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Hacking Fatigue with Tim Noakes Plus More 4-Hour Body Fun

Q&A Session

Dave Asprey: The cool fact for today's podcast is what your brain is made of? It turns out the average brain is about 77% water, 12% fat, 8% protein, 2% minerals, and only 1% carbs. This is one of those reasons that eating 70% of your diet from carbs might not be the best thing you could do for your brain and it's also a reason why you should stay hydrated.

[Podcast Music]

Dave Asprey: You're listening to Episode Three of Upgraded Self Radio. This is Dave and Armi from the Bulletproof Executive Blog talking about how you can upgrade your mind, your body, and your life to levels you've never thought possible. Today, we have a great interview with Dr. Tim Noakes. He's one of the world's foremost exercise scientists and has developed one of the most unique theories on fatigue and what's really holding you back from reaching your full potential. Even if you're not an athlete, you want to hear this: Fatigue applies to us all, even cubicle dwellers, who have more work than they can handle. In fact, guys like me.

Fatigue is caused by the brain shutting down parts of the body before they can be damaged. This is a systems thinking approach that Dr. Noakes has created for his book. Instead of looking at, say, lactic acid in the muscles as something that causes fatigue, he is saying that the body is designed to self-regulate and that the brain is part of that challenge. He also has some really interesting comments about Tim Ferriss' recommendation in the *Four Hour Body* to use an ice pack and Dr. Noakes explains why as this may or may not work as advertised.

We also have a lot going on in the blog. This week, we started our series on grass-fed meat and we'll be continuing to make some articles about that for the next few weeks, pretty much everything you ever wanted to know about grass-fed meat and why it's so important to help you feel bulletproof. We're going to show you why it's better, how to buy it, where to look for it, and a few things that you probably haven't heard about.

Our Biohacker Report is jam packed as usual. We've got a couple of new studies on creativity and the human mind and the relationship between gut bacteria and brain function. Again, if you're an athlete or if you're an entrepreneur, both of these are really relevant to what you do every day.

We also have a great bonus at the end of the podcast. You can get a free copy of Tim Noakes' new book called *Challenging Beliefs*. It's forthcoming, so as soon as it comes out, we'll be able to send it to you. In order to win, all you have to do is twitter a link to this podcast with quote or comments before September 13, 2011. We'll choose our favorite comment tweet and the person who tweets that will win the book. We'll send it to you as soon as we can. If you'd like to learn more about us, you can find us on

Twitter. You can get into touch on Facebook or you can sign up for an email or newsletter. There are links to all of those on *bulletproofexec.com*.

So Armi, let's get going. Let's talk about what biohacks you've working on this week. What are you doing?

Armi Legge: Well, I've got a triathlon this weekend, so one of the things I've been doing is changing out my taper, which is when you reduce the amount of training before a race. And what I have been doing is I've been inserting something called Tabata Intervals and I've been doing some very specific swim training that I'll probably be blogging about sometime soon. And I've been also changing my diet a little bit and instead of carb loading earlier in the week, I'm tweaking what kinds of carbs I'm eating, what kind of fats I'm eating, and a lot of other stuff. And also, I'm changing my weight training protocol in the lead up to the race. So, we'll see how that all works out this weekend. What about you, man?

Dave Asprey: Well, we had a couple of neat things going on. I just got back yesterday from Burning Man, the Arts Festival that's in the middle of the desert. And I had the crazy schedule. I flew from Victoria to San Francisco to London to Copenhagen to Sweden to London to San Francisco to Las Vegas, all in 11 days and then I went to spend several days in a really hostile desert at high altitude with very low humidity and huge amounts of dust and very little sleep and pretty much a perfect recipe for getting sick. And because of the Bulletproof techniques that I have been using, I was less sick than most of the people who didn't do all the crazy traveling before going to the desert and in fact, I felt really good the whole time by sticking to the Bulletproof Diet and by taking the right supplements.

The second thing I'm doing that's extremely exciting is that last night, I just plugged in the BrainMaster Atlantis, a two-channel clinical grade EEG machine, which is going to let me do even more of the type of brain hacking and neurofeedback that I had been interested in doing. So, over the next few weeks, I'm hoping to get up to speed with this system and to be able to share some results of what I learned and what I'm able to achieve with it.

Armi Legge: Well, I can't wait until those articles to come out, man. That's going to be awesome. So, are you ready to get on to the listener Q&A and see how people clicked up this week?

[Dave Asprey]: Yeah, let's do it.

Armi Legge: Cool! This is the Listener Q&A, and the first question comes from Michael, "Great site, Dave, but I have one question. Is it more cost effective to go for the Paleo Pemmican or the Collagen Powder? As with the Paleo Pemmican, you get the whole shebang with collagen too, while collagen is just by itself. What for you personally gave the most benefits and is it overkill to take both?

Dave Asprey: They're different. If you only take one, your best bet is the Paleo Pemmican because it's got a bunch of stuff in it that goes beyond just Collagen. It has some healthy fats in it, some of the MCTs. But it also has Lactoferrin, which is basically the immune activating part of mother's milk. It's a subfraction that comes out in some forms of way, but it doesn't have the milk allergens in it that people are allergic to milk have. So it's more immune stimulating and it's closer to like a meal replacement or a meal supplement sort of thing.

If you're interested in the hydration effects and in joints and skin and all, and only those things without all the other benefits, you could go a straight Collagen. I would say the Paleo Pemmican is more well-rounded and it's designed to have the right fat-protein ratio that something more like a Pemmican would

have. I'm also pretty excited to announce that in the next few weeks, we're hoping to come out with a new version of a protein powder that I personally formulated in order to have even more immune stimulating properties different ones than the current Paleo Pemmican, but something that would go really well as meal replacement and something that will be more cost effective and have amazing benefits.

Armi Legge: I can actually attest that. One of the things I've been playing around is trying out the Paleo Pemmican for recovery between workouts and it works amazingly well.

So, this next question comes from Rachel, "It seems like you take a ton of different supplements. I was wondering if you could outline exactly which ones you take and why?"

Dave Asprey: You know, I can. If I'm doing a certain thing for my body, I might take a set of supplements. If I am trying to do something else, I might take different ones. If I get less sleep, I'll take more of one, less of another. So, there are two approaches to supplementation. One is that you pretty much take the same thing every day, hopefully at about the same time, and that works, but it also means that your body becomes acclimated to it, so you're better off to take some breaks with your supplements to prevent an in between process called hormesis. What I did when I'm really trying to heal some things in my body and I'm trying to be at my fullest performance, I did a spreadsheet and figured out that if I had the time and energy and focus to do it, I would take about 187 pills a day, which I think is like two more than Ray Criswell. I'll be publishing that spreadsheet some other time. However, I take something closer to about forty or fifty pills a day, many of which are large size molecules that just take several pills each.

So, yeah, I can do this and what I will do is very much like we did for the Bulletproof Diet. I'll show you a diagram that says, "For this thing to be achieved for you, you'll need to take these vitamins, and these ones are more important than these other ones." Because you could spend hundreds of thousands of dollars, in fact, well, you know, I have spent more than a hundred thousand dollars on vitamins over the years, but it's most important that you realize where you get the most bank for your buck and you start with the biggest things that don't cost a lot and over time – or because you have specific health concerns, you start tweaking and adding more expensive molecules that make a difference specifically for you.

Armi Legge: Are there any supplements that you do recommend to take regularly without break such as vitamin D?

Dave Asprey: Yeah. I think D is one of those things that you pretty much need to take it without breaks unless you're spending a lot of time in the sun with your clothes off and no sunscreen. Most people actually wear clothes when they're out in the sun, so even if you're out, you know, you probably ought to be taking your D every day, but you might reduce the volume based on what you do. I think for people who attended Burning Man last week, a lot of them actually were in the sun with very few clothes on, so for those people, maybe they did skip their vitamin D and it was okay. Other than that though, we don't wear togas outside most of the time.

Vitamin C is another thing. You should take it most of the time, but you should take some breaks from it. If you take it regularly all the time, and then you quit it for two days, you'll actually get bleeding gums and it's basically a version of scurvy that comes from withdrawing the high levels of vitamin C that you're used to and you'll cure yourself in about two days as your body reallocates the vitamin C that's in your body, but you do want relatively high levels of that on a regular basis because it helps you form healthy collagen in your skin and it helps your liver make its primary detoxifying enzyme, which is called the glutathione.

Armi Legge: Cool! And we also have a Lipoceutical Glutathione too, don't we? That's pretty beneficial.

