Announcer: Bulletproof Radio, a station of high-performance.

Dave: You're listening to Bulletproof Radio with Dave Asprey. Today's guest is Dr. Eric Kandel, he is a Nobel prize-winning renowned neuroscientist with a psychiatric background, and truly one of the pioneers of modern brain science. He's been described by a colleague as one of the truly great intellects, one of the greatest scientists, and greatest neuroscientists of the last hundred years, and something I would agree with.

Dave: Dr. Kandel, my wife studied at the Karolinska Institute, where you gave an acceptance speech, and she was actually in the audience when you accepted it, and she asked me to tell you at the beginning of the interview that your medical textbook was her favorite book in all of medical school. She was really excited when she found out that we're going to get a chance to speak live, so truly an honor to have you on the show.

Eric: Well, I'm delighted to be here.

Dave: You recently wrote a book called The Disordered Mind: What Unusual Brains Tell Us About Ourselves, after decades and decades of research, and looking at the mind, what do unusual brains, what does it tells about ourselves? What can we all learn from this? I've never had a chance to talk to someone who has this much knowledge in one brain, and asked that one, "What do we learn?" The one point.

Eric: Well, we see what different regions of the brain do, what their function is, because we see that if some particular behavioral function is abnormal we can trace it down to particular brain architecture, and that allows us to relate structure function. There are a number of ways of doing it, but there's a very powerful way of doing that. What did the different brain regions, and sub-regions mediate in terms of behavioral function?

Dave: Does this mean that if someone has a structural problem in their brain that they're stuck? If you got hit in the head when you were a child, that part of your brain doesn't do what it was supposed to do. Is there hope?

Eric: If it's a child, yes. For example, you have damaged your left hemisphere, which is involved in speech, if that occurs to you as an adult you have something which is very unlikely to return to you in its normal level of function. If this happens to you when you're less than, let's say 12 years old, there's a very good chance that the right hemisphere will take over and compensate for it. There's plasticity in the young brain that is lacking in your brain and mine.

Dave: Do you believe that we'll ever be able to turn on childlike neuroplasticity in adults?

Eric: Probably not.

Dave: Probably not, okay. What drives that assessment?

Eric: Well, there are anatomical changes that occur in the brain as you mature that's almost impossible to reverse, so it's hard to consider that. Perhaps one can have a brain explant, that is to take some immature brains, perhaps from somebody else, and implant in to your brain, and that might get incorporated and function as a immature brain in your skull, underneath your skull. It's unlikely, but that's an outside possibility.

Dave: When we talk about unusual brains it brings to mind a couple stories. I interviewed a woman who has a phenomenal brain for research and asked her, "Why can you do what you do?" She said, "When I was 21 I had a virus in a part of my brain, and it created a lesion that grew another part of my brain inside of it," and she says ever since that happened she could look at a stack of research papers, and synthesize it in a way she never could before. I always, like you, look at these outliers, or my wife, she hit her head when she was eight before that 12-year-old thing, it took out the language processing center of her brain. She fell off of a two-story building, and was unconscious for three days. She could do simultaneous translation and speak five languages, and run an emergency room, but they now hypothesize having looked at the structures in her brain, that it's because the right hemisphere took over, but she was a child a example, the other one was an adult example.

Dave: If you put on your 50 year in the future hat, do you see any hope for people being able to programmatically make those kind of changes to our brains or do you think that's just too messy, and it's unlikely we'll ever be able to do it?

Eric: It's hard to predict what's going to happen 50 years from now. It's hard enough to predict what's going to happen 10 years from now. I think it's unlikely, also to explant, to take a piece of brain from one person and put it into another person's head is not an easy game.

Dave: No.

Eric: It's not the kind of thing you want to do routinely, you want to do it as an emergency measure. You don't want to do it as a way of enhancing your brain, probably the more effective way of enhancing the brain is to practice studying foreign language, the piano, the cello, etc., etc. That will cause enlargement of certain areas of the brain, give you new capabilities that you didn't have before, particularly if you started at a young age where the brain is most plastic, you have the greatest chance of developing new capabilities that you didn't have before.

Dave: There are a variety of compounds that we've discovered, that increase things like nerve growth factor or a brain-derived neurotrophic factor, BDNF, and it seems like we can raise levels of those by at least 50% in adults, even with things like exercise. In your experience in neuroscience, are those techniques likely to be valuable for helping adults learn better or do you think those factors are ... that's not enough?

Eric: I think it's unlikely that those factors will help with that. [Inaudible 00:06:37] it's certainly possible they will get some compounds, hormones, and substances that will enhance cognitive capabilities. The substances that you mentioned are those that are normally present in brain, and they're particularly helpful if some part of the brain is lesioned that produces that. By giving it exogenously you can compensate for the natural production of that by the brain.

Dave: That makes a lot of sense. I want to go back to two years before I was born, back to 1970, when you looked at how chemical signals change the structure of the connections between synapses. How did you arrive at the breakthrough to understand that? What was the learning process that led up to the aha moment for you? We're talking about the aplasia.

