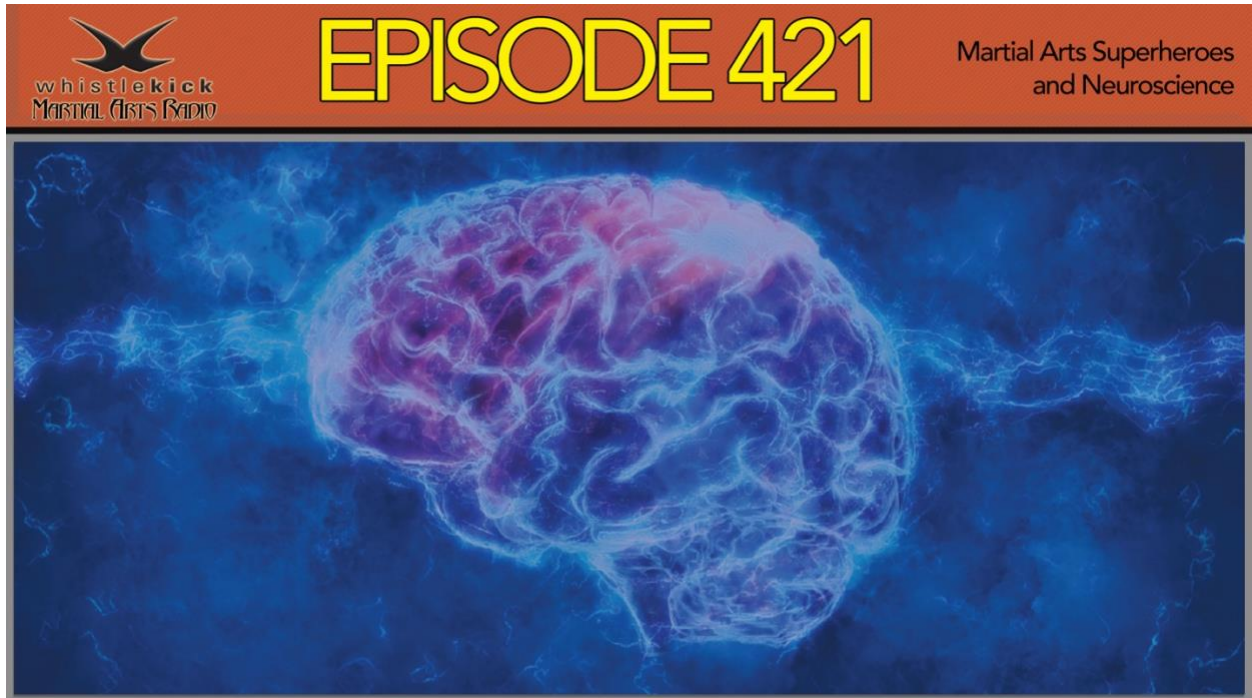




Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com



Jeremy Lesniak:

Hello and thanks for coming by! This is whistlekick martial arts radio episode 421. Today's episode is titled Martial Arts, Superheroes and Neuroscience. Kind of a strange title but honestly, it's hard to put today's conversation into a short title but I am joined by my guest Sensei Paul Zehr and, as you listen, that title will make a lot more sense. Now, don't forget, we do this show twice a week and you can find out everything about the show and the episode and the guest at whistlekickmartialartsradio.com. You can sign up for the newsletter where we give you discounts, we tell you about new products, we do a lot and we only send that out a couple times a month. If you want to know more, the best place to go is whistlekick.com. We've got everything that we've got going on over there. Links to the various projects and websites that we do and we've got a store. That store has protective equipment, uniforms, training aids, apparel, a ton of stuff and you can find that, of course, at whistlekick.com and if you use the code PODCAST15, you get to save 15% on the whole shebang. This is the point in the show where I give you an intro, where I set the tone for what you're going to hear or why we reached out to a certain guest or maybe, talk about what it was in our initial conversations with the guest that help you understand why we brought them on the show. I can't do that. I can't do that with today's episode because we talked about some really interesting, really different stuff and to try and boil that off into two or three sentences just doesn't work so I'm going to ask that you trust me. If you've listened this far, I'm sure you're going to, but just go ahead! Listen to this episode and I found it to be fascinating because of the ways that Sensei Zehr connects what seem to be very different things but of course, the way he looks at



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

them, the way he presents them and the way I heard them, it makes complete sense so I hope you enjoy today's slightly different but, nonetheless, entertaining and informative episode. Sensei Zehr, welcome to whistlekick martial arts radio.

Paul Zehr:

Well, thanks for having me on.

Jeremy Lesniak:

It is an honor to have you on and, listeners, we've started doing this a little bit more. We reach out to someone who hasn't been on the show before, who hasn't told their personal story but they have something to say. Something that maybe they can flesh out for us and today, we reach out to Sensei Zehr to talk about what I'm going to call a connection between martial arts and the brain so we did a little bit of research and your name kept coming up and we reached out and fortunately, you were kind enough to say yeah, I'll come on the show so even though we're going to talk about that stuff, you and I, we batted around what, really you proposed a little bit of flow in the conversation and it kind of started with how you started with martial arts. I'd love for you to kind of take that as you suggested and give us that lead point and we can roll forward.

