Dr. Tommy Wood: Enhancing Brain Performance & Preventing Dementia

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Dr. Andy Galpin
The science and practice of enhancing human performance for sport, play, and life. Welcome to Perform.

Dr. Andy Galpin
I'm Dr. Andy Galpin. I'm a professor and scientist and the executive director of the Human Performance Center at Parker University. In today's conversation, I'm going to be talking to my friend, Dr. Tommy Wood. Tommy has an undergraduate degree in biochemistry from Cambridge University, a medical degree from Oxford, as well as a PhD in physiology and neuroscience. Tommy is now running his neonatal neuroscience lab at the University of Washington. In addition to all that, he is a well-versed rower and strongman and has worked with athletes across every sport, and in particular, more recently, focusing a lot on Formula 1 drivers. And I say all this to help you understand that Tommy's ability to run back and forth between physiology and science and application into human performance is really unparalleled in the areas of brain health and cognitive function. So in our discussions today, we talk a lot about those areas.

Dr. Andy Galpin
We talk about how to enhance, understand, identify short-term cognitive performance, what that even means, what that looks like from an exercise and supplementation and technology perspective. And then we talk about how that looks in the long term. So how do we prevent and even deter or eliminate things like dementia and brain aging? And Tommy, over the course of our discussion, will bring up at least five points that I feel like are quite counterintuitive or, in other words, are going to surprise or potentially even aggravate some folks out there. The reality of it is, I don't think a lot of us truly understand the current state of the literature on both short and long-term cognitive function, and Tommy does a wonderful job in this conversation of bringing that to the forefront so we really are more understanding of what the literature says and how that transfers into practical application.

Dr. Andy Galpin
Another thing I think worth mentioning here that we get into, that I get asked about all the time is how things like exercise have a causal effect on brain health. And, of course, there's a

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correlation between strong muscle and physical performance and how well you age, but how is it directly impacting and how is that a causal, if it is at all? Tommy wonderfully walks us through all that in a way that I think everyone can comprehend and get a great grasp on. So with all that in mind, I hope you thoroughly enjoy this conversation today with Dr. Tommy Wood. Dr. Tommy Wood, welcome to Perform.

Dr. Tommy Wood
Thanks so much for having me. I'm really excited to be here with you.

Dr. Andy Galpin
There's a lot of things I want to get into today, things that you and I have chatted about before, but mostly things that I actually don't know the answer to. Hopefully, I can pry some information out of you about enhancing brain performance, things that we can do now in the short term, as well as long-term brain health. But I think before we can get to that, for my own personal sake, I know I say some of these things wrong-

Dr. Tommy Wood
Uh-huh

Dr. Andy Galpin
... so I'm hoping you can fix this. But maybe it would be best for us to just start off with what is cognitive performance? How do you define that? How should we think about it, and what are the aspects of cognitive performance?

Dr. Tommy Wood
I think one issue that's come up a lot recently in this field is that some of these things are actually very hard to define. So when we think about cognitive function more broadly, the way that we've traditionally thought about it is how do you perform on some standard cognitive test, like an IQ test?

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
And then there are tests for a whole bunch of other functions like executive function or response inhibition, trying to suppress the desire to make a response, which is an important part of planning, and the prefrontal cortex plays a big role there. Also testing working memory and all these other things that we might-- or our ability to learn and remember in short periods of time. And that's what we've had because that's what we've got. We have standardized tests. We know how you score compared to other people. We think we understand which parts of the brain are involved in those functions. But the real problem is that while they do relate slightly to the different functions you and I would want to do from day to day, that's an imperfect association.

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And beyond that, there are a whole suite of cognitive functions or things that we do with our brain that you can't really measure with those tests.

Dr. Tommy Wood
So part of the problem is defining what is it that you want your brain to do, and you almost have to become sort of your own baseline because I can test your executive function and I can test your working memory, but if you're an artist, those things don't relate to that at all. And you can do some standardized tests of creativity and stuff like that, but it's just not the same. So I think cognitive function, in reality, is very personal, and it depends on what you want your brain to do and when you want your brain to do it. But I think that if we're trying to define brain health, for want of a better word, it is having a brain that does those things. So some understanding of what you want to do, when you want to do it, and how can you support your brain in doing that.

Dr. Andy Galpin
Okay, so the way that I, pun intended, my brain puts this together- ... is I think about when I say brain health-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... I'm referring to do I have lesions in my brain?

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
Do I have brain damage? And then when I think of cognitive function, I'm usually thinking about performance, right? So reaction time, memory, word recall, executive function. Is that a fair way to characterize it, or should I add a third part there, or?

Dr. Tommy Wood
I think about brain health more holistically, and in reality, we know that structure and function in the brain are directly linked. The brain has quite a lot of redundancy-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... so you can lose function in an area and either recover it or maybe you don't even notice that that function is lost. So I wouldn't even necessarily separate them out in that way. I think it would depend on what you're measuring. So we can measure brain health based on an EEG signal, like different electrical activity in different regions of the brain, how those different networks are

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connected. We can also measure brain health in terms of, well, how do you feel today?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Because that's essentially an integrated output of all the different things that your brain is experiencing. So that's why I think about brain health more broadly. And that relates both to minute-to-minute performance and enhancing that, as well as what's your long-term trajectory of function and are you then at risk of significant detriments of function and dementia long term?

Dr. Andy Galpin
Right. Clearly, if I have some physical structure damaged in my brain, I won't have the acute performance either.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? I'm going to have some, however that may manifest itself. Could be any of the examples you said.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But does that work backwards as well? In other words, because I'm maybe having a hard time with some form of cognitive function, does that indicate some likelihood of actually having some structural damage as well, or is that street one way?

Dr. Tommy Wood
Because of the redundancy in the structural systems, you don't necessarily have a direct one-to-one connection. And you'll probably lose, or for some people, you lose some functions, or the functions decline before you can see, say, on brain imaging, oh yes, here's some atrophy. Here's some loss of volume or here's damage in a certain area. So I think that may just be partly because of the resolution of the things that we can measure. So maybe we get to a point where you have a really, really strong MRI, and we can see in very fine detail all the little blood vessels and all the small parts of all the regions of the brain, and then you could get a more direct connection. So I think they are very closely connected, and if you're losing a function, there's probably going to be a structural correlate of that. But in all likelihood, because function is also going to be driven by nutrient status, mitochondrial function, some of these other things, you might start to have issues with function before you see a structural issue on a brain scan or

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something like that.

Dr. Andy Galpin
Okay. If then that is true, if I improve some sort of, I'll just keep calling these short-term acute functionalities, how likely is that then to carry over into long-term brain health?

Dr. Tommy Wood
The way that I think about the brain is because I'm a bit of a meathead, as you know.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
I enjoy lifting weights, and the more time I spend studying the brain, the more the brain could be thought to respond similarly to, say, skeletal muscle in response to exercise. So all the things that you've spent decades researching, these processes are very similar in the brain. And what that really means is that function is driven by stimulus. Just like if you're trying to get strong and jacked, you need to apply mechanical tension to the skeletal muscle, right? Regardless of everything else that you do. And you can improve that response with sleep and nutrition and things like that, but no stimulus, no response. And the brain is essentially the same. And what you see is that when you stimulate certain networks or areas of the brain with certain activities, in response, you then see an improvement in structure because structure comes from that stimulus and then the way that the brain responds to it.

Dr. Tommy Wood
And the brain is capable of that pretty much throughout the entire lifespan.

Dr. Andy Galpin
That's really interesting because almost always when we hear this stuff talked about, we hear it in the sense of neuroplasticity.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? So you have a capacity issue, some neurological adaptation, which it is structural, but for the most time, we don't think about that as a structural change.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
We just think it as a functional.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? So you have a new capacity. Your reaction time is faster, your word recall, whatever, right? But what you're actually saying is there's also a, as noticeable physical change akin to muscle, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So when I train my muscle, I have neurological adaptations that make me stronger. I also have larger biceps. I'm not assuming I don't have a larger brain, right?

Dr. Tommy Wood
Well, obviously the space within the skull is limited, but to some extent, you do have a larger brain. And we know that with aging in particular, and as you follow a trajectory, say, into dementia, your brain gets smaller.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
You get atrophy of the brain. You can then see increases in the volume of the brain in response to certain stimuli. So you can get, particularly once the volume of the brain has started to decline as you get older, you can see then a response in terms of volume with certain stimuli. So that's not just neuronal connections, but part of it is, so you have greater density of connections, right? That's the neuroplasticity, new neurons talking to each other. Early on in the loss of volume of the brain, people think about neurons dying, but actually that happens quite late. What's happening is those neurons themselves are just shrinking up.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
So they're still there. They still have the capacity for function, but if you're not-

Dr. Andy Galpin
Atrophy before apoptosis.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And if you're not using them, right, they will then follow that trajectory. But that can be recovered. Plus, neurons make up less than 50% of the cells in the brain. You have multiple other cell types. You have a huge vascular network in the brain, and so when you're improving volume, you're also improving other cell types. The extracellular matrix is really important in terms of all the proteins that sort of regulate how the cells interact. So yes, you can improve volume. It's not just neurons, though. And I think often we focus on neurons, but really there's so much else going on at the same time.

Dr. Andy Galpin
Man, I'm totally guilty of that.

Dr. Andy Galpin
I know certain aspects of the brain change physically in a good or bad way in response to perturbations, but I just always give it the neuroplasticity twist.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
So I'd love to come back to that. I want to know more about it, but I got to ask, since we're right here I don't think there's any more debate, at least in my understanding of the literature, anymore about whether or not exercise and things like that are good for long-term brain health.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
What there is considerable debate on, though, is can you actually improve cognitive function right now? You said this earlier, if you want to do an IQ test and then I coach you on that IQ test, you will improve.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
You could probably pick about every metric in the brain possible, but that doesn't necessarily mean you're getting better cognitive function. It just means the brain is neuroplastic and it shows an adaptation response to stimuli. So I'm more interested in where you stand on that global argument. First of all, is there even an argument? Is it pretty well scientifically established?

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Where does that field lie? And then overall, tell me, can we actually improve cognitive function? And then for sure, if we can, I want to know how.

Dr. Tommy Wood
So again, it really depends who you ask and how you're measuring cognitive function.

Dr. Andy Galpin
I'm asking you.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
You tell me.

Dr. Tommy Wood
You're asking me, but if you were to sample a large number of cognitive neuroscientists, and even some of the people that I work with, some will say, "Yes, you can improve cognitive function," and some will say, "No, you can't." And this is partly driven by how we're testing it, which we've kind of covered. And yes, we know that people who spend longer in education, they have improved cognitive function, but part of it is just because they get better at taking tests.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Right? And when any study does longitudinal testing of cognitive function, everybody gets better, even the control group, because they just get better at taking the test. So then when you're thinking long term, which we'll come back to, I think there is a good amount of evidence that we can improve cognitive function when you're in a period of decline. But then if you're thinking right now, how can I improve my cognitive function? I think the way that I think about it is, again, related to skill development and what it is that we actually want our brains to do. And the human brain, more so than any other species, is evolved to adapt to the environment so that it can optimally perform within that environment. That means that whatever you want your brain to do, and if you train it in the right way, you will improve function, any skill learning, language, sports, and then when you've done that, you have improved cognitive function, right?

Dr. Tommy Wood
You're using your brain to perform some skill. You have improved at that over time, and your cognitive function has therefore improved. We also know that there's then carryover from specific skill learning to more broader cognitive function, particularly longer term. But if you define it that way, I think that we know that the process of skill development is the process of

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enhancing cognitive function, and then it's just a case of, how do I maximize that adaptation, and how do I maximize the expression of that skill once I've attained it?

Dr. Andy Galpin
Today's episode is sponsored by AG1. AG1 is a vitamin mineral drink with probiotics, prebiotics, and adaptogens. Initially, I was extremely skeptical of AG1, as I am with all supplement companies, but after months of discussions with their lead nutritional scientist and the general team at AG1, I've been impressed by AG1's commitment to sourcing the highest quality ingredients and constantly updating their formulas to have the right ingredients in the optimal amounts. AG1 also rigorously tests their products to ensure that every single batch is free of banned substances, allergens, heavy metals, microbes, pesticides, herbicides, residual solvents, and mycotoxins. It's even earned the prestigious NSF Certified for Sport third-party testing approval stamp. Now, most people in the performance space talk a lot about macronutrients, like protein, carbohydrates, and fats, and these are obviously critically important, but so are the micronutrients like vitamins and minerals.

Dr. Andy Galpin
And even if you're eating a healthy diet, it's often hard to get enough of these vitamins and minerals, along with the probiotics, prebiotics, and adaptogens to keep your body performing at its best. It's for these reasons and many others that I personally take AG1 almost every day. Now, it's of course, not a replacement for eating whole, healthy foods, but it is a great way to make sure that you're plugging in any gaps in your nutrition to improve your energy, bolster your immune system, and just generally help promote a healthy gut microbiome and more. If you'd like to try AG1, you can go to drinkag1.com/perform to receive five free travel packs plus a year's supply of vitamin D3 plus K2. Again, that's drinkag1.com/perform to receive five free travel packs plus a year's supply of vitamin D3 plus K2. If I want to improve creativity, just do more creative tasks.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
If I want to improve memory, practice memory.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
And this probably expands to any way we would define cognitive function-

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Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... for a normal, young, healthy person, right? So actionable step number one would be simply that.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
If you want to get better at writing, write.

Dr. Tommy Wood
Write more.

Dr. Andy Galpin
That was one of my favorite. I had a friend, several friends who are writers, and it's stunning how low energy, last minute that they can pull up, smash out 3,000 words.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
And you're like, "That would've taken me months to write," right? This is what they do naturally. That makes a ton of sense. Where is the broader applicability? Are there any maybe specific domains of cognitive function that have better transferability to others?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Are there any particular types, whether this is maybe exercise, nutrition, or brain training devices or tactics that have a more wide ranging and broader applicability, or is it all pretty much they're going to be good on their individual one and then have very little transfer?

Dr. Tommy Wood
So this is the principle of near transfer versus far transfer. So near transfer means that you learn to get good at the thing that you want to get good at, and then it doesn't really translate elsewhere. It's been the problem with brain training As has typically been done for the past few decades, and that's one of the reasons why people think you can't enhance cognitive function is because when you do brain training, what you get better at is just some version-

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Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... of the test. That doesn't then make you a better functioning person out in the real world. But if your near transfer is relevant to you, say it's writing or some other kind of specific skill or language, then near transfer can be enough. But we also know that if you're trying to think about far transfer, so improving some cognitive function that then translates to other cognitive functions, then activities that train certain aspects of decision making in the prefrontal cortex, they seem to be associated with some far transfer. Just you get better at regulating your own internal thought and decision making processes, and that relates to a wide variety of scenarios. Then some of the other things that you mentioned, like exercise is one that supports, and it's exercise specific, so resistance training and aerobic training have effects on different areas of the brain and they-

Dr. Andy Galpin
Both good but different.

Dr. Tommy Wood
Yeah, both good but different. But then that applies to functions more broadly. You're going for a run and that aerobic exercise is particularly good at improving certain aspects of memory, and so it doesn't matter what you're memorizing. Memory is broadly enhanced. So some of the lifestyle factors that we know are critical for brain health and cognitive function, they broadly support cognitive function as well as skill learning in the first place. But then some specific skills may be just related to that skill as you use it.

Dr. Andy Galpin
Okay. I'm going to give you a couple of avatars here.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And I'm asking this personally.

Dr. Andy Galpin
You've worked with athletes across, geez, every sport imaginable. You've worked with industry folks. You've worked with non-athletes. You've done concussion stuff. You've done aging stuff. So you're all over the map in terms of your skillset.

Dr. Tommy Wood
Mm-hmm.

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Dr. Andy Galpin
So with this, somebody comes to you and says, "Hey, look, my brain's healthy. I'm 40 years old. I'm not super worried about dementia and Alzheimer's, things like that. My lifestyle factors are exercise. I sleep well. I don't drink. I don't smoke," so on and so forth. "I don't have a thing I'm looking for. I don't know what I'm looking for. I maybe run a company, have kids," something like that.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
"What should I do to enhance my brain function right now?" And I can't define that. I don't know if that means I need to be creative. I don't know if that means I need to have more reaction time. Where would you start with that individual in terms of what you said at the beginning? You should make your own baseline test. What should I be thinking about? And are there some tactics where you say, "Okay. I need all the information. I would really need all," but maybe two or three things here to start off that generally work pretty well.

Dr. Tommy Wood
So generally, I'd think about when somebody like that comes to me, and they say, "I'm healthy. My brain works great. I'd like to improve it as much as I can or maintain it for as long as possible." The first thing is just to make sure if that first statement is true.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
And the easiest way to do that is with some simple blood tests, determine some-- Nutritional status becomes really critical for the brain. We can deal with poor nutritional status, and the brain works just fine early in life, but if you're trying to maximize everything, we know vitamin D, iron status, magnesium, B vitamins, omega-3s, some of these, and glucose regulation, or at least just making sure you don't have prediabetes. Some of the basics. I would just make sure that all of that is buttoned up, and that's easy to address.

Dr. Andy Galpin
Would you mainly say those are energy metabolism markers? As long as your energy metabolism's fine, you're probably okay?

Dr. Tommy Wood
So there's an interesting thing about energy metabolism in the brain and as it relates to brain structure as well, which is that it kind of follows a U-shaped curve. So at low levels of energy availability, we start to lose brain structure and brain function just because we don't have the

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energy to support it. And then we see a very clear energy toxicity effect as well. So if we have prediabetes, diabetes, lipid dysregulation, all the markers of energy toxicity, which are very, very common. Two thirds, if not more, adults in the US have some version of that. Then you start to see a decline in cognitive function and brain volume as well. So yes, energy regulation is really important, but some of those nutrients have their own effects in terms of brain structure as well. So if you think about the relationship between B vitamins and omega-3s, this has been shown again, and again, and again that they interact.

Dr. Tommy Wood
So if you have good status of one but not the other, you see no effect, and vice versa. And this is where we've had trials that say, "We give omega-3s, but they don't work," or, "We give B vitamins, but they don't work," but they haven't taken the other into account. And it makes perfect sense because if you want DHA, the long-chain omega-3 fatty acid, to sit in the synapse where you want it to help communication between two neurons, it needs to first get into the brain, and that requires usually healthy insulin sensitivity and energy regulation, and then it needs to go down the path of being attached to some kind of phospholipid. So choline, or serine, or ethanolamine. So you need that to be available, and then you need methylation to work so that these things get attached together, and that's where the B vitamins become important. So some of these things are directly structural, as well as being functional, thinking about energy and mitochondria.

Dr. Andy Galpin
I don't want to lose the plot. I'll come back to our avatar here in a second. I have many follow-ups to that. I'll ask just one, though. I don't think people would've assumed you can get a reasonable assessment of short-term, immediate, acute cognitive function from blood.

Dr. Tommy Wood
Mm. So Right now, you probably can't. You and I are in the process of developing what should be a fairly simple blood test that relates directly to cognitive function, dementia risk, also mortality risk. But like I said, critically, cognitive function right now. It's not going to be perfect.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
But it does relate generally to nutritional status and energy status, which makes perfect sense. So on top of that, I think you could really button up the details with making sure that you have all your nutrient ducks in a row. But in reality, if you were going to try, at the population level at least, try and predict somebody's cognitive function, you could see if they have prediabetes or any kind of nutrient deficiency, they're going to have lower cognitive function, and there's

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dozens, hundreds of studies that show that.

