Following is the full text of Don Vaughn's talk titled "Neurohacking: rewiring your brain" at TEDxUCLA conference.

Don Vaughn – TEDx Talk TRANSCRIPT

Inside each one of us is a beautiful symphony. 100 billion neurons firing in concert, constructing this vivid reality that we're living in. And inside each little piece of that neural activity lives a little bit of what makes you, you.

And after your experiences today, that activity will have shifted and you will never be the same. You are inextricably tied to your brain.

When I first learned these principles, when I was 16, I fell in love with the brain, and I've been doing neuroscience research ever since.

Now, one day, we were doing a new MRI experiment. And I was surprised because the experiment went well, but much to all of our shock, I had a hole in my brain. It was a pretty big one too; it was like 30% of my cerebellum just wasn't there.

Which, as you might imagine, I was pretty shocked because I didn't feel like anything about me or my life and my experience of the world had changed or was missing.

The cerebellum is one of the most fundamental parts of your brain. It has, like, 80% of all of your neurons. So I got interested.

Now, there's this collision between what your brain is supposed to do and then what it's dealt, and somehow it finds a middle ground. And I became really interested in the idea of your brain as a dynamic, flexible system.

And to that end, I want to tell you the story of Cameron Mott. Just after her third birthday, Cameron started having violent seizures. They started becoming worse and worse, and eventually, she was losing her ability to

speak.

Doctors diagnosed her with something called Rasmussen's encephalitis, and the only real treatment for this was a hemisphererectomy — cutting out half of her brain. And keep in mind that one half of your brain controls and is responsible for movement and sensation in the other half of your body.

So this surgery would immediately leave Cameron hemiplegic. But just four weeks post-op, she walked out of the hospital. And she is still dealing with a bit of hemiplegia and a bit of peripheral vision loss. But otherwise, she is able to run around with her peers, and she is cognitively quite deft — it's amazing.

And I wondered, you know — consider that for a second: if I gave you half of a car, or half of a phone, you wouldn't be going anywhere in LA, and you wouldn't be on Twitter right now tweeting about how mind expanding TEDxUCLA is.

Because for most devices, 50% equals broken. But somehow in this instance with Cameron, 50% is almost equal to 100%.

HOW IS THAT POSSIBLE?

Well, the remaining part of Cameron's brain sensed the massive loss of neural tissue, and it physically rewired and reorganized itself to take over everything that the other half had previously handled. That is an ability known as **neuroplasticity**. It's the ability of the brain to change itself — to rewire.

And so, I think it's not a very good analogy when people say your brain is like a computer. It's actually just a really bad one because your brain is not static hardware.

And although the prevailing view in neuroscience for a long time was that the adult brain is a fixed processing unit, it seems like every day we find a new result that says that's not the case at all.

While there is structure to your brain, it is dynamic, flexible biology. Let me say that again: You and your brain are static, but you're also dynamic — you can change yourself.

So the idea worth spreading is this: What if we were able to treat injuries and impairments in an entirely new way, by hacking into your brain's ability to rewire itself.

To show you what I mean, let's look at how we've treated depression.

Since 1952, scientists and doctors have addressed the question of treatment for depression as a fixed hardware problem where there is a deficiency of "happy" neurotransmitters, like serotonin, dopamine, norepinephrine.

And in this context, it makes perfect sense that the way to go about it is to discover and design drugs which increase those neurotransmitter levels. Enter MAOIs, tricyclics, SSRIs — there are hundreds of them, but they all work in pretty much the same way.

And these are marvels of modern medicine. I mean, on anti-depressants, we see about two-thirds of people see some sort of symptom relief. But that still leaves 1.5 million people, in the US alone, who are still struggling to enjoy their lives, who are becoming disconnected from their friends and their families. It is an awful, debilitating disease.

So what if we were able — what would become possible — if we addressed the problem from the perspective of neuroplasticity? So what we're doing is we're essentially finding regions in the brain that show different activation in depressed patients than in normals.

So for example, if someone with depression shows dorsolateral prefrontal cortex — it is not as active as it is in other brains — we actually use electromagnetic currents from devices placed on the scalp to induce neural rewiring in those areas.

So in the case of the area that was less active than normal, we give a pulse, we stimulate it, we do whatever we can over several sessions to say: Can we upregulate that? Can we make this brain essentially push back towards normal behavior, one area at a time?

And while this is a new technology, some of the pioneering work by Dr. Jonathan Downer at the University of Toronto shows nearly a 33% remission rate for treatment-resistant depression, which is depression where patients have seen no relief from therapy, they've seen no relief from anti-depressants, and they are running out of options.