Paul Zehr:

Yeah, I'm pleased to talk about that especially because I think, a lot of the ways we think about neuroscience which is my specialty in research really relates to a lot of things we do in martial arts but, in my particular case, it all started with my mom who got me interested in comic books and superheroes when I was a kid because she grew up back in the Golden Age of Comics when Superman and Batman and Captain America and these folks were literally first hitting the pages of these pulp comics and she adored comic books when she was a kid and got me into reading them as well as a kind of a gateway drug to all kinds of reading and the thinking I did just thinking the fantastical things I saw in comic book characters, characters like Batman, like Shang Chi, like Iron Fist, these martial arts guys, really got me interested and help feed an interest in martial arts and from that, once I started doing martial arts as an early teenager, I just got fascinated with once you get past the realization that you're not going to be Iron Fist in a couple of weeks, I got interested in the science of human performance and what really just fascinated me like what the heck is going on? I gained some skill, of course, from training as you do but I'd see teachers and very high ranking and extremely skilled martial artists who'd come from Japan or wherever they were from and they would be demonstrating things or getting things with me and I'd be like it is like a superhero what I'm seeing that kind of skills like how did that person do that and that really got me fascinated on trying to understand the science of that which took me to university where I did an undergraduate and master's degree in kinesiology really of things and did actual research studies on some aspects of the physiology of martial arts at that time, cardiovascular and neuromuscular stuff but then, shortly after that, and this sort of planted a theme that I didn't recognize until later, instead of



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

just dealing with highly trained folks and what they're able to do, I really got an interest in what the nervous system was doing, controlling those movements which at first were studies of martial arts which became trying to understand the rehabilitation of walking after a stroke and spinal cord injury. I spent a lot of my career doing studies that were about trying to understand the continuum of human performance until we got highly trained folks who can be trained to be almost superhuman and we got other folks who are on the same continuum but a lower level of performance who've had some kind of injury or damage to the brain or spinal cord that has pushed them to a lower level of performance and they can benefit from the same ideas and training principles and physiology and neurobiology to improve their abilities and I want to share that with people through teaching and training and doing research and talking about it which got me into science communication because I want to communicate the wonders of different things that go on in the body. That kind of captivated me back as a teenager and when I did my science communication stuff, I want to do it in a way that folks would find accessible and interesting to learn about so I chose superhero comic book characters like Batman, Captain America, Ironman, batgirl and I slipped in there, all kinds of things around human performance, neurobiology, neural plasticity of training and how the brain and spinal cord adapt to things and, in many cases, particularly for Batman, a big example I use for my Becoming Batman book was all about Batman as a martial artist and what's going on in his brain and spinal cord, what's happening with his muscles and how would that be the same if it were Batwoman or batgirl and how we're all very similar and even trying to talk about all my books actually bring up martial arts. I talk about how, in my Inventing Ironman book, I mention that tony stark's got this fantastic suit of armor but it doesn't always work right but he actually has to train in martial arts too and give examples of that, same for Captain America, same for batgirl, all these characters that I've used in my different books are all about trying to explore the positive potential of martial arts training in doing different things, whether it's getting stronger yourself and having a feeling of self-confidence and achievement or, in the case of those superheroes, sort of being part of the back story of them and during that process, it's kind of interesting sometimes if you reflect on what you're doing and why. I started to realize a lot of the things was connected and all kind of came back to that start in martial arts that teaching martial arts or training in martial arts is about empowering other folks, literally, providing physical prowess for self-defense skills but empowerment through knowledge and ability and skills which is basically what I realized at that point some years ago, essentially, the core of everything that I do as a person in the world, as a scientist, as an author or as a martial artist and sort of brought all these things together to think about how I can continue the work to help empower folks after injury or just states like ageing and so on which kind of circled me back to where I started and someone listening in could sort of imagine a big sort of calligraphy diagram of the void that you often see, the big circle starting as I did back in my teenage years with martial arts and the science of martial arts, it kind of circled back and trying to complete that calligraphy with some recent work that we've been doing where a lot of my studies prior to the most recent projects had been looking at ways we can help somebody who's had a stroke, for example, who doesn't walk very well because of their injury. How can we help them, retrain them to improve their walking ability, improve their strength and balance? These kind of things and we've used interventions



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

like different things and studies like arm cycling training, arm and leg cycling, strength training, machine-based stuff that you find in a lab or a rec center. All my research interventions tend to be, I wanted them, if we're going to test something and find out it works, I want to make sure folks can use it right away so I don't want fancy machines and devices that you can only find in my lab. I want them to be accessible and with those ideas in mind, we recently have started to address the idea of using martial arts training in older adults and in folks with stroke, Parkinson's disease and other sort of ageing, typically ageing associated pathologies as a way to help them be empowered and address some of the deficit they're finding in the hope to help improve their function. We actually, because you got to have little acronyms, we call it the KICC which is the Karate Intervention for Chronic Conditions and it's been really neat to actually apply all those things that I've spent the last 36 or 37 years in martial arts, about 30 years in science, putting them all together as a way to help people and when I reflect on that, which I have tended to do as I've gotten older and think about how I got where I am or where I'm trying to go, it sort of brings me back to how all that stuff started that a mom who just tried to share her interests in comic books and human performance seed was planted in me and took me on this journey that I continue on that it's really quite fulfilling.