Eric: Between 1957 and 1960 I worked at the National Institute of Health, and I had earlier, in medical school, I had a six-month elective period in which I could do whatever I wanted to, and I wanted to be a psychoanalyst. I thought that even a psychoanalyst should know something about the brain, [inaudible 00:08:01] on the brain, and I just loved it. Based upon that one experience I was nominated for the National Institute of Health. I'm nominated, but I graduated from medical school. Physicians were being drafted into the surface for two-year stint, but those that were eligible were selected for a research program at the NIH. I was selected for research program at the NIH, and I enjoyed it so much I stayed not two years, but three years, and had a wonderful experience there.

Eric: What I did there was to record from single cells in the hippocampus, the area of the brain that was known to be very importantly involved in memory storage, and I found how T cells worked, but I didn't learn that much about memory storage. I realized that to study memory, particularly at the beginning, you needed to look at a behavior and see how it is modified by learning, looking at the hippocampus was a little bit too complicated as the first step. I decided to look for a simple system, that had a simple reflex behavior, and could be modified by learning. I focused in on the marine snail Aplysia because it has the largest nerve cells in the animal kingdom, and relatively few of them. You could work out a neural circuit and withdrawal reflex in terms of the individual cells that mediate it, work out the whole pattern of connections, and then modify that behavior with a simple learning process, and see what happens in that neural circuit when the animal learn something.

Eric: For example, if I bang my hand on this table, and I continue to do that, you will get bored, and after a while you will ignore that. That's called habituation. When you look at a neural circuit that mediates this simple behavior, and you stimulate that reflex repeatedly the reflex gets weaker and weaker, and when you look at the neural circuit you'll find that the connections between the sensory neurons and the motor neurons are getting progressively weaker. That was the first demonstration, the learning affects the strength of synaptic connections. If you scare the hell out of that, that's a startle, that same stimulus to produce a very weak reflex will produce a much larger reflex, my strong reflex, that's called sensitization.

Eric: When we look at what happens at the neural circuit, you see there's a connection that was there to begin with, and had a certain strength that weaken with habituation, moved in the opposite direction as sensitization became much, much stronger. That was the first demonstration that learning involves the change in synaptic strength. Our neurons communicate with each other, and that is to activate a general principle.

Dave: How could we take that new understanding of the brain, and apply it to the things that we do as human beings?

Eric: Do you play tennis?

Dave: I play ping-pong. It's pretty close.

Eric: Okay. When you practice ping-pong what do you think you're doing?

Dave: Pretty much change the synaptic strength.

Eric: You got it. When you continue to hit you're getting ... the reflex gets more and more effective, more efficient, a number of things go on, your attentional system also improves, but you strengthen connections in order to do that.

Dave: Recently, the military's been using transcranial electrical stimulation to increase learning speed, in fact I run an electro current over my brain when I play ping-pong sometimes, using a device called a halo, before that I used an electrophoresis machine to do it, and in studies in the military it seems to let people learn specialized skills about twice as fast. Do you think that's a dangerous thing, or maybe a good thing?

Eric: I think you would have to, not just stimulate the brain in a very general way, you'd have to stimulate specific areas. I think as long as it's done in a controlled fashion, a limited degree, it's an experiment.

Dave: It is.

Eric: What circumstances it works and what circumstances it doesn't work? What is the age range of people who benefit from this? It's a new finding, it needs now to be explored in terms of safety and significance.

Dave: At this point, it definitely passed the FDA, and it's just running on the motor cortex regions, so for physical skills. I think I see the differences, but it's hard to also blind myself, because you can feel it, and it's also hard to know, maybe I would've learned that fast anyway without the electrical current, but-

Eric: This is most likely to be most effective in people who have damage to the motor cortex, for one reason or another, to let them recoup their original function, to bring in other areas that compensate for the fact that their primary areas have been weakened by disease.

Dave: I'm also very interested in your work on nicotine. I interviewed a professor from Vanderbilt University, who wrote the first paper in 1988 on using oral nicotine, not smoking for treating Alzheimer's disease, and he's been studying it for a long time. But I also know that you've looked at memory disorders, mental illness, and nicotine addiction along with your wife Denise. What's your take on nicotine after this research?

Eric: Well, nicotine acts in the brain and enhances the actions of certain drugs that you take after nicotine. It has a powerful effect on the brain, whether it's all beneficial is not at all clear. I don't think smoking is a particularly good idea, but smoking is more than nicotine, there is also inhaling all the stuff that comes with the cigarette.

Dave: I would unequivocally say having nowhere near your level of scientific credibility, but written some science books, and looked it deep, smoking is just bad from an aging perspective.

Eric: Smoking is more than nicotine.

Dave: Much more.

Eric: It's inhaling all those stuff that comes with a lit cigarette.

Dave: For nicotine itself, it seems like for some brains there are very strong benefits, but for other brains it just doesn't work, much like a lot of things.

Eric: Yes.