Dr. Andy Galpin
Do they need to necessarily be at a technical deficiency there, or if they're say a bottom 10th percentile, they should pay attention? Do we have any insights into where those cutoffs start to lie for these metrics?

Dr. Tommy Wood
Yeah. You're right that in general, what we consider to be a deficiency nowadays is usually you're below the normal range, right? You're in the bottom 2.5% of some nutrient marker and you're going to have some ... Your day to day cognitive function is not your main issue. There's going to be even bigger-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... problems than that. But there are some cutoffs for all of these things. In general, say blood sugar regulation, you want to make sure that normal fasting blood sugar, not prediabetic. Beyond that, there's probably not that much benefit from being lower than that, but something like homocysteine is a marker of methylation status. Generally, if you went to a lab, the normal range is 13, 15.

Dr. Andy Galpin
Five to ... Like bottom end-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... five, high end-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... 13, 14, 15.

Dr. Tommy Wood
And most people will say you target below 15. In terms of cognitive function, it probably needs to be less than 11. Some people would go a little bit lower than that for things like cardiovascular disease risk. But then, similarly for omega-3 fatty acids, if you do something like the omega-3 index, you probably want to be ideally over 6%, maybe closer to 8% or higher. And like I said,

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those two things interact.

Dr. Andy Galpin
Yeah. I would say that in our experience, if you are above nine to 10-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... for homocysteine, we're looking very seriously at other things.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And an omega, you'd be surprised how many are under five.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Very commonly. This is why you see in those folks a little bit of basic multivitamin and omega-3 support, and all of a sudden, the brain fog is gone.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
The decline, it just disappears-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... from these people really quickly, which is really of no surprise. So, coming back to us then, we check those blood markers, then what for that?

Dr. Tommy Wood
So, then you can make sure that the other lifestyle factors are all in a row. And when we think about long term cognitive function, there's kind of a framework for thinking about that.

Dr. Tommy Wood
So, sleep and all these other things, stress mitigation. I definitely look at all these other lifestyle factors. But if you're thinking about enhancing cognitive function-

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Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... like I said earlier, I think stimulus is really the most important thing. Your avatar probably has quite a cognitively stimulating job, which we know increases long term cognitive function and decreases the risk of dementia long term. So then I would think about a lifelong plan of ongoing broad cognitive stimuli. So if he's never played a musical instrument, he learns to play a musical instrument. If all his exercise is in the gym and it's unimodal, then he picks up an open skill sport. He goes to play pickleball or learns to skateboard.

Dr. Andy Galpin
God forbid, no more people playing pickleball. Don't do that, Tommy.

Dr. Tommy Wood
If he has never spoken another language, then he learns a language. Some of these things, it's interesting when you look across the literature, the one activity that probably ticks a lot of these boxes and seems to really support cognitive function as well as mental health is dancing.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And because that brings in play, it's an open skill, there's music, it's social. So a dance class with his partner-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... would be a great way to integrate a bunch of these things together.

Dr. Andy Galpin
Cognitive demanding.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
What does that actually mean?

Dr. Tommy Wood
That's a question that I actually can't answer. I talk about cognitive demand a bunch, but in reality, we don't know. It's a theoretical concept because we could put you in an MRI scanner

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and we could see which areas of your brain become active, or we could do the same thing with EEG. But in reality, how do I quantify the stimulus that's being put on you compared to somebody else? We can't. What's the equivalent of volume in the brain compared to, say, lifting weights, where I can quantify how many bicep curls did I do, what was the weight? You could look at velocity and all these other things. We can't do that with the brain. So yes. And so I kind of hope that one day we'll be able to quantify that, so then we could say this is the cognitive demand that you're getting. This is the stimulus, and this is the adaptation that we expect to see. But right now, some of it is still a bit theoretical.

Dr. Tommy Wood
And when you think about cognitive stimulus and cognitive enhancement, one of the reasons why there's so much controversy is because it's actually quite a young field.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
The cognitive enhancement field is where exercise science was decades ago, four or five decades ago maybe. So the principles all make sense. You can see it happen in animal models. You can measure the fact that these neurons were activated. But how you truly dig down and quantify the networks being activated, and the level of that activation or maybe what's required in order to see a response, that's something that still needs to be worked on.

Dr. Andy Galpin
Dance makes sense to me because you didn't say these words, but sensory input is a huge impact-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... here, right? So proprioception, in the case of dance, it is hearing, you're feeling the other person probably, you're feeling the ground. You don't want to step on toes. It is rhythmic. These are all different parts of the brain-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... if that's a fair way to say it. And now you also have memory. It's this step and this step-

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Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... and this step, right? Plus improvisation. All the four or five different areas immediately make sense. When you think about something like, let's just say pickleball.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
You said earlier, if you are a skilled pickleball player, then the act of playing pickleball is not as cognitively demanding, I'm assuming-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... as it was the first week you played.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Right? Now there's still some because you're reacting to the external environment, change of direction. This is proprioception. Where am I at in space? What shot am I going to make? What's the score? All those things, right? But it's not as high as it used to be the last time because parts of that experience now of where to put your hands, how to swing your technique, have been now pushed to, we'll just call it subconscious, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
This is learning.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
This is how you get better at sports, right?

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
Where the cognitive demand piece to me sits a little bit differently. Again, I don't know if I'm actually thinking about this correctly because if I think about a day-to-day work experience for me, the dance thing makes sense because of all those different sensory inputs. When I think cognitive demand, I'm thinking some sort of difficult mental task.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
I'm not thinking like a physical body movement, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So I'm thinking if I'm reading a scientific paper, that to me feels like a high cognitive demanding task. But in reality, I can do that scrolling my phone pretty quickly. Hubris aside here, it does not take me long to scroll through a paper anymore and get the gist of do I buy it, do I not buy it, shoddy paper. Where other folks, I certainly would say myself as a graduate student, like the whole day-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... reading every word, right, to get the gist of it. Is it just something that is a generally hard task? If I'm doing, if I'm writing, is that always going to be a high cognitive demand? If I'm sending an email, is that always going to be low?

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
I know, for example, just speaking from my relationship, if my wife gives me information about something with the kids from school, that's the highest cognitive demanding effort I will have in my whole day. I'm like, "Wait, who? What's the kid's name again?" I have to drop everything and completely pay attention, or else it goes to zero.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
The next day she'll remind me, and I have zero recollection. If she listens to this, she's going to die in anger listening because she's like, "Yeah, it's infuriating." She does the same, by the way. So to the point of saying, is it the task itself? Is it novelty, as long as I'm doing something different? Where do we know that something is cog-- Or where can we get closer to guessing?

Dr. Tommy Wood
So novelty plays a big role, and it's probably because novelty drives attention and focus.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
And if you're actually going to respond to a stimulus, you need to direct attentional resources to it. So then difficulty becomes important as well. So it should be challenging, and you should be giving it your full attention and focus, whatever it is. And then those are probably some of the prerequisites in order to see some kind of adaptation in the brain. How you subjectively feel about a task being difficult, although I'm a big fan of the subjective for a lot of things, in this case, it doesn't really work.

Dr. Andy Galpin
Really?

Dr. Tommy Wood
And it's probably because of the way that we use our brains nowadays. What you mentioned earlier, listening to your wife talk about something to do with the kids, and you said the only way that you can actually internalize it if you give her your attention. So what that tells me is what you're doing is multitasking. And you're not actually multitasking. What you're doing is task switching. So you're trying to pay attention to this thing in front of you right here, and then you're trying to pay attention to her, and there's a cost every time you do that because you have to refocus. And what happens is essentially you're not doing either, or you're doing both or three things very poorly.

Dr. Andy Galpin
I think I set the world record for highest task switching cost ever. If I have to task switch like that, I have to literally sit down, I'm like, shake my head. I'm like, "Okay, hold on. Give me a minute. Okay, what?"

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
The lag, it's like a bad video game. It's so long on me when I switch tasks. I'm just like . I focus my whole day on not doing that-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... because it is so catastrophic for me to have to do that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I can do the task, but I'll have no memory of it.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It'll be gone for forever.

Dr. Tommy Wood
I'm actually very similar. I am a terrible task switcher, and my wife always jokes I'm a terrible multitasker. And recently, I've leaned into it.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
The human brain cannot task switch like that efficiently. People just can't do it.

Dr. Tommy Wood
You may have to be able to navigate that for your job, but in reality, work by Gloria Mark shows how constant task switching is very stressful. And every time you switch a task, you have that cost of time, as well as the fact that if you're distracted from a task, it may be a long period of time before you ever return to it. And during that whole period of time while you're not doing the task that you actually want to be doing right now, there's this sort of underlying simmering stress because you know it's there, but you're not doing it. So I think a big part of this is that multitasking, as we call it, or task switching, which is very common now, email to this document you're writing to social media.

Dr. Tommy Wood
It's what a friend of mine, James Hewitt, calls the cognitive middle gear, and you kind of imagine

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it. So I'll keep going over to my terrible exercise analogies, but it's kind of like spending all your time at threshold It's incredibly physically tiring, but the adaptation you get from it is kind of disproportionate to how much it drains you.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Right?

Dr. Andy Galpin
Yep. This is the last couple of sets that you did where you got nothing different-

Dr. Tommy Wood
Uh-huh

Dr. Andy Galpin
... but you got high fatigue.

Dr. Tommy Wood
Yes, exactly.

Dr. Andy Galpin
Super fatigue.

Dr. Tommy Wood
And you're doing that with your brain all day.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So what you really want to do is to try and periodize that as much as you can, right? So you have your periods of intense focus, intense cognitive performance, and that's your deep work, the time when you really need to get stuff done. And then the rest of the time, you're doing your zone two brain work. And that can be answering emails, some of the basic stuff. As soon as you start to do a ton of those things at the same time, you start to sort of head back into middle gear. But you kind of have to think about almost polarizing your brain use just like a lot of people might polarize their training.

Dr. Andy Galpin
Your lab does mostly neonatal stuff-

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Dr. Tommy Wood
Yes

Dr. Andy Galpin
... right? So your actual scientific time is mostly spent in young developing brain.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? You've clearly done work across the entire lifespan. Does that task-switching energy increase as you get older? Because I feel like when I was a kid, I could task switch immediately. I don't actually have a recollection of it being a problem as a grad student.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But now I'm like, "Oh my gosh, just detrimental." And why I'm asking that is I'm wondering if that is the case, could that be explaining some part of people feeling like they have cognitive decline?

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
Feeling like their energy's lower throughout the day, feeling like their brain fog is hitting now, when in reality they're just burning more gas and they had no idea.

Dr. Tommy Wood
Yeah. Particularly early on in life, I think the brain interacts with the environment in the way that we should be doing as adults and we're not doing. If you watch a kid learning how to walk, that is all their focus on.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Right? And essentially for the first 30 years of life, the brain is continuing to adapt and mature, and it can still respond to stimuli after that, but it takes almost half our lifetime for the brain to finish adapting to its environment. And that adaptation is driven by learning these skills, social interaction, language, motor skills. But particularly early on, that's all the brain is focused on doing, right? I'm going to spend this next 10 minutes trying to stand up, and then I'm going to take a nap.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And my brain is going to start to figure out all the inputs that it received during that period of time.

Dr. Andy Galpin
I've had some days like that. No doubt.

Dr. Tommy Wood
Even now.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And so then as you get into the teenage years, I think that you're right. Kids seem to be able to jump back and forth continuously, and that probably is that they are better at focusing their attention very quickly. And I think that's partly because all the other things that we have to deal with when we're older-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... aren't in place. So a lot of what happens as we get older and we think that our cognitive function is diminishing is actually just a product of the environment, as well as the fact that we're not focusing on tasks in the way that we should in order to maximize the benefit from them. So when you're trying to learn a new skill in your 40s, you obviously have less time to do it. You have kids to worry about. You probably didn't sleep very well. You're stressed about your job and all these other things. And then you say, "Oh, I just can't learn a language like I could when I was a kid." But when you're a kid, you have nothing else to do.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Right? You have your French class three times a week, and all you're doing in that class is learning French, and you're dedicating, whether or not you enjoy it-

Dr. Andy Galpin
Sure

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Dr. Tommy Wood
... or you actually paid attention at the time, right? But you have these focused periods to just work on learning the skill, whereas you're learning French as an adult, it's like, well, I'll do 10 minutes of Duolingo while I'm sat in traffic.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And then you wonder why you're not learning French as well as you could when you were younger.

Dr. Andy Galpin
Right.

Dr. Tommy Wood
And some of these adaptations do slow over time, but it's not that the adult brain can't do it. It's that we're not actually applying the principles that we did when we were younger in order to learn these skills.

Dr. Andy Galpin
Today's episode is sponsored by LMNT. LMNT is an electrolyte drink mix that has an ideal electrolyte ratio of sodium, potassium, and magnesium, but no sugar. Hydration is critical to performance, both physical and mental performance. Countless studies have shown that even a slight degree of dehydration, even as small as 1%, can lead to decreases in physical output and mental performance. We also know that electrolytes are critical to proper hydration, which I've been harping on for years. But you can't do that proper hydration by only drinking water. You need to get the right amount of electrolytes in the right ratios, and that's why I'm a huge fan of LMNT. In fact, many of you will probably remember that I featured LMNT in my YouTube series on optimizing hydration nearly five years ago. I featured LMNT in these videos because their blend of 1,000 milligrams of sodium, 200 milligrams potassium, and 60 milligrams of magnesium really is unique and different than any other electrolyte on the market, and it has great scientific support.

Dr. Andy Galpin
I use LMNT constantly, particularly when I'm sweating a lot, and I routinely make it a part of my clients' optimization programs. If you'd like to try LMNT, you can go to drinkLMNT.com/perform to claim a free LMNT sample pack with the purchase of any LMNT drink mix. Again, that's drinkLMNT.com/perform to claim a free sample pack. Okay, so making sure that we are trying to focus on singular tasks at a time and having potentially a little bit of a buffer When we switch from one to the next in terms of expectations.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? We're not going to be on the next one quickly. So if we go to our 40-year-old, and we're back on this avatar, he's saying, "Okay, I just kind of want to enhance my brain function there."

Dr. Andy Galpin
I drug us off track there pretty quick. So coming back to that, what would be, again, your recommendations of things to think about, stuff that he could generally try? You mentioned learning a new language-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... Duolingo. Are there any other specific brain training things? Do those things work? I guess we'll even start there.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Nutrition, supplementation, nootropics. What are things we can do in that? Again, I'm not diseased-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... I'm not hurting. We'll get to that later. Just feeling pretty good.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
What can I do to make my brains gains?

Dr. Tommy Wood
I think most brain training as it currently exists is probably not enough for us to see significant file transfer. And again-

Dr. Andy Galpin
In that person

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Dr. Tommy Wood
... in that particular avatar. I think we're now starting to see a revolution in VR, particularly in AR, where that might start to change, and you have very complex environments that you have to navigate and problem solve within, and these are some of the things that the brain thrives on. And they're delivered via the eyes, which is one of the primary stimuli that drives neural organization and then all the downstream consequences of that. So compared to looking at puzzles on a computer screen, having some in-depth audio and visual stimulus in a virtual reality environment is much more similar to the way that we normally develop complex skills and drive brain development. So I think we're going to see more and more of that coming online. Even in regular adults, and actually in kids and older adults, the current technology for, say, video games, when in, say, a complex 3D environment, there's been a bit in VR so far, research.

Dr. Tommy Wood
I think that's going to really explode over the next few years with all the devices that are now available. But even I think the game that has the most research is Super Mario World 3D. And people who play Super Mario World 3D for a few weeks compared to something like Tetris or Solitaire see greater improvements in certain standardized cognitive function tests. So even that kind of new complex world, a lot of orientation, puzzle solving.

Dr. Andy Galpin
High effort, high focus.

Dr. Tommy Wood
Yeah. And you're going to die if you're not actually paying attention.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Whereas, and probably the same in Tetris, but not in Solitaire. And actually, with increasing complexity, you see increasing improvements in cognitive function. So providing these complex, multidimensional, and multisensory inputs, I think we already have some evidence that that can improve cognitive function in healthy adults, and I think we'll only see more of that in the next few years.

Dr. Andy Galpin
You just gave every sub 50-year-old permission to tell their parents, "I told you so. I told you the video games were okay for me."

Dr. Andy Galpin
Fair characterization or no. If cognitive function is low, either maybe young or old or aging, something like a puzzle, brain training, BrainHQ is probably the-

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Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... most studied one.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Many randomized control trials potentially can help.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
However, if you are kind of normal to above, going past that, that's just not cognitively demanding.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Most likely not, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So now you have to get into situations where, again, you care more or there's a heart rate elevation.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
There's some other functional physiological demand that provides enough of a stimuli to cause adaptation. So video games of that ilk, I'm sure there are plenty of other ones-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... but you get the concept, right?

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It has to be all those things you laid out.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
This is where something like a dance would also then fit in, right? Learning a new skill, presumably rock climbing or surfing, where your environmental exposures-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... and temperature changes are great activities.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Combat sports of course are fantastic for this.

Dr. Tommy Wood
Just don't get punched in the head too much.

Dr. Andy Galpin
Too much. Yeah.

Dr. Andy Galpin
What about from a nutrition side, supplementation side? Is there anything you can do? Or on the inverse of that, is there anything that you just have to avoid? Are there particular nutrients or styles of eating that are really bad for the normal, non-diseased person, or what do we know about that side? Outside of energy toxicity-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... which you talked about long term was a problem.

Dr. Tommy Wood
Yeah. So in reality, the answer is no, there's nothing that anybody has to avoid. There's some

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reasonable observational epidemiological evidence to say diets high in ultra-processed foods, which that classification is problematic because it includes-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... protein powder, which I would happily recommend to people, but also Twinkies, right?

Dr. Andy Galpin
Sure. Look, we can be pedantic about this.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
But a diet high in you fill in the blank here-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... probably not good.

Dr. Tommy Wood
Yeah, exactly.

Dr. Andy Galpin
Okay. I don't know if we have the direct mechanistic research on that for this question, but we don't have to stretch our imaginations far to say there's so many other reasons-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... why you should avoid that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Okay.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
So outside of that.

Dr. Tommy Wood
Yeah. And then that's a lot of the downstream effects of that are driven either by nutrient deficiencies or energy toxicity, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So the things that we've already covered. In terms of supplementation, it then probably becomes a case of what is it that you're trying to achieve and when are you trying to achieve it? So I think in healthy individuals, in athletes, we see some interesting improvements in broad cognitive function with, say, creatine supplementation.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
Particularly in aspects of memory So that's something that's always high on the list. Everything else that I think would go on the definitely take could also be related to the nutritional piece.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So magnesium status, vitamin D, all those other kinds of things.

Dr. Tommy Wood
When you're then thinking about, say, supplements or nootropics, often what you see is that there's a trade-off, that you enhance one function at the price of another. And that's fine, but that has to be a choice. You can't just take these things and think, "I'm going to be better at everything," because the brain doesn't work like that. Well, nothing in physiology works like that generally.

Dr. Andy Galpin
Yeah. No free passes.

Dr. Tommy Wood
No free passes, no biological free lunch. So then, it's just going to depend on what you're trying to achieve. So if you've had issues with sleep or stress long term, then there are interesting things like theanine, ashwagandha, KSM-66. They seem to improve stress and also cognitive

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function in those settings.