Jeremy Lesniak:

There was that instruction, those classes, whether it's one on one, this KICC program that you just mentioned, would those of us watching know that you were teaching these people towards a certain goal or does it look like a normal martial arts class?

Paul Zehr:

It looks like, generally, a normal martial arts class with the exception of what I sort of done is modified some of the material so that it's not as challenging at certain contexts in the beginning so, for example, for the purposes of the intervention we did, we took a thing like sort of any wrist-locking things and break-falling and anything, we also removed kicking from any of the techniques we were teaching in the initial portion so that the balance challenge is that folks would be experiencing more about shifting their weight, where they step if they're punching or blocking and turning in a certain stance, rather than have them teetering on one leg and doing a kick which is ironic given the name of the intervention but PUNCH didn't work right as a thing so the idea would be, if we're going to continue with some of this stuff would be, of course, to slowly start introducing more about what we essentially did was what I would call as a more graduated entry to a lot of the technical content that you'd find in a typical martial arts training session probably anywhere or certainly when I'm teaching but it would look very similar. We make sure, one of the main reasons that I like the idea of piloting an intervention using martial arts is that, given my background, it's not surprising that I'm a big advocate for people to be physically active and to do things in the world but I think activities need to be meaningful and what I mean by that is, and I don't want to put this activity down and I do it myself, writing a stationary bike or running on a treadmill or whatever it is but those activities are really just for physiological training. You're really trying to work on your cardiovascular fitness because you don't have an opportunity to do that in another part



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

of your life necessarily or fitting in your exercise bout or what have you. Learning martial arts, though, is more about empowering you and feeling about some functional ability that goes with the things you're doing and in fact, in my opinion and the way I tend to approach things, it's more that you kind of have a fitness benefit just in passing but that's not the major focus but you should have that but it's going to occur as a result of the meaningful activity you're doing. You're going to be feeling that the activity you've learned and the skills, the physical skills you have feeling of empowerment, and I bring that up because one of the things that we definitely did maintain, even in this group of older adults and I just say this as an aside, what an amazing experience it was to actually teach a 90-year old martial arts for the very first time in their life. We had a few folks who were fairly old who were out there trying to do these things and were interested and they got recruited in this study because they're interested in trying the martial arts and it was just amazing to actually see them gaining some of the abilities, learning some of the patterning we were doing and also, coming back to what I was saying about the meaningful aspect, make sure that we taught it, the martial arts intervention, in the way that we would normally do in a dojo or training session normally which was to explain these movements, we're doing them a little slower, we're doing this, we're doing that, here's the meaning of the movement. This is meant to be the defense against the kick and this means to grab the leg and this is a punch here and this is this and then making sure that even though they did them slower, we also worked through some of the applications so they got the full flavor of everything. This movement you're doing is dodging away, it's deflecting an act and grab the arm and then you were punched or whatever the example would be but making sure that they got exposed to that because, for them, that was providing more meaning and context and, for me as a martial artist, of course, that's so I could be authentic and have integrity about what I was trying to share and what some of my trainees who were involved in the training as well were doing but that it also allowed for a situation where, as a scientist, I could imagine that they're getting more buy-in to some of the things that they're doing and the way they're going to feel about themselves after learning martial arts for a 5-week intervention which is what we typically have used for these sort of brief intervention test studies, they're going to feel a little bit different and probably more positively about what they did than if they did arm cycling in the lab for the same kind of sessions and dose of activity. Even though it might be similar time commitment, folks didn't tend to leave the lab after doing arm cycling training which was quite powerful and a really useful thing to have done and has a really important application in rehabilitation but you don't tend to feel, I don't think, the same way about yourself in your capacity that I really got in arm cycling as compared to I learned how to defend myself even if it's slower and I think that's really critical to getting folks engaged in trying to improve themselves and their abilities.

Jeremy Lesniak:

Now, I would imagine if this is happening as part of scientific research that you have some data that you're collecting before, maybe even during and certainly after these 5-week interventions. What does that data collection look like?