And another wonderful thing about the idea of neuroplasticity is that while drugs are very specific on a molecular level, they're quite general still in their delivery, often affecting a whole host of parts around the body that we didn't intend, and leading to the laundry list of side effects that you're probably used to hearing at rapid speed at the end of drug commercials.

ALSO READ: Gurdeep Parhar on Fixing Racism: Racism is at the Root of Many of Humanity's Evils at TEDxStanleyPark (Transcript)

But neuroplasticity kind of takes the other approach. Instead, we're targeting very large patches of your brain, but we're leaving the rest of you alone. We're now in the midst of the personal medicine revolution — you can sequence your genome; you can get SNPs — it's $100-$200.

I think neuroplasticity can fit into this because the devices that we use can be tailored very specifically to each individual. We can deliver just the right stimulating pulse for John, and we can give just the right targeting area for Jenny.

There is a lot of flexibility to make sure that we address the fact that we're as different on the inside — probably more so — than we are on the outside, and any optimal treatment mechanism should cater to that.

So, to me this seems like science fiction coming true. I mean, we are on the frontier of non-invasively being able to rewire your brain to alleviate certain types of mental disorders.

While there is certainly debate in the literature as there always is: What's the right sham? What's the right control? Where do you target? It doesn't matter.

We're almost there, and the possibilities are startling. And once we get there, the next question becomes: **If we can rewire your brain using devices, would it at all be possible to help your brain rewire itself with just your own thoughts?**

I know it seems kind of crazy, but that's the idea of something called real-time neurofeedback. Essentially, what we're doing, if you give the example of, let's say, addiction. In cocaine addiction, we show a subject luring images of cocaine, and we induce their craving networks.

So these are cocaine addicts. And then we present them with a real-time feedback of what their brain is actually doing. What is the craving network in your brain really doing? And the idea is that we're asking people to surf their mental landscape and do whatever it is they need to do to make that bar go down, which essentially is exploiting whatever conscious control, and probably in most cases unconscious control, that you have over your own brain to rewire it intelligently at just the right times, with just a little bit of biofeedback.

Now, I think this has real implications for the legal system because we're getting to the point where our neurochemistry is getting really good. We're now able to give different types of drugs to change mood states.

And in one case, we, as a government, are now disarming criminals with drugs. And that might sound like a 1984-esque type of statement, but consider that we already do it.

In California and many other states, we mandate what's called chemical castration for re-offending sex offenders. So they're forced to take medroxyprogesterone acetate to reduce their libido — and it's effective.

And I'm not here to comment on the morality of the subject, but I do feel that as we look for new ways to rehabilitate criminals instead of warehouse them, neuroplasticity would be an incredible option, where, before we say, you have to take this drug or we're not letting you out, we instead see: Is there any possibility for this person to be rewired or to rewire themselves?

And moving beyond deficits, what if instead of just treating deficits, we actually use this to improve ourselves, just our own impulse control — where — yeah, all right, I don't know which one I want right now — where we use our own intelligent brain plasticity to modulate and upregulate our long-term decision-making, our attention, our impulse control.

What if we went to the biofeedback mental gym as much as we went to the real gym, and we lifted our behavioral problems with as much vigor as we lift our 45 pound plates. I think it's a beautiful idea.

And there's one more application of neuroplasticity I'd like to talk with you about, but in order to do so, we're going to run a quick experiment.

Everyone, look under your seats. Some of you will see a pair of earplugs; they look like this. And some of you stole them before the break. I know who you are. Pull them out. Okay.

So here's the experiment. Those of you who have earplugs, you're going to be speakers, and everyone else, you're going to be listeners. Okay? Open

them up. Get ready.

Now, I'd like you all to meet my friend Mimi. Mimi is seven months old, and she loves to talk. When I press Play, your job, speakers, is to mimic what she's saying. Listeners, your job is to see how well did they do. Okay, put in your earplugs.

And for those of you at home, go ahead and plug your ears the old fashioned way and see if you can play along.

(Cute baby noises)

Take out your earplugs.

Yeah, like, pretty terrible, actually. And look, I kind of set you all up to fail on that one because lip reading is a really difficult problem. But lip reading babies who, as all you missed, can make vocalizations without their mouth moving at all, and then who speak with toys in their mouth is a really, really difficult problem. This is harder than neuroscience.

And so imagine, though, that Mimi is your child, and this is every day of your life. That's the reality for deaf parents and the over 90% of their children who are hearing-able. And this can lead to a real divide between families because parents are unable to engage in traditional baby talk.

And it's now very clear that traditional baby talk is not the cute or annoying musings of parents, but instead, it is a tool specifically designed by nature to teach language and to foster connection.

