# Healing the Brain: Insights from a Neurologist
https://mindmatters.ai/podcast/ep275

Announcer:

Greetings and welcome to Mind Matters News. Our brains are amazingly complex systems, and like most complex systems, there's, unfortunately, lots of ways things can go wrong. However, our brain is also adaptive, able to cope with or heal from some issues, either on its own over time or with medical intervention. Today, we have Neurologist, Dr. Andrew Knox, to discuss some of what can go wrong and how we can fix certain issues. Along the way, we'll also talk about how our minds interact with our bodies and the mysteries behind that connection. Enjoy.

Robert J. Marks:

Welcome to Mind Matters News. I am your brainy host, Robert J. Marks. The brain is a marvelous organ, still not totally understood. Artificial neural networks, my field, are devices, artificial intelligence that are supposed to be a simulation to the human brain, but comparing the brain to artificial neural networks is like comparing the human heart to a pump handle. We're just not even close. We are far from any sort of duplication of the human brain, and the gap is wide and we might never get there. I also know that as I get older, I feel my brain or my mind, I'm not sure which, slowing down, but the brain also breaks and there is depression, autism, epilepsy, and a number of other things. Neurologists, neurosurgeons can sometimes fix the human brain, and that's what we want to talk about today on Mind Matters News. Our guest is Dr. Andrew Knox. Dr. Knox is a neurologist at the University of Wisconsin School of Medicine and Public Health, who specializes in childhood epilepsy, intractable epilepsy, and evaluation for epilepsy surgery. Andrew, welcome.

Andrew Knox:

Thanks so much.

Robert J. Marks:

I got to ask you a personal question, you work with kids whose brains are broken.

Andrew Knox:

Yep.

Robert J. Marks:

Man, I would find this tough. You see little kids and you see them having epileptic seizures and you see kids with brain damage and I don't know, I would have a hard time just leaving this at work and not taking it home. But I suspect people in your profession have to develop rhino skin and separate the medical aspects from your personal feelings. Do your experiences bother you after your work sometimes?

Andrew Knox:

Well, sometimes they do. Actually, one of the wonderful things about doing epilepsy is that there's a wide spectrum of what epilepsy looks like. So there are some kids who have frequent daily seizures that cause all sorts of problems. They have a lot of other cognitive problems too, and those cases are hard, but there are plenty of other kids who have a few seizures over the course of their life and they go away after a few years. So you see kids in lots of different places, which I think is helpful, just with dealing with fatigue and caring for patients. And even in the difficult cases, it is gratifying to work with those families. I've met some amazing people that way, and so there's good that comes out of it.

Robert J. Marks:

I guess that is the positive side. Every once in a while, when you see a positive result, it must give you a warm feeling that you are part of achieving that result. That's really cool.

Andrew Knox:

And one of the big things, I think, that is part of being a doctor or part of medicine is just being with people in cases when they're sick or when things are difficult and helping them through those times. So that's an important thing we can do for patients, even if there's not a cure that we can offer to them for their specific medical problem.

Robert J. Marks:

So in a way, it's like a ministry for you in a way, right?

Andrew Knox:

Yeah, yeah.

Robert J. Marks:

Andrew, you got to help me here, and I'm going to start by confessing my ignorance, I don't have a clear idea of the difference between the professions that deal with the brain. There's neurologists, there's neuroscientists, there's psychiatrists and psychologist. And each, I suspect, looks at the brain from a different angle. Now, you're a neurologist, how does a neurologist think about the brain? Do you have a special way to look at the brain?

Andrew Knox:

So neurologists are, usually, primarily concerned with thinking about the hardware of the brain, so disorders, where you can see some part of the brain is broken, either looking with imaging studies, or by looking with pathology under a microscope, or looking with EEG, a study that looks at brainwave activity. So we're more concerned with low-level brain problems. Psychiatry and psychology usually approach the brain from the standpoint of the mind. So thinking about not what's happening with the physical substrate of the brain, but what is happening in people's thought processes and what sort of dysfunction is there in thought processes. Now, obviously, there's overlap between the two.

Robert J. Marks:

That's what I was going to ask. There has to be an overlap between the two. So what is that?

Andrew Knox:

Well, that overlap can... in some ways, is still not totally well understood. It can come out in different ways. So if you think about depression, say, there are certain brain structures that are implicated in depression, there are things like neurotransmitters that are implicated in depression. There's certainly cases of depression where treating with a particular medication that addresses a neurotransmitter will improve a person's depression or help get rid of the problem.

Robert J. Marks:

Let's drill down a little bit. Could you define and talk about neurotransmitters? What is that and why are you concerned with them?

Andrew Knox:

Yes. So the brain, it is base level, is comprised of neurons, these cells that use electrical signals to integrate information, then communicate with each other, and then there's other supportive tissues or glial tissues. So the point of neurons is to communicate with each other, and the way they communicate with each other is by neurotransmitters. You have structures called synapses, which are the connections between the output coming from one neuron and the input to another neuron. So they communicate via little chemical messengers, and that's what you refer, or what I'm referring to when I say neurotransmitters.

Robert J. Marks:

I see.

Andrew Knox:

Substances that neurons use to communicate with each other.

Robert J. Marks:

As I age, I mentioned I felt my brain slowing down or my neurotransmitters being turned down with a little knob as a function of age.

Andrew Knox:

You could potentially say that. Certainly, in kids, if you look at how brains develop over the first 18 years of life, you can see that kids' brains are actually building more synapses, so more of those connections between different neurons over the first 10 years of life. A kid may have, actually, twice as many neurons as a typical adult.

Robert J. Marks:

Really?

Andrew Knox:

Yeah. And then part of maturing is actually getting rid of extra synapses.

Robert J. Marks:

Now, are these synapses that you're not using in some sense?

Andrew Knox:

Yeah. Your brain is developing its structure in real time or pathways or communication that makes sense between neurons. There's probably a nice analogy to how you think about neural networks. You start out with a neural network, and then you train it, and as you train it, some connections become stronger, some become weaker, the brain goes further to actually remove some of those connections entirely. And that, probably, improves cognitive function when you are in the childhood age range.

Robert J. Marks:

That's interesting. In artificial neural networks, there used to be a process, I haven't heard about this for years, called pruning, where... and if you have some neurons that are sitting there and not doing anything, they will eventually be removed algorithmically from what's happening. Say, for example, even inputs, maybe you're trying to classify a dog from a cat or something, and one of your inputs is the weather in Wisconsin.

Andrew Knox:

Yep.

Robert J. Marks:

That is going to have nothing to do with whether what you're talking about is a cat or a dog. So that weather in Wisconsin node is going to be totally removed. So that does happen in artificial neural networks. So interesting. So that happens in kids as we age.

Andrew Knox:

It does, and that's part of normal brain development. For the exact same reasons you said, some of those initial connections that you make probably are not useful. So as you get older, as you get experience, the brain prunes down to the connections that are most beneficial.

Robert J. Marks:

Now, does the getting rid of the neurons continue or does it level off at someplace? I'm hoping you say it levels off, but I don't know.

Andrew Knox:

It does level off.

Robert J. Marks:

Okay, good, good.

Andrew Knox:

And here, we're not talking about getting rid of the neurons either. We're just talking about getting rid of some of the connections between different neurons. So by and large, the number of neurons stays about the same.

Robert J. Marks:

I see. Interesting. So we've talked about the difference between neurology and psychology, and I guess, this is... you characterized it as hardware versus software. You deal with the hardware and the psychologists deal with the software of the mind. So let's get now into some of the work that you do and talk about how the brain breaks. That's a pretty strong statement. Breaks is different than slows down. So how does a brain break?

Andrew Knox:

I mean, that is fundamentally what neurology studies. So there are many different ways the brain can break, and we can go through some of the typical examples, and I think it gives some good insight into how neurologists think about the connection between brains and minds too.

Robert J. Marks:

Okay, good, good.

Andrew Knox:

So most people think of neurology as having come out of the study of strokes, a typical problem that comes up in, usually, later on in life, but there are kids who have strokes as well. The basic idea of a stroke is that you have something that blocks blood flow to a particular part of the brain, and when that happens, then the brain tissue in a particular area dies. So neurologists who cared for patients with strokes noticed that many patients come in with the same set of symptoms. And so then early on, they would do pathology. So they would look at the brain after the patient had died and found that the brain tissue is lost in a particular area.

And they noticed that there is a good correlation between losing brain tissue in a particular area and the symptoms the patient might have. For example, if you had a stroke in what we would call a primary motor area, an area with the connections to motor pathways through the rest of the body, all of those patients might lose the ability to move their arm on one side of the body or their leg or their face or all three of those things.

Robert J. Marks:

Now, some of those things, I think people can recover from, and I've heard the word neuroplasticity. It's like if part of the brain fails, then another part of the brain takes over. Is that right?

Andrew Knox:

Yes.

Robert J. Marks:

I'm sure that there's cases where you can't cure it but there are cases where you can. And does neuroplasticity play a role in that?

Andrew Knox:

Yeah, it absolutely does. So there actually aren't too many areas where if you have an injury to that part of the brain, you can't have other parts of the brain takeover.

Robert J. Marks:

Wow.

Andrew Knox:

There are a few special areas, so again, areas involved with language to some extent are less plastic. Visual pathways are hard-coded into the brain. So strokes and primary visual areas, you wouldn't expect to recover normal vision after that. Similar for primary motor areas, usually, if you have a stroke in a primary motor area, you would expect to have long-term motor deficits.

Robert J. Marks:

In a motor area, you mean things that just affect how you move your arms and legs and things of that sort?

Andrew Knox:

Yeah, exactly. Yep. Those are the big three that... There are some sensory areas that are the same way, where if you have a stroke in a primary sensory area, you might always have problems sensing or feeling sensation in your right hand or your right leg or something like that. But again, those are the specific exceptions to the more general rule that the brain is good at moving function between different areas.