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

Paul Zehr:

What we try to do and I'm very systematic about how I approach various aspects of my career but especially from the science end of things so we have already developed kind of a template for how we would do these interventions and the kinds of measures that we would make so we knew or we had a good idea about what sort of measures might be the most sensitive, what reflects the functional gain, all of these things because of all the other interventions studies we've done in the past using things, as I've mentioned, strength training or arm and legs cycling training or various other modalities so the basic idea that we do in my research program for these interventions is we have a bunch of pre-tests and one of the things that I've been pushing very hard for in my application studies, these interventions, is we don't typically use a control group like a complete control untrained group to compare people to. The whole idea of control groups, designs like that, you need for doing a drug study but if you're doing physical intervention, you're getting too much variability from people so what we do is it takes a lot more time what we do but I think is much better. We get folks to come into the lab and they have to do the pre-test. All the measures we're going to do three times in three different days and we use that to develop, let's say you're going to do that in the lab, you're going to do one of our interventions, you have to come in and do the same pre-test measures of strength, balance, control of spinal cord excitability, of muscle activation, the psychological questionnaires that we administer as well, you do them multiple times so we kind of create the variabilities for you like how much you change from day to day so when we could know at the end of the intervention. We do the post-test assessment as this data that we get in the end of the intervention actually will present a meaningful change from what you're baseline is so it takes a long time and participants have to be okay with the idea of doing all the kind of boring stuff at the beginning when really they, in this case, were quite keen to do martial arts training but we do all the measures before, 3 different sessions, then we have the 5 weeks of training then we get the folks back into the lab within the week of the last session to do their post-test assessment so it's actually a pretty big time commitment for people, both the folks involved and as the participants in our study which are obviously the only way we can do these tests but also for my graduate trainees, the masters and doctoral students, that are training with me who were involved in these projects including one of my trainees who led the bulk of all the training for folks, I tended to come on Fridays but they were training Monday, Wednesday and Friday, because of my own schedule but one of my doctoral trainees will be finishing her PhD this fall and who just recently achieved her black belt with me, becoming the first and probably only trainee I'll ever had that will actually get a PhD and a blackbelt under my supervision which is, yeah, this is cool actually. I bring it up because, for me, it's actually a neat thing to think about all these stuff we've been talking about here how martial arts can empower all these things and to have someone who was especially keen when she was interested in coming to work with me for her neuroscience training but really had done martial arts elsewhere was really keen on training with me on martial arts as well but a lot of time for [00:21:05], that's the student, for her to do all the work in the intervention itself so a lot of time and effort goes into these things but, of course,



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

that should be no surprise to anybody who's interested in martial arts, right? It takes time and effort and perseverance and repetition so there's some things here that definitely overlap.

Jeremy Lesniak:

Can you give us an example of one of those data points that you're collecting before and after and what a, I don't know if you've done enough of this, and say what a typical or average median change is?

Paul Zehr:

We can't say quite yet. This is sort of hot off the presses, so to speak, we just completed the interventions and all of the data analysis is all ongoing because it takes quite a while but what I can tell you is, I can give you an example the kind of things that we tend to see. One of the ideas that's really important as kind of a science question and social question around helping folks get better ability, they've got Parkinson's or a neurodegenerative disease like Parkinson's where you're trying to affect the disease trajectory that doing martial arts is not quite a cure for Parkinson's but it can change the slope of the decline so if it's a little steep, it might be a little bit less steep. We know that other activities can do that or if you've had a stroke and you've got some balance issues which is very typically arising after lesion in the brain that occurs as a result of the stroke event, the idea of training to improve balance and/or just older adults we know that folks tend to have decreased balance control as they get older and a result of all these things is that the people are more vulnerable to falling down and when we're younger or we're doing martial arts or maybe we're doing martial arts which involve a lot of falling down and learning how to do it, we don't think about the potential catastrophic event that can occur if somebody who's frail, older adult, say 80 years of age, falls down and breaks their hip. What that actually does is the cardiovascular system and how often that results in a massive cardiac event and big potentially life-threatening outcomes, it's a serious issue so one of the things that we try to build into this is the idea being that really what we're doing with martial arts training, generally, is this training our balance and our posture so that's embedded in the training and the way we measure that, we develop from some other studies a way to give a postural perturbation, meaning something that affects your balance control. Some labs, what that would mean, would be like a really fancy device you'd stand on that would tip and change and kind of like you're in a moving boat, a train or something taking off from the station, slowing down where you'd have a perturbation where what you're standing on and then you look at your reactions and how long it takes and those kinds of things but we develop something that I thought was a bit closer to the idea of what we really experience most of the time during the day which is we see something or we step a certain way in reaction to something and that movement itself sort of takes us off the base of support and makes us more tipping and likely to fall over so those are more realistic sort of day to day thing so we developed this protocol where you'd be standing on a force plate or, in fact, we used a modified Wii balance board because we want these things to be in another study to be something to make and adapt and use in the community very quickly and so, you're standing on this balance board and you're watching a computer screen and on the computer screen, we've calculated where your center of pressure is which means if you were to look at your base of support,