Dave: How would someone listening to the show go about knowing whether coffee, nicotine, egg yolks, or any other compound, fish oil, anything that may affect their brain, how would they go about knowing whether it works or not, given there's so much individual variability?

Eric: Well, the first thing is that we very carefully read the literature.

Dave: Yes.

Eric: Let's see where they would take a population of people, let's say a hundred people, a thousand people, and you expose, you divide them into two groups, a controlled group and experimental group. Give a controlled group seltzer, and you give the other group part of what the experimental drug is, and you see where there's a difference between the two groups. Then you can statistically decide whether or not the drug that you're testing is beneficial, and how, and what it does that is beneficial for you. It may also be detrimental, but may be beneficial, but it may carry some downsides with it. It's very important to understand how a drug works, and all of its ramifications before one approves it. That's why the FDA is there to evaluate the safety of these drugs.

Dave: It works really well for populations to do that, and when you have an individual looking at a drug, like say Modafinil, which is a well-known cognitive enhancer, in some people doesn't do anything, in other people it turns the lights on in a new way, and it changes their ability to think, even their typing speed. I'm looking down the road and saying if we know that there is this statistical curve of how it works across a population, do you think we're getting close to being able to tell genetically or environmentally or via some other mechanism, whether a drug is going to work for one individual versus a broad population? Or do you think that's still far out in where we're going?

Eric: Well, it depends upon the drug, in certain drugs you'd see that certain genetic predispositions allow the drug to work or prevent the drug from working. There are some situations in which the biologic information that we already have on that person or can easily obtained on that person, will tell us whether this drug will be effective or ineffective in that particular individual.

Dave: I'm hopeful that companies like 23andMe, and ancestry.com, that are now getting genetic information on hundreds of millions of people, and starting to be able to do the broadest epidemiological stuff possible, to see not only does this drug work, if you share that information with them, but it only works for people who have this whole genetic profile. I've started to see some new information coming out of that. Do you think that, that approach is going to be adequate, to at least peel back the onion on many drugs, or is it going to take more than that?

Eric: I think you really hit the nail right on the head. People differ from one another biologically, that is it's largely genetically. If you look at any single drug in a population there'd be a variability in how effective the drug is, and knowing the genetic makeup of a person, and if you tested that drug in a variety of different people with different genetic makeup you can predict whether this is a good candidate for the drug or this person is a bad candidate. That's important to know, because if a person has an illness it can be helped by the drug. He may be one of a number of people with that illness that would be helped, but there are other people who have other biological predispositions who may not be helped. The more we know about the biological underpinnings of a person, the more likely we are to make intelligent decisions about which kind of drugs will be helpful on which kind of disorders.

Dave: I am exceptionally hopeful that this new data set is going to change our understanding of individual biological variance, so that those unusual brains and unusual neurological structures, and unusual genetic structures can be teased out, and we'll be able to go into a doctor and say, "Oh, why don't you try this set of compounds instead of this set?"

Eric: Well, this is happening. We are beginning to get it at just an early stage, but physicians can tell from your biological history whether one kind of antihypertensive medication is more likely to be better for you or another. In a number of disease states, there are several different drugs that will work, and which one may be determined by your biological makeup.

Dave: It seems like one of the most exciting times ever to be alive, given the amount of information that we have available as laypeople, and as researchers and physicians. How do you deal with, or maybe a better question is, how have you dealt with this amazing onslaught of information? If you go back to when you were working at the NIH in the 60's, you had a number of research papers, and you had connections with other researchers, and you'd have hallway conversations, and you go to symposiums, and now it seems like every day there's a hundred papers that could be interesting, to the things that you care about, how do you decide what to look at?

Eric: These hundred papers relates to a universe of science. Let's say I'm a cardiologist, I'm interested in the biology that relates to the heart and to the circulation, etc., that's a more discrete number, and a number of those articles had come up with findings that are modest, others come up with findings that are wrong, and then finally there are those that come up with findings that are correct, and significant enough to make you rethink the kinds of therapeutic approaches you want to take to a patient with a certain kind of cardiac condition.

Dave: You sort of sort the papers.

Eric: Exactly.

Dave: Based on what you're attempting to learn about or modify. That ties into something that you said about reductionism, you once said, "It's better to make small progress in something really, really important than to push a trivial issue ahead." How do you think about reductionism, and have you thought about it in your work?

Eric: I'm a reductionist. I try whenever possible, use a simple example of a larger problem, and try to drive it into the ground, and then I come back and look at a more complex variant of that, but I like beginning on solid data.

Dave: How do you make that decision about what's really important versus trivial?

Eric: If you see a big change in the behavior it's important, if you see a small change in behavior it could be trivial, it's [inaudible 00:21:40].

Dave: You're very results-oriented, the person who is psychotic isn't psychotic, maybe we should pay attention there. That's a very pragmatic answer. How did it feel when you went through and you proved that Dr. Cajal, a 1906 Nobel Prize winner, you proved that he was right, that he said, he hypothesized the nerve cells talk to one another at the synapse. When you had that proof point in your lab what happens in your mind? Did you run around the streets saying, "Eureka," or did you celebrate with champagne? What was it like?

