Transcript for David Eagleman | Making Sense of The Brain (Episode 622)
Full show notes found here: https://theartofcharm.com/622/

DAVID: These are issues involved in, for example, nanorobotics, getting super tiny little robots into every neuron in your brain. Things like this so that we can actually read lots of brain activity in a useful way and eventually write to the brain activity also.

JORDAN: Welcome to The Art of Charm. I'm Jordan Harbinger. On this episode, we're talking with my friend David Eagleman. He's a neuroscientist, TED fellow, a Stanford professor, he's known for his work brain plasticity, time perceptions, synesthesia, neuro law, he's a council member in the World Economic Forum, and a New York Times best selling author, published in 28 languages. So, if you're not impressed yet, it's you. It's not me and it's certainly not him.

David has an amazing knowledge of the brain, really -- has some of the most interesting insights into how our brain is and how it works that I've read in a long, long time. But it's his way of combining that insight with an exceptional ability to articulate those same insights and making them useful to you and me is one of the main reasons why I wanted to have him on the show today. I could not wait to have David on the show. We're going to discuss how our brains construct our reality and my favorite part of this, really, is augmenting our senses and even inventing new senses -- just like Ghost in the Shell, if you've seen that movie. This is just not that far off. This is an incredible episode so enjoy this one with David Eagleman.

Well this stuff fascinates me because our brains are a large part of what makes us, us. And if I slam the door on my hand on the way out to the bathroom, that's a bummer. And it might be harder for me to write or eat, I might night be able to eat a salad with my hands like you just did so expertly. However, if I damage my brain, even a little bit, in a way that's barely perceptible by most people, I kind of lose a part of me, in a way. With this goes down this whole Buddhism rabbit hole maybe, but I feel like any time your brain gets damaged, the physical

part, you end up with weird software quirks. Is it safe to say our brains kind of are us, in some way?

DAVID: Yeah, it's the densest representation of you. So, even if you damage a very tiny piece, that can change your decision making, your risk aversion, your capacity to, you know, name animals or see colors or a hundred other things that we see. And through centuries of these sorts of case studies, that's how we know a lot about the landscape of the brain and how we know how this is this representation of you. Now that -- we don't entirely know that it is entirely you because you've got lots of communication with other parts of your body. I think of it like the rest of this is the greater metro area and this is the city here.

JORDAN: The other thing that fascinated me that the concept from one of your books is that the consciousness part -- because I know people are going to go, "No your mind isn't you," and here's 7,000 books written by Indians with names that have 25 character in them that you've got to read that prove this. But the consciousness part of our brain is kind of like the newspaper reports on all the other things that are happening that are already computed by the subconscious brain and I know I'm non-sciencing this up pretty good right now.

DAVID: The issue is that -- I was thinking a lot about all the activity that happens in a nation and there's so much that's going on at any given time and so, what you want in a newspaper is just the headlines. Just the very top level. And that's the same thing about -- that's what our consciousness is giving us, is just that top headline. Just yesterday, actually, I looked at the activity monitor on my Mac. And I don't know if you've done that before --

JORDAN: Sure.

DAVID: -- but there are lots of little programs running that I've never even heard of. I have no idea what they're doing but they're all doing fundamental stuff and I thought, that's a pretty interesting analogy to what's going on in the brain. There's so

much stuff. You know, okay, make sure you breathe, get through the proper thing with your blood and your body and do all this stuff that's going on. And all sorts of basic cognitive things too, about putting ideas together and evaluating hypotheses and simulating possible futures. All of that is running under the hood, so to speak, where it's happening at an unconscious level. The conscious mind just gets access to the very top little bit, the newspaper headlines, in this case.

JORDAN: Yeah, it seems like -- same activity monitor sort of analogy -- you go, "What's taking up all this memory?" and then you kill one of those things, the kernel task and suddenly it shuts down and goes, "Ah well, you just shut down your breathing and your heart rate of your computer. You've got to restart." You know, the whole thing is toast.

DAVID: Exactly. By the way, this is something that struck me as interesting because there's so many ways in which we do this. So obviously if you shut down breathing or heartbeat, that's noticeable, but with drugs of all sorts for example, your cognition changes massively. It's like shutting down one of these sub programs where you don't exactly know what it does but it changes the behavior of the whole system. The whole other rest of the system operates in a different way.

JORDAN: Yeah, I'm trying to think of an analogy for that but it would be kind of like, "All right, well we're going to shut down the one that makes everything show up on the screen." So now you're just guessing when you're typing or moving the mouse. So everything's going to be off and kind of weird and that could easily happen if you're taking something that shuts down the part of your brain that feels a certain way. And you go, "Look! When I hit my hand with this hammer, it's funny." And it's like, that's not going to be funny after this substance wears off and the rest of that brain turns back on.

DAVID: Right, right, right.

JORDAN: So it's not the operating system that we see in our conscious brain, it's the screen. It's the printer.

DAVID: And the reason is, you know, you've got almost 100 billion neurons -- neurons are the specialized cell type in the brain. These are doing incredibly complicated things. And by incredibly complicated I mean things we haven't even scratched the surface of yet in terms of the algorithms that they're running that make us up. I don't think we could even function at our scale of space and time if we had access to that level of detail. I mean you can't keep 100 billion things in mind and, you know, each one of these neurons is talking to about 10,000 of its neighbors. And so to operate at this scale of getting rabbits and mates and finding the river and the tree and so on, that level of detail is completely meaningless to us. And what you need at this level is something that's just -- that's higher like, "How am I getting along with this person? How do I get this mate? How do I get this piece of food over here?"

JORDAN: Right, yeah, something that's more top line and the rest of it gets taken care of, sort of automatically. We're the last ones to know what's actually going on in the brain because most of the time we don't need to know and the breathing, the inhale that I just took before that last sentence, that happens automatically because if I had to think of that, my processing power for holding this conversation -- which is already limited, both right now especially, but in general -- is going to suffer because of that.

