

Shrink Rap Radio #163, July 11, 2008, Exercise and the Brain
David Van Nuys, Ph.D., aka “Dr. Dave” interviews John J. Ratey, M.D.
(transcribed from www.ShrinkRapRadio.com by Susan Argyelan)

Excerpt: *There is just a flock of evidence for the benefits for depression, for anxiety, for panic disorder. You know, part of what the real message is, is if you activate your brain with exercise, you're going to release a lot of the neurotransmitters that we aim with in psychopharmacology; you know, our drugs that we use: serotonin drugs, dopamine drugs, norepinephrine drugs. All tend to try, we think, to elevate the levels of these neurotransmitters. Well, exercise does that pretty quickly.*

Introduction: That was the voice of my guest, Dr. John Ratey. John J. Ratey, M.D., is author of the new book, [Spark: The Revolutionary New Science of Exercise and the Brain](#). Dr. Ratey is also an associate clinical professor of psychiatry at Harvard Medical School and has a private practice in Cambridge, MA. For more than a decade, he's taught residents and Harvard medical students as the assistant director of resident training at the Massachusetts Mental Health Center. He continues to teach psychiatrists as a regular instructor in Harvard's Continuing Medical Education Program. And, as a clinical researcher, he's published more than 60 papers in peer-reviewed journals in the fields of psychiatry and psychopharmacology. Since 1998, Dr. Ratey has been selected each year as one of the Best Doctors in America by his peers. Recently, Dr. Ratey was the recipient of the 2006 Excellence in Advocacy Award. Now, here's the interview.

Dr. Dave: Dr. John Ratey, welcome to Shrink Rap Radio.

John J. Ratey: Thanks for having me.

Dr. Dave: I guess we've known for a long time that exercise is good for our bodies. But your book suggests that there's been a revolution in terms of understanding the impact of exercise on our brain. Do I have that right?

Ratey: You sure do. I think the way I tell people is that exercise is really for our brain, and all the nice side effects happen in the body, because exercise does so much to promote brain health, equilibrium, improve the brain function, better than anything that we know of.

Dr. Dave: Wow. Wow. It's interesting. How did you get into studying the impact of exercise on the brain?

Ratey: Well, I did most of my training here in Boston, and I came in the middle of the marathon craze. So, we were, at the same time, learning so much about the brain, and then with the marathoning and the whole business of endorphin rush came about, and we were all going out to exercise to raise our endorphins and improve our mood, etc. And so I became fascinated with it when I began seeing patients who

had an injury and could no longer train, and they would get depressed, almost predictably. And then a number of patients came in who had been in marathon training all of their lives or some variation thereof, and who had to stop for aging injury of the knee or the ankle. And they found that they, for the first time in their life, couldn't pay attention. After they sort of went through their depression and their mood was back to where it should be, they could no longer focus like they used to and do all the kinds of things that they were able to do when they were running six to seven to eight miles a day under an hour. You know, being in that kind of aerobically fit state, that they could no longer do that, and that they were feeling like they had minimal brain dysfunction at that time, we called it, and so that got me started and very interested in ADD. But at the same time we were – I was – attuned to the literature on, oh, exercise helped with depression, that came out of a number of areas, but certainly from Duke University, that was looking... It was the first real group to look at exercise as a treatment for cardiovascular problems and prevention. And they also said, "Hey, our people that we have training for their hearts are also, have a much better mood, less stress, less hostility, less anxiety." And they began, then, to focus on that in the Department of Psychology and Psychiatry. So they began to do studies, and all the studies bore out that exercise had a direct impact on mood and stress and anxiety. So, it became a very interesting pursuit of mine.

Dr. Dave: About when was that? When was that going on at Duke, that they were starting to release...

Ratey: Oh, that was in the late, throughout the '70s, really.

Dr. Dave: Okay.

Ratey: And then in the '80s and '90s, it sort of moved from just the cardiac treatment or prevention to more of its impact on psychology, or they began to do studies on that and highlight the fact that this was a pretty good way of treating some of our psychiatric ailments. And then at the, in 1999, they came up with a very, very important study that got lots of play for about two days, and then everybody quickly forgot about it, that exercise was as good as Zoloft in treating moderate depression.

