make this available to people, for it to be FDA approved and paid for, typically there'd have to be precedent.

00:30:11:19 - 00:30:22:53
Leslie
So in this situation, there is precedent because there's been brain implants before, right? So is it more precedent of what the procedure is or precedent of the diagnosis for the reason that we're putting it in?

00:30:23:55 - 00:31:02:36
Dr. Bederson
It’s both. And also we have to demonstrate efficacy. Yeah. We had two fascinating speakers, one from the FDA, who is helping us understand the regulatory needs, to make this possible, to implant for longer durations of time. And the other was from the center, the CMS, the center for, Medicare, Medicaid Services, Medicare and Medicaid Services, they I felt like they're both on the side of the patient really trying to help us navigate waters that will bring this technology more rapidly and very safely to the patient.

00:31:03:45 - 00:31:32:33
Dr. Bederson
And both of the issues you raised are going to be very important. What is the invasiveness and safeness safety of the procedure and then how efficacious is it? They spoke a lot about what is reasonable. What is reasonable for, a government to pay for. Are you going to pay for someone who can barely, you know, move a mouse around?

00:31:32:38 - 00:31:45:11
Dr. Bederson
Millions of dollars? Maybe not. But if you develop technology that allows them to fully use a computer operating system and it costs much less, then maybe that is something that can be approved.

00:31:45:12 - 00:31:51:37

Dr. Bederson
So it's a pretty complicated game that we're we're all working together to solve this, these problems.

00:31:51:43 - 00:31:57:30
Leslie
And there's a lot of players in this. So research development neurosurgeons

00:31:57:31 - 00:31:59:55
Leslie
FDA I mean who are all the players

00:31:59:53 - 00:32:01:58
Dr. Bederson
most important player is the patient

00:32:01:58 - 00:32:02:30
Speaker 4
Yeah

00:32:02:28 - 00:32:29:05
Dr. Bederson
by far. And that's something that I'm sure I know that we all reacted to pretty strongly during our symposium. There have only been a handful of patients in the entire world who have had brain computer interfaces implanted right now, and these are really the heroes, they're undergoing procedures that may not be as fully tested as, as many other medical procedures.

00:32:29:05 - 00:32:29:37
Dr. Bederson
And

00:32:29:37 - 00:32:38:04
Dr. Bederson
many times they're, you know, suffering from dire illnesses. We heard from several paralyzed patients who had had BCI.

00:32:38:03 - 00:32:58:38
Dr. Bederson
So you mentioned those players, all of which very important. The other one to mention is industry, two of the most important industries are at Mount Sinai. And really, this has been a partnership between academia and industry in funding the research that will drive this forward.

00:32:58:38 - 00:33:08:07

Leslie
So we're really lucky here in New York that we have access to literally everyone how to at Mount Sinai, how do we bring all of that together in order to advance this field?

00:33:08:19 - 00:33:18:37
Dr. Bederson
It's a wonderful question. And, you can see even in this room, we have three people from different fields working together to solve these problems.

00:33:18:38 - 00:33:39:02
Dr. Bederson
One of the issues that we faced early on was the seeming separation between industry that drives so much of the advancing technology and academic medicine. You have experts like myself in neurosurgery. You have scientists, from many, many different fields.

00:33:39:07 - 00:34:13:54
Dr. Bederson
How do we get those together with industry? In the neurosurgery department, we created Sinai Biodesign. And the idea of biodesign is to co-locate engineers, surgeons, scientists, the legal framework and the experimental, the experimental framework so that we can solve our patients medical problems by developing new technological solutions that bring value to the patients and train the next generation of entrepreneur scientists.

00:34:14:09 - 00:34:17:46
Leslie
So it's like a onsite medical device incubator.

00:34:18:05 - 00:34:28:17
Dr. Bederson
It is. That's almost exactly what it is. Although in addition to the incubation of new ideas, technologies and patents and companies,

00:34:28:18 - 00:34:55:14
Dr. Bederson
we're also partnering with major industry partners such as Stryker, like, hopefully Medtronic and others. These are major industry players who have technology, and we would like to provide a safe but much easier method for them to have access to clinical trials that are done under the rigor of an academic medical center.

00:34:55:19 - 00:35:16:03
Dr. Bederson
At the same time, we would like to have our surgeons get access to engineers, sometimes from industry, sometimes embedded within bio design, so that they can bring their problems to our

engineers and we can back and forth iterate solutions that might take much longer if we didn't have everything located in bio design.

00:35:16:46 - 00:35:20:24
Leslie
So what's the difference between bio design in your lab?

00:35:20:23 - 00:35:24:07
Leslie
Like what are you guys do that's similar, and what do you guys do that's different?

00:35:24:07 - 00:35:28:17
Dr. Saez
So we are an academic lab, right? And so

00:35:28:17 - 00:35:46:50
Dr. Saez
we have ties with industry and we care about regulations and so on. But really our fundamental goal is the production of new scientific knowledge, new ways to understand the brain and new therapies that we can apply to to patients. Now we are a player in the bio and bio design infrastructure, right?

00:35:46:50 - 00:36:08:49
Dr. Saez
We're one of those key components, together with the clinicians and the engineers and industry and so on and so forth. And so that's that's kind of a a very fruitful interaction, which I personally found really fun because we all come at the same problem with slightly different, lenses. Right? And we attack it from different angles, which makes it very interactive and kind of intellectually stimulating.