Dave Asprey: Okay, that's a good point. If you're doing something that's particularly toxic or you're eating foods that aren't so good or if you're cutting back on sleep, which actually reduces your ability to remove toxins, or if you're traveling, that's something that I do take because your liver can only make glutathione if it has vitamin C plus N-acetyl-cysteine and several other cofactors. So, you can pretty much bypass your liver's production of that all together by just taking glutathione that enters your blood stream directly through the wall of the gut, which is a pretty neat little hack for molecules that otherwise are digested. That's not, however, something that I recommend you take every day unless your liver is weak. It's something you should take when you don't get enough sleep or when you travel or when you're stressed or when you need an exercise recovery very quickly. I take a bottle of it with me whenever I travel and I take it before I get on a plane and after I get off the plane and before I go to sleep in a hotel room.

Armi Legge: Sounds smart. This next question is from Kent, "What is your take on animal research that shows being on a high-fat diet is strongly linked with decreased insulin sensitivity?

Dave Asprey: I think that's one of the elegant beautiful links about the human body and that shows that it's a well-run system. And it makes sense that if you are eating a high-fat diet without enough carbs that you get decreased insulin sensitivity and that's because the carbs that your body was expecting are actually necessary, first and foremost, for the brain. So, this healthy insulin sensitivity decrease is caused simply by your body saying, "The brain gets first dibs on glucose." And the rest of the body, well, you're going to have to learn to live on fat, which is a very healthy thing to do anyway. This is not unhealthy. I also would point out that a lot of that research is not looking at specific fats. They're saying, "high-fat diet", and I'll tell you, a high hydrogenated fat or a high omega-6 fat diet is going to cause decreased insulin sensitivity because it's going to affect your cell wall flexibility and you won't be able to express your insulin receptors through the cell walls. So, anytime someone says a high-fat diet does this, it's pretty much like saying a high-food diet does this because there are gazillion types of fats. And if they don't say which fats and where they came from, it's not a valid study.

Armi Legge: I agree. Yeah. One of the other problems I think common with these things is people think that that's permanent or that is going to lead to type 2 diabetes and like that study we talked about earlier where they said it causes type 2 diabetes, that's not true. It causes mild insulin resistance and that's completely temporary and goes away the second you start eating more carbs. So, it's not you're going to get fat from eating high-fat diet.

Dave Asprey: Yeah. So, decreased insulin sensitivity is just fine as long as it's not permanent just like you're saying, so I have zero concerns there. And if this was a major issue after many, many years of eating the Bulletproof Diet and over the years, I'm strengthening it and improving it, you would think that I would have like massive insulin sensitivity, but it's actually better than it was years ago. I used to have big problems with blood sugar swings. I don't know. In fact, last week, just to confirm it for myself, I bought a ten dollar blood glucose meter and I haven't played with one in ten years just to see, and what you know? I don't see there are problems here even though I eat an incredibly high-fat diet.

Armi Legge: Yeah, sounds good. This next one is from Dave strangely enough, a different one, "If the goal is fifty to sixty percent of calories from healthy fats, and I'm assuming he's talking about the Bulletproof Diet here, that implies that healthy fats are full of nutrients. Could you expand on this? Also, what keeps fats down the gullet from becoming fat around the waistline?"

Dave Asprey: I love it when people use the word "gullet" in their nutritional talking. These are usually people who are maybe anorectic or who have like some kind of weird food aversions going on. Because the bottom line is that's, I would say, a kind of some charged language there, which is kind of funny. I would say it's the same thing that keeps vegetarians who put cucumbers down their gullet from getting fat. So let's say, whatever. Nice attempt on the question there, Dave.

But there are nutrients that are in butter, conjugated linoleic acid, medium chain triglycerides, not that many of them in butter actually, stearic acid, and all of those are nutrients, in case that's not really clear to people. However, there are also some trace nutrients and vitamins in it as well. Vitamins A, a little bit of D, E, and K are also present in good amounts in things like butter. Animal fats are full of all kinds of other things, different links fatty acid chains, some of which if you eat grass-fed beef, the bacteria in the stomach of the beef make, I believe, there are 17 chains, I could be wrong on the length, fatty acids that aren't found otherwise that are biologically active. So, the idea that fats are empty calories as the FDA would tell you is actually completely wrong. They are no more or less empty than other foods. I would say that fat itself is a nutrient and that's perfectly okay. We run on that stuff.

Armi Legge: Yeah, something also I'd like to add to that is that a lot of people look at vegetables, they're colorful and they're all bright and shiny and basically and everything, and they think like those are some kind of magical multivitamin when a lot of people don't realize that even if they're eating a lots of vegetables, they're eating not enough fat. They're not gonna be absorbing those vitamins and nutrients because they are fat soluble. So, the vitamins and minerals and nutrients that are in high-fat foods are actually more bioavailable to your body too.

Dave Asprey: In fact, I'm glad you said that. My take on vegetables is that they're most effective as carriers for more butter in your diet. If you're starving yourself by taking a cucumber and, you know dehydrating it or something and not putting any fat on it and eating the thing, you're not only not getting all the benefits of it, you're basically giving your body food that is not high performing in any way, shape, or form. This is the scam about the ANDI, aggregate nutrient density index and the whole foods it is running right now, it just makes me itch. And the reason for that is that they're using water as part of the equation here. So, they're saying, "Oh, look, you know, the, the nutrient density here is really good because as a percentage of calories, it's great." But the problem is that if you buy watermelon, it's almost all water. It's not nutrients of any form, yet they would say, because of that, this has a high nutrient density as a percentage of calories. That's BS. I will any day of the week eat a pound of butter or a pound of grass-fed meat over a pound of watermelon and I would challenge anyone to do the watermelon every day for, let's say, a month and look at what it does to their health even though it has a higher ANDI scores than grass-fed meat.

Armi Legge: Agreed. And just another thing to add on this is that a lot of the nutrients in vegetables are actually not technically nutrients such as carrots. For a long time, I was thinking I was getting all the Vitamin A I needed by eating tons of carrots, I still like carrots, I still eat them for carbs. They're great. But you can't just rely on this because the carrots don't actually contain Vitamin A. They contain beta carotene, which is very poorly converted into Vitamin A in the body, so they have literally had these groups around the world that were showing signs of Vitamin A deficiency even though they are taking far more than the recommended daily amount, but it was from vegetables because it wasn't a bioavailable form like you'd get from animal products like grass-fed butter.

Dave Asprey: I completely agree.

Armi Legge: Cool. So, this next one is from Ronn, and he has two parts to the question, “Hi, Dave. I’m new to your site and all the fascinating information here. So, if my question has already been asked and answered elsewhere, I haven’t found it yet. One, I’ve had dairy allergies since childhood. Could I substitute Extra Virgin coconut oil for the butter in Bulletproof Coffee? If not, any other suggestions on replacements for dairy?” And why don't you just go ahead with that before we go on to the next one.

DA: Sure. So funny enough, I’ve also had dairy allergies since childhood, although they weren’t diagnosed until a little bit later in life. If I eat cheese or even eat something that's cooked with a couple of tablespoons of milk, I get swollen joints. This has been a problem forever. So you can usually handle grass-fed butter because there’s very, very little protein in it. And you don’t mention if it’s dairy protein or dairy sugar lactose, that’s your problem. But I’m guessing, it’s casein or the protein that’s there. Butter is low casein. If that’s still a problem for you, you can actually buy grass-fed ghee, which is clarified butter. Clarified butter that’s made properly has zero protein in it. It is just this healthy saturated and a few of the slightly less saturated fats that are in butter. And people who are allergic to dairy can almost always handle ghee and actually, they eat it, and they can’t get enough, like they usually over eat it to the point that they’re nauseous because their body is like, “Oh, thank God, I finally got these fats I needed.” I’ve seen that happen over and over. So, I would really try ghee. It also tastes kind of like caramel in coffee. It’s awesome in coffee. You could use Extra Virgin Coconut Oil in Bulletproof Coffee. I do that sometimes, although it tastes better and it blends better if you do straight unsalted grass-fed butter plus maybe 30 percent of the fat as Medium Chain Triglyceride oil that has the most effect biologically and it tastes best with the best head of foam on it. You could also do canned coconut milk in there, which tastes really good and it frosts very nicely as well. Coconut milk in ghee would give you a beautiful head of foam on Bulletproof Coffee.

Armi Legge: Cool. His next question is, “I’m a 95% to 99% raw food vegetarian, a vegetarian for 35 years now, raw foodie for four years. I eat eggs occasionally, and can tolerate small amounts of raw goat milk cheese once in a while. Is raw goat milk cheese evil? Is there a place for me in the Bulletproof Diet plan?"