Robert J. Marks:

I find that amazing. That's just, to me, astonishing. There are very overt cases where you see this happening. I've seen blind people, for example, that aren't using the neurons that they were supposed to use for sight, and they've developed the capability of going into a room and just clicking, going, (clicking sound), and hearing the echo like a bat, and actually, seeing through the echo their environment. That is an astonishing application of neuroplasticity. I think some of the other things that you're talking about a little bit more subtle, you see the recovery, but they're not as in your face as the clicking.

Andrew Knox:

Well, I would say that's a different way of coping. They haven't regained an ability that they had before, but they've developed a different set of abilities they have. So like you say, if you lose the sense of vision, your sense of hearing may become more acute. It may become better, and you may develop ways to use that to replace that other function. But the examples I was talking about, I was actually talking more about recovering a function that you had before. So if you have a stroke-

Robert J. Marks:

I see.

Andrew Knox:

... in the left motor area and you, for a while, can't move your right hand, even after six months, you can have some recovery of that function, even though those neurons aren't growing back. And that's because there are connections from the other side of the brain to that hand as well. So those connections may become stronger and you may be able to use them better.

Robert J. Marks:

I see. So there is a difference between adapting for something you haven't had since birth and then adapting from a function that you've lost through, for example, a stroke?

Andrew Knox:

Yeah.

Robert J. Marks:

I see.

Andrew Knox:

I would make a distinction between adapting for loss of a function by developing a new function that you don't usually... or that you wouldn't have developed otherwise, versus the brain adapting to recover a function that you've lost, that same function.

Robert J. Marks:

Now, strokes in kids, what's the primary cause of that? Is it something which is genetic? Is it something that's happened to them, an accident?

Andrew Knox:

It's a spectrum of things. Their infections can actually be a common cause or an immune response to an infection. Clotting disorders can be a common cause. There's a disease called sickle cell disease, which can be a common cause for stroke in kids.

Robert J. Marks:

Yes.

Andrew Knox:

Actually, there are a number of kids now who have substantial heart malformations or congenital cardiac problems. 40 years ago, many of those kids would've just died very early in life. Now they can actually live relatively full lives, but one of the consequence of their cardiac disease, they're more prone to developing clots and that sort of thing, which can be a cause for stroke. So they're a patient population where we see strokes in kids a little more often.

Robert J. Marks:

I see. Have you noticed any increase or decrease in the number of strokes the kids have or has that been something which has been constant?

Andrew Knox:

I think that's something that's been relatively constant.

Robert J. Marks:

I see.

Andrew Knox:

And again, we see it much less in kids than in adults, but about we do see them from time to time.

Robert J. Marks:

One of the ways you mentioned that brains can break is dementia. And I always associate dementia with old age, but can kids have dementia?

Andrew Knox:

So there are some disorders where kids can have dementia. So dementia is a little different from strokes. Strokes, the idea is you have an injury to a particular part of the brain, and then you wind up losing the function that goes with that particular area of the brain. Dementia, usually, you have a problem that affects the whole brain at the same time, or at least the brain more diffusely. So it's not one particular area of the brain, it's the brain as a whole. You don't lose all of the neurons in the brain at the same time, but you start to progressively have injury to more and more neurons throughout the whole brain. So that causes this different sort of change where you see loss of cognitive function over time.

Robert J. Marks:

So you can say that dementia is distributed, whereas strokes are localized.

Andrew Knox:

Yeah, exactly.

Robert J. Marks:

I see.

Andrew Knox:

And less vocal. Now, there are exceptions to everything in neurology, but I think that's a good way to think about dementia. So kids can have sometimes particular kinds of genetic or problems with cellular processes that lead to something like dementia. So in adults, it's much more likely to be a part of the natural aging process. In children, usually, it would take a specific disorder that they have that would cause earlier onset dementia.

Robert J. Marks:

So it is something which is gradual then?

Andrew Knox:

It is gradual. You think of strokes being something that you see the effects of the stroke over minutes to hours. Dementia, usually, you think of seeing the effects over months to years. So again, usually, you don't necessarily lose one particular function on one side of the body but you see the effects of that diffuse loss of neurons. You see that with more global cognitive functions. So problems paying attention to things, problems with memory, problems with just understanding the world around you. And some of those symptoms can follow really interesting progressions that maybe give some insights into how brains work.

Robert J. Marks:

For example, I would like to hear about this, what would be a progression that would give you an insight into the way the brain works?

Andrew Knox:

Well, so I've thought at times, how does the brain store memories? There are different schemes for storing memories, but patients with the Alzheimer's seem to have this progression, where as you get further down the disease, more of their early memories seem to come back to the surface, or it often seems like they're convinced they're living in the world they lived in when they were a child. And it's made me wonder if the way the brain stores memories, it's an associative sort of scheme where it uses the previous memories you have to build up into new memories. And then as you have injury to the brain, perhaps you lose those most recent memories first and then go backwards through that scheme.

Robert J. Marks:

So Alzheimer is a type of dementia. Do kids get Alzheimer's?

Andrew Knox:

Kids generally do not get Alzheimer's. Many of the dementias can look similar with different sorts of emphasis. There are certain language processes that are a particular problem with Alzheimer's. There's another kind of dementia called frontotemporal dementia, where decision-making and controlling appropriate behaviors tends to be the bigger problem. Those, again, are all adult onset dementias. The pediatric dementias are more specific to specific genetic disorders. And usually, they have other associated symptoms too. One example might be Juvenile Huntington's disease.

Robert J. Marks:

Ooh, okay, that's not good.

Andrew Knox:

Yeah, it's not. So those children's would have dementia, and along with it, they would usually have other motor disorders too, problems like dystonia, where muscles are stiff in ways they aren't supposed to be.

Robert J. Marks:

I see. I learned a new word from our conversation before, and I practiced pronouncing it, but I'm probably going to screw it up, paroxysmal.

Andrew Knox:

Paroxysmal.

Robert J. Marks:

Paroxysmal. I had it right but I screwed it up there. What is that? I'm not going to try to say it again. What is that-

Andrew Knox:

What is a paroxysmal disorder?

Robert J. Marks:

Yeah.

Andrew Knox:

So that's a blanket term for any kind of problem that suddenly comes and then goes.

Robert J. Marks:

Ooh.

Andrew Knox:

So epilepsy or seizures would be an example of a paroxysmal disorder. Everything's working fine, and then the seizure happens, something's dramatically different, it ends, and then things go back to normal.

Robert J. Marks:

So a seizure would be an example of that?

Andrew Knox:

Yep, a seizure would be an example.

Robert J. Marks:

Another word I learned from you is syncope.

Andrew Knox:

Oh, yeah. So syncope often looks like a seizure. Syncope is, basically, a brief loss of consciousness, which usually happens because for one reason or another, you don't get enough blood flow up to your head. So probably many people have had the experience of standing up and then suddenly feeling lightheaded, maybe you see some tunnel vision, some black blurriness on the edges of your vision.

Robert J. Marks:

Oh, I see little dots.

Andrew Knox:

Oh, yep, yep. Dots can happen too. And if that's dramatic enough, some people may have experienced that the blackness on the edges of your vision eventually absorbs your whole vision, and you have other strange feelings, and then suddenly, you wake up on the floor looking up at people who are wondering what just happened to you. That would be a syncopal episode where you totally lost consciousness because for a short period of time, you didn't have enough blood flow to your brain.

Robert J. Marks:

And at what point should I be concerned if I'm suffering from syncope, because I get up too quick, I have low blood pressure, I get up too quick, whoa, too dizzy, I got to get up slow. But there was one time when I was a teenager that I got up real quick and I was exactly like you said, I was sitting back down and people were looking at me saying, "Are you okay?" And I thought, well, I don't know what happened.

Andrew Knox:

I've done that too.

Robert J. Marks:

Really? Okay.

Andrew Knox:

Most people, particularly, young people don't need to worry if they have syncope. The most common cause is because your blood pressure sits low, and so then your body doesn't compensate well when you stand up. The only problem that really causes for you is you tend to almost pass out sometimes. There are other patients who have what's called a vasovagal response. That's the sort of scenario where someone is coming at you with a needle to draw your blood, and all of a sudden, you feel sweaty and not so good. And then you might have a similar syncopal episode because of that response to that stimulus that you have. So those are the common causes of syncope. Those are pretty benign. They won't cause you any long-term problems. There can be some other causes that are a little more serious. There's some kinds of heart dysfunction that can cause syncope. So there are a few rare people who have syncope who might have a more serious issue, but that is the exception rather than the rule.

Robert J. Marks:

What do they call the person that takes your blood? They have a fancy word for it.

Andrew Knox:

A phlebotomist.

Robert J. Marks:

A phlebotomist, yes. Now, I give blood regularly. I go to functional medicine and they take my blood all the time. And I used to be scared, and then I realized that the expectation was a heck of a lot worse than the realization. So I just swallowed an eye, look at the needle going in and going, oh, that's interesting. But I asked these people, who are the people that wimp out the most? And on more than one occasion, I think for three different phlebotomist, they said that it's the guys that come in with big muscles and tattoos, which I thought was very interesting. It's like they want to put up this facade of this big, tough, macho guy, but they come in and they face a needle and they get all sweaty and stuff. So there's something deep and psychological about that, I think. In the diagnosis of some of these things, especially dementia, let's talk about dementia again, it doesn't look like that's something which would be diagnosed by a neurologist. That's more of a psychologist diagnosis. Is that right, or is it-

Andrew Knox:

So dementia is still something that's managed by neurologists. Some of this is just historically who's managed what. But again, dementia does come out of some change in the brain hardware. So for Alzheimer's disease, if you look on pathology, there are abnormalities that are not supposed to be there. They talk about plaques and tangles that you can see.