00:36:09:23 - 00:36:31:41
Dr. Saez
I see it as my job to think about the more conceptual issues. Right. What is it that we're trying to do, and how can we do it with the tools that we have our disposal? If we have a problem that does not have the right, that we don't have the right tool to attach to attack, then maybe we can, in the context of by design, go to the engineers and say, hey, I really need something that does these.

00:36:31:47 - 00:36:49:04
Dr. Saez
And so it becomes a virtuous cycle of interaction between, you know, more conceptually driven and more implementation because I couldn't design a new set of electrodes. Right. That's not what I do. And if if I go to the engineers and they are able to design a set of electrodes, they do

something in specific. That's that's amazing.

00:36:49:04 - 00:37:11:47
Dr. Saez
It allows me to do the experiments, generate knowledge. It can also be potentially communicated to industry or leverage, as a startup or like there's a whole ecosystem of all these different players. And, and we all have our roles to play. But yeah, I think I think my, my place is on the scientific and the kind of looking forward side, of things.

00:37:11:47 - 00:37:12:21
Leslie
Right. And I could.

00:37:12:22 - 00:37:16:32
Dr. Bederson
give you a really cool example that came from Ignacio s lab.

00:37:16:32 - 00:37:17:43
Leslie
I'd like to hear it.

00:37:17:42 - 00:37:19:52
Dr. Bederson
We

00:37:19:52 - 00:37:44:29
Dr. Bederson
we were all together in the operating room doing one of the first, in fact, the first ever, temporary implantation of for high density surface electrodes. So we had 4000 electrodes on one of my patients, brains, spanning the motor and sensory cortex.

00:37:44:34 - 00:37:50:38
Dr. Bederson
This is the first time we've ever recorded from that many electrodes at one time in a living patient.

00:37:50:38 - 00:38:02:51
Dr. Bederson
it scientists in Ignacio s lab and have really brilliant grad student named, Ali, has been helping us interpret the signals that we obtained that day.

00:38:02:51 - 00:38:06:28
Dr. Bederson

And what she has done is to create a pipeline.

00:38:06:43 - 00:38:36:38
Dr. Bederson
What she calls is a pipeline. And what that is, is a series of analyzes that take the data, the raw data that we obtained in the operating room and process it in a way that makes it meaningful. And this is where I ultimately will come in, because right now we have brilliant scientists who are interpreting the data and helping us understand the precise transition fabric, for example, from the motor cortex to the sensory cortex and between the different areas of the motor cortex.

00:38:36:43 - 00:38:46:45
Dr. Bederson
This takes weeks, if not months, of detailed analysis, but she's creating a pipeline that will allow us on the next case, which could be next week for all I know

00:38:46:45 - 00:38:52:52
Dr. Bederson
to now process in days rather than weeks or months. So you see

00:38:52:52 - 00:39:05:46
Dr. Bederson
Biodesign bringing in the company that creates the electrodes, the neurosurgeon having the relationship with patients so that they have a trusting enough relationship that we can safely put these electrodes on.

00:39:05:46 - 00:39:11:53
Dr. Bederson
And the science, from Doctor Ignacio lab that allows us to interpret the results.

00:39:11:53 - 00:39:27:32
Leslie
And from my own personal experience, I mean, I'm usually the one asking the patient, hey, can we do this? You know, we're getting ready to do a surgery on you for X condition. We're going to be making this opening. We're going to be there anyway. Hey, would you let us do this thing so we can learn for someone else?

00:39:27:32 - 00:39:28:54
Leslie
It has nothing to do with you

00:39:29:14 - 00:39:38:04
Dr. Bederson
What is your experience been with patient? What has your experience been with patients who

are trying to decide whether to volunteer for this?

00:39:38:04 - 00:40:02:40
Leslie
don't think I've ever come across a patient who, as long as you present it transparently and appropriately, and I think the way that I do it seems to work because I very rarely get to know what I say is, hey, listen, the reason we're able to offer you the surgery that we're doing with the advanced digital technology, neuro navigation and with the skills he has is because people hundreds of people, before you agreed to let us try something,

00:40:02:40 - 00:40:04:01
Leslie
we're asking you.

00:40:04:01 - 00:40:18:05
Leslie
This is not going to help you there. We've already learned what we need to help you. But in the future, whether it's a year or ten years from now, there's information that we're going to learn from what we're about to do that's going to help hundreds of other patients. Will you let us do this? And everyone says, yes,

00:40:18:03 - 00:40:20:38
Leslie
and, you know, I'm not promising anything extra.

00:40:20:38 - 00:40:26:37
Leslie
I'm just saying, like, listen, this is for the future of of neurosurgery. And I don't think people say people don't really say no.

00:40:26:42 - 00:40:27:19
Speaker 5

00:40:27:19 - 00:40:43:33
Dr. Saez
Yeah it’s amazing. I, I've had that experience many, many times with I work with patients in the epilepsy monitoring unit and it's the exact same thing. Right. These are patients that are going through surgery. It's not the best time in their lives. They're usually, you know, anxious about the whole procedure as any any human being would be.

00:40:43:46 - 00:40:50:55
Dr. Saez

And they have this immediate, generous and selfless response of, I'm here because someone volunteered 10 or 20 years ago. So

00:40:50:55 - 00:40:54:14
Dr. Saez
it is kind of my duty to do it. So the next generation of patients benefits from it.

00:40:54:20 - 00:40:54:21
Speaker 1
I

00:40:54:21 - 00:41:00:29
Leslie
do say, Will this help me? And I'm like, absolutely not. It will not. And they're like, okay.