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

where is the center of mass located and where is the most pressure under your base of support and, of course, if you are within your base of support, somewhere between your feet somewhere, you're not likely to fall over just standing there. As it begins to shift outside your base of support, you'll fall down. Of course, that's what people are doing when they're throwing folks in martial arts. We're trying to shift the people off their base of support to make them tippy and, in the case of this perturbation, they'll be watching the screen and then randomly, the dot that represents that sort of center point where all the pressure is located would move outside their base of support in a certain direction. What they have to do is follow it, the idea is to follow that dot and as soon as they actually get close to the dot, it zooms back to that center again and so, what they have to do is shift their weight in the direction of going off-balance and quickly shift it back which was meant and is meant to be similar to the kind of things that would happen when somebody is just normally behaving in the world every day. If you have an intact nervous system and no damage, you're doing this kind of stuff all the time and don't even notice it whereas if you had some balance concerns and some problems based on the pathology, you're in danger and likely to fall down sometimes so the idea was to assess how good and fast and strong people were, how long it took, what were the synergies of the muscles, the legs and arms that were part of these corrections and bringing things back and try to look at them. How that looked before the intervention and then did it change afterwards where the idea would be that you would be faster, for example, at returning to the base of support after you've perturbed yourself after the training. That seems to be what we're seeing as well as what we predict we would see with these balance corrections but, in terms of the overall percentage change, we don't have those number quite yet but the important piece here is that what this is all reflecting and, we measure this as well, things like within the nervous system, the adaptations occurring in the brain and spinal cord that we can indirectly assess by evoking reflexes and looking at what's going on in your spinal cord for corrective reactions there as well, we also assess those things so we can know are we actually inducing meaningful changes in the nervous system activity so what your brain and spinal cord, what we normally call the training and there's neuroplasticity, the idea that the nervous system, because it's been subjected to all these different and new stresses of learning the martial arts pattern and self-defense techniques that involve shifting body weight and moving in certain ways and changing synergies of muscles and attention and posture, that those are providing the queues that drive an adaptive change so that your body gets better at doing it which is what we all consider to be what happens when we do any kind of training.

Jeremy Lesniak:

I find this subject fascinating and if you, if any of the listeners, I'm sure, you're hyperaware far more than I am, but if any of the listeners are interested in strength training, that is an industry that has really been leaning into the nervous system, CNS, talking about adaptation for about a couple years now from what I've been observing and what I find fascinating because I have a very rudimentary understanding of the nervous system and, in a moment I'll ask you to talk a little bit more about that but I'm kind of setting this up, what I find fascinating when I look at martial arts, when I look at the way many martial arts classes, especially what I see as more traditional martial arts classes operate, there's no way that they



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

understood the science of the nervous system and how that worked in the body but it's as if they were still aware of what needed to be done to create those adaptation and I find that completely fascinating and I suspect you bumped into the same stuff too and felt the same way.

Paul Zehr:

Yeah, one of the things that's interesting, especially in a way, you can sort of say I've kind of got a collision of worlds in my own experience because of Asian martial arts sort of training and sort of western scientific training and sort of those things sort of colliding, not necessarily colliding but both those things coexisting. I don't think of them colliding actually, I think of them very much like Taoism Yin Yang kind of idea that they're coexisting and they're mutually supportive that they're kind of circling around the same ideas but they're just explaining things in a different way based on the kind of knowledge skills and abilities of the folks who either develop the science, the western science, the explanations and discoveries around certain things or the tried and true method from the Asian martial arts of people just doing things for a long period of time and figuring out what worked and what didn't work so I think it's interesting that these two things can coexist and I think an important thing when we try to understand something like martial arts training or strength training or any sort of training, it is the idea that, from a scientific perspective we'd say, you're providing a stress, your body exist in a certain kind of balance in all of its physiological systems and science's term for that is homeostasis but really just means balance. It just means that things have adapted to whatever's going on so if we're thinking about muscle strength, it means whatever you do in your daily life and including any training you might do, your body will adapt to needs that you have told it you need based on what you've done and physiological systems are super thrifty. They don't want to adapt to things and get extra strong muscles if they don't have to because it cost energy. All this stuff comes down to evolutionary pressures and how biological systems work and they're extraordinarily thrifty. If you want muscles to get stronger, you got to stress them for a reasonable amount of overload so there's real stress for some period of time so the body finally goes okay, okay, okay. We'll activate the muscles more strongly, we'll make the muscle fibers bigger, we'll put some more mitochondria in there, we'll do all those stuff because it will cost energy. Your body doesn't want to do it unless it has to and on the flipside, once you stop doing it, the body right away wants to go back to the thriftiest thing. We'll make those muscle fibers smaller, we'll get rid of some of those mitochondria. We'll reduce the blood flow because you're not using it so why would it maintain that? It would cost energy to do that and if you think about that idea then everything that goes on in training is all about stress and adaptation. You're just providing certain stresses and watching the body adapt and change according to that which was a major theme of really the Batman book I wrote which is all about the physiology about human training. It was really about thinking about stress as they're going and creating a character like Batman, how does the body adapt and I use that example now because that's really, in that book, I put him as the ultimate sort of martial artist, really, and if we think about the eastern traditions of doing things, they didn't think of it necessarily in the way I just described but that's what they were doing if you think about really extreme techniques, even of some of the hard body conditioning, the iron palm training that you find in some of the Chinese text,