DAVID: Yeah, exactly right. And most of what we do is we automatize behaviors. So, we learn how to walk, we learn how to eat -- there are various things that are already pre-programmed or pre-programmed enough that it's easy for us. We learn how to speak language depending on what we're exposed to in our culture and so on. But when you learn something new, like how to ride a bicycle, at first you have to pay a lot of attention to it. You know exactly where your torso and your balance and everything that's going on. After a while, when that becomes automatized, you don't have to pay any attention to it,

consciously. So that frees up all this conscious bandwidth and most of what we do is totally automatized. I mean it's trivial to drive your car, which if you can remember back when you were 15 years old, it was hard to learn how to do that.

JORDAN: Yeah. It was terrifying.

DAVID: Yeah. So we get to do all that stuff in an automatized fashion and that frees us up to think about the next tasks and other, longer term goals.

JORDAN: Sure. Or do our makeup and eat some food and make a phone call and look at the radio and all the other things that most people do when they're driving. Send a couple texts, which is a little scary because it also -- we have this sort of illusion that since it's automatized, we're doing it in exactly the same safe way that we were if we were focused on it.

DAVID: Well there are many cases actually where the things that are automatized actually function better than if you paid attention to them.

JORDAN: I believe that.

DAVID: Yeah. I mean just look at riding a bicycle. If you really pay attention, "Okay how exactly am I moving my,--" you'll probably crash. If you play a musical instrument, you know that if you start paying attention to what your fingers are doing, you're dead. You can't do it anymore because what's happening is so fast and sophisticated that you can't possibly address that with the slow low-bandwidth consciousness. This has to be something that the rest of your brain takes care of and just does for you.

JORDAN: Yeah that does make sense. Although with the -- I'm going to stay to my guns on the driving thing and that you should probably focus on that and not let --

DAVID: Oh, I agree. Of course you shouldn't take your eyes off the road to text, yeah.

JORDAN: Yeah your brain still needs the other inputs that you think, "Oh, I don't need this anymore, I'm so good at it. I can just look down now."

DAVID: Yeah.

JORDAN: Still needs the input.

DAVID: Yeah. I mean an example that I often use is the lane change example. And this was in my book *Incognito*, I don't know if you remember --

JORDAN: I did.

DAVID: Oh, okay I'm hoping --

JORDAN: I did read it.

DAVID: I'm hoping you don't remember this example because I'm going to ask you to do this. So put your hands on your steering wheel.

JORDAN: Okay.

DAVID: You're in the center lane driving 30 miles an hour and I want you to make a lane change into your right lane. So, make a lane change.

JORDAN: Into the right lane? Okay. And then --

DAVID: So it turns out that's totally wrong. What that does is that just turned your car to the right and then you went over the sidewalk and you crashed.

JORDAN: Oh, so I just -- I turned this way and then never straightened it back.

DAVID: And then back to -- no, you straightened back out. What you did is --

JORDAN: Did I?

DAVID: -- you turned to the right and then you straightened back out which makes you now going straight, to the right.

JORDAN: Okay.

DAVID: The way you make a lane change is you go to the right, back to center, all the way to the left, and back to center again. That's what a lane change looks like.

JORDAN: Right.

DAVID: And you do it every day and you're not consciously aware of how you do it. So this is an example of --

JORDAN: I'm a terrible driver.

DAVID: It might be an example of that also but it's an example of the way your unconscious brain can just take care of stuff in ways that you don't even have conscious access to.

JORDAN: Because you've got to correct back in order to straighten out.

DAVID: Exactly.

JORDAN: So, yeah, all I did was instead of going in a circle to the right, I just went into a straight line and, yeah, crashed into a bus station.

DAVID: Yeah, yeah, exactly.

JORDAN: Gotcha.

DAVID: So there's so much that our brains take care of that we're not even aware of and what we have to do is try to, you know, dig

and scratch to even get a sense of what's going on down there. People often ask me about this issue of, you know for example, expert meditators and so on, whether they're deep down in there. But I think it's more of a party trick actually. They're just scratching the surface. If you can do something pretty extraordinary like, you know, change your blood flow to one arm versus the other or some of these things that meditators can do, that's cool. But that's 1 1-billionth of what your brain is actually up to down under there.

JORDAN: Which is really neat to know that we can't ever -- or at least not now -- access that with current technology.

DAVID: And it's not even clear that we're -- as a neuroscientist, you know, we want to get in there and understand it. But I mean from a psychological perspective, if we could actually get down into there, I think it would be so alien to us that it wouldn't even be worth it. Just look at something like dreams. You have dreams every night and you wake up and you think, "God that was bizarre." I mean I hate dreaming, it's like sticking my head in the night blender every night. I have all these high emotions and you wake up and you think, "God what a waste of effort and emotion that was," but that's just like the smallest window into the kind of stuff that's happening down in there that if you actually could get down in there, it wouldn't make sense to us at our levels of space and time and I think it wouldn't have any meaning to us.

So just as an example, if I explained to you why you love strawberry ice cream, all the way down to the -- well, this neuron -- then this happens -- and this releases dopamine and that's why you love strawberry ice cream. It doesn't change at all your experience of eating strawberry ice cream.

JORDAN: Right.

DAVID: Like, if I wrote a whole book and you read the book and you loved the book, it doesn't change anything about your psychological subjective experience in the world.

JORDAN: Yeah you can keep the book, I'll just have the ice cream at that point.

DAVID: Exactly. And so that's the sense in which, you know, even as we get down there and start to understand things better and better, the meaning that it has to us will be sort of an academic one, I think.

JORDAN: Yeah. I suppose that -- well, you know more about that than I do. For me, listening to all this stuff -- this book was kind of like the *Cosmos* of the brain. So I spoke earlier to this guy Isaac Lidsky, who actually -- he went blind as an adult and he used to be on *Saved by the Bell*, which is kind of interesting because he was like this child actor who had everything going and then he just slowly,but not that slowly, went blind. And then ended up becoming the only blind clerk on the supreme court and everything like that. I mean he just did not -- he didn't exactly give up. And he was talking about how seeing and vision -- it's not really about the eyes. He visualizes just as clearly as he did when he had working eyes, it's just that the eyes are no longer -- the input's not working anymore for him.