00:41:01:01 - 00:41:22:30
Dr. Saez
I wanted to touch on, kind of elaborate a little bit on some of the betters and said about the, the amount and quality of the data that we're getting through these neurosurgical interventions because, human neuroscience has kind of exploited over the last 10 or 20 years. And one of the reasons is because we've been recently able to measure the activity of the human brain, and in the vast majority of cases, that is done non-invasively.

00:41:22:30 - 00:41:34:49
Dr. Saez
Right? We bring a human participant, we put them in the scanner, and we take images of their brain, and we try to understand what's going on. Or we do, EEG, electroencephalography. And that gives you some measure of brain activity.

00:41:34:49 - 00:41:46:32
Dr. Saez
But the difference between those noninvasive measures, the quantity and quality of data and the quantity of quality of data that we get in doctor betters homes or when we operate there is just night and day.

00:41:46:53 - 00:42:06:27
Dr. Saez
Imagine. So I like to use this analogy. Imagine the brain as an orchestra of different, you know, cells and brain regions that are trying to do the thing, and they're kind of generating a symphony. When you're doing this noninvasive, when you're using these noninvasive techniques, it's it's equivalent to going through the med opera house and kind of sitting outside and listening to the muffled symphony.

00:42:06:41 - 00:42:29:08
Dr. Saez
And you maybe can appreciate the tempo and the intensity, some very vague and diffuse measure of exactly what's going on. Looked at the doctor better. Something is doing. And and that experiment that he mentioned is actually kind of a world record for the number of electrodes implanted in the human brain is he is positioning over four thousands of these electrodes directly onto onto the brain of these participant.

00:42:29:08 - 00:42:33:47
Dr. Saez
And you literally are sitting in the middle of the orchestra and

00:42:33:47 - 00:43:03:54
Dr. Saez
you're listening to the nuances of the different instruments, and you can, you know, someone who's sitting next to, to the brass, portion versus someone with the percussion, like you're going to start seeing all sorts of nuances, some of which are kind of impossible to anticipate, like we don't fully know what we're going to see because we're moving from a very limited, very diffuse, picture of brain activity to these highly dense and rich and amazing activity that is also changing through time very fast.

00:43:03:54 - 00:43:04:29
Dr. Saez
Right?

00:43:04:29 - 00:43:24:36
Dr. Saez
So imagine, another analogy is, you know, when we used to have screens that were small in the early cell phones, which had like 15 pixels or whatever, right, like a very limited amount. And now you have your 4K TV at home. You're still seeing an image. Is it the same ID? Is it the same image? Well, to some extent it is, but really it is.

00:43:24:36 - 00:43:34:20
Dr. Saez
And I mean the nuance, the depth, the complexity that you're going to see is completely new and improved. Right? It's the same, with, with these surgical interventions.

00:43:34:20 - 00:43:51:32
Leslie
Do we ever see a world where all of this information that they're learning from being on the brain directly, where that then field feedbacks to you with like right now, like when you look at the brain, you're looking at gross anatomy. Right. And there are some things that you can do with like dynamic sequences or flow movement. Right.

00:43:51:32 - 00:43:56:52
Leslie
But you're not looking at electrical but with like DTI, when you're looking at tracks,

00:43:56:52 - 00:44:04:48
Leslie
instead of having it be like a general idea of what we think that is that can come into reality. Does that possible?

00:44:04:46 - 00:44:11:15
Dr. Doshi
And I mean, a lot of work has been done in and not specific electrical but functional. Right. So,

00:44:11:15 - 00:44:27:12
Dr. Doshi
we typically think about imaging, and its origins are really around, you know, structural imaging like an anatomy, you know, where specific parts, you know, if you're looking at the brain, what specific parts, you know, where they're located, how pathology affects those.

00:44:27:12 - 00:44:30:24
Dr. Doshi
You know, how diseases affects those. So we're really just seeing,

00:44:30:24 - 00:44:48:14
Dr. Doshi
one point in time. Right. But for years, I mean, ten, 15, 20 years, you know, we've had a lot of opportunity and innovation on things like functional imaging. I think that's what you were talking about, you know, is, is and it's able to really look at, a bunch of different things.

00:44:48:14 - 00:45:00:58
Dr. Doshi
You know, one is to look at just how the brain activity works, you know, where blood flow is going to, and then you can ask patients to do specific tasks. You can also do it leverage like they don't do tasks. They just think of something.

00:45:00:58 - 00:45:07:57
Dr. Doshi
And you know, theoretically the blood flow to that area should increase, and we can leverage MRI techniques.

00:45:08:02 - 00:45:08:58
Dr. Doshi

Because of the advancement.

00:45:08:59 - 00:45:11:18
Leslie
Is there like a special radio tracer you have to give

00:45:11:19 - 00:45:12:45
Dr. Doshi
Know there's nothing actually,

00:45:12:45 - 00:45:13:00
Dr. Doshi
you know.

00:45:13:01 - 00:45:14:18
Leslie
It's just blood flow. Blood flow?

00:45:14:20 - 00:45:15:21
Dr. Doshi
It's essentially blood flow.

00:45:15:22 - 00:45:26:12
Dr. Doshi
And what happens with that is you really are able to see the activity, you know, relative to the other activity in the brain. So it really looks at like, you know, one area that's kind of lighting up compared to the rest of the brain.

00:45:26:11 - 00:45:32:32
Dr. Doshi
And so that's how you can kind of tell if somebody is using part of the brain for a specific task or specific thought.

00:45:32:36 - 00:45:34:24
Dr. Doshi
And then you can use all this information

00:45:34:24 - 00:46:01:12
Dr. Doshi
with that, with, you know, the advances in MRI and with, the ability to do higher resolutions and even leverage that technology, you can pinpoint even really detailed like really to to a smaller area of where you want to go. And when you get that resolution, then it helps with, you know, identifying areas, really that either for treatment, you know, of course, for, for functional things,

you know, for functional, analysis.

