



Dr. Elise Bialylew, founder of Mindful in May (mindfulinmay.org) and The Mind Life Project (www.mindlifeproject.com) and author of The Happiness Plan, interviews Michael Merzenich.

MICHAEL MERZENICH

Dr. Michael Merzenich is the pioneer of neuroplasticity – the brain’s ability to change and adapt. Having published more than 150 peer reviewed articles and being bestowed in 2016 with the Kavli Prize (one of the world’s top neuroscience prizes), it’s fair to say Dr Merzenich is perhaps the most recognisable figure in brain plasticity today and contributes a breadth of knowledge to how we develop competence through experience and learning. You can read more about Dr Merzenich’s work in his book, *Soft-Wired: How the New Science of Brain Plasticity Can Change Your Life*.

Elise: Michael, welcome to the program, and I’m so thrilled to have you here. I’m a huge fan of your work and I’m so excited to be able to share this with the many thousands of listeners. So, thank you.

Michael Merzenich: Nice to meet with you Elise.

Elise: Now, Michael, just to begin with – for those who may not have come upon your work – I wondered if you could give a short background about who you are and what the work is that you do in the world.

Michael Merzenich: For many years, I was a professor at University of California. I’m now an emeritus professor, and my focus was on issues of the brain. I was really interested in the brain as a basis of trying to understand the origins of our human abilities and with that information I was very interested in translating that science for the benefit of humankind. The research early on focused on the development of cochlear implants and the study of the organisation of the great sensory systems of the brain. The commercial cochlear implants came from my research laboratory and in studying them and the organisation of brain systems, I began to realise, and conducted experiments that demonstrated, that the brain was continuously plastic throughout life, and was continually remodelling itself as a function of how we engaged it. There were other people that argued this historically concurrently, but we did a lot to demonstrate that fact, demonstrate that each time you acquire an ability or improve on any ability, you’re actually remodelling brain circuits and remodelling the brain in other physical and functional ways that are really important. We realised that as a function of how you used your brain you, your brain could be healthy or not very healthy. Just as your health was

determined like your physical body as a function of how you're engaging it, if you engaged it in a good way, you'd have a healthy machine up there, a healthy organ. And if you didn't you wouldn't. And we've tried very hard to translate this into tools that could help people in medical direction and in a quality of life direction. Everyone has the capacity to improve their neurology, which is another way of saying improving themselves at any point of life. So, why not do that and why not help people understand that they can do that and why not help people on that journey, to make it more possible, to make it more convenient, to make it more realistic for them to do that. And that's been one of the important motivations in my life. Not just of course the average person, we want to help them, but also a strong focus on children and adults who are really struggling. And using the brain in a sense this power to change the brain, to change the brain in ways that could improve their life and help them restore themselves, hopefully to normalcy. If there's ever a cure for the great abnormalities of neurological psychiatric medicine, a true cure, that cure would involve the correction of the functionality of the brain which in its complexity can only really be achieved if the brain corrects itself. No pill, no simple strategy, you can't stimulate anything, you can't give any chemical distortion that will do that. The only way that can possibly occur is if the brain fixes itself by changing itself in a corrective direction. So, pills might help, stimulating the brain might help in doing that, but ultimately the brain has to do the hard work itself. Just like you can't ever expect to have a really fit body if you never exercise it. Just can't happen. That would be a miracle.

Elise: Can I just jump in there and clarify something, because as you're saying....

Michael Merzenich: That was a long answer, wasn't it?

Elise: It was but it's wonderful. I wanted to jump in on this point, because what immediately came up in my mind as you were saying that – we'll go into various domains of this as we continue this conversation - was around depression because you just said that the brain ultimately needs to do its own work. So, what do you mean by that in the context of, say, something like depression where people are taking an external tablet a lot of the time. Can you just clarify?

Michael Merzenich: In depression there are a series of progressive changes that ultimately lead you into a ditch, into trouble. And they're complexly involved with things that are targeted by the medicine, but they also involve other things that relate to the origin of the changes that led to the down-regulation of those chemicals in the brain. So actually neurologically, depression is a complex business, it involves distortions of five or six different fundamental systems and processes and the pill addresses one of them. You could say, the other four or five remain in a sense uncorrected. I mean ultimately, you live your life again, you're doing better, you will have some self-correction, so that's great. You'll feel better. But actually, because you haven't really corrected those other things, to normalise them, you're highly at risk for recurrence of the problem because the underpinnings of the problem are still there. And if you could look at the brain more completely and say "what if I really wanted to cure this condition, what are all of those things I need to fix?" and that's more than can be ever delivered by the pill, okay? Because there are other things that aren't quite right or maybe are very distorted that need to be corrected. And the same applies to psychotherapy. I could consider what I could

do behaviourally and I could do a lot. With about the same probabilities with the pill, I could grasp maybe the problems that gave rise to those changes in my neurology. And not quite in the same form as delivered from the pill but still I'm better and I get out in the world and I'm doing better and I'm correcting myself, my brain is correcting itself to some extent, but not completely. Because completely, requires a more complicated view of things and more complicated correction. It's important to understand that ultimately we will correct depression by addressing all of the problems that manifested, all of the things that are in the way. And that will be closer to a real cure.