Dr. Dave: Yeah.

Ratey: And so, as I say, that got a lot of press immediately in the New York Times, Newsweek, CNN – on, you know, all over the place, but then quickly disappeared from anybody's thoughts or awareness, but not mine...

Dr. Dave: (laughs)

Ratey: ...because I was already hooked on exercise as a treatment for, an important treatment for all kinds of psychiatric issues. And, I had been on... talking about it and reading about it, and keeping up with the literature. And then in '95, there

came a wonderful paper showing that exercise, in fact, was a great way to increase the brain's concentration of a very important protein that we had just discovered some years before called BDNF, or brain-derived neurotrophic factor. And I call it "Miracle-Gro for the brain" because it really is brain fertilizer. And that just piqued my interest no end; and as well, that started the whole field of neuroscience *including* exercise in their purview in a very, very big way.

Dr. Dave: Okay. I want to get into BDNF some more a little bit further along, but I want to make sure I understood, you yourself were a marathoner, or still are a marathoner?

Ratey: No, no, no. No, my knees never let me do it. An old football injury...

Dr. Dave: Oh, okay.

Ratey: But I was always an exerciser. I played squash three times a week, and really, from medical school on, I was in pretty good aerobic fitness in a variety of different ways – playing basketball and what have you. And then I began to try to do marathoning. And my wife was running the marathons.

Dr. Dave: Hmm...

Ratey: So, I was trying to support that, but my knees couldn't take it. So...

Dr. Dave: Okay, well, I'm not surprised to hear about the kinds of physical activities you've been involved in, because at the end of the book, you describe your own exercise regimen. And it's pretty impressive; it made me wonder if you'd been "a jock" all your life. And, it sounds like maybe you have been.

Ratey: Oh, well, I grew up in western Pennsylvania back when all the quarterbacks were flying out of there, and it was a pretty heavy sports area...

Dr. Dave: Aha.

Ratey: ...for everybody, and I was a nationally ranked – I mean, not nationally ranked, but I'd played in the nationals in tennis and high school – and played three sports a bunch of times throughout my high-school career. So, I was always very much into activity, for sure.

Dr. Dave: It's interesting. I frequently reflect on the way that everything that happens in our lives seems to come together and gets rolled into our work. And so, it's interesting that this kind of history that you have in your personal life of involvement with physical activity somehow ends up also, you know, playing a role in your professional life much later on. Now, the Greeks – the Greek ideal – emphasized both physical prowess and accomplishment in the arts as an important component in developing its citizens and music, and so on, and physical prowess.

And yet it seems like P.E. and the arts are the first things that get cut back during tight times.

Ratey: Exactly, and I think this is, this is so misunderstood and misapplied. You know, if our mission really is to develop our children, and not just educate them so they can pass tests, one needs to look at the whole range of activities and personal development that the arts and fitness really bring to the table. And I think, you know, the whole, now that the obesity crisis is hard upon us, and the diabetes crisis emanating from the obesity crisis amongst our children, there are people now paying attention not only to diet, but also to our level of *unfitness*.

Dr. Dave: Yes. Well, early in the book, you offer a case history of a high school in Illinois that made P.E. central to their program. And, that's, you make reference to that program throughout the book. So, take us through that, if you will.

Ratey: Oh, I could spend three hours talking about that wonderful high school!