Dr. Tommy Wood
If you're thinking about trying to perform in the moment in a given sport, so I can use Formula 1 as an example. We've worked with multiple drivers who, because of their engineers and the teammate they're competing against, one of the metrics that you can easily see, they show it on the TV right at the beginning of the race, is reaction time. So how quickly did this driver get off the line?

Dr. Tommy Wood
When you try and increase that or try and decrease or improve reaction speed, decrease reaction time, then there are some, the supplement that would first come to mind is caffeine.

Dr. Andy Galpin
Yep.

Dr. Tommy Wood
Right?

Dr. Andy Galpin
No doubt.

Dr. Tommy Wood
And it works. We know that caffeine improves psychomotor vigilance, and it improves reaction time. However, we also know that at higher doses, caffeine decreases complex skill ability and decreases certain aspects of executive function.

Dr. Andy Galpin
You couldn't imagine any scenario in which you would want to be driving 200 miles an hour on 1,000 milligrams of caffeine.

Dr. Tommy Wood
Yeah, absolutely not.

Dr. Tommy Wood
But it's been done, or it's been tried, and you'll see a great reaction time off the line, and then you're trying to navigate the first corner at 200 miles an hour or 150 miles an hour-

Dr. Andy Galpin
No way

Dr. Tommy Wood
... with 90 other cars around you, and you'll plow into the first corner.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So this then comes into the idea of getting into the right window of arousal for some given cognitive task, and we can use supplements to do that. But we can also use breathing techniques, exercise to kind of modulate some of that. So there are some supplements and, depending on the task, maybe caffeine is the right one. For most people who are habitual caffeine users, you're generally just reversing the deficit caused by a caffeine deficiency at the moment-

Dr. Andy Galpin
Mm-hmm

Dr. Tommy Wood
... rather than enhancing function, which is fine.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
We just had coffees before we came in here, right?

Dr. Tommy Wood
But then beyond that, it's going to really depend on the task, and that's largely going to be related to arousal, what level of arousal is going to be ideal for the task that you're trying to perform, and each task is probably going to have a different ideal level of arousal.

Dr. Andy Galpin
It's really interesting you say that because with all the athletes we work with, there is a spectrum of caffeine use.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
Not only within the person to person that happens, but I mean as a categorically between sports. If you take, for example, our NFL players, they generally are on a pretty high dose of caffeine.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
It's a cognitive sport, but our golfers, absolutely not.

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Dr. Tommy Wood
Oh, yeah.

Dr. Andy Galpin
Maybe a cup in the morning or something like that, and that's it. Maybe 50 mgs or something like that, some little top off, but they can't have that kind of neural control on very much caffeine-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... at all. Many of them are just no caffeine, period.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Some of our fighting sports, they can be a little bit of a mix depending on what kind of a fighter they are.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
But they can be on all kinds of different areas of this. I know personally, I'm kind of on the golf world. I generally like one shot of espresso.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
That is good for the day, just kind of moldering around a little bit. If I have afternoon, I want decaf or quarter caf, then I'm like, "That's perfect for me." I have other friends who are the opposite.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It's just like six, eight, 10 servings a day, and they're going. If I use almost any form of nootropic-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and I've probably tried a dozen outside of caffeine and nicotine, I can't get a word out.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
My cognitive function goes to zero. If I do a 10th of a serving, I just can't use it at all. But I'd say 90% of the people we've coached with Alpha GPC or things like that have a positive experience.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So Dr. Wood, why can I not think straight? I have to think about every word that comes out of my mouth if I do the smallest half dose of Alpha GPC.

Dr. Tommy Wood
That's a really great question, and the answer is, I don't know.

Dr. Andy Galpin
What the

Dr. Tommy Wood
A lot of people I know really like-

Dr. Andy Galpin
I've been wanting to know this for a decade, by the way

Dr. Tommy Wood
... The reason why I can't answer that question is because there isn't that much high-quality research on Alpha GPC. There's quite a lot on CDP-choline or citicoline.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So another form of choline, which people say that Alpha GPC is more likely to get into the brain, more likely to be turned into acetylcholine. But there isn't that much really good quality research. So when I talk about choline supplementation, I'll always fall back on citicoline because that's-

Dr. Andy Galpin
Way more data

Dr. Tommy Wood
... it's much better understood. So the reason why I can't answer your question is because I don't think anybody's really looked at that.

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Dr. Andy Galpin
Anyone that tells me things like Alpha GPC don't work, you're out of your mind. You're out of your mind because if I take a quarter a dose, I can't think-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... straight. So it absolutely works. I guess it depends on your-

Dr. Tommy Wood
Well, it depends what-

Dr. Andy Galpin
Like earlier

Dr. Tommy Wood
... yeah, what it means by working.

Dr. Andy Galpin
How you're defining sort of work.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Are there any categorical pros, cons to the things. So you mentioned one earlier, an example of caffeine.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
You might get enhanced reaction time, but perhaps you have a decrease in focus or attention if it's-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... over-stimulation.

Dr. Tommy Wood
Mm.

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Dr. Andy Galpin
Are there any other general swings, like with Alpha-GPC or any other ones like where just generally if you get more... I don't know. Does it even work like that? If you get more focused, does that then take away creativity?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Or are there any other kind of like big switches that happen like that?

Dr. Tommy Wood
There's been, as far as I know, a lot less research on those different trade-offs. There was a little bit historically on some of the racetams-

Dr. Andy Galpin
Yep

Dr. Tommy Wood
... and showed something similar, right? You might have an improvement in some aspect of executive function or memory, but then verbal fluency or some other aspect of cognitive function decreased in response. The stimulants broadly do seem to have that trade-off that we mentioned with caffeine. So there's a recent study that came out and compared caffeine to methylphenidate and some-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... of the other stimulants that are regularly used by students and-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... to when they're studying or the clinical population like ADHD, who actually-

Dr. Andy Galpin
Yep

Dr. Tommy Wood
... might benefit from them, and you tend to see something similar. So you might improve on one aspect of cognitive function, but especially certain aspects of executive function seem to decrease. What's interesting is that a lot of, you see this in the psychedelic microdosing

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literature, you see it in the cannabis literature, people think-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... they're more creative, or they think they have improved cognitive function, but actually if you measure it objectively, they don't. And it actually parallels some of the caffeine research where people-

Dr. Andy Galpin
You just set the whole internet on fire.

Dr. Andy Galpin
Sorry.

Dr. Tommy Wood
And so what often happens is people think they're functioning better, and this has happened in some caffeine studies as well. They think they're functioning better, but actually, objectively, they're functioning worse. So there's this decoupling of the subjective-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... and the objective again. And none of this is inherently bad. It's just knowing what it is you're trying to achieve in the given moment.

Dr. Andy Galpin
What is that? Because you see the same thing in sleep literature.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
If you sleep deprive people, not even to extremes, six hours a night, things like that, you'll see routinely, cognitive function decreases massively with almost, not always, but a lot of times, no subjective change.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So people think, "I'm totally fine."

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
"I'm totally fine." And then on a standardized test, they're hot garbage. What's actually happening that makes you feel like you're, is it just the acute self-preservation, something must be going on here that is catastrophic or important, so we're going to maintain total short-term focus and-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... just disregard the real world? What is happening here?

Dr. Tommy Wood
It's funny because you often see the opposite in sleep literature, which is where, like Ellen Langer's work, where they randomized people-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... to sleep for eight hours, but they told them they slept for five hours.

Dr. Andy Galpin
Totally.

Dr. Tommy Wood
Right? So they slept a perfect amount, but they thought, "I didn't sleep well, therefore I'm not going to perform well," and they don't-

Dr. Andy Galpin
And actually performed it, yeah.

Dr. Tommy Wood
And they don't perform well-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... because they have this expectation. So I think for some of it, there is this aspect of what do you expect to happen, and-

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Dr. Andy Galpin
Mm

Dr. Tommy Wood
... thoughts drive physiology. We know that's the case. But, and there's ton-- We can do that across blood sugar control, sleep, even how physical activity affects mortality.

Dr. Andy Galpin
We've done it with lifting weights.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Where we actually put different numbers on the barbell. We ran a couple of these random deception studies-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... with it. Yeah, you will definitely PR.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If you think the bar is 15 pounds lighter than it is, you will absolutely PR.

Dr. Tommy Wood
And they've done it with anabolic steroids as well.

Dr. Andy Galpin
Oh, yeah.

Dr. Tommy Wood
Right? That was the one-

Dr. Andy Galpin
That manifesting that-

Dr. Tommy Wood
... most famous ones.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Yeah. What a tremendous one. Yeah.

Dr. Tommy Wood
So some of it is just purely driven by expectation, and I think this translates into everything in terms of how we think about our cognitive function. Is like, what are we expecting from ourselves today? And that becomes a self-fulfilling prophecy because our thoughts drive our physiology, and then you get the result that you expect. But sometimes, like you said, you, in the opposite scenario, where you haven't slept well, you think you're fine, and you can still measure an objective decrease in function.

Dr. Tommy Wood
There is still some baseline requirement that we have these things in place for cognitive function. So some of it's driven by expectation, but expectation isn't going to be enough to overcome, right, really significant deficits.

Dr. Andy Galpin
Of course. Yeah. And we saw this a ton at Absolute Rest initially, and we've seen this in various aspects where set and setting and habit-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... override most small effect.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
In other words, if you wake up in the morning and you brew coffee, and then you do the whole routine, and then you sit down at your computer, and then you start writing, then that is going to have a massive nootropic effect, not necessarily just simply because of the caffeine in that particular case, but because your brain body knows the pattern of when we get down here, this is when we do our deep work, right?

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So if one day you got switched out something else there, you will not have as much of a problem as you would maybe if the setting is switched.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Right? So it's not that the caffeine did or didn't work. It's the whole-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... set and setting that brings the experience. From a sleep perspective, if you have a certain habit, a certain behavior that then promotes quality sleep or does the opposite, that's the pattern that you'll see, right?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So you can try all the sleep supplements you want. It's not going to matter if you have this chaotic-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... sleep routine, right? So you're not saying that those things aren't doing anything. It's just that the benefit is potentially only going to be seen if the rest of the situation is captured-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... and clear because there's just too much noise in that overall system, and that makes a ton of sense from me. We've mentioned this stuff a couple of times, but I want to go back just a little bit to our avatar. Let's say that person's good. We did as much as we could on him. But now let's say he or she is saying, "Okay, I'm not normal-

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Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... cognitive function. I don't think I have brain disease." It's brain fog.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Right? And it's not perceptive. It is noticeable. It is real. There's this big decline. You hear a lot of these, certainly in the last couple of years, about potentially long COVID.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
It happened after I got COVID, or didn't, or got a whatever, and just for whatever reason, we're down there. How does somebody know what that actually is?

Dr. Andy Galpin
Are there tests that you can take? Are there online surveys-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... or things that the average person could try? And then secondly, again, what do I do to improve that?

Dr. Tommy Wood
This is another controversial area, the idea of brain fog, which I kind of use interchangeably with the more formal definition, which is subjective cognitive decline. That's-

Dr. Andy Galpin
Oh, brain fog's way nicer sounding.

Dr. Tommy Wood
So when you look at the stages of dementia now, they include some of these periods. So first, everything's good. No subjective or objective change. And then next, there's probably a subjective decline before you see an objective change in function, right? Or at least that's assuming that you don't have years of longitudinal cognitive function tests in this person, which nobody has. So if you feel like, "I have this brain fog, I feel like something's not quite right," but if I gave you a bunch of standardized cognitive function tests, you'd be within the normal range,

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and I'd say, "There's nothing wrong with you."

Dr. Andy Galpin
Right.

Dr. Tommy Wood
But there's quite a lot of research now suggesting that that subjective decline, which has a lot of overlap with the idea of brain fog, then is associated with improved or increased risk of first, mild cognitive impairment, which is the next step of cognitive decline, and then dementia. Obviously, not everybody who gets brain fog is going to get dementia, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
I want to say that right now.

Dr. Andy Galpin
Yeah, you just terrified the internet. You set them on fire earlier. Now they're all terrified that-

Dr. Tommy Wood
And that is definitely not true. But I think the fact that they are linked, at least at the population level statistically, suggests that that could be a signal of some kind of impending issue or the beginnings of an initial issue. Now, most of that in that stage is thought to be reversible. Even if you ask dusty, old neurologists who've thought about this, they would tell you-- And that if you look at the sort of the spectrum that's in published papers, they'll say that at this stage, it's reversible. So then you have to think about, well, what are the potential contributors to this? And there are just the same old basics that are going to come up again and again and again. And so we already covered the nutrition stuff.

Dr. Tommy Wood
Like you said, you've even seen that in your own clients, right? You address some basic nutritional things, and a lot of this stuff lifts immediately.

Dr. Andy Galpin
I'd probably say 60% of our clients have a subjective score of cognitive function of 5 or less-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... out of 10.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? So whether they actually have brain fog or don't, over half of our people think that their brain is functioning poorly.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And I would say our success rate is over 90%-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... with all that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And we've done lots-- Sometimes it is more complicated-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... but a lot of the times, if you cover all the bases, we have stunningly high results.

Dr. Tommy Wood
Yeah. And that makes perfect sense if you think about the framework of how I think about cognitive function. And so maybe this is the time to bring that, and because it then relates to long-term cognitive decline as well. So to fit all these different pieces together, and we've touched on a lot of them, I have what I call now the three S model, which is stimulus, supply, and support. And these are the three broad categories of the things that are required to maintain and sustain cognitive function. And some inputs will cover many of those at the same time, right? So sometimes I've put up a picture in a lecture and said, "Here's my model," and somebody's like, "Yes, but something goes there and there." I'm like, "Yeah, I know, but it was just-"

Dr. Andy Galpin
It's a picture.

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Dr. Tommy Wood
Yeah, it's just a picture, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Just to kind of simplify it. But we've talked about stimulus, and I think that's the primary driver of a lot of cognitive function. But in order to respond to stimulus, we need a few things. So in the supply bucket, we have good cardiovascular function, right? What you see in the brain when you have an increase in activity in some network associated with some function is you see an increase in blood flow and direction of resources to that area of the brain.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
This is the process of neurovascular coupling, right? So when neurons become active, blood vessels in that area dilate. We direct resources to that area. This requires a healthy vascular system, right? And so it's almost exactly the same process as what happens in the coronary arteries in the heart as we get into the process of heart disease. And therefore, there's a lot of overlap in risk factors for heart disease and risk factors for dementia and cognitive decline, probably because of that vascular component. So everything that would improve cardiovascular health then helps to support this. Exercise being one, but obviously other aspects of making sure you have low cardiovascular risk, blood pressure, lipids, if necessary, all those kinds of things.

Dr. Tommy Wood
Then you need some kind of energy source, right? For most parts of the brain, most of the time, it's going to be glucose, but it certainly could be lactate, it could be ketones, right? And they need to get there and need to be able to get across, and that's where some of the energy toxicity piece comes into play. And then you need nutrients to build and maintain the structures of the brain. And we've talked about omega-3s and B vitamins being critical components. So that's the supply part, right? If you want to actually create a response to a stimulus, you need all of those things in place. Then the support side is a few things. One is, are you allowing the opportunity for the brain to respond to stimulus? And again, to return to our gym analogy, everybody knows you don't get bigger in the gym, you get bigger when you rest, right? And the brain is exactly the same. So sleep being critical to that.

Dr. Tommy Wood
An absence of chronic uncontrolled or uncontrollable stresses is a big point as well. And we're currently writing a paper that sort of lays out this in a more academic way, sort of like a systems

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approach to cognitive function. And when you talk about stress in the support side, even sort of like other neuroscientists in the field or people get a little bit uncertain about that because when you look at stress and what it does to the brain, in many senses it is a cognitive demand that creates neuronal hypermetabolism. So you almost have to think about it as over-training.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Right? So it's preventing the ability, right? It's junk volume for your brain. It's preventing the ability to adapt. So that's part of it. And then you also want to avoid any kind of exposures that prevent some of these adaptations from happening. So, excessive alcohol, smoking, air pollution is really common.

Dr. Tommy Wood
And so if you're trying to address brain fog in an individual, these are all the areas that you have to think about, right? You have to think about energy metabolism, vascular health, sleep, stress, other exposures. We already talked about nutrient status. And some other things that can inhibit this process include chronic inflammation. So that's where I think long COVID starts to come into play, and we know that you can see chronic inflammatory processes in the brain, in certain individuals who have ongoing symptoms after COVID. You see the same thing often years or decades after certain traumatic brain injuries, and the amount of residual inflammation that you have in the brain relates to then cognitive function or cognitive deficits in that individual. How you address that becomes tricky, but that's also not going to be necessarily relevant to the vast majority of people who might be experiencing these things.

Dr. Tommy Wood
So that framework, I think gives you then a chance to say, well, where is the likely deficit, or where's the issue that we're most likely to focus-- going to see benefit? And why it's also important, I think, to think about it in that kind of framework is that these risks and components aren't linear.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
Like when we talk about risk factors for cognitive decline or cognitive issues, you just get a list of-

Dr. Andy Galpin
Mm-hmm

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Dr. Tommy Wood
... 12, some people it's 50 risk factors, and they talk about it as if you have to hit all of them perfectly in order to see improvements in cognitive function. And that's actually not true. They interact and they synergize. So we know that if you have high blood pressure, you'll offset some of that risk if you sleep better. But if you don't sleep well, you'll offset some of that risk if you do exercise. So you don't have to perfectly hit everything in order to plug all the holes in the roof, which is one of the analogies that's kind of used for these processes. Actually, you can pull a few levers a little bit and you'll then almost see or often see outsized benefits.

Dr. Andy Galpin
So before we transition to this next area, if I had to summarize, if I feel like my cognitive function is fine, I'm not having any deficit right now, but I want to improve it, then searching for novel tasks-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... is probably the way to go. Ideally, ones that have multiple sensory inputs, so smell, memory, different forms of cognitive function, creativity, executive function, like different aspects, novel tasks are there.

Dr. Tommy Wood
And avoid extended or continuous task switching because we know that's a significant stressor that's going to be very relevant to the avatar that you presented.

Dr. Andy Galpin
100%.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Yep. Thank you for that. If on the opposite, where I feel like I have some sort of cognitive dysfunction, I've lost it, then we go after the three S model.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And we figure out presumably where area of that I'm struggling the most with. So is it the supply area? What were the other ones?

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Dr. Tommy Wood
Yeah, so supply and support. Or it could still be stimulus, right?

Dr. Andy Galpin
Or stimulus, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So maybe I'm not doing enough different things. Maybe there is some hole somewhere.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So more than likely, you've got a hole in your game somewhere.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
That's either then causing excessive energy. You feel like your energy's low, but what's actually happening is you're burning a lot of energy and you don't really realize it because your stress load is high.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And that's actually literally burning fuel in your brain-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... right? To keep that managed. I would say of the people I'm talking about that we coach in Arete that has that 90%, I don't think we've seen anybody that has a problem outside of that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Oftentimes they think that.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
They are for sure convinced that there's something off the wall going on.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And that has occasionally happened.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But most of the time, and I'm not simply saying the basics, most of the time if we do a full true analysis of sleep, stress management, movement, daily format, so how your actual life is structured-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... hydration, and mental health on top of nutrition, blood work, things like that, something is generally very, very bad.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And they may not see that, perceive that, but once we get that cleaned up, sometimes it's been as simple honestly as hydration.