Elise: Yes, thank you. And I think that helps to really paint the picture because in our society people really have come to believe that one tablet will fix the problem completely.

Michael Merzenich: Really it's a very crude approach medically. We'll look back on it in fifty years from now and say "wow, that was an era in which we really believed that pills could deal with problems for something as complicated as the brain, that completely distorting it could be the basis of a cure". And really it can't be. The life of the brain is more complicated than that.

Elise: Thank you for clarifying that. Now I just wanted to give the audience a context of your work and if you could just share historically how significant your work has been in terms of how we understood the brain before some of the work you were doing compared to how we do now.

Michael Merzenich: Well, a predominant view in brain science and in neurology not so many years ago was that the brain was plastic when you're a baby and then it grew up, the plasticity was a part of the developmental process of growing up with the brain. So it changed as a function of your experiences when you were very little and then it matured into a hardwired and fixed connectational state where all the wiring of the brain was frozen. You could think of it like being a computer on your desk that operated very reliably because the development had reached an end stage. You now have a brain. And also, it was believed that all of the elements in the brain, all of the neurons were born; they all reach their adult state. The view that the brain was frozen that it'll have only one direction which it could change from very early life forward to the end of life, that direction was to deteriorate. Because it really did not have the powers of changing its operational connections, of changing its basic machinery. And we now know, we did experiments 35-40 years ago that demonstrated that that was simply not true, that the brain is continually changing itself. Let's say other people contributed critically to this before us and after us, many experiments. But the experiments in the mainstream of neurological medicine, the neuroscience were so compelling that overwhelmingly in education and in medicine people believe that only the brain of the baby or small child can change. We began to show that in fact any time the brain is injured, any time you learn a skill or a new ability, acquire an ability improving at anything, that improvement is accounted for by brain remodelling. The brain actually rewires itself in a way that accounts for the acquisition of skill. I learn to read, I develop a reading brain. A massive reconnection, massive remodelling. Learning to read is all about brain remodelling. Learning anything is about brain remodelling. So, brain remodelling accounts for the creation of the operational person. Everything you're

specialised in, everything you're good at, everything you can do is a consequence of your engaging your brain and using it and changing it to enable those skills that define what you can and can't do. It's the brain's big trick. So, imagine science 34 years ago: almost everybody believed that this did not occur. Actually it's probably the most fundamental important thing that brains did and that was to remodel themselves and change themselves to account for the evolution of our abilities.

Elise: So, what do we know now about the process of neuroplasticity across the lifetime. Are there critical periods? What can you tell us about that?

Michael Merzenich: Well, first of all, the science is massive. Several hundred thousand papers relate to that. Maybe forty percent of all scientific papers relate in some fundamental way to the brain, to these processes of change, so there's a massive amount of information. It's understood in great detail. We do know that plasticity in a very young brain is different from the plasticity when you're older. There is a special thing occurring when you're an infant, and that's primarily due to the fact that plasticity in infancy is unregulated. You could think of it as anything that baby's exposed to changes the brain. And the reason for that in simple terms is that the brain has not grown the machinery that it needs to control its own change. So, when you're little, when you're born, the brain actually can't make decisions about what it should permit to change the brain. It can't control the way the brain is changing itself. But it grows up pretty early in life, it begins to establish that control. And ultimately, what it's going to do is to primarily limit change to those situations in which it judges change to be good for it. Okay, now think about what a fabulous thing that is. I mean the brain actually evolves its processes in a young child's brain so that ultimately it can make its own determination of whether that change is good for it. That is to say, help it achieve the goals it's directed to achieving or are positive in a sense of establishing more control of its own operations. So, the machine is actually controlling its own evolution.

Elise: Incredible.

Michael Merzenich: It's a miracle. I mean, it's a fabulous thing.

Elise: On that point though I'm imagining that our brains uniquely determine how the brain learns what is good, and what it should allow to change would obviously be a reflection of its environment or what it has known. For example I'm thinking about a child in a highly stressed situation versus a child in a loving, calm environment and how that would impact.