Dr. Dave: (laughs)

Ratey: It's not just a high school; it's the whole school system. Sort of an, it's an evolved physical-ed program over the 18 years, really, when one of the teachers in the junior high school – one of the junior high schools in this area that have 19,000 children, we're talking, in this whole school system. But he decided that he wasn't doing his job because his kids were getting talked about as being more and more unfit. And so, they began to, he began to say, "Okay, we have to switch our focus from sports to fitness, and then, over the years, sort of develop, fine-tune that, and reintroduce sports." At first, people were just running and playing very heavy activity games. And then they brought sports back in but still paid attention to managing the level of fitness in a big, big way, and then infected the high school...and then the other high school, and then the other junior highs. And so, they all began to develop this program that now is second to none, that I'm aware of. And I got interested in it because I heard about it in 2002 (?), and their statistics were phenomenal in that 3% of their children were considered overweight; not obese, but overweight – 3% of 19,000 kids, that's pretty impressive. Then, that same year, their eighth graders – all 96% of them – took the International Science and Math Test, which is called the TIMS (ph) test, which countries take and compete with one another. And the U.S. is always ranked in the teens somewhere – and Hong Kong and Taiwan and Singapore are always up in the top five or so – in science and math. Well, they took, those eighth graders took it, and they came in number one in the world in science...

Dr. Dave: Amazing!

Ratey: ...and number six in math. Yes. And so, even though they spent 45 minutes a day in fitness training, basically – with sports included, of course – they weren't suffering in their academic pursuits.

Dr. Dave: This all took place in Naperville, is that right? Naperville, Illinois?

Ratey: Yeah, Naperville, Illinois. Yep, yep. It evolved over an 18-year period of time.

Dr. Dave: Okay.

Ratey: It just wasn't like, you know, set upon them. And they, the phys ed faculty became relevant... (laughs)

Dr. Dave: (laughs)

Ratey: ...and they just weren't sports teachers, or sports leaders, or coaches, even though they continued to have very high sports profiles in their leagues, yet their... but all the kids were included in this program. I mean, all – and it wasn't preferentially designed for the athletes. It was for everybody to pay attention. The big move was to get cardiac monitors, or heart-rate monitors, for each of the kids, back 17-18 years ago in one class, where they've got 30 of them. And they began to use that as a marker for their grade. If you could remain in your zone, in your own zone, then your grade was dependent on that. And this, then, has been a cornerstone of their program to do that. But now, they've introduced all kinds of very creative ways of keeping the kids moving, and everybody's moving all the time. In their sports, it's two-on-two, three-on-three, four-on-four. They've now taken on a flourish of being the neuroscience experts in the school. So, it's really, really been quite an interesting transition, and they certainly don't look like the old-style gym teachers that we think of.

Dr. Dave: Yeah, yeah. And, as I listen to you, I'm realizing that sports and fitness are not necessarily the same thing.

Ratey: Right. Absolutely. Sports has that competitive element and it's not, and if you think about playing on a sports team, if you're not playing, you're not really getting much of the fitness perspective there...

Dr. Dave: (laughs) Right.

Ratey: ...if you're sitting on the bench. So, they said, okay, we can't depend on just everybody going and doing a sport, although that's fine if they are, you know, and playing and participating. But they've switched the whole focus to "fitness first."

Dr. Dave: Yes, and I like that use of the heart monitors so that it sounds like the kids were competing with themselves, not with other kids; that is, they were trying to better their own personal scores.

Ratey: Absolutely. And that sort of, you know, from that, as I say, it's the cornerstone of the program, where everybody can achieve excellence in, against *themselves*

from the beginning. So people that are overweight, to begin with, or, you know, when they come in, in sixth grade; or they really aren't very fit, they will have a certain heart rate that they continue to maintain, and then eventually, that will lead to more fitness and more work done by getting their heart rate into that zone. So, it's inevitable that eventually they'll raise their level of fitness. And they found that this is indeed what happens.

Dr. Dave: Well, that sounds like such a wonderful development, 'cause I remember when I was in school that for many people, P.E. was like their *least* favorite class, and it was humiliating for them: the fat kid who couldn't pull himself up the rope, or you know, people who had various kinds of problems. And, it sounds like this is a very different approach.

Ratey: Oh, God, it's completely, it blew me away, and it continues to blow me away, and my hair stands up every time I talk about it...