Dave Asprey: I hear this pretty often from vegetarians, particularly vegans, and I can see there is probably a couple of dozen vegetarians or vegans who after talking with me for a while have actually changed their diet to include at least some amounts of meat. There’re a couple of questions on this. Eating eggs occasionally is really important. I’m saying this from the perspective of someone, when I was 300 pounds, I did go for a raw diet. I did it for about nine months. The first two or three months, I was raw vegetarian. The first four to six weeks, you feel really good because you’re eating a lot less of the type of toxins that your body is used to eating, which usually come from grain-fed meats and Mycotoxins in normal food products. So, you get cleaned out, but then you start running short on nutrients, particularly the healthy fats that your body needs.

So, what I did is I added raw meat into my diet. So, I did raw eggs, raw steak, raw chicken, raw turkey, and raw fish in the form of sushi. There are healthy ways to do this and what you do is you sterilize the meat, needs to be pastured meat, you sterilize it in a mixture of ten drops of Lugol’s Iodine in a bowl of water. When you do that, you’re killing anything that’s on the surface of the meat. You can also ozonate the meat if you have an ozone machine that’s capable of making ozonated water. So, if you do that as a raw food person, you’re still raw, but you’ll find that an ounce of meat is profoundly – just profoundly energy providing. You'll feel so good and it also fills you up like a full steak wouldn’t fill up someone. So, if you have the time and energy to be a raw foodie, adding raw meat is actually less work than preparing most raw food dishes like blending cashews after you’ve soaked them and all that, it’s less work. I would add three egg yolks a day, you can eat the white because you’re probably protein deficient. I tell a lot of people to toss the whites, eat the yolks. I love friends who eat egg white omelets like Tim Ferriss says because I get to eat the yolks. I love that. Raw goat milk cheese, it all depends on what bacteria and fungus made the cheese. The odds are it probably wasn’t a very healthy one and that it makes particularly some toxins in it. You might be better off with nut cheese that’s not fermented.

And for the question, is there a place for you in a Bulletproof Diet plan, the Bulletproof Diet is about being 100% optimized and having the most energy and resilience you can possible get from all variables.

So, from that perspective, well, no. There isn't a place for you in the Bulletproof Diet plan because you're making the choice to be a vegetarian, which by definition means that you are going to be not as far on that curve as it is possible. However, there is a place for you in the Bulletproof Diet plan given the constraints that you've placed on yourself and that you can optimize that as much as possible and to that extent, yes, if you adopt as much to the Bulletproof Diet like the percentage of calories and all. As a vegetarian if you eat enough eggs, you can probably pull it off, especially if you cut out soy. You'll at least be as optimized as you can be.

I would point out, however, that the Bulletproof Diet has a lower ecological footprint than any vegetarian diet known to man. If you eat only two pounds of grass-fed steak every day as your protein source, two pounds is quite a lot by the way, you're killing .7 animals per year. And as a system's thinker, I'm looking at the system that includes the soil, includes soil organisms, insects, rabbits, bunnies, mice, snakes, lizards, grasshoppers, and the like, every time you eat that, that bowl of rice or legumes, usually a tractor did cut that down and if you walk around behind the tractor, you can collect bagfuls of dead animals. Anyone who has lived in the farming community knows about tractor kills as well as the destruction of top soil that comes even from organic farming. You can with the right organic farming preserve soil, but it still is a very big challenge and most farming isn't.

So if you're trying to be a vegetarian to save the planet, man, it's time to be a Bulletproof Diet guy and to incorporate locally grown grass-fed meat that was raised on land that wasn't agriculturally suitable for farming. That's what I do. I kill less animals than any vegetarian I know on a yearly basis.

Armi Legge: I'd also like to add that the moral and ethical and political reasons behind vegetarians are also pretty flawed. We are obviously not going to go into a whole podcast about that. We may in the future because that is an interesting topic, but if you want to learn more about that, you ought to check out the book, the Vegetarian Myth, but it's very eye opening for a lot of vegetarians. So, if you want to check that out, it will be great. We will have a link for that along with everything else we talked about in the show notes.

Cool! So, that does it for the Listener Q & A of this episode. If you have questions for the podcast, you can contact us on Twitter, Facebook, or in the Contact form in the Show Notes of this episode. We'll also pick through the comments to find good questions, so if you leave a comment in one of our articles, it'll probably make its way into the podcast. Now, we're going to move on to our exclusive interview with Dr. Tim Noakes.

Podcast Interview

Armi Legge: Hey, folks. It's Armi Legge. And today, we have Tim Noakes, the author of the Lore of Running. He is a Sports Research scientist. He is the head of the Exercise Science and Sports Medicine Research Unit at the University of Cape Town. He's run over 71 marathons and ultra-marathons. He's regarded as one of the top experts in sports efficiency and performance. I think I just said he wrote the Lore of Running, which is one of the definitive books on running and has some extremely unique ideas. Tim, thank you so much for coming on.

Tim Noakes: My pleasure, thanks for having me, Armi.

AL: Cool. So the thing I wanted to talk about today mostly was your theory of the Central Governor Fatigue Theory, and could you explain exactly what that is?

Tim Noakes: Yeah! To give you some background, when I started in exercise sciences in 1981, the theory which was popular then and probably still is popular is that when you exercise, the reason why you get tired is because your muscles run out of oxygen or glycogen or something else and they then refuse to work, and that's how fatigue occurs. And over the period of 25 years or so, I realized the problem with that model is it doesn't include the brain. And so, it's a brain-less model. And the reality of the human condition is that the brain is there to make sure that we don't get into trouble and it regulates our behavior.

As a consequence of the research we did, it came to me that in fact, what you have during exercise is that the brain is regulating the system to make sure that you don't run into trouble. So, the Central Governor model simply says that during exercise, the brain is receiving information from all parts of the body and it modifies your behavior. It slows you down or speeds you up in response to all those inputs. As a consequence, when you finish the exercise without collapsing catastrophically as it happens according to the other model, so what we've done is we've just said that exercise is a controlled behavior and it's controlled by the brain and the control starts the instant you start the exercise, the brain has already calculated what is safe for you to do under the prevailing conditions and it then shepherds you to the finish, making sure that you don't run into trouble. And that's the idea.

Armi Legge: So, if somebody started having a flare in the middle of a run and their legs start to seize up and really hurt, that would be more of a neurological response by the brain to try and make sure damage do not occur to the legs?

Tim Noakes: Yeah, and I'll go even further than that all the symptoms you have during exercise are generated by your brain. They're unique to you, and they may be completely different to any symptoms anyone else has. So, we all assume that we feel the same sensations and symptoms during exercise, but that is not proven. My view is that the sensations of discomfort are the way the brain regulates the performance. The symptoms are utterly completely illusory. They are generated by the brain and they have nothing to do with the state of the body at that time. They only are related directly to how close you are to the finish. So, anyone who's run enough or exercised enough in competition knows that your symptoms of discomfort arise as a function of how close you are to the finish, and it doesn't matter whether you run ten miles or hundred miles. When you've gone about 60% of the distance, you start to feel really dreadful and you want to start to quit. And therefore, it's not related to the exact distance you have traveled, but to how close you are to the finish. So, we go even further, we think that the best athletes are the ones who make the illusion that interferes less with their running. So, the less good runners, the symptoms are more illusory and they're worse and they, therefore, slow down more than the elite athletes, who are resistant to the symptoms. That's what people say, "I'm a great athlete. I don't feel the symptoms." If you're a great athlete, you could actually don't generate the symptoms.

Armi Legge: So, this explains some of the large discrepancies between basically what makes a pro and what makes an amateur and that their ability to not produce these kinds of pain signals allow them to push their body further and harder?

Tim Noakes: Yeah, and I think it starts with the other way because they believe they're so good and they have a faith in their performance and they have learned over the years how good they are. And of course, they have some different physiology. They then, during exercise, don't generate the symptoms at the

same rate as the less good athlete. But let's make a point that you can't take a useless biology and turn it into a champion by changing the brain. What I'm saying is, if you have people of the same biology, there are many very good athletes in the world, but the few who stand out, stand out because of the way they use their brains during exercise.

And I always say that the difference between the best athletes and the less good or the winner and even the second place, you won't find that in biology. You'll find that in the brain and the way the brain functions.

Armi Legge: Are there any specific studies looking at that and basically comparing the number one person to the number two person and looking at the differences in their biology and not finding any difference?

Tim Noakes: Yeah, absolutely. Because I know marathon running basically and I've studied enough marathon runners to know that. If we took the very best runners in the world and stuck them on a treadmill, we couldn't predict whether they could run a 2 hour 2 marathon or 2 hour 15 marathon. So, their biology would be no different from other runners who are running 2 hours 15.