DAVID: I mean, yeah, one example of this generally is every night when you go to sleep and you dream, your eyes are closed but you're having full, rich, visual experience. So we're all used to this about not needing the eyes to be open in order to have vision. Yeah I suspect that over time his visual experience will change and if he's a really good introspector, he'll be able to tell us ways in which it changed. Because it's probably not exactly the same as it always was. But yeah, that's fascinating. I'd love to talk about that.

JORDAN: How does the brain then construct vision? Because it's not our eyes that construct the pictures, right? Our eyes take in light and things like that but, you mentioned in one of your talks that -- where we met actually -- that you can create vision based on other sets of senses. How does the brain construct a picture of things?

DAVID: So, almost all the vision is happening internally, which is to say, your brain is making guesses about what's going on out there and it's using all its past experience and it's attention based on what your goals are at the moment to figure out what is going on out there. And then the data that's coming up through the eye balls, is just a little tiny part of that. There's a little bit of data dribbling up through here that gets to the brain and that's just used to essentially modulate this activity. It's used to verify or discount what your internal model is. But the whole thing is, you've got an internal model of what you believe is out there, and then that's what your vision is.

So, as far as whether we can use other senses to get information, the brain is fundamentally multisensory. What it really cares about is taking in all these information sources, like air compression waves and photons and molecules and pressure and heat and stuff, and put together a big picture of what's going on out there. Even as people lose senses, they're still able to function in the world pretty well, get by. And I think what you're referring to is one of the things that I'm working on which is called sensory substitution which is can we feed information into the brain via an unusual channel, and get the brain to perceive it?

JORDAN: Like that mountaineer who uses the camera on his tongue somehow?

DAVID: Yeah, he has a camera mounted here and there's an electro-tactile on his tongue that represents the visual image. So if he looks and there's a rock here, he'll feel that on his tongue. It feels like Pop Rocks on the tongue. And people can get so good at this -- it's called the brain port -- they can get so good at it that they can throw a ball into a basket at a distance or navigate a complex obstacle course. People can do quite sophisticated things with this.

The first example of that actually goes back to 1969, about using a video feed and translating it into another sense. In that case it

was a series of pokes in the back. Blind people were sat in a dental chair and there's a solenoid grid and whatever is in front of the camera, people feel that poked into their back. And blind people get quite good at telling, "Oh, that's a line, that's a circle, that's a face," and so on. So one of the things I'm working on is how we can, for deaf people, completely replace -- their cochlea, their inner ear is broken for whatever reason -- can we completely replace that with the skin of the torso? So we have a vest that's covered in vibratory motors and we capture all the sound and translate on the fly, into patterns of vibration on the torso. And so they're feeling, "Buzz," and they can understand the spoken world that way.

JORDAN: That's incredible. So essentially we replace the hearing, the eardrum or whatever -- you said the cochlear area which is not functioning, and we say, "All right, these different vibrations on your body are now going to represent sounds." So in their brain, is that then represented as sound or are they just getting so used to feeling something that they say, "Okay this is what sounds are now," or do we not know?

DAVID: We don't know that yet. Ask me that again in about a year and I'll have deeper insight into that. But, because one of the questions that I'm very curious about is the following, which is, "Why is it that vision feels to you so different than hearing, which feels so different than touch or taste or smell? Given that, when you look in the brain it's all the same stuff. It's all spikes among neurons." If I showed you some piece of cortex. I said, "Ooh, look at all this activity going on there," you couldn't tell me if that's auditory cortex or visual or somatosensory, it all looks the same. The question is why does it feel so different? Why does vision feel like, "Oh, I'm seeing," where as touch feels like I'm -- I hypothesize that it's about the structure of the data.

So with vision, you have have two 2-dimensional sheets of the eyes, with hearing you have it's a one dimensional signal through time, touch is this high dimensional signal and so on. And I hypothesize that the structure of the data is what defines what it feels like. If that's the case, then if we're feeding in

auditory information, even though we're feeding it through the skin of the torso instead of the cochlea, it'll essentially be hearing. It'll be essentially the same thing as hearing. Now what's applied by this is if we feed in completely new senses, new information streams, people will have another sense. It's not like vision, it's not like touch, it's not like hearing, it's this other thing.

JORDAN: That they can't necessarily describe because it's not like -- they're not seeing it, they're not smelling it, they're not hearing it, they're perceiving it in this other way that is completely alien to us.

DAVID: Exactly. So let's say I feed in stock market data to you. And so all day long you're feeling all these stocks and what's going on and you start feeling like, "Oh, you know, I feel like oil is about to crash," and, "I feel like Google is about to do something well," and whatever. You're feeling that. Yeah, that's the point, you could never describe it. Why? It's because language is all about a shared communication like, "Oh, when you say this word I know what you mean because I have the same experience, blah, blah, blah."

JORDAN: It's hot and it looks blue and it's also cold after it turns red. You know what that means. It's weird but you know what it means.

DAVID: Well right. I know what that means but if you tried to explain it to a blind person -- if you tried to come into someone who's been blind from birth and explain what blue is like and red is like, you could try really hard and they might even pretend at some point that they understand you, but they can't understand you because they've never had that experience, that qualia.

JORDAN: If they were born blind.

DAVID: If they were born blind. And so they'll never get what you mean there. It's the same thing. If you're feeling stock market data and you try to explain to me, "Wow I feel this and it feels like this, blah, blah," you could try and try and I'd never quite get

what it is until I wear the stock market vest and experience that for a month or so and I start getting it and then we'd have to make up a word together. We'd call it the shmegeggy or something instead of vision or hearing or whatever.