Michael Merzenich: Right. Well, the brain is substantially seeking the good and the good on one level is hedonistic rewards. So, it's seeking the food, it's seeking affection, it's seeking things that stimulate the release of chemicals into the brain you can say that contribute pleasure to us. So, that's on one level. The other thing the brain is doing is the brain is commonly holding information in mind and what's called working memory on a higher level in the brain, and that's providing information about the success of what it's trying to do. So, the individuals trying to, let's say develop some skill. I'm learning to use a fork as a child, I'm learning how to pick it up. So the brain is evaluating the success of the try and it remembers all of those earlier attempts and it knows what a good try is. And when a good try occurs, the child might

be successful in using that fork to spear something and deliver it to the mouth. The brain is rewarded, and rewards the try and says in a sense “save those new connections, that was a good try”. It does that inadvertently, over and over and over again. It’s continually evaluating the success of the achievements, and performance in whatever it’s trying to do. That’s the basis of skill acquisition. It’s the brain’s own self-evaluation on the basis of remembered behavioural success, and you have developed most of the skills and abilities that define what you’re good at or not good at whatever you can do operationally on the basis of the brain establishing that kind of control. So it’s controlling when it allows change, and if you have a bad try, it says in a sense “don’t save that one, that was a bad try”. This is all addressed by chemical release in the brain.

Elise: So, on a practical level, let’s say someone is trying to learn an instrument, they’re trying to learn the guitar, but obviously for anyone that’s learnt an instrument, it’s very challenging when you start to get your fingers around those cords, and it might not necessarily feel good. So are there any ways that we can actually enhance or trick the brain into thinking “this is good, remember this” or it is just kind of an automatic process?

Michael Merzenich: You don’t want to trick the brain into thinking that bad performance is good. And when you’re doing something like this, you have those little moments of real pleasure and joy. That’s a brain especially strongly responding by changing itself in those moments. It’s also the most valuable moments in the acquisition of the ability: you know when you did a better job, you know when you got that finger in just right, you know when the sound of the passage was beautiful, you know it. That knowing is reflecting processes in the brain that are saying “save that one, that was a good one”. So, basically, during your performance, on the basis of which practices are rewarding to you, your brain is changing itself. One of the things about it... in engagement in any activity like this, go into it with a cheerful and good attitude.

Elise: Yea, that’s what I was trying to understand. If we can enhance our learning and our neuroplasticity in some way by the attitude that we...

Michael Merzenich: Absolutely. The understanding that things can change, the expectation that things can change possibly modulates the processes that control change.

Elise: Wow, okay, that’s really significant for the audience to understand. So it’s the attitude that you’re bringing to the possibility of change is going to support that change.

Michael Merzenich: Right. And then on the other hand, if everything in life is impossible for you now that you’re a little older, that’s going to be reflected in the capacity of your brain to sustain you.

Elise: Can you say more on that?

Michael Merzenich: Don’t adopt this “I can’t do anything anymore” attitude. I mean, there are two things that I’m negative about. One is now that you’re down-regulating processes that you want to be up, and secondly, you’re not engaging in activities that can keep your brain alive. Because the brain needs to undergo continuously refining activities. I mean, what if I

never practice fine movement at all with my hands, never use them for anything? What do you think my hand control would be in five years from now? Will I be able to pick up the pencil and write with it if I hadn't written with it for five years? Well, I wouldn't be as good at it. It's a path to sliding backward in life.

Elise: And this fits with something that I heard you speak about which was in some ways unbelievable, a bit frightening and quite curious which was this idea that if I could take your hand and put you under training ... can you speak about the idea of neuroplasticity being a two-way street...

Michael Merzenich: Right. Well, we know that it's bidirectional which is really interesting. Most people have no idea that this is in play. We know in fact that as you age and you lose ability, that's really primarily a consequence of what you could call a negative plasticity. The brain is changing itself by active plasticity processes. And the reason it's doing it is to sustain control. Critical thing for the brain is to get the answer right. When the brain is actually going as fast as it can, it's doing, it's resolving information in as much detail as it can, as long as it gets the answer right. If the process becomes sloppy or noisy or unreliable, it has to slow down. The brain has to basically look more broadly for the answer and the answers are those things that would ultimately relate to your survival and to your being able to take care of yourself as an independent agent. So, on the other hand, at any point in life you can throw that plasticity switch and move everything in the opposite direction. From deterioration to improvement. So, we know.... we've conducted experiments in which you can quite quickly convert the hand of a monkey into a useless claw by training it. This is a common human experience, generating a focal dystonia of the hand because of how you're using it in a job for example. But I can take you, and engage you in training and in two or three weeks, you would utterly lose the control of your hand, and now your hand would be represented very crudely in your brain, and you'd struggle to identify even the large and prominent objects being held in your hand. On the other hand, I could take you and train you and even from that degraded state radically improve your ability to use your hand and drive you to a supernormal performance ability. The plasticity is bidirectional. You can go south or you can go north. And, in fact you have control of the switch. So, when you think of deterioration and ageing, in a sense you're deteriorating functionally to a large extent, not in every way - because nothing lasts forever - but to a large extent that deterioration is a product of negative plasticity. And the reason it's occurring in a sense is because you're not paying attention to your brain, you're not doing what the brain needs to sustain high performance ability. Why not do it? Because you can throw that plasticity switch and drive it in a corrected direction at any time you in a sense choose.