00:46:01:17 - 00:46:10:02
Dr. Doshi
So there's been a lot of excitement around that. And the technology is, is definitely going to move towards being able to do that a lot more noninvasively as well.

00:46:10:19 - 00:46:28:16
Leslie
You know, one of the reasons that we have this podcast in here at Mount Sinai Health System is we get to interview specialists in their field who have devoted their life and their career not only to patients, but to the future. And like, I live in your world and I am blown away about by what we can do.

00:46:28:16 - 00:46:34:25
Leslie
And it even here in New York City in the tri state area, there are things that we offer that other institutions. So,

00:46:34:25 - 00:46:47:16
Leslie
I mean, I send people for scans that live in other states, and I ask them just to do like one simple sequence and they can't do that, let alone, I mean, fMRI you've been doing for a while, but even the next steps really are only offered at major institutions that can do all of this.

00:46:47:20 - 00:46:57:13
Dr. Doshi
Yeah, and I'll just comment on that. You know, I think it's a real, tribute to people like Doctor Patterson, you know, and our, subspecialists. I mean, we have extremely, highly skilled,

00:46:57:13 - 00:47:09:31
Dr. Doshi
surgeons and, you know, medical professionals, and patients come for that, you know, they comes. That's where it starts with, because of the skill that they have, the training that they put themselves.

00:47:09:31 - 00:47:24:31
Dr. Doshi
I know doctor medicine. Has it gone across the world to train, you know, and he's brought everything back to Mount Sinai, and he's trained numerous, individuals under him that are extremely talented, that have stayed at Mount Sinai. So I think that says a lot about the people that are here that brings the patients,

00:47:24:30 - 00:47:29:33
Dr. Doshi
and then it's a trickle down, you know, what happens is then we are then required.

00:47:29:33 - 00:47:43:51
Dr. Doshi
We have to then have a certain level of, you know, refinement in how we look at things and how we deliver care. And that may be from, you know, just purely how we deliver care, in the hospital, but also on the imaging side, you

00:47:43:51 - 00:47:48:31
Dr. Doshi
know, we have to have the best equipment. We have to make sure we have the best all the sequences.

00:47:48:36 - 00:48:10:44
Dr. Doshi
If, if it's helpful for doctor medicine, we have to have a relationship with Doctor Bettison and his team to do the appropriate imaging sequences. That's why you might not see five sequences. You see 15 sequences because that's going to give him the information that he needs. It also helps the radiologist to. As a radiologist, I feel like I have learned so much from just seeing all these images.

00:48:10:44 - 00:48:28:34
Dr. Doshi
The complexity that comes through, it makes me a better neuro radiologist. So when I see complexity, I'm less fearful of actually looking at it and figuring out what it is. And I have this open line of communication with my surgeons with, you know, the specialist and I can have these discussions and say, what's going on with the patient?

00:48:28:36 - 00:48:34:28
Dr. Doshi
What can we do? You know, what is help me figure out what's going on with the patient. I can help them figure out what's going on with the patient.

00:48:34:28 - 00:48:46:53
Dr. Doshi
And I think, it's a, you know, as you said, ecosystem. I think that's a great word. It's this ecosystem that really drives that innovation, that really the innovation is driven because we're all trying to have the best patient care as possible.

00:48:46:53 - 00:49:01:20
Leslie

had I had Dean Charney on here recently and, he was telling me, I asked him what's made what has made you so successful? And he said that I choose to work with people who are passionate, dedicated and want to keep learning.

00:49:01:20 - 00:49:08:13
Leslie
And you said that you know, him being our leader. When I came to work with him, I had no idea what I was in for.

00:49:08:18 - 00:49:14:54
Leslie
When he sits there and he, like, pulls his glasses down and starts thinking, I have to get my pen ready because I'm like, up, here we go, here comes a new project.

00:49:14:57 - 00:49:22:35
Leslie
but it's true. I never in a million. First of all, I didn't ever think I would be good at reading scans. And now I see a patient.

00:49:22:35 - 00:49:34:19
Leslie
I think it might, you know, I'm like, oh, that might be a cavernous. Let me get a good swan sequence on them. The fact that I know the difference between, like, how Gary is related to Swan and what everything is like in a million years, I never thought as a Pi I'd be able to do that.

00:49:34:18 - 00:49:40:58
Leslie
But he expects people around him to be the best because we need to keep catching up to him, because he keeps creeping along.

00:49:41:02 - 00:49:54:53
Leslie
And and he's one example of a surgeon like this at Mount Sinai. I mean, in my opinion, the best. But that's the beauty is we all get to work. And in an ecosystem like this where we have people who expect that.

00:49:55:05 - 00:49:58:23
Dr. Bederson
Meanwhile, I thought all this time patients were coming to see you.

00:49:59:47 - 00:50:10:36
Leslie
But that see, I'm part of what I bring to the table is part of the ecosystem, too, you know, there's

the smile and the reassurance and the detailed workup, you know, knowing how to get everything that we need to be successful.

00:50:10:34 - 00:50:20:22
Leslie
I think it's all really important. And it's incredible that we where everything that we just talked about today is absolutely incredible that that's on the docket and what we're moving forward.

00:50:20:25 - 00:50:35:00
Leslie
One of the things like, literally, the reason we have this podcast is to give the real information from the experts who do this, because a lot of people find their information from Facebook chats. Are you concerned about the misinformation regarding BCI? Is there are issues about that?