JORDAN: Right.

DAVID: And we'd know what we mean by it but nobody else would.

(COMMERCIAL BREAK)

JORDAN: You have words in certain languages like Danish has this word like hygge that's supposed to be like comfort and homey but this is beyond that. That's at least an amalgamation of things that humans understand.

DAVID: Exactly and you can tell me this Danish word means comfort and homey --

JORDAN: Right, yeah.

DAVID: -- and I pretty much got what the word is. But yeah, this will be something that anybody who's not experienced in that sense could ever, ever get.

JORDAN: And do you think there's an unlimited number of those types of senses and feelings in our brain, available, potentially?

DAVID: Potentially, yes. I think we have no data to tell us anything about the limits of that. You know something I've been very interested in is, you know, looking across the animal kingdom -- I spend a lot of my time just reading very detailed papers about these weird fish and animal species and whatever that are found, that have completely different sensors than we do, which allow them to do completely other things. You know so like electro reception where you can tell about magnetic feels because you have electroreceptors in your body. Certain fish have that. Other animals do echolocation and other animals pick up on ultrasound. Obviously lots of animals pick up in the

ultraviolet range in vision and so on. So there's lots of different signals animals can get in and I suspect that their quality, their experience of that, is different than ours as a result.

JORDAN: Sure like a flat where I'm senses, I don't know, electro signals from other living things in the ocean.

DAVID: Yeah, yeah. And so, the issue is what are the limits of this ? I kind of feel like -- I mean this is almost too big to imagine that it's true but it might be true, which is that we're just now at this moment in history, for the first time in millions of years, where we can suddenly feed in completely new senses to the brain. Which as you may know, I see this as a very general purpose computing device, and I see all these sensors that we have as peripheral plug and play devices. And, so we can plug in different sorts of peripherals of completely new experiences and if this is right, we're going to know this in the next few years about what kind of completely different sense we can have.

JORDAN: Does this mean then that everybody's experience is then super subjective because it's only based on what our individuals brains are constructing?

DAVID: Oh, yeah. That's already true, even though we have the same peripheral devices. You know everybody, essentially, is living on their own planet. Like Matt Damon in The Martian, everyone's on their own planet. There's enough of a bandwidth between us that we can talk and I can say, "Hey Jordan, can you pass the red thing," and you -- because you know, we've learned a lot and we have the capacity to have this low bandwidth in between our planets, but it's already the case that it's quite different. And the question is, now if we start having completely different senses, to what degree will we even be able to understand each other? That's just a weird thing that we're walking into in the future here.

JORDAN: Yeah, it's incredible because I'm thinking, okay, if there was a way for you to experience -- not even look at, because that's

throwing another dimension into it -- a print out of exactly everything that I see right now, that I hear right now, that I smell right now, that I'm experiencing right now -- just a snapshot -- it would not match if you were sitting in this exact same seat looking in the exact same direction. It would not match. And it wouldn't just be, well you know, you've got some tofu from your salad that's changing the way -- even if I look at a tree, and you look at that same tree from the exact same angle, your brain is making a different picture than mine is.

DAVID: Yeah that's right because it has everything to with what my goals are, what relevance the tree has to me -- most likely, I'm going to look at the tree and think, "Okay, well how do I get around it? To the right or to the left?" But let's say you're somebody who studies trees, then you might look at it and say, "Oh, it's this type of tree," and then someone else comes up and thinks, "Yeah I really want to hang a swing, so which branch is the right branch to hang it from?" You know there's a million different ways you can look at a tree and it all has to do with what your goals are and what your background and experience is. So that's totally right, the part that hits our retina or hits our ears, is just a fraction of what we experience.

JORDAN: I was talking with Lisa Feldman Barrett who studies a lot of emotions and things like that, and she mentioned that all that our eyes are doing -- all of our senses really -- what they're doing is kind of fact checking the picture that our brain has already made to make sure it's valid.

DAVID: This is exactly what I meant by the internal model which is that your brain has got this internal model that's running and it's just, with the little bit of data that comes in through the senses, it's saying, "Okay," you know, "look, I think I'm sittin in my office at Stanford with Jordan, we're talking and blah blah blah," you know, and all of this is consistent. Yeah I can feel the chair, I can see you, and so on. And so, it feels like, okay that's all consistent. But if there's something really weird, I suddenly see that there's something completely off that I didn't expect, then I become consciously aware that I pay attention to that

because the important thing to pay attention to are the things that violate your expectations that --

JORDAN: Right.

DAVID: -- are not consistent with your model. That is what will grab your attention.

JORDAN: So if I'm born without a sense of smell, is all the smell related data just missing from the model? Do I know that it's missing or it just doesn't matter, it's completely irrelevant?

DAVID: Great question. It is completely missing and you do not know that it's missing. As we were talking before, it struck me that -- it would be an interesting analogy to think if everybody in the world were blind except for you -- so you had vision, you could see things at a distance and say, "Oh, look there's something coming over the hill," and everybody in the world would be absolutely blown away by this and think you're magical and think like, "How could Jordan have known that there was something coming over the hill a mile away when we had to wait for it to get close and hear it and then touch it and so on. And he even knew what it was!" I mean, it would seem completely insanely magical but to the people who are blind, they wouldn't know that they're missing something.

You may have heard, you know, an analogy that I've used before is this issue that when I look at my dog who's got a great big snout and, you know, 200 million scent receptors -- you know, my dog is having this incredible experience of smell. I just watch her go around and do these things. We don't feel like, "Oh, man, we've got this sort of, black hole where smell should be and we've got these little impoverished noses here." Instead we just -- we're totally ensconced in our view of the world and that, as far as we're concerned, is the entirety of reality.

This Ted Talk on this concept of the umwelt, which is the part of your ecosystem that you can detect.

JORDAN: Sure. I was looking for an excuse to use that word during the show.