Elise: So, in some ways society has been under the impression – there's a common belief – that as you get old, your brain's just going to go downhill, and in some ways that's been a self-fulfilling prophecy because people believe it, therefore they don't challenge themselves. Is that how you see it? Is that correct?

Michael Merzenich: Yes, that's how it is. We've done many of these studies on animal brains and rodents and in primates but you can take an animal near the end of life and you can look at many things that relate to the organic health of the brain or to its functionality and you can

say well, how many of these things are different from the brain in the prime of life. I mean young, vigorous adult, sort of in the peak of life. In a human this would be roughly around their 30th birthday. Everything's different, everything you look at, everything you measure. We've measured more than thirty different fundamental physical, chemical functional things that distinguish the brain at the end of life and the brain at the prime of life. You'll say, how many of those things advantage the older brain? And the answer is none of them. In every way older is slower, less reliable, degraded, physically deteriorating. In every way the younger brain is advantaged. Then you'd say how many of those things in the old brain can be driven in a youthful direction by engaging the brain in training, and I'm going to give it exercise in appropriate forms. And when I do that, everything is reversed. Everything. Everything we've measured.

Elise: Extraordinary.

Michael Merzenich: SO in fact one of the astounding things in studies of animals is that most things are reversed all the way back so that the brain in all of these 30 dimensions looks like the brain of an animal in the prime of life or very close to it. And they're not just reversed, they're reversed dramatically. And it's because plasticity is bidirectional. Powerfully bidirectional designed by god or mother nature to be bidirectional.

Elise: Can you talk about your work with humans in this way? Because I was completely blown away to hear about that and your work with brainHQ and the outcomes of this.

Michael Merzenich: Yes, we created brainHQ to try to drive changes in humans, and our focus is on normal ageing and a variety of clinical indications. We are interested in psychiatric illness of different types and people that suffer neurological injuries for a wide variety of reasons. In fact more than a hundred control trials have been conducted using the strategy for a whole variety of ways that people lose their way cognitively or mentally, or and in neurological control. And we've applied it in every one of these trials. There are positive outcomes. Now they vary as the function of the malady, but there are two main things I would say about it. One is that there's a strong indication in the science that we can apply a combination of lifestyle changes – not just brain training on a computer but other things that you would do, meditation-related, physical exercise, other things that you could do, issues of diet and so forth - along with exercising the brain itself intensely to manage your brain health so that you are at least operating with high functionality. When you do this, there's a strong indication that it will be protective for you, that you'll be a more effective, you know, presumably a happier and more capable human being but you'll also have a healthy organ up there in your skull. At the present time, we fundamentally have no brain medicine, and when you go to your doctor for your annual physical exam and your doctor says “well, how are you doing, Elise?” and you say “well, I guess I'm doing okay”...well, you just had your annual brain exam. That's not medicine, okay? So the fact that we could look into our brain by measuring behavioural things that index the nature of what's inside and make simple chemical measurements that index what's happening inside, can provide us with a basis of saying “hey, Elise, you should consider lifestyle changes”, so that you're operating your life more to the advantage of your brain”. Just like I would consider if I see your blood pressure's high and I'd

say do this or that, you know, and then if that's not enough, I would prescribe some form of medicine. In the case of brain what I might prescribe perhaps would be meditation, or something like intensive brain training with brainHQ or some other way. But the point is I would manage your health.

Elise: And specifically the brain health.

Michael Merzenich: Right, exactly. And I'd see depression coming or I'd see that you have schizophrenia or I'd see that you're slipping and ultimately this might lead to Parkinson's disease or dementia or something else that could be devastating. And I'd just stop it, I'd stop the train.

Elise: Amazing!

Michael Merzenich: Right now what we do is we wait for the train to go off the tracks.

Elise: So, in some ways we're living in a context where the medicine is gross. We're not really in there preventing brain deterioration. We're just getting to it when the brain's already showing these significant symptoms.