Robert J. Marks:

Plaques and tangles, is this in the pathology of the brain?

Andrew Knox:

Yes, this is on the pathology.

Robert J. Marks:

I see.

Andrew Knox:

So you have substance accumulating that's not supposed to be there, which causes injury to the brain and this progressive loss of function. So dementia has always been owned as a neurologic disorder and is usually something that neurologists manage. With Alzheimer's, people have been looking for a long time for treatments for this disorder, for medications that can slow progression.

Robert J. Marks:

Sure.

Andrew Knox:

And there are some that are available, but they work much less well than we would like. The field continues to look for things that you can do to slow that process, but if you're thinking about the contrast between neurology and psychology, again, something like depression would be a more typical sort of psychology owned disorder, where you have you know often you can identify particular thought patterns that are also associated with that disorder. And the strategies for coping with the disorder often are rooted in changing those thought processes. Things like cognitive behavioral therapy.

PART 1 OF 4 ENDS [00:27:04]

Robert J. Marks:

Yes. You also talked about something called non-epileptic seizures. What is a non-epileptic seizure? Every seizure that I've ever seen is epileptic, the people's eyes. I had a student, a master's student that's suffered from epilepsy and it's not a fun thing to be in the room when they suffer a seizure. It's something which comes, they wake up, at least in this case, he was a little cloudy minded, but eventually regained his senses. But there's a non-epileptic seizure. What would that be?

Andrew Knox:

Yeah, so this is a great example of sort of the interface between neurology and psychiatry. So a patient who has non-epileptic seizures experiences all the symptoms of a seizure. So from their perspective, they might notice involuntary movements of their body, and then they might lose consciousness and then wake up later.

Robert J. Marks:

Okay.

Andrew Knox:

Similar to a patient who has an epileptic seizure. The difference is that if that patient, if you were recording their brain waves, you wouldn't see any sort of change in the brain wave pattern. And so it's thought that those sorts of seizures come not out of dysfunction of particular neurons, but of certain thought processes or certain thoughts that potentially lie in the subconscious. Let me develop that a little further. So taking a step back and just talking about what is an epileptic seizure?

So what we think happens during an epileptic seizure, usually you have your neurons are firing off at sort of their appropriate times, working on their particular tasks that they have. The analogy I like to use with patients is you can think of it like a city full of people, the people are all going about doing their particular jobs or things that they're doing. During an epileptic seizure for a variety of different reasons, neurons usually wind up firing off together all at the same time in a way that's not helpful.

I explain this to patients, as you can think of it as a group of people in the city start to have a riot. They're all upset about something enough that they gather together, they all go to the center of the town and are yelling at people to change things. That riot goes on for a while, and then eventually people go their separate ways, it stops and the city goes back to functioning like normal. So you see evidence of that sort of a change in neuronal behavior if you're recording brain waves. So during an epileptic seizure, you see spikes in the brainwave patterns that happen a couple of times a second or even many times a second. So that's how I think of an epileptic seizure. Does that explanation make sense?

Robert J. Marks:

Yes, it does. Yes.

Andrew Knox:

Okay. Yeah. So then the contrast for a non-epileptic seizure, you don't have that same change in that the people are all coming together to the center of the city and rioting. You don't see those regular discharges on the EEG when you look at the brainwave patterns. In fact, if you look at an EEG during a non-epileptic seizure, the brainwave patterns are unchanged. So they look the same as the patient at any other time, but the patient is still experiencing all the symptoms of a seizure. And again, that happens because some part of how the brain is working to process what's happening is dysfunctional, usually in the patient's subconscious. So this can happen for a variety of different reasons. The classic illustration that I give patients is it's been described that patients who witness something that is a terrible traumatic event that they can't process, might wind up developing symptoms later that express that trauma that they just experienced.

Robert J. Marks:

I see.

Andrew Knox:

So a different variant. This would be another variant of a functional neurologic disorder. Non-epileptic seizures are one example of a functional disorder. Another example might be, let's say someone witnessed the brutal murder of their spouse, and then two or three days later, suddenly they are blind, they can no longer see. The neurologist does the exam, they see the pupils seem to respond normally, the eyes even seem to track in ways that you would expect. And yet the person is unable to see. That would be another example of a functional disorder. The brain hardware, the pathways that process visual information are intact, but there's something about that trauma that they witnessed that is preventing them from processing visual information and interpreting it the way they usually do. Does that make sense?

Robert J. Marks:

Yeah. Interesting. Okay. So I would describe as an engineer, I would say that an epileptic seizure, it's a difference between coherence and non-coherence, coherence and kind of chaos, if you will, in the brain.

Andrew Knox:

Yeah. Yep, yep. You could absolutely distinguish things in that way.

Robert J. Marks:

Okay, good.

Andrew Knox:

The way I like to describe this to patients or explain it to patients that comes out of my computer engineering background is epileptic seizures are like a hardware problem. You can see a change in the way that individual neurons are firing off, whereas non-epileptic seizures are more like a software problem. The hardware is working okay but the way the brain is processing the information is not working correctly during that period of time. And patients seem to be able to identify with that pretty well. Everyone can think of when they've loaded or tried to run too many apps on their phone at the same time, and the thing eventually just locks up and then you have to restart it, and then it goes back to normal function. And that's probably a good analogy in some way for what happens during non-epileptic seizures.

Robert J. Marks:

Understood. You mentioned things happening in the subconscious. Do we have access to measure activity in the subconscious in any way?

Andrew Knox:

The answer to that question is not straightforward, and there are probably people who could answer it better than I could, but I think there's probably not a good way to objectively access what's happening in the subconscious.

Robert J. Marks:

I see.

Andrew Knox:

Most insight into what is happening in the subconscious is going to come through the individual themselves, and it'll come over time. So that's part of the whole idea of psychotherapy is to spend time getting more access to some of those things that are happening in the subconscious that may cause some of the problems that you're having in a disorder like psychogenic non-epileptic seizures.

Robert J. Marks:

Okay. Understood. So the subconscious would be more in the area of what a psychologist would deal with, is that right?

Andrew Knox:

Yeah.

Robert J. Marks:

Okay.

Andrew Knox:

Yep.

Robert J. Marks:

Wonderful. Another disorder is functional gait disorders. Now, let me tell you about an interview that I did with a neuroscientist who had kind of a potential cure for gait disorders. He would show people walking with incredible gait disorders. In other words, they could hardly walk. They needed to grab the walls or handles in order to maintain their balance. But then they did something, they put a little vibrator on their tongues and this vibrator on the tongue, it was almost like a miracle, the people could walk better. That seemed to be very strange. Have you ever heard of this?

Andrew Knox:

I have heard of things along those lines, not that specifically.

Robert J. Marks:

Okay. Well, anyway, these guys, they tried to commercialize this. They went to the FDA, and there's a big difference between okaying a physical device that operates inside the body as opposed to external of the body. And since they put it in the mouth, they said it was internal to the body. So all of a sudden the hoops that these guys had to jump were just too great. So unfortunately, it was something that was tried to be reduced to practice, but the business plan didn't make it. I thought that some of these results were just astonishing in terms of the recovery, at least from what I saw. You never know what's true. You never know what's false. It was on the web, so it must be true, I guess.

Andrew Knox:

Certainly.

Robert J. Marks:

So tell me about functional gait disorders and how that relates to the way that the brain breaks.

Andrew Knox:

Yeah, those are really just another example of a functional disorder similar to a non-epileptic seizure or functional blindness that we talked about.

Robert J. Marks:

Sure.

Andrew Knox:

So really any sort of functional disorders that are rooted in disordered thought processes can wind up manifesting as a whole variety of different symptoms. So there's some patients who, because of their functional disorder, wake up and one day discover, "I can't walk normally anymore. I'm just not able to walk." There's some really interesting tricks that can help some of those patients. You mentioned the tongue vibrator thing.

Robert J. Marks:

Yes.

Andrew Knox:

Another trick that you see sometimes if a patient is unable to walk normally forward, they may still be able to walk normally backward.

Robert J. Marks:

Really?

Andrew Knox:

And so identifying things like that are helpful for the treatment of the disorder. Usually those disorders you treat along two different lines. One part of the treatment is cognitive behavioral therapy, so working with a psychologist to identify what are the thought patterns that are causing this particular symptom in the first place. The other line that you approach them through is by usually doing therapies, and that needs to be targeted to what the particular problem is. But for someone who can't walk anymore, they're going to work with a physical therapist to sort of rebuild that ability to walk. And discovering something like, "Huh, I can't walk forward, but I can walk backward," gives you a good sort of jumping off point for then re-learning sort of how to walk forward again.

Robert J. Marks:

Interesting. Fascinating.

Last time we talked about all of the ways or many of the ways that the brain can break, we included in the strokes injury to the brain, dementia. We found out, interestingly, dementia can happen sometimes in little kids. We talked about seizure and we talked about functional disorders like non-epileptic seizures and functional gait disorders. So we're first of all going to talk about how you fix some of these things, be a little bit more positive, and this, I'm sure is what Dr. Knox takes home with them and has warm feelings about when he can help people, and talk about some of the ways that we can make people better. So let's talk about this. What are some of the tools that we have to fix the brain?

Andrew Knox:

Yeah. Actually, among the different medical specialties, people often think of neurology as the specialty where we don't have lots of tools to fix things, but that's not really true. There are a number of things that we can do for many, if not most of our patients. I think broadly, maybe you could say a couple of different tools we have, and this is going to be different for different disorders. But there are medications that we can use to help address dysfunction in the brain. In the specific field of epilepsy, there are other interventions you can do like surgeries in some cases. In other cases, dietary changes can be helpful for treating seizures. There are devices that can be used to help address brain problems. The vagal nerve stimulator would be one example that has been around for a long time. And then there are for dysfunction that lies more in the realm of the mind, there are certainly psychologists are helpful too, or strategies like cognitive behavioral therapy can address this function.