So that's the level, which we can currently study. Either we are not measuring the right biology or the biology we're measuring is not the predictor of the performance. And there is something else, for example the brain. There could be biological, physiological variables that we aren't measuring. But, for example, people will tell you that the VO2 Max, the maximal oxygen consumption, is a good predictor of performance. Well, that reality is that VO2 max values measured in the 1930s are no higher or lower than the best athletes today. So, the same physiology is producing performances that are substantially better today than they were 50, 60, 70 years ago.

So, it doesn't look like the biology has changed much in the elite athletes. What has changed is their perception of what they can achieve.

Armi Legge: So, how does this theory explain muscle damage? Because I ran a 10K back in late April and my legs hurt for a while after doing that race. So, is muscle damage still a factor when it comes to fatigue during a race like actual tears in the muscle fibers?

Tim Noakes: I'm not sure. So, I think we have to look at, are we talking about the localized muscle tears, which will be a muscle injury. I think they're neurologically based, but I don't think you've consciously caused those injuries. So, I think that what happens there is you get a localized muscle injury, which is very common, the muscle cell itself is not deranged. The nervous system is the problem and it causes excessive activation of muscle fibers and they eventually go into spasm and as a consequence, the whole muscle goes into spasm to try to protect the area of damage.

And I'm convinced from my own experiences over 40 years, that's a brain-based phenomenon. So, if you tear your muscles in a 10K race and you have to stop, I think that that is not the muscle tearing because it's weak, it's because the neural mechanisms are at fault, and you need to correct the neural mechanisms and that's I don't think what you're talking about. I think you're talking about a generalized muscle ache and discomfort that you develop after exercise and that lasts for a few days.

And there, it's obviously most apparent, if you run a downhill race. And so obviously, one would ask, "Was it a downhill race?" And if so, that would be the explanation and you weren't quite adapted for any downhill. We know that you will have some damage and we also know that the next time you run in the same conditions, your muscles will be more resistant to that damage. So, the one thing that this regulator doesn't seem to be able to pick up is that muscle damage because people will run a downhill marathon and the next day, they can barely walk. So, why didn't the Governor stop them? And we don't know, but the answer is it can't be able to detect the damage that's happening and tell you to stop for those reasons. It doesn't seem to take note very well.

Armi Legge: Basically, like the race I went did have a lot of hills, but I usually do train a lot on hills, and my legs really didn't hurt that much during the race except for, as you said earlier, the very end, then again, as you said, they hurt terribly the next today. So I think that's a perfect example of what you're

talking about. Do you think a lot of the things athletes take for granted as in bonking and that kind of thing or when you run out of energy are really just a manifestation of the brain trying to protect the body?

Tim Noakes: Indeed, it's developing the symptoms and depending on how you've overridden the symptoms before, and so they'll get progressively worse. I used to bonk in marathon races and I've subsequently learned because I had far too high carbohydrate diet and that was the problem. Once you are adapted to a high-carbohydrate diet, you become so carbohydrate dependent that you need lots of carbohydrate during the exercise. I discovered that anyway around and that was to take in enormous amounts of carbohydrate during exercise. But in my case, the symptoms I used to get where that I suddenly would think, "I can't finish this race." "How can I possibly run another 10 miles, it's absolutely impossible? And that to me was the symptom that indicated that I was low in blood glucose. And if I ingested carbohydrate within about five minutes, the symptoms would disappear and I would recover. So there, what was happening as I understand it, my blood glucose was dropping or it was threatening to fall and the brain was saying, "Okay, the only symptom that I can get you to slow down is to make you feel terrible and think that you aren't going to finish." That's one example of where the symptoms become very apparent and they seem to serve a good purpose. But as soon as you take the carbohydrate, you lose the symptoms very quickly and you can speed up thereafter.

Armi Legge: I think what you just said was one of the most important parts of the interview, just to the idea that athletes need to have a high carbohydrate diet is not true, and I completely agree. I noticed that with myself from my own training even doing faster training and that kind of thing, your body doesn't need that. So, thank you for saying that. So what are some of the common explanations for fatigue that you think are probably not accurate? You mentioned muscle soreness and we've talked about bonking. Are there any other generalized themes that a lot of researchers follow that you think aren't necessarily accurate?

Tim Noakes: There are basically three models of exercise, how it's regulated, and the one is the peripheral model where everything goes wrong in the muscle itself and that stops you exercising. And that really can't explain very much because it can't explain why you choose a pace when you're exercising and it can't explain why you speed up at the finish. Because if the muscle is really very exhausted, you'd never be able to speed up. But the characteristic of competition is that athletes speed up near the end and the greatest of athletes are the ones who speed up the most in the last kilometer or lap of the race.

If your muscles were the reason why you couldn't run any faster earlier in the race, then why can you suddenly speed up at the end? And the answer is because it's your brain that is regulating the system. So, the peripheral model doesn't work. The peripheral model is that you either run out of glycogen, so you run out of carbohydrates and you have to stop, or you've got too much lactic acid in the muscle, then you have to stop, or you've got too much phosphate, and so, all of this have done another failure and that doesn't really explain the models.

The other one is a brain model where the brain suddenly runs out of something or gets too hot or the chemicals change and that also doesn't work because that's also a catastrophe model and the brain doesn't work like that. The whole function of the brain is to protect you. For example, if you were to starve yourself, the one organ that is not affected is your brain. Your brain weight will always be the same at death if you were starving. So the brain has developed all these methods looking after itself and it would do everything to shut down the periphery and make you slow down in order to protect itself. And in a sense, that's the Governor model that the brain will respond to all the information that it's receiving and it will then choose what work rate is appropriate for you.

Armi Legge: So could you take us through exactly what occurs in the Central Governor model with a runner running a marathon, could you take us through the different stages of how this Central Governor Theory would influence his performance?

Tim Noakes: Well, first off, if you want to run a marathon, you have to think about it for a couple of months. So, it's a _____ statement. If I said, "Let's go and race 10Ks tomorrow," you'd be there. If I said, "Let's go and race 15Ks," I would obviously give you the distances in American terms. If you were going to run six miles, you'd say, "Sure, no problem, I'll meet you tomorrow, and we can race tomorrow morning." If it was ten miles, you'd say the same. If I'd say twenty miles, you'd say,

“Actually, I don't think I can prepare myself immediately overnight.” And if I said it’s a marathon, you’d say, “No, no, no, no, I can’t go out and race it tomorrow. I’ve got to give two months to prepare for it,” and much of that preparation is mental. And so the race I used to love was the 56-Mile Comrades Marathon and it would take me two years to prepare for that.

I could only do it every second year. So, it would take me a year to get over my previous effort and then it would take me a couple of months to think, “Okay, I can start training properly for it" and then I would train flat out for six months and run it, and that would be my mental preparation. Of course, we thought it was physical preparation, but I don’t think it is.

So, for the last two months, you are preparing mentally for this race and you start to visualize it, and that’s your brain getting ready to push you and accept the discomfort that you’re going to go through. And then for the last three days, you’re going to sleep more and rest more because your brain needs a chance to store something, I don’t know what it is, so that when you get really tired near the end of the race, you are going to be better.

The only marathon I never finished was when I was doing my internship in medicine and we were working 100 hours a week. I just set a Saturday morning off, so here we probably were sleeping every second or third night. We weren't sleeping every night and I reached twenty miles in the race, and I just said, “That’s it, I can’t be bothered.” It was the only time I ever quit in a race. I have no question that it was because my mental preparation just wasn’t there. And I was just so exhausted from working so hard in the hospital that I couldn’t do it.

So, those are the effects, so then you stop the race, and you have _____ prepared and how important is the race for you, is it going to be a training race or is it going to be a race where I’m trying to do as hard as I can, or is it the Olympic Marathon? And depending on that, your motivation will be different.

What then happens is that, in my view, the brain has already worked out how fast you’re going to run for the whole race and it starts your symptoms of discomfort, which we rate as the ratings of perceived exertion and as you go through the race, there’s a linear increase in these ratings. So, the exercise originally feels moderate or moderately hard, then it becomes hard, and then it becomes harder. And then on the other end, it becomes very, very hard and then it becomes extremely hard, which would be a rating of 19 on the Borg scale on the rating of perceived exertion. And that’s the characteristic that happens.