Dr. Dave: (laughs)

Ratey: ...because it's so, it was such a change agent there, for me, and that really solidified my... I mean, I've always been tinkering in all the books that I've written, in [Driven to Distraction](#), and [Answers \(to Distraction\)](#), and then in [User's Guide to the Brain](#), I emphasize – we emphasize, Dr. Hallowell and I emphasize – the importance of exercise as an important part of the treatment, and of any psychiatric problem, but certainly for the attention problems. And so, I've always been gripped with that and had started to work on a book many times over the years. But then when this program – Naperville – came my way, and I just said, okay, this is really the motivation to start really exploring it. And, I spent 2½ years, like, reading two gigabytes of .pdfs ...

Dr. Dave: (laughs)

Ratey: ...on neuroscience and exercise, and then used a magazine editor, Eric Hagerman, to ghost-write it for me. In other words, I would tell him, we would go over what I wanted to say, and he would have to understand what I was telling him to be able to write it...

Dr. Dave: Sure.

Ratey: ...so that it wasn't coming from my "academese" background. And it was something that I had to make him understand before could write about it, so...

Dr. Dave: Well, in fact, it does read very well. And there's a lot of good science in it, *and* it reads very well. And, you know, it seems to me that there... I hope these ideas really spread, and it does seem like it's an uphill battle, as you pointed out: the exercise-over-Zoloft advantage made the news for about two days and disappeared. I'm guessing that on the one hand, a lot of this stuff is very

politicized, you know, like raising test grades in the schools and concentrating on the three R's. It's always this political hot-potato on the one hand, and then on the other hand, you have the pharmaceutical companies, who have a lot of money and vested interest in pills vs. something that we have built-in, like the ability to work on our fitness.

Ratey: Exactly, and no, I couldn't agree more. I mean, I think our whole ethos in medicine is sort of dominated by that antibiotic approach, which is, there was a cure for disorders which, for bacterial problems, right? You'd wipe it out with an antibiotic, and now, that began to pervade all our thinking about using medicine. We have that today even in psychiatry, where we're affecting the brain. And, we know darn well that most of the drugs that we use are accidents; we came upon them accidentally. And, I'm a very big prescriber of medicine, so I'm talking not as someone who flails away directly and all the time at the industry, but it certainly has been pervasive and has changed the way we look at psychiatric and brain problems in perhaps a way that we need to redo. And, you know, the wellness concept is growing and burgeoning all over the place, and not just in the schools but in mental health centers and treatment areas. And, now there's all this interest in exercise as prevention treatment, for instance, for substance abuse. There was a big conference at National Institute on Drug Abuse just a few weeks ago that I attended that was about that, trying – and they've allocated a whole bunch of money to say, "Okay, how can we, what forms of exercise? What can we do? Let's study this to see if we can begin to cut into the addiction problem that we have in every country."

Dr. Dave: Yes. You mentioned BDNF earlier as kind of the "brain fertilizer," "endogenous brain fertilizer," and I was interested to read that there was an important interaction of BDNF in the hippocampus, because I recently interviewed Sue Halpern. I don't know if you know her work, but she's written a book, a new book on memory, and it seems that the problems of both Alzheimer's and normal memory loss due to aging have to do with molecules in the hippocampus.

Ratey: Yes, and that's one of the, one of the big, sort of "tie ups" with exercise, why neuroscience is abuzz about exercise and has been in the past 10 years – ever since the initial study came out – because we know that, I mean, we're almost certain that there's not much, there's not many other things that are better than exercise for raising the level of BDNF, which is seen as the, as I say, as the "fertilizer" for brain cells... makes them more pliable, makes them more able to do their job, helps with their resilience so they withstand the stresses in aging and being beaten around by just use and all. And, also, the big news is – in the past six or seven years – is how we make our own new nerve cells every day, and specifically in the hippocampus, and that, from stem cells. Pardon George Bush, but you know, I mean, despite that. (laughs)

Dr. Dave: (laughs) Yes.

Ratey: We're making, we have stem cells in our brain, and this BDNF is one of those important proteins or moieties that are there to help these stem cells to grow to, into brand-new brain cells. And, there's all this debate whether or not you need a new nerve cell to have, to really solidify new memory or not. I mean, we're making a lot every day as we're losing others, but that's for future analysis.