Dr. Tommy Wood
Mm-hmm. Yeah, I didn't mention that, but fits right into that supply side, right? That's-

Dr. Andy Galpin
It's stunning

Dr. Tommy Wood
... a critical component.

Dr. Andy Galpin
Sometimes it's low, sometimes it's high.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
I've talked about this so many times now, but particularly females, they just stress drink water. They just chug it. And we're like, "You can't drink two gallons of water a day." I'm being a little bit hyperbolic, but not much there.

Dr. Tommy Wood
Yeah. Mm-hmm.

Dr. Andy Galpin
And you lower that back to normal, and headaches go away. Function comes back, and you're like, "Oh, I feel smart again." So those are, I think, really insightful things that we can do.

Dr. Tommy Wood
Yeah. Mm-hmm.

Dr. Andy Galpin
Today's episode is sponsored by Renaissance Periodization. If you want to put on muscle through science-backed training programs, look no further than Renaissance Periodization. Renaissance Periodization guides users through effective and easy-to-follow strength training programs all through their hypertrophy app. These programs are designed by the absolute best in the industry, including one of my favorite sports scientists and professional bodybuilders, Dr. Mike Israetel. You may recognize that name because I referenced him and his work countless times over the years. Whether you're looking to put on muscle, gain strength, or both, these programs will help you achieve your goals and have produced results in thousands of men and women. Renaissance Periodization also has a diet app that is backed by the latest science and innovation in the field of nutrition and takes the complexity out of dieting, helping you achieve your ideal body composition.

Dr. Andy Galpin
If you'd like to try Renaissance Periodization, go to rpstrength.com/perform to save up to $50 off your subscription. Again, that's rpstrength.com/perform to save up to $50 off of your subscription. Last little thing I want to ask about before we move forward to something you've kind of been alluding to, but that is vision training.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
You mentioned reaction time, and I'm bringing this up because we see this actually a lot with our

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athletes, and people tend to not realize it. The first time I caught wind of this was actually a number of years ago working with high-level Major League Baseball players. There was actually some cool work out of Japan. It found that the variance in Major League Baseball players, the successful batting average, it was something absurd, like 70% of variance was all in visual.

Dr. Tommy Wood
Yeah. Mm.

Dr. Andy Galpin
Ocular metrics explained almost everything.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And that's when I was like, "Whoa."

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
If we really think we're going to service our baseball players better, and if we're not testing and monitoring and improving vision, we're going after pennies-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... on the dollar here.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So what do we know about testing vision outside of, of course, you need glasses, things like that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And then can I get that tested? How do I get that tested? And then what do I do to improve it if I can't test and just, again, are there exercise, are there breathwork, are there nutrition? How do we improve vision? Supplements, whatever the case may be.

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Dr. Tommy Wood
Recently, we've done some work also in Formula One drivers with vision, because this is a big part of their job, and it's essential. You start to lose some visual acuity before you're going to lose a lot of other functions. The eyes are an extension of the brain, essentially. So a lot of the stuff that we just talked about actually applies here as well.

Dr. Andy Galpin
Really?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So that basic stuff should improve vision as well.

Dr. Tommy Wood
Yeah. And I did some analyses with some large population data sets in order to try and answer some of this question. Of course, it's in a general population, but if you're looking at different aspects of visual acuity, even just measured with a standard test, you'll see that blood sugar control, nutrient status, all of these things also, smoking and all that kind of stuff. All those same risk factors that we know are important for cognitive function, they then relate to visual acuity as well. So those same principles come into play, and all those same nutrients are going to be important as well because you're essentially firing neurons from the eye into the brain, right? It's the same process. When you then think about visual assessment, there are a whole bunch of different platforms that you can do this with, depending on how much money you have and what you have access to. But RightEye is one that's fairly good.

Dr. Tommy Wood
Certainly looks at different aspects of eye tracking, which is important for athletes, but also after concussions and things like that. You can also do much more complex eye imaging, like optical tomography, that can give you a much better idea of the structure of the eye itself and if there's any potential issues there.

Dr. Tommy Wood
When you then think about visual training, a lot of it comes down to similar principles.

Dr. Andy Galpin
Hmm.

Dr. Tommy Wood
And actually, there's a big overlap between your visual training and both physical and cognitive training because part of it is neurological and part of it is physical, right? You are training

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muscles in the eye. So when we start to lose visual acuity, you can reverse that with essentially progressive overload-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... of the ocular muscles by just trying to focus on something that's just beyond the reach of your current visual acuity. Similarly, if, say, so dark light contrast is the same. We spend a lot of time exposed to the same intensity of light indoors. And so then that may be part of the reason why we lose some dark light contrast as we get older. There's a nutritional piece as well, but how often do we see and try and see in true dark, and how often do we see in bright light? And it's not that often because we're not exposing ourselves to those differences in light levels. So you can then do training with visual tracking. So when I was trying to put together a program for, say, a Formula One driver that want to try and maintain visual tracking, there are some off-the-shelf things that you can use. There's some nice evidence for something like Neurotracker, where you do multiple object tracking.

Dr. Tommy Wood
That's probably not nearly as complex as you would need to do when driving a Formula One car, but for somebody who's done no visual training, there's some reasonable evidence to say that multiple object tracking just on your computer can improve some aspects of vision. And then beyond that, it's just thinking how do you create more and more complex situations where you then train these muscles. So, I spoke to a friend of mine who's former Special Forces and does a lot of this kind of training with individuals. And so one of his favorite tasks is to use a baseball that you hang on some kind of string, and then you have either letters or some kind of symbols on it. So then you can first start with the ball just hanging still and vertical, and then you can practice, say, focusing on the far distance, focusing on a symbol on the ball, then focusing even closer. So you can practice quickly switching visual depth.

Dr. Tommy Wood
But then you can also do things like make the pendulum swing, and then you have to track a certain symbol as the ball rotates, and then also do that by quickly changing visual fields. And so then you're essentially training all these different parameters of vision, both visual field as well as looking all the different directions that you might choose to look. So the extremes of peripheral vision and as well as up gaze and down gaze. And it seems that you probably can't overcome a huge visual deficit. But a lot of these different features of vision do seem to be trainable.

Dr. Andy Galpin
There's an old thing we used to do in baseball where you have a bucket of balls.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And you throw balls to a hitter, and the hitter has to identify different numbers and letters.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So you're going to imagine you got a bucket of balls there, and you got a one on one of the balls. The next ball has a B on it.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And so on like that. And then you throw it, and the batter not only has to hit the ball, but then say, "That was four."

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
"That was F." Things like that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Are you telling me that that might plausibly actually work?

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
You've vindicated every 1980s baseball hitting coach.

Dr. Tommy Wood
Normally, it's like some of these old school training methods just seem like hazing and-

Dr. Andy Galpin
Yeah

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Dr. Tommy Wood
... they're kind of these attritional processes, but some of it might actually work.

Dr. Andy Galpin
Okay. So you could do things like that. We see this a lot of the times in combat sports and stuff as well. We throw different numbers out there. I think what you said at the beginning makes a ton of sense. It's the same exact principles of training your muscle, which were the same as training your physical brain.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And now your eye, right?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
It is progressive overload. It is stimuli. It is changing things. There's a variety.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And then it is intention and focus.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So you couple those things together, you could probably come up with just about any drill-

Dr. Tommy Wood
Yeah. Exactly

Dr. Andy Galpin
... that you really wanted.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It doesn't matter-

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Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... a whole heck of a lot.

Dr. Andy Galpin
Vitamin A, carotene. What about things like this? It makes sense if you Wikipedia-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... very quickly what those things are.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Clearly, there's evidence if you've got certain physical or cognitive or physical issues in your eye, especially from a vitamin A deficiency-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... then of course, it's going to work.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But for the normal person, and the reason I'm asking this is I know of multiple companies now-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... that sell very specific, very expensive supplements for vision.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
For normal vision, to enhanced vision, for Special Forces-

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Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... for certain sporting populations. I know you don't know the data on all these. I don't even know them. But in general, is it plausible that they work? Is it completely implausible, or do we not know?

Dr. Tommy Wood
So a lot of supplements that we use to boost any function, or are used to boost any function like testosterone boosters or these kind of visual boosters, there's probably going to be a benefit in the setting of an insufficiency or deficiency.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
But then increasing above that, you're not going to see any benefit. For some people, retinol is important. We know retinol is important in the eye. Some people, due to a genetic polymorphism, aren't as good at converting beta-carotene into retinol, so maybe there's some interindividual variability there. But no, more isn't going to be better. Certainly, other things do seem to suggest some benefit, and it's kind of like squint a bit and it might help. But some of the antioxidants, lutein-

Dr. Andy Galpin
Yep

Dr. Tommy Wood
... astaxanthin, zeaxanthin, they seem to be associated with improvements in cognitive function and sometimes a supplement. There are trials that show some of those supplements can improve visual acuity and some other aspects of vision.

Dr. Andy Galpin
Yeah. Actually, that's reasonably well demonstrated-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... at this point. My question with those trials are always, are you simply seeing a metric of somebody who had suboptimal physiology?

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Dr. Tommy Wood
Oh, I'm sure.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Probably in most scenarios, because we know that most people have some nutritional requirement or metabolic health issue or something like that. So then if you have a bunch of oxidative stress in your eye because you're pre-diabetic, then an antioxidant that can get into that system is likely to show benefit.

Dr. Andy Galpin
Yeah. Right. Which is not to say you shouldn't use it.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If this is your first entry into enhancement for that individual as a coaching tool, that happens.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Sometimes you struggle with people, and you're like, "You know what? I'm just going to give them an easy win because we've been trying the nutrition, we've been trying to get them to stop drinking as much, and they won't," but then they see benefit there. So I actually don't want to-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... dismay that too much.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
We take a different approach, of course, generally. And so we haven't really seen much benefit-

Dr. Tommy Wood
Yeah

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Dr. Andy Galpin
... in those folks, but I'm not surprised by that. So you've mentioned this multiple times now, and whether it be from the energy toxicity or your metabolic and energy sustain principles with cognitive function, but I'm wondering how specifically things like creatine actually enhance brain function. You can take this actually from both angles. There's just like actual cognitive function. First of all, does it? If I take creatine right now, am I going to have an improvement in cognitive function? And then what about long-term brain as well? So kind of two-part question there about creatine specific, I guess we'll just start there.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And then how actually it's doing those, if it is at all.

Dr. Tommy Wood
So whether you would see a significant benefit from creatine right now probably depends a little, or you take your dose of 10 grams and what are you going to see? It probably depends a little bit on your context, but You probably saw the recent paper that showed that after one night of sleep deprivation, creatine can overcome some of those deficits.

Dr. Andy Galpin
Cognitively.

Dr. Tommy Wood
Cognitively.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And that was actually shown a few years ago with rugby skills in rugby players. You may have seen that paper as well, where they had players after a period of sleep deprivation, they gave them either creatine or caffeine and saw similar improvements in rugby specific skills compared to a placebo.

Dr. Andy Galpin
Yeah. With a very different mechanism here, right?

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
You're talking about a stimulant and versus a fuel, right? Totally opposite.

Dr. Tommy Wood
Yeah. So, however, you could probably relate both of those to energetics in some way, because caffeine is overcoming or it's inhibiting the metabolic downregulation caused by adenosine, which is part of what drives sleep pressure and the need for sleep. As you accumulate metabolites like adenosine, they then sort of suppress metabolic activity in the brain, which then is associated with reduced function. And something like caffeine overcomes that, whereas creatine can acutely provide a buffer, an energetic buffer that allows you to maintain function in the face of increasing metabolic pressure to sleep. So even though different mechanisms, they kind of maybe converge on something similar. I know a lot of people who, every time they take creatine, they notice an immediate sort of boost of some kind-

Dr. Andy Galpin
Really?

Dr. Tommy Wood
... of cognitive function. Yeah. And there's been a lot of discussion over the years about whether creatine negatively impacts sleep. For that reason, it's slightly stimulating for some people.

Dr. Andy Galpin
Mm-hmm.

Dr. Tommy Wood
I've certainly found that in myself. I work out in the afternoon, if I take creatine after my workouts, I don't sleep as well.

Dr. Andy Galpin
Really?

Dr. Tommy Wood
But if I take it first thing in the morning, it's fine, because I've kind of separated it away. And not everybody's like that. And certainly, we know that responses to creatine are very heterogeneous, right? Some people see-

Dr. Andy Galpin
Totally

Dr. Tommy Wood
... big responses, some people see smaller responses. And some of it may be related to methylation status because creatine, when we make our own, which we make a lot of, is the most methylation intensive process in the body. You spend more of your methyl groups

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producing creatine than anything else. And so it could be related to that as well as a whole host of how much creatine do you normally have in your diet and things like that.

Dr. Andy Galpin
So if I've gotten genetic testing done and I'm-

Dr. Tommy Wood
No, don't do it. Shh. Don't go there.

Dr. Andy Galpin
Okay. So I think based on your reaction, just give us a little bit of an insight into your fervor there.

Dr. Tommy Wood
So, whenever somebody talks about methylation, they immediately start talking about genetic testing, and there's a lot of that out there right now. Yes, genetic polymorphisms do change the functional level of enzymes related to methylation. The one that people talk about the most is MTHFR. Different polymorphisms within MTHFR change the activity of that enzyme, in a test tube, right? If I take-

Dr. Andy Galpin
In theory.

Dr. Tommy Wood
Right, in theory. And then they do, in some ways, relate to other markers of methylation. So, homocysteine, we mentioned briefly earlier, is an important marker for a risk factor of a wide variety of diseases. It's directly related to your current methylation status.

Dr. Tommy Wood
But in most cases, an elevation of homocysteine related to those polymorphisms is driven by some kind of nutrient deficiency or insufficiency. Sometimes your requirement is slightly higher because of a polymorphism. But in general, I have yet to see a study that would change my mind when I say, "I can tell everything I need to tell from a blood test, I can tell from your phenotype, and there's no additional information that I get from your genotype." Whereas the opposite is not true. If I just measure your genetics, I don't know what's going on with you, and I still need to measure your B vitamin levels and your B vitamin status, your methylation status. So, for most people, measuring those polymorphisms is not helpful, but what it does is it drives a huge amount of fear because people are like, "I'm a poor methylator." What does that even mean? You're continuously methylating, right? If you don't methylate, you die.

Dr. Andy Galpin
Yeah.

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Dr. Tommy Wood
Right? You can't turn genes on and off. You literally can't do anything. So we create this massive nocebo around these different polymorphisms, which I think is net harmful when, yes, sometimes this is an issue, but if you have a significant decrease in MTHFR function of, in air quotes, related to an MTHFR polymorphism, all you have to do to see a significant reduction in, say, homocysteine, is make sure that you're eating the recommended daily allowance of riboflavin. It's-

Dr. Andy Galpin
Not hard at all

Dr. Tommy Wood
... it's not hard. It's literally nothing. And that's because the polymorphisms change how MTHFR bind to FAD, which is the proton carrier that that enzyme uses. So all you need to do is slightly increase availability of riboflavin to be converted into FAD, and that's it. And it doesn't require super doses, it literally just two milligrams a day. It's nothing.

Dr. Andy Galpin
There's also a very low relationship between those polymorphisms and actual homocysteine.

Dr. Tommy Wood
Oh, yeah.

Dr. Andy Galpin
Like very.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Sub 1%.

Dr. Tommy Wood
Yeah, and I've published a paper on that, actually, for that exact reason. I did these big simulation studies looking at the normal distribution of homocysteine by MTHFR polymorphism from published data, and essentially about 1% of your homocysteine is predicted by your level of activity of your MTHFR enzyme.

Dr. Andy Galpin
Yeah. So why not just measure the homocysteine?

Dr. Tommy Wood
Exactly. Yeah.

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Dr. Andy Galpin
I did a whole episode on genetic testing-

Dr. Tommy Wood
Uh-huh

Dr. Andy Galpin
... in season one, so please feel free to go back and listen to that if you want. So we'll move on for now-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... because we can get aggressive there. But I think what potentially is interesting here is, say somebody has done that testing, so it doesn't matter. They've already paid the money.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
They're in, so tough luck. And potentially they've had or think or are actually low with methylation status.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
Would that person then potentially be more likely to be a hyper-responder to creatine for that exact reason, or would...

Dr. Tommy Wood
That's what I've hypothesized, but I, and maybe if this study has been done, somebody send it to me because I'd love to see it, but I think that might be the case.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
That would make sense because so much of your methylation currency is spent on creatine production, and if you have to decrease some of that production because you're, quote-unquote, "a poor methylator" or you have poor methylation status, poor B vitamin status, then it would make sense that you would sacrifice some creatine production, and then-

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Dr. Andy Galpin
Mm

Dr. Tommy Wood
... would respond better to creatine supplementation. But so in theory, yes, but I don't think anybody's actually looked at that.

Dr. Andy Galpin
I wonder if it works the opposite way then as well. So somebody who's had potentially, we'll exclude placebo, which is a large portion of this, but-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... people that have had some sort of genetic testing done, then gone on high doses of B vitamins-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and felt a massive response.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I wonder if those people could also then simply just go to creatine instead.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Which is, I won't say safer, but a little bit less risky, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Not a lot of downside to creatine, not a lot of downside to B vitamins, but more.

Dr. Tommy Wood
Mm-hmm.

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Dr. Andy Galpin
You're going to get other consequences that you maybe didn't realize you're going after with high doses of, depending on which vitamin B you go after.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But less potential downsides-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... I would think that you can go after.

Dr. Tommy Wood
What's interesting is that unfortunately, these kind of questions haven't really been addressed in the literature, right? So I can quote studies on supplementing with B vitamins in-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... individuals with elevated homocysteine.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And right, we know how that can be important, and but then we can also talk about studies where they give doses of creatine, and particularly in older populations and those who've maybe started to see some element of cognitive decline, you see a greater effect size of supplementing with creatine. But I don't think anybody's looked at, like, well, what if you gave one or the other, or is there a trade-off?

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
These are super interesting and important questions, but because of the reductionist-

Dr. Andy Galpin
Mm

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Dr. Tommy Wood
... evidence-based medicine model that we currently have, we just try one thing at a time and don't necessarily consider-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... the context around it.

Dr. Andy Galpin
Vitamin Bs, I'm all for. That's great.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I just know that a reasonably high percentage of people will get really nauseous-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... or have GI distress-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... from them, and so for those folks, potentially maybe creatine is a little bit of an alternative option if you think you have a methylation or you actually do, either way, and B vitamins don't sit well with you-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... especially at that dosage-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... then maybe creatine gives you some percentage of that benefit as well.

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Dr. Tommy Wood
Certainly, we've done, when I was working with a lot of individuals in a similar arena to what you do now, we might-

Dr. Andy Galpin
This is taking, you've worked with-

Dr. Tommy Wood
Looking at people's blood tests, yeah

Dr. Andy Galpin
... thousands of people with their blood work and providing-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... individualized protocols.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
This is what you've done for a very long time.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And this is general population as well as with athletes. And if B vitamin status looked okay, but maybe homocysteine was still elevated or we needed other strategies to help bring down homocysteine, then creatine and choline, or lecithin, which is a-

Dr. Andy Galpin
Mm

Dr. Tommy Wood
... plant-derived source of phosphatidylcholine, they were good alternative options or something you could add on top.

Dr. Andy Galpin
Yeah, okay.

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Dr. Andy Galpin
Why then does creatine help with cognitive function, if it does? And we'll get back to that second part of that two-part question.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
Is it the methylation support that it's giving you? Is there other mechanisms? What exactly is creatine doing for the brain?