Now, what’s interesting is that this is a linear function of the distance. But, I doubt that everything in your body is changing as a linear function of how far you’d run. So, what inputs to set that rating of perceived exertion is I really don’t know. And in our view, it’s set before you start by some sort of expectation that the body has set for the race. So, it would be easy to say that as you get hotter, that explains why your rating of perceived exertion rises. It would be easier to say that as you become more dehydrated, that causes your rating of perceived exertion to rise. Well, as you run out of glycogen, that causes the rating of perceived exertion to rise. The only problem is that the RPE rises, as I said, right from the start of the race when none of these things has changed very much. So, it can’t be those variables. So, it’s mystical as to what is determining the symptoms that you develop during the race. And my conclusion is that it’s got something to do with your expectation that you’ve developed over the years and the brain uses that to set the rate at which the sensations of discomfort will rise during the exercise.

Armi Legge: I've heard of book called Run by Matt Fitzgerald, and he talked a lot about performing workouts that increased your confidence versus workouts that necessarily increased your muscle’s ability to perform workload and that kind of thing, and that basically sounds like what you’re talking about, basically training your body to respond differently to forms of stress. Is that what you’re saying?

Tim Noakes: Yeah, I think. He definitely advanced the theory because we never said that and he interpreted it quite correctly, I think that what you’re trying to do when you’re trying to run faster, that’s the key. You’re not trying to change your VO2 max or whatever, whatever, or your anaerobic threshold. That’s not what it’s about, it’s about running faster. And he said that you have to try in yourself to run faster and become confident at it. And when I read that, I realized that’s exactly what we do, do. I remember because what I did first was rowing or called crew in the United States and that’s exactly what

we did. We just taught ourselves to row faster and it was over. We used to race 2000 meters, but we taught ourselves to race faster over 500 meters, and you would just get your brain around the concept that actually you could row faster. And eventually, you put that in 2000 meters and then it is 2000 meters. We were not training to say, "Oh, my VO2 max is going up." We were always racing the clock and I think that's the reality, that you want to run faster, so you must train and get your body to realize what it feels like to run at the faster pacers and eventually, you will have the confidence that you can run faster.

And a lot of the running that we do is the low pace and the endurance running, which really doesn't do that and certainly, one of the findings I have learned in our research and both from my own experiences are that when you get in any of the race, you really have to start doing interval training and very quickly with using few intervals, your performance can go up dramatically. And, that's what is surprising. Eight hard sessions of interval sessions will improve your performance dramatically. In my view, that's got nothing to do with physiology, but it's got everything to do with adapting your brain to accept actually you can run faster without damaging it.

Armi Legge: Cool! So, the rating of perceived exertion that most people think of is kind of primitive and that kind of thing and I think a lot of coaches are moving towards heard rate training and power training and those kinds of metrics. Do you think perceived exertion is still a fairly good representation of how hard you're working?

Tim Noakes: No, it's not because it's a measure of how close you are to the finish.

AL: Hmm.

TN: That's the key. So, you see the rating of perceived exertion was started as a measure of your intensity and it's not the heart rate. It's a much better measure of intensity and is very reproducible though. If you train regularly at the same heart rate, you'll be doing the same, roughly the same intensity. So, if you want to know your intensity, the heart rate is really a very good measure whereas rating of perceived exertion doesn't tell you your intensity because it rises the longer you go on. So, if you run at the same intensity, you're rating of perceived exertion will rise, and therefore, it's not related to the intensity. It's related to how long you can keep going at that pace. So, that's what the information you get from the rating of perceived exertion and it is how long can I go at this pace?

Armi Legge: So, how can people improve their resistance to fatigue? You mentioned mental training and mentally preparing yourself before races. We talked about intervals. Is there anything else people can do?

Tim Noakes: You develop self-belief.

Armi Legge: Hmm.

Tim Noakes: Have a coach who tells you, you can do things that you don't believe you can do. So, I think that's the key that how do you know how good you are, but the coach tells you. So, why is it in the United States or in any country are a few iconic coaches in whatever sport it is, be it American football or baseball or track and field, there are only a few iconic coaches who can get the best out of the athletes. And, their success in part is because the athlete believes the coach cares for them. But let's put that aside. It's somehow the coach understands how good this athlete is and pictures the challenge, so it's appropriate for that athlete. I always think of Jim Ryun, he was one of my great heroes, he was the first school boy runner to run a sub-four-minute-mile, and he tells the story that he started running at 13. And at the age of 15, the coach calls him in and says, "Jim, what can you think you can run in two years' time?" And he says, "Oh! I have no idea, maybe a 4:10." And his coach says, "No, Jim. You can run a sub-four-minute mile," and he says, "You're crazy coach. There's no way I can do it."

Two years later, he runs a sub-four-minute mile. If the coach hadn't said it, it wouldn't have happened, but the point of course is that the coach can't go on and tell everyone in the club, "You can all run a sub-four-minute mile." He had to know that Jim Ryun was a one athlete in a billion who could do it, but he spotted the brilliance in the young man and set the target that was appropriate.

But if he hadn't set the target, Jim Ryun would have thought he was 4:10 miler and not a 3:59 miler. So, the coach is crucially important in setting the standard and showing the athlete that if he believes strongly enough, he'll be able to do it.

Armi Legge: So, positive reinforcement is one of the big parts of this that seems and getting positive feedback from your coach. Could the opposite also be true about trying to avoid negative influences on your psyche and avoid people to counter you down like when you're talking about, "Yeah, I'd really like to run, you know, a 4:30 mile at this race," and when your friends are like, "Oh, you'll never do that." Is it good to avoid people like that at least before a race?

Tim Noakes: You have to absolutely avoid these people. I was looking for quite on that very topic recently. I was reading a running book in which the guys – it's in Oxford and Cambridge Boat Race, which is the same as the Harvard Yale Boat Race. The race is same distance about four miles, which is amazing because most races are over one and a half miles or 2000 meters. But, you have to keep the same intensity for four miles that you normally keep for a mile-and-a-half.

One guy said, "You have to believe that you can do it before you start," and then he said, "You have to overcome all the negative impressions that you've had from your coach and everyone else implying that you actually can't do it." And I found that interesting because you shouldn't be in an environment, which is negative. That's not going to help you. You have to believe, anyway you are going to learn to believe as if people will support you, and then you start to achieve. I guess there are some people for whom negative motivation does help and I am just going to prove you wrong. But for many people, that doesn't work. You've got to have the support of the coach and to believe the coach.

Armi Legge: So, how was your believes on the Central Governor Theory evolved over time? I'm sure when you first started learning about this, you were probably still following the already pretty conceived notions about fatigue. So, how did your kind of involvement in this develop over time?

Tim Noakes: Well, I think it really started in 1981 when we started our research and what happened was we started doing VO2 max testing in athletes and we were told that you will always find a plateau, in other words, oxygen consumption will rise, as you make the athlete exercise harder and harder and harder, and then suddenly there will be no further rise.

And, so the athlete will continue for a minute or two on the treadmill, but his or her oxygen consumption will not rise one milliliter higher and as a consequence you show this plateau and what that means is that the heart is no longer able to provide more oxygen to the muscles. The muscles become anaerobic. The anaerobiosis then causes lactic acid production. The lactic acid shuts down the muscles.

Our problem was we couldn't find this in the majority of athletes. But at that time in 1981, if you wanted to publish a study of the VO2 max in athletes, you had to write. In 100% of athletes, we saw the plateau phenomenon. So, we had the choice, you either lie because we didn't see it 100% of the athletes or we found out what's going on. And I said, "Okay. In those athletes, we don't get a plateau." My view is they don't show an optimal efficiency. Then, we started testing athletes and found that the VO2 max was a dreadfully poor predictor of performance. So, I could get two athletes with a VO2 max of 70, and one would be running a three-hour marathon and one would be running a two-hour-twenty marathon.

So I said, "If the oxygen consumption is so important, why can't this person with a VO2 max of 70 or so, and he's running three-hour marathon, why can't he run a two-hour-twenty marathon? And then we started looking at some of the best athletes that we had in South Africa at that time and their VO2 maxes were 73, 74, went fantastic. As I have indicated, we measured values of 74 in other runners who were two-and-a-half hours. But, then we noticed that the key predictor of their performance on our testing was how fast they ran on the treadmill during our test. So, for example, the test protocol was that we would start the treadmill at say 12 km/hour, let's say about 8 miles/hour, and then we would speed it up one kilometer an hour every minute. What we noticed was that really elite athletes were able to reach twenty-five kilometers per hour. In other words, they were running sub-four-minute-mile pace, and they would sustain that for two minutes at least on the treadmill having already run for ten minutes at progressively increasing speeds. And we noticed that that was the predictor of their performance, so the speed they reached on the treadmill was the predictor of their performance and it was very, very good predictor. If

you couldn't reach 25 kilometers per hour on the treadmill under those test conditions, you'd never run a four-minute mile and you'd never run a two-hour-eight marathon. So, those were the data.