Dr. Dave: Okay. And you suggest that BDNF affects not just the learning, but also the *rate* of learning.

Ratey: Oh, yeah. No, I mean, it makes our cells do what they're supposed to do, which is... "Learning" means it's not just in the hippocampus but all throughout the brain. "Learning" means you wire your cells together in a cell assembly, so you have a couple million billion cells involved in the concept of a red wagon, for instance, okay? For having that concept solidify, you practice, practice the image and the label. And there are all different parts of the brain that come together, but they're all wired up, meaning that they're selectively connected one to another. And the more you practice, the harder the wiring gets, and BDNF is an important element in helping the cells to be ready to learn, to learn new concepts and to develop new skills, etc. It's also, by the way, one of the, in the past five years, one of the areas that people looking at manic-depressive disorder or bipolar disorder and unipolar depression or serious depression are very interested in this. Because one of the things we know is, in those states of depression – serious depression – you see a decrease in BDNF, an increase in stress, and a decrease, actually, an eroding of the brain. And with treatment – with an antidepressant or with ECT – shock therapy – or with exercise, you see a return to normal, if you will, of the brain's ability to learn and develop. And, you actually see brain growth – regrowth.

Dr. Dave: Wow. That's incredible.

Ratey: Yes.

Dr. Dave: You've made reference here a couple of times to what I guess is called neurogenesis, or brain plasticity, and...

Ratey: No, they're not the same.

Dr. Dave: Oh, they're not the same?

Ratey: Oh, no. Brain plasticity is the ability of our cells to change. That's what neuroplasticity is about, the nerve cells to change and grow. Neurogenesis means a brand-new nerve cell. And it's very sexy, because we didn't know until 1999 that we could do this in humans, that we actually, this occurred. Because when we were in medical school and all throughout my career, we were taught, and the mantra was, that you were born with a certain number of brain cells at birth, and you start losing them right away, and there's no recovery, and there's no change. But it's very, very different, and people will make that confusion because neurogenesis is so

darn sexy that everybody wants to equate the two. And it's far from being equivalent.

Dr. Dave: Okay. But they're both very important and...

Ratey: Oh, absolutely.

Dr. Dave: ...and hopeful processes.

Ratey: Oh, yeah. No, I think the way to think of it is, neurogenesis is sort of the queen of neuroplasticity. In other words, that's the ultimate in neuroplasticity.

Dr. Dave: Yeah, and...

Ratey: Making these new cells.

Dr. Dave: ...in the book, you pointed out that there used to be public service announcements warning that alcohol kills brain cells, and that they would never grow back. Now, we don't want to encourage anybody to become an alcoholic, because now we know brain cells *can* grow back, right? (laughs)

Ratey: (laughs) Yes, yes, they can grow back. But we don't want to encourage that. That's not the point.

Dr. Dave: Right. On page 53, you say exercise improves learning on three levels. Can you take us through those three levels?

Ratey: Well, the first is that it helps... The very first level is that it makes for a better learner; that is, it makes the learner less impulsive; that is, less fidgety; makes them more focused, improves their motivation to learn, improves their ability to overcome frustration, too. And all this is based in science. It's not just like observation and good thinking about it, but it's in science, with rats and mice and all. And we know... And people. And, we know this happens, so that there... After a bout of exercise and/or with increasing levels of aerobic fitness, you have a better learner sitting in their chair. I'm thinking of the school student...

Dr. Dave: Mm-hmm...

Ratey: ...but also, even in business, or even in life...for all of us.

Dr. Dave: Yes.

Ratey: Then you have an increase in neuroplasticity or brain plasticity in general; that is, you get the cells, provide the absolute right environment for our cells to do what they're supposed to do, which is to bind to one another so we can adapt to the world. Thinking about it from an evolutionary perspective, that's what gives us –

our brain – such a great gift, to help us adapt to new environments, which, translation: learning. And that we learn when we change our brain, when our brains are changed; when our nerve cells are connected more, one to another, to lock in that red-wagon construct. Then the third way is this new area of neurogenesis, or new brain cells that we grow, and that’s the real, as they say, “sexy and exciting” part.