Dr. Tommy Wood
I think one of the things that I've found most interesting across strategies that seem to robustly improve cognitive function, either across the lifespan or in multiple different groups, is that they usually do more than one thing.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
And any time we've tried something that only does one thing, it doesn't work.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
That's just like a-

Dr. Andy Galpin
Stunning

Dr. Tommy Wood
... a lesson from neuroscience in general and also a lot of just developing drugs in medicine in general.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And so I think it's probably going to be a bit of all of these things. So, we know that homocysteine is a risk factor for cognitive decline, and that's probably because it's a marker of methylation status, right? So are you able to generate, say, membranes in cells in the brain like we talked about earlier, but equally, homocysteine can directly increase the accumulation of hyperphosphorylated tau, which is one of the markers of risk factors of dementia. It's a marker of

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previous brain trauma and a number of other things. So it may contribute to cognitive decline in a number of ways, and so if creatine is offsetting some of that issue, you may have some benefit there. Then there's the energetic piece, right? It's going to give you a short-term energetic buffer as phosphocreatine in neuronal cells, and the brain is the most metabolically expensive organ in the body on a calories per or watts per gram comparison.

Dr. Tommy Wood
And so any time you have either a suppression of metabolism, say adenosine or some kind of acute injury, and that can either be a stroke, it could be cardiac arrest, it could be brain trauma, where you have some kind of deficit in energy production, then creatine also seems to potentially be beneficial. Although, some of the studies suggest you can supplement afterwards, but most of the benefit seems to be if it's on board beforehand. And of course, a lot of this evidence comes from animal models, because you can't do that ... easily in humans. So some of it is an energetic buffer, and then some of it, one thing that creatine seems to do is to help stabilize and regulate calcium handling in mitochondria, which is related to acute injuries, but also to long-term mitochondrial function, which then supports long-term cell function in the brain.

Dr. Andy Galpin
Really quickly, I don't want to drag this down too far, but you've mentioned it multiple times. What is methylation?

Dr. Tommy Wood
So-

Dr. Andy Galpin
Why does it matter? And just real quick on this one.

Dr. Tommy Wood
Yeah. So methylation is basically the transfer of methyl groups, which is basically a one carbon group or a carbon with three hydrogens that gets moved around. And this is used to convert different metabolites in the body in multiple different cellular reactions. Like you change a molecule from one into another by methylating it. But it's also really important for things like gene regulation.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So people might have heard of biological age, epigenetics. The major form of epigenetics and gene regulation and the sort of more common measures of epigenetic biological age are all based on methylation status. So you have these, what are called CpG islands on DNA, which is where essentially the cell puts on these methylation tags, which regulates whether a gene is

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turned on and off, and these tags seem to shift over time that's associated with biological aging. So it's this really central process that drives so many different parts of biology.

Dr. Andy Galpin
It's in every cell-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of your body. It's on DNA, it's on protein. Moving a carbon is hard-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... chemically, right? So it's got to be a major thing to get it to move off of one, which changes the entire function-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... molecule. So I think the way that you stated it is very nice. It's a core biological thing. You don't adapt, you don't grow, you don't shrink, you don't go any direction-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... without methylation. So thank you for that. Now we have a little bit of understanding of why that's important.

Dr. Andy Galpin
Then regarding the creatine in the brain, the second part you said was fueling.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
All right. Walk me through how creatine actually, you mentioned it kind of quickly with just a touch of jargon there, which-

Dr. Tommy Wood
Yeah

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Dr. Andy Galpin
... for the folks that don't know what an intermediate and a substrate are.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
How is creatine actually providing fuel for your brain? And then on the second part of that is, well, what's the normal fuel-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... for our brain?

Dr. Tommy Wood
When you think about different energy systems, and I think people could watch endless lectures from you talking about different energy systems in exercise, and those principles in some ways are very similar in the brain. Although the majority of cells in the brain are, like we said earlier, derive energy from glucose, goes through glycolysis, then enters the electron, the pyruvate, or lactate pyruvate goes into the electron transport chain in the mitochondria. But all of that is done to generate high energy phosphates via usually or mainly ATP, right? So ATP is your energy currency.

Dr. Tommy Wood
Sort of a much shorter term energy currency or that allows you to recycle ATP when you've used it up is the phosphocreatine system. So your creatine is phosphorylated with a high energy phosphate, and you use that to regenerate ATP. So for very energetically expensive processes where you can't get enough energy throughout that longer process, the glycolysis and aerobic metabolism, then the buffer comes from the phosphocreatine system. And it seems that even for normal cognitive function, there is some benefit from having more of that buffer on board, both acutely and chronically.

Dr. Andy Galpin
So just like your muscles-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... or any other part of your system, they have to rely on energy.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
The nerves need the energy to conduct, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And so people, I guess, sometimes don't always grasp the fact that your brain, when we say it's energetically demanding, it's because it's going through a ton of metabolism.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
We have this connotation that muscle and metabolism-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... kind of thing, but the brain is metabolism

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... as well. Your basal metabolic rate, the amount of energy you burn throughout the day, your fast or slow metabolism, all these things are, it's in your brain-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... as well. And so it produces energy much like anything else. It can use fat as a fuel source, theoretically.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
It can use carbohydrates, it could use ketones or anything else, and then creatine, just like it is in your muscle, provides that stoichiometry of one to one, right?

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So not a lot of energy per molecule of creatine, so it gets used up and turned and burned quickly, but the upside is it gives you that energy really fast.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And so while you're maybe slow to metabolize, and you mentioned this, so we'll bring it up, your brain will actually then generate lactate.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So if you're thinking really hard and thinking a long time, are you feeling the burn in your brain? Is that lactate building up? Is that what's happening?

Dr. Tommy Wood
I don't think, lactate doesn't accumulate. It just gets generated and used. You could probably measure... So this is where I think creatine becomes important, and you're potentially, if I put microdialysis needles really accurately in certain parts of the brain, and then you start to upregulate the use of that network for a specific function, because there's going to be a slight delay between increased ATP production and the requirement, right? You actually need that energy before you realize you need it, right? Everything that we see and do has essentially already happened because of the time lag that it takes for us to actually interpret those actions. So that energy is needed immediately, and it could be that because of the lag in the system, upregulating energy production, that's where creatine becomes important-

Dr. Andy Galpin
Yep

Dr. Tommy Wood
... in a network as you activate it. Then you would probably start to see locally, if you could measure it with, say, carbon-13 metabolism or something like that. You could have a radiotracer on your lactate, and you could see that your astrocytes, which make your lactate for your neurons, will probably increase production because your neurons are more active in that area. They're going to require more energy. They've used up their phosphocreatine system, and then the astrocytes locally are going to produce more lactate. None of it's going to accumulate

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because it's getting used, but flux through the system is probably increasing.

Dr. Andy Galpin
And this is potentially why people have looked a lot at lactate-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... as a supplement or as a medication or a therapy for various aspects of brain injury and brain damage. I don't want to go into this in too much detail because I covered a whole episode in season one, episode 10, all on a paper that you led with Dr. Federica Conti and myself and some other folks as well, on what we know exactly regarding supplementation and nutrition for brain injury. So this is concussions, CBIs, and things like that.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So you can go and watch that whole episode and download that whole grid for all those details there. But in that paper, I remember we had a very short section regarding lactate.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And what do we know about lactate for concussions and stuff like that? And so before you answer that, I want to set the stage just a tiny bit. You can feel free to maybe double tap on creatine a little bit here since we brought it up. But I think it's really important. I've seen you give the best explanation I've ever seen of what a concussion actually is and what it is not.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And so maybe just quickly tell us your egg analogy.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And then that'll help explain a little bit of why maybe these things do or don't work for...

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So, how does a concussion actually work? Today's episode is sponsored by Momentous. Momentous makes the highest quality supplements on the market, period. Many of you know me, and you know that I do not trust the vast majority of supplement companies, and for good reason. Many studies have shown that anywhere between 10 to up to 40% of supplements have accidental contaminants, intentional alterations, mislabeling, or other serious issues. But Momentous is different. I literally spent years vetting the company, their products, and leadership team before personally officially partnering with them in 2023. Every single one of Momentous's products is third-party tested to ensure quality, and many are even NSF certified for sport. Now, while I love all of their products, the ones I use the most, both personally and with my clients, are what I call the big three. And these are the omega-3 fish oil, creatine, and newly improved whey protein formula.

Dr. Andy Galpin
These three supplements have fantastic data supporting their benefits, and they have been shown to be very safe across basically all populations of people: young, old, men, women, et cetera. Now, nobody has to use supplements, and I hope you never feel pressured to do so. But if you're interested in supplements, it's important that you get them from the highest quality providers. So that's why I stick exclusively to Momentous. If you'd like to give Momentous a try, go to livemomentous.com/perform to get 20% off your order. Again, that's livemomentous.com/perform to get 20% off.

Dr. Tommy Wood
To zoom out for a second, I think one of the reasons why we have really failed to produce consistent therapies or reproducible therapies for concussions is because we don't study them properly, and we don't study them properly because we don't understand them properly.

Dr. Andy Galpin
Hard to fix when you can't define.

Dr. Tommy Wood
Exactly. And so what is normally done, or when people think about a concussion, and if you read papers, you'll still see this consistently, experts in the field talking about it.

Dr. Tommy Wood
You'll hear something like the slosh effect.

Dr. Tommy Wood
Or you imagine a head getting bashed and then the brain banging around inside the skull, hitting

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one side of the skull, then banging and hitting the other side, and that's what they call a contrecoup injury, which is basically you see some injury on the opposite side from where the impact occurred.

Dr. Tommy Wood
The brain is mainly fat and water, and it is then surrounded by fluid, and it's inside a solid box.

Dr. Andy Galpin
And that fluid is full of salt.

Dr. Tommy Wood
That fluid is full of salt.

Dr. Tommy Wood
If you take a solid box full of water, even if it's got something very fragile inside, and you shake it really hard, that fragile thing does not bang against the sides because the water buffers it, or the CSF, the fluid.

Dr. Andy Galpin
I saw you do this.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It was one of the coolest things I've ever seen. You took an egg, and you put it in a jar with salt water. I don't remember the concentration you put it in.

Dr. Tommy Wood
Oh, it was just normal saline.

Dr. Andy Galpin
Yeah. And you screwed the top of a ball jar or whatever it was.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And you shook the living crap out of the egg, and the yolk didn't break.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
At all.

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Dr. Tommy Wood
No.

Dr. Andy Galpin
Because it's not hitting anything.

Dr. Tommy Wood
No.

Dr. Andy Galpin
It's smashed together with-

Dr. Tommy Wood
It stays right in the middle.

Dr. Andy Galpin
In that moment, I went, "What?" Because I had said that always.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I did not know that until you showed me that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Not me, but you were showing other people.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And I was like, "Wow."

Dr. Tommy Wood
So if you could, while I'm shaking it, image the jar, what you would see is you would see distortions along the surface of the egg yolk inside this jar. So there are distortions and-

Dr. Andy Galpin
So the egg, instead of being a perfect circle-

Dr. Tommy Wood
Yeah

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Dr. Andy Galpin
... turns into an oval.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It's not smashing against-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... the wall. It's just being distorted and it's being accordioned.

Dr. Tommy Wood
Exactly.

Dr. Andy Galpin
Squished and pulled back apart.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right.

Dr. Tommy Wood
So how we generally study concussions is the other version of the egg experiment, which I also showed, which is that you have your egg yolk in your solution, and you leave a big chunk of air in the top of the jar. You shake that, immediately it turns into salad dressing, right? Immediately, you disperse that egg yolk throughout the liquid. That's how we normally study concussion. But what happens if you then look at where injury is in people who've had concussions. So like you look at individuals who have CTE, right? They probably have some ongoing history of concussions. It's happened multiple times. If you look at where the injury has accumulated, it's not at the surface of the brain. It's not the brain banging against the skull. What's happening is that these distortions, like waves of energy that are transferred through the brain, is at the interfaces of different parts of the brain. So particularly the interfaces between the gray matter on the outside and the white matter underneath.

Dr. Andy Galpin
Yeah. It's connective tissue.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
They're tearing the connective tissue.

Dr. Tommy Wood
Yeah. So usually right at the base of the sulci. So you think about the brain as really wrinkly, right? Those are the gyri. The sort of the divots in between those wrinkles, the sulci, at the base of those, that's where you tend to see injury. And it's because you have tissues of different densities where then the distortion travels at different rates.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So then you create this shearing effect at those interfaces. And if the shearing effect is very large, you can rip axons. You also create direct axonal injury. If it's a blast wave, then obviously you're not directly shearing anything, but you still seem to injure those same areas because the energy wave is transferring through the brain at different rates. And so that's where the injury accumulates, is at those interfaces.

Dr. Andy Galpin
So then how do things like creatine and lactate help? Do they work at all? And if so, how?

Dr. Tommy Wood
I've been really excited about the potential for lactate in traumatic brain injury, and that excitement aligns very similarly with ketones. But people have been talking about them for a long time, and I'm still waiting for some good-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... some good human studies.

Dr. Andy Galpin
I've been probably talking about it for a decade-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... online, like in front of people on podcasts and things like that.

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Dr. Tommy Wood
Yeah. So I believe that they could be beneficial, but we just haven't seen really high-quality evidence yet. However-

Dr. Andy Galpin
No, that's clear.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
We haven't seen evidence that shows they don't work either.

Dr. Tommy Wood
No, absolutely.

Dr. Andy Galpin
Just studies just aren't being done.

Dr. Tommy Wood
Yeah. No.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And if I were to get a significant concussion or TBI, I'm going straight to the ketone esters because I believe that there's a high chance of benefit with low risk. Anybody who's like, "I don't have a randomized control trial to tell you that that's the case," but I think it could be beneficial.

Dr. Andy Galpin
Use your brain as a neuroscientist.

Dr. Tommy Wood
If it was my brain, that's what I would do.

Dr. Andy Galpin
As an MD PhD in brain health, this is what you would do. Infer that for what you will, folks.

Dr. Tommy Wood
Part of it is that it's essentially providing some kind of metabolic substrate in an area of the brain where there is impaired metabolism. So one of the consistent responses you see to an acute brain injury, and again, strokes, cardiac arrests, traumatic brain injuries, is what we call energy failure. So there's this gap between energy requirements and energy supply because you have

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dysfunctional mitochondria.

Dr. Tommy Wood
Ketones and lactate can kind of bypass some of that and seem to be less energetically expensive, or they're more energetically efficient in terms of generating ATP. Like the effect is small, but in that kind of setting, a small effect may be enough to help minimize injury. There's also going to be some other signaling effects that could be beneficial, like both lactate and ketones have a whole range of other anti-inflammatory neurotrophic kind of effects. So lactate seems to help, and ketones seem to help drive an increase in production in BDNF, brain-derived neurotrophic factor, which could help recovery. So beyond their effect on your metabolism, they may have these other downstream effects as well. But another reason why this is important is that in the acute injury setting, the brain may become relatively insensitive to glucose, or glucose uptake decreases. But that doesn't seem to be the case because the transporter is different, and both ketones and lactate go in through the monocarboxylate transporters, which aren't necessarily affected in that state.

Dr. Tommy Wood
So some of it could be that particularly ketones might be more metabolically efficient in terms of energy production, but also they may be more likely to get into the brain in the setting of an acute injury to help support energy production.

Dr. Andy Galpin
Are they potentially less negatively influenced by inflammatory markers as well?

Dr. Tommy Wood
Yes, potentially. Although, it kind of depends on what's going on and how they're getting in.

Dr. Andy Galpin
I don't naturally associate physical structural damage with metabolic problems.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
What's the connection here? Why is it if I have a structural tear...

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And this is a case in muscle, by the way.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
That my brain is, well, then it's inflammation, it's damage.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So you need to give me something that's anti-inflammatory, NSAIDs or some other drug that is going to reduce the inflammation, or you need to give me something that's going to repair the structure, DHA, fish oil, like some structural thing.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Why are we seeing and having to deal with, and why are metabolic issues so prevalent?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Glucose dysregulation, things like that.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And then why is energetic the solution when we have a physical structural tear?

Dr. Tommy Wood
So one of the reasons why you have impaired glucose metabolism is because of the inflammatory response. And a normal inflammatory response creates peripheral insulin resistance in order to divert glucose to the immune system in order to respond. So some-

Dr. Andy Galpin
Because it has to have energy. The immune system has to get energy as well.

Dr. Tommy Wood
Yeah. So that's a good thing-

Dr. Andy Galpin
Yeah

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Dr. Tommy Wood
... in order to generate a normal immune response, but can then cause issues in other tissues because they become insulin resistant, driven by the inflammatory response.

Dr. Tommy Wood
The direct metabolic effect of injury is due to the changes that happen at the cell or in the nerves in response to that injury. So if it's like a direct shearing effect, or even in concussions where you haven't fully sheared neurons, you may have stretched them, and you may have vascular changes that impair the ability to deliver oxygen to those tissues. And in all of those settings, you can get essentially a hyperstimulation of those neurons. So they start to fire a bunch. When you get this hyperstimulation of neurons, and you can see this with low oxygen states or with acute sort of stretching, if you acutely stretch the neurons, they increase their firing rate. That creates a large production of what we call excitatory neurotransmitters, things like glutamate, which are-

Dr. Andy Galpin
That's the most common one, right?

Dr. Tommy Wood
Yeah, the most common one, but there are others. That then starts this sort of wave of increase in signaling. You then essentially hyperstimulate the downstream neurons. You get these big shifts in calcium within the cell, and then that calcium impairs mitochondrial function. And at very high levels can actually stimulate what we call the mitochondrial permeability transition, which is essentially the mitochondria saying, "I can't take anymore," and then that then triggers cell death. So it's essentially an overstimulation, which can be driven either by low oxygen or stretching, which then sort of creates this cascade that impairs mitochondrial function.

Dr. Andy Galpin
You mentioned calcium again. That was also the third part of our criteria we talked about earlier, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Like that having that third issue. So I want to ask more about that, but let me see if I can summarize what you just said quickly. In the case of a brain injury, you're going to immediately have some sort of inflammatory response.

Dr. Tommy Wood
Mm-hmm.

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Dr. Andy Galpin
Which is a great thing, right? The whole point of the inflammatory response is to let your immune system know we need to divert attention and start physically, mechanically repairing collagen and whatever else is there, right? Unfortunately, those immune cells require energy.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And so you have to then divert glucose to them.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And the best way to divert glucose to them is to block it from going other places.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
Right? Now, in this short-term thing, we've basically given other areas diabetes.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Like we've made them insulin resistant on purpose so that we can focus our glucose to the immune cells. The immune cells then show up to the place of injury. This is all a good thing.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
But because of that, we're going to start running into... In fact, we could also be dealing with tears and damage to the actual membrane of the cells, right?

Dr. Tommy Wood
Mm-hmm.

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Dr. Andy Galpin
Them cells could be physically torn, which then is going to allow things coming in and out of the cell that we don't want, and we have, like calcium.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And having other problems with that. That's the normal process. If we were to then go take copious amounts of, say, anti-inflammatories at that stage, and this is probably one of the reasons why they don't do this.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Right? We are probably going to run into issues because we're blocking that natural process, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So we want some sort of, I'm presuming, inflammation immediately, but probably not super excessive.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
But not small-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... either, right? By the way, I'm guessing all this because this is exactly how it works in bone and muscle.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So tell me when I start to deviate here, right? I'm literally guessing.