00:50:35:56 - 00:51:07:23
Dr. Bederson
I'm sure there's always misinformation out there. One of the things I've heard people worry about is whether a BCI implantation can read your mind or influence your thoughts. We've heard about people who believe they've been chipped, for example. And there are implications that somehow BCI can transmit your thoughts elsewhere. Can, spy on your mind or can somehow influence what you think?

00:51:07:28 - 00:51:42:32
Dr. Bederson
My experience so far has been there's nothing even remotely like that at the moment. We don't even know what thinking is. Frankly, what we what we see when in electrodes implanted are activation of individual electrodes. And we're trying desperately to put together what some of that information, even means. We're quite focused, as you heard, on motor BCI, which is interpreting the brain signals to affect motion or to operate an operating system or to speak.

00:51:42:37 - 00:51:58:49
Dr. Bederson
Yes. There's intention, as we discussed earlier, the intention to kick a leg translated to move a mouse, but not intention in the sense of am I intending to steal something or do something bad, or have bad thoughts.

00:51:58:49 - 00:52:15:46
Dr. Bederson
what we're really focused on is trying to help people with very dire problems. You don't put a BCI in a patient who doesn't have a very serious problem. They must either require a brain operation or have something that's devastating to them.

00:52:15:50 - 00:52:26:59
Dr. Bederson
So we're trying to help people with the gravest of conditions. Certainly there's no implication of controlling thought or ability of even being close to that.

00:52:26:58 - 00:52:38:11
Leslie
I feel like I think this regularly, especially in my own household. Like, use your whole brain. Like, how much of our brain do we actually use? We have a I mean, I feel like I have a pretty big brain. How much of this is my actually using every day of it?

00:52:38:11 - 00:52:57:37
Dr. Saez
All of it. Maybe not all of it at the same time. All the time. Right. Because there's specialization. There's parts of the brain, for instance, that are active. When you're looking at something, there's parts of the brain, they're active when you listen to something or when you move, and so on and so forth. So at any given point in time, it might be true that you're engaging 10% of the brain areas to carry out any specific behavior.

00:52:57:52 - 00:53:25:00
Dr. Saez
But think about it. Evolution is highly, highly, highly optimized. And what I mean by that is that brain tissue is very expensive energetically. Right. You use about 25% of your energy just to feed your brain. And that is unusual because either animals don't use that much energy to feed our brains. Right. So we have to really have a really strong evolutionarily advantage to keep this very expensive piece of tissue around.

00:53:25:04 - 00:53:41:10
Dr. Saez
And, you know, we don't have that problem anymore. But, evolutionarily, your problem that you face on a day to day basis is getting enough energy to make it to the next day and survive. And a lot of energy is consumed by your brain. You better have a good reason to have a brain in the first place.

00:53:41:15 - 00:53:58:01
Dr. Saez
So we do have a lot of good reasons to have brains. The way I think about it, one fundamental reason to have a brain is to generate behavior that helps you survive, pass on your genes, and so on and so forth. Right. If a piece of brain is redundant or is not doing anything, it will be lost in evolution.

00:53:58:06 - 00:54:09:31
Dr. Saez

Every single piece of your brain has a specific function. Do we understand what every piece of the brain is doing at any given point in time? Maybe not yet, but there's really very likely a very good reason why everything is in

00:54:09:35 - 00:54:28:54
Leslie
So as a surgical neurosurgery, we often use the term eloquent and non eloquent brain. Right. So if a patient comes in and has a big tumor, let's say, you know, a right frontal tumor compressing or involving a lot of brain, we're probably a little bit less worried about that than something in occipital. And that's because maybe this is more eloquent.

00:54:28:54 - 00:54:31:35
Leslie
So can you describe the difference between eloquent and not eloquent?

00:54:31:36 - 00:54:50:54
Dr. Saez
Absolutely. I think, you know, I think all of cortex is useful. But some of it is more visibly useful than other parts. Right. So, for instance, I know one doctor Bitterman, does tumor resection surgeries. He. And you help him do those. He has to be very careful to not resect parts of the brain that, for instance, control the movement of your hand.

00:54:51:05 - 00:55:07:50
Dr. Saez
Right? You resect it out, and then suddenly the patient can move their hand. And so that is a very grave deficit that you've induced through the surgery. Right. So that's what we would be traditionally called eloquent cortex. And eloquent just means in this context, we know exactly what this piece of brain is doing. And if you remove it, you're going to cause a deficit.

00:55:07:55 - 00:55:26:19
Dr. Saez
So it's very easy to understand. Eloquent cortex. For pieces of the brain that have very clearly sensory or motor functions. Right. If I, if I take this piece of brain out, you can't move your hand. If I take this piece of brain out, you can't understand language. If I take this piece of brain out, you can't hear anymore.

00:55:26:24 - 00:55:54:11
Dr. Saez
Those are very obvious deficits, right? That we constantly test our patients for in the context of tumor resections. But going back to my earlier point, I think it's unlikely that there's any part of me that doesn't do anything right. But it might not be that visible. And so, for example, historically, the prefrontal cortex, which is the frontal part of your brain, which is really developed in humans with compared when compared to monkeys and even rodents and other mammals.

00:55:54:16 - 00:56:11:00
Dr. Saez
That's been kind of a mysterious part of the brain because it's unclear what it does. We don't really know. You can have a lesion in the prefrontal cortex, and it might not be immediately obvious what's happening to you. But as we learn more in advance, our understanding, you start realizing, oh, you know, this patient actually is different.