Robert J. Marks:

Okay. Well, let's talk about some of the medications. I think one of the first ones for depression was Prozac, and I think this is like 30 years old or something like that. What do these medications do?

Andrew Knox:

Yeah. So again, there are many different medications for different disorders. If you're thinking specifically Prozac, that medication is a selective serotonin reuptake inhibitor. So I think last time we talked about our brain has neurotransmitters, substances that are used to communicate between neurons across the synapse. And these medications basically make those substances more or less available or perhaps more or less active at those synapses. So it sort of makes a change throughout the whole brain about how it is processing information.

Robert J. Marks:

I see. I also want to talk about, yeah, because I was on Prozac for a while, and man, it made a big difference. I remember taking Prozac, gosh, this was I guess 30 years ago when it first came out, and my wife made me go to the doctor and he said, "How you doing?" I said, "I'm doing okay." My wife said, "No, he's not doing very well." So the doctor said, "Well, let's try some Prozac." So I took some kind of reluctantly, and I remember waking up about a month later and sitting up in bed and going, "Oh my gosh, I'm happy." It was the first time for a long time. So that serotonin, whatever that was, began to flow in my brain and it started to flow, and it's been wonderful since. So that was just an amazing medication.

Andrew Knox:

Yeah, that's great. We still definitely use that medication often as a first line treatment for depression, and that's the sort of thing we always hope happens when you use these medications. It doesn't always work out as well as it did for you, unfortunately. And I think that's not totally surprising when you think about how we're using these medications. This is another area, I think where analogies to computers are sort of useful or analogies between computers and brains. Using a medication to change how the brain is working is a little bit like if you had a computer, let's say you build a computer, computers are built out of billions of transistors.

Robert J. Marks:

Yes.

Andrew Knox:

Let's say something was wrong with the transistor that you used to build your computer. So you have billions of these slightly misfunctioning transistors. If you could, I don't know, let's say do something to your processor that you had that made all of them function a little more like they were supposed to, then it's conceivable that that might make your computer work better. But it's still kind of a blunt tool. Initially, it seemed kind of preposterous to me that you would expect to be able to give all the transistors a little more electrons or something and expect your computer to work better. But we're sort of doing a similar thing using medications that work on the brain.

Robert J. Marks:

Interesting.

Andrew Knox:

Does that make sense?

Robert J. Marks:

Yeah, it does. What it reminds me of, you always have analogies between what you're learning and stuff you do. Dr. Egbert, who's the director of this show, and I are working on a project of phased array antennas, and these phased array antennas don't work as well as they could. They're depressed. So we could go in and we can tune the electronics. We can choose to tune the electronics so that the electronics make it work better. So I guess that tuning of the electronics is kind of like this Prozac. Very interesting. I think there's analogies all over the place.

Andrew Knox:

Yes. Now, for something like depression, most of us think of depression as one disorder, but the reality is probably there are many different kinds of brain dysfunction that can lead to depression. So there may be some patients where the real problem is there's just not enough serotonin around to do the normal sort of signaling, and that's a patient who may respond very well to that medication. But you may have another patient where there is a different neurotransmitter that is out of balance, or perhaps the problem is not a specific neurotransmitter at all. Perhaps the problem lies specifically in the realm of dysfunctional thoughts that this patient has over and over. Maybe they keep thinking, "I hate myself, I hate myself, I hate myself." And out of that comes their depression. Those patients, not all of those patients would respond in the same way to a medication like Prozac.

Robert J. Marks:

I see. Because their depression is not due to the flow of serotonin. It is a psychological feedback that keeps feeding on itself.

Andrew Knox:

Right.

Robert J. Marks:

I got it. I got it.

Andrew Knox:

Now, all this becomes more complicated because all these things are related. So the thought processes are happening in a brain that is built on these physical substrates, and the thoughts you have probably affect how neurons behave. It may affect levels of some of these neurotransmitters. So it's a sort of large entangled web that is difficult to totally understand.

Robert J. Marks:

Okay. One of the statistics I read is that people that take antidepressants are more prone to commit suicide. I thought this was such a stupid statistic because people that are depressed already have this inclination towards suicide, and if the medication doesn't work well, they go ahead with it. It's a terrible thing to advertise.

Andrew Knox:

It comes about, it's on a number of the package inserts of the antidepressants that they may increase risk for suicide.

Robert J. Marks:

But is that really true, Andrew, or is it that the sample set is actually biased towards suicide in the beginning?

Andrew Knox:

Oh, I think it definitely comes out of the sample set, and some of this just gets down to how adverse effects are reported. So if you do a clinical trial studying a new antidepressant medication, you've got a group that has a placebo, so is not getting the drug, but they think they are. And then the group that is getting the true drug. Then you look at how many patients in each of those groups had a particular side effect. You could look at suicide and you might say, "Oh, look, six patients who were treated with the medication committed suicide, but only three patients who were treated with the placebo committed suicide."

Robert J. Marks:

Yes.

Andrew Knox:

So then they would say, "Well, this medication may increase your risk for suicide" but that doesn't show causally that the medication is the reason for your committing suicide.

Robert J. Marks:

I see.

Andrew Knox:

It's just an association. It may be that everyone was having suicidal ideation and the patients who took the medicine got a little more motivated and more of them acted on those thoughts they were having. And sometimes it can just be natural variation between the two groups too, but you still have to report it if it's there.

Robert J. Marks:

Wow. Interesting. Well, we're talking about ways to fix the brain, and one of them is antidepressants, and there's also anti-seizure medications. How do those work? Anti-seizure medications, how do they figure out where the seizures are coming from and stop them?

Andrew Knox:

Anti-seizure medications work in a similar sort of way, really to the antidepressants, just acting on different receptors or neurotransmitters. So many of those medications, the first ones that were created act on a receptor called a GABA receptor or GABA.

Robert J. Marks:

Could you spell that?

Andrew Knox:

G-A-B-A.

Robert J. Marks:

GABA. GABA. Okay.

Andrew Knox:

Yep. So that's usually thought of as the primary inhibitory neurotransmitter in the brain. So it's a neurotransmitter that would make a neuron a little bit less likely to fire off.

Robert J. Marks:

So some seizures are caused by neurons not firing, is what you're saying? Is that right?

Andrew Knox:

Well, so the idea would be that sometimes if neurons get too excited or they're too likely to fire, then maybe a network of them will produce something like a seizure. And if you give a medication that works, that increases activity at GABA receptors, that may make them less likely to fire and you may prevent the seizure from happening. Make sense?

Robert J. Marks:

Yes. Okay. Understood. Well, since we're talking about anti-seizure medications, let's talk about epilepsy surgery. I want to tell you a little story. I had a student, a wonderful student, we'll call him David, and David had epilepsy. In fact, he's the one that had a seizure in my office at one time, and that was not fun to look at all. But one of the things about David, he was always positive, he was always happy, he was a Christian, he was always looking at his happiness and his faith in God. And I tell you, this is a guy that probably will never drive in his life because he has seizures and he has a very limited life. He's making a good living now as an engineer.

But he went on for some epilepsy surgery, and one of the things they did is they cut a flap out of his skull and they placed on his skull an array of sensors that they were doing something with. It was a total failure. In fact, his brain began to swell up, they had to stop the procedures, and sew him back up. So I guess sometimes those things work, that kind of epilepsy surgery. Tell me about epilepsy surgery, and I don't know, do you know what they were trying to do with that array of sensors?

Andrew Knox:

Yeah, I do. Yeah, I'll work up to explaining what they were doing there.

Robert J. Marks:

Okay.

Andrew Knox:

So maybe just some general background. So many patients with epilepsy will become seizure free on one of the medications they try. In fact, we usually quote, "Two thirds of patients will become totally seizure free on one of their first two appropriately chosen anti-seizure medications."

Robert J. Marks:

Wow.

Andrew Knox:

So those are reasonably good numbers.

Robert J. Marks:

Those are good numbers. My friend David, he tried diet, he tried this operation, everything, nothing worked. So he was in that one third.

Andrew Knox:

So he was in that other third. Yep. So we would say they have drug resistant epilepsy, and unfortunately, once you fail two appropriately chosen medications, the chances of responding to other medications gets lower. So like 3 to 10% chance we say for any particular medicine you try. So like you said, we think about things like dietary options, the ketogenic diet can be helpful for some patients. And then surgical options is the other option. For surgical options, you can think of two broad groups. One group is resective options, or we would say curative options, things that we think will totally get rid of the seizures. And the other group is palliative options. Things that aren't going to totally get rid of the seizures, but they'll make them happen less often.

Robert J. Marks:

Palliative, I've heard the word. What does it mean?

Andrew Knox:

Palliative means you don't think you're fixing the problem, but you're going to make things better than they were.

Robert J. Marks:

Oh, okay. I tell that with people, "I can't solve your problems, but I can help you enjoy them." So it's kind of like that.

Andrew Knox:

That is one way to put it.

Robert J. Marks:

Okay.

Andrew Knox:

That's good. Yeah. So patient resective surgery, the idea is pretty simple. If you have seizures that only come from one spot in the brain and you can show that that part of the brain is not doing anything else that's essential, meaning you wouldn't have terrible problems if it were removed, then you can take that part of the brain out and then the patient's seizures are gone. Okay. So it's a simple idea, but practically it's difficult to execute that.

Robert J. Marks:

So I think in David's case, what they were trying to do is they were trying to locate those points of seizure.

Andrew Knox:

Exactly. So that is the challenge of epilepsy surgery, locating exactly where the seizures come from. We have a variety of different tools for doing that. Different imaging tools, different EEG tools. But even with those tools, we still don't get as definitive an answer we would like in many cases.