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

some of the Okinawan traditions or you might find in Thailand in Muay Thai where you have people trying to condition the body and skin and bones by repeatedly striking something. They understood that stuff. If you actually go and read those old books, they've been translated, many of them now have been translated into English and you learn about how you do iron palm training or something. It starts off with putting your palm repeatedly into something filled with peas or something then filled with sand and then it's filled with more granular stuff and then small pebbles and it's very extreme training but the point of it is they understood the idea of gradually building up to something and of repeatedly applying the stress even if they didn't think of it as homeostasis so I think it's interesting if you do look at the different traditions where a lot of those ideas are obviously contained in some of the training methodology even though it was never thought of in the way we would understand it now and I think it's very interesting. It's also really important we try to understand things the way we can understand them so we can help figure out ways to help optimize them or to help maybe teach them better or that kind of thing but at the same time, not to just because someone else has a different way of describing the same thing doesn't mean that our way of describing is necessarily better or theirs is better and ours is worse. It's just a different understanding of the same concept.

Jeremy Lesniak:

Now, you mention that you teach one of your grad students that earned a black belt from you. Given what you know, your understanding of the nervous system, of adaptation, of how the body truly responds to these stresses, do you teach in any different way than you were taught?

Paul Zehr:

Yes, I do. I think, I mean, I definitely...I've been involved in a variety of things over the years but I spent major months a time in 3 different martial art systems and I would say that the teachers I've had in those different systems had different ways of approaching their own methodology as well as the stuff they were teaching. A lot of, as folks that do martial arts realize, there's quite a bit of variability even within a given system based on how the content is delivered based on the characteristics of the teacher. A lot of what...I've changed my own teaching practice quite a bit over the years because initially, when you first do something and you start doing stuff and you just do it the way you were taught it and I don't mean that content, I don't mean this certain form or kata or whatever it is that historically is meant to be taught in this way. I meant the training is taught like how do you do a warm up? What kind of things are the technical components? How much is technique versus how much is it physical conditioning? Those kind of things and certainly, I've evolved quite a bit over time to try and reflect my own understanding, both as a martial artist of course, but also, from the perspective of science and really, at one point, I approached martial arts training, I guess I would say mostly from the lens of physical conditioning, if I could say it that way. More to say, just from the perspective, exercise and I would say that now I still maintain parts of that but my lens of looking at it is more around motor-skill learning and neuroplasticity and because the idea here is that what you're really trying to do is help people figure out how to get their brains and spinal cords to do the right things and remember them and that's a little



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

different than the lens we sometimes have for physical conditioning and you can have both but they aren't exactly the same thing. The idea of exercise and training, we often sort of conflate and put together as if they're the same thing but, I would say that, exercise is often meant in the context more of just the physical conditioning without the technical content so much whereas training can have both so I would say that, over time, I've tended to evolve a way of my own teaching and training that respects both those ideas.

Jeremy Lesniak:

Now, you've brought up neuroplasticity a couple times and you gave us a little bit of definition of what it is but how do you activate it? How do you create neuroplasticity?

Paul Zehr:

The basic idea of what neuroplasticity is on a kind of big, big, meta, sort of whole systems level means getting better at something but the way that actually works if you drill right down, you try to imagine why did you get better doing that punch or that kick or that receiving action or that strike or that break follow that throw or whatever it was you did as a martial artist or any skill, any activity you're doing, why did that happen? When you start drilling down into that, you get right down to thinking about how cells are connected in the nervous system. The nervous system has a bunch of different components in it, but what we call more the computational cells are the neurons, those are the ones that are involved in production of our speech right now that we're having and the thoughts we're doing, the movements we might produce. Those neurons have certain properties and, using a metaphor, I like to use the same metaphor for the nervous system as I guess you might do for the muscular system or any biological system, again, it comes down to this idea of being thrifty and not adapting unless you have to so, just to go left on that metaphor and come back to neuroplasticity but it's related to the same idea, if you want to get stronger at lifting a weight, you have to be lifting a weight that's enough outside your body's sort of balance point that you actually need to get stronger, that your nervous system needs to activate more muscle, that you actually need to build stronger muscle tissue. If you aren't exceeding that, your body is not going to adapt so that's an easy one for people to think about and the same thing is happening in the stuff inside your brain that's producing the actual muscle contraction we're just talking about. The neurons in your motor cortex, that's the part of your brain that sends the commands down from the final decision to move in the brain that go down to the spinal cord and activate the neurons in the spinal cord that go out to your muscles that actually cause them to contract and the important part of all these that's common that underlies the idea of neuroplasticity is repetition. That one of the main ways in which your nervous system understands that something is important enough to be something it needs to adapt to is when you keep repeatedly providing those stresses. In the same way that, if you were to do that Ancient training or something that we'd read about in some of the old Chinese textbooks or in the Bubishi, Okinawan, Japanese Karate or something where you're repeatedly banging your hand and your arm into something and you're getting calluses and you're getting stronger bones and so on, your body's adapting to that stress and giving you that visible change. The invisible change