DAVID: Great. So the idea with the umwelt is -- for a tick it's picking up on temperature and butyric acid and that's its whole world. That's what it picks up on. For the black ghost knifefish it's picking up on electrical signals and perturbations and those -- for the echolocating bat it's picking up on air compression waves and so on. And we've all got our own umwelt, and for us we've got these little noses but here's the thing that I find amazing. Whatever our umwelt is, we assume that's the entire objective reality out there.

What I've noticed a lot now is like, when I was giving my Ted Talk, I and the audience both really got this sense of where the umwelt could go. And then afterwards, say 30 minutes afterwards, everyone's back. Everyone's back in their umwelt and I am too. I mean, I'm the guy who put this talk together and I talk about all the ways in which we could sense the world. It's so natural for us to snap back to that and think, "Okay well, probably this is the whole reality out there. You know, I can see things, I can smell things, that's probably the whole reality out there," even though I know and the audience knows that it's not true, it doesn't last. That truth doesn't last long. That, I find interesting.

JORDAN: Yeah it seems like, it's a -- maybe a healthy way to live, somehow. There's an illusion that we are just ware of everything that's in front of us and we get it, and that's the whole of what there is to perceive. So we're under an illusion that we're not seeing an illusion.

DAVID: Yeah, this is a very stubborn psychological filter to get beyond. This is one of science's most basic fundamental things is figuring out, "What are these psychological illusions that we have and how do we make an n-run (ph) around these and study this?" But I just find it interesting that I can spend my days, you know, really trying to get past it but as soon as I'm back, you know, with my kids on the swing and pushing them

and whatever, none of that stuff matters because I have evolved. You know, the product of four billion years of evolution of, you know, “Here’s what you’re reality is and here’s what you need to survive.” So I just -- I forget about that other part.

JORDAN: So yeah, don’t spend too much time out of that or don’t spend any time outside of that.

DAVID: Right.

JORDAN: Which is one reason why maybe some of the drug experience psychedelic stuff is so interesting is because it’s turning off certain things or at least messing with the wiring where it’s like, “Hey a new sense maybe, or a new thing is happening here.”

DAVID: Yeah, that’s right. We’re about a year of from having the vest on the market and one of the things we’ve built into it is an open API so that anybody can pass any kind of data stream into it and experience, you know, whether that stock market or Twitter data or weather data or whatever kind of data you want -- you can experience that and develop a new qualia and it may be that sort of in a year from now, the human species starts proliferating into all these different kinds of experiences that can be had.

JORDAN: So the way that people who can’t hear could listen to music, would just be a synesthetic experience, in some way?

DAVID: Well, so if a deaf person just wants to feel the music -- we’ve actually been doing that a lot with the deaf community, they totally enjoy that. But I mean one step beyond that, which is that they actually want to learn how to understand everything that’s going on, what you say, what I say -- there’s a knock on the door, there’s a siren, they hear it all, exactly the way you hear it. The way that we hear it is, you know, we’ve got these sound waves that hit our ear, and from there everything becomes -- you know, by the time you get to the inner ear, everything just becomes spikes that go to the brain. And this is

the same thing, you just wear the vest. You've got spikes that are going up to the brain through the spinal cord.

JORDAN: So it's electrical signals no matter what by the time it gets to the computer.

DAVID: Exactly right.

JORDAN: So it doesn't really matter how they come in.

DAVID: It's all the same currency, yeah.

JORDAN: That's crazy. So if our brain is constantly making these choices out of, I guess ambiguity, to make the model that we're working with, does that make social judgements as well? What types of judgements does it make? I mean it makes every kind in theory but --

DAVID: It makes every kind. And so, yeah. I mean it's very weird to note the amount of stuff that we come to the table with. Or -- so I have two kids, five years old and two years old, and I watch them -- about the kind of social judgements they make and about other people. "He treated me badly," and, "This is my toy." All these things unpack in a very natural sort of sequence as in, there's nothing surprising that my five year old has all these particular opinions on these things. It's because we come with all this software that just unpacks in a certain way. And what's very weird is, you know, some of the programs are meant to unpack later. So, when my children turn 13, you know, suddenly they'll become interested in parts of their body they weren't very interested in before and other people's bodies and so on. Yet all of a sudden, cognition changes, because new software that's been sitting on the shelf gets unpacked. It's very weird.

JORDAN: Good luck with that, yeah.

DAVID: We are simply living inside the software library.

JORDAN: And in our live programs we teach things like reading body language and vocal tonality and eye contact, and really, all it's doing or all we're trying to do is, convey certain mental models that you can use that hopefully will stick in your brain with practice and things like that that say, "When this is what shows up on someone's face or in their body, then you can react in this other way that will give you an advantage over somebody who does not know how to handle this particular experience."

DAVID: Yeah.

JORDAN: But really stoked at the idea that we might be able to add new senses into this --

DAVID: Yeah.

JORDAN: -- I mean that's just like a crazy advantage.

DAVID: Yeah that's right. You know and teaching people, "Okay when this," you know, "do this sort of response," that's really useful given that we're all humans and we all have the same sort of things going on. It's helpful to tell people, "Hey this is an effective method to get what you need which is," whatever it is -- you know, not rejection or get the thing that they want, or whatever it is. But, fundamentally what it comes down to is all these desires that we have, we essentially come, you know, pre-programed with these. You can't help the fact that you are attracted to particular mates and that you want people to like you and that you don't want to be ostracised from a group and the list goes on and on. A hundred things we could name that you're just pre-programed with.

JORDAN: It seems really interesting in a way that we could modify these things and also a little bit unfair that we can't just choose them --

DAVID: I know.

JORDAN: -- and make it easier, unfortunately.

DAVID: Yeah. I have some friends who are getting older by the way, and they find that the amount of time they spend thinking about sex and sexuality is going down and they feel very liberated by that. They feel like, okay as that module is sort of, you know, moving towards shutting down or slowing down, that frees up a lot of mental space, things that took up a lot of cycles before, now you get more room to think about things.