Robert J. Marks:

I see.

Andrew Knox:

So in David's case, usually you start by doing some imaging studies like an MRI, functional MRI. You can do a PET scan to look at brain metabolism. You can do a kind of scan called a SPEC scan to look at blood flow right at the start of a seizure and then blood flow at other times and see what changes right when the seizure starts.

Robert J. Marks:

Well, that was the interesting thing. He went to the hospital and he says, "All my life, I've been trying to avoid seizures. And I went to the hospital and they told me try to have a seizure," which was terrible because that's the only way that they could do the localization is if he had a seizure.

Andrew Knox:

Yeah. So that is part of the workup for epilepsy surgery. That's sort of the opposite of what we're usually trying to do. So there are a number of tools that we do. We start out with non-invasive tools, and then sometimes if we need more information, we'll actually record directly from the brain itself, which is I think what they were doing with David.

Robert J. Marks:

Yes. Yeah. Unfortunately it didn't work, so I guess it works sometimes.

Andrew Knox:

Yeah, sometimes you can have edema like that. That's sort of a rare complication, but it can happen in some cases. Thankfully, it's never happened when I've been involved.

Robert J. Marks:

Okay.

Andrew Knox:

Actually, there are two ways you can do that monitoring. You can do it either, like you said with a grid that you place on the surface of the brain and it records from the brain. Now, we often do stereo-EEG. We pick specific places where we want to record from and then use a robot, basically, in the operating room to find those exact trajectories that we want, drill small holes in the skull at those locations, and then pass an electrode through into the brain. And it actually turns out, that's tolerated much better.

So patients, yeah, we've done that with a number of patients at this point, and none have certainly had any of those sorts of problems that you were describing with David. Most patients don't even need ibuprofen or Tylenol or anything afterwards. They just are stuck in their hospital bed watching TV and waiting for a seizure to happen.

PART 2 OF 4 ENDS [00:54:04]

Robert J. Marks:

That's something incredible. There's no nerves in the brain.

Andrew Knox:

Right.

Robert J. Marks:

Are you familiar at all with Elon Musk's work in Neuralink where he is trying to-

Andrew Knox:

I haven't followed it closely. I've been thinking as a neurologist, I probably should pay more attention to what he's doing just so I can ask or answer other people's questions.

Robert J. Marks:

Well, I think what he's doing is, I don't think that he wants to link the human brain directly to all of Wikipedia. I'm already connected with it, but Wikipedia, it's just through my fingers as opposed to my brain.

Andrew Knox:

Yup, and your eyes.

Robert J. Marks:

I only can think of one thing at a time. I mean, when I multiply two three-digit numbers, I have to write it down to keep track of my short-term memory and my multiplication tables in order to work it out. I don't want the Neuralink is going to do in terms of increasing my intelligence, but the place where it seems to be working and working nicely is helping people that are paraplegic or have some motor function problems and they can do things with this Neuralink that they couldn't do before. So anyway, that, I think, is kind of promising.

Andrew Knox:

Yeah, I think so. A number of people are interested in brain machine interfaces. And it is promising, particularly for people who have problems with the normal way that we would interact with the world. I think it will do a lot of good for people.

Robert J. Marks:

And I'm just wondering if he or anybody else is looking at these Neuralinks and seeing if they can help do things like diagnose epilepsy.

Andrew Knox:

Yeah. It's using the same basic tools. People are looking at that in different ways. Lots of people in the epilepsy field.

Robert J. Marks:

Okay. We're talking about different ways to fix the brain. We have medications, we have such as anti-seizure medications, antidepressants. We have epilepsy surgery, and another one is devices and the response to neurostimulation. How do I stimulate my neurons? I think I wake up some morning and I want to stimulate my neurons, so how do I do that?

Andrew Knox:

Well, I don't know that you need to use any of the methods we're going to talk about here. Probably going for a run is a reasonable thing.

Robert J. Marks:

Yes. Okay.

Andrew Knox:

To try just to get a little stimulation if you're not suffering from these problems. So, there are a variety of different ways neurostimulation can be done. One of the oldest sort of tools that's been used in the field of epilepsy is the vagal nerve stimulator.

Robert J. Marks:

The bagel nerve. What is that?

Andrew Knox:

The vagal nerve.

Robert J. Marks:

Vagal nerve.

Andrew Knox:

The vagal nerve, yup.

Robert J. Marks:

Not the bagel nerve. Bagel is a-

Andrew Knox:

Not the bagel nerve.

Robert J. Marks:

... type of bread. Okay, the vagal nerve. Okay.

Andrew Knox:

Although, the vagal nerve does innervate your stomach, so there might be a relationship there.

Robert J. Marks:

Okay, very good.

Andrew Knox:

Yeah. It's a nerve that is responsible for controlling a variety of different autonomic functions, including the stomach.

Robert J. Marks:

What is autonomic? You're using words and I'm kind of embarrassed I don't know them, but I'm old enough where I'm no longer embarrassed by asking questions.

Andrew Knox:

Yeah, I appreciate the questions. You can sort of divide the nervous system up into two parts. There's the somatic nervous system, so the one that deals with controlling muscles and the senses and that sort of thing. And then there's the autonomic nervous system. That's the one that's responsible for control of your various inner organs or guts and that sort of thing. So yeah, you can think of it as controlling your stomach and your heart and other organs like that.

Robert J. Marks:

Okay. Thank you. Go ahead then.

Andrew Knox:

Right. So the vagal nerve stimulator. Someone discovered that you can attach a device that's sort of like the pacemaker to the vagal nerve in the neck and repeatedly stimulating that nerve for whatever reason seems to make patients have seizures less often. Not all patients, but many patients. The mechanisms are not well understood, but there's a definite effect there. And subsequently, people have realized that that sort of stimulation may be helpful for other disorders too. For example, it can be used for refractory cases of depression.

Robert J. Marks:

Oh, okay.

Andrew Knox:

Yeah. So that was sort of the first pass of neurostimulation.

Robert J. Marks:

I have a cousin that was suffering from a lot of pain and he went in and they did something with the spine in order to alleviate his pain. And they went in and I guess it's very sensitive to the location, and so they were poking around. His problem was in his bowel region, and so they were poking around and one of them went directly to his groin and he started jumping up and down and all of the nurses and the doctor says, "What's going on?" He said, "It's in my groin," and they all started laughing. But is that an example of it, where they do the neurostimulation in the spine in some way?

Andrew Knox:

Yep, yep. That is another good example of neurostimulation. So for certain pain disorders, spinal stimulation specifically can be helpful. I haven't done as much with that myself, but it is another kind of neurostimulation. So in the field of epilepsy, another option that we consider that's a little more direct would be responsive neurostimulation or RNS. This device is actually implanted sort of on the underside of the skull, and you leave electrodes in the brain or on the surface of the brain that are attached to the device, and the device records brain activity. And then if it detects a pattern that looks like a seizure pattern, it can stimulate those electrodes.

Robert J. Marks:

I see.

Andrew Knox:

The initial idea was this may be helpful because it may interrupt the seizure or prevent it from developing or spreading to other areas. But it turns out there's actually probably also just as much and maybe more benefit that comes just from giving periodic stimulation to that area of the brain that's irritable and is producing seizures.

Robert J. Marks:

So this sounds like a device that's wearable, is that right?

Andrew Knox:

This is not wearable because it's implanted into the skull itself.

Robert J. Marks:

Oh, okay. Well, it's-

Andrew Knox:

So you keep it with you all the time, but you're not, well, I guess you're wearing it in a sense.

Robert J. Marks:

It depends on your definition of wearing, I suppose. Okay, yes, understood.

Andrew Knox:

Yep, you keep it with you all the time. And then there's a way to load information from the device to a computer so your epilepsy doctor can look at the patterns that are happening, determine how often seizures are happening, and then decide whether we need to tweak how the device is detecting seizures or stimulating to prevent them.

Robert J. Marks:

I see. Is this a common thing? I don't know if I know anybody that has these things with a transplant. You wouldn't call it a transplant, you would call it a-

Andrew Knox:

I wouldn't call it a transplant, right, because it didn't come from another person. Implants, I think, you would say.

Robert J. Marks:

Implants. Implants. That's a word I'm looking for.

Andrew Knox:

Yeah. It's usually not the first thing we go to. This would be used in patients who do have seizures coming from one area of the brain, but there might be some reason you wouldn't want to remove that area. Perhaps it's an important motor area or an important language area. It also gets used occasionally if you have seizures that are coming from two different places. Say you have seizures that are coming from both of your temporal lobes. We know that you can't remove both of your temporal lobes because if you do, you'll lose the ability to form new memories. So, the device can be used as a way in that scenario to help control the patient's seizures.

Robert J. Marks:

But before you use this, you have to know the source of the seizures. Is that right?

Andrew Knox:

That's correct. Yep. So, a lot of time and energy and effort is spent doing our best to pin down exactly where the seizures come from.

Robert J. Marks:

Okay. How to fix the brain? Medications, epilepsy surgery, neurostimulation devices. And the last thing I want to talk about, and this is a good segue into our next topic that we're going to do in the next podcast, is cognitive behavioral therapy. Tell me about that.

Andrew Knox:

So cognitive behavioral therapy lies sort of in the domain of the mind or in the realm of psychology. The idea of cognitive behavioral therapy is if you have a disorder that's coming from pathologic thought processes, cognitive behavioral therapy involves meeting with a psychologist to better understand what kinds of thoughts you're having, what particular thoughts may not be beneficial or may be causing the dysfunction, and then coming up with ways to change those thought patterns.

One example might be if someone had, say, an eating disorder, because every time they looked at themselves, they thought, "I look terrible. I'm horrible. I look ugly." The goal would be to get an idea of what specific thoughts are involved in that cycle, and then you would try to learn to replace those thoughts every time they happen with something else like, "No, I know that's not true."