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

that is seen only in the skill you're acquiring is the neuroplasticity you're getting from providing certain sets of commands that you're trying to repeatedly work on the skill that is a function of now, your brain networks and your spinal cord network, those collection of neurons, now working in a more refined way to produce the pattern you're trying to achieve and it's when those connections then are expressed, they are strengthened and they're strengthened by changes in the synapses which are the connections between neurons which are incredibly flexible depending upon what's actually applied to them, in terms of training or whatever kind of thing we're doing, and that's really the heart of neuroplasticity and the way to understand why repetition and specificity, what you're doing is so important was kind of captured by this guy back in the '40s and '50s, a Canadian psychologist and neurologist called Donald Hebb. He came up with this idea that became known as Hebbian plasticity so gives back to the day that when you got to discovery things and get them named after you. I still haven't gotten one for me so I think I'll probably end my career without something named after me unfortunately but I'll live with that but the basic slogan he came up was neurons that fire together, wire together and the idea is that if you're providing the right connections between things, which means providing a certain pattern over and over again, your nervous system will recognize, oh, okay. When I'm standing in this way and my body's in this way and I'm moving my muscles, I'm trying to move my arm by moving my muscles, these things are all coming together at the same time, getting the same sensory feedback for what I'm doing, my body receptors are telling me where I'm standing and what I'm doing then trying to produce this same pattern, that gives rise to this neuroplasticity which is really interesting because what you're really doing, you can't control that directly. You can't just think neuroplasticity when it comes to the motor system so you're instead trying to emulate and reproduce a pattern of something you've seen. You're learning a new technique, you watch your teacher do it and then you're trying to do and you're not doing it very well but you keep trying, you keep trying. What you're doing is providing all the cues for your brain and spinal cord to slowly adapt to what you're doing to shape it so that it becomes the thing you want with all that kind of firing together and wiring together idea and that becomes the pattern that emerges and that is the sort of underlying way in which you're acquiring the skills that go with the activity and the specific techniques or patterns that you're learning and that's really what we think as neuroplasticity. This idea that you get this adaptation in the coordination of the nervous system to help produce the movements you're trying to learn.

Jeremy Lesniak:

Based on the research that you're doing, what's the hope? Is the hope that you'll put together a program from ageing individuals to maintain or, maybe, even improve their nervous system response or is the goal here simply to create the data and let others run with it? What are your goals, I guess?

Paul Zehr:

I think, for me, the main thing here is to look at sort of a way to have, sorry, can you hear the dog in the background?



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Jeremy Lesniak:

It's a little bit of a squeak but we've had far worse.

Paul Zehr:

Hopefully, my dog...we're supposed to keep the dog...

Jeremy Lesniak:

Nah, it's alright.

Paul Zehr:

Anyway, the end goal here of the work we're trying to do was originally kind of a proof of principle of these ideas to just sort of see how adaptable and how useful a training stress like learning martial arts might be for older individuals who are at risk for things like falling and also, for those who've had nervous system damage. One of the reasons why we got into this was also driven by the idea that, I'm a very strong advocate for accessibility of these training interventions so that's why in our other studies, instead of developing fancy apparatus that we could have in the lab that would be useful for helping people to walk better, we chose devices that you could just go to a rec center and find that are already existing so we discovered some approaches how to get better at walking that might help somebody who had a stroke, they can just go and do it in the community if they want to and that brings me to the idea of martial arts. You don't need any equipment at all. You just need space, right? You need space and you need somebody to help teach you something in a safe way so it's as accessible as you can possibly imagine like a rehab technique to be so that was part of it as well, that if we can come up with ideas here, part of it would be other people can refine some of it which is, of course, what happens when you publish science. Other folks, hopefully, if the ideas that you have tested and the data are all good, then folks will leverage that into other things. On a personal, more sort of community-based level for myself, I am also trying to think about ways that we could start developing community-based programs that will have ideas in them of a sort of just a tweaking of how we might teach martial arts that's specifically developed for older adults who, if you train a martial arts long enough, you tend to meet lots of older adults who've been training for long periods of time. I think of some of my own teachers and you're training somebody who is 75 who's been training for 65 years. You've got somebody who's done that kind of thing but we don't tend to find nearly as much as someone who says oh yeah, I just started doing Karate or whatever when I was 60 or I started when I was 70 or whatever it is and, in the case of some of the folks I was mentioning, some of these, 85 or 90 and what I'm hoping is that we can talk about the benefits of some of the activities like martial arts that would be gained by older adults who might do it and enjoy that kind of training and would therefore be more empowered to think that hey, this is something that anybody can do. We talk about martial arts, if it's applied properly is a lifelong activity. Well, it doesn't mean you had to have started when you were young or younger. Why not think about having an entry point where you're much older and thinking about being able to do an activity that's