(COMMERCIAL BREAK)

JORDAN: I would have done a lot better in school if there were no women around because I would have spent a lot less time thinking about how my hair looks or how this shirt matches with this thing or name it. I wasted -- most of my bandwidth was spent during this 10 or 15 year period thinking about, pretty much nothing else --

DAVID: Yeah.

JORDAN: -- to the detriment of everything else.

DAVID: This is an interesting example because what it shows is that, you know, we as a society, as a civilization, we've grown to this point where you think, "Look it's really important to send kids to school and do this sort of thing," which it is. It is super important for us to do that, given our goals and desires as a civilization but we're really fighting what is a more natural thing, which is, you know, by the time you're 13 or 14 years old, you're interested in mating and that's what we're geared to do. And so there's all this effort that fights against that, say, "All right, stay in your desk Jordan. I'm going to teach you," you know, "10 dates in Mongolian history that are important," and so on, and you just have to try to fight our --

JORDAN: Right.

DAVID: -- pre-programming with this other piece.

JORDAN: I was thinking, “Oh, I must have ADHD,” and no, what I had was --

DAVID: Four billion years of evolution.

JORDAN: Attraction to the opposite sex, yeah. If we are dealing with mental models that our brains create and that’s what sort of makes up our perception and then dot dot dot, our identity or whatever, it seems like, then our memories must -- which are just recollections of that same perception -- those are also not totally accurate, they’re false. And so they would include, maybe, things that are based on, not even just what we see and experience but things that we thought we saw and experienced, that we maybe heard about or saw on television. So does that mean that our identity -- and forgive me, I’m going down this philosophy road here, this Jason Silva type road here -- does that mean that if our identity is made up of memories of ourselves, that a certain portion of our identity or maybe even the whole thing, is basically a fabrication of our brain, or by our brain?

DAVID: So -- so yes and no. So there’s a difference, of course, between saying memory is not accurate and saying it’s false. Because, it’s not necessarily that it’s false, it is the case that what we write down isn’t like a video recording or like the way a computer stores zeros and ones, it’s very different from that, it’s about sensations and impressions, not all of which are accurate. And of course, putting memory aside, you can just be in a situation where somebody says something to you and you think, “I can’t believe that guy,” and your whole life you remember that moment but actually it was you misinterpreted what he meant by it and so on. Even when our memory is totally accurate, we might not even have the right interpretation of what it was that led up to that moment.

So yes it is the case that our whole identity, built from the sum total of our memories, and so it is this very weird thing that beliefs we hold rest on this. And typically until people get older and a little bit wiser, they really believe that their memories are

correct and they believe that they're interpretation of the world is correct. You know, we all tell ourselves stories about things and it takes some amount of maturity to realize, okay well that's just a story, and yeah, maybe that's what actually happened. Maybe that's what the person meant, maybe not. But yeah, I think it's especially tough on young people that their whole who they are is built as the sum total of these memories and impressions.

JORDAN: The brain seems to trick us a lot. Almost -- maybe on purpose, maybe just little fables but tell me about alien hand syndrome. This thing is weird.

DAVID: Yeah well it's funny because I think it's not so weird. It's interesting. But alien hand syndrome is where because of a lesion in the brain, damage to the brain, something starts -- your hand, for example, starts having a mind of its own, is what it seems like. That's why it's called an alien hand. So your hand -- there was some dumb movie, Evil Dead 2 or something like that?

JORDAN: Sure.

DAVID: Where the guy's hands started doing things and so on. But it's kind of like this. Like I might start zipping up my jacket with this hand and this hand pulls it down. And I say, "No I want to zip my jacket up," and it's doing its own thing.

JORDAN: So you're fighting yourself although it's like you have two separate control systems.

DAVID: Exactly. What's happening is one part of your brain is controlling this arm and the other part is controlling this arm and they just have different ideas what's going on. The interesting part that this exposes to my mind is the fact that under normal circumstances, you always have conflict -- enormous amounts of conflict -- going on in the brain, as -- if you read my book Incognito, you know this issue that I described. The brain is a team of rivals which is to say, you've

got all these different networks that have different drives. They want different things at every given moment and they're always battling it out to steer the ship. You know, so it's sort of like a neural parliament in a sense.

Anyway, the times that that becomes clear is when you do things like cut the Corpus Callosum, which connects the two halves or do various things that -- brain damage in one place or another. That's when you start really exposing the rivalries that are happening under the hood. Normally, these get arbitrated so that by the time it all rises to consciousness, you say, "Oh, I'm going to do that. I'm going to get the tofu salad," or whatever.

JORDAN: Tell me about zombie routine.

DAVID: So the idea with zombie routines is it's just that you've got all these completely automatized things going on in your brain all the time. So, this is an example of it, what we were just talking about with alien hand or whatever. But, all the stuff that we're used to thinking about like, "Oh, my heart beat is taking care of my gut, the digestion, I'm walking, I'm balancing, I'm shifting my position every once in a while so that my blood flow goes through my legs well and so on." These are all zombie routines. They're just completely automatized. Most of them we'd never even have access to. This stuff is so fascinating. It's exactly like this thing we talked about with the activity monitor on the computer where you just see these other zombie routines that your computer is running, that you'll never, ever crack open that function and see what it's doing. But it's just doing something that's super critical to the mission.

JORDAN: Are there ways in which, in the future, we might create conscious machines that could control other subroutines and automatize those so that our brain power is maybe -- is freed up for something else? Or is it by that time that we can create those, the brain is then an obsolete piece of computing.

DAVID: Oh, interesting. For better or worse, the brain will never become obsolete because we are brain owners and we -- if I said to you,

"Hey Jordan, we're just going to kill you now because your brain is obsolete because we have better computers," you wouldn't want to die, so --

JORDAN: I might want a better brain, though. I might not want this bio one, I might want a better one.