Robert J. Marks:

In fact, that's a common symptom of depression. You think that you're no good, that the whole world's better than you are, and I guess that just feeds back in itself and it makes you feel worse. But you're saying that this can be treated with therapy then?

Andrew Knox:

Right, exactly. So, for many disorders, that is considered the gold standard for treating them. Particularly, I'm thinking back to functional disorders that we've discussed already. That is the most effective thing we have to cure some of those disorders. Now, obviously, that's not going to cure everything. Your cure needs to be targeted to what the problem is. So, you probably wouldn't cure epileptic seizures with cognitive behavioral therapy. That wouldn't be expected to work at all.

Robert J. Marks:

Of course.

Andrew Knox:

But, for many disorders, it can be beneficial or even the gold standard treatment.

Robert J. Marks:

I have a good friend, and you probably maybe know him professionally. I don't know if he's a good friend. He's certainly an acquaintance. J. P. Moreland from Biola University, one of the greatest living Christian philosophers. He suffered from incredible depression, and he wrote a book about it called Finding Quiet. I would recommend it to anybody who is suffering from depression that doesn't want to go to a therapist, maybe wants to self-treat. But it's called Finding Quiet.

And one of the things that ... Well, he says, first of all, you got to involve yourself, he's a Christian, so he says involve yourself in prayer, but go to the psychiatrist and get the medication. Go to the psychologist. But one of the things he found very useful is anytime he had a depressing thought, he always gave it a name, like Frank. And so, he had this depressing thought that he was no good, and he would talk to Frank as opposed to pound it down inside of him, and I thought this was really ingenious.

He said, "Hi, Frank. Boy, you're back again. I didn't want you back, but here you are. You know what, I don't have time for you now, but maybe later. Go away." And so, he dealt with it in that specific fashion, and I'm sure that this is part of this therapy that people go through for depression doing things like that and going through these mental exercises in order to break that loop, that feedback loop that makes them more depressing.

Andrew Knox:

Yeah. The goal of therapy is always to give the patient techniques that they use to address those problems. You always think of it as a time where you're trying to teach someone how to, those sorts of strategies to order their mental life as opposed to just the thing itself that helps being there in therapy.

Robert J. Marks:

Wonderful, wonderful. We want to talk today about the so-called mind-brain problem, sometimes it's called the mind-body problem. And it's been debated for centuries. And the question is, is the mind just a part of the brain, is an emergent property of the brain? Is consciousness part of the brain? Or are there parts of the mind that are distinct from the brain?

Now, there's two schools of thought in the extreme on this. There's the monist who believe that the mind is an emergent property of the brain. And then there's the dualist who believe that the mind is separate from the brain in some sense. There might be some overlap, but they're certainly not distinct. I would wager that most theists or dualists, Descartes, for example, in talking about the mind-body problem, talked about the mind as the soul. And Andrew, you have mentioned to me that you think that most neurologists are monists. Is that right? And if so, how come?

Andrew Knox:

So I think there is ... Yeah, and bent towards being a monist for a couple of reasons. One is I think just from a worldview standpoint, many of the people I've worked with in neurology seem to be of a naturalist bent. So the idea being that all there is is the physical world, and I think that lends itself to the monist viewpoint of the mind-brain problem. The other practical reason is it sort of comes out of how the field of neurology developed.

We talked a little bit about strokes and how you look at a patient who has an injury to a particular part of the brain, and then you see that they lose a particular function. So, neurology kind of has embedded into it this way of thinking that certain parts of the brain do certain things or associated with certain functions. And it just sort of naturally leads to the idea that, okay, the physical substrate, the brain does this thing or that thing. And so, probably it's responsible for all of how a person is. Does that make sense?

Robert J. Marks:

Yeah, it does. Okay, understood. Wow, most of the neurologists are modest. I helped write a biography of Walter Bradley with Bill Dembski. And Walter was in deposition one time and he was questioned about the difference between a naturalist and a theist, in this case, specifically a Christian perspective. And he was asked a question from an ACLU lawyer who was a naturalist and a theist. He said, "Dr. Bradley, are you a Christian?" And he says, "Well, yes I am." And he says, "Well, how as a Christian can we trust you to come up with definitive, disinterested answers in the area of science?" And Walter was testifying about science books in the state of Texas. It's a really big thing because when a science book is adopted in the state of Texas, it's adopted in a number of different states.

Bradley's response was, I think, wonderful. He said, "I'm sorry, sir. I'm not the one with the problem. You're the one with the problem. You have ensconced yourself in a small silo of expertise and belief, and everything that you come across must fit within this silo. Now, I can accept things happening in a natural way," he says, "but from my perspective, it isn't the question of whether or not God did it. The question was how God did it. And I would say, sir, that I have a much broader perspective and could be much more objective than you are because you are constrained to this little silo of naturalism." I thought that was just a beautiful response and I think a very appropriate response for people that are naturalists. And this is what you're saying of neurologists. They believe they're monist so everything that they see has to be fit within this little silo of naturalism. It's frustrating.

Andrew Knox:

Well, it's a good example. We all like to think of ourselves as impartial or fair judges of things, but we're all constrained by the things we believe about the world. Sometimes those assumptions have practical implications for questions, sometimes they don't. But in this case, if you are someone who thinks that there only is the physical world, then, of course, you're going to say it doesn't make any sense for there to be a brain and a soul, two separate things. You're sort of stuck believing that it has to come out of the physical activity of the brain itself.

And to be fair, someone who is a Christian has probably some of the same or bringing some of the same assumptions in, and it affects how we think about the problem a little bit too. If you're a Christian, you're told in the Bible that there is a soul and there is the body, and there are different things, and so you can't help but bring that into how you study these sorts of problems.

Robert J. Marks:

That's true. Everybody has their bias. I always say artificial intelligence without bias is like water without wet. You have to have some sort of bias. But in my case, there's been a number of times when my mind has been changed. And I think that that's one of the beautiful things about faith, and specifically Christianity, is that you can address any problem. There's nothing which prohibits you from looking at anything. Well, you mentioned some things which happened in neurology that you think are problematic for the monist, and I'm wondering if you could go through some of those from a neurologist point of view.

Andrew Knox:

Sure. Now, I think it's probably worth giving the disclaimer that I'm not sure that any of these things are an absolute invalidation of the monist standpoint.

Robert J. Marks:

Would you say, however, they are evidence of dualism?

Andrew Knox:

Yeah. There are problems for monism or things to consider.

Robert J. Marks:

Well, yeah. I love a quote by Stephen Hawking. He said, "Nothing in physics is ever proved, you just accumulate evidence." Nothing in physics is ever proven, you just accumulate evidence. So this is evidence for dualism. Not a proof, but evidence. Okay, go ahead.

Andrew Knox:

Right. And neurology is way worse than physics too, right?

Robert J. Marks:

Yes.

Andrew Knox:

There's plenty of unknown in both domains. But one of the things that draws some of us to neurology is just there's so little that's known that there's still a lot to be learned, which is fun. But yeah, I always think it means you should also be cautious about making absolute assertions as to how things are working.

Robert J. Marks:

You shouldn't make absolute conclusions about something. You're absolutely right. Okay, go ahead.

Andrew Knox:

Brilliant. Okay. So, let's start with epilepsy, since that's sort of the area that I know best.

Robert J. Marks:

Yes.

Andrew Knox:

Okay. So if you assume that the soul entirely comes out of the brain, or that the mind and the brain are the same thing, you would think that there would be, if you remove enough of the brain, you'd expect to see substantial changes in a person. But you can do fairly dramatic surgery affecting part of the brain and not see a change in how the person acts, or how they behave or who they are. We have some patients who have more severe kinds of epilepsy where seizures start up on one side of the brain and they can't be controlled. So there's a procedure you can do called a hemispherectomy where that entire half of the brain is removed.

Robert J. Marks:

They take out half of your brain?

Andrew Knox:

So, historically, they took out literally half of the brain. Then they discovered there are a lot of complications that come with actually physically removing half of the brain. So they've shifted to disconnecting half of the brain. They still take out a chunk of that brain. They remove or they disconnect the corpus callosum. They disconnect other motor pathways. And the physical brain still remains there, but it's not connected to anything else and not doing anything anymore.

Robert J. Marks:

Really? Okay.

Andrew Knox:

Yeah. So, even with removing half of the brain, the person doesn't seem to change. They will have some new deficits, so they won't be able to see half of the world on one side. They probably won't be able to move their arm on one side well, they won't be able to move their leg well. There can be some subtle changes in cognitive function, like how they would do on an IQ test, but it's not a very dramatic change.

Robert J. Marks:

So their IQs would probably go down a little bit, is that what you're saying?

Andrew Knox:

Yeah, they would, yeah. But it's not like they're a different person despite half of the brain being gone.

Robert J. Marks:

Oh my goodness. One of the arguments that I've heard, this is from a neurosurgeon, Michael Egnor, he does operations. There's probably a fancy word for it. He calls it a split brain operation, where they go through and they separate the left half of the brain hemisphere from the right half of the brain hemisphere in order to get rid of communications for an epileptic signal that starts on one side of the brain and goes to the other side of the brain. If you do the slicing, then that communication path is disrupted.

Now, if we had a mind associated with the brain after that, you essentially have two brains, I think. And it's like you said in these, well, let's see a word I learned from you, hemispherectomy. It's like in that where they remove part of your brain, you're still you. You still have the same mind, if you will.

Andrew Knox:

Right. So that's maybe even better evidence that it's more complicated than just the physical substrate of the brain correlating directly to who you are. Because like you said, there aren't two yous. You don't see those people arguing with themselves or running into those sorts of problems.

Robert J. Marks:

I do understand that they do have, sometimes, some psychological problems they have to overcome.