And you can imagine if that was gone, it would be a really difficult issue. So the question that Dr. Arianna Anderson and myself at UCLA asked was: If you can't get infant vocalizations in through the ears, is there another option?

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Well, when you scan brains across the population, you see that there are very specific parts of your cortex that are devoted to processing one type of sensory modality or another.

So, for example, this morning on the TEDx tour through UCLA's Staglin Center, we see that there's a very particular part of Stephanie's brain that lights up to only visual information.

And independently, there's a completely separate part of the brain that responds only to touch. But here's where it gets really interesting. When you scan the brains while blind people are feeling braille, you don't just get the touch parts of their brain active, you see visual areas active as well.

And similarly, when you scan the brains of the deaf population while they're communicating using sign language, you don't just see the visual areas active from seeing the gestures, but you actually see auditory cortex activated. Somehow, your brain isn't just plastic, it's not just random, it is intelligently plastic.

And somehow, it's rewiring itself in order to maximize and process as much information from the outside world as possible. Somehow your brain is learning to see braille and to hear sign language. So, this is called **sensory substitution**, and the idea, as Paul Bach-y-Rita and David Eagleman have exploited, is that you can take information from one sense that's lost, translate it to a different sensory modality, and put it in that way.

Surprisingly, your brain figures it out because your brain is plastic. And this is the idea that we've taken, and we've moved forward with developing an application with a small grant from UCLA called "Chatter

Baby."

And what Chatter Baby does is it turns auditory information into visual information — it's a type of sensory substitution. So now Mimi's chatter comes alive in visual form. You don't miss anything now.

Even though her lips aren't moving, you can see what's going on. And the idea is that deaf parents can use this tool to learn baby talk and to connect as deeply as possible with their child, and we believe that eventually, once they become fluent in using this tool, they will be able to hear their child through sight.

And to me, that is just such an important application of neuroplasticity. And this shows that it's not just a fun tool for turning auditory information into visuals, but instead, sensory processing plasticity, it has the ability to connect deaf parents and their babies. That's the power of plasticity.

But that's only half the battle. The other part of this disconnect is that when deaf parents aren't in the same room as their children, they don't know what mood they're in. And the best baby monitors out there on the market, they say, yes, there's sound; no, there's no sound.

But that doesn't really tell me what I care about. It doesn't tell me, is my child happy and content? Or instead, are they hungry? Are they crying? Is something going on that I need to be there and I need to address?

Instead, I'm constantly wondering, sound? No sound? I don't know.

So what we're doing with Chatter Baby is we are gathering the world's largest database of infant sounds, and we're then using sophisticated mathematics to take that sound and predict what child's mood states are. So he's really hungry.

And the idea is that we can use neuroplasticity to make a real difference in

how deaf parents communicate with their children. And I've talked to you about now how to treat depression and addiction and sensory impairments using neuroplasticity, but that's really only the beginning.

We're starting to move into diseases that you wouldn't expect would be treated by something like this, like Alzheimer's and Parkinson's and stroke. And that's really just the beginning of what I've been calling neurohacking.

And I don't mean neurohacking in the sense that these aren't thoroughly researched — they're really well thought-out ideas, and there's a lot of literature to support why they work.

But in the sense that we're not directly trying to fix the nuts and the bolts of all these problems; we're not trying to change every biochemical cascade that's going on in the brain, which is essentially the root of the problem.

But there are a hundred trillion connections in your brain, and each one of them is like a city with a thousand chemical cascades going on. It is such a difficult problem.

So instead, what I think some of the biggest advances in neuroscience and all of what we're doing is going to be exploiting, this incredible quality of your brain that is uniquely yours to rewire and reallocate itself based on what it needs.

And if we step back for a moment from neuroscience, the question for you I have today is: Where in your life are you waiting to understand every little nut and bolt of a problem, every nuance, before you decide to solve it and make a change?

If you're trying effect social change in Los Angeles with six million people, there's probably a couple million that don't want to hear your story, and

they are not going to be helpful to you.

But instead of focusing on what's broken and what doesn't work, maybe take a lesson from neurohacking and use what does still work to get the results you want.

Thank you.

Resources for Further Reading:

Challenging Our Lazy Brain: Ronald Paredes at TEDxYouth@NIS (Transcript)

Max Cynader: Enhancing The Plasticity of The Brain at TEDxStanleyPark (Transcript)

Mehdi Ordikhani-Seyedlar: What Happens in Your Brain When You Pay Attention? (Transcript)

How Data is Helping us Unravel the Mysteries of the Brain: Steve McCarroll (Transcript)