Eric: The one you're talking about is Ramon Y Cajal, that's pronounced Cahal.

Dave: I said [inaudible 00:22:22] ... I said Cohool, [crosstalk 00:22:24]. Cajal, thank you.

Eric: He was the first one to really pinpoint the fact that neurons communicate to each other at specialized junctions called synapses. He also suggested that learning may involve alterations in the strength of the synaptic connections. I was one of the people who came along later on, substantially later on, and showed that his suggestion of how learning occurs is correct. I found that learning involves changes in the strength of synaptic connections. Cajal was fantastically important, one of the, perhaps the most important Father of Neuroanatomy.

Dave: I want to know how you celebrated when you came to that full conclusion, when you saw the data on your lab bench, and you said, "Wow, I've got really solid proof of this.

Now we know." Did you go home with Denise and have a dinner? What do you do when you just realized you've proven a major point that's world-changing?

Eric: The first thing you ask yourself, "What are the controls I have to run in order to convince myself that this is so, so some skeptic like you won't think this a big baloney?" You want to think of the controls that you need to run, but of course when one goes home, and [inaudible 00:23:37] enjoys myself. It is a wonderful thing, and also to have it being recognized generally, the paper being recognized as an important paper, is very satisfying that your colleagues think it's important.

Dave: You do celebrate.

Eric: Of course.

Dave: How does a Nobel Prize winner celebrate? I wouldn't know.

Eric: Champagne.

Dave: Champagne, all right. The real French stuff, right? All right.

Eric: Get me out of these work clothes into a dry martini is what the golfers used to say.

Dave: I love it. All right, let's talk about memory, your memory is exceptionally sharp. You're going to be celebrating your 89th birthday about when the podcast hits the air. My birthday is a few days after yours, so happy birthday in advance.

Eric: Thank you.

Dave: What have you done to keep your memory, both short-term and long-term, working as well as it does?

Eric: I don't do anything specific about it, but I read, I write, I talk to people. I don't go home and memorize poetry, but I stay intellectually involved. Many people my age have retired, no longer involved. I'm talking to you from my lab. This is my office, research is going on just on the other side of the wall here, and I'm involved in ... I don't work every day, I only work about five and half days a week, but I'm here, I'm intellectually involved in what goes on in science, and it stimulates the brain. Also, when I'm out of the lab I also stimulate the brain, I go to the opera. I do things, that almost everything you and I do during the course of the day involves intellectual activity of one kind or another.

Dave: Continuing to exercise your brain by using it, it keeps it younger [crosstalk 00:25:37] running.

Eric: Yes.

Dave: Can you talk about self-perpetuating memories and what you've discovered about those?

Eric: By self-perpetuating you mean what?

Dave: A self-perpetuating protein at the synapse, that if memories are sustained for a long period of time what changes versus things you ... you memorize a phone number, you dial it, and you forget it.

Eric: There are mechanisms that the synapse that once you produce a change in synaptic strength it produce an alterations in the local machinery or protein synthesis, it keeps the process going. There's an alteration in gene expression that gets transported down to the synapse, and that allows the synapse to produce more protein, more substances that are necessary to strengthen that synapse.

Dave: What happens if you are remembering something traumatic versus pleasurable?

Eric: Well, they both produce alterations in synaptic strength, but they produce it in different systems, and some systems that mediate pleasure, some systems that mediate pain, to recruit different anatomical pathways, to mediate one versus the other.

Dave: Do you support the concept of PTSD, the post-traumatic stress disorder?

Eric: Absolutely.

Dave: I was hoping you would say that. It's certainly something that I've experienced.

Eric: I am able and scare you, I can tap lightly the next time and you'll startle. There's no question, this is true for all of us, we have different thresholds. Some people are much more sensitive to it. Also, once you've been really frightened you're much more susceptible to less threatening stimuli.

Dave: Do you think that's something that we can change?

Eric: No. I think that's built-in to us, and it is probably beneficial. We want to be able to startle. We want to be able to move away from stimuli that are dangerous, but we should be able to get progressively better ways of helping people overcome the excessive fear that they show on a variety of circumstances. For example if somebody is at the war front, and sees a bomb explode nearby, and he hears this terrible noise that's associated with it, they may be frightened every time they hear even a slight noise. That's sort of post-traumatic stress disorder, one should be able to get them over it, if only by habituating to play that sound in a way that is clearly innocuous, and convince the person's nervous system that no damage is going to occur.

Dave: Is there a way to look at the way we lay down pleasurable memories, and use that kind of, that system in order to get it active when people are re-experiencing those sounds? In other words, is there a way to turn the brain on to pleasure mode versus fear mode?

Eric: Not so very easily.

Dave: Why do we remember things from childhood like a song that sticks in your head from childhood, and other things like high school algebra just go away? What's going on with the way we store and sort information like that?

Eric: Well, somethings are more satisfying and more meaningful to us than others, and probably something is your mother's love or the first girl that you met and you really like, it's more important to you than high school algebra.