Then I said, "Well, there is something in the muscle that's determining this," and maybe these athletes have super powerful muscles and it's got nothing to do with oxygen and that was the hypothesis at the time and then only later did I realize that in fact, they have to have super powerful muscles and you never thought that, but Haile Gebrselassie, I can tell you, his muscles must be as powerful as the most strongest weightlifter in the world because when his foot is on the ground to run faster, his foot must be on the ground for a short time and to run faster, his foot must be on the ground for even shorter time. So, he's got a few milliseconds to generate enough force to bounce him four or three meters through the air. So he's got no time to do that and you can only do that if you've got very strong muscles. But, more to the point, what I realized is that the amount of muscle that you would recruit must be very important. Because when you're running, you don't recruit 100% of all your multiunits in your muscles. You only recruit a proportion of the muscle mass.

For example, near the end of the marathon, you're probably recruiting only 40% of your muscle. So, I began to realize that if you wanted to be a great runner just by recruiting 43, 44, 45% of the muscle and also making the muscle very powerful would make you a better runner. And those things are related to the brain, not to oxygen delivery to the muscle. And then I suddenly realized to know the major characteristic of humans that they can exercise without killing themselves under extreme conditions of heat or altitude and then I realized that brain must be there to regulate, to make sure you don't run into trouble. So, that was the final realization that's, sort of, finally brought the whole model together.

Armi Legge: So, you talked about making the muscles more powerful. Will things like plyometrics and weight training help with that?

Tim Noakes: Absolutely. We don't do half of it and I mean there are older runners in this country who would tell you that by just lifting weights and particularly doing eccentric loading of the calf muscles, you can get by with much less training in ultra-marathons. And I also know that Bruce Fordyce, who is the great South African ultra-marathon and he won the Comrades Marathon nine times, he really became good as a downhill runner when he started to do a lot of eccentric loading of his quadriceps muscles, so, yes, you have to do weight training for your muscles of the lower leg if you want to be a really good runner.

Armi Legge: Something else I've noticed since I've started doing more weight training is that it also boosts your confidence. So, it seems like it's coming at least from two sides, you are both strengthening the muscles, which allows you to produce more force, and then at the same time, you just feel more confident because you've been doing weight training. Do you think that could be part of why it helps?

Tim Noakes: Yeah, exactly. What you're referring to now is a potential placebo effect. In other words, if you believe something, it will make you go better, and that's the reality. There's a massive of placebo effect in everything we do. Franz Stampfl, who coached Roger Bannister to become the first sub-four-minute miler said exactly that. He said, "Training is an act of faith. You have to believe" and I couldn't understand that for 50 years because we were teaching the reason why you run faster is because your VO2 max gets higher or your heart gets stronger. How could it be changing your belief systems? And I absolutely do believe that placebo effect is that if you believe your training is going to make you better, it will and conversely if you don't believe it's going to help you, don't do it because it is not going to help. So, if you believe that the weight training is helping, it is going to help and it could have a substantial effect.

Armi Legge: Could there be other activities as well such as shaving your legs before a race or wearing certain clothing and that kind of thing - Could that also provide a placebo effect?

Tim Noakes: Exactly. Anything that you believe will help, will help. And we showed that years ago interestingly with carbohydrate ingestion where we did studies where we gave placebos to people and told them they were taking carbohydrate and then sometimes, we would give them carbohydrates and we would mask the taste, then we'd say, "No, actually, you're not getting an active carbohydrate." And they always did best when they were given carbohydrate and they believed it was carbohydrate. But, when

they were given water with a taste added so that tasted like carbohydrate, and they were told that was carbohydrate, they performed almost as well as when they got carbohydrate and believed it was carbohydrate. And the placebo effect is enormous.

Armi Legge: Wow! Yeah. Are there any other good examples that you can think of the Central Governor Theory in action? Any major studies that really stand out to you?

Tim Noakes: I've written an article in which we review the whole basis for it. There are about 50 studies at least, which you can only explain on the basis of the Central Governor. In the Central Governor model, the first thing is that you could influence the brain directly and influence the performance without changing anything in the periphery and there are about 30 studies that show that. Just off the top of my head, one of them is if you ingest carbohydrate acutely, within seconds your performance goes up.

So, if we're measuring your force output of your muscles and we give you glucose by mouth, within seconds, you can pick up a heavier weight and that can't be because the glucose has been absorbed. It's because the glucose is acting on your tongue and at the back of your mouth, and the brain is then picking up the information that this is beneficial to you and your performance goes up. So, you can't explain that any other way.

Another interesting one is if you give people who are getting cramps salt, or you give them pickle juice, for example. The cramps are much more likely to go away if they drink pickle juice. And the only problem is that cramps disappear long before the pickle juice gets into the circulation. So again, it's the central effect through the brain and these people, of course, get confused as they would have proved that the salt deficiency was cramping, not at all because the salt didn't even get into the bloodstream before the cramps were broken. So, those are couple of examples.

The other one is the amphetamine effect that the, the most effective drug that aids performance is amphetamines. And, they're unavailable today in the forms that they were available in the 1950s and the athletes in the 1950s who took these amphetamines were at great risk of getting heat stroke because if they exercise in the heat, they would block out the feedback from the body telling the brain that it's too hot. There are many famous cases, Simpson, the British cyclist, who died in the Tour de France on Mont Ventoux. He was taking amphetamines on that day and he drove himself to death or sucked himself to death, but he had raced many, many times under hot conditions and it never happened. So, there the amphetamines are acting as blocking out the Central Governor effect. They are the very dangerous drugs because they know to override the Governor and develop heat stroke.

Now, along those lines, if you remember Paula Radcliffe in 2004 in the Athens Marathon, she stopped running at thirty-six kilometers and she was paralyzed because she said, "I couldn't put one foot in front of the other." She didn't say, "I was tired and I would walk to the finish." The reality was she going to be paid a million pounds if she finished the race and she didn't finish it. So, all she had to do was just walk to the finish and she couldn't because she was paralyzed. In my view, what happened was her body temperature got to 42 degrees centigrade and the brain said, "That's it. If we don't stop you now, you're going to get heat stroke, so we're going to stop here and you have to sit on the side of the road and wait until your temperature has gone down." And that was a classic example of the Central Governor stopping her running in order to make sure she didn't develop heat stroke.

And this of course was in the greatest race and the most important race, which as I have indicated, not only could she win a gold medal, but she could also win the million pounds. So, she had every incentive to finish the race, but she couldn't because her brain stopped her and just to make the point, the reason why it stopped her was because she had accumulated heat too rapidly because she was too big. She weighed 52 kilograms and she couldn't run at her chosen pace under those conditions and lose all the heat whereas the Japanese lady, who beat her, weighed 40 kilograms. And only at 40 kilograms, can you run that fast and not accumulate to so much heat that it eventually stops you?

Armi Legge: Could the pressure of the race also had influenced her performance? As you said, she was getting paid a million pounds, it was that Athens, kind of birth of the marathon, and it was in the Olympics and it was the gold medal race, could all of that have really played on her mind in the days

preceding the race and maybe she started contemplating what would happen if she didn't win and that could have negatively influenced her performance?

Tim Noakes: No, I don't think so. I think that she's one of the greatest athletes of all time. I think she was well-prepared for the race, although she hadn't done enough heat training, but besides that actually if the temperature had been two degrees cooler she would have won the race and she wouldn't have developed the condition. But let's get back here because if you read what she described, she says, "I felt terrible from the start." Now, she interprets that to mean that she wasn't really properly prepared for the race.

But according to the Central Governor, the explanation is simple that she was overriding what her body was telling her. Her body was saying, "Slow down, slow down, slow down. You can't finish if you keep running at this pace." But she overrode it because she couldn't understand why she couldn't run next to this other athlete, who she perceived to be a less good athlete, and that's the reality. The Japanese lady was three or four minutes slower under cool conditions.

And so poor lady, we reasoned to believe that she should have been running way ahead easily, but she didn't understand the biological problem, but the point was her body was telling her, "Slow down, slow down, slow down," and she was overriding it. And when you override it, then you get the symptoms and you just feel it's terrible, and, so that's what happened. It was because she wanted to win so badly that she forced herself to run, but if she couldn't run slower, she wouldn't have won and she knew that.