Dr. Dave: So, there are so many benefits to exercise; in the broad strokes, the three that you just mentioned. What kind of exercise is best? That’s what people are going to wonder, “Well, what kind of exercise should I be doing? How often? To what intensity?”

Ratey: Well, the most important thing is to do something that you’re going to continue with, you know? Because that’s what’s important, because people get on an exercise regimen and then drop off. The best kind, of course, is to do something that’s self-reinforcing, that you enjoy, that you enjoy with others, that you do outside, so something like tennis or hiking, or, you know, playing a sport is just ideal. And you don’t even think that you’re exercising.

Dr. Dave: Yeah.

Ratey: And then there’s most of us, who can’t do that all the time or don’t have the set-up for that, or don’t take the energy to find that set-up, who exercise in the gym. And that’s because it’s convenient, it’s quick; you know, you can do it at your own convenience. But the important part of all this is to ritualize it so that you don’t miss it; that is, you know, now they’re recommending from Health and Human Services that we do it every day, most days, for 30-40 minutes, getting our heart rate up to about 60-70% of your maximum heart rate. Really, sort of just beneath the “sweating index,” if you will. Brisk walking, for instance, will get you there. So you have to do that which is going to be best for you, that is going to keep you at it. It’s best done outside; there’s more benefits from being out in the open air and near nature. It’s best even times six, probably (I’m just making that up) with others, because one, it’s more enjoyable. There’s more action going on; there’s the benefit of the social encounter, which is key and crucial in our lives. And all these really help generate, move the brain to optimal brain function.

Dr. Dave: Yeah, that makes a lot of sense to me. I used to enjoy tennis, and I still would enjoy it but I have knee problems that are slowing me down. But what I’ve been doing recently, is I’ve got an exercise bike in my garage, and I have a, an iPhone. I watch feature-length films on my iPhone while I’m pedaling on my bike, and I’m able to do that most days, now, for about 40 minutes. But I do miss –

Ratey: See, but that’s –

Dr. Dave: Yeah...

Ratey: That's what it takes, you know. That's where we're in, now, with [exergaming](#) coming online, with the Wii, and with Dance, Dance Revolution...

Dr. Dave: Mm-hmm...

Ratey: I mean, we're sort of moving into that era where we're going to use our technology to help us stay with it, get with it, move into new realms so that we can make our brain and psyche better.

Dr. Dave: What about the Wii? You know, I don't have a Wii. I've heard about it, and I've wondered, well, is that just a bunch of hype, or could it really be beneficial?

Ratey: No, it's for real. It's for real. It's for real, and it's going to be for real if you can get one. (laughs)

Dr. Dave: (laughs) I hear they're hard to find.

Ratey: Yes, it's an eight, six-to-eight, six-month wait if you don't... You can get them, I think, at eBay. Somebody took, one of my patients, got it, but he had to pay a premium of \$60 or something like that. So, out there, but if you can't wait... But he claims – and others, too – have talked about the real, you can really, there's different programs on the Wii exercise piece, but you can really get, it can really get you going.

Dr. Dave: I'm going to look into that. That sounds great. Now, what about – something we haven't spoken much about yet is stress, and the relationship between exercise and stress reduction.

Ratey: Yes, I think that, to me, was the most compelling chapter in the book, I mean even more so than the cognition and Naperville chapter. But stress is really misunderstood by me, even, going into it, because after reading all the neuroscience lately, looked at neuroscience, I've come to respect stress in a very different way. Because you have to look at stress as a spectrum, and what most people talk about stress, they talk about, it's really toxic stress. It's really stress that doesn't go away, that stays with you all the time. And, it's worry about your job, or your kids...

Dr. Dave: Mm-hmm...