Andrew Knox:

Yep, it is true. And there are some symptoms you can expect to see right after surgery. Some of those get better. Sometimes there can be sort of strange things that happen, an arm moving on one side of the body in a way that you don't expect or that you don't feel like you have total control over. But, again, it's not like they're two separate people living in one brain.

Robert J. Marks:

I think that that is very, very compelling. Now, are you familiar with the split brain operation? Do they totally do the split brain? There's still something common, isn't it? Isn't there still a pathway?

Andrew Knox:

There are still connections, yeah. So, the split brain operation more formally is called a corpus callosotomy. The corpus callosum is the major connection between the two halves of the brain. There's still some small connections in anterior and posterior commissure and some frontal connections as well. But I think I wouldn't expect those are mitigating a lot of a person's consciousness. So, all of that to say, I think your point holds true that the fact that you don't become two people with a corpus callosotomy is a problem for the monist viewpoint.

Robert J. Marks:

Another one that you pointed out, which I agree, is evidence of that the mind is separate from the body or near-death experiences. You've been around a lot of patients that have had brain surgeries and have probably been anesthetized maybe to the point of, I don't know, I don't think that they're brain-dead, or maybe they are brain-dead, but they come back and they've had these incredible out of world experiences. Tell me about your experiences and your thoughts about near-death experiences.

Andrew Knox:

Well, yeah. So, actually, my experiences in that domain are relatively limited. There aren't too many I've had who have run into those sorts of experiences. But I understand that you have researched some of these things, right? Working towards putting something together, yeah?

Robert J. Marks:

Oh yeah. In fact, I think that it's just incredible evidence of something happening above and beyond the brain. And there is this great book that I just read by Bruce Greyson. It was called After. And Bruce Greyson was a psychiatrist. He got interested in near-death experiences and he actually formed a society that studied them. He published a lot in them. He had a journal, which he started on near-death experiences.

And this is really interesting. If you go to Amazon.com, they have a list of tens and hundreds of books on near-death experiences. So, it's something which has just become popular in the last, I don't know, decade or so. I think it's because of the medical capability of resurrecting these people after they are brain-dead and body dead and having these out-of-body experiences. But Greyson points out, he says that 90% of the people that have these near-death experiences believe that they're real. They're also life-changing. They come out of this situation totally different people. Yeah, he just finds this astonishing. So I don't know if anybody's interested in near-death experiences. Bruce Greyson's book is recommended. It's called After. Now, he's a psychiatrist, he isn't a theist, and so his, I don't know, for some reason not being a theist gives people more credibility. I don't know if that's necessarily true, but we use that a lot. If you want a more theist book, I think a great one is by John Burke called Imagine Heaven. He also has a sequence of videos on YouTube. The videos on YouTube are incredibly compelling. Because I tell you, you read about near-death experiences, that's one thing. You talk to the people who have experienced the near-death experiences and it's totally different.

You see their commitment, they begin to cry, they begin to break down, and a lot of people display wonderful experiences of kind of going to heaven, if you will. That's what John Burke says that they do. Bruce Greyson doesn't say heaven, but it is kind of an afterlife experience. But the ones that are chilling are the ones that went to hell. You want to watch something that is just chilling, watch the John Burke interview with a guy that went to hell. You see this guy, he breaks down, he just starts crying and sobbing when he relives this near-death experience, and you know that indeed these are real experiences in the sense that 90% of the people that have them say that they are real. Now, I actually asked one of your colleagues, Timoni, about near-death experiences. He said, "Well, I can give you drugs like," I don't think he mentioned it, but LSD or peyote mushrooms or something like that, and you can experience something similar.

But there's near-death experiences which are documented and it's more than one. Again, it isn't proof, but it's certainly evidence about these experiences that the things that these near-death experience people go through, one of which is in more than one equation... One equation, that's my engineer coming out, more than one occasion that somebody who has been blind since birth is able to see. What the heck is happening there? They talk about there's this one story about a girl that didn't know what she was experiencing, but finally she saw herself on the operating table and she was able to identify I think it was something she was wearing or her hair or something like that, and she says, "Oh my goodness, I'm seeing for the first time in my life."

There's other cases where people had out-of-body experiences, they could tell things that happened external to the operating room. In one case, there were objects which were not visible at all from any perspective and the person experienced them. In fact, Bruce Greyson, the way he got interested in near-death experiences was really fascinating. He said he was eating french fries or something like that, and he was putting ketchup on them, and he had a beeper. So he's been in this area for 40 years. The guy's been doing near-death experiences for 40 years. So his beeper went off and they used to call that beepellipsy where the beep went off and he jumped and he spilled ketchup on his tie.

Well, he took his napkin and he dabbed it in a sheet of water and he rubbed it and tried to get it off and it couldn't go off. It turned out at the time he was treating, he was a psychiatrist now, he was treating a girl that had tried to commit suicide that was in a deep coma. He began to talk to her sister trying to tell her what was going on with her sister that tried to commit suicide. Well, the next day or in a couple of days, he met with the suicide victim and they began to talk. The suicide victim who was in a coma said, "Yeah, I saw you." Greyson said, "Well, yeah, sure." I don't know, I'm a big skeptic if I hear a single anecdote, I like to see a bunch of them in order to accumulate evidence, but a single anecdote doesn't make it.

But she says, "Yeah, I saw you talking to my sister." He thought, "Yeah, yeah, sure. Okay." She said, "Yeah, you were wearing a gray flannel suit and your tie had this red spot on it." So she was able to actually identify that red spot, not having seen her sister or talked to anybody else in terms of that out-of-body experience, that near-death experience. I don't know how those sort of experiences such as blind people seeing, such as identifying objects not visible anywhere and these other things, I don't see that how they could be induced by taking LSD or peyote mushrooms.

PART 3 OF 4 ENDS [01:21:04]

Andrew Knox:

Right. Yeah, I agree. If you're trying to argue for a dualist perspective, those sorts of stories are the most compelling from near-death experiences, ones where people witness what happens while they are cardiac arrested or that sort of thing, and can reproduce those details. It's hard to explain how that would happen just from an honest viewpoint.

Robert J. Marks:

Yeah, exactly. When pressed on this, most people kind of change the subjects. In other words, this is not addressable. They think it's some sort of parlor trick or some sort of thing.

Andrew Knox:

Yeah, yeah. Well, I mean, right. To be fair, it's easy enough to say, "Oh, maybe some of those stories have just been made up or people added those details."

Robert J. Marks:

Yes.

Andrew Knox:

I haven't talked directly to the people who have had these sorts of experiences. But I don't know, I prefer to take them at face value at this point.

Robert J. Marks:

But reading again Bruce Greyson's book called After, he has documented thousands of these near-death experiences, and he has a number of these unexplainable cases which are documented. I mean, I don't know if they're chilling. They're a little bit chilling, but they're also pretty compelling. I think they are. So I guess I've revealed myself as a dualist. Where are you at?

Andrew Knox:

So where am I? I am a dualist as well. I'm perhaps a weaker dualist than some. There's certainly all sorts of ways that the brain and the mind are interrelated. I think I mentioned in passing, you can't remove both temporal lobes because if you remove both temporal lobes, you can't form new memories.

Robert J. Marks:

Yes.

Andrew Knox:

Yeah. Memory seems like something that's an important part of what the soul is, or our mind or our spiritual self. So again, it strikes me as a way where the two certainly are closely linked together.

Robert J. Marks:

Oh, I don't think it's distinct. I think that there is fuzzy overlap, but I think I believe, I think is in the area of what you say you think that, yeah, there is kind of compelling evidence that the mind is not totally a part of the emergent property of the brain.

Andrew Knox:

Right. So the question becomes, can you explain, is the mind entirely dependent on the brain or can it exist apart from the brain? Or are there parts of the mind that are definitely distinct from the physical brain?

Robert J. Marks:

Yes.

Andrew Knox:

I think that's probably true, or I think that is true. Now, part of my reason for believing that actually comes more I think from my faith than what I know about neurology, if that makes sense.

Robert J. Marks:

Okay. Well, let me ask you about that. You and I are both followers of Christ, and you have some thoughts on what scripture teaches your faith from the doctrine of resurrections, and you mentioned I think 1 Corinthians 15.

Andrew Knox:

Yeah, that's right. So Paul is very clear that there is life beyond this one, and that if we follow Christ, then we will, after we die, be resurrected and be given a new and glorified body. The implication there too is that we remain the same person but with a new body. So that belief really requires that the mind somehow be separable from the physical substrate of the brain.

Robert J. Marks:

Right. If one is going to talk about things such as eternal life, right?

Andrew Knox:

Right. If they were one and the same, then when the brain was gone, there wouldn't be any way to preserve the mind, preserve the person. But as Christians, we're told that will happen. So you're stuck saying at least that the two can be disentangled. Now, I can sympathize with someone potentially who says all of what we experience as the mind comes about because of the physical substrate of the brain, and then God creates a new brain that somehow starts at the same point and then the mind comes out of that one. So some might argue that that's still some sort of in-between position between dualism and monism or some kind of soft monism, I guess.

Robert J. Marks:

Yeah.

Andrew Knox:

I can't work out specifically which of those things is happening. I think the thing I care the most about is I'm saying that I really don't agree with the hard sort of monism, that the mind is sort of it's there, but it comes from the physical substrate and it's kind of an illusion, and actually everything you do is just determined by your physical brain and you're sort of a prisoner to that. I reject that philosophy in teaching. I think there are all sorts of problems that come from that and that it's not compatible with a Christian worldview.

Robert J. Marks:

One of the people that I learned from quite a bit, Andrew, was Roger Penrose, who is a naturalist who believes that the human brain of the computer can never be creative. He wrote an entire book called The Emperor's New Mind about this, just a fascinating book. Yet Penrose believes that there can still be a naturalistic explanation, and we're seeing this happening more and more now as people are beginning to talk about maybe there's something happening in the quantum realm. The idea of my book, Non-Computable You, that I wrote was that everything that a computer does is algorithmic, and there are things that humans do which are non-algorithmic. They can't be explained by step-by-step procedures.