Armi Legge: So, now, we talked about exercise, and I'd like to talk a little bit about how the Central Governor Theory might be used in regular everyday life, specifically, let's say with sleep deprivation. So if somebody, let's say, slept for only five hours a night and then woke up the next day – De Torre France would be a good example. These riders at times have to sleep for very small amounts of time and then get up and ride over 100 miles the next day at incredibly high speeds. Do you think a large part of their ability to do that is just the fact that they have convinced themselves that it's possible?

Tim Noakes: Well, exactly, and they don't use it as a negative. So, to be a great athlete, you have to obliterate the negatives and not use them as an excuse as the rest of us would. So, the rest of us would say, "Oh, gee! I didn't sleep enough last night, so clearly, I'm not going to perform well," and then that sets what the performance is.

So, I believe very strongly that the outcome is what you believe it will be. And you then use the symptoms as an excuse or as an explanation. So, "Gee, I didn't feel good during this race. No wonder I ran so poorly." But the reality is that you generated the symptoms yourself and they are there for use to condone what you did or to justify what you did. I have this really interesting explanation for why does an athlete comes second, and particularly, if it's a close race. And in my view, the athlete who comes second justifies the performance by producing symptoms, which are more severe than there really need to be. So, you know, it's, "Oh, gee! I really tried my hardest, but I was exhausted." Well, in fact, that's a justification, and if you understand that those symptoms are generated by yourself, you realize how you could influence the outcome by believing you want to be more tired than you really are.

Armi Legge: I've done this with myself. I know at times, I used to believe like, "Oh, if I didn't sleep like eight hours, my performance will drop," and then at other times when we kind of block that out, it works. Could that work with other people too in like everyday settings? I know a lot of people will say things like, "Oh, if I don't eat for like in another four hours, I am going to lose all my focus and I won't be able to concentrate" and that kind of thing. Do you think a lot of that is they've just kind of entrain that belief that if they don't have a snack or something, they're going to go hypoglycemic or tired? Do you think overcoming that in their own minds could also be beneficial and an example of the Central Governor Theory?

Tim Noakes: Well, you're talking about the negative placebos, it is no. That's the opposite placebo. They're setting themselves up for failure. I can't explain that and what you believe is what the outcome will be. That's how the brain functions. And if you believe something enough, that's what the outcome will be. So, how can you possibly go out and run, when you've got all of these thoughts, I'm not going to perform well today, how can you perform well under those conditions? You absolutely can't. And of

course, the old argument was, "Well, the muscles are determining it", but that's not the reality. It's your motivation and that's driving you through the Central Governor.

And if your motivation is low when you start and you're explaining why you're not going to perform well, well, the only thing the brain is going to do, it's going to do exactly as you wanted to do, and you're going to underperform. And the great athletes are the ones who never, never ever think like that. If I said please think like that, they'd switch it off immediately and correct their thinking. And I am sure you've dealt with some astonishing athletes in your time. But I have met the very, very best or different, and Mark Allen was one of the guys, the great triathlete, who was to me one of the great athletes I have ever met. Paula Newby-Fraser was another one because I helped her. She was a South African before she immigrated to United States. And, they didn't conceive that defeat was possible, and that's it. When they went to the start and Mark Allen had to learn because he lost the Ironman six times before he won it, but once he won it, he didn't go to the race believing he could lose, and Paula was the same. She didn't believe she could lose, and that's the difference eventually. They have such strong self belief that when they're running, the thoughts of failure just don't come into their heads.

Armi Legge: I'd like you to talk a little about some kind of weird and a little wacky examples of the Central Governor. One of the things I read about you that you discovered something called Anticipatory Thermogenesis. Could you explain what that is?

Tim Noakes: That was with my good friend, Lewis Pugh, who swam at the North Pole, swam one kilometer at the North Pole in his Speedo and with a cap on and gaggles. So, he was completely naked apart from the Speedo. And what we noticed with him was that before all the swims that we did, whether we did that in Cape Town in an ice bath or at the North Pole that in the last half hour or so before the swim, he would start to eat up and start to sweat.

And when I was dressing him at the North Pole in icicle conditions, he was actually sweating and that was because his temperature had risen from the normal of thirty-seven degrees Centigrade or ninety-eight degrees Fahrenheit, and it had risen by about two degrees Fahrenheit, in fact it was more, it was more like three degrees Fahrenheit. So it went up to 38.4 degrees Centigrade, and that's made a huge difference to him because that extra degree allowed him to swim for about ten minutes longer in this very cold waters.

Now, are there examples of this happening? Yes, there are. There are certain bird species in Cape Town and elsewhere and one is the penguin, which is a very big fat bird. And when it goes up and swims in cold water, it doesn't heat up before.

But there's another diving bird called the cormorant, which is very, very thin and you can tell when the cormorant is about to go out and start fishing and diving for a fish because its body temperature rises and when it's gone about two degrees higher than normal, then the bird will leave the nest and fly out and go and start fishing. So that's the Anticipatory Thermogenesis, and it has a role in that it allows the birds to dive for more fish before they get cold and have to stop.

And the same with Lewis Pugh, it allowed him to swim for an extra ten minutes at the North Pole, and that ten minutes allowed him to finish the one kilometer. There are other very famous examples of Tibetan Monks who use this and they thought themselves how to do it. And so, you can put a wet ice cold towel on the back of a Tibetan Monk overnight, and they would generate enough heat to dry that blanket or that towel overnight, and that's a well-described phenomenon. So, probably, many people can do the Anticipatory Thermogenesis, but if you want to be a long distance swimmer, it certainly would be helpful if you can do it.

Armi Legge: One of the people I have read about is Tim Ferriss, and I don't know if you know him, but he's the scam biohacker entrepreneur guy. He is a very interesting guy. And, one of his recommendations for weight loss and fat loss is to put ice packs on your shoulders to increase your body's thermogenesis and fat burning. Do you think that is an effective or could be an effective method? And do you think it might be explained by the Central Governor Theory?

TN: I know Tim quite well. He actually came to South Africa and we did some tests on him and helped Tim with some things. The reality of weight loss and weight control is that, if you use those mechanisms, the body will compensate and you'll either eat more or you'll do less exercise. So, the body is a

homeostat as far as its body weight goes, and that is also a Central Governor mechanism, but it's related to activity and the food consumption and why all of the advice on nutrition fails is because it doesn't include the brain in the models. So, you have to put the brain in, and the brain acts through appetite.

And, and if you want to lose weight, you have to get the diets that will associate you and, and allow you to eat fewer calories. And for many of us, the only diet that allowed that to happen is a high-protein, high-fat diet. And in contrast, the high-carbohydrate diet stimulates appetite and stimulates overeating. So, Tim would be advised to tell people to look to their nutritional and the macro-nutrient composition of the diet. And if you want to lose weight, and if you're a runner, eating a high-carbohydrate diet will prevent the weight loss. All that happens is if you're eating a high-carbohydrate diet, you can run all day and all night, and you will simply eat more and you'll never lose weight.

If you want to lose weight and run, you've got to change your diet and reduce the carbohydrate content and then the brain becomes a better controller and it allows you to do more exercise without stimulating your appetite to eat more. And you'll eventually reach a steady state depending on how much carbohydrate is in your diet. If you want to then reduce further, you have to reduce the carbohydrate content from the diet further. So, that's the real information you need if you are an athlete.

The brain is absolutely involved in the regulation of your body weight. You can't fool it, but what does fool it and disturbs it and makes it unable to regulate your weight is forcing it to eat more carbohydrate than your body can tolerate, and that's because we evolved as hunters and our gut is designed to process protein and fat and the liver and the rest of the body is not designed to process glucose rushing into it from high carbohydrate meals, particularly refined carbohydrates, that's what the body can't cope with.

The fact that there are athletes like the Kenyans who can survive on a 75% carbohydrate diet doesn't change the reality. They are genetically different and the runners are a small population who can cope with the high-carbohydrate diet. But for many of the athletes I deal with whose body mass index is a little bit over 25, it's like 27, 28 and they do all this training and they can't get their weight down and they wonder why, so they say, "Well, I must run more". They've got to change the carbohydrate composition of their diet. As soon as they reduce the carbohydrate content, the weight will come flooding off.

Armi Legge: Speaking of brain when it comes to weight loss and using the Central Governor Theory for that kind of thing, my friend Dave Asprey, who does the show with me, he eats about 4500 calories a day, between 4000 and 4500, he hasn't done exercise for like two years and he is still pretty lean and he eats a modified Paleo diet that's very high in fat and protein and very low in carbohydrate. Do you think part of the reason he is able to do that is his body has adapted to a larger caloric intake?

Tim Noakes: Now, that's a very high caloric intake.

Armi Legge: Yeah.