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Dr. Tommy Wood
So I'll jump in just quickly to say that in general, in brain injury, everybody's thought that these inflammatory responses to injury are a bad thing, and we should try and-

Dr. Andy Galpin
Just like muscle

Dr. Tommy Wood
... try and prevent them.

Dr. Andy Galpin
But yeah.

Dr. Tommy Wood
And so far that has generally failed. And actually, there are some therapies, nothing that's available right now, but there are some therapies that seem to augment some of the initial responses to injury, inflammatory response to injury. So like in the minute, it looks worse, but actually that then ends up resulting in improvement longer term.

Dr. Andy Galpin
There are cascades of drugs that pre-dose pro-inflammatory cytokines and whole-- And then give them to you.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
So like give an exaggerated-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... inflammatory response in, again, another tissue. I'm not surprised it's the same in bone or in the brain. So once we get past that, the issue then becomes if that stays around too long.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And now we're starting to damage mitochondria, and now we're having an issue with regulating energy, and that's why then providing energetic support so that the cell can stay alive.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Right? If that cell now, in the case of the cell we're talking about, the brain cell, runs out of energy, then we're going to die, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And so it's a hard time managing energy. And this is why probably initially, in the case of an acute injury, we want to maintain temperature.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
Right? I know that's one thing we covered a little bit in the paper, but I know you spent a lot of time on because of this process, right? When things get really, really hot, metabolism has a hard time hanging on, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So things get overheated.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Managing blood glucose in general so that this curve is normal, and then at that point, providing energetic support.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So those were kind of the three big areas in the acute setting, where if you were to actually have a real injury and you were to get treatment in a hospital, particularly temperature and glucose are probably the two things they're going to-

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Dr. Tommy Wood
Oh, yeah

Dr. Andy Galpin
... pay attention to most, right?

Dr. Tommy Wood
Yeah. If you were in like a neuro ICU because you had a significant traumatic brain injury, then glucose regulation and thermoregulation are known to be critically important. I think we kind of hypothesize that in much less severe injuries, these things are still relevant, so we should think about them. There haven't been a ton of trials in that area because they're hard to do, but it kind of makes sense that just because you don't have a massive injury doesn't mean that those things aren't important for a, quote unquote, "just a concussion" compared to a major brain trauma.

Dr. Andy Galpin
What about things like at-home brain tests?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So whether these are ... technologies where you can test cognitive function. I doubt there's any at-home concussion tests that you can do.

Dr. Tommy Wood
No. So most concussion tests, they generally require either some kind of baseline cognitive function test. So there's things like the impact test. The military have their own version of this. There's other tests that are probably more sensitive to concussions called the King-Devick test, which is basically you have to read off a complex grid of numbers and letters that kind of overlap if you can't read them properly. But you need a baseline score, and you need the same person to kind of administer it. You also see there are some available devices where you can measure changes in event-related potentials. So, the electrical signal that you get if you show somebody an auditory or visual stimulus that seem to be pretty good predictors of there's actually been an effect of a concussion and then recovery. But all of this kind of requires some kind of specialist to be involved usually.

Dr. Tommy Wood
More broadly, in terms of cognitive function, what's interesting is that there aren't a ton of easily available cognitive function tests that you can just do at home and do repeatedly. There are some apps and things that kind of have some of this stuff built in, but it's difficult to standardize.

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Dr. Tommy Wood
One, depending on if you have, say, access to some kind of healthcare provider, there are nice companies like Craos which give a bunch of standardized cognitive function tests you can do at home on a desktop. A lot of neurologists and neuroscientists use something like that. I think the main cognitive function test that I know of that anybody can do at home for free, and is validated, actually has been put online by a charity that I work with in the UK called Food for the Brain, and they have a validated online cognitive function test that includes measures of executive function, working memory, and processing speed. And you can just go on their website and you can just do it, and you can track it over time. And we currently have a database of more than half a million people who've taken it, and dozens of thousands of them also have done lifestyle questionnaires about sleep and all those kinds of things we talked about.

Dr. Tommy Wood
So we're in the process of doing a lot of research from that database. Right at the beginning, we've just sort of been given access to be able to do some of that. But people can do that test. I will say that in terms of cognitive function tests, it's one of the ones that has the biggest learning effect on the second attempt-

Dr. Andy Galpin
Hmm

Dr. Tommy Wood
... just because of the way this test is structured. So if you're going to do it and you want to track things over time, I would do it a couple of times in succession, so you know it, and then use the second or third time as your baseline. And then track it over time. But there are a number of people now in this space because I can now go to Quest or LabCorp, and I can get whatever blood tests I want, but I can't get a really good, well-validated, multidimensional cognitive function test, so that's something that we and other people are working on.

Dr. Andy Galpin
Any other technologies, consumer-based EEG things that ... And you can or cannot mention the exact products if you'd like.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
But just where does that field stand? I know that there's probably half a dozen or more that immediately come to mind.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
Some of them sit in the front of my head, some-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... in my ear-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... some back places. Walk me through, again, you can give specifics if you want or not-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... but the general lay of the land of at-home based EEG technology.

Dr. Tommy Wood
I think it's an area where there's a ton of promise. It's just figuring out-

Dr. Andy Galpin
That's never a good start.

Dr. Tommy Wood
No, well, I think in a good-- So I guess the short answer is, is there anything that gives you everything you would want right now? Probably not.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
However, with very simple EEG devices, and there are some that are set up in earphones, so I think the one that I know is most widely available, or at least will be soon, is this company called Neurable. The one, the frontal EEG, like Muse, is something that people are going to be familiar with. And actually, there are versions of the Muse that have the sensors around the ear as well. Some of the-

Dr. Andy Galpin
Why does it matter if it's in the front of the forehead versus the ear?

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Dr. Tommy Wood
It depends. And it depends on what you're looking at.

Dr. Tommy Wood
With some of my collaborators, we're looking at different EEG frequencies, and people have heard of alpha, beta, theta, delta, and the different, the relative frequencies and power of these different ... So even within a frequency band, people will have different average frequencies, and then the total amplitude of the wave is the power. And your mean frequency and power in those different frequency bands relates to different aspects of cognitive function. So certain aspects of alpha seem to predict, say, learning speed for learning a second language and some other aspects of cognitive function. Some companies have created focus metrics. So you can tell when your brain is focused. That's either based on certain measures of alpha or sometimes they have an alpha plus beta divided by delta plus theta, or some kind of ratio of the different frequencies. And that stuff is pretty good. The problem is that each individual company kind of focuses on one thing, right?

Dr. Tommy Wood
So you're using it for neurofeedback in kind of like a meditation type-

Dr. Andy Galpin
Muse, right?

Dr. Tommy Wood
... setting. Yeah. Or you're using it to kind of tell when you're focusing well, and then your focus is starting to drop off and maybe it's time to take a break. I think that you could get a lot more And broader information about somebody's cognitive function over time with some of these technologies, even simple setups, but just nobody's really done that yet. So selling focus or selling meditation, that stuff's great. Don't get me wrong, I think it's an important start, but I think there's a lot more that could be done if we had the right information, and we sort of tracked it in people over time.

Dr. Andy Galpin
Yeah. So the only, well, perhaps not maybe the only, but the largest consideration there for the consumer is just that last point.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So it's going to be, at least that I'm aware of, that you're aware of, any consumer-faced product there is going to have one particular aspect-

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Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of cognitive function, but it will almost certainly not test-

Dr. Tommy Wood
Mm

Dr. Andy Galpin
... nor train and help you evaluate other aspects-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of cognitive function, which is not their fault. This is a more than small technological-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... limitations.

Dr. Tommy Wood
It's difficult. Yeah

Dr. Andy Galpin
Really challenging. The calcium question.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
Right? So what does calcium have to do with this entire project? Why does it matter if calcium influx is happening or this excitotoxicity with glutamate? What's that got to do with it? And then does calcium work then as a supplement I can take to enhance cognitive function to deal with brain injury? Walk us through the story with calcium.

Dr. Tommy Wood
So I think this is another area where the brain and muscle kind of tell a similar story, right? We know that muscular-

Dr. Andy Galpin
And the heart

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Dr. Tommy Wood
And the heart, right. That muscular contraction is driven by cycling of calcium, right? And a lot of signaling processes, including mitochondrial function, and then the transfer of information across cells in the brain is driven by waves of calcium. And so that then opens and closes different channels. It activates or deactivates different energetic processes as it regulates mitochondrial function just like it does in the muscles. So when you have large excessive or unregulated influx of calcium into a cell, one of the prototypical downstream effects is mitochondrial dysfunction and eventually mitochondrial death. And mitochondrial death, you essentially have cell death.

Dr. Andy Galpin
Cell. Totally.

Dr. Tommy Wood
Right

Dr. Andy Galpin
That's what you're going to see is cell death.

Dr. Tommy Wood
So when you then think about calcium as a supplement, obviously those two things don't go directly together. You can't take more calcium and then have better regulation of energetics in the brain, unfortunately, because it's just a lot more complicated than that. But I think this is where some other things come into play. We know that vitamin D is really important for cognitive function. One of its role, it's essentially a steroid hormone, but one of its roles is in the regulation of calcium, so that could be playing a role there. We know magnesium and calcium play together and often sort of playing off one another. We know that magnesium is really critical there. So some of these other factors that we know are important for cognitive function may be playing a role through regulation of calcium. But if you were just going to take more calcium, unfortunately, it's not going to end up in your brain and improve cognitive function unless, for whatever reason, you were calcium deficient, which is relatively rare.

Dr. Tommy Wood
Usually, it's other factors, vitamin K status, other things that are playing a big role there.

Dr. Andy Galpin
Yeah. What's the RDA for calcium? 1,000 milligrams a day?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Something like that, right?

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Dr. Andy Galpin
You don't rarely see people, or you don't often see people-

Dr. Tommy Wood
It might even be like 700 or 800 milligrams. It's not that much.

Dr. Andy Galpin
Okay. Maybe you see less then. Yeah. A smidgens of broccoli.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And it's like some dairy.

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
You're probably there pretty close.

Dr. Tommy Wood
If you eat any dairy, you'll hit your RDA of calcium.

Dr. Andy Galpin
Yeah. You're not going to smash that up there. It also seems to be one of the minerals particularly that doesn't like to be outside of its window.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
In the sense that if you get a little bit high on magnesium, particularly if you're really physically active, that's probably okay.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
In fact, oftentimes that's good.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
You don't want to do that with calcium.

Dr. Tommy Wood
No. And it's even more tightly regulated because it's essentially a trigger for so many, and it's how so many biological processes are regulated.

Dr. Andy Galpin
Your heart will stop.

Dr. Tommy Wood
Yeah. So you need it to be in a really tight-

Dr. Andy Galpin
Your brain will stop. It's not a good thing.

Dr. Tommy Wood
... window. Yeah

Dr. Andy Galpin
Way low, way high, so it's not one ... and for those cases, thinking back over your career, how many times do you think you've recommended calcium supplementation based on blood work or things like that?

Dr. Tommy Wood
I think the only time we routinely recommended it was in osteoporotic older individuals, but you were taking it with vitamin D, and we were trying to cover some other bases as well. So just giving calcium on its own, I don't think I've ever recommended.

Dr. Andy Galpin
Yeah. So not in your performance enhancement with your athletes, not in your practice as a medical doctor.

Dr. Tommy Wood
No.

Dr. Andy Galpin
None of those things, right?

Dr. Tommy Wood
No.

Dr. Andy Galpin
I don't think I've ever given it out though. So magnesium, ubiquitously.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Everybody basically.

Dr. Tommy Wood
Hose people down with it. Yeah

Dr. Andy Galpin
Totally. But calcium's probably not one of the ones. So probably not one of the markers we're going to go after for either cognitive enhancement or the brain injury-

Dr. Tommy Wood
Yeah. Mm-hmm

Dr. Andy Galpin
... things like that. Okay.

Dr. Andy Galpin
You have said three things thus far in our conversation that have irritated probably many people.

Dr. Tommy Wood
Are you going to remind them what they are?

Dr. Andy Galpin
I am. And then I want to see if we can go for a fourth.

Dr. Tommy Wood
Okay.

Dr. Andy Galpin
One thing you said was that things like microdosing psychedelics and marijuana probably don't, potentially don't necessarily enhance creativity.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
They certainly enhance your perception of it, but maybe actually you're not doing better work, you're just high and think your stuff is great when it sucks.

Dr. Tommy Wood
Yeah. Uh-huh.

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Dr. Andy Galpin
Okay. That was number one. The whole Internet will hate me for that, too. The second thing you said was actually that you're fairly convinced at this point that we can actually enhance cognitive function.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Which doesn't sound controversial to some, but for others, are going to be really upset about that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And what you mean by that is general.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So that it's transferable to other modes of cognitive function.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
As we just talked about, focus is not the same as executive function. That's not the same as word recall, et cetera.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And that can be improved, and we laid out various cases for that.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Third one you said was that in fact, concussions and brain injuries are not your brain slamming against your skull.

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Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
That probably could happen. It's plausible, but most likely you have either a temperature or distortion or metabolic issue or combinations of those there.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Fourth one, and I've heard you on record, so true or false here. You are of the opinion that dementia and late onset Alzheimer's, not early onset-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... to be clear, are 100% preventable.

Dr. Tommy Wood
I've never said 100%.

Dr. Andy Galpin
Okay. All right.

Dr. Andy Galpin
Okay.

Dr. Tommy Wood
So I would say, so and this really at this point shouldn't be controversial because again, dusty neurological institutions led by establishment individuals would say the same thing. That I would say that the party line is that 45% of dementia is probably preventable. That's from the Lancet Commission run by Gil Livingston and a bunch of experts across the world. It was just updated. It used to be 40%, now it's 45%. They increased the number of risk factors that they included. I would say it's easily the majority because there are some things that they didn't include.

Dr. Andy Galpin
60-plus percent.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
70-plus percent.

Dr. Tommy Wood
Yeah. So other estimates, so say, Yin Tai Yu, who's at Fudan University, and his group have done a ton of modeling and prediction from large population data sets. They think that somewhere between up to 70-something percent of dementia is preventable if we were able to address all the different risk factors that contribute to it.

Dr. Andy Galpin
Okay. So this is an enormous departure-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... from what the lexicon, right? So not only potentially is it a departure from the scientific community, but if you were to walk down the street and just ask people about, first of all, they'll call it Alzheimer's probably, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But dementia, I don't know anyone who thinks that this is anything besides this just happens with age.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Or it's like cancer where it's just bad luck of the draw. Potentially, some people might think, "Oh, if I drink a lot of alcohol..." But I don't think many people think it's anything besides those ones. So not only are you saying that that is not the case-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... but that it is in large part, call it even 40% is impressive-

Dr. Tommy Wood
Yeah

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Dr. Andy Galpin
... but probably more realistically, 70-plus percent of dementia is extinguishable. So two part question, is this a prevention issue or is this a reversal?

Dr. Tommy Wood
Mm. There are certainly some people out there who working with individual clinical cases have said they have seen what they feel is reversal of Alzheimer's disease. That I'm still not-

Dr. Andy Galpin
Hard

Dr. Tommy Wood
... Yeah, hard.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Because once you've reached that point of significant atrophy and significant pathology, it's very difficult to restore function and/or reverse or-

Dr. Andy Galpin
Structurally what you're trying to-

Dr. Tommy Wood
Yeah, structurally, but then also to respond to some of the things that we know improve cognitive function. So this is all prevention. And-

Dr. Andy Galpin
Case studies, maybe things like that, that like-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... in terms of reversal.

Dr. Tommy Wood
Yeah. So some-

Dr. Andy Galpin
Dementia is the same case or just Alzheimer's?

Dr. Tommy Wood
Most of this is focused on Alzheimer's.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
But some people will say, in certain cases of frontotemporal dementia or Lewy body dementia, they've seen significant improvements in cognitive function, and it's by generally addressing the same things. But I wouldn't come here and promise reversal. But I do think prevention, there's massive potential. And-

Dr. Andy Galpin
Slowing down onset or slowing down progression is certainly a thing.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
We'll talk about that separately.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I'll keep it going. I'll bring it back to that. So there's reversing, there's stopping the progression-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... and then there's stopping it from happening.

Dr. Tommy Wood
Yes.

Dr. Andy Galpin
So okay, continue on with the prevention piece.

Dr. Tommy Wood
So and I think all of this is essentially connected, and the same risk factors apply essentially across the board, regardless of where you're trying to intervene. It probably just gets harder the further you go along. So when they classify them in the Lancet Commission report, they sort of classify them by stages of life. So early life, the most significant modifiable risk factor is education. So the more years of education you have, the lower your risk of later dementia. And then late life cognitive stimulus also becomes important. And that's been shown again in meta-analyses by Professor Yin Tai Yu's group and is incorporated into this Lancet Commission

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report. So I think that's a good place to start because it fits with my worldview that stimulus is really important.

Dr. Andy Galpin
That's always great.

Dr. Tommy Wood
And so-

Dr. Andy Galpin
And you have, by the way, you and Josh have a paper, open access paper. We'll fully link to that in the show notes, so you guys can go fully read that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Continue on. If you want to read this whole breakdown, that paper will be up for you.

Dr. Tommy Wood
Yeah. So you can kind of hear or think about this idea, and again, it's sort of driven by that same idea. That stimulating tissue, like the function of a tissue, is directly proportional to the stimulus applied to it. The liver's the same, the immune system's the same, muscle's the same. And so when you look at trajectories of cognitive function across the lifespan, and there are multiple meta-analyses, and a lot of this has to be observational, but what you see is that those who have more years of education, they have a higher peak of cognitive function, and that's you spend more time devoting more resources to enhancing cognitive function.

Dr. Andy Galpin
I'm sorry to cut you off for, like, the fourth time.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But I have to linger on that point. It makes intuitive sense that the more time I spend on education, the enhanced cognitive function I have.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? But that's not what you just said.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
What you just said was you reach a higher peak.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I hope people are thinking into what the heck that means, right? We all can progress, we can improve, but getting to a higher total maximum peak is really not the same as just increasing in speed.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And what's stunning me about this, and I'll keep going back to it, you will see the same thing with bone.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
The maximum bone density you get is going to be predicted by what you did between ages 10 to 14.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Now, the rate of increase is pretty much ubiquitous. Up and down is the same, but determining how high that peak is, is all about what you do in that window.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So I'm just so stunned right now that I knew the increase. I certainly would've said, "Hey, would you improve cognitive function?" Yes.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
If you train.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
But I was not anticipating you would say that the height of that peak is going to be determined by that as well.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Because you're going to deal with the downside the rest of your life.

Dr. Tommy Wood
Exactly. Yeah. And so, a lot of other things go into that, but you generally see that the higher your-- So if you think about peak cognitive function, which depending on what cognitive function you're looking at and how you measure it, the peak is going to be somewhere between 20 and 30 years old, and generally an individual peaks sometime around the time they finish formal education. So all of that kind of lines up to say that the more time you spend on that, the higher the peak, and at that peak, the peak is higher in those who, on average, you have longer education.

Dr. Andy Galpin
Across multiple methods of testing cognition.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Your cognitive function. Yeah.