Dave: It's a measure of importance ...

Eric: And satisfaction.

Dave: And satisfaction. Do we have any other control over how our memories are stored?

Eric: Yes, repetition.

Dave: Repetition, okay.

Eric: If you want to learn French you can't have one conversation in French expansion and expect to master the language. You have to go and learn it, and one way to learn it is learning the grammar, repeating things, practicing, speaking it, etc., etc., etc. Practice makes perfect is one component of learning.

Dave: I have found that for me to really learn something at the deepest level, I either have to teach it, and I was a teacher at the University California for about five years, or I have to write a book about it. What is it about teaching or the act of synthesizing to write that makes things stay in your brain?

Eric: Well, you've described it perfectly, if you really take it apart so you understand the component parts, and how they fit together, so that you can explain it to your grandchild, it's going to stick in your head as well, as you're making it easy for the grandchild to understand it. Taking a complex piece of information, and simplifying it, thinking it through is a very, very good way of learning [inaudible 00:30:43] for long periods of time.

Dave: Is there a better way to do that?

Eric: Well, repetition is very good.

Dave: It's either repetition or-

Eric: But [inaudible 00:30:51], if you don't understand it, it's very hard to remember it.

Dave: I got it. It's either repetition or disassembly, and reassembly in a new way are the two big techniques.

Eric: That's related, yes.

Dave: In your newest book you talked about something you could call a unified theory of the mind. How would you explain the one theory of the mind around how our sense of self emerges from physical matter?

Eric: Well, people used to think that brain and mind are separate, that the brain mediates walking or running motor activities, but mind, understanding something, communicating something else is not mediated by the brain. Now we know that every mental process is a biological process that comes in the brain. Simple or complex, trivial and sublime, they're all brain processes. Every mental processes our brain process has been a major advance over the last 50 years.

Dave: Have you dug in on the role of mitochondria in the mind or in the brain?

Eric: I've obviously know that mitochondria is source of energy in the cells are important, particularly in synapses, but I haven't worked in mitochondria in any particular way.

Dave: Okay, you haven't worked with them in a particular way.Because I know that in your book on disorder things you talked about autism and depression, and schizophrenia and Parkinson, and addiction, and there are clear mitochondrial links to those things, and that neurons have more mitochondria. I've spent a lot of time on my last book, looking at how do mitochondria behave that affects how neurons behave, and it seems like if there's not enough electricity being made by a mitochondria you wouldn't get enough synaptic firing, and that that may be an important part, at least in some conditions. Knowing that you're not a mitochondria expert, does that that theory hold water, given that you know way more about the brain than I probably ever will, is that an area worthy of exploration?

Eric: That's like you know more about mitochondria than you ever will. I would have to read up on that, at the moment I'm not convinced.

Dave: But is it at least worthy of asking?

Eric: Absolutely. Absolutely.

Dave: Good, good deal.

Eric: It's [inaudible 00:33:16] important, but we don't know all the roles they have in learning and memory.

Dave: We absolutely don't, in fact I think we don't know, we don't know very much about them at all right now. I want to go back to short-term memories. What's the difference between that example of remembering a phone number, what happens in your synapses for something that you know you're only going to need for a little while, versus something that gets embedded in your brain? I know we talked about repetition, but what's happening at a synaptic level when you just want to remember it for a little while?

Eric: There's a short-term changes in synaptic strength. When you learn something for short-term memory, a memory that persists a minutes the synapse changes, where it's a functional change, and it only lasts for minutes. But if you learned something through repetition or because it's very powerful for you, you actually see an anatomical change occur at the synapse. The synapse becomes anatomically more powerful, and that's reflected in its physiology also. The pre-synaptic terminal is larger, the post-synaptic contact point is larger, the synapse is much more effective because it's anatomically more effective. There are mental differences between short-term memory and long-term memory. Short-term memory involves a functional change at the synapse, long-term memory involves an anatomical change. Moreover, that anatomical change is produced by alterations in gene expression, the signal gets sent from the synapse to the nucleus, new gene products are produced, transported out of the synapse, and that allows the growth of new synaptic connections.

Dave: Is there something we can do to increase meaning consciously to make it easier to remember those short-term things, and make them longer-term?

Eric: Repetition, my boy. Repetition, practice makes perfect.

Dave: I'm feeling good that you've told me that five times, by repeating it for me then I'll be able to remember it.

Eric: [Inaudible 00:35:15], she's at the therapy session.

Dave: Let's talk about exercise.

Eric: Excellent.

Dave: We know that exercise is good for the brain at this point, and when The New York Times was interviewing you, I think last year, you said you've exercised your whole life. Now there weren't a lot of people who practiced exercise in the 50's and 60's, but you did, what made you decide to do that?