Ratey: ...or your relationship, or something that just nags you all the time. That's stress, toxic stress. There's no, but the way to really look at stress is it, stress is necessary for us to live and move. Everything we do is really stress, meaning, in the best way I think about stress, come to appreciate it is, that when you challenge your cells and your body to do more than you would if you were just lying down – which to some people is stressful – you know, or just sitting there watching the twelfth time, Law and Order, or something like that – that is not stressing much.

And so, but everything else is really about stress: moving, learning, a lot of things we do are stressful. But they're stress with a recovery period, and that's what's important, where you don't get that with toxic stress. You don't get that recovery, but with, for instance, lifting weights – I mean, you tax the muscle and you stress the muscle. And you break it, and you challenge it, and you over-challenge it. But then, you have a recovery period, which is where, which is what's so important, is you have all this growth going on to make it tougher and more resilient for the next, you know, part of your life. And the same thing happens in the brain, that you re-tax the brain and you do with all kinds of exercise. Exercise taxes the brain, makes all the cells click away just as we do with learning. With some of the cells of the brain, you do the same kind of thing: you demand more of them. They have to work harder, they develop – with working harder, they have breakdown products, the free radicals, all from Berkeley, out near your way. You know, those free radicals that run around and cause trouble.

Dr. Dave: Mm-hmm...

Ratey: And inside the cell, they punch holes in proteins and break up DNA, and they're very much part of the aging process, but also the sort of slowing-down process. Well, when you have something that you're stressing for a short period of time, intracellularly, you build up a resilience because you build up the internal factors to help deal with these free radicals that you make from using too much energy, using more energy than you would normally. And that's really the way to look at stress. And then with that (inaudible) the internal, I think of them as janitorial service – you get the antioxidant enzymes built up intracellularly. And all these great and wonderful new things that we're, I've just learned about, that help manage protein-bending because of activity and putting DNA back together, and all this kind of stuff that we know about now, and sort of what we call "stress inoculation," or periods of stress with ample periods of recovery, you have built up the janitorial service to help clean up the toxic mess that's going to result every time you use your cells. So you have, in this recovery period, you build up more than you need, and that's the beginning of intracellular resilience. And exercise, some, many of the dietary things we take in; learning and challenging ourselves are all good ways of developing that internal resilience that will help us live longer and be more active as we go.

Dr. Dave: Well, hearing about all this scientific support certainly helps to boost my motivation. It's a great reminder and a metaphorical shot in the arm to kind of keep going, keep exercising. Let's talk a bit about the benefits of exercising in dealing with various clinical conditions. Let's start with anxiety, which may manifest itself in a generalized way or in phobias or in panic. What evidence is there that exercise can benefit those conditions?

Ratey: Oh, I think there's tons of evidence for that. And there is just a flock of evidence for the benefits for depression, for anxiety, for panic disorder. You know, part of what the real-world (?) message is, is if you activate your brain with exercise,

you're going to release a lot of the neurotransmitters that we aim with in psychopharmacology, you know, our drugs that we use. Serotonin drugs, dopamine drugs, norepinephrine drugs all tend to try, we think, elevate the levels of these neurotransmitters. Well, exercise does that pretty quickly. When you're moving, you're doing better. You have more dopamine circulating, more epinephrine, and eventually more serotonin. So, this is one of the quick ways of thinking about how we, all these things work in the brain. And then, of course, there's more elaborate effects also.

Dr. Dave: I was interested to see that you recommend combining exercise with cognitive behavioral therapy, that it seems to make it more effective. Can you say something about that?

Ratey: Well, I think it makes change more effective.

Dr. Dave: Okay.

Ratey: That exercise helps cognitive therapy go better, and then cognitive therapy – because you can get your cells ready to learn, right? But you have to feed them something. (laughs) So then if you feed them something that will help them change, or lead them down the way of changing, that is, learning something new, or new strategies, or trying to impose this idea, you know, when you, that it's okay when in the past, you've been phobic to an event or stimulus, then you, you know, then you're going to be more effective at making your cells learn that, and in a much better environment. Plus, then you need to have that cognitive therapy piece to solidify, or to introduce and then solidify, the brain to change.