Dr. Tommy Wood
And you have to talk about the fact that different people get access to longer periods of-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... and so all of that plays-- Socioeconomic status plays a big role, and access plays a big role here. But I think in the Lancet Commission report, they said that 5% of dementia was preventable if just everybody got adequate-

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Dr. Andy Galpin
Went to school. Yeah

Dr. Tommy Wood
... yeah, got adequate education. And the reason for that is, so if we then imagine some trajectory of cognitive decline that occurs in everybody on average, and the rate is different, and we can change the rate of decline, but if all you did was educate people more early in life, they would have a higher peak. The rate of decline would be the same-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... but they'd reach the point of dementia later. Because they've started from a higher peak, the same rate of decline means they reach dementia later, and maybe they die of something else first, and they never get dementia. So that's how that then happens. We also-

Dr. Andy Galpin
Quickly define age there, early in age. Is that adolescence? Is that high school? Is that all of it, just kind of ubiquitously?

Dr. Tommy Wood
In terms of what?

Dr. Andy Galpin
You just said that the higher and more education we give them early in life.

Dr. Tommy Wood
Oh, yeah. So this is just the traditional education years.

Dr. Andy Galpin
Got it. Okay.

Dr. Tommy Wood
So you go up-

Dr. Andy Galpin
Just not a specific, "Hey, between age five and eight is the most."

Dr. Tommy Wood
No.

Dr. Andy Galpin
Okay.

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Dr. Tommy Wood
So it's just total years of education.

Dr. Andy Galpin
Got it.

Dr. Tommy Wood
So did you do complete high school, bachelor's degree, graduate school? There's sort of a roughly linear-

Dr. Andy Galpin
Got it

Dr. Tommy Wood
... relationship.

Dr. Andy Galpin
Okay.

Dr. Tommy Wood
And then there are several studies that show that late-life cognitive engagement or stimulus, and they've measured it with how often you read books, and go to museums, and all these kinds of things, or they've done it through how cognitively stimulating is your work. That then also slows or is associated with a slower rate of decline, and also a slower or a lower risk of dementia. So there was one study they actually included and sort of stole the forest plot from it, and they include it in the Lancet Commission report. They had early life education, and then they had how cognitively stimulating your job was. And what they saw was that people who had more early life education but not a stimulating job, and cognitively stimulating job, and people who had less early life education but a cognitively stimulating job later in life, they had about the same risk of dementia. So you can offset a lower education early in life with more cognitive stimulation later in life.

Dr. Tommy Wood
The lowest risk was obviously those who had both. But yes, there's a huge amount of benefit you get from that early stimulation through education, but it's not like you're now written in stone like, "This is your destiny. Now you have a higher risk of dementia if you didn't get that," because there's lots of evidence to suggest that stimulation, either through your job or other things, will then slow that decline later in life. So you can still do something about it later on.

Dr. Andy Galpin
It's so interesting because you're halfway between muscle and bone now.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Such that the muscle you develop as a child has almost no bearing-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... on how much muscle you can develop. If you start lifting weights for the first time at 50, your rate of increase in muscle growth will be the same-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... as if you lifted weights when you were 10 or not, or basically anything like that. So in that case, earlier development has very little bearing on progression, so the rate of increase. That said, bone is the opposite. Whatever you get basically as a kid-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... in large part is going to determine where you're out there. So you have this halfway house of where muscle is not reliant upon when you're a kid. Bone was almost entirely. And now what you're saying is brain is a little bit of both. You got to either one.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
You can do it early in life, you can do it late in life. Obviously, both is great. Or worst case here, and I would have to imagine, I don't know if you actually know the numbers here, but the folks that were the double-dipping on the bad side.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So no education and low cognitive demanding job, I have to imagine their rates of Alzheimer and dementia as well as progression is probably the most aggressive there.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
By an order, maybe not a magnitude, but some fold.

Dr. Tommy Wood
Yeah. So in this paper that was published in the BMJ a few years ago, that was your reference group, and then everybody else just did better.

Dr. Andy Galpin
Just 2.0s, 2.7s.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Just doubling over there. Okay. So I guess if you had a great childhood education, tremendous. Don't rest on your laurels. Continue to challenge-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... cognitive demanding, whatever that may be.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If you didn't, though, you still can-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... regain much of that by doing something. Just don't use that to have your mind-numbing job as we are there. So it is, in either case, largely preventable. I think the departure here is early onset Alzheimer's-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... is a different ballgame entirely here.

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I don't want to spend too much time here, but now you're probably looking at probably opposite, like 70-plus percent is maybe even higher, is genetic-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... and just bad draw here.

Dr. Tommy Wood
So I think just to finish the first piece, we think about life stages, and then think about the life stages of risk factors, then in the middle of life, a lot of what they're talking about is body composition, physical activity Smoking, alcohol, all the stuff that we've talked about already. In terms of if we eliminated those, we could eliminate-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... the related dementia. And then one thing that we haven't talked about before, or at least not related to this, is sensory inputs. So that's some of the late-life risk factors they talk about.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
Obviously, brain trauma is another one in mid-life.

Dr. Andy Galpin
Don't retire.

Dr. Tommy Wood
Yeah. But no, sensory inputs are like vision and hearing.

Dr. Andy Galpin
Yep.

Dr. Tommy Wood
So there's now a pretty good body of evidence that suggests that if you have cataracts, you have a higher risk of dementia. That risk is reversed if you have cataract surgery. If you have

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hearing loss, like presbycusis as you get older, you have a higher risk of dementia. That is reversed, particularly in high-risk people, if you get hearing aids. So if you start to lose a sense, and a lot of people are just like, "I'm going to battle through because I don't want to have a hearing aid," or whatever.

Dr. Andy Galpin
Oh.

Dr. Tommy Wood
Don't do that. If you start to have hearing loss, get a hearing aid because that's going to be associated with a lower risk of dementia. So making sure you're still getting those sensory inputs into the brain remains really critical.

Dr. Andy Galpin
So don't lose your sense of smell, don't lose your vision, don't lose your hearing. Probably in the, I'm going to guess, 50 to 60 year range, if you start getting in that age window-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and you start seeing precipitous declines in any of those functions, then you want to reverse that-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... as quickly as you possibly can.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Because of what you've been saying all day.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If you can't hear, stimuli doesn't go in there-

Dr. Tommy Wood
Yeah

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Dr. Andy Galpin
... then that part of your brain presumably dies.

Dr. Tommy Wood
It makes perfect sense, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
You're not using those networks anymore, so they're going to decline, but then everything else they're connected to is going to be affected as well.

Dr. Andy Galpin
I assume the same thing is true with proprioception in terms of balance.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Things like that, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So make sure that you continue to train balance, work on balance. I think this is a pretty easy story to tell for exercise in nature.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? Exercising in the outdoor. Exercising inside in the gym is great, but now you're outside, you're going up and down, you're seeing different things-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... hearing, smelling.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
So on and so forth.

Dr. Tommy Wood
Differing light exposures, like the effect of, say, seeing green spaces on autonomic nervous system regulation. There's a ton of-

Dr. Andy Galpin
Temperature is different.

Dr. Tommy Wood
Yeah, there's a ton of different ways that could-

Dr. Andy Galpin
Yeah. Okay. So I'm on board there. It's highly preventable. You said this earlier as well. You talked about exercise a bunch.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
This was one of the more stunning parts about our earlier conversation when you said, and I'm stupefied that I never made this connection. I've said this 1,000 times. Plus thousands of times. And I never really grasped the fact that when you exercise, you're going to have neurological neuroplasticity.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Nerve, nerve, nerve. But then the actual structure of the brain, and I promised I wanted to come back to this.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So here we are coming back to it. It's the second time I've actually come back to a topic I said I wanted to come back to. But I want you to explain this to me about what areas of the brain physically are improved by exercise? Does it determine or does it depend on the type of exercise?

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
Is strength training different? Do we know any details about the exercise? Is it a certain amount of sets or reps or styles? What do we know? So what do I do and how does it actually help? And then the last part about that is there a law of, "Hey, I didn't start soon enough."

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
"So now it's too late."

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
All right. So give me the jazz on how lifting weights makes my brain... What do you call it? Bigger muscles, bigger brains or-

Dr. Tommy Wood
More bigger, more brainier.

Dr. Andy Galpin
More bigger, more brainier. There you go. I've heard you say that before.

Dr. Tommy Wood
So a good place to start is the first ever study, I think, that was done that showed that you could increase the size of a certain part of the brain in humans was with an exercise intervention. It was published in 2011.

Dr. Andy Galpin
Exercise for the win. I'm telling you, folks.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Exercise scientists run science. You just don't like to admit it.

Dr. Tommy Wood
So this was published in PNAS in 2011, and what they did is they-

Dr. Andy Galpin
Oh, that recent?

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Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Oh, wow.

Dr. Tommy Wood
Yeah. So before then, we knew that if you just looked at brains of people who'd recently died, you could see that there were certain areas of the brain where there was some neurogenesis, particularly the dentate gyrus of the hippocampus. But to actually physically see an increase in size of a part of the brain, this was the hippocampus, which is generally just thought to get smaller and smaller over time. That hadn't been seen before.

Dr. Andy Galpin
Yeah. Hard to do in humans.

Dr. Tommy Wood
Yeah. And so the other side of that is that we don't know if there's more neurons being generated. We know it's bigger, right?

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
So this is like it could be glia, it could be extracellular matrix. There's a whole bunch of things that go into that, but that doesn't necessarily matter. We see improvements in brain structure and volume with an exercise intervention. So what they did in this study, individuals in their 60s and 70s, they had them do a walking program 40 minutes, three times a week for a year. That's it. Brisk walking. And that was enough to significantly improve or increase the size of the hippocampus.

Dr. Andy Galpin
These are non-exercisers?

Dr. Tommy Wood
These are non-exercisers.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
Yeah. And they sort of worked their way up to a certain intensity, and they did it for 40 minutes, three times a week for a year. The increases in size of the hippocampus correlated with

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improvements in VO2 max, which also correlated with improvements in or increases in production of BDNF, brain-derived neurotrophic factor. So in a sedentary population, we know we can see improvements in the structure of the brain with aerobic exercise. What was interesting is that in this study, they didn't necessarily see significant improvements in cognitive function. They saw improvements in structure, but function didn't necessarily track with it.

Dr. Tommy Wood
Part of this is probably an intensity piece.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
So there was a very recent study that looked at different levels of intensity of exercise, aerobic exercise again, and structure and function of the hippocampus. So now we're thinking about memory-related tests And they found the greatest benefit in individuals doing a high-intensity exercise training, and it was essentially the Norwegian four-by-four protocol. Four minutes at 75% to 80% VO2 max heart rate. And they saw maintenance of structure of volume of the hippocampus compared to control groups, where those decreased, and improvements in cognitive function, they think related to that area of the brain. So some aerobic activity of any kind in people who are sedentary, if it improves their cardiovascular fitness, then you're going to see improvements in brain structure. To see correlated improvements in brain function, intensity is probably going to be important. In that study, they're generating a ton of lactate, whereas they weren't in that original walking study.

Dr. Tommy Wood
So that could be one way of that happening.

Dr. Andy Galpin
Lactate for the win again.

Dr. Tommy Wood
So, in general, what you see across multiple studies is that the gray matter of the brain, so now we're talking the outer cortex and the hippocampus primarily, seems to be benefited by aerobic exercise. And in general, aerobic exercise seems to be associated with improvements in memory. Again, the hippocampus is really important there. If we're thinking about the amount that you have to do, it's essentially going to be two or three times a week, some kind of activity that is improving your cardiovascular fitness wherever you've started from. But probably at least once a week, doing something that's very intense. Some kind of sprint type or high-intensity interval training. At least that's what sort of aligns with the literature.

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Dr. Tommy Wood
In terms of resistance exercise, you see benefits in different areas of the brain. So resistance exercise seems to primarily benefit the white matter, which kind of sits between the cortex and the deep brain. And that's where you have your myelinated axons, the fast connections.

Dr. Andy Galpin
The hyper-speed zone.

Dr. Tommy Wood
The hyper-speed zone-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... is the transfer of information-

Dr. Andy Galpin
Yeah

Dr. Tommy Wood
... from the brain to the body and throughout the brain. And so we actually just published a review paper talking about the studies where they'd done a resistance training intervention compared to a control group and then looked at brain structure over time, and this is what you see is either improvements in the white matter or prevention of decline of the structure of the white matter. And then that's also associated with improvements in cognitive function, particularly with resistance training executive function, so like prefrontal cortex function. So different areas of the brain affected by different types of exercise, which are then associated with different improvements in cognitive function. The minimum effective dose for sustained improvement seems to be two sessions a week. Like super standard six to eight exercises covering the whole body for three sets of eight to 12 reps. Just like the most basic resistance training program twice a week for at least six months, and you see significant improvements in brain structure and associated cognitive function.

Dr. Tommy Wood
So those are kind of the different ways that those different exercises kind of come together. Then you get more of a glo-- If you do both, hopefully some kind of global improvement in cognitive function.

Dr. Andy Galpin
So it is never been shown, I know this, but it would, based on all that, be reasonable to presume if I wanted to develop an exercise program that was specifically targeted with the primary

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objective of keeping my brain as healthy as long as possible, not necessarily my body composition or muscle or strength or anything like that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I wanted to do an exercise program for that. One could theoretically say, okay, lift weights a couple of days a week-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... in exactly what you'd mentioned. Five to eight exercises, whole body.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
A couple sets each.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
That'd be two days a week.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
One day a week, do something that is closer, let's just even say the Norwegian-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... four-by-four.

Dr. Tommy Wood
That's a great option, yeah.

Dr. Andy Galpin
Four minutes of the highest amount of work.

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Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
People get mad when you describe this as four minutes of max effort or all out.

Dr. Tommy Wood
Yeah, because it's not... Yeah.

Dr. Andy Galpin
You can't go all out for four minutes. But the highest amount of work you can do for four minutes-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... rest for four minutes and do it again. I don't really think, friends, I cannot imagine a world in which that specificity matters.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
You don't have to do the four.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
You could probably do just about any type-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of high intensity endurance conditioning work, and it would probably be the same. But let's just say for simplicity, you did four by four once or twice a week. Was that those interventions?

Dr. Tommy Wood
I think they were doing it three times a week.

Dr. Andy Galpin
Okay.

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Dr. Tommy Wood
But if you're doing other aerobic exercise and resistance training, I think you're probably not going to need to do... Like a four by four three times a week, that sucks.

Dr. Andy Galpin
That's pretty damn hard.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Especially for six months straight.

Dr. Tommy Wood
Extended periods of time, yeah.

Dr. Andy Galpin
Yeah. I'm going to say realistically, as an exercise scientist, I'll give you permission to cut that to two-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... per week.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And then maybe one to two or three sessions a week of the more lower intensity standard endurance exercise, cardio, whether this is even physical activity, walking.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Or would they actually need to do more like 50, 60% heart rate for that kind of cardiovascular adaptation?

Dr. Tommy Wood
So, this is the age-old question is what's the exact intensity required to see-

Dr. Andy Galpin
Yeah

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Dr. Tommy Wood
... a specific adaptation? I think that, and it's the same, we did a podcast talking about the four by four study-

Dr. Andy Galpin
On your podcast

Dr. Tommy Wood
... on my podcast. And then somebody was like, "Well, what if I can't maintain my heart rate in that zone for that long?"

Dr. Andy Galpin
Yeah. I get it.

Dr. Tommy Wood
And like, just do it. Yeah, right. Do whatever you can for four minutes, and you'll get better over time. And so I think it's the same thing.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
If it's a casual stroll, you're probably not getting adaptation, but equally, if a brisk walk is hard work for you, then that's going to be a good place to be.

Dr. Andy Galpin
Yeah. This one riles me up so much because I get it. People want specific numbers, but I'm so resistant to do that because it doesn't actually matter usually.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It's a rough concept of where you're at.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
So if those numbers help you, great.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
But something like that, here's the reality. Don't think that your brain all of a sudden won't adapt-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... if you do half that.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If you did one day of lifting, one day of intervals, and a couple of days of walking, it's better than the zero.

Dr. Tommy Wood
Oh, yeah.

Dr. Andy Galpin
It's a lot better.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So you don't have to hit that minimum number to get any effect whatsoever, right? Probably getting closer to that final destination, but if that takes you six months or six years to get to where you can handle that, that being that little three-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... protocol we talked about, it's fine.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Get there eventually.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
And you'll probably get much of the benefit, which is great.

Dr. Andy Galpin
This actually answers a big question that I have dealt with a lot. You and I actually have a paper together again that you led where we found physical strength predicted, I think it was 5%-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of cognitive function, right? And I'll say that again. Physical strength predicted 5% of cognitive function.

Dr. Andy Galpin
People have talked about at length how leg strength, how grip strength fires people up, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And the common claim here is like, "Oh, grip strength is just a proxy for overall health."

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And certainly true.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
If you look at research on folks that have dementia, you'll see, I think actually one paper found, I can't even think it was a UK Biobank paper, about a half a million people in it, found that I think 30% of Alzheimer's death was explained by low grip strength.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? Not a small number.

Dr. Tommy Wood
And there's a recent study showing that frailty precedes Alzheimer's by several years, on

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average.

Dr. Andy Galpin
Multiple years, I would imagine, right?

Dr. Tommy Wood
Yeah. And if you're frail, you're not doing all the things that we know continue to stimulate or support brain function, right?

Dr. Andy Galpin
So what I want you to kill, and perhaps this is a fifth thing that'll irritate the internet that we're going to call it, is the idea that this stuff, the grip strength, leg strength, is exclusively an indirect or a correlation, right? Of course, there are some-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... folks who are struggling with dementia are probably also then going to struggle with movement, and there'll be a backwards direction, right? There'd be a causation, but it would kind of be backwards-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... causation, right? So end this horrible idea that strength is only a correlation to brain health, and you just actually kind of answered the question before-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... which is like, how is it actually causal? But then spell this out as directly as possible so I can cut this clip and send it to people every damn time I get told, "It's just a correlation."

Dr. Tommy Wood
Technically, people are right. A lot of this comes from epidemiological research.

Dr. Andy Galpin
No, no.

Dr. Tommy Wood
Correlation isn't causation. However, there were several studies we just talked about, some

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where you randomize somebody to a resistance training intervention. Their strength improves, brain function improves, right? Brain structure improves. And actually related to the point that you were making in one of those studies, yes, you see sustained improvements in white matter structure with two sessions a week, but you got improvements in cognitive function with just one session a week, right?

Dr. Andy Galpin
Bingo.

Dr. Tommy Wood
These effects, particularly if people aren't doing much exercise, are essentially linear. And like-

Dr. Andy Galpin
So if you could ask for a more causal function and structure benefit-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... and in a dose response.

Dr. Tommy Wood
Yeah. So-

Dr. Andy Galpin
What else do we need here?

Dr. Tommy Wood
That essentially says it's causal, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So depending on the type of research, of course, people are right. You can't tell causation. However, what people also don't necessarily understand is that in a perfect epidemiological study, if you could account for every confounder and mediating and moderating relationships, what you have left is causation. That is like-

Dr. Andy Galpin
By definition

Dr. Tommy Wood
... that is a definition of causation. So yes, epidemiological studies technically don't show

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causation, but if you could-- It's difficult because you don't always get the variables you want, right? You can determine causation from an epidemiological study. That is possible. That's allowed in a frequentist model of statistics.

Dr. Andy Galpin
I'll count that as like 4.5 thing that the internet's going to get mad at. Yeah. I don't think people understand basic statistics with that.