DAVID: Well, so there's a sense in which we already have that. So, you know, we all carry around this little rectangle supercomputer in our pockets which connects us to the entirety of human knowledge and learning up to now. So there's already a sense in which you've got this great symbiosis going. There's been a lot of interest lately in this issue of, "Can we make it so that we're not interfacing via our fat thumbs but we've got this faster thing?" That is actually an extraordinarily difficult problem to solve. So, you know, there have been a couple of companies that have launched recently -- say they're going to do this, to work on ways of doing this, one is called Kernel, one is called Neurolink. The difficulty is, you can't do this thing of implanting electrodes, which is the traditional way that in neuroscience and neurosurgery the way of getting to the brain, which is this soft, pink material that's surrounded with the skull, right?

JORDAN: Like cochlear implants? How they just kind of touch inside your brain?

DAVID: Right, a cochlear implant is slightly different because you're just slipping an electrode strip into the inner ear there.

JORDAN: Ah.

DAVID: But this is actually drill a hole in the skull, stick electrodes into the brain itself. That's the idea there. I kind of think that idea will never catch on in the consumer space and here's why. It's because there's always risk of infection and death on the surgery table and so neurosurgeons simply aren't going to do it for somebody who simply wants a better interface with their computer.

JORDAN: Right.

DAVID: And I don't even know that consumers would want to do it. Obviously these surgeries do happen but they're for people with real disorders and deficits like, you know, they've got Parkinson's Disease that prevents them from being able to even walk around in the world. So you can do a neurosurgery there. It's a big undertaking but it's worth it for what it gets you. But the question is, would it ever become a consumer thing where you do neurosurgery? I just don't think so.

JORDAN: Yeah. It's a little risky just to have quicker access to Google search engine or something like that.

DAVID: Exactly right. Exactly right. So I think we need to come up with other ideas and they're a lot of nascent incipient ideas that will one day grow into something that could be consumer ready. And these are issues involved in, for example, nanorobotics -- getting super tiny little robots into every neuron in your brain -- or genetic techniques, to be able to change the way that your neurons behave and know when they're firing. Things like this so that we could actually read lots of brain activity in a useful way and eventually write to the brain activity, also.

JORDAN: That would be very, very cool. Because I think everybody kind of wants to level up a little bit and everybody wants to be superhuman. If our brains can interpret data from anywhere, like the camera that has the grid on the tongue, the vest that people can feel to hear, then we could theoretically invent things that are external but are maybe better than our natural gear for data gathering.

DAVID: Oh, yeah, totally. I mean one thing that I'm interested in with the vest, for example, is you know, setting up cameras in other rooms, and I can feel where people are moving around and I know, "Oh, yes, someone just entered the third room over there." "How do you know?" "I felt it." That's easy stuff and what that illustrates is just, you know, our eyes are limited because, "Oh,

there's a wall here." Well that's the end of that, I can't see past that. But it's just super easy for us to hook up our tech to really make it better than -- better than the experiences we have now.

JORDAN: Sure.

DAVID: One of the things I'm interested in is the spectrum of electromagnetic radiation. There's a very thin strip here which we call visible light, which is that those wavelengths that we can see --

JORDAN: Exactly.

DAVID: -- because of the machinery in our retina. But there's all this other space out here, of other wavelengths that are moving around that are totally invisible to us. A colleague of mine is making microwave sensors to put on satellites so that he can look at the earth in the microwave range. It's a long story why. But what the discovered, quite accidentally, is when you look at the planet in the microwave range, you can see in that range, what water is drinkable and which water is polluted.

JORDAN: Oh, wow!

DAVID: And that was a new discovery that they didn't expect. Nobody expected, but they just figured that out, accidentally. But just imagine if I'm actually feeling in all these different wavelengths, what kind of accidental discoveries I would make there about, "Oh, wow did you know? If I'm seeing a person in this completely other range, I can tell this other thing." The sky is the limit as far as the kind of discoveries we can make if we just strap these on humans and have them walk around and experience their daily life.

JORDAN: Yeah, it's fascinating for me to see that, look, in other words, instead of eyes or in addition to eyes, I could have sensors that can sense heat, they can sense thing's motion over super long distances, in the dark. You could have a FLIR, like those infrared cameras that -- or a heat camera that can easily be

super sensitive enough to go through walls and buildings. And, if I'm a law enforcement military search and rescue, I could theoretically -- instead of having this complicated piece of gear or having to radio to a helicopter or a truck -- I could look in a certain direction, or just not even look, I could hold my hand our or wherever the FLIR sensor is and go, "There's four people, six meters deep, trapped in something. They don't have that much air and there's water in there too."

DAVID: Exactly.

JORDAN: I could know all of that, but instead of being able to go, "Okay I see that in this computer and it's being radiod," I just, feel it.

DAVID: Exactly.

JORDAN: And I'm already in action.

DAVID: Exactly right and it sounds so weird to think, "Oh, could you just feel that kind of information?" but you know, if you look at the amount of information coming in through our eyes right now, it's so absolutely enormous. And colors don't exist in the outside world, the colors that I'm experiencing essentially carry information for me. Like, oh, yeah, it's different wavelengths of electromagnetic radiation and that tells me where the ripe fruit is against the green leaves of the tree and so on. All this stuff I'm just feeling, in a sense, already but we take vision for granted. I just open my eyes, there's the world.

JORDAN: Sure.

DAVID: The vest is probably our best bet for the next 50 years or something, until we figure out better ways to get deeper in there and plug things directly into the brain, but that is not as easy as people think.

JORDAN: Yeah, it's not just the Matrix worth of the little cord to the back of the head.

DAVID: Yeah, exactly. Because, you know essentially -- and also if you stick an electrode in the brain, the brain tissue rejects that the same way that your finger will spit out a splinter over time. It, you know, pushes it out. It's doing the same thing with an electrode in the brain. So I think electrodes are probably not the way to go and it'll have to be something much more sophisticated than that.

JORDAN: And what timeline do you think we're on for things like that?