Penrose is actually the one where I got this idea from, even though he's a naturalist, but he looked around and he said that, "Well, you know that the only thing in this world that I can think of that is non-algorithmic, that is still naturalistic is quantum mechanics. He looked at the quantum world, which is non-algorithmic, the collapse of a wave function is totally non-algorithmic, and he says, "I think that the secret to consciousness lies there." Then there's been other people which have come across and they talk about the idea of quantum consciousness.

However, trying to review the material, I see no evidence that this quantum theory has any traction. It isn't to say that it won't, but my point is, as being a theist and talking about my silo being outside, including naturalism and also outside of naturalism, I do believe that maybe quantum things may someday indeed prove or lend evidence to why we are conscious. We just don't know yet. It could be, and we might never know.

Andrew Knox:

Yeah, I mean, I think if you were a naturalist, you could probably make a good argument for a monistic worldview that didn't involve quantum behavior. But yeah, I don't know either. You can argue sort of everything is a result of quantum mechanics, right?

Robert J. Marks:

Well, I guess, yeah, if you drill down deep enough, I suppose you can.

Andrew Knox:

Right.

Robert J. Marks:

But of course, I maintain that there are things which are non-algorithmic. I would talk about human emotion such as love, compassion, and the non-obvious ones are sentience, understanding and creativity. Properly defined, we have to go through and we have to define what those are before we can talk about them, but properly defined, yeah, they're not going to be creative, they're not going to be sentient and they're not going to understand what they're doing, and that's my contention and the entire focus of my book, so. But I believe that maybe there is something to the quantum, and then you have to ask the question, let me ask you this, see what you think.

There are organs which are grown in pigs, okay? They do like a pancreas, because the pig is very close to humans in some biological sense that I don't understand. They asked the person that was growing the pancreas and the pig, "Hey, could you grow a brain in the pig, a human brain?" The answer was yes. Then the question is, if you grew a brain in a human pig, would there be any sort of things such as consciousness or non-algorithmic things that it could do? I think that that is totally non-answerable now, I don't know, maybe you have some thoughts on it, but-

Andrew Knox:

Yeah, the closest I've come to dealing with that question, I guess, so I'm interested in epilepsy from a research standpoint too. Actually, a lot of what I do is computer modeling of seizures.

Robert J. Marks:

Oh.

Andrew Knox:

Which ironically sort of assumes this correlation between the physical world and what people experience on a higher level brain or higher level mind function.

Robert J. Marks:

Yes.

Andrew Knox:

But anyway, in thinking about different ways to study this, I talked briefly with some folks here who do research with brain organoids.

Robert J. Marks:

What is a brain organoid?

Andrew Knox:

So you basically take certain kinds of cells from a person and you can induce them to turn into neurons, and then you can induce them to start following typical brain development patterns using some of the same techniques you'd use to make a pig pancreas or that sort of thing. So you have little clumps of brain tissue basically that grow in a dish. So my question for them was, "Oh, cool, you have these shapes that are sort of organized layers of neurons and that sort of thing. Do they have seizures or can you make them have seizures?" He kind of laughed and said, "That's a great question." It's like, "I don't really know." So when you have a structure like that, certainly they don't do normal sort of activities, and it's hard to understand whether they even have typical abnormal brain activities, common dysfunctions like seizures or other problems.

Robert J. Marks:

Interesting.

Andrew Knox:

So those technologies are very interesting, very, very young, shall we say.

Robert J. Marks:

So what are they using these brain organoids for? Are they using it to supplement missing brain tissue or something?

Andrew Knox:

No, no. They're used mostly for research at this point to better understand brain development and sort of the sequence of events that happens in neurons and potentially to understand some kinds of disorders too.

Robert J. Marks:

In your crystal ball, do you think they will ever be used for that sort of purpose for supplementing brain tissue?

Andrew Knox:

Not soon, if ever.

Robert J. Marks:

That's a safe answer, Andrew. Okay.

Andrew Knox:

Yeah. I would say definitely not in the next five years.

Robert J. Marks:

Okay. Well, that's going to be really interesting.

Andrew Knox:

Anything beyond five years, I'm really hesitant to say anything about.

Robert J. Marks:

Okay, I want to leave you with a neurological joke that I do with my kids around visitors. When my kids were like one and a half, this is totally off topic, brand new topic. When they were about one and a half, they were just learning to talk. I would say, "Okay, come here, Joshua. Okay, where's your nose?" He would point to his nose, I would say, "Good. Where's your lips?" He would point to his lips. "And your eyes." He'd point to the eyes and then the ears. Then I'd say, "Where's your medulla oblongata?" The reason that's so funny is medulla oblongata is just a funny word to say. It really is. But I trained him to reach over and grab the bottom of the back of his neck.

Andrew Knox:

Nice.

Robert J. Marks:

He knew where the medulla oblongata was. So my kids have grown up knowing a little bit about neurology from what I trained them as kids.

Andrew Knox:

That's great.

Robert J. Marks:

Where's your medulla oblongata? I don't think there is another organ in the body that has as funny a name as the medulla oblongata.

Andrew Knox:

I agree with you.

Robert J. Marks:

Okay. Well, Andrew, what a joy to talk to you.

Andrew Knox:

Actually, I have one other thing.

Robert J. Marks:

Sure.

Andrew Knox:

Just before we move on that I wanted to mention. So we sort of talked about how your worldview affects how you look at some of these problems, whether you're a dualist or a monist.

Robert J. Marks:

Yes.

Andrew Knox:

I do think that despite some people's worldview though, there's maybe an implicit assumption or we naturally assume that people actually are dualists. So some of the most ardent monists are folks who also are arguing for one day we should be able to transfer human consciousness into a computer.

Robert J. Marks:

Oh, yes. Can we upload ourselves?

Andrew Knox:

Right. You say, "Well, you make a different physical substrate and then move the same information over to this other system." But again, implicit in that is something that maybe monism isn't quite right, because how can you transfer the same person to a different thing if it's not entirely dependent on the physical substrate? Does that make sense?

Robert J. Marks:

It does. I have a problem with it on a more fundamental level. I think, and again, I learned this from a Nobel laureate, Roger Penrose, that there are parts of the brain and parts of our mind that are non-algorithmic.

Andrew Knox:

Yeah.

Robert J. Marks:

If indeed that is the case, then when we upload ourselves to a computer, we can only upload the algorithmic part. We can't upload emotions. We can't upload the ability to create or understand or be sentient or I believe conscious. So I think that if you took any person and you took away all of their non-algorithmic traits, they would be pretty boring people.

Andrew Knox:

Certainly true. Yeah.

Robert J. Marks:

Yeah. So I think that if we do a computer, it can't be the computers of the type we use today. It would have to at least be one of these computers that was an organoid or something like that. How you would do that, I have no idea.

Andrew Knox:

Right.

Robert J. Marks:

So what do you think? Do you agree?

Andrew Knox:

Oh, I don't think that's anything people will ever be able to do. Yeah. Beyond that, I'm not exactly sure how to go about answering the question. Yeah, I think maybe we joke in neurology sometimes about the idea of brain transplants as a solution to problems.

Robert J. Marks:

Okay. Let me ask you, is that possible?

Andrew Knox:

No.

Robert J. Marks:

Okay. It isn't possible.

Andrew Knox:

Not currently. Could it ever be possible? I don't know. There are a lot of things I don't know.

Robert J. Marks:

I could see that being a way of achieving immortality maybe.

Andrew Knox:

Yeah, right. So that raises all sorts of interesting ethical questions if something like that even were possible. If you could do that, maybe that would give other answers to the mind-body problem. My gut instinct is that that is never going to happen.

Robert J. Marks:

Well, I'm just wondering if the connectivity problems, I have read about people that have proposed head transplants, and of course, this is really ridiculous. I think they've done it on animals, but currently the interface with the spine is so complicated that anytime you try to do a head transplant on a human being, that transplant recipient would be a quadriplegic because you couldn't connect the spinal cord. You couldn't get the rest of the body to work. So that doesn't seem to be a very good way of doing this.

Andrew Knox:

Yeah, probably not. Now, is it possible that someday you could find a way of doing that and then give growth factors that caused things in the spine and brain to connect, and maybe you could have some 20-year rehabilitation paradigm that would let you start to use things in the way you did before? Maybe. I don't know. But I think it's unlikely.

Robert J. Marks:

It's interesting because I maintain that nature and humans abhor a spiritual vacuum. If you are a monist, you want to achieve immortality. Now, us as Christians, we've known about immortality for a long time. Their answer for immortality is the upload of the brain. So it's these two total different philosophies trying to achieve immortality in a different way.

Andrew Knox:

Right. I agree with you. Again, I think it shows that really all of us have some sense that there's more to us than just our physical body.

Robert J. Marks:

Yes.

Andrew Knox:

If you're a monist, you probably had to work to try to unlearn that at some point. But the part of you that has intuition that that's true sort of still peeks out sometimes. I think that's where a lot of the discussion about uploading yourself to a computer has come from.

Robert J. Marks:

Yes. Okay. Fascinating stuff. Andrew, this has been a great time.

Andrew Knox:

I agree.

Robert J. Marks:

I've really enjoyed chatting with you. We have been visiting with Dr. Andrew Knox. Dr. Knox is a pediatric neurologist at the University of Wisconsin School of Medicine and Public Health. Thank you, Andrew. I had a lot of fun.

Andrew Knox:

You're welcome.

Robert J. Marks:

Blessings. So until next time, be of good cheer.

Announcer:

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PART 4 OF 4 ENDS [01:45:16]