00:56:11:24 - 00:56:12:50
Leslie
Or they are acting different.

00:56:12:50 - 00:56:17:00
Dr. Saez
They're acting different and you're very close to the patients. You notice that very

00:56:17:00 - 00:56:18:36
Dr. Saez
very, very clearly.

00:56:18:36 - 00:56:23:23
Leslie
I sometimes feel like I don't meet my patients until months after surgery because you're meeting a totally different person,

00:56:23:23 - 00:56:36:20
Dr. Saez
Right. So how would you describe that? Because, you know, when you when you're very careful with eloquent cortex versus unknown eloquent cortex, sometimes you can change something that is not that obvious. And it's subtle, but you pick up on it when you talk to them.

00:56:36:20 - 00:56:36:37
Speaker 1

00:56:36:37 - 00:56:54:09
Leslie
The biggest ones are frontal and cerebellar. Right. So there are surgeries that we do where we know there's either a lot of compression of the frontal lobe or cerebellum. And to avoid post-operative swelling we'll remove some of the frontal lobe or some of the cerebellum for the cerebellar patients. I tell them you you'll probably be fine.

00:56:54:09 - 00:57:13:18

Leslie
You're going to have some balancing coordination issues after surgery. It might linger a little bit longer if we have to remove a little bit more for approach for frontal lobe. We don't ever I don't really ever see that much of a change if we have to remove a little bit for an approach. But for someone who had significant compression before surgery and then we do a decompression.

00:57:13:27 - 00:57:35:53
Leslie
I mean, I have patients who I, I actually shared a story here recently. I've had patients who are depressed, angry. I mean, they, they they gain a lot of weight. They won't go to the gym. I had a lawyer who was getting fired from his job. And next thing you know, we find this big tumor. All the swelling comes down afterwards, and this, like, happy, motivated person.

00:57:35:53 - 00:57:50:32
Leslie
So it really the it leads to this frontal ability, this these emotional and decision making changes that I swear these patients are completely different people 3 to 4 months after surgery than when we first started.

00:57:50:32 - 00:57:51:36
Leslie
Yeah. It's amazing.

00:57:51:36 - 00:57:54:46
Dr. Doshi
I was going to say also if you look at like just stroke, right.

00:57:54:46 - 00:57:55:06
Dr. Doshi
Like, yeah,

00:57:55:06 - 00:58:06:03
Dr. Doshi
like, you know, when we look at stroke in a patient comes to the emergency room with the stroke, it's much easier to say this is a patient with a stroke if they have a very, specific deficit,

00:58:06:03 - 00:58:06:31
Dr. Doshi
Right?

00:58:06:31 - 00:58:09:35
Dr. Doshi
an issue with moving their arm, they can't speak.

00:58:09:40 - 00:58:29:59
Dr. Doshi
And then you're really concerned that, okay, there's a stroke because we can localize where where that is, is to what you were saying. And, you know, versus the inability to walk or like, you know, tripping or something or a personality change, the same pathology, same thing can be happening in the brain, a stroke or tumor or mass, as you were saying.

00:58:30:04 - 00:58:50:45
Dr. Doshi
But it's not as clear. So that's where the imaging obviously helps very significantly in really identifying what the underlying causes. And, and you can imagine as you're treating these people, if you have a very clear deficit, then you're triggered to say, okay, this is what I want to do. I want to do the imaging. I have a good idea of what's going on.

00:58:50:49 - 00:58:57:16
Dr. Doshi
If it's the other thing is a non eloquent and, you know, personality changes, it's very difficult to know what the next steps are.

00:58:57:16 - 00:59:02:28
Leslie
Yeah. Families are like oh we just thought grannie was becoming mean. You know.

00:59:02:28 - 00:59:07:38
Leslie
And it may and sometimes that's the case but it might not be you.

00:59:07:38 - 00:59:22:35
Leslie
So we talked about eloquent, not eloquent, but even eloquent. There's more of a breakdown. So eloquent can mean vision hearing, seeing, moving. So like what is the difference between those tissues. Like the tissues that give you vision versus speech?

00:59:22:52 - 00:59:43:40
Dr. Saez
Well, at a cellular level, not much really. The brain is highly modular. Cortex is actually, you can think of a little motif about a centimeter, sorry, a half a millimeter, square in diameter column that is repeated throughout the brain. So you have a lot of copies of the same thing. And then the trick is how they're connected.

00:59:43:45 - 00:59:57:35
Dr. Saez

Meaning what kind of information flows into a region of the brain and where it should send to. Right. So, for example, sensory parts of the brain, your occipital cortex, which is in the back of your head and is the part of the brain that processes that vision, receives input from the retina.

00:59:57:35 - 01:00:00:26
Dr. Saez
So light comes in through your eyes, hits the retina, it's send there.

01:00:00:31 - 01:00:16:22
Dr. Saez
And so it receives that type of information, and it processes it. And it is very highly eloquent because we know that's the kind of information that it's doing. I like to think of it this way. Things that are very close to the external world are much easier to study in the brain, and nothing is easy, but easier, right?

01:00:16:22 - 01:00:36:52
Dr. Saez
What do I mean by that? If you put someone in this country and you present a bunch of tones and you, you give them auditory stimulation, their auditory cortex is going to light up and you're going to go like, oh, eloquent cortex, that is processing auditory information. You can do the same thing with a visual stimulus and so on and so forth, because it's kind of the first step in the brain that processes this information.

01:00:36:57 - 01:00:56:34
Dr. Saez
And it's easy to elicit that response because you have pretty good experimental control over how to do these. That's going in going out of the brain. You have motor control. And it's kind of similar in the sense that I can ask a patient to move, you know, make a fist, punch or grasp something. And, and the motor cortex will light up.