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

enjoyable so you're not, we're not trying to talk about doing sport Karate or something like that where we're going in tournaments or something with folks who are 85 but rather, the holistic sort of whole body integrated, mind, body, stuff that goes on at the core of the training anyway is the key focus and trying to think about getting that to a group of, a large group of folks in our societies who probably wouldn't normally see themselves doing those activities and one of the things that you need from sort of reconvincing standpoint, sometimes there's also the scientific evidence saying look, here's what actually happen with people when they do this. Here's how your balance got better, here's how you got stronger, here's how there's a change in your spinal cord excitability that tells us about this neuroplasticity changes that are happening. Look, here's the psychological questionnaire which assessed your feelings of competency and empowerment and so on. Look at how your viewpoint has changed. These are the kind of things that the science help inform us around and that I hope other people will take up and continue to do but also, for in my own hands here in my own community, thinking about ways to create actual community-based streams where older adults can think about yeah, you know what? I'm going to do my martial arts training. I want to do that. I've always wanted to, now I have the opportunity and I'm not put off by the idea that it's a young person's activity.

Jeremy Lesniak:

This has been fascinating stuff and I'm hoping that the listeners are enjoying it, if nothing else, I am. You're educating me and heck, it's my show. I get to do that. I get to take some joy in learning but I imagine that we might have some school instructors out there listening saying okay, I get it. I hear what you're saying but I'm not quite sure where to start so what, if you were to give people in charge of curriculum, one thing to start with to take that incorporates the science, the evidence, the things that you're understanding into their own programs, what would that be?

Paul Zehr:

I would say start slow. I mean, one of the things that we see in a lot of martial arts training interventions, not training interventions, but actual training experiences that folks have, it really is a lot of the time taught more for the really active young adult in a sense of how intense it might be, what the demands might be and I'm not talking about taking away the authenticity or the integrity of something. I'm just saying slow it down. To simplify it a little bit, make it less, if your, whatever your martial arts practice involves a lot of kicking techniques or things like that, things that would challenge balance significantly, modify it initially or find other parts of your training curriculum where you have exercises and drills and forms and so on that adults can practice to dole up their skills that don't have those extreme balance challenges at first and realize that eventually, a lot of these folks will be able to do those things but it's going to take longer so you need to go slow and you need to be very patient and have different expectations on the time for the outcomes. That's the biggest thing, I would say, and that's something that we spend sort of a lot of time thinking about when it came to the intervention stuff that we've been trying to do based on modifications for some of the systems I'm training. It just means changing your frame of reference so it doesn't mean teaching, it means teaching the same kind



Episode 421 – Martial Arts Superheroes and Neuroscience | whistlekickMartialArtsRadio.com

of content with the same intentions but the specifics are just different for the group you're working with and that trajectory for how long it will take somebody who's like 70 or 75 or something starting one of these interventions, it's going to take them a lot longer to get to where you might think a person who's 30 will get to but that's okay, I mean, that's fine. It sort of means adjusting your expectations, I guess, along with going slow. For some folks, that's going to be hard to do depending upon what their practice is normally like and the way that they teach martial arts or the things that they get out of it so, for example, if you're focus is predominantly just sports application and tournament fighting and so on, then what I'm saying is this is going to be harder to implement, to be honest, but if that includes, it has a component there but also includes other, what you might call, more traditional training, it's going to be a little easier to implement. It just takes adaptation of the methodology so it fits better with the group you're trying to teach and share your knowledge with and I think it's just a bit of a shift in perspective. I believe, at least based on my own experiences, that it can still be authentic, it can still have integrity. It's just implemented a little bit differently.

Jeremy Lesniak:

So, now, do you see what I mean by that intro? How do you boil that conversation down? There was a lot there. There's some great stuff there and, personally, I found some really actionable information on how to look at the way I train, the way I teach, the way I view people in martial arts and that's what it's all about. That's what we hope to do with this show is to give you tools that you can work from and Sensei Zehr, thank you for coming on and giving us such absolutely wonderful, cutting-edge information. I appreciate it and I hope to have you back someday to talk more about the research that you're doing. If you want to see the links or get a transcript, photos, all the other stuff we got going on, head on over to whistlekickmartialartsradio.com, episode 421. You can see all the resources for this episode. You can find all the other episodes. We don't paywall them. We don't do any of that silly stuff that other shows do. You can get access to everything we've ever done for free and if you feel like helping us out because of all the stuff that we've done? Easiest thing to do, best thing, go to whistlekick.com, grab yourself a t-shirt, grab yourself a new uniform, maybe some training gear. We work really hard to make sure the stuff we put out is the best we can make and hopefully, there's something over there that you can use. Now, if not, don't forget that you can share an episode or leave us a review. Anything you can do to support us, we would really appreciate that. Our social media, @whistlekick, Facebook, Twitter, Instagram, YouTube. My email address: jeremy@whistlekick.com. Until next time, train hard, smile and have a great day!