Eric: I'm embarrassed to tell you this. First of all, I was in Vienna, 1938 ,when Hitler marched in. One sport that Jewish boys in Vienna learned after Hitler marched in, was to run away. I was surprisingly fast. When I came to the United States I tried out for my high school track team at Erasmus Hall High School, and I was co-captain of my track team in my senior year. In fact, it was the coach of the track team who asked me, "Eric, where are you applying to college?" I said, "I'm applying to Brooklyn College, my brother's going there, it's a very good school." He said, "Have you ever thought of Harvard?" I said, "No." He said, "Why don't you apply to Harvard?"

Eric: I applied to Harvard, and I got in, that was due to my track coach pushing me, not that I was a great track star at all, but I was not. I was not good enough to really compete strongly at that level, but I was quite good in high school. I placed in the city championship, and I ran on a relay team with three other people, a relay team is four people, and we won at all sorts of major events, the Penn Relays, the Signal Relays etc.

Dave: You learned in high school that it felt good, and you just kept doing it ever since.

Eric: Right, well I became very athletically buffed, and in high school I was almost crazy in the amount of time I spent practicing for running. The co-captain of the team with me was a guy called Ronald Berman, who also is my roommate in Harvard, we went to Harvard together. He was better than I was, but together in high school we took track very seriously, and even on the weekend when there was no school we would go running. We'd find a track and we'd go running there. We worked out.

Dave: Did you ever start smoking?

Eric: I smoked for a while, let's say between 25 and 27 I smoked.

Dave: Just for a couple years. It's unusual to quit, especially given how common smoking was at that time in society. What led you to quit?

Eric: I knew it was bad for me, and I guess I didn't enjoy it all that much, I didn't become addicted to it very badly, and my wife Denise didn't like it very much.

Dave: That's a good way to quit addiction, when your wife doesn't like it. The next book I'm working on is around anti-aging. I've spent 20 years running a nonprofit in the space and-

Eric: I'm working at that also.

Dave: You're doing something right with anti-aging.

Eric: It's [inaudible 00:38:35] I'm working on anti-aging. I found the cure.

Dave: What is it?

Eric: The cure is walking.

Dave: I love that answer. Tell me more.

Eric: The cure is walking. There's a guy called Gerard Karsenty, he was one of several at Columbia, one of several people that showed that bone is an endocrine gland, and it releases a hormone called osteocalcin. I've been interested in whether or not osteocalcin is enhanced, releases enhanced when you walk, and the answer is, it is. I found that one way of overcoming age-related memory loss, which is a significant problem, is by walking. I used to swim most days, and I've now substituted walking for swimming. I walk to work, and I walk from work, and I have a rucksack rather than my briefcase, because when you walk a significant difference a briefcase is asymmetrical if you carry it on hand, while a rucksack is on your back, and it gives you greater freedom.

Dave: You get more even loading on the spine, and over the course of walking for 20 years you don't want to be crooked on one side. That makes great sense. In the research that I found for my last book on mitochondria, it turns out 20 minutes of walking a day is enough to cause mitogenesis, and to keep your mitochondria young and strong, there's-

Eric: [Inaudible 00:40:07].

Dave: Something there.

Eric: Dependent support.

Dave: I also use a machine. I have a lab here at my house around longevity, and recovering faster than Mother Nature maybe wanted you to, and the machine allows you to, under your own power, flex your bones, and keep them flexed for five seconds.

Eric: It sounds very good.

Dave: It's probably raising osteocalcin, and we certainly know it stops osteoporosis in most people, even cervical osteoporosis. I feel like there's all these new things around, the effect of certain frequencies of light on tissue healing, on collagen synthesis, and all these new discoveries that are coming from all sorts of different disciplines, that end up taking different biological systems in the body, and keeping them younger. Do you do anything like ... Do you do anything like that as part of your anti-aging? Aside from walking, and I'm assuming eating a reasonably healthy diet, and not overindulging on champagne, are you doing unusual things?

Eric: No.

Dave: No.

Eric: I walk. I like to swim. For example, when Denise and I travel, I always insist that the hotel we check into has a good pool, and around the home there are a number of pools that I can use. Those are the major exercise that I get. We have a trainer coming once a week, and we do push-ups and things like this.

Dave: Well, you're doing very well having worked with a variety of people over age 70. Your memory seems like it's completely sharp, and you're recovering things from high school at will, and that's highly unusual. Do you think you're genetically gifted in that way, or is this just the way you've lived your life?

Eric: Not at all.

Dave: Not at all. All right. If you look at someone who's, say 20 years old today, who has the benefit of your work, and hundreds of thousands of other people around the world, how long do you think they might be able to keep their memory intact or even how long do you think they might be able to live?

Eric: Well, certainly as a result of the improvement in medical care, a result of the improvement in how we attend to our body in order to keep ourselves as physically healthy as possible, and as a result of the study of the effects of alcohol and smoking, etc., etc., there are a number of things that easily become dangerous rather than being beneficial. We now have a reasonable idea of what kinds of things are good for us, and what kinds of things that aren't good for us, and a combination of a good diet, a good physical activity, and a minimum amount of alcohol, and no smoking if it all possible, gives us the beginning of a formula for a reasonably healthy life.