Michael Merzenich: We treat disaster in neurological medicine. We treat disaster in psychiatry. We wait until a person cannot manage their life, they're totally off the rails and then we say how do we get them back on the rails? But what we should be doing is we should be anticipating how the brain is changing in ways that are going to lead them into this ditch. And most issues of neurology and medicine - certainly the development of a neurodegenerative disease or psychiatric disease - they are the end points of a long progression. So the infirmities of ageing itself, you know, would take forty-fifty years to come into play, and all those years are years of negative change before the disaster occurs. I mean, we should be considering health all along. And, Elise, the amazing thing to me about it is that it's not just health, it's also your functional capabilities, so it's you, it's how well you are doing. Are you keeping up with all those young people in the office - well, you've got a lot more knowledge about things, you should be running circles around them. It's you, it's how much useful ability you're accumulating in life. You should be growing, not retreating. You have the capacity to do that. Why wouldn't you do it?

Elise: And can I ask you at the moment does the technology exist to, for example, be able to look... if I came into your office and you are going to do a brain health check on me, could you do that at this moment?

Michael Merzenich: Yes. Again, one of the magical things about this, Elise, is the fact that, as I said, when you look at a brain that's deteriorating or really struggling, we've looked at about thirty things. And they've all changed negatively. Everything is compromised. And now I engage the brain in training and there's subtle forms of training involved. But when I engaged the brain I need to drive all of those things back in a corrective direction. That's another way of saying that I can use a single thing or two or three things, two or three simple things, I can measure your performance behaviourally, and I can have a pretty good idea of the state of your brain health. It would be equivalent to measuring your blood pressure, maybe the oxidation of

blood by putting that little thing on the tip of your finger, maybe measure your pulse rate. And one of those things is brain speed, processing speed. So, if you go to brainHQ and you are to conduct the processing speed exercise – there's such a category of exercise there about improving the processing speed – a processing speed is a critical thing that will define the state of your brain health. If you're really slow, you have a problem, so you can calibrate yourself.

Elise: So, you get that feedback through the program.

Michael Merzenich: You can calibrate yourself against the rest of the people that have ever done it, measured these things in the human race. So, several hundred thousand people have done that at least. And you can see how you shape up in relation to those people, and if you're at the 30th percentile or the 20th percentile or the 10th percentile, you'd better get busy. You need to do something about it. All the answers shouldn't come from working on the computer, you should think about lifestyle changes. Lots of things can help you elevate your processing speed.

Elise: Can you say specifically what that would be?

Michael Merzenich: Play ping-pong, or a net game, something you have to respond to with rapidity to what you see, and some kind of complex movement game. Anything like that. A whole variety of things like that. But also continually challenging yourself in whatever you're doing in a sense, to do it at speed. So, you can do all kinds of things in everyday life or you might find a better way for you to try to accomplish this. And calibrate yourself and see if you're driving yourself correctly. And if you're not driving yourself correctly, maybe you need to go to the computer. But do something about it. Another important index is an index of distractor suppression, how noisy are the processes of brain, and these are reflected by how easily you are distracted when there is noise in the room or there are other issues like this. That's another signature indication of course you have to separate that from hearing loss. Because if you have hearing loss, you can also be troubled by noisy rooms. But distractor suppression is another index, important index of the health of the brain inside.

Elise: Can I ask you on the topic of distraction: I'm wondering what your perspective is around the time that we're living in and what's going on with our brains when we're using facebook and we're constantly multitasking and... Have you got any research or any perspectives on that?

Michael Merzenich: Well, I certainly have a perspective about it. I have not studied it directly, but lots of other people have. And I think what you can say about it without question is that it's driving changes in our brain that are unprecedented. The average brain is very different operationally from the average brain of thirty years ago, and dramatically different from the average brains of hundred years ago. And if you think about it, the way we're engaging our brain in all kinds of ways now, is different 24/7 than it was thirty years ago. I mean we're in or on the little screen of these devices continually. We're continually totally absorbed by them, everything that's important for us is within the dimensions of that screen. We're very poorly connected, we're not mindful, except occasionally, about anything else. We're not commonly translating what we see or feel or hear into direct action in any complicated way. You know,

maybe our action is like this, it's all with the thumbs. Which is amazing. Now, that's going to have a different consequence for us and also we have this fast moving, sort of attention-grabbing demand from almost everywhere. We're not stimulated enough unless there's a slam bang occurring at a high rate. I mean, this is changing us, it's changing our fundamental neurology. Now, is it good for us? Well, there are some things about modern technology that are fabulous. I mean, the fact that we can look up information from the beginning of time and find the answers to all kinds of things is great for us.

Elise: Yea, and the fact you're using the brainhq.com, that's you're using technology to train the brain.