Dr. Tommy Wood
Yeah. So right. The people have worse physical health. We know, so in the study that we did, if you had higher blood sugar, higher HBA1c, you had lower strength. But I think that's also bidirectional, right? More insulin resistance, that's going to worsen muscular function. But if we think about the potential mechanisms by which this happens, if you're doing things that improve strength, that's a direct neuromuscular stimulus. We've already talked about the importance of stimulus. The next important thing is that your skeletal muscle is your biggest and most important glucose sink. So if we're thinking about the importance of energy regulation, then your muscle, the more muscle you have and the more you move it, the greater amount of glucose you can move through that system. And this has been done for decades and decades and decades. So your skeletal muscle and your physical activity are two of the best ways to improve glucose handling and energetic handling more broadly.

Dr. Tommy Wood
And then the final piece is that when you contract your muscles, you release a whole bunch of stuff, right? Your muscles are organs. So lactate, BDNF, MOTS-c, irisin, LAC-PHI, pick your metabolites of-

Dr. Andy Galpin
Cytokines, extrakines, myokines

Dr. Tommy Wood
Yeah. IL6. Whatever it is, pick your favorite metabolite du jour.

Dr. Andy Galpin
Right.

Dr. Tommy Wood
We're still discovering on it like taurine. We're still discovering on a weekly basis the things that are released during exercise that have broad benefits. So all of that comes together to suggest that, yes, it's a bidirectional relationship, but by improving muscular size and strength and function, and those usually go together, but not always, depending on who you are. There is four or five, if not more, different mechanisms that would directly relate to improvements in cognitive function and brain health.

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Dr. Andy Galpin
I hope that ends the conversation. I'm going to move on, although we could probably have done a whole ... conversation just on that. But one little piece here, it makes sense to me energetically-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... based on what you just described. It makes sense to me from a neuromuscular perspective that the strength training works backwards, right?

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
And so the same neurological system that makes you squeeze your hand together, it starts in your brain, keeps it alive. How does the white matter, what's the stimuli from exercising muscle? Because it makes sense when I think about muscle.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It doesn't happen this way, folks, but as a teaching point, if you think about I lifted some weights, the muscles that I contracted, they pulled, they got stretched, they contracted, they got damaged.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Again, it doesn't happen this way, but I can paint that picture in my head. I'm not stretching the tissue-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... in my brain when I'm-

Dr. Tommy Wood
Uh-huh

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Dr. Andy Galpin
... lifting weights.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So how am I generating more or preserving my physical tissue outside of the metabolic and the astrocytes and the nervous system side?

Dr. Tommy Wood
Yes. So I think all of those play an important role.

Dr. Tommy Wood
For instance, we know that as we age, things like changes in metabolic health and white matter structure in the brain probably better track with cognitive function than, say, something like amyloid accumulation in your brain. Actually, the trajectory follows more closely, and that's going to be related to ... So the white matter trajectory is going to be related to things like metabolic health for the reasons we talked about. But I think there's a direct stimulating effect, right? As you are both learning the new skill of the muscular control required to move weight in that way, I think you're directly stimulating some of those pathways. So pathways relate to motor pathways, or white matter pathways associated with motor control. I think you're directly stimulating those, and then we know as you stimulate those, you offset all those things we talked about earlier in terms of adaptations that improve structure and function.

Dr. Tommy Wood
And then more broadly, I think that's where some of the signaling pieces come into play. What's interesting is that there is an overlap in some of the things that are produced in aerobic exercise versus resistance training, but we do see region specific effects. So it's probably there's some coupling of what's going on, like a specific stimulus plus the hormonal milieu or the myokines and things that are released. And I think it's some combination of that. It's really hard to test these mechanisms in humans, and it's actually also really hard to get rats to do bicep curls. So it's-

Dr. Andy Galpin
Squats is easy, but yeah

Dr. Tommy Wood
... Yeah. Or because they have like, they do-

Dr. Andy Galpin
Pull-ups

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Dr. Tommy Wood
... they do weighted wheels, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So it's kind of like a weighted Jacob's Ladder kind of thing-

Dr. Andy Galpin
Yeah. Yeah

Dr. Tommy Wood
... is what they do for resistance training in rats. But I think it's some combination of those things.

Dr. Andy Galpin
If you look at this from the muscle, skeletal muscle perspective, I should probably be saying it that whole. I always say muscle, skeletal muscle.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
All right. A little bit different. It doesn't require damage.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
There's another thing that people have this false thought of you have to break a muscle down to grow back, which is fundamentally not only not true, but it actually doesn't happen very often.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Right? It's not generally what's causing muscle damage. It's not causing soreness, and it's definitely not the stimuli to grow.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
You can simply change energetics-

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Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and stimulate muscle growth, skeletal muscle growth.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I can't see why you couldn't do that in the brain.

Dr. Tommy Wood
Yeah. It's-

Dr. Andy Galpin
It's the same thing.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
It doesn't require a stretch and a damage.

Dr. Tommy Wood
Yeah. All of these adaptations are driven by an increase in energetic flux, right?

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
That's what it is at its most basic state, and then that drives neuroplasticity, it drives autophagy, it drives all these other regulatory processes that we know are involved in aging and reversing those. And so anything you can do locally in muscle, increasing energetic flux through aerobic exercise, and then the same, any stimulus in the brain, you're increasing the amount of energy that's moving through the system. That acts as a stimulus that then the same processes occur.

Dr. Andy Galpin
Is that why you think those different modes of exercise produce different actual brain adaptations?

Dr. Tommy Wood
I think that's part of it, yeah.

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Dr. Tommy Wood
But all those things seem to ... Dissecting those exact pathways hasn't been done, but if you think about, well, you do a heavy set of leg press, so you release a ton of lactate, right? And you release a lot of lactate when you do the four-by-four protocol, but you seem to get different responses in the brain.

Dr. Andy Galpin
Really?

Dr. Tommy Wood
So it's the combination of multiple things sort of coming together.

Dr. Andy Galpin
All right. Fascinating. We're going to press the button on more things you're going to irritate- ... the world about.

Dr. Andy Galpin
I don't need the full dive here.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Give me the, what we used to say in the '90s and 2000s, the Reader's Digest version.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
I only now recently realized that kids have no idea what that means.

Dr. Tommy Wood
No.

Dr. Andy Galpin
That analogy now, people are like, "The what?" I'm like, "All right. TLDR."

Dr. Tommy Wood
Because-

Dr. Andy Galpin
Okay, fine

Dr. Tommy Wood
... yeah, TLDR. Well, nobody reads anymore.

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Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
So .

Dr. Andy Galpin
Right. You mentioned tau-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and amyloids.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And for folks that don't know this story, these for many years have been surrogates or markers of, would you say brain aging? Brain damage?

Dr. Tommy Wood
Well, yeah, sort of the brain pathology that then-

Dr. Andy Galpin
Brain pathology

Dr. Tommy Wood
... leads to Alzheimer's disease. Yeah.

Dr. Andy Galpin
Right. And then recently, some information came out that perhaps we'll just leave the person nameless, but one of the prominent scientists in this area had, we'll just say, not necessarily fake data, but there was some controversy, and so I've seen reactions-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... that are on one side of the equation of like, okay, he just used a couple of pictures in grants. Scientists do this all the time. He didn't fake data.

Dr. Tommy Wood
Mm-hmm.

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Dr. Andy Galpin
He just kind of got lazy. You submit grants and grants and grants, and you're using a representative image to show a concept, it's not that big a deal.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
All the way to reactions on the other side of the equation, which is, okay, 30 years of research in this area is all thrown out now.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
If you feel like you can't answer this quickly, then that's okay. Feel free to pass. But where at do we know-- Should people still be worried about this approach? Because you can test it. People pay to get it tested. How much should we worry about tau in relation to brain health?

Dr. Tommy Wood
Yes. So this is a long question to answer because-

Dr. Andy Galpin
I know

Dr. Tommy Wood
... essentially it starts with Alois Alzheimer and his mentor Emil Kraepelin in Germany in the beginning of the 20th century. However, I think we can say that there has been this overriding, or there's still the overriding idea that Alzheimer's disease is driven by something called the amyloid cascade hypothesis.

Dr. Tommy Wood
Amyloid precursor protein is produced in the brain normally. It's really important for neuroplasticity, a whole bunch of things. If you got rid of APP and amyloid entirely, basically the brain doesn't function at all.

Dr. Tommy Wood
But this precursor protein can get cut in different ways by these secretases. One version of that accumulates to create these sort of waxy amyloid plaques. When that happens, that then stimulates the production of tau. So tau is normally part of the microtubule cytoskeleton of neurons, really important for directing axons and where they go and how they connect. And it sort of dissociates from that, becomes phosphorylated, and accumulates. And then that damages neurons.

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Dr. Andy Galpin
So the buildup of tau is generally associated as a bad thing.

Dr. Tommy Wood
Yeah. And then that sort of damages neurons, and that's associated with loss of function.

Dr. Andy Galpin
You can pick your poison here. If you look at sleep-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... you will see basically an inverse relationship with sleep efficiency or sleep quality and tau buildup. Like you could pick this in any realm of there, and it'd be hard to ignore all-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... of those papers.

Dr. Tommy Wood
So I think this certainly plays a role. I think that, and there's been an increasing number of voices that say that there are other things that have to be playing a significant role here as well. So we've become really hyper-focused on this one pathway, when this pathway, like you said, is triggered by a whole bunch of things that we know have effects beyond how it affects that pathway, right? We know that sleep is important regardless of the fact that if you don't sleep, you accumulate a bit more amyloid in the brain, right? And we know that tau accumulates after head trauma, but there are other effects that head trauma has beyond its effect on tau. So we've kind of really hyper-focused on this pathway, but there's a bunch of other stuff that's happening at the same time. And I think while we shouldn't throw the baby out with the bath water, because some of that is certainly playing a role, I think we'll miss a huge amount of benefit in people if we don't focus on the other things that are going on at the same time.

Dr. Tommy Wood
And so there's been some studies with amyloid where a similar problem, some issues with the data, maybe some of it was duplicated or fabricated. I think there's enough evidence to suggest this is playing a role. I just think the role is probably smaller than we've kind of assumed it to have.

Dr. Andy Galpin
Yeah. I mean, I'll say that for you because I'm not in this field. You may have to save face a little

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bit, but I can only speak of this from my area of science, and I've seen this game play out.

Dr. Tommy Wood
Mm-hmm.

Dr. Andy Galpin
Where the funding sources, the national funding sources, just start onslaughting. And probably for good reason. Initial papers come out, it gets really exciting, and they just put all the dollars-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... on one particular thing. And this is by my read of the situation from the outside, and this is basically what happened, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And it becomes really hard with anybody else with an idea or an approach or a metric to get funding because they're just throttling it all on one area. And then when information like this comes out, it becomes really disheartening and upsetting to folks who got their ideas shut down for-

Dr. Tommy Wood
Yeah

Dr. Andy Galpin
... careers.

Dr. Tommy Wood
Mm.

Dr. Andy Galpin
And going, "We told you to stop focusing on that."

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
And I think that's somewhere in the neighborhood of a fair criticism.

Dr. Tommy Wood
If people are interested in this history, they should read the book "How Not to Study a Disease"

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by Carl Harrop, which kind of documents this exact process.

Dr. Andy Galpin
Mm.

Dr. Tommy Wood
And that step that you were talking about, this happened with the NIA, the National Institute on Aging.

Dr. Andy Galpin
Yep.

Dr. Tommy Wood
They essentially said that Alzheimer's and amyloid were synonymous through a few different position papers over time. And so then it came to the point where if you wanted to start to study Alzheimer's disease, you had to study amyloid. That doesn't mean that amyloid doesn't play a role. It just means that they kind of purposefully ignored a lot of other research of important things that are taking part in the process as well.

Dr. Andy Galpin
Man, just beyond frustrating.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Ah, just the whatever. Okay. We'll save our peace on that. I've got a handful of really quick questions just to finish this off here. But before we do that, a really fast recap. You've irritated the world on at least five points. And gave us a lot of light on if you want to enhance cognitive function, you're good, but you're trying to go to great. You talked about a lot of different ways to do that. Search for novelty and probably vision-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... and hearing and brain training and different things like that. And an important note there is just because that actual cognitive task is impressive or complicated doesn't necessarily mean it's cognitively demanding.

Dr. Tommy Wood
Yeah.

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Dr. Andy Galpin
Especially if you've been doing it a long time, right?

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
Whatever that task may be.

Dr. Andy Galpin
If you're having some sort of deficit, brain fog, we'll call it, and you called it some other technical word, I'm going to call it brain fog, right? Make sure that you don't have some sort of holistic hole that is literally burning extra cognitive energy. And so it's not that you have brain fog per se, it's just that you are actually low on cognitive fuel physically because of external stressor or sleep or alcohol. Like some other micronutrient deficiency is most likely at play there, right? That's the most likely explanation. Or inflammatory from long COVID-

Dr. Tommy Wood
Yeah. Mm-hmm

Dr. Andy Galpin
... like some other process like that.

Dr. Andy Galpin
Percussions are not your brain slamming against your skull wall. And then a lot of strategies to what they actually are, and that explained why those strategies work. And then that things that Like marijuana and psychedelics, not to dwell on them, we spent very little time on those.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
We could probably discuss that further. But perception is not necessarily the same as subjective-

Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... in terms of cognitive function. And I forgot the other ones you irritated people with, but we covered many of them. So lastly, really fast, because you covered a lot of areas, I tried to do my best to ask the quick questions along the way, but I surely missed plenty. So question number one is, if somebody has questions for you on these things-

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Dr. Tommy Wood
Mm-hmm

Dr. Andy Galpin
... what's the best way that they can learn more from you? Can they contact you directly? How does this work?

Dr. Tommy Wood
The best place is probably, so I have a podcast, "The Best of Brain Fitness" podcast. Josh Turknett, who's a neurologist, is my co-host.

Dr. Andy Galpin
A neuroscientist and a neurologist working together.

Dr. Tommy Wood
So, and then we can come at it from those relative points. And so if it's more clinical, he'll cover it. If it's more basic science or statistical or something, then I'll cover it.

Dr. Andy Galpin
And that's a weekly show or every other week or something like that. Yeah.

Dr. Tommy Wood
And so-

Dr. Andy Galpin
On YouTube and all the normal places

Dr. Tommy Wood
... all the normal places.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And, so you can, it's a question and answer style show. So you submit a question, and then we'll answer it, one question every episode. And so that's nice because if you have a question, somebody else probably has that same question, and then other people can-

Dr. Andy Galpin
Always. Yeah

Dr. Tommy Wood
... can benefit from it. And then, equally, my Instagram, @drtommywood. You can DM me, but I might direct you towards the podcast because then-

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Dr. Andy Galpin
Don't DM him. Just go to the podcast first. But you also have your Substack as well.

Dr. Tommy Wood
Yeah. So-

Dr. Andy Galpin
Which is a, I love this format, by the way.

Dr. Tommy Wood
Yeah. So-

Dr. Andy Galpin
It's free

Dr. Tommy Wood
... it's free. Free Substack, "Best of Brain Fitness" Substack. When you sign up, when you put in your email, you get emailed a PDF, which covers all the nutrients and blood tests that we would recommend, just basics for people who are worried about long-term cognitive function. So all the stuff we talked about today.

Dr. Andy Galpin
But they can get that direct PDF to them.

Dr. Tommy Wood
Yeah. That'll be emailed directly to you. And then every time we have a news article or a podcast or whatever, that comes through the Substack.

Dr. Andy Galpin
Okay. And there is an option to pay there. They don't have to, though.

Dr. Tommy Wood
No.

Dr. Andy Galpin
But if they do pay, then they can get access to additional questions one-on-one. Is that how it works?

Dr. Tommy Wood
Yeah. So we have, there is an op-- You can always opt to pay for Substack, although all of our content is free. But if you do pay, then we do, we've just started doing some AMAs, so you can join us on a Zoom call and just ask us whatever you want.

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Dr. Andy Galpin
Literally live in person.

Dr. Tommy Wood
Live in person.

Dr. Andy Galpin
Wow. Craziness. Yeah, I don't know how you do that. You're wild, man. And if they want to come visit your lab at the University of Washington and get their brain tested, is that an option yet?

Dr. Tommy Wood
TBD.

Dr. Andy Galpin
TBD.

Dr. Tommy Wood
Coming soon.

Dr. Andy Galpin
Little spoiler, friends, there. So none yet. Okay. You've been incredibly gracious with your time and expertise, man. Really appreciate it. It's always fun hanging out. Bummer we didn't get to lift weights this time, but perhaps next time. The last thing I want to ask you here, and I'm putting you on the spot.

Dr. Tommy Wood
All right.

Dr. Andy Galpin
If you got anointed to the MAHA board, the Make America Healthy Again.

Dr. Tommy Wood
Uh-huh.

Dr. Andy Galpin
And you said, "Dr. Tommy Wood, you are an MD, you're a PhD from Oxford and Cambridge and now at the University of Washington," what would be your first, most important, biggest charge you would say, this is what I want to get done to make America's brains, I don't know if healthier again is the right word, but we'll just say make them healthier?

Dr. Tommy Wood
I think just because it's... It would be two-pronged. One is educate people to know that you can slow and prevent cognitive decline and improve cognitive function, right? Because in order to change that, you need to know it's possible, and most people don't know that it's possible. And

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then I would focus on the importance of cognitive stimulus. And the reason for that is other aspects, supposedly, of what's going to happen in that movement are going to address metabolic health and other things that we know are important. But the idea that cognitive function is driven by cognitive stimulus is still sort of underappreciated. So that would be my primary directive. And as part of that, I might dramatically decrease funding for mouse studies in Alzheimer's disease because I don't think that's gotten us anywhere.

Dr. Andy Galpin
Hmm. Interesting.

Dr. Andy Galpin
And this is from someone who does animal research in your lab.

Dr. Tommy Wood
Yeah. I do that for my job. Yeah.

Dr. Andy Galpin
Yeah.

Dr. Tommy Wood
And a lot of what we do does not relate to humans at all or doesn't end up relating to humans at all.

Dr. Andy Galpin
Yeah. Ends up as a failure.

Dr. Tommy Wood
Yeah.

Dr. Andy Galpin
So, well, I can assure you, my friend, when your name comes up on that ballot, I will tick that box and vote for Dr. Wood on the thing. So thank you so much, man. Appreciate you being here.

Dr. Tommy Wood
Thank you so much for having me. This has been really great.

Dr. Andy Galpin
I hope you enjoyed that conversation with Dr. Tommy Wood. To follow along and learn more from Tommy, I encourage you to check out his social media as well as his free podcast and Substack accounts. Direct links to all of those will be provided in our show notes, and I would encourage you to check them out there. Thank you for joining for today's episode. My goal, as always, is to share exciting scientific insights that help you perform at your best. If the show resonates with you and you want to help ensure this information remains free and accessible to

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Dr. Andy Galpin

Finally, you can share today's episode with a friend who you think would enjoy it. If you have any content, questions, or suggestions, please put those in the comments section on YouTube. I really do try my best to read them all and to see what you have to say. I use my Instagram and X profiles also exclusively for scientific communication, so those are great places to follow along for more learning. My handle is @drandygalpin on both platforms. We also have an email newsletter that distills all of our episodes into the most actionable takeaways. We have newsletters on how to improve fitness and VO2 max, how to build muscle and strength, and much more. To subscribe to the newsletter, just go to performpodcast.com and click Newsletter. It's completely free, and we do not share your email with anybody. Thank you for listening. And never forget, in the famous words of Bill Bowerman, "If you have a body, you are an athlete."

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