Tim Noakes: It's twice as what I eat and I'm 84 kilograms, and I don't know what his weight is, but that's a huge intake. So, the prediction would be that he would have to be doing three or four hours exercise a day to balance that up. So, if he's not doing three or four hours and he's balancing his nutrition on that, then it's really interesting.

But if you're not eating carbohydrate, you know the theory is you can afford to eat as much as you like of protein and fat. But, if he has changed his diet, I would predict that if he was eating 4500 calories of which 50% was carbohydrate, he wouldn't be able to maintain this body weight on that.

Armi Legge: I think he would agree.

Tim Noakes: I mean the whole theory of the high-protein high-fat diet is in fact you don't have to restrict, you can eat as much as you like and you don't put on weight, and it is the carbohydrate content that drives your weight up.

Armi Legge: One of the other interesting theories I think relates a lot to this, I know we are getting close to the end, but I just thought you'd find this really interesting, is the Theory of Food Reward and it's the one that's been becoming more popular. It's basically then put together mostly by a guy named Stephan Guyenet. He writes a blog called wholehealthsource.blogspot.com.

And what they found in past studies is, I think there were some studies in 1950s where they had these people eating diets that had no stimuli whatsoever. They were bland like they're drinking out of these liquid tube things that had no flavor, no texture, no smell, no color, and they put obese people on the systems and after, I think, about four weeks or four months, but either way, the people were eating like two to three hundred calories a day and they said they felt completely satiated and their weight continued to drop and everything.

So, the metabolism wasn't slowing down and the idea is that the stimuli in the diet like super satiating foods and these refined foods raise to the level, which the body likes to maintain body fat. And by removing those, it tricks the brain into trying to lower its own body fat. Have you heard of those?

Tim Noakes: No, I haven't heard of that theory, but I mean, if that's what they've found. But again, I would guess that they were low-carbohydrate diets. So, to me, the easiest explanation for obesity is that it's a function of how sensitive your fat cells are to insulin and how sensitive to glucose and insulin your muscles are. If your muscles are highly glucose sensitive and insulin sensitive, when you take lots of carbohydrate, you will distribute that into the carbohydrate reserves without requiring much insulin and so you won't grow fat.

The problem arises if you have resistance of the muscles to take up the glucose and the insulin, and so you over secrete insulin. And on top of that, you have fat cells, which are highly sensitive to insulin. Because in the face of glucose and insulin, the fat cells, if they are sensitive will simply just grow and become huge. There is something about repeatedly stimulating these fat cells with glucose and insulin that makes them get bigger and bigger and bigger, and that makes you hungry and want to eat more and also to become physically inactive.

So, in my view, the simplest understanding of obesity is how sensitive your fat cells are to glucose and insulin. And if you have very sensitive fat cells, you will become obese if you eat a high carbohydrate diet. If you have fat cells that don't respond to glucose and insulin, you can eat all the carbohydrates you like and it will not have any detrimental effects on your fat stores and then because of that on your health. So, I think the individuality of the response to diet can be explained almost – Well, again, let's say, not almost entirely, but a large portion of it can be explained by how sensitive your fat cells are to glucose and insulin.

Armi Legge: Cool! Thank you very much for talking about this, Tim. I know we went a little over our time, but I just loved talking to you man. You're awesome. So, if people want to learn a little more about you, are there any books or anything that you would recommend they check out or any websites?

Tim Noakes: Well, thank you for asking, but obviously, Lore of Running tells you a little bit, but my scientific autobiography is coming out in three weeks' time and that's a history of all the ideas that we've developed and tested and the reasons behind them, and the book is called Challenging Beliefs. So, it's going to be published in South Africa and released in three weeks' time. So, that will give people an idea of who I am and why I think as I do. Then in June or July next year, I've got a book coming up called Waterlogged and that is a history of the changing advice athletes are being given about drinking during exercise and the role of dehydration and so on in performance. So, we're hoping that that's going to be out in June next year, but it's a lot of work to get it out.

And then finally, you could check the website of the Sports Science Institute of South Africa and that's where I work. We have a website out there, which will indicate what work we're doing and what our researches is about.

Armi Legge: Well, Tim, thank you so much. I'll make sure there's a link to everything we talked about in the show notes. Oh, I'd love to get you back to talk about hydration in sports as well.

Tim Noakes: It will be a great pleasure, Armi. I think that we have a lot to talk about there as well, so I really enjoyed this and thank you for having me on your show.

Armi Legge: Oh, thank you, Tim. Have a nice day.

Tim Noakes: Thanks so much! Bye bye!

Biohacker Report

Dave Asprey: This is the part of the show where we bring you some of the latest researches that caught our attention. The first study that we came across was called "*Why we crave creativity but reject creative ideas*." This came out of the University of Pennsylvania, my Alma Mater. I'm a _____ grad, so I'm a UPenn guy. And what this study found was that the creative ideas are novel by definition, but that when people experience novelty, they get feelings of uncertainty, and they actually become uncomfortable. I experience this all the time when I walk into a room even in my work in computer security and I sort of mention, "Oh, yeah. I'm also a biohacker and I've upgraded my brain by many IQ points."

Now, I've done this sometimes to people who I think are open to creativity and I'll see them step back two or three paces and I'll get a look of alarm and, and I'm not trying to come on stronger, I'm just saying, "Look, I'm a creative person and this is what I do for fun, like this is exciting to me." It turns out that people who are attracted to the Bulletproof Executive idea and sort of ethic and says, "Oh, this is about self-improvement" and it's about, you know, not just sticking to what, what you see in a magazine article somewhere, but it's actually understanding how you're wired and integrating the cognitive and behavioral as well as the nutritional and the physical stuff in order to make yourself everything you can be to achieve what you're here to do. So, this is a really neat study from that perspective.

They also found that people have dismissed creative ideas in favor of ideas that are purely practical. So, you might have a creative idea, this is what we could save in ten years of effort, but they'll say, "Oh, this is tried and true method that takes ten years, it's tried and true." So we're just not even going to invest in the creative idea.

This dynamic, by the way, has fueled most of my career and this ties indirectly to disruptive technologies and the idea that the people who are creative and can push and sell and make that creative idea happen usually end up disrupting those people who do it the tried and true way. People who are bulletproof tend to be creative and they tend to be disruptive and that's a good thing. Disruption is fun.

They also found that if you produce major amounts of objective evidence that shore up the validity of your proposals, so you have a creative idea and you create huge reports and do studies that show it's going to work, that it has no effect on motivating people to accept it.

This means that if you want to sell your creative idea, it's about selling it. It's not about proving it. And most people who are engineering biased will think, "Oh, this is about proving it." And this anti-creativity bias is really subtle, so people aren't aware of it. So, they don't even recognize the creative idea, they just filter it out without ever thinking, "Oh, God! That's amazing." Really cool study. We have a link on our site. It's worth reading if you basically work in a field where you're trying to make things happen in a new way.

The second study is called "*Bacteria in the Gut Influence Brains of Mice*". And these scientists at the University of College Cork in Ireland found that a probiotic broth actually caused less fear in rats and that those rats showed less stress and were more adventurous. So, this is a great illustration of how important healthy bacteria in your stomach are. You actually perform better. You'll even have less nightmares I've noticed and I've seen some studies on that as well when you have healthy bacteria in the gut.

People oftentimes don't think about, it but you have more neurotransmitters in your gut including the intestines and even in your brain, and that there are strong connections between your brain and your GI tract and strong connections between your heart and your brain. So, if you are a purely rational person, you may think, "Oh, it's what happens with my brain and it matters." If you're a systems thinker or a biohacker, you realize that you cannot extract the brain from the gut and the heart and the peripheral nervous system and the autonomic nervous system and that they work in conjunction. And when you change one, you change the other. This is why I recommend taking a probiotic, but I also think it's very important, which probiotics you take because they have different effects on your health and it may also depend on your genetic makeup, which ones work best for you.

Armi Legge: All right. That's it for the Biohacker Report. Now, we're going to say goodbye and tell you where you can find out more information about Bulletproof exec.

Dave Asprey: All right. You can find links to everything we talked about in the Show Notes at bulletproofexec.com, that's like Bulletproof Executive but short for executive. If you enjoyed this, you can help by leaving a positive ranking for us on iTunes. If you twitter a link to this show along with your thoughts about it, we'll pick our favorite tweet to win a copy of Dr. Noakes' book when it comes out. If you'd like to learn more about biohacking, follow us on Twitter on @bulletproofexec and check the blog. If this was really useful to you, you can also consider ordering yourself upgrades from our small business sister site at upgradedself.com.

Take care, Armi. I'll see you soon.

Armi Legge: All right, man. I'll see you soon. Bye.