Michael Merzenich: Absolutely, we're using technology to try to help people get past what technology is doing to them (laughter). But the other aspect of this of course is that every time I look up an answer, I'm not exercising my brain and its reasoning powers. Hundreds of thousands of times a year, where I could be reasoning out some problem, some little reasoning cycle, instead I'm looking up an answer. In all kinds of ways, what I'm doing is fundamentally different. Let me tell you a little story. Every morning I go for a walk. Thirty years ago, almost everyone was connected to other people around them on the streets around my home. A person that looked at you, smiled, you know, you could say they were really interested and they were alive in the walk. Now almost everybody's a living zombie. Nobody, almost nobody – it's a rare person – that's connecting with other people in their physical environment. It's a rare person that has any connection with it, it's a rare person that's mindful about it. And that's very unnatural. It means that you're not exercising the machine of the brain that's maintaining your high resolution abilities. It means that you're not reconstructing your physical environments and mastering them, you don't even know where things are any more. And I tell people “think about what's on your street in detail, reconstruct it in your mind, then go out and look!”. Are you a master of your environment? Most people when they go out and look are amazed at the things out there, they're really amazed.

Elise: I read something – I don't know if it was something you wrote about, I heard you say something – about when we're using screens all the time, how it's affecting our vision, our visual field or...

Michael Merzenich: Right. One thing we do is we look at screens and everything important is on the screen, outside the limits of the field of the screen it's just a distraction. So, the consequence of that is – and also driving contributes to this - in both behaviours we're primarily focused on things directly in front of our nose, and things that are more distant in peripheral vision are not only not important but they're distractors to us. So, the consequence of that is that as we get older, we constrain the field of view in front of us that we actually command. This is one of the primary targets of brainHQ, to re-expand our view of the world. It's relatively easy to do. But actually, by the time the average individual is about 80, they've lost half of the world in front of them, they don't see it. They see the things directly in front of them, but anything off to the right or left or up or down is out of sight. They don't see it. Now, if you thought about and someone said to you: “hey, I want you to trade in your big screen TV for a

little one”. Who would want to do that? But in a sense you learn your way into constraining the world in front of you, and now you don’t see the bird over there.

Elise: And you also might have more of a risk of tripping over something and falling.

Michael Merzenich: Or the car coming at you from the intersection you don’t see it until it actually hits you. That’s why there’s a big increase of traffic accidents when you’re older, most of those accidents come because you don’t see things in the visual periphery in time to avoid them. So, here’s another example of negative learning: you’ve learned in a way, you’ve changed your brain in a way that constrains its operational capacities, and it’s all a product of plasticity. I mean, but it’s just plasticity in the wrong direction.

Elise: Right! Michael, I wanted to ask you – to dig a bit deeper around – how neuroplasticity actually happens and specifically the relationship between our attention and neuroplasticity. Because in this program people are practicing mindfulness regularly and refining their attention and I’ve heard about this but I would love you to explain the relevance of attention and neuroplasticity.

Michael Merzenich: Right. It’s a critical aspect of it. Attention has the effect of amplifying the release of critical enablers of plasticity. So, one of these enablers which is called the noradrenaline or norepinephrine contributes to your brightness, your alertness. You could think of it as a control on the light switch. You know, when you wake up, you wake up with noradrenaline flooding your brain and when you see anything that’s surprising or novel or interesting basically. That brightness you have when your brain is in good shape is the product of release of noradrenaline. What it does is that it amplifies the activity of your brain generally and sort of turns up the volume. And it’s basically helping you resolve what it is that you’ve just seen as interesting or just heard as interesting, right? And it’s a strong enabler of plasticity if I turn up that volume to change the brain with greater efficiency. Now, the second chemical that’s released in the same condition is called the acetylcholine. And acetylcholine is an enabler of plasticity in another way. What it does is basically when it’s released, when you have a strong attentional signal, it basically controls the things that your brain can change too. What it is doing it is enabling change, it’s saying okay, now you can change this thing and move a little bit better and in a stronger direction in this way. Or it’s basically critically changing the platform that’s governing change. Both of these things are a direct product of the levels of your attentional control. So, attentionally related exercises are wonderful, and they’re a starting point for almost all useful learning. Actually what we do in brainHQ is commonly we begin by focusing on attention control. When people allow us to set up their own training program for them, we always start with attentionally related exercises. And if you go to brainHQ, you’ll see a category of exercises called attention-related and do those, that’s a really good place to start in livening up your brain and increasing its learning powers. Let me start again Elise by saying something really simple about this. We have a capacity to change the learning machine within the brain itself. It’s plastic. It’s not just about improving our ability to play tennis or ping-pong or golf or something, it’s about improving our ability to learn, to change, to improve our brightness, our alertness, our connectedness with things. You can do this powerfully in many ways through forms of progressive meditation training. You can do this with specific

exercises like the exercise we made in brainHQ. It's extremely valuable to do this. You know, there's a common belief that older people lose the plasticity to learn. Right. They do. You take the average seventy-year-old and they're a poor learner. But a machinery that can control learning rate is plastic. So, the main reason that they're a poor learner is that it's unexercised.