Dr. Dave: Okay. Well, there are a number of clinical conditions that we could go through, but I won't march you through them all. Certainly, in the book, you talk about the benefits of exercise in dealing with a range of things going from addiction to aging, to ADHD and so on. But there are a couple of theoretical issues here that I wanted to touch on before I let you go. You talk about a shift from the neurotransmitter hypothesis to connectivity theory. I'm sure it's very complex, but can you briefly take us through that?

Ratey: Well, this is really looking at the depressive disorders, but it relates to all the psychiatric disorders that we deal with. The neurotransmitter idea was just, you know, when we started using antidepressants, we were looking at the neurotransmitter norepinephrine, that we were increasing norepinephrine with our early antidepressants. And everybody was over-focused on that as the problem with depression; there wasn't enough norepinephrine. So in the 70s, everybody was measuring urine to measure breakdown products of norepinephrine to try to categorize different depressions or manic-depressions, or whatever. And then, serotonin came on the scene, especially when Prozac came out in the late 80s, as also being *as* important or even *more* important. I think it's *as* important – not really *more* important – but *as* important as norepinephrine. So we grew up – I

grew up – in the idea that it was a neurotransmitter-based problem, that depression was, that there was something out of whack with these neurotransmitters. And more recently, what we see is depression as a brain state that we see a big reduction in neuroplasticity, an increase in stress, and in stress teardown of the brain. So, you see, there's brain erosion that can occur with chronic depressive disorders, or manic-depression or bipolar disorder. And part of what you see – and we know clinically, from experience and observation, when people are depressed, they don't learn very well. They don't learn very much; they're not interested. But they're not able to "log it in," or encode it, that new information in. They don't, their neuroplasticity is shut down; they're no longer able to connect nearly as, those brain cells together nearly as they once did. And in fact, they erode those connections. So, and then when you change that state with drugs or ECT or psychotherapy or cognitive behavioral therapy or whatever, to bring about a change and a shift in the psychological or psychiatric state and brain state, you see a return to this neuroplasticity. So, and one of the big markers in that continues to be our old friend, BDNF. So, any effort by tech companies in the past seven years or so has been aiming at BDNF to see how they could elevate that to be a good antidepressant or a mood regulator, and it seems like there's a lot of work in that and value in that. And as I said, there's nothing that we know of yet, that I see, that we would do to the brain, to ourselves, other than... that does better at raising that and improving our neuroplasticity other than exercise.

Dr. Dave: Right. You know, as a kind of a side note, I was fascinated to read, in your chapter on depression, that you were undergoing daily psychoanalysis during medical school, even as you were getting deeply involved in all this brain science. So, what's your bottom line about talking therapies such as psychoanalysis today?

Ratey: Oh, I think that there's still lots of room for psychotherapy and understanding and feeling connected to another person where you never did before. I mean, it wasn't just in medical school. It was in my residency and for ten years after. So I was in, I beat out Woody Allen, I think...

Dr. Dave: (laughs)

Ratey: ...for the longest psychoanalysis, and it still didn't do much. But no, I mean it, I mean I'm very much, still very much involved with talking to patients and trying to help them understand themselves because I think, as I say, it's not just about optimizing your brain function, but then what are you going to put in there? So, I think there's still quite a lot to be gained.

Dr. Dave: Okay, well, it's time for us to wrap things up here. I wonder if there's any last thought you'd like to leave with our listeners.

Ratey: Well, I do. There is, my overall mantra is really, go after those challenges and embrace them. Every challenge causes your brain to be active and stressed, and it builds for the future. So, and exercise is one of those great challenges that you can

do on a daily basis. If you get into that routine, if you make it part of your life, and if you see the value of it, what it can do. Because it certainly helps delay the onset of cognitive decline and helps you function at optimal level.

Dr. Dave: Dr. John Ratey, thank you so much for being my guest today on Shrink Rap Radio.

Ratey: Thanks for having me. I really enjoyed it.