01:00:56:39 - 01:01:19:27
Dr. Saez
Right. So those are the parts of the brain that are closer to what's out in the external world. And that makes them easy to study because we have control over the external world. Now, we think a lot about sensory motor transformations. Meaning, okay, you see something, something mysterious happens, and then you do something. And it's the in-between part where the non eloquent cortex is in.

01:01:19:27 - 01:01:35:00
Dr. Saez
The mysterious stuff happens. Right? Because it is relatively easy to imagine that you have a lot of a part of the brain that lights up when you hear a symphony. And it is easy to imagine that a part of the brain that that lights up when you're playing a piano. But what happens in between?

How does your memory come into play?

01:01:35:00 - 01:01:39:31
Dr. Saez
How that everything that you've learned, how does your emotional reaction to the music come into play?

01:01:39:31 - 01:02:01:30
Dr. Saez
How does the context, in which you're doing that come into play? And that is potentially the non eloquent cortex that we were talking about. Right. Which are my new very important cognitive functions that are not so obvious. Right. So you mind you do all those but you're not feeling anything that's not a healthy brain, but it's not as easy to tap into or study as it is.

01:02:01:35 - 01:02:09:15
Dr. Saez
If you're just not capable of, you know, playing the piano when you were before. Right? But all those functions that are kind of inner meshed in that, you know, cortical dark matter.

01:02:09:15 - 01:02:23:19
Leslie
interesting. Like, I, I do a lot of a new patient intake and where I'll see patients that come in and they get, let's say, somebody Joe Smith has a headache, he gets a scan, the scanner finds some abnormality, they come in, I see them, evaluate them, and I'm just blown away.

01:02:23:19 - 01:02:40:40
Leslie
There are conditions called like arachnoid cysts or dandy walker. There are conditions where there's like not much brain tissue at all. But yet the person is fine. Totally. Never knew they've gone their whole life with like half of their brain tissue. So I guess it's not quantity, it's quality.

01:02:41:42 - 01:02:43:47
Dr. Saez
yeah it's amazing. Right. And and

01:02:44:04 - 01:02:59:58
Dr. Saez
were talking about plasticity earlier and how the brain adapts after injury and how you can, you know, there's reports, for example, of people who lose their, their sight because they have an accident and they don't get visual input anymore. That part of the brain that used to process visual input is now repurposed to do something else.

01:03:00:02 - 01:03:19:52

Dr. Saez
And they, you know, and of course, there's kind of anecdotal and more solid evidence that these people become much more sensitive to other sorts of sensory stimuli. Right. There's a compensation that happens. Part of it is because you have a piece of brain that used to be very busy processing all these visual stimuli, and now it's not receiving any of those inputs.

01:03:19:52 - 01:03:21:43
Dr. Saez
So the brain is like, okay, waste

01:03:21:42 - 01:03:23:22
Leslie
We got to do something. Yeah.

01:03:23:22 - 01:03:24:56
Dr. Saez
use this for something else.

01:03:24:55 - 01:03:26:17
Leslie
It's incredible.

01:03:26:17 - 01:03:28:03
Leslie
It's also incredible what we still don't know.

01:03:28:08 - 01:03:31:21
Dr. Saez
Yeah, yeah. We don't know a lot.

01:03:31:56 - 01:03:38:38
Dr. Doshi
I'll just add it because it was interesting what you were saying about, you know, sometimes you see patients and they have something in the brain and they're totally fine.

01:03:38:37 - 01:03:41:17
Leslie
or they have nothing, or there's like a whole space of nothing.

01:03:41:19 - 01:03:56:26
Dr. Doshi
they have nothing. And obviously they're coming to see you for some reason. And so you're looking at the brain and it goes back to like, you know we don't always image. Right. Like we're

not I'm not walking or people are not walking around. And nowadays, you know, people are getting a whole body MRI and screening and things like that.

01:03:56:26 - 01:04:14:57
Dr. Doshi
And it's important to remember this aspect of like, you know, you know, it's it's not just the pictures, it's the patient. Right? So we always say that, you know, don't treat the picture or treat the patient. And I think that's an important thing because, as we look in like, you can have things in the brain, you can have things that are not normal in the brain, but.

01:04:15:20 - 01:04:23:45
Dr. Doshi
it doesn't mean they're bad. Exactly. Because if you're functioning and things are going well and there might be things that are not going well but that are not attributable to that particular thing.

01:04:23:45 - 01:04:36:47
Leslie
I want you guys to each take a turn, and, I'm going to give you your opening line and then you're going to complete it. You're going to say three things. I would never do as a neurosurgeon, three things I would never do as an hour radiologist.

01:04:36:52 - 01:04:45:46
Leslie
So I want you guys to think about, three things that you would never do, or three things that are the most important to me as a neurosurgeon. You have to make it a little bit fun, a little bit kitschy.

01:04:45:49 - 01:04:54:50
Leslie
If you don't like that, then you can tell a really incredible kind of heartwarming story about something that you did amazing.

01:04:54:55 - 01:04:58:37
Dr. Bederson
Three things I would never do as a neurosurgeon. And this is not meant to be profound.

01:05:02:07 - 01:05:34:28
Dr. Bederson
I would never not attempt something new. You know, thinking big and getting big things done is just as easy as getting small things done. It takes the same amount of energy to create a new program as it does to change the way our scissors are sharpened in the basement of our operating rooms. So thinking big, attempting new things.