DAVID: It's impossible to know. But, you know, 50 years we'll have something consumer based if I had to make a wild guess.

JORDAN: What about using things like the grid on the tongue? Is that just -- there's just not enough surface area to get the right type of bandwidth?

DAVID: Well the reason I'm much more interested with what we're doing with the vest than this tongue grid -- the tongue grid is a terrific proof of principle. You can't eat and you can't speak with it in your mouth, so that's the reason I'm not too high on that as a device. The other thing is, you know, it hangs out of your mouth in this way and it is socially embarrassing to people to do this kind of thing. I mean, I don't just mean the brain port but I mean even something like a hearing aid is socially embarrassing.

JORDAN: Sure.

DAVID: So, what I wanted to do with the vest from the very beginning is, this is something you wear under your clothes, no one even knows you're wearing it, but it's translating the world for you or translating whatever sense you want, but no one even knows you're wearing it. And that's the idea.

JORDAN: Yeah, that makes sense. I'm just thinking -- my brain's going wild with like, "What if you could line my esophagus with a grid or something that nobody could see? And there's a lot more

surface area there." Or maybe it goes under my skin which sounds gross and painful but also theoretically possible.

DAVID: I think all these are good ideas. The only problem is -- I love the idea of lining your esophagus but you have to actually go in there and do some sort of minor surgery to get that in place.

JORDAN: I don't know how minor that is, right? Yeah.

DAVID: It would be relatively minor but as opposed to you buy a vest, for under a thousand bucks, and you zip it up under your clothes, and you're set. It feels like there's an advantage to that that it hasn't been immediately obvious to me what the next step would be that would be better. As in, "Oh, I'm going to go in and get a surgery and be out for two days to have this thing," like you know, maybe that's useful but we not only have the vest, but we have a wristband. We're also building a pair of pants with vibratory motors in it and so you can get lots of different data streams, pretty easily, cheaply from the outside.

JORDAN: How quickly can I learn how to use this? Because if I'm wearing the vest right now, it just feels like a tickly shirt, right? Or some kind of weird vibrating -- it doesn't mean anything.

DAVID: Yeah, it totally depends on what you're trying to learn. So, many of the things that we're doing have zero learning curve. People immediately get it. They just get it. Others have like, 15 second learning curve, where you just --

JORDAN: Really?

DAVID: Yeah.

JORDAN: Because the brain learns how to use the data right away.

DAVID: Exactly but it totally depends on the kind of data. So that's one end of the extreme but the other end of the extreme is learning language. Learning how to use the vest as an ear, that takes

about a month. So you train for about an hour every day using these cool games we have. The games -- the phone presents a word to the vest, so you feel, “Buzz,” and then you have, let’s say two words, and you have to choose, “Which word did I just feel? Did I feel knee or door?” And so you make a guess and you’re 50 percent at first. But what happens is people’s performance starts improving, steadily, and it just keeps on improving. So that’s at the long end of how long it takes to learn something other things are --

JORDAN: That’s incredible. So, what’s one of the things you’re most excited about? Of course allowing deaf people to be able to hear with the vest. What are you going to use it for when you get one that you can take home?

DAVID: I can just say, as far as a clear market path -- because, you know, we have to get this out in that way -- we’re doing things with deafness, we’re doing things with blindness, we’re doing things with prosthetic legs. Just as an example, when -- you know, when somebody gets a prosthetic leg, they don’t learn how to walk very easily. They have to look at where their leg is at all times because they’re not getting any feedback from it.

JORDAN: Sure, sure.

DAVID: So we’re just hooking up pressure and angle sensors, and then feeding that into the vest and you can feel exactly what your leg is doing, just like you and I feel what our legs are doing. So, there are lots of things like that that are addressing particular deficits and then there’s the whole world of things we’re doing about adding senses.

JORDAN: Sure. When are you going to be able to let the world know what this stuff is?

DAVID: Probably in about a year from now.

JORDAN: All right, we’ll see you in a year.

DAVID: Good, good. I'm looking forward to it.

JORDAN: David, thank you so much, it's been amazing.

DAVID: Great, thank you Jordan. Cheers.

JORDAN: So this was freaking fascinating. I was not lying about that. The fact that we can, in very short periods of time, create new senses that we can learn to use without Neurolink, without even all that stuff that's far away, just by having our brain learn ways of decoding new input is just mind blowing and kind of shocking that we haven't done it before. This is the beginning of something incredible. You heard it hear first. And a great big thank you to David Eagleman. We'll have his work linked up in the show notes for this episode and if you enjoyed this, don't forget to thank David on Twitter. We'll have that linked in the show notes as well. Tweet at me your number one takeaway from David Eagleman.

I'm @theartofcharm on Twitter and let me know what you think of future senses and technology. I'm interested to see what you all think might be possible in the very near future. You can tap your phone screen if you're looking for the show notes for this episode, if you're trying to find Twitter handles or info from anything that's been discussed today on the show.

Our programs, our live program details at theartofcharm.com/bootcamp. This is by far and away my favorite part of running AoC. There is so much development that takes place at these workshops. Nonverbal communication, persuasion, influence, just renegotiating with yourself the identity that you have in the world. It sounds a little frou-frou there but you'll just come out the other side a completely changed man and that much I guarantee you, literally. If you're thinking about this a little bit, please get in touch ASAP. We're sold out a few months in advance, as always. Just get in touch with us, we'll get some info to you so you can plan ahead at theartofcharm.com/bootcamp is where you can find more on that.

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This hands on stuff, ready to apply, right out of the box, on reading body language, having charismatic nonverbal communication, the science of attraction, negotiation techniques, networking and influence strategies, persuasion tactics and everything else that we teach here at The Art of Charm. It'll make you a better networker, a better connector, and a better thinker. That's theartofcharm.com/challenge or text the word 'charmed' C-H-A-R-M-E-D to 33444. For full show notes for this and all previous episodes, head on over to theartofcharm.com/podcast.

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