Dave: When you look at how the world has changed over the last, almost nine decades of your life, do you have any thoughts about how the world is going to change over the next nine decades? You have the benefit of having seen way more history than I've seen, you have wisdom that I may have when I'm 90, how do you put on your future's hat and say, "Well, here's where I think things are going," do you spend time on that? Do you have theories about it, ones that aren't proven yet?

Eric: I have a difficult enough time living in the present [inaudible 00:43:39] not much about what's coming in the future. I clearly see that for example in medicine, there are many problems that we're beginning to understand, and that we are beginning to treat, and it will get better and better. For Example coronary artery disease, we know that diet is very important for that. We know hypertension has to be controlled in order to minimize cardiac damage, etc., etc. We've learned a lot of hygienic rules that improve the physical quality of our life, and they're very important, and they're not that difficult to follow. The trouble is that people become addicted to certain products. They become addicted to smoking. They become addicted not to one or two glasses of wine in the evening, but to several glasses of wine, followed by several glasses of scotch, whatever. Beginning with scotch, and then going to one, whatever the sequence is. I think one has to be reasonable about what one takes in. I think diet is very, very important.

Dave: For someone who starts now in their 20, if they take advantage of what we know about walking, and food, they have a much better chance when they're 90, of having a highly functioning brain.

Eric: Absolutely, absolutely. Also, watch your weight. Obesity is a terribly detrimental thing.

Dave: I weighed 300 pounds when I was about 23.

Eric: Wow.

Dave: I'm 9.6% body fat right now, and it took me years to figure out all the stuff that was going on, but I-

Eric: [Inaudible 00:45:23] you look terrific now.

Dave: I would have to just double-down on what you said there, being obese is really not good for you, including for your brain.

Eric: Absolutely not.

Dave: Is there a field of medicine, knowing what you know now, that if you were to start over that you would go into? If you are just entering medical school now, what would you pay the most attention to?

Eric: I still like psychiatry, which is what I was trained in. It was a primitive discipline when I entered it. It's a primitive discipline now, but it's making progress. We're beginning to understand the brain better and better. We're beginning to relate different mental illnesses to different parts of the brain, and although we have not made tremendous therapeutic progress in the last 20 years. I feel like over a period of 40 years, we haven't made significant progress. I think that will continue to come. It's an area in which much growth is likely to occur.

Dave: Even if you were starting your career again today you would still go in to psychiatry?

Eric: I would [inaudible 00:46:24] psychiatry, yes. Also, one aspect of psychiatry, an important part of psychiatry is psychotherapy, if you will, being comfortable with patients, their good behavior, their are bad behavior, their painful behavior, and not being empathic, but expressing instinctively your empathic response to them. You just have to enjoy being with people, and I like that part of it a great deal.

Dave: You still write an enormous number of books, you have a long string of highly successful books that have won the highest literary awards. How do you sit down when it's time to write a book? How do you know when it's time? How do you go about doing it? Do you stay up late typing? What's your ritual for writing?

Eric: How do I know what I think unless I read what I write? I'm serious. I write with pencil and paper. I don't type. I mean, I can type very badly, but I don't type it out. I write it out, then I have a secretary types it out for me. She's very gracious and reads my handwriting particularly well. I do many drafts, but I enjoy writing a great deal. I get enormous pleasure out of it. I can write on planes when I'm traveling. I write in the evening at home after dinner, on the weekends and, I really get a lot of pleasure out of doing that.

Dave: Are you working on new book now?

Eric: At the moment I'm not working on a new book, no.

Dave: Do you still read fiction?

Eric: Not very much.

Dave: Not very much.

Eric: [Inaudible 00:48:03].

Dave: Do you have a favorite fiction book from your life that made a big difference for you?

Eric: Moby Dick.

Dave: Moby Dick.

Eric: That made a big difference for me.

Dave: What difference did it make?

Eric: Well, it's such a fantastic story of seeing this whole animal life evolve. It really provided biology and fiction in the same context.

Dave: Got it. It's always interesting to hear what someone who creates work goes to for inspiration, and what a fantastic perspective on it. I love the infusing of biology and fiction. When you do sit down to write your next book on paper do you form the outline, and fill it in or do you just let it flow from your brain, and then re-draft it?

Eric: I usually have an outline of something, a chapter, a couple of chapters, just something like that, and I sit down, and I just scribble it out. I don't pay much attention to the detail of the form. I cross things out, and correct them, but I consider the first draft just really a beginning to get me going, an then my secretary types it up for me, and I play with it, and amend what I've written, and expand.

Dave: Your process definitely seems to be working because you are, you're prolific as a writer, in addition as a scientist, and that's something that I know I can learn from. Thank you for sharing your secrets.

Eric: You raise a very, very good point. One of the things that I find, to my surprise, that distinguishes me from my colleagues who's every bit as good as I am in science, is that I communicate better with the public in part because I write, but also I was on the Charlie Rose program. I've been in a number of television programs that are designed to allow scientists to speak in straightforward language to the general public, and I've always enjoyed doing that.