01:05:34:32 - 01:05:47:13
Dr. Bederson
I would never not do that. Number two, even though I used to do it as a kid, I would never ride a motorcycle without a helmet.

01:05:47:20 - 01:05:51:41
Leslie
But I have seen you almost get on a bike. An actual bike without a helmet?

01:05:54:22 - 01:05:54:51
Speaker 4
as

01:05:54:51 - 01:05:56:39
Dr. Bederson
Things I would never do as a neurosurgeon, you know, I would

01:05:56:39 - 01:06:03:59
Dr. Bederson
not necessarily sometimes be as reckless as I am. If I were in control

01:06:05:53 - 01:06:30:33
Dr. Bederson
And the third thing is, I would never prioritize ideas, performance, accomplishment over the relationships that I have with other people because as you heard today, it's this ecosystem allowing people's talents to rise to the top that make it, make it work so well here,

01:06:31:14 - 01:06:32:17
Leslie
I love that.

01:06:32:35 - 01:06:35:01
Dr. Bederson
Yeah. Not meant to be profound.

01:06:35:01 - 01:06:38:39
Leslie
No, I liked it. What about you?

01:06:38:54 - 01:07:05:12
Dr. Saez
Three things I would never do as a scientist. That's a tough one, because there's so many things that we can be doing wrong every day. I think that I'm going to have to go with. Don't lose

sight of the goal, right. It's very easy to get sidetracked by intermediate goals. Like, you know, getting the next paper, getting the next grant, and so on and so forth and kind of forget.

01:07:05:12 - 01:07:21:03
Dr. Saez
And I've had that feeling a couple times in my career where I'm like, I'm doing something and I'm thinking, is this really going to help our patients? And if the answer is no, then you have to pivot and you have to change and you have to correct course. Right. And it's kind of easy to get distracted by these intermediate goals.

01:07:21:03 - 01:07:41:54
Dr. Saez
So not not do that. The second is not be isolated. Right. We've we've talked about the ecosystem and the synergies that come with talking to others, from other disciplines, even within science, within, other people who have other models of disease and work on different problems and so on. That always makes for an engaging conversation.

01:07:41:57 - 01:07:59:06
Dr. Saez
You never know when the idea is going to strike you, and it's going to, come out of left field and inspire you to do something else that that you hadn't thought about. When you're looking, you're talking to someone who does something completely different. And the third one would be, I don't know, actually,

01:07:59:19 - 01:08:01:26
Leslie
You don't have to have three. It's okay to have to

01:08:01:26 - 01:08:07:09
Dr. Saez
It's okay to have two. There's so many that I could put a number three, but, I'm just going to leave it at that.

01:08:07:09 - 01:08:07:45
Leslie
Okay,

01:08:07:45 - 01:08:09:03
Dr. Saez
Thanks.

01:08:09:40 - 01:08:18:05
Dr. Doshi

All right. Three things I would never do as another radiologist. I guess I wouldn't call myself a body radiologist.

01:08:19:23 - 01:08:45:52
Dr. Doshi
I think, the other thing is, I would never stop asking questions. I think for radiologists in particular, you know, it's important, you know, we're looking at images and I think it's very important that, people don't fall into a vacuum of just looking at pictures. I think that, it's like when you go see art in a museum, you know, context is so key.

01:08:45:56 - 01:08:57:46
Dr. Doshi
And, you know, you don't if you look at just art and there's some value to it and, you know, you're looking at it in a way that you're interpreting. But when you're given context, you look at things very differently.

01:08:57:46 - 01:09:01:30
Leslie
Why why did this why was a scan ordered. Yeah. Why was how old is this

01:09:01:31 - 01:09:02:18
Dr. Doshi
Or I look into

01:09:02:18 - 01:09:27:50
Dr. Doshi
the history and I see, you know, maybe a course of treatment that's been done or, you know, or something. And we've had this conversation. Yeah. Where you've sent me things and I've looked back and I've looked at what medications are on. And, you know, you tie those things in with the, with, with what's happening with the patient, and you can maybe see what's what's going on with the imaging.

01:09:27:55 - 01:09:53:26
Dr. Doshi
And then, you know, the other thing I would just say is, it's kind of a general thing, is the third thing would be, to not have empathy, you know, and I think, for radiologists in a reading room, you know, it's often the idea of, again, being in a bit of a vacuum, but it's really, you know, you're there for the patient and it's it's really trying to, understand what they're going through.

01:09:53:26 - 01:10:09:29
Dr. Doshi
And we see it. We see a lot of a lot. You know, in radiology, we're sometimes the first person to see the pathology. And you might have a child, you might have, you know, you know, somebody

who fell off, a ladder or just someone coming in that's older that for the first time they had a seizure.

01:10:09:29 - 01:10:26:42
Dr. Doshi
And you're catching for the first time that they have some pathology in the brain. Right. And, you know, I think it's this kind of, you know, we're again, in a vacuum looking at pictures. But there's a person behind those pictures and everything that you say and all the things you describe are going to affect the next sequence of events for them.

01:10:26:47 - 01:10:27:47
Dr. Doshi
Right.

01:10:28:02 - 01:10:37:02
Leslie
Okay. Well, I want to thank you guys for being here today. I really enjoyed having you. I learned something, which is great. I think we like, talked like the tip of the iceberg here.

01:10:37:02 - 01:10:39:44
Leslie
So I think we definitely need to come back when there's more

01:10:39:46 - 01:10:43:45
Leslie
patients and talk more about the future. But, thank you so much for being here.

01:10:43:45 - 01:10:44:52
Leslie
I really appreciate it.