Elise: They stop learning.

Michael Merzenich: They haven't been learning a lot, right? Get to it, exercise it. Do these things that can increase your attentional control and you're doing your brain a real favour.

Elise: So, really, it's the "if you don't use it you'll lose it".

Michael Merzenich: Another thing, Elise, that I tell people, I say "be mindful". And by that I mean when you're out in the world, really drink it in, look for the surprises, look for things that are interesting to you, look for things that are novel. I mean, this is brain food, this is engaging this same machinery. Because whenever the brain detects a surprise, it turns up this machinery. And ultimately, if it turns it up repeatedly, it up-regulates it. It's now operating consistently with more power.

Elise: So it turns up what machinery?

Michael Merzenich: The machinery that's controlling your brightness and your learning thing.

Elise: Right! So it's like really making an effort to engage the brain in reality.

Michael Merzenich: Exactly. Again, you're wasting so much time when you walk across the landscape of planet earth not paying attention to it. Because the world is full of wonderful surprises if you just look for them. And one of the things that happens on the little screen – well you can find surprises, you can look at youtube videos forever. But to a large extent what you see is not really surprising, it's all controlled. And that's not nearly so useful as finding the insect on the flower and saying "wow, what the hell!". I think that this disengaging from the real physical world is one of the primary changes that's occurring in the contemporary brain that's we're going to probably pay a price for not too many years into the future.

Elise: Michael, I'm aware of the time, I just have a couple of more questions and then I want to also share more about your book and brainHQ. You know, there's this Hebb's Law which is thrown around a lot, that neurons that fire together, wire together. Can you just give us more of an explanation around what this actually means in relationship to what we do.

Michael Merzenich: When you're learning something, the brain is basically changing itself on the basis of the information or the inputs that are occurring moment by moment in time that contribute to the right answer. So, basically what it does is that all of those things that occur concurrently are strengthened together. And what it's doing by that strengthening is it's changing its connections, it's wiring them together. You could say it's strengthening them together so that it increases the reliability of their operations. And it also increases their cooperative contribution to the learning. So, I see things that have different qualities or

characteristics at that moment in time that have contributed to the acquisition of this ability of distinguishing this from that, let's say, and the brain basically wires those things together that represent all of those aspects. Okay? And that's the basis of the brain creating everything, its model of the world, the things that go together are wired together.

Elise: So, can you just speak to how that relates to let's say if we're learning something new and developing these new pathways of neuroplasticity. Can you speak to how neurons that fire together wire together in that context like on a practical sort of level. Again, maybe in the instrument example or...

Michael Merzenich: I tried to explain this in my book *Soft-Wired* but – the brain basically has two things it has to accomplish. It has to strengthen the connections for all of those things moment by moment in time that relate to any complex performance. So, let's say that I'm learning to toss balls in the air, you know, I'm playing, I'm juggling, and the brain basically has to learn these actions that relate to each little moment of time that I require to perform a task like that successfully. And it's a very complicated thing it has to do, but it also has to do a second thing: it has to associate all of those things in serial order. So each time one little event occurs – this'll all occur in a very fast rate - it basically has to drive an influence on the next event. It's making a prediction about what the next event will be and it's connecting it by wiring. It's doing all of this by changing its wiring on the basis of the co-concurrence of activity each little moment in time. And we've seen this in many many ways, thousands of ways in different experiments. We see this connection occurring for the combination of things that might represent the essence of that little moment. And then are linking successive moments. I mean, it's sort of hard to comprehend but on the other hand it's such an amazing, fabulous, self-organising property for this machine that has evolved with biological chemistry. It's just amazing that it's doing this on this level. It's doing that for every ability that we improve or acquire.

Elise: Perhaps you could give some tangible examples of how long this training takes before you see changes and what is the potential you've seen for humans.