Dave: Do you think that's because of the time you spent studying psychiatry and spending time on the couch, or at least with the patient on a couch?

Eric: No, I think it's due to the fact that in my early years, in addition to being a competent scientist I was also recognized as a very good teacher. I was recruited to NYU to develop the neuroscience program there, and then Columbia stole me from NYU to develop the neuroscience program there, and I worked terribly hard to develop those programs. I would ... In a medical school, in a neuroscience course, I'm making up the number, let's say there are 40 lectures, no [inaudible 00:51:11] 40 lectures.

Eric: One person might give eight lectures, 10 lectures, and then you have a number of people who give five lectures. Some people only give two lectures, and what I would do is I would not only rehearse my own lectures, I would rehearse the whole course. I'd sit in, I listen to other people's lectures, and they saw that I did this, and then they started to do this for themselves. In my early years, if I was going to Chicago to give a lecture I would rehearse it, and I've encouraged my colleagues to do the same thing. That really got me, help me in understanding when am I getting across, and when am I confusing people, and that's very helpful.

Dave: You practiced being a teacher, in becoming an excellent teacher, and then you took that into your writing.

Eric: Very well said.

Dave: That is beautiful and inspiring for me, thank you. Dr. Kandel, I have one more question for you in our interview, if someone came to you tomorrow, based on your life's experience, including your work, but not just your work, everything you've lived through in 80, almost 89 years, "I'd like your advice. I want to perform better at everything I do as a human being," which includes relationships, living, being happy, career, all these stuff, three most important pieces of wisdom or advice that you would offer to someone, say who was 20 or 25. What would you offer? Just three.

Eric: A good marriage is a marvelous, marvelous bedrock on which to live one's life. You have not only a lover, but a best friend whom you can really rely on under all circumstances to tell you, "That's bullshit, and this not." That's so helpful to have. You know, no axes to grind, not infrequently when we go out in the evening I turn to Denise and say, "Does this look all right? Blah-blah-blah-blah." It's wonderful to have a person who's concerned about you from a different point of view than you are concerned about yourself as an objective perspective. A good marriage is just a wonderful thing.

Dave: That's one, so definitely have a good marriage. You get two more.

Eric: A good career is not a bad idea, it's something that you'll really, really enjoy, and knock yourself out to do something original in it. Third, stay physically active.

Dave: Stay physically active, beautiful pieces of advice. Thank you so much, it's been a great honor to be able to interview you, and to learn from your life's wisdom, in addition to all the amazing neuroscience that you've done in your career. Thank you again for being on Bulletproof Radio, Dr. Kandel.

Eric: [Inaudible 00:54:08], I really enjoyed discussing things with you.

Dave: We got the show, would you ... I normally recommend to people at the end of the show that they read something or look at something from the guest to learn more. You have done so many great things that I'm not sure where I should send people, should I ask them to read your most recent book? Would that be helpful?

Eric: I've written four books for the general public. I think the one that is probably the most interesting for the general public is called In Search Of Memory: The Emergence of A New Science Of Mind. The New York Times' Book Review said, "It is scrupulously detailed, yet magnificently panoramic autobiography." I didn't write that, it was The

New York Times who wrote that. "Arresting and indeed unforgettable, an enchanting book," nice things were said about it. Then I wrote three other books, I think that's the best book.

Dave: That's the best book?

Eric: Yes.

Dave: All right.

Eric: In terms of a general introduction to my work, and it's the first of the four. The next book I wrote was called The Age Of Insight: The Quest To Understand The Unconscious In Art, Mind, and Brain, from Vienna 1900 to the Present. That takes my interest in clinical question [inaudible 00:55:33], Viennese artists, that's where I come from, and there brings my interest in art up-to-date.

Dave: All right.

Eric: A third book I wrote is, I'm interested pointing out how the arts and the sciences are not two worlds apart, but often artists use the same kind of strategies that scientists use in order to solve their problem. They use reductionist strategies, they may paint in very simple ways, take a [inaudible 00:56:05] like this for example, what could be more reductionist than this?

Dave: Right.

Eric: Or he does, he put bands of color on it, if you sit in front of one of these paintings it's like a religious experience, because each one of those bands of color is in fact several layers on top of each other. You can see the deeper layers coming through, it's really almost a religious experience, it's wonderful.

Dave: I love that you wrote a book on art and brain science.

Eric: Yes.

Dave: It seems like sometimes in the quest for reductionism in Western science the role of art gets lost, and here you are-

Eric: It's so marvelous, and it's so ... such if you go to my house you would have such a good time, even my office, I have art hanging on the wall here. Denise and I just love to be surrounded by art. On weekends we usually, at least hit one museum or something like that.

Dave: That is so beautiful. If you like today's show, I highly encourage you to read some of Dr. Kandel's books, and any of these books will be illuminating, and it's rare to be able to get inside the mind of one of the great leaders of science, and see how he thinks, how we evolved, and even how he thinks the brain and art interact. If you like reading or you like listening, I highly recommend Dr. Kandel's books.