Michael Merzenich: One of the things that we saw in animal experiments was that if we looked at an animal at the end of life and we trained it, then we could look at the operational characteristics of the brain or its physical nature, we could see that we could drive it back to the prime of life, basically when it was in the peak of its performance. And we've done similar experiments in humans in the sense that we've looked at humans' functional age and processing speed, how fast the brain can operate in its basic processing – and we see that systematically the average person slows down decade by decade, and the slowing is dramatic from the twentieth or thirtieth birthday to the seventieth or eightieth birthday. Those changes are stunning. Older brains are slow, sluggish in every way, everything you measure. Well, turns out you can engage that old brain and quite rapidly drive it to a youthful performance level. So, it's quite easy to drive the brain to a performance level that matches the untrained thirty-year-old. Now if you train the thirty year old, you'll guide their performance up as well. But let's not tell them the secret. Let's get a jump on them. Because your brain can operate just as fast as theirs can. The changes can be dramatic are commonly dramatic. We've also shown that

you can train older individuals in control trials in very limited ways and drive very strong improvements on performance. So, for example, you can train a person for ten hours and you can show that their ability to perform an everyday task by that ten hours of training can be twice as fast and much more competent and reliable in the task. As a consequence of a ten hours of practice they might have half as many traffic accidents over the subsequent five years.

Elise: Incredible!

Michael Merzenich: So, not just a big effect of relatively limited exercise in the right form but also long lasting. And turns out if you train a person for five years - and this is a particular controlled trial - and then a year later for ten hours and a year later for four hours and then two years later for two hours and then look seven years later at these total of eighteen hours, seven years later, now they're 85 years old – only half as many in the trained population that's the control population developed dementia.

Elise: Wow!

Michael Merzenich: So, you can actually have a powerful impact for their brain health by very limited dose of training.

Elise: That's really extraordinary.

Michael Merzenich: And these kind of studies point the way directly to thinking about how we would manage brain health because we can continue the training, they don't have to just be trained in such a limited and sporadic way, and we can be monitoring the consequences of the training from the point of view of their performance month by month, year by year. And we can do what's necessary to keep their brain in a high operational state. And by such a strategy we have to be protecting more than fifty percent. So I think we're going to see a rapidly evolving future of managed brain health. We know what to do: first thing we're going to do is we're going to say "change your lifestyle, Mary, do something better" or "you've got to think about living your life to the advantage of your brain." And if that's not enough, we're going to say "I want you to take this class of meditation, I want you to go into a brain training seriously". There will be a series of progressive things that we know will advantage your brain. I want to say one last thing about meditation. In meditation the exercises that you have focused on - for example an attentional program - are brain exercises, they are going to change your brain. I mean, your brain is plastic if you exercise it systematically in these ways, you don't need to be operating with a physical device, mental works just fine. There are many beautiful experiments with meditation practices which show that you're going to improve your ability to make distinctions about things, to detect the details of what you're seeing, to improve your listening skills by meditative practice. That is to say, by organised progressive improvement of your operations that are mental. And they are driving exactly the same processes that you're driving to change when you operate on a machine or with a device, with a physical exercise in a game. Just the same. It's all plasticity.

Elise: Well, thank you so much for so generously sharing your thoughts and your time. Before we finish, I just wanted to ask if there's anything else that you wanted to share with the listeners that we might not have covered and you feel is important about your work.

Michael Merzenich: I would say just one other thing and that is to say one of the most important things that you can work to control is your sense of joy and your spirit of generosity. I just want to say that because when you're generous, you're rewarding your brain just as much as receiving someone else's generosity. And that's because the giving also exercises a critical machine of your brain that controls learning rate and emotion, the machinery that controls the release of dopamine. So, I haven't said anything up to this point about thinking about leading a generous lifestyle as a strategy for brain health. But it's an important one. Think of trying to move yourself in a more rightful direction. You know, I love the book by Dalai Lama and Desmond Tutu about Joy...

Elise: Book of Joy.

Michael Merzenich: I mean, what a great concept! And almost every person that I know that has lived to be very old and is very healthy mentally has a positive generous spirit about them, and I highly recommend that as one of the most important things that you should think about doing. Not just physical activities, not just some intensive learning thing... learn, learn to be joyful. I strongly recommend that.

Elise: That's an official prescription from professor Merzenich.

Michael Merzenich: Absolutely!

Elise: And thank you so much for highlighting that. I think it's such a wonderful way to end and I think it connects also with so much of what we're seeing now from some of the meditation masters and the neuroscientists that are looking at how it's affecting the brain and how these practices of... practising compassion, practising empathetic joy, they're self-generative, aren't they?

Michael Merzenich: Absolutely! It's all good.

Elise: Thank you so much. It's been such a pleasure to speaking with you. And I'm sure after the interview everyone will be excited to learn more about your book *Soft-Wired*, and from brainHQ.com for them to get a good dose of brain health. So, thank you very-very much!

Michael Merzenich: Thank you, Elise, it's been fun.